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VOLCANIC STUDIES IN THE BIRCH-UCHI LAKES AREA OF ONTARIO

by

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Volcanic Studies in the Birch-Uchi Lakes Area of Ontario

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Abstract

Detailed stratigraphic studies in the Birch-Uchi lakes area of northwestern Ontario have shown that volcanic components are arranged in superimposed sequences or cycles. Each cycle displays a progression from predominantly basic effusives below to predominantly acid to intermediate extrusives above. Sedimentary rocks are preferentially associated with the acid to intermediate extrusive phases. Parts of two volcanic cycles are present.

The average stratigraphic thickness of the volcanic rocks present is 31,000 feet. The original volcanic-sedimentary pile was probably in the order of 40,000 feet. The present lithologic content of the volcanic-sedimentary pile of this area is estimated to be: basalt - 47 percent; andesite and dacite - 23 percent; rhyodacite and rhyolite - 10 percent; sedimentary rocks - 9 percent; gabbro-peridotite - 8 percent; and granite - 3 percent.

Basalt, the dominant volcanic component and present mainly in effusive forms, is of general tholeiitic character. Andesite, dacite, rhyodacite and rhyolite, present mainly in pyroclastic forms, are of the calc-alkalic suite. The average chemical compositions of the volcanic components and of the stratigraphic divisions of the volcanic pile are consistent with a theory of derivation by differentiation of a single, tholeiitic, parent magma.

Gold occurrences in the area are preferentially distributed with respect to the volcanic succession; stratigraphically, most occurrences are located in the upper acid part of the Lower volcanic cycle; lithologically, most occurrences are associated with interbanded rhyolite-dacite pyroclastics and andesite-basalt lava flows; structurally, most gold-bearing quartz veins either lie at the contact of enclosing volcanic units or occupy cross-cutting fractures in a narrow stratigraphic range of lithologic units.

A common magmatic derivation for the gold and enclosing volcanic rocks is advocated. The preferential distribution of the gold deposits with respect to the volcanic succession may express related emplacement histories. Possible methods of gold emplacement are considered. Similar stratigraphic studies in other Archean greenstone belts are desirable.

VOLCANIC STUDIES IN THE BIRCH-UCHI LAKES AREA OF ONTARIO

By A.M. Goodwin[1]

INTRODUCTION

Statement of Problem

Archean greenstone belts of the Canadian Shield, of predominant volcanic composition, have long been recognized as principal repositories of gold, base metals, and iron deposits. In further aid of mineral exploration in Ontario a program of volcanic studies of selected greenstone belts was commenced in 1963 by the Ontario Department of Mines. The program of study has centred upon detailed stratigraphic sectioning and sampling of thick, extensive volcanic-sedimentary piles that form the greenstone belts.

The immediate purpose of the study has been to establish the general stratigraphic framework and sequential composition of the volcanic components and to thereby assess their possible genetic affiliation with associated mineral deposits. It is anticipated that systematic study of several greenstone belts of diverse compositions and metal contents will, by shedding light on the nature of Archean volcanism, lead to metallogenetic conclusions of practical importance to mineral exploration.

The Birch-Uchi Lakes greenstone belt of northwestern Ontario was selected for first study because, as revealed by earlier workers, the structure of the belt is relatively simple, the volcanic successions thick and varied, and associated mineral

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deposits significant in number and value.

Accordingly, during the 1963 field season, selected stratigraphic sections across thick volcanic-sedimentary piles in the Birch-Uchi lakes area were examined in detail; volcanic units were sampled for bulk chemical analyses; and associated mineral occurrences were examined. This data, combined with earlier information serves to 1) provide a generalized stratigraphic framework of the belt, 2) define the volcanic components with respect to chemical composition and orders of extrusion, and 3) permit a preliminary assessment of mineral relationship to this particular Archean volcanic environment.

Location and Access

The Birch-Uchi lakes area, approximately 80 miles long and 40 miles wide, is bounded by Long. 92°20' and 92°50' and Lat. 51°00' and 51°30' in the District of Kenora (Fig. 1). Although without road contact, ready access is provided by small aircraft either from Red Lake 40 miles to the west, or from Sioux Lookout 80 miles to the south. Within the area, a fine network of lakes including Woman, Confederation, Washagomis and Birch lakes provides ready mobility by canoe and small motorboat.

Work Done

In order to determine general volcanic and stratigraphic relationships, three key parts of the Birch-Uchi lakes area were examined in detail during the 1963 field season (Fig. 3); the south key part extends from Leg Lake on the east to Woman Lake on the west; the centre key part from Grace Lake on the east to Woman Lake on the west; and the north key part from Springpole Lake on the south to Richardson Lake on the north.

Within each of the three key parts, complete stratigraphic sections and parts of stratigraphic sections were studied in detail; typical volcanic units were sampled in stratigraphic order; and mineral occurrences were examined. This new data together with the results of earlier geological and aeromagnetic surveys (G.S.C.-O.D.M.) (see references) was incorporated in a general geological map (Fig. 2).

A total of 8 weeks was spent in the area by a three-man party, the time being apportioned as follows; south part - 3 weeks; centre part - 3 weeks; and north part - 2 weeks.

Topography

The surface of the area though uneven in detail is flat in general, the local relief rarely exceeding 150 feet. Low, gravel, boulder and rock ridges and mounds are typically interspersed with labyrinths of irregular, island-studded, interconnecting lakes of various sizes and shapes. Most lakes are elongated in conformity with the local bedrock strike; in the south part of the area, the main lakes such as Uchi, Confederation, Woman, and Washagomis are oriented north-south, in the north part, however, the larger lakes, such as Shabumeni, Swain, Springpole and Birch, are oriented either northeast-southwest or east-west. In those parts of the area underlain by granite most lakes, such as Perrigo and Okanse, are round or/ and the adjoining hills more hummocky than elsewhere.

The Cenozoic mantle, mainly glacial sand, clay, and boulder till, is generally thin and rock outcrop relatively abundant. However, in the north part and, locally, in the central part, as, for example, near Swain Lake, Grace Lake and south of Casummit Lake, a relatively thick mantle hinders or prevents adequate bedrock examination.

Acknowledgments

F.H. Hubbard and D.J. Ellwood were energetic and willing assistants during the field season. Dr. Hubbard, as senior assistant, conducted independent stratigraphic studies. Mr. Ellwood was in charge of rock sampling (see further p. 62). R.H. Ridler assisted for a brief period at Birch Lake. Particular thanks are expressed to all.

The writer gratefully acknowledges the willing cooperation of Lands and Forests personnel at Pickle Lake and Red Lake.

All chemical analyses were made in the chemical laboratories of the Ontario Department of Mines. Thanks are due to Mr. D.A.

Moddle, Director of the Laboratory Branch, in this regard.

Previous Geological Work

The discovery of gold occurrences in the Red Lake area 40 miles to the west in the early 1920's stimulated interest in the Birch-Uchi lakes area. The area was first systematically mapped in 1926 by J.W. Greig (1927) for the Ontario Department of Mines. In 1927, E.L. Bruce (1928) examined and reported upon gold deposits in the south part of the area. In response to further mining developments in the ensuing years, G.D. Furse, (1933) W.D. Harding, (1936) and H.C. Horwood (1937) completed more detailed mapping in the north part of the area, and J.E. Thomson (1938) and J.D. Bateman (1939a, 1939b) in the south part, all for the Ontario Department of Mines.

The Geological Survey of Canada has recently reported upon reconnaissance bedrock studies conducted as part of a joint Federal-Provincial airmagnetic project of northwestern Ontario (Duffell, et al 1963).

Since the first gold discoveries in the Birch-Uchi lakes area in 1926, 245,582 ozs. gold worth 8.5 million dollars at current market prices has been produced. There is no regular production in the area at present.

