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Geology of South Patten River Area
District of Cochrane

By
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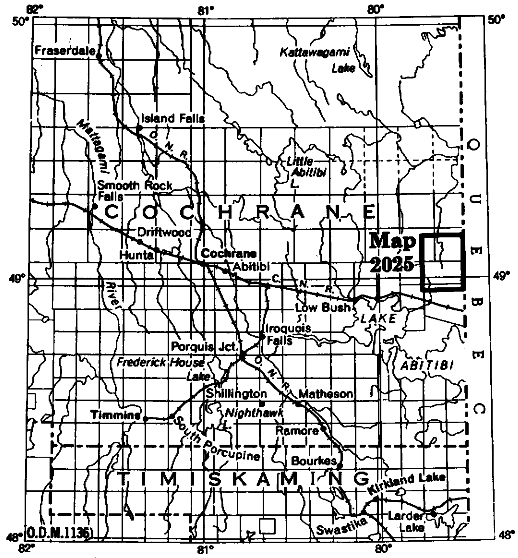
ABSTRACT

Hepburn township, the northern 2 miles of Sargeant township, all but the northern 1¾ miles of Adair township, and the southeast quarter of Abbotsford township, District of Cochrane, are underlain by poorly exposed Precambrian rocks, consisting of a steeply inclined metavolcanic-metasedimentary assemblage intruded by early basic sills, three granitic masses, and late diabase dikes.

The Adair Volcanic Rocks, composed of equal amounts of intermediate to basic and acid volcanic rocks, are the oldest rocks recognized in the metavolcanic-metasedimentary assemblage. These rocks extend across the central part of the map-area from Abbotsford township into the province of Quebec, where they form the host rock to the Normetal orebody. The Scapa Metasediments, an apparently thick sequence of greywacke and calc-silicate rocks, conformably overlie



Key map showing the location of the South Patten River area. Scale, 1 inch to 50 miles.

the Adair Volcanic Rocks and are separated from the highly sheared, intermediate to basic Bonis Volcanic Rocks that border the Sargeant Batholith on the south margin of the area, by a structural break, possibly a thrust fault. First mapped in the adjacent townships of Steele, Bonis, and Scapa, the Bonis Volcanic Rocks and Scapa Metasediments are on strike with similar rocks in the province of Quebec.

A few metagabbro sills lie in the Scapa Metasediments in west-central Hepburn township, The Adair Volcanic Rocks have been intruded and metamorphosed by the Patten River Pluton. on the east-central margin of the area, and are cut by granitic rocks that form part of the Mistawak Batholith, in northeastern Adair township. Diabase dikes of two ages intrude all the previous rocks.

Numerous mineralized shear zones in the Adair Volcanic Rocks contain dominant pyrite and pyrrhotite, and assays of grab samples show traces of copper and nickel, and rarely, lead, zinc, gold, and silver. Upon assay, grab samples from quartz veins in altered greywacke in southwestern Hepburn township show traces of gold and silver.

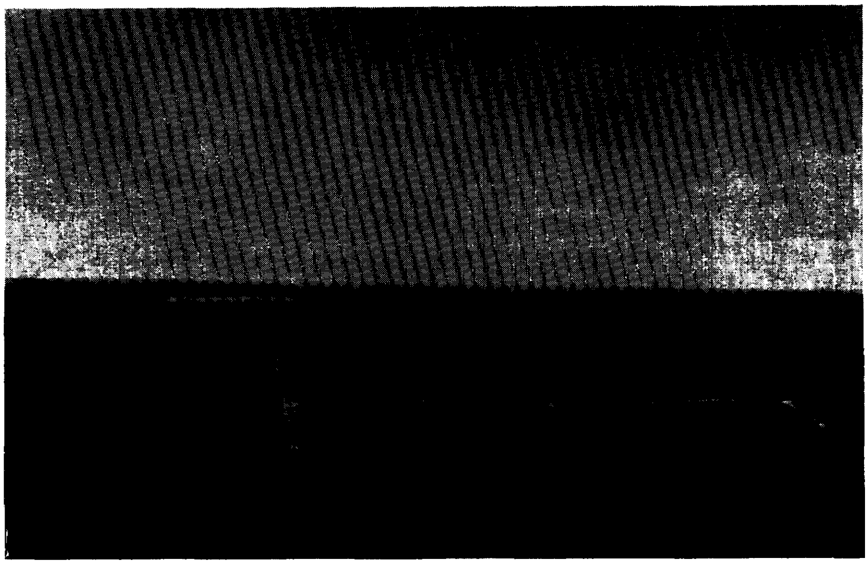
Geology of South Patten River Area

By

S. B. Lumbers[1]

INTRODUCTION

The South Patten River map-area, in the District of Cochrane, consists of the northernmost 2 miles of Sargeant township, Hepburn township, all but the northernmost 1¾ miles of Adair township, and the southeast quarter of Abbotsford township. The Ontario-Quebec boundary, between latitudes 48°55′00″ and 49°10′00″, forms the east boundary of the map-area. Portage Hill, on the east boundary of Hepburn township, is 7 miles west of the Normetal mine.



View of the South Patten River area, from the Adair fire tower looking south towards Joe Lake. Note the numerous logging roads in the centre of the picture.

The map-area lies within the Iroquois Falls concession of the Abitibi Power and Paper Company and, during 1960, was uninhabited except for two logging camps in operation and a local Indian trapper. Most of the forest has been cut over for pulp wood.

No mineral production or economic mineral occurrences have been reported from the area. Since the 1920's, prospectors and mining companies have shown interest in the region, chiefly because of its proximity to the Normetal mine.

[1]Postgraduate student, Princeton University.

International Nickel Company of Canada Limited did considerable exploration work in Abbotsford township during the spring and summer of 1960, and Falconbridge Nickel Mines Limited had a geophysical party active in the area for a few weeks in mid-summer of 1960.

Geological mapping of the South Patten River area, on a scale of 1 inch to $\frac{1}{4}$ mile, was completed in the 1960 field season by the author and three assistants. Hepburn and Sargeant townships adjoin Scapa and Bonis townships, which were mapped by the author during the 1959 field season (Lumbers 1959). Map sheets of the Forest Resources Inventory series, Ontario Department of Lands and Forests, and surveys of roads by the Abitibi Power and Paper Company were used in compiling basemaps for the geology. Rock exposures and most of the topographic details were transferred from air photographs to the basemap. As the final map was produced on a scale of 1 inch to $\frac{1}{2}$ mile, many of the outcrops had to be generalized and slightly enlarged. Most buildings shown on the map are abandoned or have collapsed, and no attempt has been made to locate numerous portable buildings used by the Abitibi Power and Paper Company during logging operations.

Acknowledgments

The co-operation received from the Abitibi Power and Paper Company was appreciated by the field party. Two cabins at Camp 28 and numerous facilities at Camp 23 were provided for the entire field season. The author especially appreciates the courtesies and helpful assistance given by J. H. Murdock, district superintendent; Ivan Dawkins, superintendent of Camp 23; and V. P. Van Vlymen, district forester.

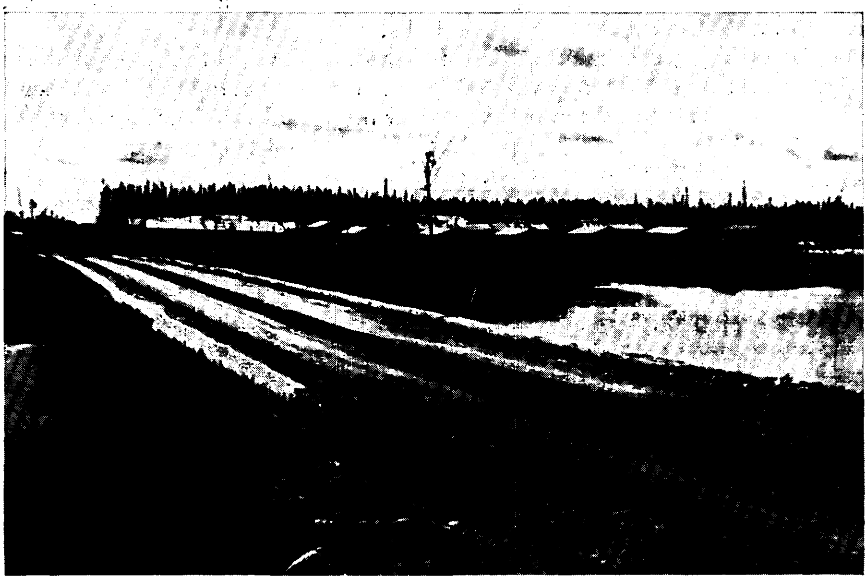
James Evans, a local Indian trapper, provided the author with information on old prospects in the vicinity of Joe Lake.

Able assistance was given the author in the field by W. E. Wiley, H. A. Frost, and R. J. Ross.

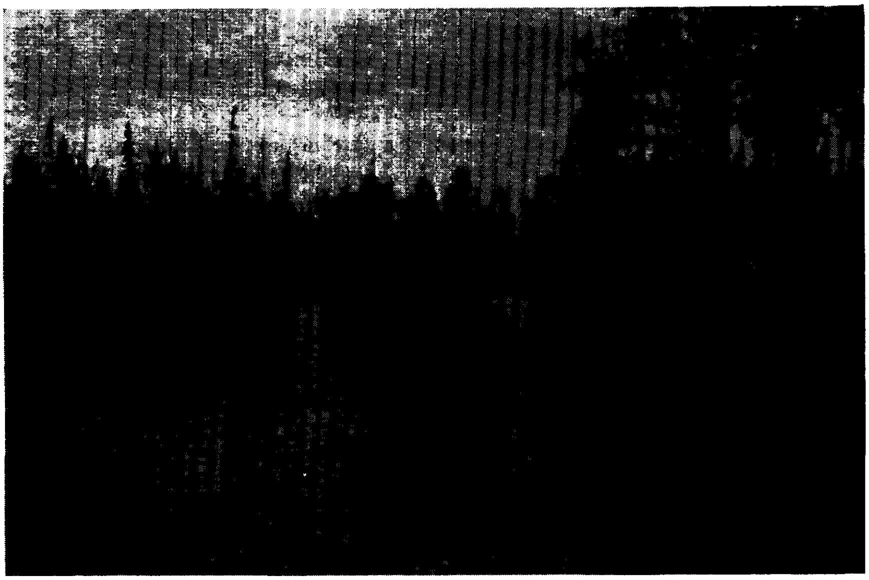
E. A. Bilodeau, Canadian National Railways agent at Eades, handled food and freight for the field party and rendered other assistance, for which the author is indebted to him.

Means of Access

The western, central, and northeastern parts of the area are accessible by: the Abitibi Power and Paper Company's "Mace Bay" road; its branch roads to Camps 30, 9, 24, and 20; and the Adair fire tower road. All these roads are gravel-surfaced and were passable during the 1960 field season. A road to Camp 21 in the southwest quarter of Adair township is no longer passable because of a washout of the bridge over the South Patten River. The "Mace Bay" road begins at Eades, a flag stop on the Canadian National railway, and connects with the "Trans-Limit" road of the Abitibi Power and Paper Company, 4.5 miles north of Eades in the southwest corner of Scapa township. The "Trans-Limit" road gives direct access to Iroquois Falls. There are bulldozed logging roads in all parts of the map-area except in the northwestern part in Abbotsford township and in the region east and south of Joe Lake in Adair township. Most of the roads were constructed between 1947 and 1960. They are well suited to swampmobile or foot travel, but the presence of many muskegs limits the use of tractors during the summer months. A few logging roads in the southwestern, southern, and eastern parts of Hepburn township were built prior to 1947 and are now partly to



Camp 23, at the junction of the Mace Bay road and the Patten River; Adair township.



Foot of the first rapids on the Patten River; east of Camp 23, Adair township.

completely overgrown. An attempt has been made to show the location of the principal logging roads on the accompanying map (No. 2028 in back pocket), and additional information concerning these roads can be obtained from the Abitibi Power and Paper Company at Iroquois Falls.

An old portage, used in the early fur-trading days in this part of northern Ontario, can be traced at intervals in the vicinity of Portage Hill and north to Joe Lake. This portage once joined a main winter trail to Moose Factory (Coulthard 1901, p. 47).

Joe Lake may be reached by aircraft, by a canoe route starting from Camp 23 on the Patten River, or on foot, using the numerous logging roads north of the lake.

A board walk, about 3 miles long, connects Camp 30, in northern Sargeant township, with the Desmeloizes village road along the boundary between ranges VI and VII, Desmeloizes township, Que. This board walk was constructed by the Abitibi Power and Paper Company for use by their employees who live in Desmeloizes township and adjacent areas in the province of Quebec.

Previous Geological Work

R. W. Coulthard (1901, p. 47) recorded the first geological observations in the area when he ascended the La Reine (Okikodosik) River to the point where it branches, west of Portage Hill. The eastern part of the area is described in the memoir on the Harricanaw-Turgeon basin (Tanton 1919) mapped in the summers of 1914 and 1915. Tanton reports in his memoir (1919, p. 3), that prospectors investigated the Patten River along its whole course after a reported discovery of gold on the river in 1912. In the fall of 1917, Hopkins (1918) made a track survey of the La Reine (Okikodosik) and Patten rivers and produced a geological map of the route covered. The geology of Sargeant and Hepburn townships, as of 1918, is shown on the map compiled by Knight *et al* (1919). Except for some mapping and exploration work done by mining companies, for which the record is scanty, the present survey is the first geological mapping carried out in the area since 1917.

The region to the east, in the province of Quebec, was re-mapped in 1928 by Mawdsley (1930) and in 1936 by Flaherty (1939). Thomson (1937) made a reconnaissance geological survey of the Burntbush River area to the north in 1934. The townships of Steele, Bonis, and Scapa to the west of the map-area were mapped in 1959 (Lumbers 1959). The aeromagnetic map of the Aylen River Area, published by the Geological Survey of Canada in 1948 (G.S.C. Map 1951) includes the south quarter of the map-area.

Topography and Drainage

Much of the region is overlain by lacustrine clays laid down in glacial Lake Barlow-Ojibway. The clays form a gently rolling, poorly drained surface, characterized by numerous muskegs. The clay surface is broken in places by low knolls and ridges consisting of glacial and glaciofluvial deposits, which have been reworked by the waters of glacial Lake Barlow-Ojibway. A few prominent ridges and hills consist of rock, partly covered with a thin veneer of Pleistocene deposits. Rock also projects through the Pleistocene sediments in flat areas, but the total bedrock exposed does not exceed 15 percent.

Adair Hill, in northwestern Adair township, is the highest point in the area, with an elevation (aneroid determination) of 1,320 feet above sea-level.

The land surface slopes away on all sides of this hill and is interrupted south of Joe Lake by a series of rock ridges, extending in a general west-northwest direction across the map-area. The ridges attain their maximum relief near the Interprovincial Boundary, where they are about 200 feet above the level of Joe Lake, which has an elevation of 1,040 feet above sea-level (Tanton 1919, p. 9). Portage Hill, the highest of these ridges, is only slightly lower than Adair Hill. The lowest altitudes in the area are in the south-central part of Hepburn township and in Sargeant township, where the general level of the clay surface is about

View from the summit of Portage Hill looking north towards the rocky ridges south of Joe Lake.