GENERAL GEOLOGY

General Statement

The bedrock is Precambrian in age. Briefly stated, the area is underlain by an older assemblage of predominantly metasedimentary rocks of the Slate Lake Series; a younger assemblage of intercalated metavolcanics and metasediments of the Uchi Series; and still younger basic to acid intrusions.

Slate Lake sediments underlie the southeast part of the area. They form a predominantly fine-grained, bedded arenaceous sequence. The principal components are impure quartzite, arkose, shale and derived schists and gneisses, together with interbanded and mutually associated iron formation, conglomerate and volcanic rocks.

The younger, predominantly volcanic assemblage, called the Uchi Series, that underlies the main part of the Birch-Uchi lakes area, comprises acid to basic volcanic rocks and associated sedimentary rocks together with derived schists. Detailed stratigraphic studies reveal that volcanic and sedimentary components are arranged in superimposed sequences or cycles. Each cycle displays a progression from basic volcanic rocks below to acid volcanic rocks above; sedimentary rocks, mainly conglomerate, breccia, greywacke, tuff, arkose, impure quartzite and minor banded iron formation, are preferantially associated with the upper, predominantly acid to intermediate phases of the volcanic cycles.

Certain fresh, gabbro-peridotite sills and other small intrusive masses may be younger in age than the volcanic assemblage.Younger granitic rocks underlie broad, marginal belts in the area; in addition, granite stocks and small batholiths are present in the older volcanic and sedimentary rocks.

Limited microscopic study of typical volcanic and sedimentary rocks from the Birch-Uchi Lakes area indicates that most rocks belong to the greenschist facies of low metamorphic rank. The most common mineral assemblage is quartz-feldspar-chlorite-sericite-zoisite-carbonate-leucoxene or close variation. Original feldspar and ferromagnesian minerals appear to have been almost completely altered to secondary mineral aggregates. In proximity to intrusive contacts, mineral assemblages of higher metamorphic rank, including biotite and amphibole, are present.

The relationships of the rock formations are shown in the following table of formations.(see p. 8)

Slate Lake Series

Slate Lake metasediments underlie the southeast part of the area. They form a predominantly fine-grained, bedded, arenaceous sequence. Viewed broadly, the sedimentary assemblage appears to be essentially homoclinal with stratigraphic tops to the north and west. The relationship of sedimentary rocks to the overlying, predominantly volcanic assemblage appears to be essentially transitional and conformable. However, Bateman (1939a) has interpreted locally divergent trends in Slate Lake sediments and the younger volcanic rocks respectively as evidence of an erosional unconformity (Bateman 1939a, p.21). The total thickness of the Slate Lake sediments has been estimated at 20,000-30,000 feet (Bateman 1939a p.12).

Table of Formations

Cenozoic

Recent:	Bedded clay, peat.
Pleistocene:	Till, sand and gravel.

Unconformity

Precambrian

Acid Intrusions:	Lamprophyre and related dikes. Quartz-feldspar porphyry and diorite porphyry. Granodiorite, granite, and syenite.

Intrusive Contact

Basic Intrusions:	Metagabbro, peridotite and pyroxenite, amphibolite.

Intrusive Contact

Uchi Series:	Impure quartzite, arkose, greywacke, shale, tuff, breccia, conglomerate and derived schists. Rhyolite to andesite flows, tuffs and breccias and derived schists. Basalt to andesite lava flows, tuffs, breccias, sills and derived schists.

Mainly Conformable
possible local unconformities

Slate Lake Series:	Basic to intermediate volcanic rocks and derived schists. Impure quartzite, arkose, greywacke, shale, conglomerate, iron formation, and derived mica schists and gneisses.

The typical lithologic component, an impure quartzite largely altered to quartz-feldspar-mica schist, displays indistinct to distinct bedding and is of undoubted sedimentary origin. Arkose and arkosic quartzite in various degrees of alteration to mica schist are common as are fissile quartz-sericite schist and local zones of rusty-weathering carbonate schist.

Conglomerate zones, transitional along and across strike to arkosic schist, are present near Slate Lake and Sawan Bay (Slate Lake) both situated immediately south of the map-area. The boulders and cobbles contained in the conglomerate are reported to be composed mainly of greenstone, felsite, and fine-grained porphyries (Bateman 1939a, p.9).

A narrow, east-trending belt of iron formation, present at Slate Lake in the southeast corner of the area (Bateman 1939a, p.7), is approximately 500 feet wide, has a steep north dip, and consists of thin layers of siliceous magnetite, interbedded with grey chert, jasper, and arenaceous sediments.

A number of narrow belts of basic volcanics are intercalated with enclosing sediments in the vicinity of Slate Lake. Pillow flows, tuff, breccias, and massive volcanic rocks are represented.

The well-bedded nature of the sediments, abundance of arkose, and quartzite, and the presence of conglomerate all suggest rapid, subaqueous deposition of detritus derived by rapid erosion of a nearby volcanic-igneous terrain of substantial relief. The presence of some volcanic intercalations suggest that intermittent volcanic activity accompanied sedimentary accumulation, possibly heralding the oncoming Uchi volcanic period.

Uchi Series

The Uchi series was defined by Bateman as the predominantly volcanic rock series that underlies the northwestern half of the Uchi-Slates Lake area (Bateman 1939a, p.12); this area, in turn, forms the southeast part of the present Birch-Uchi lakes area. In view of the unique character of the name and the continuity of the volcanic assemblage in question across the entire Birch-Uchi lakes area, the term Uchi Series is retained. The Uchi Series is redefined as the predominantly volcanic rock assemblage of the Birch-Uchi lakes area of Ontario which overlies to the north and west the Slate Lake sediments and is itself intruded by younger predominantly granitic rocks. Volcanic and sedimentary rocks of the Uchi Series extend, in the south part of the map-area, from the northwest quarter of Birkett township on the east to the midpoint of Corless township on the west; and, in the north part of the map-area, from the north part of McNaughton township on the south to Richardson Lake on the north (see Fig. 2).

Uchi volcanic-sedimentary rocks dip nearly vertical with the exception of those near Springpole Lake in the north part where moderate dips prevail. The strike of the rocks is mainly north-south in the south half of the area and northeast-southwest to east-west in the north part of the area.

Basic Volcanic Rocks

Distribution: In the south half of the area (Uchi Lake-Woman Lake-Grace Lake) basic volcanic rocks underlie three main north-trending belts (see Fig. 2). The east belt, some 20 miles long and 10,000 to 20,000 feet wide, extends from Leg Lake on the south to Grace Lake on the north. The centre belt is up to 20,000 feet wide; it extends for 16 miles from Lost Bay on the south Swain Lake on the north. The west belt is up to 20,000 feet wide; it extends for 8 miles from the southwest extension of Woman Lake on the south to Narrow Lake on the north.

In the north half (Swain Lake-Birch Lake-Springpole Lake) of the area, three main belts of basic volcanic rocks are also present. The west belt, 10,000 to 20,000 feet wide, extends in a north-northeast direction from Swain Lake on the south to Mink Lake on the north. The north belt, about 10,000 feet wide and 16 miles long, extends northwestward through Richardson Lake. The southeast belt, about 30,000 feet wide and 10 miles long, underlies Springpole Lake and part of the east arm of Birch Lake.

In addition, other smaller bands of basic volcanic rocks are present in the area as, for example, in the centre of McNaughton township, near Bertha Lake and Seagrave Lake to the east, and at South Bay and Exit Bay of Birch Lake.

Lithology: The common constituents of the basic volcanic belts are lava flows, tuffs, breccias and associated sills and dikes all of basalt-andesite composition. Massive lava phases are most common; they typically alternate with breccia, pillow, and ropy phases. Amygdaloidal structures are present locally.

Great thicknesses of superimposed lava flows and associated sills are present in all the basic volcanic belts. Individual flows are up to 100 feet thick but are mainly 10 to 50 feet thick. Many flows contain an upper breccia zone, 2 to 10 feet thick, composed of angular to sub-angular, massive to scoriaceous fragments in a massive lava matrix. These breccia zones commonly grade along and across strike into pillow zones. Between the lava flows, thin zones of banded tuff, chaotic breccia, or tuff-breccia are commonly present.

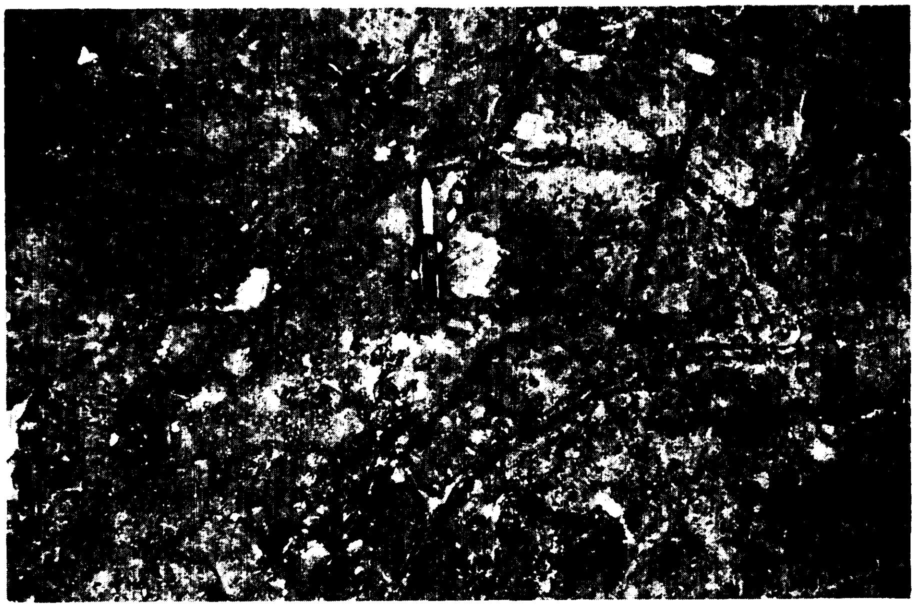
Amygdaloidal lava is widely though sparingly distributed across the area. Individual amygdules, generally less than $\frac{1}{4}$ inch diameter, are typically concentrated in narrow zones and bands parallel, and often close to, the top of the lava flows. Most amygdules are quartz filled; some contain calcite or rusty weathering iron carbonate minerals.

Although the basic volcanic rocks range in colour from light tan to dark green, a dull greenish-grey colour is most common. Colour is a deceptive guide to rock composition. For example, basalt flows at Washagomis Lake and North Bay of Confederation Lake are a light grey to pale tan colour as a result of pervasive zoisitization; on the other hand, andesite lava at Springpole Lake is a deep green colour due to incipient thermal metamorphic recrystallization. The field distinction between basalt and andesite is difficult and often impossible particularly with transitional types. In general, in distinguishing basic volcanic rocks, rock hardness is a better guide to rock composition than is rock colour.

Considerable thicknesses of fine-grained tuff and tuff-breccia are present, much of it massive and chaotic, thereby lacking evidence of fragment sorting during accumulation. Locally, this material grades into poorly banded tuff with some graded bedding. The fine-grained fragmental phases are often difficult to distinguish from massive lava. Indeed, many seemingly massive basic volcanic units, upon close examination, are seen to contain occasional fragments thereby suggesting that the entire unit is, in fact, of pyroclastic origin.

Pillow lava is widespread and locally abundant as, for example, south and west of Lost Bay of Confederation Lake. The pillows vary greatly in size and shape. Larger pillows are 2 to 3 feet long and 1 to 2 feet wide on exposed surface with well rounded tops and 1 to 3 well-defined downward projections. All gradations from well-formed pillows to poorly defined bulbous units of apparently similar derivation are present. Pillow zones are typically gradational to breccia zones within the same lava flows. Many breccia zones contain fragments of pillow selvages presumably derived by continuous flowage and breaking up of early formed pillows.

Basic sills and dikes are present in all flow-breccia accumulations particularly those near Uchi Lake in the south and Richardson Lake in the north. These intrusive units



1. Andesite pillow lava with top of flow in direction of knife blade; near Uchi mine.

typically are from 2 to 20 feet thick; some are several hundred feet thick. Most are concordant or sub-concordant with enclosing lava flows. In some cases, chilled margins are clearly defined; in other cases, gradational contacts with enclosing lava makes it uncertain whether the rock is of extrusive or intrusive origin. Porphyritic intrusive phases are also present; for example, at the north end of Woman Lake a green, mottle textured diorite dike, 18 inches wide, present in andesite flows, contains numerous, $\frac{1}{2}$ to 1-inch-diameter plagioclase crystals at, or near, the chilled margins.

Environment of Accumulation: In general, the basic volcanic rocks appear to represent broad, irregular, coalescing, shield-like accumulations of lava flows, pyroclastics and associated intrusive forms. The presence of pillow structures, interbedded tuffs, and occasional cherty layers indicate that subaqueous conditions prevailed. The alteration in sequence of lava flows and pyroclastics suggest that prevailing lava outflow alternated with extensive pyroclastic extrusion. Whether egress to surface was by way of volcanic vents, fissures, or combination of the two, is not readily apparent; whatever the method, it resulted in broad, extensive distribution of relatively uniform basic volcanic assemblages.

Acid to Intermediate Volcanic Rocks

Distribution: Two main belts of predominantly intermediate to acid volcanic rocks are present in both the south and north parts of the area.

In the south part (Uchi Lake-Woman Lake-Swain Lake), an eastern belt, 6,000 to 15,000 feet wide, extends for 16 miles from Uchi Lake on the south to Swain Lake on the north. To the west, a second, parallel belt, 10,000 feet wide at the south end of Woman Lake, extends northward for 10 miles to the north end of Woman Lake, gradually widening in this interval to a maximum of 30,000 feet. A small, subsidiary, acid volcanic zone of restricted distribution lies southwest of Lost Bay of Confederation Lake.

In the north part of the area (Swain Lake-Birch Lake-Springpole Lake) a relatively thin belt of intermediate to acid volcanic rocks, 3,000 to 9,000 feet wide, extends in a northeasterly direction for 16 miles from the east end of Swain Lake across the north part of Birch Lake. A second band, approximately 10,000 feet wide and 16 miles long, extends northwesterly through Casummit Lake which is situated 2 miles north of Birch Lake.