930–950 feet above sea-level. Surveys of the "Mace Bay" road by the Abitibi Power and Paper Company show altitudes ranging from 1,050 to 1,100 feet above sea-level for the area between mileages 10 and 17. North of mileage 18 the altitudes range from 980 to 1,000 feet above sea-level.

ROCK EXPOSURES

Rock exposures are found mainly in well-drained areas with altitudes greater than 1,000 feet. Such areas commonly contain an abundant growth of birch, jackpine, and poplar. The only bedrock found in low, clay-covered areas is that exposed during construction of logging roads and by a few of the larger streams. Most of the outcrops lie in western Hepburn township, in the vicinity of Joe Lake, northwestern Adair township, and northern Sargeant township.

The rocks most resistant to erosion are best exposed. These include diabase, the metavolcanics, and to a lesser degree, the granitic rocks. Diabase has protected older, less-resistant rocks from glacial erosion, with the result that many of the best exposures of metasediments are in the vicinity of diabase dikes.

The view from the Adair fire tower reveals that many of the rocky hills, both within and outside the map-area, have flat tops and general accordance of summit levels, suggesting an old peneplain surface. Cooke, James, and Mawdsley

(1931, p. 20), in their mapping of the Rouyn-Harricanaw region to the east of the map-area, related this peneplain to a general uplift of the land surface that occurred during the Pliocene epoch.

GLACIOFLUVIAL DEPOSITS

The most prominent glaciofluvial deposit in the map-area is an esker that strikes northward from central Sargeant township through Hepburn and Abbotsford townships. The trend of the esker is clearly marked by numerous associated kettle lakes, especially in Sargeant township where the esker is best preserved. Near the "Mace Bay" road, the esker is obscured by a large sand plain, which extends north into Abbotsford township and east of Hepburn Lake. Numerous rocky knolls and a few boulder gravel and clay ridges are scattered through the sand plain, which is a high area marking the east end of Steele Ridge, which trends through Steele and Scapa townships to the west.

Other esker-like ridges are found north of Bill Lake at the Interprovincial Boundary and south of Adair Hill. Reworking of these deposits by the waters of glacial Lake Barlow-Ojibway has produced broad, sandy aprons and lag concentrates of boulder gravel. There are also sandy areas around the margins of some muskegs.

DRAINAGE

Drainage within the map-area can be divided into two major systems: the Patten River system, which drains northward to the Turgeon River basin; and the Aylen River–La Reine (Okikodosik) River system, which flows south to Lake Abitibi. The large sand plain in western Hepburn and southern Abbotsford townships, and the range of rocky ridges to the south of Joe Lake constitute effective water-divides between the two systems. Most of the streams in both drainage systems are consequent on the Barlow-Ojibway clay plain and follow sinuous courses with swampy shore lines. Interfluvial areas are poorly drained and covered in places by muskegs. In the numerous streams the water is dark brown in colour, having been derived mainly from muskeg areas, but in places it has a turbid appearance due to finely suspended clay particles.

Much of the map-area is drained by the Patten River and its tributaries, which include the South Patten River, Hepburn Creek, and Adair Creek. The western part of the area in Abbotsford township is drained by the East Kabika River and its tributaries, which flow north to join the Burntbush River, a part of the Turgeon River basin. The southwest corner of Hepburn township and adjacent parts of Sargeant township are drained by the Aylen River and Departure Creek, both of which flow into Departure Bay, Lower Abitibi Lake. The remainder of the map-area in Sargeant township and the southern and eastern parts of Hepburn township are drained by the La Reine (Okikodosik) River and its main tributary, Boischere Creek.

Natural Resources

Most of the commercial timber within the map-area has been cut, or destroyed by fire. The following parts of the region were still not cut over in the 1960 field season: a 6-square mile area extending about 2 miles north of the Camp 30 road, immediately east of Camp 30; the area east and south of Joe Lake in Adair township; the part of the map-area in Abbotsford township, 1.5 miles north of Camp 20; the area in the vicinity of Adair Hill north of the fire tower in

Adair township. Burned-over parts of the map-area are: a strip up to 2 miles wide straddling the "Mace Bay" road in the vicinity of mileages 9 to 13, and extending east from Scapa township to the South Patten River in central Hepburn township; a small area extending 1 mile east of the "Mace Bay" road between mileages 16 and 17 in Adair township; the area east and south of Joe Lake in Adair township; a ¼-square-mile area in Abbotsford township, 1½ miles north of Camp 20 and 1½ miles east of the East Kabika River. No important fires have ravaged the forests of the region since 1951, so the burned areas are now covered by second-growth spruce, jackpine, poplar, birch and, in places, thick patches of alder. Young spruce, jackpine, and balsam are abundant in many of the older cut-over areas. Recently-cut areas are covered chiefly by poplar, birch, alder, and slash. Areas not cut over or burned contain a mature growth of spruce, balsam, and jackpine intermixed with birch and poplar. Black spruce, tamarack, and alder are common in muskegs.

Game and fur-bearing animals seen by the field party during the 1960 field season were moose, black bear, rabbit, red fox, beaver, skunk, mink, lynx, and otter. Moose were frequently encountered in traversing logging roads. Numerous beaver dams in many of the streams made travel difficult owing to flooding. Caribou pass through the region periodically, but none were seen by the field party. Other animals reported from the area were wolf, red deer, marten, and fisher. Some trapping is carried on by Indians.

GENERAL GEOLOGY

Precambrian rocks, consisting of a steeply inclined metavolcanic-metasedimentary assemblage, and basic-to-acid intrusions, underlie the South Patten River map-area. The oldest rocks recognized, the Adair Volcanic Rocks, comprise an unknown thickness of interbedded acid and basic metamorphosed volcanic rocks, and rare iron formation. To the south, these metavolcanics are conformably overlain by a unit of metamorphosed greywacke up to 6 miles wide. This unit separates the Adair Volcanic Rocks from highly sheared intermediate-to-basic metavolcanics marginal to the Sargeant Batholith. The metasediments and highly sheared metavolcanics are correlated with the Scapa Metasediments and Bonis Volcanic Rocks of the adjoining Steele, Bonis, and Scapa area.

There are a few narrow basic sills in the western part of the metasediments. These sills are now metagabbro and are possibly related to similar sills mapped in the Scapa Metasediments in Scapa township.

The metavolcanic-metasedimentary assemblage is intruded in the northeastern part of the area by the Mistawak Batholith; in the eastern part by the Patten River Pluton; and in the southern part by the Sargeant Batholith. These granitic masses range in composition from quartz monzonite to diorite. Relative ages of the masses are unknown, but all are younger than the metavolcanic-metasedimentary assemblage.

North- and northeast-trending diabase dikes intrude all other rocks in the area. The north-trending set is composed of quartz diabase. The northeast set consists of quartz diabase, altered diabase, and olivine diabase. Relative ages of the two dike sets are unknown. By reference to other areas in northeastern Ontario, where north and northeast diabase dike sets are well-developed, the northeast set is tentatively assigned a later age than the north set.

South Patten River Area

Extensive Pleistocene deposits and muskegs of Recent age cover most of the Precambrian bedrock. Three types of Pleistocene deposits are present: glacial, consisting of boulder clay; glaciofluvial, consisting of silt, sand, and gravel; and glaciolacustrine lake deposits of varved clay, sand, and boulder gravel, laid down in glacial Lake Barlow-Ojibway. Recent deposits consist chiefly of peat and vegetal debris formed in muskegs and stream deposits.

The geological succession is summarized in the following table of formations.

Table of Formations

CENOZOIC

RECENT: Peat, river deposits.

PLEISTOCENE: Varved clay, boulder clay, silt, sand, pebble gravel, boulder gravel.

Unconformity

PRECAMBRIAN

LATE BASIC INTRUSIONS

Late Diabase:
Olivine diabase, quartz diabase, and diabase (dikes).

Early Diabase:
Quartz diabase (dikes).

Intrusive Contact

ACID INTRUSIONS

Mistawak Batholith:
Leucogranodiorite, leucocratic quartz monzonite, feldspar porphyry and, quartz-feldspar porphyry dikes, pegmatite, granitic gneiss, felsite.

Patten River Pluton:
Leucogranodiorite, feldspar porphyry and quartz-feldspar porphyry dikes felsite, pegmatite.

Sargeant Batholith:
Hornblende diorite and pyroxene diorite, quartz diorite, leucogranodiorite, and porphyritic granodiorite, quartz monzonite, feldspar porphyry and quartz-feldspar porphyry dikes, granitic gneiss, rare pegmatite.

(Age relationships between the three acid intrusions are not known.)

Intrusive Contact

EARLY BASIC INTRUSIONS:
Metagabbro.

Intrusive Contact

METAVOLCANIC-METASEDIMENTARY ASSEMBLAGE

Bonis Volcanic Rocks:
Amphibolitized intermediate to basic lava, pillow lava; amphibole schist; tuff.

(Age relationship between the Bonis Volcanic Rocks and the divisions listed below is not known.)

Fault?

Scapa Metasediments:
Metamorphosed greywacke, calc-silicate rocks, iron formation; rare conglomerate and arkose.

Adair Volcanic Rocks:
Intermediate to basic volcanic rocks: pillow lava, porphyritic lava, gabbroic lava, flow breccia, tuff and agglomerate, amphibolite, garnet-amphibole rocks, rare iron formation.
Acid volcanic rocks: acid lavas, tuff, rocks of unknown origin.

Metavolcanic-Metasedimentary Assemblage

ADAIR VOLCANIC ROCKS

A poorly exposed belt of metamorphosed, basic to acid volcanic rocks extends diagonally across the map-area from northeastern Hepburn township, through southern and east-central Adair township, and for an unknown distance into eastern Abbotsford township. This belt, here called the Adair Volcanic Rocks, continues southeastward across the Interprovincial Boundary at least as far as Chazel township. The Mistawak Batholith borders the belt on the north in Adair township, and the Patter River Pluton, which straddles the Interprovincial Boundary, lies entirely within the belt. Structural evidence obtained in the map-area suggests that the Adair Volcanic Rocks face south and conformably underlie the Scapa Metasediments. The total thickness of the volcanic rocks is unknown.

Intermediate to Basic Volcanic Rocks

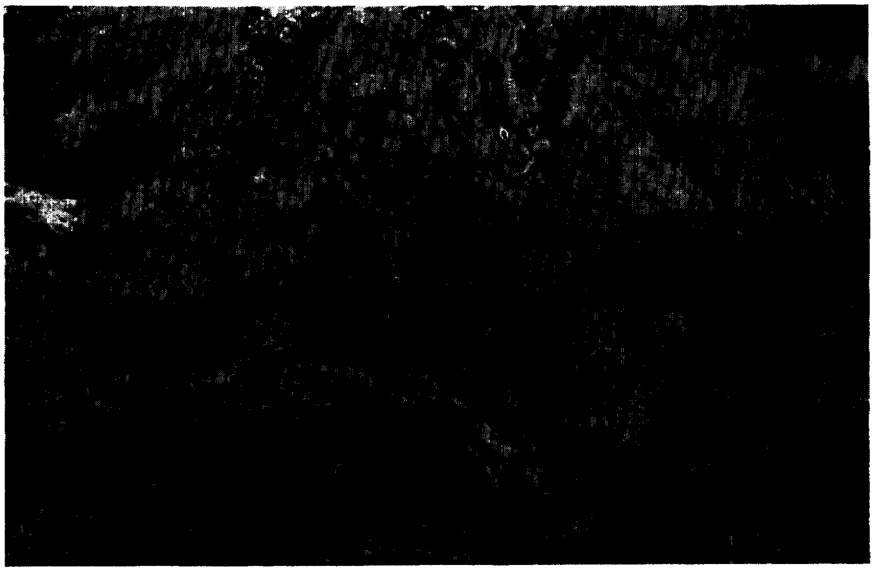
Flow Rocks

Outcrop distribution of the Adair Volcanic Rocks suggests that the southern and central parts of the belt are composed mainly of metamorphosed basaltic and perhaps andesitic flows. Elsewhere, especially southeast of Joe Lake, these rocks form flows ranging from a few feet to over 40 feet thick, intercalated with acid metavolcanics. The general distribution of these flows within acid volcanic outcrops is shown on the geological map (No. 2028, back pocket).

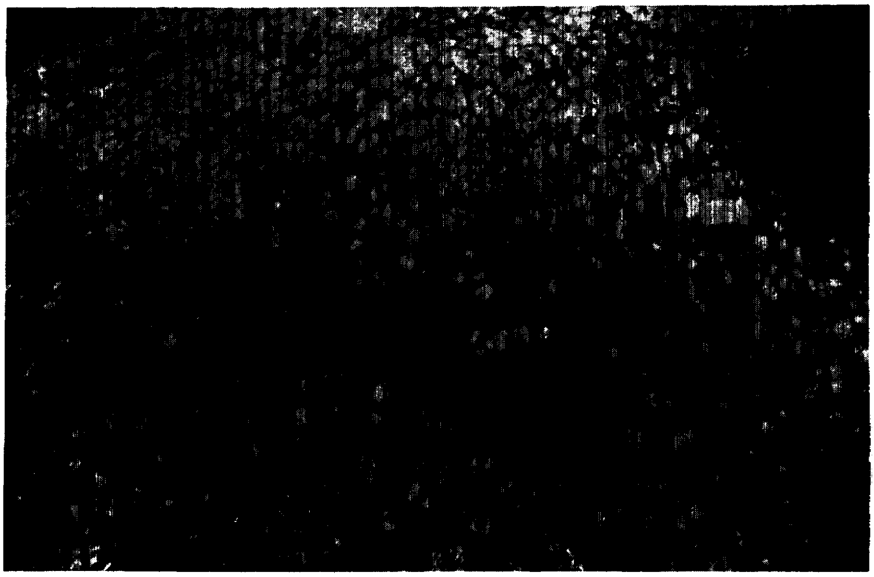
Metamorphism of the flow rocks has produced fine- to medium-grained, amphibole-rich metavolcanics ranging in colour from grey or pale green to dark greenish black. Most of the flow rocks are foliated and exhibit volcanic structures. Massive, amygdaloidal, pillowed, diabasic or gabbroic, and porphyritic types are recognized. Pillows are generally deformed, but in places in the southern and central parts of the belt a few top determinations were obtained. Flow breccia, grain gradation, and flow contacts were seen, but never all three in a single flow. Some of the rocks resemble the Bonis volcanic amphibolites, being sheared and rarely discontinuously laminated. Where highly sheared, the flow rocks are commonly carbonatized, epidotized, or mineralized with pyrite, pyrrhotite and, rarely, chalcopyrite.