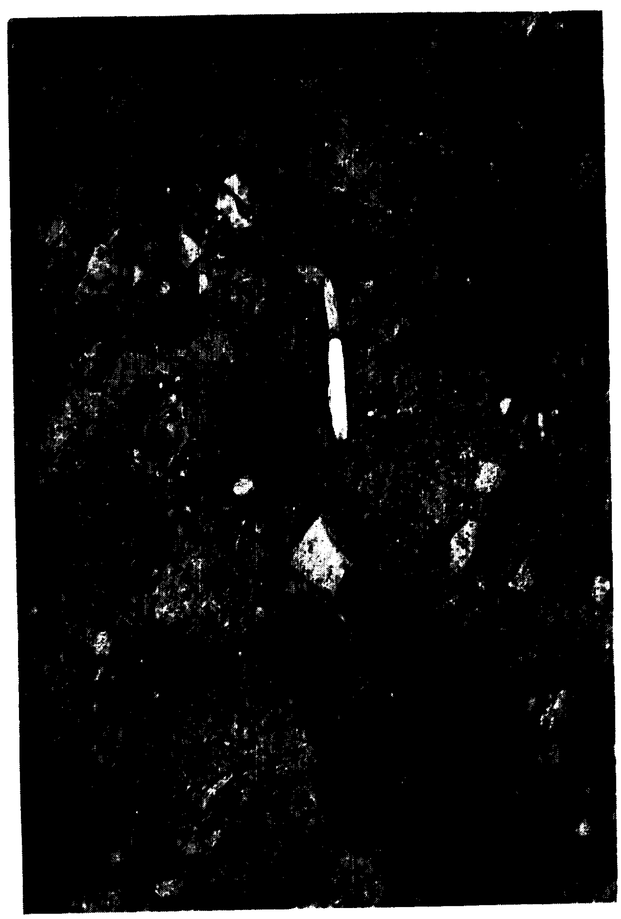
Lithology: A great variety of rock types and forms are present in the acid to intermediate volcanic belts of this area. Fragmental forms predominate; they range from fine-grained tuffs to coarse agglomerates all indicative of widespread and prevailing explosive activity during the period of accumulation. In addition, intercalated basic to intermediate lava flows and breccias are present. In general, volcanic fragmental rocks of intermediate to moderately silicic composition such as andesite, dacite, and rhyodacite predominate. Highly silicic rock types, such as rhyolite, though present in all the acid to intermediate volcanic belts, are notably subordinate. Indeed, scarcity of rhyolite in the rock sequence at large is a characteristic feature of the Birch-Uchi lakes volcanic pile.

In general, the acid to intermediate volcanic belts contain a profusion of acid to intermediate pyroclastic rocks and rare acid lava flows intercalated with flows, breccias, and sills of basaltic-andesitic composition. Predominating are 1) massive to well-bedded, occasionally spherulitic and silicified, lithic tuffs, crystal tuffs, and tuff breccias; 2) fine- to coarse-grained breccia and agglomerate, both pure and mixed the latter containing diverse assortments of pumiceous, amygdaloidal, vesicular, porphyritic and massive fragments, mainly angular but locally sub-angular to rounded, in a fine-grained, generally more basic matrix; 3) massive to faintly and thinly banded tuffs and flows; 4) bedded cherty tuffs; and 5) diatreme breccias. Most fragmental volcanic accumulations contain occasional, generally thin, intercalations of greywacke, shale, cherty iron formation, and, more rarely, conglomerate.

Considering the area at large, the coarser fragmental phases, possibly reflecting proximity to source vents or fissures, are located near UchiLake in the south, at the north end of Woman Lake in the centre, and on the islands and long peninsula of Birch Lake in the north part of the area.

To the north of Wabunk Bay of Uchi Lake, several zones of unusually coarse dacite-andesite breccia, each 100 to 800 feet thick, contain abundant, grey-green, highly vesicular, angular fragments, each commonly 6 to 12 inches long but measuring up to 36 by 24 inches in dimension, in a subordinate, grey-green,

2. Deformed dacite breccia with transecting diorite dike; on transmission line right-of-way north of Uchi Lake.



3. Dacite tuff breccia showing angular dacite fragments in tuff matrix; on transmission line right-of-way north of Wabunk Bay of Birch Lake.

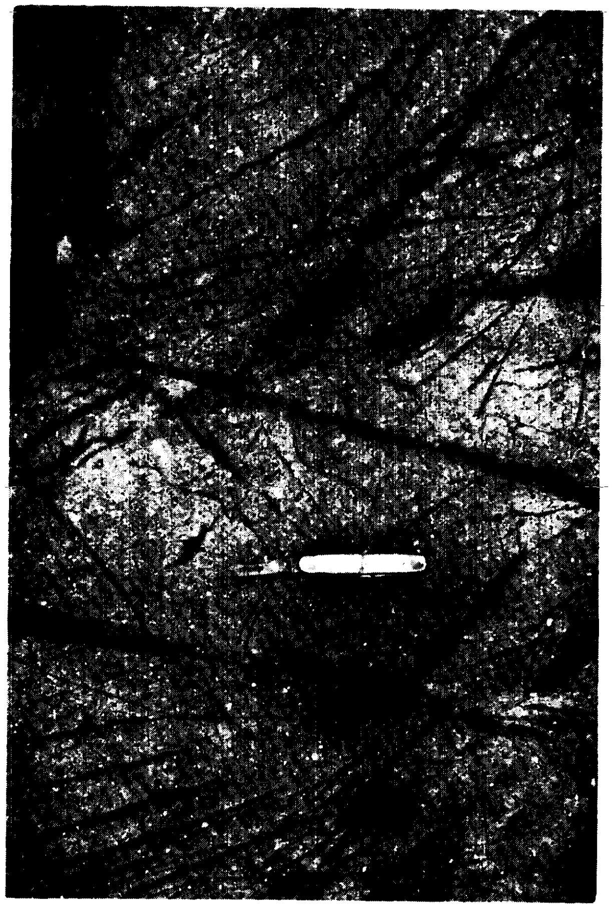
tuffaceous matrix. Interbedded with the coarse breccia are (1) assorted dacite breccia composed of whitish, angular, dacite fragments ranging from barely perceptible, lithic chips to large, angular, vesicular fragments 16 inches in diameter, in a subordinate, andesite matrix. (2) pumiceous dacite breccia with a markedly chaotic association of medium grey, highly vesicular, angular to subangular, dacite fragments each ranging from 1 to 6 inches in diameter; (3) grey-green, irregularly banded, fine-grained dacite tuff containing occasional, dark- to light-grey, massive to porphyritic, dacite fragments, each 6 to 12 inches long; (4) dacite tuff breccia containing innumerable, angular, unsorted, dense to vesicular, massive to porphyritic, grey to green feldspathic fragments up to 6 inches in diameter, in a grey-green, tuffaceous matrix; and (5) greyish-green, broad banded to massive, andesitic tuff.

On the north shore and adjoining islands of Birch Lake dacite breccia contains streaky, light grey, dense, lithic fragments, each 1 to 3 inches across and 6 to 12 inches long, in a medium grey, subordinate tuff matrix. Interzoned breccia of similar composition contains close-packed, light grey, lithic fragments in a green, tuffaceous matrix.

At the west end of the long peninsula that projects eastward into Birch Lake, dark grey, massive, crystal tuff lacking discernible evidence of bedding or layering of any sort, contains closely packed sub-rounded, subhedral to euhedral feldspar crystals together with glassy grey quartz grains set in a subordinate, fine-grained matrix of similar composition. This

4. Coarse dacite-andesite breccia showing great range in size and angularity of fragments; largest fragment 36 inches long; on transmission line right-of-way north of Wabunk Bay of Uchi Lake.

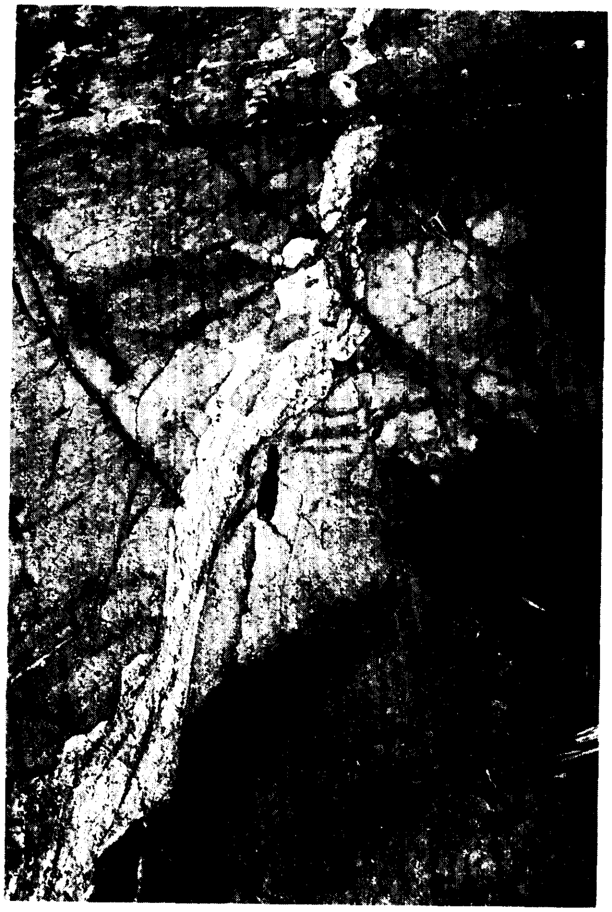
5. Dacite breccia; angular to sub-rounded dacite porphyry fragments in tuff matrix; near south shore of long peninsula extending eastward into Birch Lake.



6. Dacite-rhyodacite crystal tuff with abundant white feldspar fragments; well jointed; on small island off south shore of east end of long peninsula extending eastward into Birch Lake.

rock appears to represent crystal shower accumulates.

Spherulitic tuffs are present, particularly in the south half of the area, where they occur intermittently along extensive stratigraphic zones. Prominent spherules were observed in the east acid volcanic belt at the following locations: on the transmission line north of Uchi Lake, at Lost Bay, at Sundown Lake, and, again, at a small lake situated ½ mile north of Sundown Lake; and, in the west acid volcanic belt at the following locations: along the transmission line between Confederation Lake and Woman Lake in Dent township, and, along the transmission line between the north end of Woman Lake and Washagomis Lake. Spherules are typically small, spherical to elongate structures present in fine-grained, acid tuff and massive, possibly lava, flows. Spherules were observed mainly in rhyodacite, occasionally in dacite, but never, so far as determined, in rhyolite or andesite. Spherules generally form close-packed, irregular aggregates. Individual spherules are typically 1/8 to ½ inch in diameter; many are cigar shaped being 1 to 3 inches long. They are composed of quartz and felsite. Larger spherules generally have a vuggy quartz centre. Rarely, concentric and radial layers and radial ribs are discernible. Faint banding and fragmental textures visible in much of the host rock suggest that most, if not all, spherules have been formed in fine-grained tuff, possibly by mineral rearrangement during consolidation and and metamorphism of volcanic ash. However, Bruce suggested that spherules are explained as rhythmic crystallization in cooling lava (Bruce 1928, p.7).



7. Possible diatreme. Small, angular, white lithic fragments and larger basalt inclusions fill transecting fracture zone in well-jointed, massive basalt sill or flow; at abandoned transformer station west of Uchi mine.

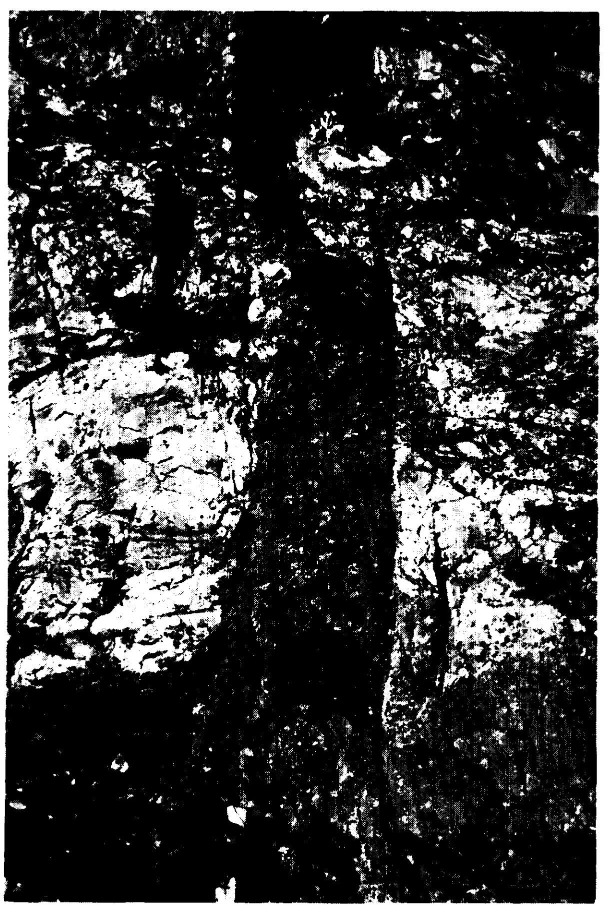
8. Close-up of photo 7. Note small, white, angular, rhyolite fragments and larger, angular basalt xenolith. Pitted texture in basalt due to presence of innumerable carbonate grains.

Thin, siliceous rhyolite units are present in most acid to intermediate volcanic belts. They were observed, for example, near Uchi mine, Hudson Patricia mine, Jason mine, and on the long peninsula that projects eastward into Birch Lake. At Uchi mine vicinity, a large number of thin rhyolite bands are intercalated with basic to intermediate lava flows. For example, an east-west stratigraphic section across 854 feet of north-trending acid-basic volcanic intercalations in the interval between the south end of Lost Bay and the small, oval lake situated 1 mile east of this point, is as follows, measured from west to east:

Thickness (feet)	Rock Type
200	Basic lava
50	Diorite sill
45	Rhyolite
5	Basic lava flow
10	Rhyolite
15	Basic lava
12	Rhyolite
30	Basic lava
6	Rhyolite
6	Basic lava
15	Rhyolite
70	Basic lava
10	Rhyolite
200	Basic lava
180	Rhyolite
854	

Thus, in this particular stratigraphic section, 7 rhyolite units each ranging from 6 to 180 feet thick and aggregating 278 feet are present. Intervening basic lava units, largely andesite but including basalt, range from 5 to 250 feet thick and total 576 feet. Elsewhere in this vicinity, rhyolite units are locally less than 1 foot thick. The rhyolite units generally thicken

9. Massive to faintly banded and fragmental cherty rhyolite tuff in sharp contact with overlying andesite-basalt lava flow. The cherty rhyolite contains numerous, internal, grey to white quartz veinlets and stringers which cut the rhyolite bands but do not cross over to the overlying lava flow. Midway along west trail leading from Lost Bay to Uchi mine.



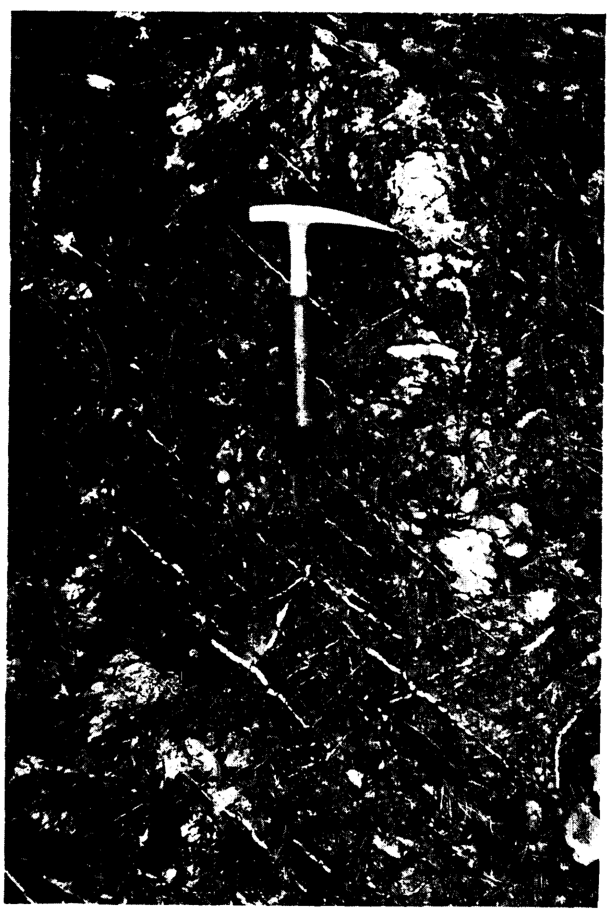
10. Dense, cherty rhyolite layer in sharp contact with underlying basalt lava flow; both cut by transecting basalt dike. Midway along west trail leading from Lost Bay to Uchi mine.

and thin considerably along strike seldom maintaining constant thickness. Some rhyolite units are remarkably extensive. For example, one such unit situated southeast of Lost Bay on the Conwold Gold and Kenalda Gold Properties, although less than 50 feet thick, has been traced along strike for more than 8,000 feet. The general distribution pattern of the rhyolite units is well displayed in map no. 47c (Thomson 1938).