Porphyritic lava is best exposed on a logging road in the southeast corner of Abbotsford township, about 100 feet north of the contact between the Scapa Metasediments and the Adair Volcanic Rocks. Here, white-weathering phenocrysts of plagioclase of from less than ¼ to 2 inches wide, are concentrated in a layer in the fine-grained upper part of a flow, estimated to be about 15 feet thick. The phenocrysts form over 50 percent of the layer and gradually decrease to disappear a few feet north of the layer. The flow coarsens to the north, where it is in sharp contact with pillow lava. Feldspar phenocrysts were noted in other flow rocks, particularly in Portage Hill, but in all these occurrences the phenocrysts are sparingly scattered throughout the rock and not concentrated in layers.

In thin sections, fine-grained flow rocks consist of pistacite, clinozoisite, saussuritized plagioclase, yellow-green to blue-green amphibole, carbonate, some quartz, and minor chlorite. Pyrite, ilmenite-magnetite, and leucoxene are common accessory constituents. Medium-grained parts of flows consist of the same minerals, but epidote is commonly a minor constituent. Quartz is present as



Pillowed flow rocks with tops to the south (towards hammer head), Adair Volcanic Rocks; 2 miles west of Camp 24 and ½ mile north of Camp 24 road, Adair township. The fine lines cutting across the outcrop are north-striking joints.



Porphyritic lava in the Adair Volcanic Rocks; 1 mile west of the Mace Bay road, just north of the Scapa Metasediments — Adair Volcanic Rocks contact, Abbotsford township.

veinlets, as lens-shaped aggregates, and as fine-grained granules scattered through the groundmass. Fine-grained, euhedral garnet is present in some medium-grained flows. Foliation in the flow rocks is due mainly to alignment of amphibole grains. One thin section of a medium-grained flow rock shows relict ophitic texture.

Garnet-Amphibole Rocks

Rocks, composed dominantly of garnet porphyroblasts up to 2 inches wide, blue-green amphibole, and quartz, are present in association with shear zones in the flow rocks and acid volcanic rocks. Epidote and biotite are essential constituents in a few of the garnet-amphibole rocks, and opaque minerals, consisting of pyrite, pyrrhotite, and ilmenite-magnetite, form as much as 7 percent of the whole. Good exposures of these rocks lie in outcrop areas adjacent to the Camp 20 road, near the east boundary of Abbotsford township. Here, garnet-amphibole rocks are particularly common in the acid volcanic rocks, where they are found as irregular patches, several feet in size, in the vicinity of rust-coloured shear zones containing pyrite, pyrrhotite, and rare chalcopyrite. Quartz is a minor constituent in garnet-amphibole rocks occurring in basic flows intercalated with acid volcanic rocks southeast of Joe Lake.

Tuff and Agglomerate

Tuff and agglomerate, in narrow layers ranging from less than 1 foot to more than 15 feet thick, are associated with flow rocks in a few places. Most of the tuffs are well-bedded, fine-grained rocks, weathering light green to light brown, which possess a good schistosity. Oval-shaped volcanic rock fragments and medium-grained feldspar crystals are commonly present. Recrystallized lenticular chert layers, less than one inch thick, are associated with some tuffs. In nearly all outcrops, the tuffaceous layers are dragfolded and contorted. Agglomerate was seen only southeast of Joe Lake. It consists of abundant, oval-shaped, porphyritic light green fragments up to 3 inches long that lie in a fine-grained, highly sheared, dark green matrix, which is rusty-weathering.

Iron Formation

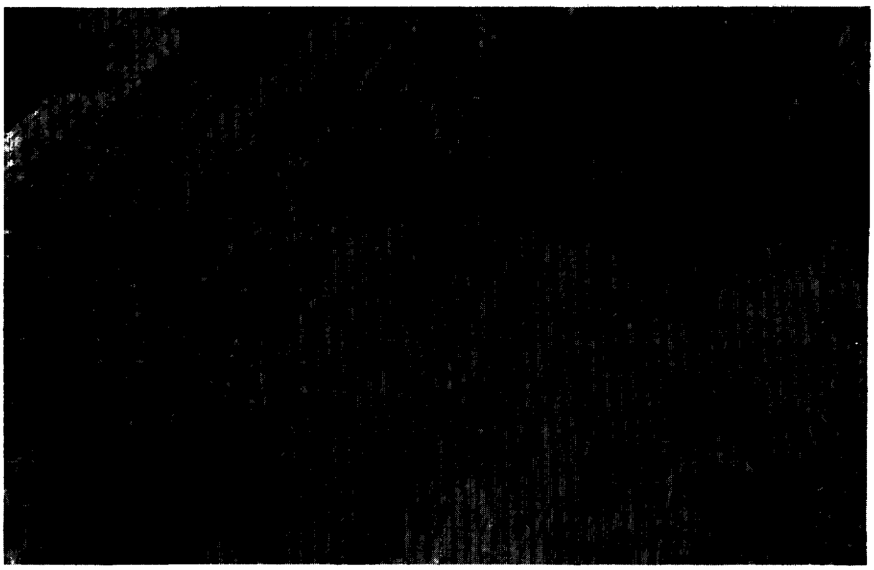
Metamorphosed ferruginous rocks were found at two localities. Rusty-weathering, siliceous iron formation forms a layer, 8 feet thick in flow rocks, about ¾ mile west of the Interprovincial Boundary. The iron formation has been explored by a small pit, 2 feet wide, 3 feet long, and 5 feet deep. A thin section of the rock shows irregular patches and layers, rich in grunerite and magnetite, scattered in a fine-grained matrix of interlocking quartz grains. Grunerite has a faint brownish pleochroism and is polysynthetically twinned. A few grunerite grains terminate in blue-green amphibole. Iron oxide staining is abundant, particularly along quartz grain boundaries. Magnetite forms about 8 percent of the rock.

Microscopic study shows about 20 percent cummingtonite in a dark grey, brownish-weathering, fine-grained, schist, rich in biotite, taken from an outcrop of flow rocks ¾ mile west of the East Kabika River. Much chlorite is associated with biotite in a groundmass of quartz and feldspar. About 5 percent magnetite and pyrite are disseminated through the rock.

Acid Volcanic Rocks

Acid volcanic rocks are abundantly exposed in the following areas: between Joe Lake and the Patten River Pluton; east and west of mileage 17 and west of mileage 18 on the "Mace Bay" road; and in the northwestern part of the map-area, east of the East Kabika River. Elsewhere these rocks are sparsely distributed as narrow interflows in the intermediate to basic volcanic rocks.

Metamorphism has largely destroyed the original character of the acid volcanic rocks. Four lithological types are recognized: a massive, fine-grained, generally poorly foliated rock, weathering brown to dark grey, that resembles massive greywacke; a finely bedded, flint-like or aphanitic rock, weathering light to dark greenish grey, which is highly sheared in places and commonly shows a conchoidal fracture; a well-foliated, porphyritic rock, weathering light to dark grey, containing numerous opalescent quartz "eyes" and minor feldspar; and a porphyritic, foliated rock, weathering light to greenish grey, containing up to 35 percent grey feldspar and a few quartz phenocrysts in a fine-grained matrix.



Finely bedded tuff (light grey) and acid volcanic rocks (dark grey), Adair Volcanic Rocks; 1 ¾ miles northwest of Camp 24, Adair township.

All four types exist as narrow layers, commonly not more than 2 feet thick. One or two of the types generally predominate in a single outcrop, although all but the greywacke-like variety are about equally abundant throughout the Adair Volcanic Rocks (*see* page 36). The first two types, which commonly contain narrow, lenticular, recrystallized chert layers, are probably tuffs. These have been distinguished on the geological map from the last two lithological types.

There is a complete gradation between the two porphyritic varieties, and many of these rocks have a streaked appearance suggestive of flow structure. Colour banding and faintly visible trains of quartz and feldspar phenocrysts cause the streaked appearance. Both varieties are referred to as "2e" on the geological map. In places, feldspar porphyry is present in the tuffaceous rocks as narrow dike- and sill-like bodies that pinch and swell along strike. Breccia, consisting of angular fragments up to 2 inches wide in a fine-grained groundmass, forms layers up to 1 foot thick in tuffaceous rocks, just north of the Camp 20 road.

Both discordant and concordant quartz veins, up to 2 feet thick, are ubiquitous in the acid volcanic rocks. Concordant veins are commonly deformed and of boudinage structure along strike, but discordant veins are undeformed except for minor faulting. No mineralization was seen in the quartz veins.

Microscopic study shows that all four lithological types have a similar mineral content. Quartz, feldspar, muscovite, and greenish biotite are present as major constituents; carbonate, pistacite, zoisite, and some chlorite as minor constituents; and apatite, pyrite, and ilmenite-magnetite as accessory minerals. The tuffaceous rocks that resemble greywacke contain angular to subrounded clastic quartz and feldspar grains. Other tuffaceous rocks consist of layers of fine-grained quartz alternating with layers of microcrystalline sericitic material, through which fine- to medium-grained quartz and euhedral feldspar are scattered.

Potash feldspar is commonly present in the groundmass of the porphyritic varieties. Phenocrysts of plagioclase are crushed or fractured. Strained and fractured quartz exists as lenticular grains up to 5 millimetres long, which parallel the foliation of the groundmass. Lenticular streaks rich in biotite and chlorite are present in the matrix of many of the opalescent quartz rocks. The groundmass quartz in the porphyritic varieties is commonly found as fine lenticular shreds. Feldspar is rare in the groundmass of some opalescent quartz rocks. Abundant quartz, muscovite, and potash feldspar in many of the opalescent quartz rocks suggest that these rocks are metamorphosed rhyolite. Some feldspar porphyries included with the acid volcanic rocks may be related to the granitic intrusions of the map-area.

Rocks of Unknown Origin

Tuffaceous rocks to the north of the Camp 20 road grade into poorly foliated rocks exposed on the road, which contain up to 20 percent coarse amphibole crystals in a fine-grained, light greenish grey groundmass. Prehnite veinlets traverse the rocks in places. The groundmass consists dominantly of altered feldspar and quartz, some biotite, and rare epidote. Euhedral, blue-green amphibole has grown across the groundmass minerals. Many amphibole grains are markedly poikiloblastic and, in a few, the groundmass forms a core. Similar rocks were found on the Interprovincial Boundary, about 250 feet east of the pit at the end of the trail that trends east from Joe Lake, and east of Camp 21. Mineralized shear zones are present at both localities.

Metamorphism of the Adair Volcanic Rocks

Acid to basic volcanic rocks bordering the Patten River Pluton are recrystallized and altered to hornfels. Elsewhere, the Adair Volcanic Rocks appear to belong to the upper part (quartz-albite-epidote-almandine subfacies) of the greenschist facies as defined by Turner (1958). Microscopic study of basic volcanic rocks near the Interprovincial Boundary, ¼ mile north of the Patten River Pluton, and from the north edge of Portage Hill, shows them to belong to the hornblende hornfels facies. The groundmass of these rocks is recrystallized and consists mainly of plagioclase and minor quartz. Epidote is rare or absent, and biotite and garnet are present as accessory minerals. Fresh to partly altered oligoclase is present as fine-grained, twinned laths or zoned granules. Amphibole has a dark blue-green to yellow-green pleochroism.

Acid volcanic rocks at the north contact of the Patten River Pluton are altered to hornfels. These rocks contain aligned, medium-grained, lenticular quartz grains and small, oval-shaped, light green patches, set in an aphanitic pinkish groundmass. The aligned quartz grains and greenish patches parallel the foliation of the acid volcanic rocks and the Patten River Pluton contact. In thin section, the greenish patches are seen to be aggregates of pistacite and a colourless clinopyroxene; most of the medium-grained quartz consists of lenticular aggregates of fine-grained quartz, and the groundmass consists of granular quartz and potash feldspar. Rocks similar to those just described are found up to 300 feet north of the contact, but the greenish patches become faint streaks and then blend into the pinkish groundmass. In thin section the greenish patches are seen to be composed mainly of chlorite, muscovite, and minor pistacite. The groundmass is a granular aggregate of partly altered potash feldspar, some plagioclase, and quartz.

SCAPA METASEDIMENTS

Stratigraphy

The Scapa Metasediments were first mapped in the adjoining Steele, Bonis, and Scapa area. These rocks extend from northern Steele township, through the northern and southeastern parts of Scapa township, to the Interprovincial Boundary in southeastern Hepburn township. Scapa Metasediments in southern Hepburn and the southeast corner of Scapa township are on strike with the Steele Metasediments, 6 miles to the west in Steele township. Steele Metasediments are exposed only in Steele township, where they are separated from the Scapa Metasediments in the northern part of the township by the Steele Volcanic Rocks. Tops of beds in both metasedimentary formations face south, and these units are lithologically similar. In Desmeloizes township, Mawdsley (1930) mapped a poorly exposed metasedimentary belt, ¾ mile wide and at least 12 miles long, which is on strike with the Scapa Metasediments in southeastern Hepburn township. This belt trends southeastward from range IX, near the Interprovincial Boundary, to range III on the east boundary of Desmeloizes township. The Scapa Metasediments are therefore part of a major metasedimentary belt that contains some volcanic rocks and is at least 35 miles long. The belt is about 8 miles wide at the west boundary of Steele township and narrows eastwardly to a width of ¾ mile in Desmeloizes township.

Greywacke

Clastic metasediments, here referred to as greywacke, form all but a minor volume of the Scapa Metasediments. The greywacke has been metamorphosed to a grade equivalent to the biotite zone of the Scapa Metasediments in Scapa township (Lumbers 1962). Two types of greywacke are recognizable: some massive greywacke in layers up to a few feet thick; and abundant greywacke with graded beds in which the individual beds range from ⅛ inch to rarely 6 inches thick. Both types range in colour from light brownish grey to dark grey to almost black.

In the massive greywackes, stratification is commonly displayed as a faint layering owing to slightly differing grain size, and rarely as lenticular layers of intraformational conglomerate, at most a few inches thick. Bedding-plane shearing is rarely developed in massive greywacke, but a poorly developed cleavage at a slight angle to the bedding is commonly present. Quartz-filled tension cracks are common in the massive greywackes and in sandy parts of some graded beds.

Biotite porphyroblasts in silty and argillaceous layers are a prominent feature of greywackes showing graded bedding. These rocks display several features indicative of mechanical deformation, including small-scale dragfolds and bedding-plane shearing, which are best developed in the argillaceous layers of individual couplets. Cleavage at 30–45 degrees to the bedding is present in argillaceous layers. Channelling and graded bedding are the only sedimentary structures present.

Concordant, unmineralized quartz veins, not more than 2 feet wide, commonly dragfolded, and of the boudinage form, are widely distributed in the greywackes. Less abundant than concordant veins, discordant quartz veins rarely show traces of pyrite mineralization, and are generally undeformed except for faulting.