Typical rhyolite, creamy white to grey in colour, is either very dense and flinty or finely granular and porous. Faint banding and intricate lamination, presumably bedding features, are common. Numerous quartz veins and thin, irregular stringers, are commonly associated with the rhyolite.

A typical rhyolite unit, 90 feet thick and lying between andesite lava flows at a point ¼ mile south of Lost Bay on the west trail south to the Uchi mine, has a sharp, clean contact with the underlying andesite lava. The basal 9 feet of the rhyolite unit is composed of particularly dense, blue-grey, rhyolite; this dense phase is gradational upwards to finely porous or granular rhyolite reflecting the presence of innumerable, tiny centres composed of chlorite and rusty weathering iron carbonate minerals; associated with this finely porous phase are (1) numerous skeletal patches of the dense rhyolite described above, and, (2) many small quartz veinlets and networks of small, dissociated quartz stringers. This porous rhyolite phase with associated quartz veinlets forms the remainder of the rhyolite unit to the top. At the top of the rhyolite unit and separating it

11. Well-banded phase of cherty rhyolite tuff with narrow, white quartz stringer cut by thin, transecting basalt dikelet. Midway along west trail leading from Lost Bay to Uchi mine.



12. "Porous" phase of cherty rhyolite tuff with occasional relict patches of dense, light grey, chalcedonic rhyolite and numerous white quartz stringers occupying two fracture sets. Midway along west trail leading from Lost Bay to Uchi mine.

in sharp contact from overlying, fresh andesite lava, is a concordant, white quartz vein 1 to 3 feet thick. Many other rhyolite units in the Uchi mine vicinity display this same dual association of finely porous, slightly altered rhyolite and the presence of abundant quartz stringers which are common in the upper part of the rhyolite unit particularly at, or within 1 to 2 feet of the upper contact. These relations suggest that silica, derived by mineral alteration of the rhyolite itself, has migrated internally, within flat-lying rhyolite units at some stage during, or following, accumulation and lithification.

Many of these thin, extensive rhyolite units in the area contain discernible, angular, lithic volcanic fragments. Some units display graded bedding, the upper fine-grained material grading down to tuff breccia with fragments up to 8 inches in diameter. Many rhyolite units are distinctly banded. These textural features, together with their stratigraphic continuity suggest that most rhyolite units represent ash fall accumulations, products of specific explosive outbursts from nearby volcanic vents or fissures.

Environment of Accumulation: The presence of well-banded, locally graded tuff together with intercalated greywacke, shale and cherty iron formations indicate that much of the acid to intermediate volcanic material accumulated subaqueously either by direct volcanic contribution or by later, down-slope slumping of material to a subaqueous site in lake or sea environment. Numerous, thick, massive tuff and coarse, angular, chaotic breccia units, on the other hand, may well have formed subaerially.

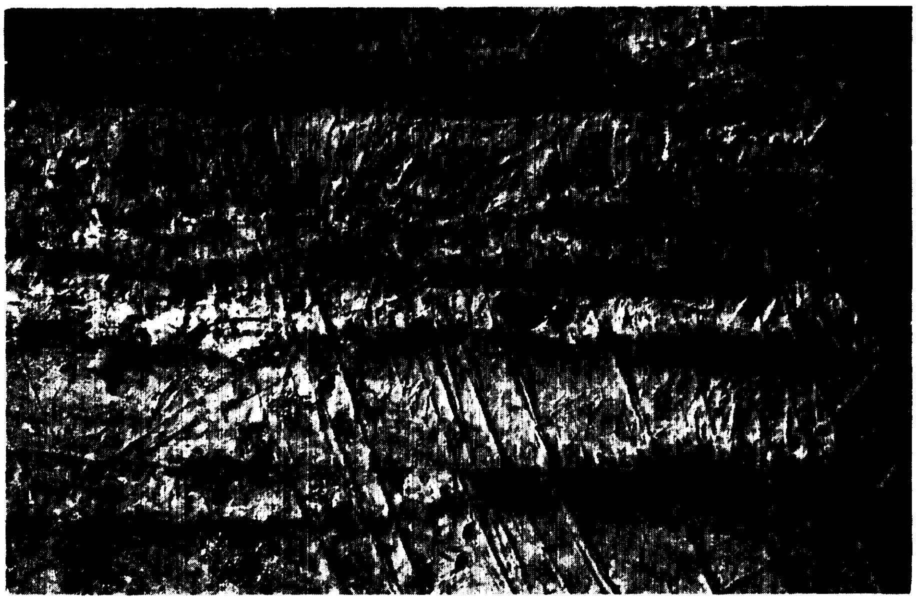
Possibly an archipelago-type of environment prevailed, the more basic, hence more fluid, volcanic material occupying extensive, low-lying; subaqueous tracts, whereas the more acid, hence more viscous, volcanic material generated high-rising, in part subaerial, hummocks, domes, spires, and broad, bulbous masses; subaerial exposure promoted normal processes of erosion, the resulting detritus being conveyed to nearby depressions and other centres of sedimentary accumulation.

Sedimentary Rocks

Distribution: Briefly stated, small proportions only of metasediments are interstratified with volcanic rocks in the south half and extreme north part of the area. In the centre part, however, particularly at Birch Lake and Grace Lake, sedimentary rocks are widespread.

In the south half of the area, thin, discontinuous bands of metasediments occur at UchiLake and Lost Bay of Confederation Lake (see Fig. 2); thicker, more continuous bands, each ranging to 3,000 feet wide, extend from Perrigo Lake on the south to Grace Lake on the north; from Sundown Lake on the south to the east end of Swain Lake on the north; and along the east shore and nearby islands of the north and centre parts of Woman Lake.

In the north half of the area a persistent band of metasediments extends northeasterly through Shabumeni Lake; another thinner, folded, east-trending band passes through Casummit Lake. A large mass of metasediments underlies Birch Lake and vicinity; it extends southward to South Bay, Exit Bay and Grace Lake, and eastward to Seagrave Lake.



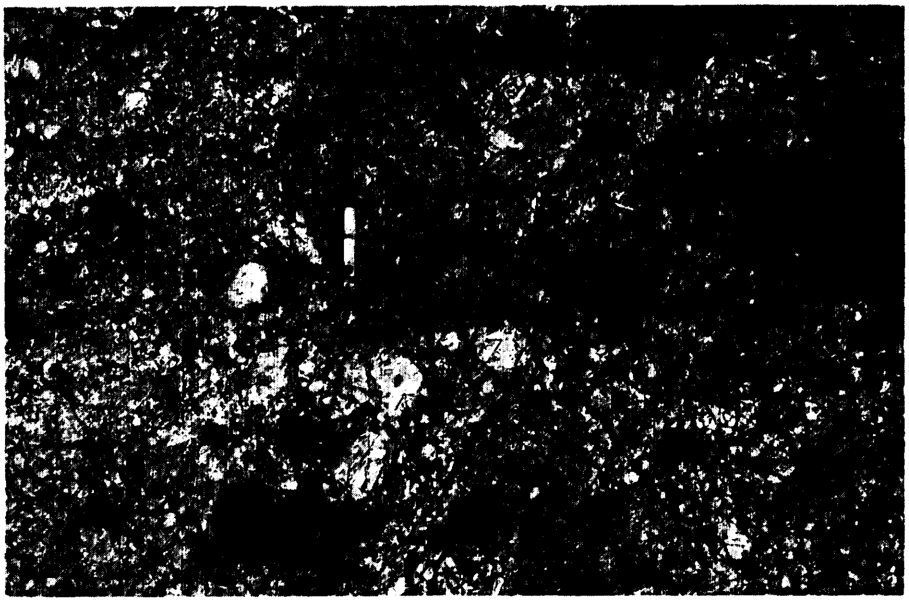
13. Well-banded greywacke-argillite at southeast shore of Lost Bay.