Microscopic study shows that quartz, which forms up to 60 percent of the whole, is the most abundant mineral in the greywackes. Quartz is commonly recrystallized, but a few angular to subrounded detrital grains are in the sandy parts of graded beds and in the massive greywackes. Lens-shaped patches of quartz are found in many thin sections of both greywacke types. Moderately to highly altered feldspar is generally next in abundance to quartz, but layers, a few inches to 20 feet thick, in greywacke in southern Hepburn township, contain more feldspar than quartz. These layers are probably impure arkose. Feldspar is mainly recrystallized and commonly forms poikiloblastic anhedral grains speckled with quartz inclusions. Detrital feldspar is present in a few greywackes in southern Hepburn township. Where it could be identified, the feldspar is albite. No potash feldspar was seen in the greywackes examined.

The original clay matrix of the greywackes has been converted to chlorite, muscovite, and biotite. These minerals constitute up to 20 percent of the greywackes and are most abundant in graded beds. Chlorite predominates over biotite and muscovite in southern Hepburn township, but elsewhere, biotite is the most common. Muscovite, chlorite, and some biotite are aligned parallel to bedding-plane shearing. Biotite, however, is present mainly as porphyroblasts that have grown across the foliation.

Rock fragments are rare; where seen, they are fine-grained argillites and volcanic rocks. Accessory minerals present are tourmaline, epidote, sphene, zircon, ilmenite-magnetite, pyrite, and apatite. Tourmaline, the most common accessory mineral, is present as well developed crystals. Dusty graphite was found in the argillaceous layers of greywacke in the northeast corner of Hepburn township. Carbonate, in irregular veinlets and blebs, is present in a few massive greywackes and in the sandy parts of graded beds.

Altered Greywacke

Zones of altered greywacke up to 100 feet wide are found near the Bonis Volcanic Rocks in southwestern Hepburn township, and just south of the "Mace Bay" road, 900 feet east of mileage 11. These rocks are greyish green and contain numerous pyrite cubes in the fine-grained parts of graded beds. Thin-section study of three rocks show they have been chloritized, carbonatized, and pyritized Much secondary pistacite is associated with chlorite in two of the rocks. The third rock, taken from the argillaceous part of a graded bed, contains about 2 percent tourmaline and minor pistacite. Two varieties of chlorite, penninite and clinochlore, were identified.

Conglomerate

A lenticular mass of conglomerate, not more than 18 feet thick, is exposed west of the drillhole shown on the map in southwestern Hepburn township. All pebbles and boulders in the conglomerate are well rounded and have been stretched to an elliptical or almost tabular shape with their long axes aligned parallel to bedding. Quartz and quartz-feldspar porphyry boulders, with a maximum diameter of 6 inches, form much of the coarse detritus. Metasediment, similar in composition to arkosic layers in greywacke to the north of the conglomerate, form the remainder of the coarse constituents. A few narrow layers and wedges of fine-grained greywacke, no more than 1 foot thick, are scattered

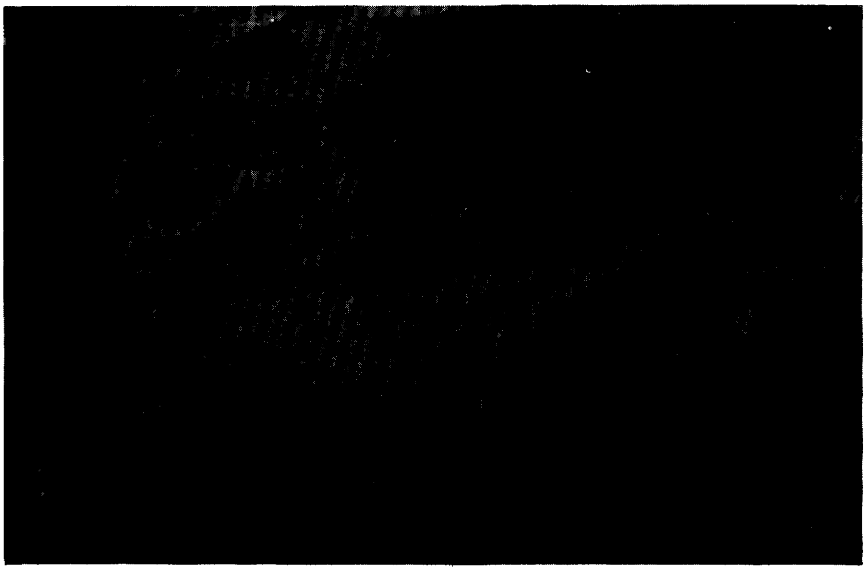
Conglomerate in the Scapa Metasediments; Hepburn township, 1½ miles south of mileage 10.5 on the "Mace Bay" road. Note the wedge of greywacke in the upper right-hand corner of the photograph.

throughout the conglomerate. The layers have the same composition as the matrix of the conglomerate and apparently represent an abrupt interruption in the deposition of the conglomerate. Dragfolded and contorted quartz veins, discordant and concordant to the bedding, are numerous. Pyrite is sparsely disseminated throughout the conglomerate.

Microscopic study shows quartz-feldspar porphyry fragments are similar to some acid volcanic porphyries of the Adair Volcanic Rocks. Well-rounded boulders and pebbles, relatively few lithological types, and the distinct bimodal character of the conglomerate are uncommon features in conglomeratic deposits associated with most greywacke sequences.

Calc-Silicate Rocks

Calc-silicate rocks are found as layers, generally not more than 1 foot thick, and as nodular masses intercalated with metamorphosed greywacke. The calc-silicate rocks are unevenly distributed in the map-area; they are particularly abundant near the Adair Volcanic Rocks in Adair and northern Hepburn townships, rare in central Hepburn, and apparently lacking in southern Hepburn township. In hand specimen, numerous rosettes and randomly distributed needles of amphibole lie in a matrix that is greenish-grey, and fine-grained. These rocks are similar to the calc-silicate layers mapped in the Scapa Metasediments in Scapa township (Lumbers 1962, p. 31).



Calc-silicate layer (below eraser on pencil) in greywacke with graded beds, Scapa Metasediments; 1 ¼ miles north of Camp 9, Abbotsford township.

Iron Formation

A dark green, rusty-weathering, amphibole-rich rock is present in outcrops near the southeast edge of the swamp surrounding Hepburn Lake and ¼ mile east of the southern tip of the lake. On a fresh surface the rock shows a poorly developed layering, which is cut almost at right angles by numerous prehnite veinlets. Pyrrhotite and minor pyrite are disseminated through the rock, but both minerals are best developed in irregular, light green siliceous areas. The rock forms layers up to 10 feet thick, which grade into greywacke.

In thin section, blue-green amphibole, quartz, and accessory biotite, chlorite, clinozoisite, pyrite, and pyrrhotite are present. Chlorite, biotite, and clinozoisite increase, and amphibole decreases, where the rock grades into greywacke. Approximately oval-shaped masses, up to 2 millimetres long and consisting of an altered, fine-grained interior surrounded by a sharply defined rim of feathery amphibole, are common, particularly in quartz-rich areas of the rock. The interior of these masses appears to be composed of altered feldspar, quartz, and possibly epidote. Fine amphibole needles and prisms are present in the interior of some masses and penetrate both the rim and interior in others. Commonly two, and rarely three, of the oval masses are coalesced.

This rock possibly represents a metamorphosed, slightly ferruginous, calcareous sediment. The oval-shaped masses may have been derived from original, siliceous, oölitic material.

BONIS VOLCANIC ROCKS

Outcrops of the Bonis Volcanic Rocks are sparsely distributed along the south border of Hepburn township and the La Reine (Okikodosik) River in the northeast corner of Sargeant township. These rocks apparently form a narrow belt, not more than ½ mile wide, between the Sargeant Batholith to the south and the Scapa Metasediments to the north. A structural break, possibly a thrust fault, separates the Bonis Volcanic Rocks from the metasediments in the adjoining Steele, Bonis, and Scapa area.

Amphibolite

The Bonis Volcanic Rocks are mainly amphibolites that range in colour from pale to dark, greyish green to almost black. Nearly all these rocks are sheared, and some are discontinuously laminated, containing alternate light and dark, lens-

Medium-grained porphyroblastic amphibolite containing granitic dikelets and patches, Bonis Volcanic Rocks; at the falls on the La Reine River, ½ mile south of the north boundary of Sargeant township.

shaped laminae. The only volcanic structures present are a few highly deformed pillows in outcrops in southwestern Hepburn township. In this same area small, irregular, rust-coloured gossan zones containing pyrite and pyrrhotite have been developed here and there in the amphibolites. A few narrow porphyry dikes and numerous quartz veinlets are commonly present in all outcrops of the volcanic rocks. Some of the dikes and veins are folded and contorted, but most are undisturbed and trend parallel to the foliation of the amphibolites. Near the contact with the Sargeant Batholith, is commonly found medium-grained amphibolite, containing porphyroblasts of pink feldspar up to ¼ inch in size. Such rocks are best exposed near the junction of the La Reine River and the logging road in northeastern Sargeant township. Here, numerous dikelets and irregular patches of pegmatite, aplite, and granitic material, generally parallel to the foliation of the amphibolite, are well developed.

In thin section, the sheared and laminated amphibolites consist mainly of blue-green amphibole, altered plagioclase, pistacite, and clinozoisite. Carbonate is abundant in a few of the rocks examined. Pyrite, quartz, apatite, and minor garnet are accessory minerals; prehnite and zeolite veinlets, transverse to the foliation, are present. Quartz exceeds 20 percent in the laminated amphibolites. The laminated structure results from the segregation of quartz and minor plagioclase, and amphibole and plagioclase into alternating layers, commonly less than one millimetre thick. Many quartz-rich layers are lenticular and show irregular boundaries against adjacent amphibole-rich layers. This laminated rock is possibly a silicified amphibolite. The amphibolites were probably derived from intermediate or basic flow rocks.

The porphyroblastic feldspar amphibolite consists of porphyroblasts of altered plagioclase and some potash feldspar in a medium- to fine-grained matrix of blue-green amphibole, plagioclase, biotite, pistacite, and accessory apatite, sphene, and quartz. Some secondary chlorite is present, and a few of the altered plagioclase grains contain inclusions of zoisite and muscovite. Although most of the amphibole and mica minerals are randomly oriented, an indistinct foliation is present.

Tuff

Thinly laminated, light to dark green tuffaceous rocks, containing a few bomb-like fragments and minor interbedded chert and feldspar porphyry, are exposed at the falls on the La Reine River immediately east of the Interprovincial Boundary. A linear, rust-coloured gossan zone, not more than 2 feet wide, and containing pyrite and pyrrhotite, lies in this outcrop on the west bank of the river.

A thin section of dark green tuff shows thin, continuous, amphibole-rich layers up to 4 millimetres wide, alternating with narrower continuous layers up to 2 millimetres wide, rich in plagioclase. Much epidote, and some pyrite, carbonate, sphene, and apatite are scattered through the rock. A few garnet crystals are found in amphibole-rich layers. Plagioclase phenocrysts rarely exist in plagioclase-rich layers, and the rock appears to grade within a few inches into an oligoclase porphyry. The porphyry consists of twinned and zoned oligoclase phenocrysts set in a granular aggregate of quartz and feldspar, and minor amphibole, epidote, biotite, pyrite, sphene, and apatite.

Early Basic Intrusions

METAGABBRO

A few narrow metagabbro sills are found in the Scapa Metasediments in west-central Hepburn township. Metagabbro outcrops lie along a line that crosses the "Mace Bay" road just east of mileage 12. There are also a few isolated exposures north of this line. The metagabbro is a medium-grained, dark green, massive to foliated rock, composed dominantly of blue-green amphibole prisms and a few plagioclase laths set in a fine-grained groundmass of quartz and feldspar. Leucoxene, pyrite, biotite, apatite, and carbonate are accessory minerals. One specimen has a relict-ophitic texture.

Metagabbro sills exposed in eastern Scapa township are on strike with the metagabbro in Hepburn. Both metagabbro zones are approximately on strike with the most easterly exposures of the Steele Volcanic Rocks at the west boundary of Scapa township. The metagabbro sills may be genetically related to the Steele Volcanic Rocks, possibly as feeders for the extrusive rocks.

Acid Intrusions

MISTAWAK BATHOLITH

Poorly exposed granitic rocks underlie much of the north half of Adair township, probably all of Clive township, and extend eastward across the Interprovincial Boundary into northern Perron and Boivin townships (Flaherty 1939). Reconnaissance mapping by Tanton (1919) suggests these granitic rocks may form a continuous mass that extends east at least to the Harricanaw River. Tanton (1919, p. 42) named this mass the Mistawak Batholith. Hopkins (1918) and Thomson (1937) found the batholith to be in contact with basic metavolcanics where the Patten River crosses the north boundary of Clive township. The western extent of the batholith is unknown.

Within Adair township nearly all outcrops of the batholith are north of the Patten River and east of the "Mace Bay" road. A few outcrops of granitic rocks and gneiss are exposed along the north and northeast shores of Joe Lake. The contact between the Adair Volcanic Rocks and the Mistawak Batholith is not exposed in the map-area. As it is based on available exposures, the assumed contact shown on the geological map is extremely tentative.

Leucocratic quartz monzonite and granodiorite predominate in the batholith as exposed in the map-area. Outcrops of quartz monzonite are pink to greyish-pink on a fresh surface, and light pink on a weathered surface. Biotite and epidote are the main mafic minerals, although amphibole is abundant in quartz monzonite exposed on the north shore of Joe Lake. The granodiorite is grey on a fresh surface, and grey with a slight green or pink tint on a weathered surface. Biotite and amphibole are common mafic constituents. Hematitized quartz is common in both quartz monzonite and granodiorite; both lithological types are medium- to almost coarse-grained, even-grained to porphyritic, and massive to well-foliated. Elongate, dark green, mafic-rich inclusions, commonly less than 2 inches long, are aligned parallel to the foliation in many granodiorites but are rare in quartz monzonites. Dikes and irregular masses of both lithological types cut one another in most outcrops, but the relationship of the quartz monzonite to the granodiorite is unknown.

Table I shows modal analyses of nine typical quartz monzonites and two granodiorites. Plagioclase ranges in composition from about An_{23} in quartz monzonite to An_{28} in granodiorite. The plagioclase is commonly zoned, twinned, and moderately to highly altered to sericite, zoisite, and muscovite. Potash feldspar is fresh to slightly altered; it displays Scotch-plaid twinning, and some is perthitic. A few medium-grained, subhedral potash feldspar grains, containing euhedral plagioclase inclusions, appear in quartz monzonite. Most of the potash feldspar forms fine-grained anhedral patches, interstitial to plagioclase, and myrmekitic intergrowths of quartz and feldspar are common at the junction of potash feldspar and plagioclase grains. Albite has partly replaced potash feldspar in many of the rocks examined.

Quartz is commonly strained and in some specimens fractured. Biotite has a greenish pleochroism and is partly altered to chlorite. The epidote present in the quartz monzonite and granodiorite is pistacite, rarely with a core of allanite, which generally is present in clusters with biotite. Accessory minerals are zircon, apatite, sphene, amphibole, and pyrite.

Granite pegmatite, aplite, felsite, granitic gneiss, and minor porphyry dikes constitute the remainder of the rocks associated with the batholith. Pegmatite

TABLE I—MODAL ANALYSES OF ROCKS OF THE MISTAWAK BATHOLITH

(ac. = accessory mineral)

Specimen No.	Locality	Quartz	Plagioclase	Potash Feldspar	Hornblende	Biotite	Epidote	Accessories
QUARTZ MONZONITE								
L-204	North shore, Joe Lake.	26.6	36.5	23.1	10.5	ac.	2.6	0.7
L-219	1.5 miles east of mileage 20, "Mace Bay" road.	23.9	41.0	27.2	ac.	6.2	1.3	0.4
L-220	1.5 miles east of mileage 20, "Mace Bay" road.	23.0	46.0	27.4	ac.	1.5	1.1	1.0
L-222	Adair tower road, 0.9 miles east of "Mace Bay" road.	25.3	42.9	23.0	ac.	4.3	2.8	1.7
L-223	Adair tower road, 0.9 miles east of "Mace Bay" road.	25.3	41.5	28.4	ac.	3.5	0.6	0.7
L-224	Adair tower road, 2.5 miles east of "Mace Bay" road.	27.3	40.2	22.4	ac.	6.7	2.3	1.1
L-227	0.25 miles east of Adair Creek.	30.7	38.3	27.1	ac.	2.3	0.4	1.2
L-230	Road, 0.25 miles northeast ranger's cabin, Adair Hill.	22.9	41.3	29.2	ac.	5.0	0.3	1.3
D-53	1 mile west of gravel pit, end of Adair tower road.	22.9	41.7	26.3	ac.	6.0	1.1	2.0
GRANODIORITE								
L-221	Adair tower road, 0.9 miles east of "Mace Bay" road.	28.6	51.1	6.1	5.5	6.1	1.7	0.9
L-229	0.75 miles north of ranger's cabin, Adair Hill.	29.3	51.5	8.2	ac.	9.2	1.0	0.8

and aplite are found as dikes, commonly less than 6 inches wide, in most outcrops of quartz monzonite and granodiorite. A few small magnetite crystals were found in pegmatite near the southwestern edge of Adair Hill.

Fine-grained, buff to pink coloured felsite, as dikes and irregular patches, was mapped in the vicinity of Joe Lake. The rocks are associated with granitic gneiss, and they cut the Adair Volcanic Rocks exposed on the south shore of Joe Lake. At this same locality, narrow feldspar porphyry and quartz-feldspar porphyry dikes also cut the Adair Volcanic Rocks. The porphyries are rocks weathering pink to white, with prominent feldspar and glassy quartz in a fine grained groundmass. Some porphyries contain minor disseminated pyrite.

Granitic gneiss is best exposed on the northeast shore of Joe Lake. The gneisses are grey, fine- to medium-grained rocks, consisting of layers rich in quartz, plagioclase, and potash feldspar, which alternate with layers rich in biotite, pistacite, and minor pyrite. The thickness of the layers ranges between a few millimetres and ¼ inch; in many places they are lens-shaped and discontinuous. In places the gneisses contain porphyroblasts of plagioclase up to 4 millimetres wide. Granitic gneiss, consisting of mixed granodiorite, quartz monzonite, and mafic-rich material, is found at the Forestry cabin near the foot of Adair Hill, and about 1 mile west of the cabin, on the Adair tower road.

PATTEN RIVER PLUTON

Covering an area of about 21 square miles, the Patten River Pluton is best exposed in Perron township in the province of Quebec. A western lobe of the pluton, comprising about 7 square miles, extends across the Interprovincial Boundary into the northeast corner of Hepburn and the southeast corner of Adair townships. The part of the pluton in Perron township has been described by Mawdsley (1930, p. 47c) and remapped by Flaherty (1939).

Within the map-area, the pluton is poorly exposed, and except for its north contact, the boundary of the mass could not be precisely located. Most outcrops consist of a massive medium- to coarse-grained leucogranodiorite, weathering pinkish-grey, which in places is porphyritic. Coarse-grained quartz, pink and grey feldspar, greenish biotite, and epidote are the principal minerals seen in the field. Near the northern margin of the batholith in Adair township, the granodiorite is markedly foliated, and in places crushed and granulated forming augen gneiss. Gneissosity and foliation of the granodiorite parallels the northern contact and the foliation of the Adair Volcanic Rocks.

Modal analyses of two massive leucogranodiorites are shown in Table II. Albite and oligoclase grains are present in sample L-132. Oligoclase (An_{17-22}) is found as finely twinned subhedral to anhedral grains up to 6 millimetres wide, and in many places shows some zoning. Albite (An_{5-7}) is commonly untwinned, intricately zoned, and is present in subhedral to anhedral grains with about the same grain diameters as oligoclase. Friedlaender (1952) noted the coexistence of albite and oligoclase in litchfieldite from the Blue Mountains, Ontario, but reports of other similiar findings are rare. Coexistence of albite and oligoclase in the same rock may be due to unmixing of low temperature oligoclase as suggested by Laves (1954).

Potash feldspar and some quartz are interstitial to plagioclase; much of the quartz is present as large grains up to 3 millimetres wide. Potash feldspar, in places perthitic, is rarely altered and shows Scotch-plaid twinning typical of

TABLE II—MODAL ANALYSES OF GRANODIORITE OF THE PATTEN RIVER PLUTON

Specimen No.	Locality	Quartz	Plagioclase	Potash Feldspar	Biotite	Epidote	Accessories
L-132	0.6 miles east of Camp 24.	27.2	49.5	10.3	7.9	4.0	1.1
L-133	0.55 miles north of cabin at northern foot of Portage Hill.	30.0	46.1	10.6	7.0	5.0	1.3

TABLE III—MODAL ANALYSES OF ROCKS OF THE SARGEANT BATHOLITH

(ac. = accessory mineral)

Specimen No.	Locality	Quartz	Plagioclase	Potash Feldspar	Hornblende	Biotite	Epidote	Accessories
	QUARTZ MONZONITE							
L-147	Camp 30 road, 1.25 miles west of Camp 30.	23.1	46.1	22.1	ac.	3.7	3.3	1.7
L-152	0.4 miles southwest of L-147.	22.3	43.7	20.7	ac.	9.1	3.6	0.6
	GRANODIORITE							
L-108	West boundary Sargeant twp., ¼ mile south of Departure Creek.	12.9	49.5	4.1	14.2	16.3	ac.	3.0
L-143	1.25 miles east-northeast of Camp 30.	24.9	45.2	17.0	ac.	5.6	6.3	1.0
L-148	Camp 30 road, 1 mile west of Camp 30.	28.7	52.2	10.2	ac.	5.3	2.9	0.7
	QUARTZ DIORITE							
L-123	1.4 miles north of Camp 25.	11.0	59.5	—	18.0	7.2	2.8	1.5

microcline. Biotite, epidote (pistacite), and rare chlorite are associated with altered dark green amphibole. Accessory minerals are sphene, zircon, pyrite, and apatite.

Dikes ranging from less than 1 foot to 100 feet wide, and consisting mainly of foliated granodiorite with some aplite, granite pegmatite, and rare feldspar porphyry, are found in the Adair Volcanic Rocks up to 350 feet north of the north contact of the Patten River Pluton. Some of these granodiorite and pegmatite-aplite dikes are contorted, of boudinage form, and concordant with the Adair Volcanic Rocks. Foliation in the Adair Volcanic Rocks is locally contorted in the vicinity of the dikes.

Rare quartz-feldspar porphyry and felsite dikes were mapped in the Adair Volcanic Rocks in the vicinity of Portage Hill.

To briefly summarize, mapping of the Patten River Pluton, both in Ontario and Quebec, indicates the presence of a moderately to intensely foliated border phase adjacent to the surrounding metavolcanics. In places along the north and east contacts, foliation and gneissosity are due to crushing and dip vertically to 45 degrees towards the centre of the pluton. The core and interior parts of the pluton are poorly exposed, but available data suggest that these parts are massive. Where the pluton is bordered by basic metavolcanics, numerous lens-shaped inclusions and hybrid rocks exist in the pluton adjacent to the contact; but where it is bordered by acid metavolcanics, inclusions and hybrid rocks are apparently lacking. Granitic, aplitic, and pegmatitic dikes are common in the surrounding metavolcanics up to ½ mile from the contact. In places along the north contact in Adair township, these dikes are deformed.

The above characteristics of the pluton suggest comparison with schlieren arches described by Balk (1937) and exemplified by the Sierra Nevada, Coast Range, and Idaho intrusions. The lack of inclusions and hybrid rocks adjacent to acid metavolcanics is possibly due to similarity in composition between the acid metavolcanics and the granodiorite, thus allowing complete assimilation of these metavolcanics by the granodiorite.

SARGEANT BATHOLITH

Granitic rocks mapped in northern Sargeant township form the north-central border of the Sargeant Batholith. This batholith, which is centred in Sargeant township, covers an area of about 400 square miles. The western part of the batholith was mapped by the author in 1959 (Lumbers 1962, pp. 52–59) and the eastern part, in the province of Quebec, by Mawdsley (1930, pp. 52c–54c). Where mapped, the batholith is poorly exposed and, except for a few places in Bonis and Desmeloizes townships, its contact with surrounding country rocks is drift covered.

Within northern Sargeant township the batholith consists of diorite, quartz diorite, granodiorite, quartz monzonite, minor granitic gneiss, and rare granite pegmatite. Granodiorite is present in nearly all outcrops; diorite and quartz diorite are marginal to the assumed contact between the batholith and the Bonis Volcanic Rocks; granitic gneiss and quartz monzonite are best developed near the south border of the map-area. Amphibolite inclusions, commonly elongate and ranging from less than 1 inch to over 20 feet wide, are abundant in the batholith near the north contact. These inclusions are aligned parallel to foliation in the batholith rocks and to the northern contact. Owing to poor exposures, the relationship between the various lithological types could not be determined.

The quartz diorite is a medium-grained, leucocratic to mesocratic rock, containing up to 50 percent dark green hornblende and, commonly, abundant biotite. Although massive varieties are present, most of the quartz diorite is foliated and contains lenticular to equidimensional, mafic-rich inclusions. A few hornblende and pyroxene diorites, similar to those mapped in Bonis township (Lumbers 1962, p. 53), are found as irregular patches up to a few feet wide with faint or gradational borders in quartz diorite and granodiorite.

Two varieties of granodiorite are present. The first is a grey to pink, leucocratic, medium- to almost coarse-grained, massive to well-foliated rock, containing conspicuous greenish granules of epidote and flakes of biotite. This variety contains abundant amphibole in places and appears to grade into quartz diorite. The second variety consists of porphyritic, grey, leucocratic, massive granodiorite, with coarse-grained, euhedral, zoned phenocrysts of plagioclase up to 2 inches wide in a medium-grained matrix. Porphyritic granodiorite is not foliated, and the plagioclase phenocrysts are randomly distributed throughout the rock.

The quartz monzonite is leucocratic, medium-grained, pink, and is characterized by the presence of hematitized quartz grains. Coarse-grained phenocrysts of potash feldspar and plagioclase are common in places. Abundant biotite and some epidote are prominent mafic constituents.

Modal analyses of a typical quartz diorite, three granodiorites, and two quartz monzonites are given in Table III. Sample L-148 is a porphyritic granodiorite; sample L-108 is a hornblende-biotite granodiorite, close in composition to quartz diorite.

Plagioclase ranges in composition from An_{20} to An_{25} in quartz monzonite and granodiorite, but in quartz diorite it is slightly more calcic, averaging An_{30}. Fine-grained quartz and plagioclase commonly envelop medium-grained plagioclase grains in quartz diorite. Irregular, narrow albitic zones are found at the borders of plagioclase grains in the quartz monzonites and granodiorites.

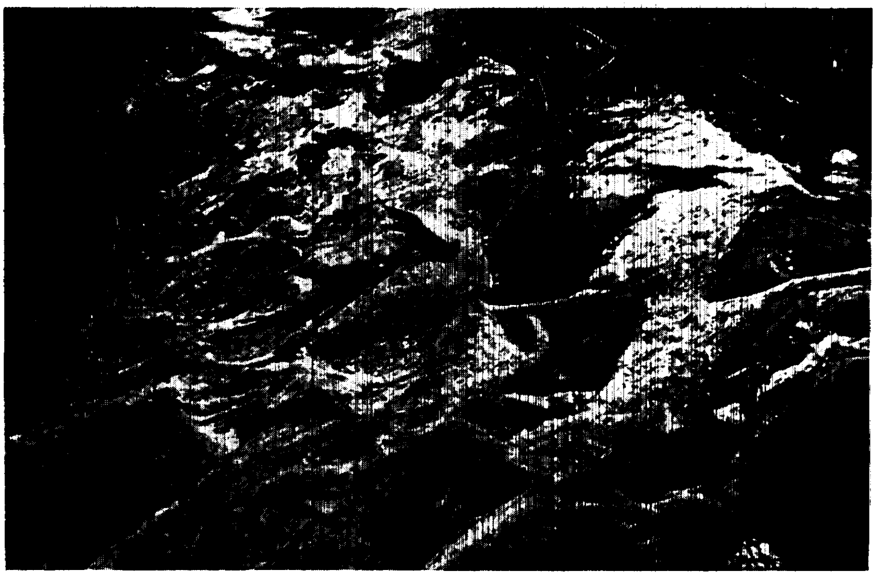
In the quartz monzonite and granodiorite, potash feldspar is microcline that lies interstitial to plagioclase in granodiorite and commonly as medium-grained subhedra in quartz monzonite. Inclusions of sodic plagioclase (commonly myrmekitic), epidote, amphibole, and biotite are common in medium-grained microcline. Some microcline is perthitic, and some has been largely replaced by albite.

Accessory constituents in the quartz monzonites and granodiorites are sphene, apatite, zircon, amphibole, and rare pyrite. Pistacite is an additional accessory constituent in quartz diorite.

Granitic gneiss lies about 1.5 miles east of Camp 25 in Sargeant township (*see* photo). The gneiss is variable in composition, but consists mainly of massive to well-foliated rocks rich in biotite and amphibole, traversed by a network of dikelets and irregular patches composed of grey biotite granite. Foliation trends are variable, even in a small area. In places, granite pegmatite and a green, biotite-amphibole-feldspar rock spotted with coarse-grained clusters of amphibole and feldspar, cut all the previous rocks. The gneiss possibly is a remnant roof pendant of the batholith.

Granite pegmatite, consisting mainly of coarse quartz and feldspar, as dikes rarely more than 6 inches wide, was mapped in a few outcrops south of the north contact of the Sargeant Batholith in northwestern Sargeant township.

Feldspar porphyry and quartz-feldspar porphyry dikes, commonly about 1 foot wide, are found in the Bonis Volcanic Rocks up to ¼ mile from the Sargeant Batholith contact. One porphyry dike was mapped in the Scapa Metasediments, 1.5 miles north of the contact, in southwestern Hepburn township.



Gneissic granite with biotite- and amphibole-rich inclusions; 1.5 miles east of Camp 25, Sargeant township.