In all cases, the metasedimentary bands include substantial amounts of intercalated volcanic rocks. This is particularly true in the case of the main sedimentary mass at Birch Lake.

Lithology: In general, the sedimentary bands are composed of greywacke, impure quartzite, arkose, banded tuff, conglomerate and, locally, banded iron formation.

At Uchi Lake, several thin, irregular bands of fine-grained sediments, each ranging from 5 to 70 feet thick, and including greywacke, slate, cherts, and bedded tuff, are conformably interbanded with enclosing volcanic rocks. They clearly represent sediments formed by local erosion during periods of temporary cessation of volcanism. Greywacke layers are locally graded, arenaceous basal parts grading up to argillaceous tops. Occasional thin zones of well-banded magnetitic slaty- and jasper-iron formation are present in the fine-grained sediments.

At Lost Bay, a thin zone, 50 to 200 feet thick, of thin- to medium-banded greywacke, present at the southeast corner of the Bay, grades northward to sedimentary breccia containing markedly angular to sub-rounded, fine- to medium-sized, volcanic felsite and quartz porphyry fragments in a subordinate gritty matrix. This particular band may represent the stratigraphic equivalent of the west-facing, sedimentary band present at Sundown Lake 5 miles to the north. The Sundown Lake sedimentary band is up to 3,000 feet thick; the stratigraphically lower (eastern) part, 500 to 1,000 feet thick, comprises thick beds and lenses of coarse conglomerate containing abundant, well-



14. Unsorted medium-sized, quartz porphyry volcaniclastic breccia. Sub-rounded nature of fragments suggest limited water abrasion. At site of former Ontario Lands and Forest's cabin on east shore of Lost Bay.

15. Medium to coarse, unsorted, volcanic conglomerate. Well-rounded to sub-rounded fragments are composed of felsite porphyry mainly but include some black chert fragments. At south shore near the east end of long peninsula projecting eastward into Birch Lake.

to subrounded pebbles and cobbles of massive felsite and felsite porphyry; this part of the band is overlain to the west by progressively finer-grained, arenaceous grits, arkose, impure quartzite, and fine-grained, well banded, black, siliceous sediments.

An east-facing, sedimentary belt that extends along the east shore of Woman Lake is composed mainly of massive to broad banded, relatively coarse-grained arkose, impure quartzite, greywacke, and conglomerate. Thick bands and lenses of coarse, boulder conglomerate, charged with angular cobbles and pebbles up to 8 inches in diameter composed of dense, felsitic lava, feldspar porphyry, quartz-feldspar porphyry, occasional grey chert and shale fragments, are associated with unusually thick bedded, coarse-grained arkose individual beds ranging to 3 feet thick. The east or stratigraphically upper, part of this sedimentary band is composed of fine-grained arkose, greywacke, and shale.

The sedimentary belt at Shabumeni Lake contains relatively fine-grained phases of greywacke, slate and quartzite. The prevailing $\frac{1}{2}$ - to 1-inch thick quartzite and slate layers, commonly finely laminated. Greywacke beds up to 4 inches thick are locally graded. Thin, inconspicuously banded, quartz-biotite schist, grey-green, fine-grained, banded tuff, and dark green to black, finely laminated, cherty tuff are common. Occasional thin zones of graphitic and sulphide-bearing shaly rocks are present. Local pebble conglomerate bands and lenses contain dominantly siliceous pebbles, from $\frac{1}{4}$ to 3 inches in diameter, composed of dense rhyolite and

16. Coarse boulder conglomerate with unsorted, well-rounded to sub-rounded, mainly felsite porphyry fragments. On south shore of small stream along portage route to north end Grace Lake.

quartz porphyry.

At Richardson Lake to the northeast, several thin, discontinuous bands and lenses of arkosic quartzite and greywacke, each less than 100 feet thick, occur intercalated with dacite tuff breccia. On the west shore of Richardson Lake, an east-trending band of iron formation, 70 feet thick, contains a lower part (to the north), composed of interbanded siliceous magnetite, chert and chlorite layers, and an upper part (to the south) composed of non-magnetitic, irregularly laminated, chert-silt intercalations. At Casummit Lake immediately to the south, several broad zones of massive to well banded, locally graded and channel-scoured arkose and quartzite include several prominent bands of finely laminated, chert-magnetite-bearing iron formation.

The main sedimentary mass of the area, located at Birch Lake, has a total estimated thickness in excess of 7,000 feet (Harding 1936, p.10). The sediments comprise conglomerate, greywacke, impure quartzite, arkose, chert, tuff, and iron formation. This sedimentary mass contains substantial proportions of volcanic rocks, mainly tuffs and breccias that closely resemble the sediments themselves; indeed, the clastic material in the sedimentary mass appears to be largely volcanic in type and derivation. The conglomerate contains abundant, well-rounded, spherical to elliptical pebbles and cobbles, up to 10 inches in diameter, composed mainly of feldspar porphyry but including cherty iron formation, vein quartz and rare granite. Thick bands and lenses of conglomerate, present in the lower stratigraphic horizons of the sedimentary sequence, particularly around the margins of the sedimentary mass, are intercalated with greywacke, arkose and tuff. Higher in the sedimentary sequence, arkose, impure quartzite, greywacke and slate predominate. Banded iron formation, composed of interbanded chert, black, magnetitic chert, and brown siliceous siderite, occur mainly in the lower stratigraphic part of the sedimentary sequence, as for example, at the southeast shore of Birch Lake and at Seagrave Lake to the southeast.

Environment of Deposition: The sedimentary rocks of this area are all, so far as determined, conformable with enclosing volcanic rocks; no evidence of angular discordancy or major erosional intervals were observed. For the most part, the clastic material appears to have accumulated subaqueously by rapid deposition of clastic material derived from nearby volcanic land-areas, or archipelagos, of significant relief undergoing rapid physical weathering. The preponderance of volcanic detritus in the sediments indicates that the source areaswere predominantly volcanic in character.

The thinner, discontinuous sedimentary bands, composed of greywacke, arkose, argillite and banded iron formation, such as present at Uchi Lake and Lost Bay in the south and Richardson and Casummit Lakes in the north, may be reasonably interpreted as products of local clastic accumulation during periods of temporary volcanic quiescence. The main sedimentary mass at Birch Lake, on the other hand, again predominantly, though not exclusively, volcanic in character, appears to represent a much more significant and sedimentary interlude probably co-extensive with active volcanic discharge and accumulation elsewhere in the area. According to this interpretation, the sedimentary mass of the area, composed largely of erosional detritus from previously formed, mainly volcanic rocks, together with fresh volcanic contributions, is, in part, the stratigraphic equivalent of volcanic rocks elsewhere in the area.