In conclusion, the north contact of the Sargeant Batholith is not exposed in Sargeant township, but available outcrops suggest that the contact is regular and characterized by the presence of much quartz diorite and hornblende granodiorite. All the batholith rocks near the north contact are foliated and contain numerous mafic inclusions, which display varying degrees of assimilation. These inclusions are aligned parallel with the contact and the foliation of the batholith rocks. Quartz diorite and hornblende granodiorite of the contact may be a hybrid border phase of the batholith.

Late Basic Intrusions

Diabase dikes, from 3 feet to 150 feet wide, cut the metavolcanic-metasedimentary assemblage and the acid intrusions in the southern, central, east-central, and extreme northeastern parts of the map-area. Outcrop distribution of the dikes suggests that two major sets are present: one striking about northeast and the other north to slightly west of north. Age relationships between the dikes in each set and between the two sets are not known. However, it is inferred that the northeast set may be the younger of the two because the areas mapped to the south and southwest of Lake Abitibi show that the northeast diabase dike sets are probably younger than the north-trending sets. The northeast set is therefore referred to as late diabase and the north set as early diabase. Early and late diabase dikes have been assigned Matachewan and Keweenawan ages in many parts of northeastern Ontario. The author believes that these widely distributed dikes may represent various periods of intrusion and to assign them indiscriminately to either the Matachewan or Keweenawan is unwarranted.

In the outcrop, the early and late diabase dikes are light to dark rocks, weathering reddish-brown, that display sharp, chilled, basaltic contacts, and grade internally to almost coarse-grained diabase in the centre. A diabase dike, 1 mile northeast of Camp 25, contains inclusions of granitic rocks up to 1.5 feet in diameter within 4 feet of its south contact with the Sargeant Batholith. Where cut by diabase dikes, the granites show narrow alteration zones containing pink feldspar and prehnite veinlets. Metavolcanics and metasediments are commonly altered to hornfels at diabase dike contacts. The diabase dike, extending from the west margin of Hepburn township northeastward into Adair township, is a continuation of a dike that was traced across Steele and Scapa townships (Lumbers 1959).

Thin sections show that the early diabase and most of the late diabase dikes are quartz diabase containing zoned laths of labradorite in micrographic intergrowth with quartz. The labradorite, ranging in composition from a core of An_{60} to a rim of An_{45}, is ophitically intergrown with euhedral to subhedral augite. The plagioclase and augite show variable degrees of alteration; the plagioclase is saussuritized, and the augite is uralitized, serpentinized, and chloritized. Biotite is commonly associated with altered augite and opaque minerals. Accessory constituents are ilmenite-magnetite commonly altered to sphene or leucoxene, and apatite. The most westerly of the diabase dikes in Sargeant township is moderately to highly altered quartz diabase. Pyrite and blebs of secondary quartz are additional constituents in this dike.

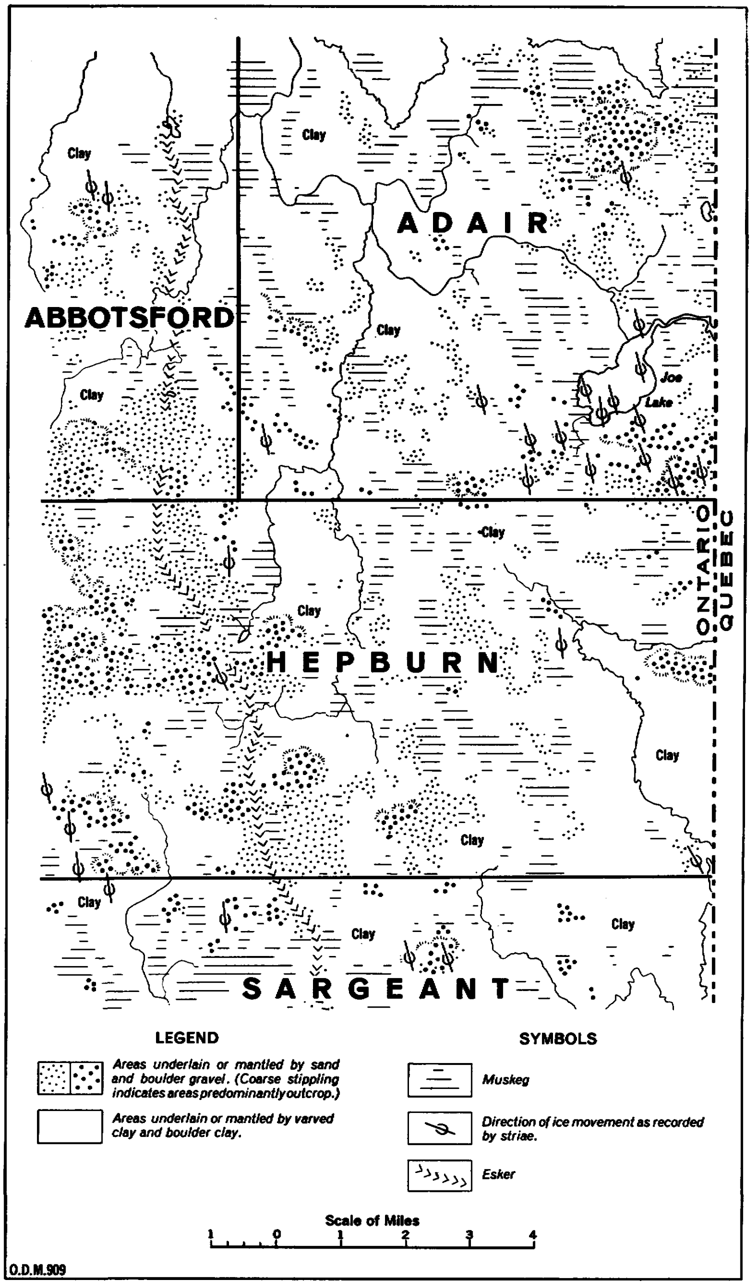
The dike, extending northeastward across the central part of the map-area in Hepburn and Adair townships, is altered diabase, which contains the same minerals as quartz diabase. Quartz, however, is not in micrographic intergrowth with plagioclase but appears to be secondary in origin.

Two olivine diabase dikes lie in northern Sargeant township. These rocks contain a more calcic labradorite (An_{67}) than the quartz diabase, and the augite has a faint violet pleochroism (titanaugite?). Olivine, forming up to 10 percent of the rock, is found as fresh to partly altered granules ophitically intergrown with plagioclase or as inclusions in augite. A few blebs of secondary quartz associated with altered plagioclase were seen in one thin section of olivine diabase.

Pleistocene

Pleistocene deposits of the map-area owe their origin to glaciation during the Wisconsin stage and to the presence of glacial Lake Barlow-Ojibway, formed concurrently with the northward retreat of the Wisconsin ice-margin. No evidence of more than one glacial stage was found, and the Cochrane till, which records a readvance of the Wisconsin ice-sheet (Hughes 1956; 1960), is absent. Glacial, glaciofluvial, and Barlow-Ojibway deposits are recognized, and their general distribution is shown in the figure (page 28).

The average of 31 glacial striae observations in the area indicates the latest movement of the ice was S.12°E. This average compares favourably with the S.9°E. average obtained from outcrops along the shores of Northeast Bay in

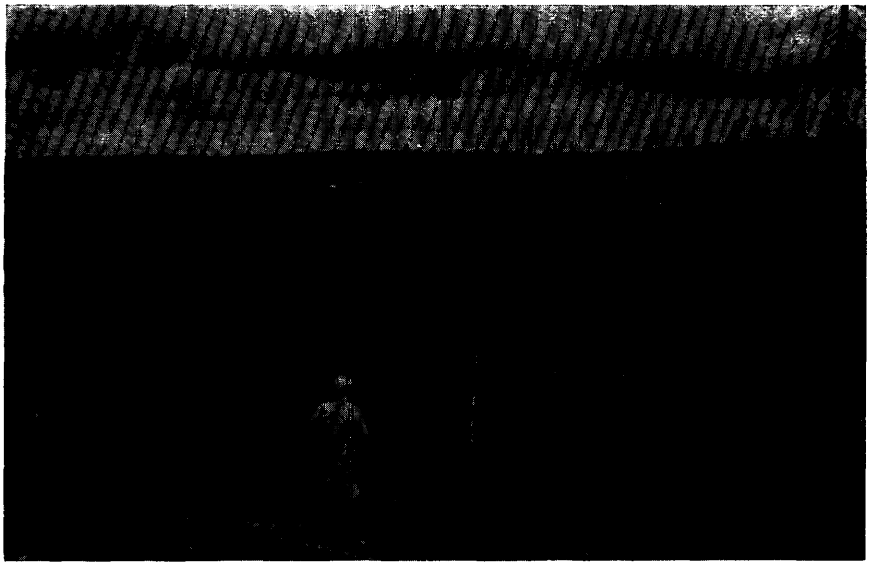


Sketch map of the Pleistocene geology of the map-area, showing the latest movement of the Wisconsin ice sheet and the distribution of glacial, glaciofluvial, and Barlow-Ojibway deposits.

Lake Abitibi, in the Steele, Bonis, and Scapa townships area. Thomson (1937) obtained a value of S.15°E. for the latest movement of ice in the Burntbush River area to the north of the map-area.

GLACIAL DEPOSITS

An extensive ground moraine of boulder clay probably veneers much of the bedrock. Exposures of boulder clay were seen only on flanks of bedrock hills and on the lee side of resistant bedrock knobs. The majority of boulders in the boulder clay are granitic in composition, although some metavolcanic and rare metasedimentary boulders do exist. A few faceted and striated boulders were seen. Diameters of these coarse fragments range from almost sand-size to blocks larger than 3 feet in diameter. Boulder erratics, up to 15 feet across and composed of amphibolite, are found just north of the Camp 9 road, ¼ mile west of the "Mace Bay" road. Rapids on the Patten River in Adair township are caused by accumulations of boulders, probably derived from the ground moraine. Where exposed, the glacial deposits have been modified by wave-action of glacial Lake Barlow-Ojibway.



Esker with a sharp-crested ridge and a kettle lake; ½ mile south of the Camp 30 road, Sargeant township.

GLACIOFLUVIAL DEPOSITS

A prominent esker, interrupted by numerous gaps and obscured by large areas of sand and gravel, trends south-southeast across the western part of the map-area. There are kettle lakes and swampy depressions in places along the flanks of the esker. In most places along its trend, the esker appears to have been flattened and modified by the waters of glacial Lake Barlow-Ojibway. However, near the south border of the map-area in Sargeant township, the esker ridge is sharp-crested and covered with cobbles and boulders, and the sides of the esker slope are at the angle of repose for coarse materials.

Kame-like mounds of gravel lie near the flanks of the esker, especially where it merges into sand plains. Other kame-like deposits are abundant in central Hepburn and Adair townships.

Numerous elongate sand and gravel ridges lie west and south of Adair Hill. These may represent crevasse fillings or are possibly Barlow-Ojibway deposits, resulting from the reworking of the glacial debris flanking Adair Hill.

BARLOW-OJIBWAY VARVED CLAY

Barlow-Ojibway varved clay overlies the glacial deposits and appears to overlie some of the glaciofluvial material. Varved clay is present in banks along the La Reine (Okikodosik) River, the Patten River, and in cuts along many of the logging roads throughout the area. Varved clay is most abundant in the southeastern part of Hepburn township and in Sargeant township, where thicknesses of 10–20 feet are exposed along the shore of Boischere Creek and the La Reine (Okikodosik) River.

Where observed, the varved clays are undeformed and brown to blue-grey in colour; the varves range from less than ¼ inch to 1 inch thick. In places, unvarved clay or sand, rarely more than 3 feet thick, overlies the varved clays.

BARLOW-OJIBWAY SAND AND GRAVEL

In many places, especially in the vicinity of the esker in the western part of the map-area and near bedrock knolls and ridges, stratified sand, gravel, and boulder gravel overlie varved clay. Good exposures of these Barlow-Ojibway sand and gravel deposits are found in road cuts along the eastern foot of Adair Hill and along the Camp 30 road where it traverses the large granitic outcrop, ¾ mile north of Boischere Creek. Stratified sand and gravel also overlie varved clay at the borders of some muskegs. At the gravel pit on the Camp 24 road, near the edge of the large muskeg 2.5 miles west of Camp 24, clay balls, up to 1 foot in diameter, are present in stratified sand and silt overlying gravel. Bedding in the sand and silt dips 10°S. All these sand and gravel deposits were probably derived from glacial and glaciofluvial materials by the waters of glacial Lake Barlow-Ojibway.

On the southern slope of Adair Hill, a series of six raised beaches was found, 470 feet east of the fire tower. Aneroid barometer readings indicate that the crest of the highest beach is about 1,242 feet above sea-level and that of the lowest, 1,209 feet above sea-level. Crests of the intervening beaches are separated from one another by distances ranging from 3 to 12 feet. Other raised beaches lie about half-way down the southern slope of Adair Hill; the lowest has an elevation of 1,168 feet above sea-level. The beach deposits are entirely boulder gravel consisting of subrounded to well-rounded granitic boulders with a maximum diameter of about 2.5 feet and an average diameter of 1 foot. Imbrication of flat boulders up the slope of the forebeach and down the slope of the inshore side is visible in a few places.

The raised beaches, the lack of glacial debris on the crest of Adair Hill above the highest beach, and the fact that Adair Hill is the highest point in the area, indicate that the whole map-area, with the possible exception of the crest of Adair Hill, was formerly submerged beneath glacial Lake Barlow-Ojibway. As the Wisconsin ice-sheet retreated, and isostatic adjustment produced differential uplift, the level of the lake dropped, and Adair Hill grew in size as an island. Other bedrock hills, lower in elevation than Adair Hill, began to form islands, as is indicated by the scarcity of Pleistocene debris on hills and ridges such as Portage Hill and the rocky ridges south of Joe Lake. Eventually glacial Lake

Raised beaches, 470 feet east of the Adair fire tower on the southern slope of Adair Hill. The highest beach is 1,242 feet above sea-level.

Barlow-Ojibway was broken up into many separate small lakes, and with continued isostatic adjustment, most of these small lakes shallowed to form muskeg areas.

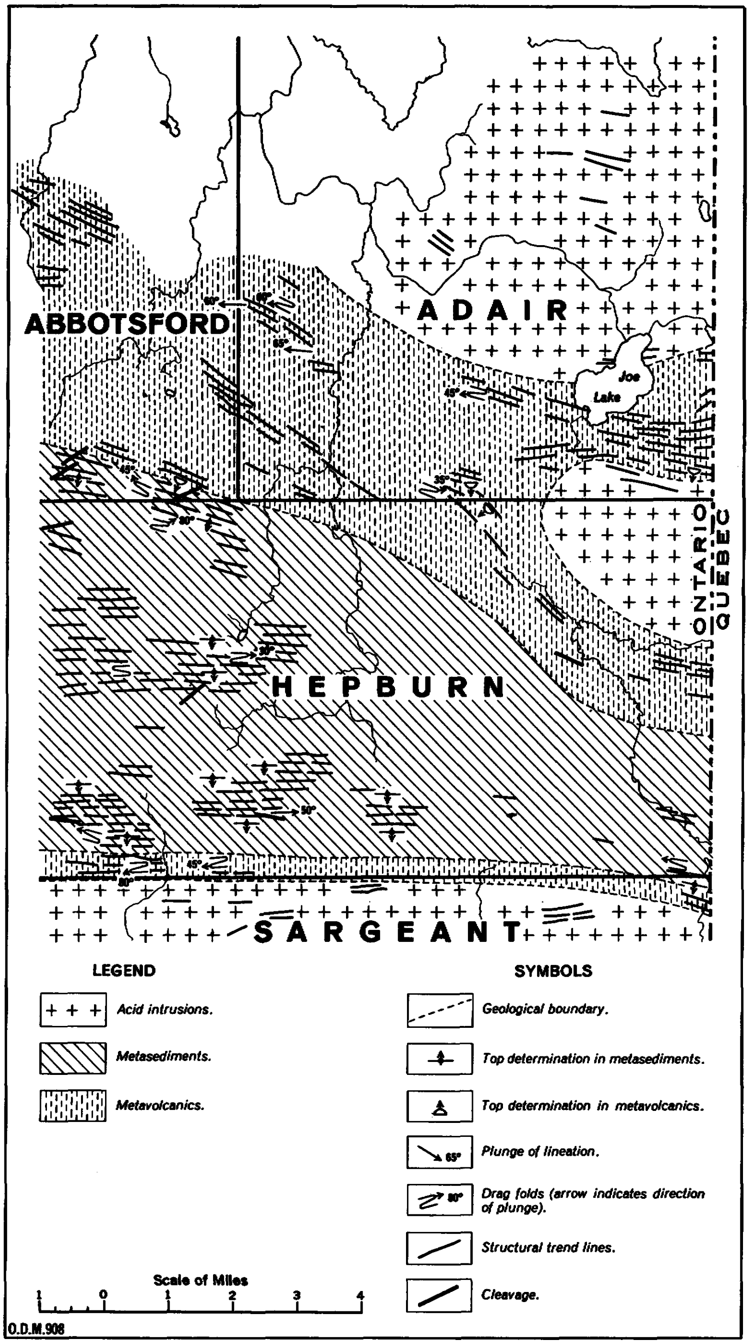
Recent

Woody sphagnum peat and other organic material now collecting in muskegs form most of the Recent deposits. Some sediment is being deposited along stream valleys, and in many places streams have eroded the Pleistocene drift to form deep V-shaped valleys. The most deeply entrenched valleys, lie in the southern part of the area, in the Aylen River–La Reine (Okikodosik) River drainage systems and in sand plains.

STRUCTURAL GEOLOGY

General Features

Lack of subsurface data, scarcity of outcrop, metamorphism, and abundant vegetal cover on many of the existing outcrops seriously restrict structural interpretation in the area. The figure, (page 32), compiled from measured attitudes of bedding, schistosity, gneissosity, lineation, cleavage, and top determinations, summarizes the general structural features as indicated by the present bedrock exposures.



Sketch map showing the structural geology of the South Patten River area.

In the adjacent Steele, Bonis, and Scapa area the metavolcanic-metasedimentary assemblage was divided into two structural units: the Bonis Volcanic Rocks, with tops to the north; and the Steele Metasediments, Steele Volcanic Rocks, and Scapa Metasediments, all with tops to the south. These same two units extend into the present map-area, but here the south-facing unit consists of the Adair Volcanic Rocks and the Scapa Metasediments. Evidence in the Steele, Bonis, and Scapa area suggests that the Bonis Volcanic Rocks are separated from the south-facing unit by a thrust fault (Lumbers 1962, p. 75). As in the area to the west, both units are steeply inclined and have undergone folding and compression caused by emplacement of large concordant plutons.

Except for small local deviations, schistosity and bedding in the metavolcanic-metasedimentary assemblage strike east and dip vertically to steeply south in southern and central Hepburn township. In northwestern Hepburn township, schistosity and bedding in the Scapa Metasediments strike east-southeast, and bedding is vertical to slightly overturned towards the north. Schistosity in the Adair Volcanic Rocks in Abbotsford, western and central Adair, and north-central Hepburn townships strikes southeast and dips vertically to steeply north. Around the Patten River Pluton in Adair and Hepburn townships, foliation in the Adair Volcanic Rocks closely follows the contact and dips vertically to 80 degrees away from the pluton. At the west end of the pluton, however, there is a sharp deflection of the regional foliation in the Adair Volcanic Rocks, similar to that in the Bonis Volcanic Rocks around the west end of the Sargeant Batholith in Steele township.

Large-scale faults and folds, except for a possible thrust fault between the Bonis Volcanic Rocks and the Scapa Metasediments, were not recognizable, and the available data suggest that the south-facing unit forms a monoclinal structure. Lack of closures in the metavolcanic-metasedimentary assemblage indicates the assemblage as a whole does not plunge steeply. Where reliable determinations could be made, dragfolds and lineations in the assemblage plunge to the east and west at moderate to steep angles.

Minor Faulting and Shear Zones

As in the adjacent Steele, Bonis, and Scapa area, small faults, in which the displacement can be measured in inches, are found in many outcrops of the Scapa Metasediments. A well-developed northeast set with left-hand movement and a poorly developed northwest set with a right-hand movement are present.

Shear zones and small faults with associated quartz, epidote, pyrite, and pyrrhotite mineralization are common in the metavolcanics, particularly in the Adair Volcanic Rocks. The shear zones are concordant with regional structures; they dip steeply and are rarely more than 2 feet wide. Two wide shear zones were mapped in the Adair Volcanic Rocks: one 20 feet wide, ½ mile southeast of Joe Lake; the other 9 feet wide, on the east border of the map-area, 1.25 miles south of Bill Lake.

Dragfolds

Dragfolded quartz veins exist, in places, in metasedimentary and metavolcanic outcrops. Dragfolds in the metavolcanics indicate right-hand movement, whereas both left- and right-hand movements are indicated by dragfolds in the

Scapa Metasediments. The plunge of the dragfolds ranges from 45°–80°W. to 30°–80°E. Many of the steep-plunging, dragfolded quartz veins are probably related to structures developed during emplacement of the plutonic rocks. The shallow-plunging dragfolds may be related to structures in the metavolcanic-metasedimentary assemblage.

Dragfolding in a tuff layer intercalcated with flow rocks. Adair Volcanic Rocks, 2 miles west of Camp 24 and ½ mile north of Camp 24 road, Adair township.

Narrow tuff beds intercalated with acid and basic flows in the Adair Volcanic Rocks display small dragfolds delineated partly by relict stratification and partly by foliation. Both Z- and S-shaped folds were seen; some are isoclinal. Typical development of these dragfolds in basic tuff can be seen in the accompanying photo.

Cleavage and Lineation

Prominent cleavage at a small angle to bedding and schistosity is present in the Scapa Metasediments in the western part of the map-area. The cleavage strikes N.55°–80°E. in northwestern Hepburn and N.80°W. in southwestern Hepburn township. Lineation given by the intersection of cleavage and bedding-plane schistosity in an outcrop of metasediments on the Camp 30 road, 1 mile north of the south boundary of Hepburn township, plunges 50°E. Lineation produced by crumpling of foliation planes in the Adair Volcanic Rocks plunges 60°–65°W.

Jointing

Of the 52 joint determinations made throughout the area, 29 were from the Mistawak Batholith and the remainder from the metavolcanic-metasedimentary assemblage and the Sargeant Batholith. No joint determinations were made in the Patten River Pluton. A contoured point diagram of the 52 joints shows maxima striking north and dipping vertically.

ECONOMIC GEOLOGY

Introduction

Except for pyrite in altered greywacke in southeastern Hepburn township, rare iron formation, and specks of pyrite in a few quartz veins, mineralization observed in the area consists almost entirely of pyrite and pyrrhotite confined to silicified, rust-coloured shear zones within the metavolcanics. During the past 30 years, examination, including trenching and diamond-drilling, of most of the prominent shear zones has failed to disclose workable mineral deposits. The rocks most favourable for mineral exploration appear to be the Adair Volcanic Rocks, which lie in the same belt as structurally and lithologically similar volcanic rocks at the Normetal mine, about 7 miles to the east of the map-area. Where exposed, the Bonis Volcanic Rocks contain only a few narrow, discontinuous gossan areas, rarely more than 1 foot wide and containing disseminated pyrite and pyrrhotite mineralization.

Although details of much of the earlier prospecting and exploration work are not available, it is apparent from the distribution of trenches, pits, diamond-drillholes, and old strippings that most of this work has been done on the Adair Volcanic Rocks. Staking and detailed prospecting in the map-area probably began in the southernmost 2½ miles of Adair township, following the discovery of the Normetal mine in 1925. In 1958, some exploration work was carried out, and 42 claims were recorded in two blocks by Kennco Explorations (Canada) Limited in southwestern Hepburn township. In 1960, much of the area was covered during an extensive geophysical survey by International Nickel Company of Canada Limited. Three claim groups were recorded in Abbotsford township, the most easterly of which lies partly in the map-area. Each claim group was examined by diamond-drilling, but the results of this work are not available. One of the drillholes is shown, on the map, at the west margin of the area in Abbotsford township. During reconnaissance work in the summer of 1960, Falconbridge Nickel Mines Limited re-examined some of the ground formerly held by Kennco Explorations in southwestern Hepburn township.

Sulphide Mineralization

Prominent zones of sulphide mineralization are numbered on the map and described below under their respective numbers. Additional zones of minor sulphide mineralization are denoted on the map by the symbol S. Pyrite and pyrrhotite were the only sulphides identified in most of the zones; magnetite and rare chalcopyrite are present in some zones in the Adair Volcanic Rocks. Grab samples taken by the author from all the localities discussed below and from a few areas of minor sulphide mineralization gave, upon assay, traces of copper and nickel and zero to trace amounts of lead, zinc, gold, and silver.

LOCATION NO. 1

A pit, 5 by 10 feet long and over 10 feet deep, partly filled with water, is located about 270 feet west of the Interprovincial Boundary, at the end of the trail extending east from the southeast shore of Joe Lake. The ruins of a small cabin lie on the trail 725 feet west of the pit. A 9-foot-wide shear zone in intermediate to basic Adair Volcanic Rocks is exposed in the pit. The shear zone strikes N.70°E. and dips 85°N. Pyrite and pyrrhotite are disseminated and in concordant layers up to 2 inches wide in siliceous mica and chlorite schists.

LOCATION NO. 2

About ½ mile west of the cabin and just south of the trail in Location No. 1, numerous gossan-capped shear zones, ranging from less than 1 foot to 20 feet wide and up to 30 feet long, are well developed over a width of 725 feet in intermediate to basic Adair Volcanic Rocks. Most of the mineralization appears to be massive and disseminated pyrite and pyrrhotite, although rare chalcopyrite was found. A narrow layer of iron formation (*see* page 11) lies in the gossan zone area, and garnet-amphibole rocks are commonly associated with the gossans.

LOCATION NO. 3

Narrow shear zones with a few quartz veins have been examined by three trenches in an outcrop of acid and intermediate to basic Adair Volcanic Rocks, just west of the creek draining into the southwest end of Joe Lake. The trenches have been partly filled by construction of a logging road that crosses the outcrop, thus burying much of the exposed mineralization. One trench is near the southwest edge of the outcrop on the east side of the logging road, a second just south of the outcrop to the west of the road, and a third approximately in the centre of the outcrop at the west edge of the road. The shear zones and volcanic rocks strike N.80°W. and dip 80°–90°S. As seen in the third trench, which contains a diamond-drillhole at its north end, the mineralization consists mainly of disseminated pyrite and pyrrhotite and rare massive pyrite stringers.

LOCATIONS NOS. 4 AND 5

A prominent tuffaceous layer, which resembles greywacke (*see* page 12), is interbedded with acid Adair Volcanic Rocks along a zone striking N.50°W., which crosses the "Mace Bay" road just south of mileage 17. These rocks are discontinuously exposed over a distance of 3 miles from just north of the Camp 24 road to the Camp 20 road, about 1 mile west of the "Mace Bay" road. Numerous, discontinuous, narrow shear zones, marked by gossan cappings, are found along the trend of the tuffaceous layer from locations Nos. 4 to 5. In places west of the "Mace Bay" road, garnet-amphibole rocks (*see* page 11) are associated with the shear zones. Three distinct zones of shearing appear to be present: a northern zone to the north of the tuffaceous layer, east of the "Mace Bay" road (Location No. 4); a central zone on the south side of the Camp 20 road near its junction with the "Mace Bay" road; and a southern zone, 330 feet south of the Camp 20 road (Location No. 5). At Location No. 4, a diamond-drillhole, plunging 40°S. and 80°E. has been drilled to examine the northern zone of shearing. Mineralization consists chiefly of pyrite and pyrrhotite in narrow lenses and disseminated throughout the shear zones. Magnetite and rare chalcopyrite were seen in the central zone of shearing; chalcopyrite is rarely present in the southern zone of shearing at Location No. 5. Containing contorted cherty layers and cut by unmineralized quartz veins, the mineralized shear zones range from 1 foot to rarely more than 5 feet wide, and most are less than 10 feet long.

LOCATION NO. 6

Altered greywacke (*see* page 15) in southwestern Hepburn township, near the Bonis Volcanic Rocks, was drilled by Kennco Explorations (Canada) Limited, in November 1958. A single drillhole, dipping 50°N., was put down to a depth of 297 feet. In addition to pyrite, some pyrrhotite was reported from the hole, and one highly siliceous zone, 5 feet wide, gave a trace of gold upon assay, according to company reports.

Gold and Silver

As well as being present in a few grab samples assayed from shear zones in the metavolcanics, traces of gold and silver were obtained from assays of two of three samples collected by the author from quartz veins in altered greywacke. These quartz veins contain minor disseminated pyrite cubes and are most common south of the drillhole in southwestern Hepburn township (Location No. 6 above), and in the outcrop of Scapa Metasediments just east of mileage 11 on the "Mace Bay" road.

A grab sample taken by the author from a sheared, rusty-weathering, 1-foot-wide quartz vein, 660 feet south of the contact of the exposed Scapa Metasediments–Adair Volcanic Rocks in southern Abbotsford township, showed no gold or silver values upon assay. Numerous other quartz veins in the metasediments and metavolcanics, including a vein 1 foot wide in a pit, 2 by 3 feet long and 3 feet deep, near the trail 1,000 feet south of the south shore of Joe Lake, are unmineralized.

Iron

Iron formation described in connection with the Scapa Metasediments and Adair Volcanic Rocks is not of economic interest owing to its highly siliceous character and limited extent. A grab sample collected by the author from the iron-formation layer in the Adair Volcanic Rocks southeast of Joe Lake assayed 9.78 percent iron.

Sand and Gravel

Sand and gravel suitable for road building is found in many parts of the area and has been used extensively by the Abitibi Power and Paper Company in construction of logging and access roads. The best grades and largest deposits are in the esker trending through the western part of the area and described in the section dealing with the Pleistocene deposits. In Barlow-Ojibway sand and gravel, the gravel pits are generally shallow, and the gravel is poor in quality.

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INDEX

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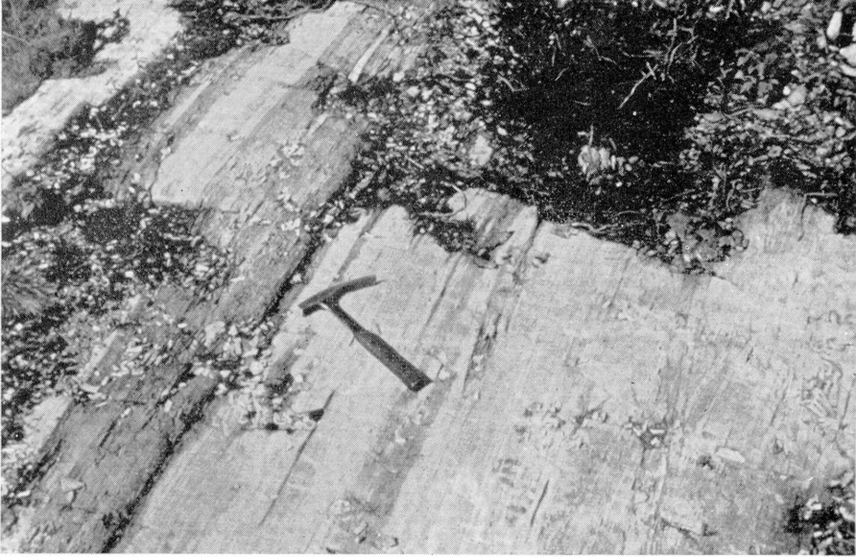
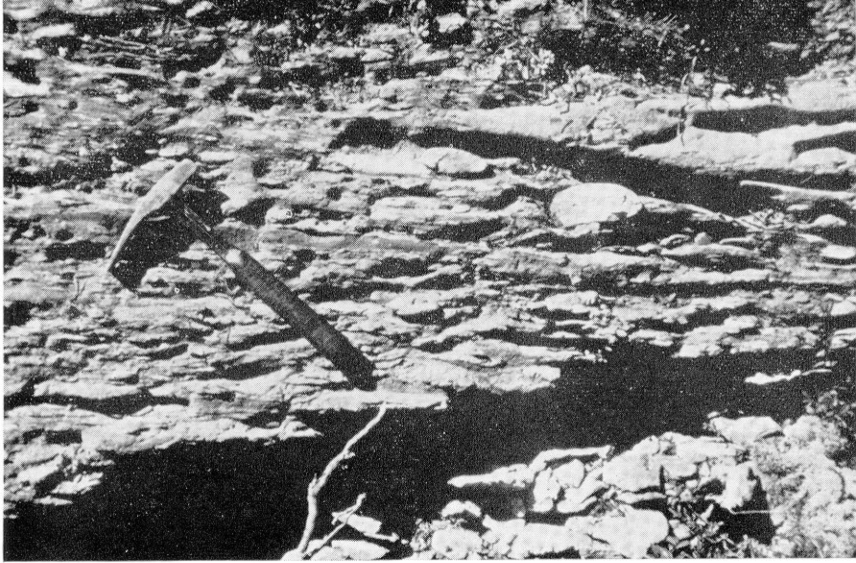
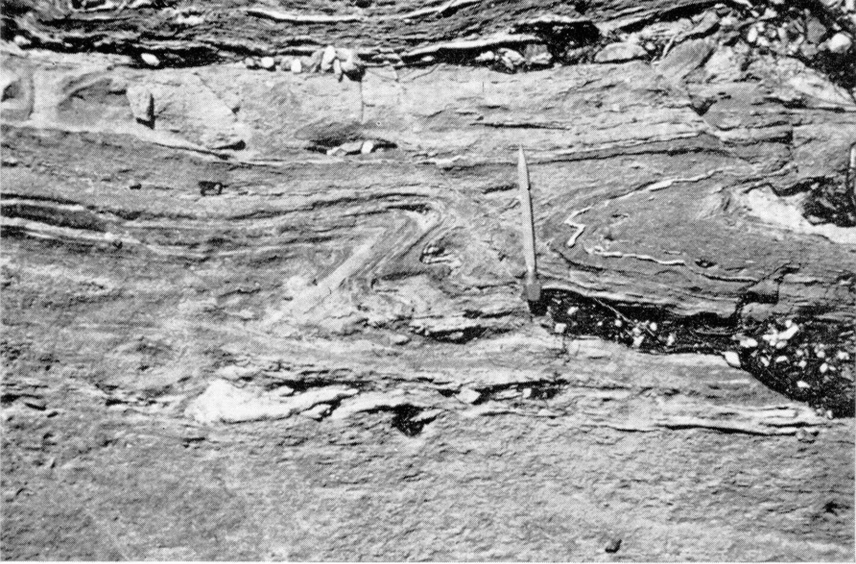


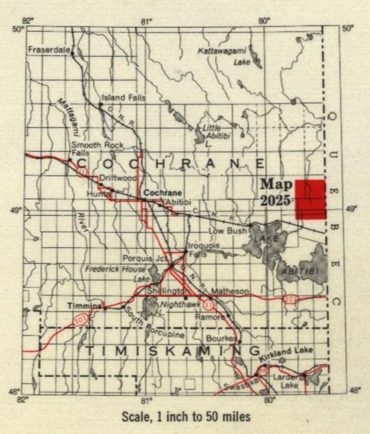




ONTARIO
DEPARTMENT OF MINES

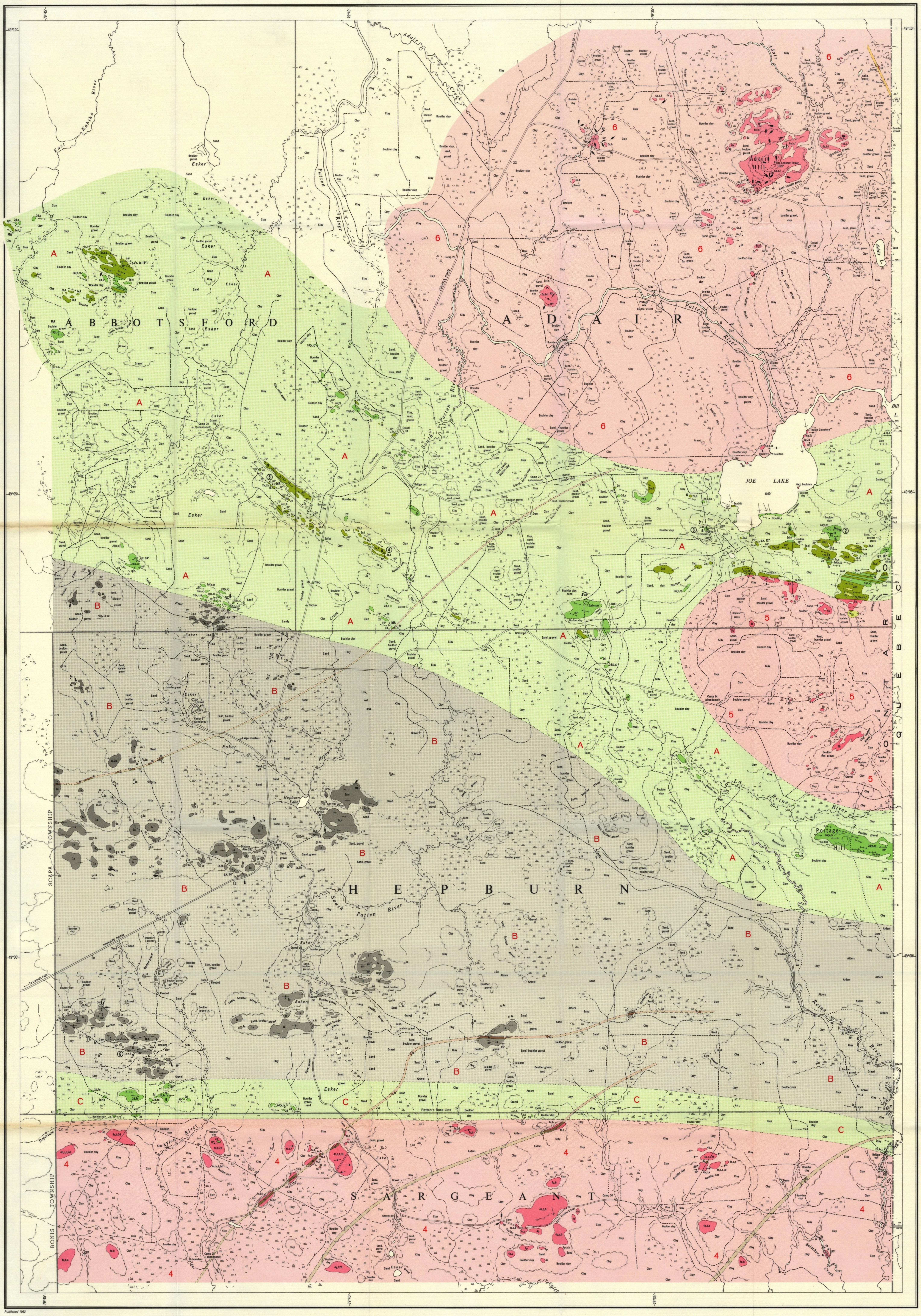
HON. G. C. WARDROPE, *Minister of Mines*
D. P. Douglass, *Deputy Minister* M. E. Hurst, *Director, Geological Branch*

Map 2025
South Patten River Area



Scale, 1 inch to 50 miles

N.T.S. reference 32D13, 32E4



LEGEND

CENOZOIC*

RECENT

Peat, river deposits.

PLEISTOCENE

Varved clay, boulder clay, silt, sand, gravel, boulder gravel.

UNCONFORMITY

PRECAMBRIAN**

LATE BASIC INTRUSIONS

Late diabase

8 — *8a Olivine diabase.* *8b Diabase.* *8c Quartz diabase.*

Early diabase

7 — *7a Quartz diabase.*

INTRUSIVE CONTACT

ACID INTRUSIONS

Mistawak Batholith***

6 — *6a Quartz monzonite.* *6b Granodiorite.* *6e Feldspar porphyry and quartz-feldspar porphyry.* *6f Pegmatite and aplite.* *6g Granitic gneiss.* *6h Felsite.*

Patten River Pluton***

5 — *5b Leucogranodiorite.* *5e Feldspar porphyry and quartz-feldspar porphyry.* *5f Pegmatite and aplite.* *5h Felsite.*

Sargeant Batholith***

4 — *4a Quartz monzonite.* *4b Granodiorite.* *4c Quartz diorite.* *4d Hornblende diorite and pyroxene diorite.* *4e Feldspar porphyry and quartz-feldspar porphyry.* *4f Pegmatite and aplite.* *4g Granitic gneiss.* *4p Porphyritic granodiorite.*

INTRUSIVE CONTACT

EARLY BASIC INTRUSIONS

3 — *3b Metagabbro.*

INTRUSIVE CONTACT

METAVOLCANIC-METASEDIMENT ASSEMBLAGE

C — Bonis Volcanic Rocks****

FAULT (?)

B — Scapa Metasediments****

A — Adair Volcanic Rocks****

VOLCANIC ROCK DIVISIONS OF THE ASSEMBLAGE

2 — *2a Intermediate to basic lava.* *2b Pillow lava.* *2c Diabasic lava.* *2d Amphibolite and amphibole schist (original rock type in brackets if known).* *2h Garnet-amphibole rocks.* *2p Porphyritic lava.* *2t Tuff.* *2x Flow breccia.*

2 — *2e Acid volcanics.*

METASEDIMENT DIVISIONS OF THE ASSEMBLAGE

1 — *1a Greywacke.* *1b Intraformational conglomerate and conglomerate.* *1c Calc-silicate rocks.* *1d Chloritized and pyritized greywacke.* *1e Arkose.*

IF — *Iron formation.*

Unconsolidated deposits. Cenozoic deposits coincide with light toned or other areas in which outcrops are absent or have not been mapped.

***Bedrock geology. Outcrops and inferred extensions of each rock unit are shown, respectively, in deep and light tones of the same colour.*

****The age relationships between the Mistawak Batholith, the Patten River Pluton and the Sargeant Batholith are not known.*

*****The age relationship of the Bonis Volcanic Rocks to the Scapa Metasediments and the Adair Volcanic Rocks is not known.*

SYMBOLS

Higher ground.
1320′ — *Altitude in feet above mean sea level.*
Muskeg or swamp, with boundary.
River, creek, stream, R=rapids; F=falls.
Bridge.
23 — *Motor road, with milepost.*
Wagon road.
Trail, portage, winter road.
Glacial striae.
8b — *Small rock outcrop.*
Boundary of rock outcrop.
Geological boundary, defined.
Geological boundary, assumed.
Geological boundary as indicated by geophysical data.
80° — *Strike and dip of bedding; direction of top unknown.*
Strike and vertical dip of bedding; direction of top unknown.
80° — *Direction (arrow) in which inclined beds face as indicated by gradation in grain size.*
Direction (arrow) in which vertical beds face as indicated by gradation in grain size.
80° — *Direction (arrow) in which overturned beds face as indicated by gradation in grain size; dip in direction of loop.*
Direction in which lava flows face as indicated by shape of pillows.
80° — *Strike and dip of schistosity.*
Strike of vertical schistosity.
Strike of schistosity, dip unknown.
80° — *Strike and dip of gneissosity.*
Strike of vertical gneissosity.
Stratiform foliation, dip unknown.
80° — *Jointing, inclined.*
Jointing, vertical.
Jointing, horizontal.
Interprovincial boundary, approximate.
Township boundary, approximate.
Building.
Pit — *Test pit.*
D.H. — *Drill hole, inclination unknown.*
40° — *Drill hole, inclined.*
q.v. 12″ — *Quartz veins, width in inches.*
S — *Sulphide mineralization.*
MA — *Magnetic attraction.*
(2) — *Location of mineral occurrence mentioned in report.*

SOURCES OF INFORMATION

Geology by S. B. Lumbers and assistants, 1960. Geology not tied to surveyed lines.

Cartography by F. W. Dawson, Ontario Department of Mines, 1962.

Base map derived from maps of the Forest Resources Inventory, and surveys of the Division of Surveys and Engineering, Ontario Department of Lands and Forests, and surveys of the Geodetic Survey of Canada, and surveys of roads by the Abitibi Power and Paper Company, with additional information by S. B. Lumbers.

Magnetic declination approximately 11½° W., 1960.

Map 2025
SOUTH PATTEN RIVER AREA
COCHRANE DISTRICT, ONTARIO

Scale 1:31,680 or 1 Inch to ½ Mile

Chains 80 60 40 20 0 1 2 Miles
Metres 1000 0 1 2 3 Kilometres
Feet 1000 0 5,000 10,000 Feet