Basic Intrusions

Basic intrusive rocks are associated, for the most part, with volcanic rocks of the Uchi Series. Numerous, long, narrow belts and lenticular masses of medium- to coarse-grained basic rocks lie within Uchi volcanic rocks near Uchi Lake, Confederation Lake, and Woman Lake in the south part, and, to lesser degree, at Richardson and Springpole lakes in the north part of the area. The basic intrusions are particularly abundant in the interval between Uchi Lake and Leg Lake (see Fig. 2). The basic intrusive rocks consist mainly of gabbro, diorite and quartz diorite and, at Leg Lake, peridotite, and dunite, together with altered equivalents.

The basic intrusions are typically in the form of long, sill-like masses up to 3,000 feet thick that are generally parallel to enclosing volcanic rocks. Thicker bodies are generally massive and retain original textures despite mineral alteration. They show few distinct intrusive relationships. However, detailed mapping has shown discordant relations of basic intrusive masses to lava flows thus demonstrating local intrusive relationships (Bateman 1939a, p.16).

Some basic intrusive masses probably represent coarser-grained, central parts of thicker basic flows, as suggested by Thomson (1938). It is possible that the undoubted basic intrusive dikes and sills of this area were derived from the same parent magma as the basic lava flows (Thomson 1938, p. 70). In either case, a close genetic relationship of basic intrusions to Uchi volcanic rocks is implied.

Acid Intrusions

Granitic rocks form large regional masses that extend beyond the boundaries of the area. In addition, small batholiths, stocks, sills and dikes enclosed within the older volcanic and sedimentary rocks are present.

The large, regional, encircling granitic masses in the vicinity of the greenstone belt are about equally divided between massive granitic phases, foliated granitic phases, and porphyritic, granitic phases (see further Map 2-1963 accompanying Duffell et al (1963). At greater distances from the margins of the greenstone belt, foliated granitic rocks are indicated to predominate.

Batholithic granite underlying the southeast part of the area near Latreille Lake is reported by Bateman (1939a, p.14) to be normal albite-muscovite granite containing accessory garnet and topaz with a well- developed, marginal, pegmatitic phase. The large granite mass in the south part of Mitchell township is reported by Bruce (1928, p.16) to be fresh, pink coloured, coarse-grained, biotite-bearing granite consisting of quartz, microcline, orthoclase, oligoclase and biotite.

The larger, enclosed batholiths and bosses of the area are situated at (1) Perrigo Lake, (2) Okanse Lake, (3) southeast of Confederation Lake, and (4) south of the eastern extension of Springpole Lake (see Fig. 2). Smaller granitic masses are present at the east shore of Confederation Lake, at Mink Lake, and between Casummit Lake and Birch Lake in the north part of the area. In addition, acidic dikes and sills, mainly porphyritic, are widespread. The Perrigo Lake mass is an oval-shaped, pink to grey, granitic body 3 to 4 miles in diameter (Bateman 1939a, p. 14). The east half consists essentially of biotite-quartz monzonite and the west half of hornblende granite; this change in composition is attributed to contamination of the igneous material by greenstone inclusions which are common in the east half of the batholith.

The granitic mass situated south and east of Confederation Lake is sill-like in outline being 12 miles long in a north-south direction and $\frac{3}{4}$ to 1 mile wide. It is composed of granite porphyry characterized by micrographic intergrowths of quartz with microperthite and albite (Bateman 1939a p.14). This granite is intrusive into diorite rock to the west. At Okanse Lake faintly porphyritic, fresh, pink, biotite granite, consists of quartz, orthoclase, microcline, oligoclase, biotite and hornblende (Bruce 1928, p.16). Granite porphyry at Richardson Lake contains numerous orthoclase phenocrysts each $\frac{1}{4}$ to 1/3 inches in diameter.

In addition to pegmatites, a wide range of dike rocks,

17. Granodiorite dike containing inclusions of metabasalt; near west margin of Perrigo Lake batholith; along transmission line right-of-way north of Wabunk Bay of Uchi Lake.

mainly porphyries, ranging from lamprophyre to aplite are present.

STRUCTURAL GEOLOGY

Folding

The general fold pattern of the area is synclinal (Fig. 2). Briefly stated, the south part (Swain Lake-Woman Lake-Uchi Lake) contains a main, north-south trending syncline; thus, rock units lying to the east of this fold axis, near Uchi Lake, Lost Bay and Honeywell Lake, face mainly to the west; whereas rock units lying to the west of the axis, near North Bay of Confederation Lake and Woman Lake, face mainly to the east. In the north part of the area (Swain Lake-Birch Lake-Springpole Lake) a more complicated fold pattern involves a group of parallel folds including a central anticline and flanking synclines; the trends of these folds, traced from west to east gradually changes from northeasterly near Swain and Shabumeni lakes to easterly near Birch and Springpole lakes. Most rocks have been folded close to the vertical; however, gently dipping beds are present between Springpole Lake and Birch Lake in the north part of the area.

Considering the fold pattern in more detail, in the south part of the area (Swain Lake-Woman Lake-Uchi Lake) the main, north-trending, synclinal axis crosses the west end of the narrows separating Lost Bay and the main part of Confederation Lake; it passes along the east shore of North Bay and extends to the east part of Washagomis Lake and beyond (see Fig. 2). To the east of this fold axis, numerous stratigraphic top determinations, both in lava flows and interbanded sediments, indicate that the rocks form part of a west-facing, monoclinal succession. This is particularly well-documented in the vicinity of Uchi Lake and Lost Bay (see further Thomson 1938, p. 72; Bateman 1939a pp.20-21). Although fewer top determinations have been recorded to the north near Honeywell and Sundown lakes, available information indicates that these rocks form part of the same west-facing monoclinal succession. To the west of the main north-trending syncline delineated above, similar structural data, mainly at Woman and Washagomis lakes, indicates that the rock sequence forms a corresponding, east-facing, monoclinal succession. In addition to this main synclinal fold, other smaller, local folds are undoubtedly present. At the northwest corner of Woman Lake a significant swing in strike to the northwest reflects a major change of fold directions.

The north part of the map-area (Swain Lake-Birch Lake-Springpole Lake) contains a more complicated fold pattern. To the west, a synclinal belt of sedimentary rocks extends from Shabumeni Lake northward to Mink Lake (see Furse 1933, p. 28). A northeast-trending anticlinal axis, defined on the basis of parallel acid-basic volcanic belts and scattered top determinations, lies between Shabumeni Lake and the main part of Birch Lake. To the southeast, a synclinal complex trends easterly near South and Exit bays, and again at Seagrave Lake to the east. Further north, an east-trending, anticlinal axis crosses the north extension of Springpole Lake. Finally, immediately to the north, synclinally folded rocks underlie the eastern extension of Birch Lake. The northwest-trending volcanic-sedimentary belt passing through Casummit Lake is interpreted as a south-facing, monoclinal succession that has undergone local flexuring at Casummit Lake (for another interpretation of Casummit Lake area see Horwood 1937, p. 12). Other folds of more limited extent are undoubtedly present in the north part of the map-area, particularly in the highly crumpled sedimentary rocks at Birch Lake.

For the most part, the fold axes of the map-area plunge steeply to the west, to the southwest, or to the south, depending upon local axial bearing. The resulting arcuate fold pattern, convex to the northwest, clearly reflects more than one stage of folding. Indeed, the pattern suggests that earlier, east- to northeast-trending, west-plunging folds were later redistributed about northwesterly-trending folds to produce the present arcuate pattern.

Shearing and Faulting

Although shearing of the volcanic and sedimentary rocks is widespread and locally intense there is only limited direct evidence in the form of defined stratigraphic offsets to prove the presence of significant faults.

On the basis of apparent stratigraphic offset across a pronounced lineament, an east-northeast-trending fault zone is inferred to pass along Swain Lake. The presence of highly sheared and carbonatized rocks midway along Swain Lake on the north shore supports this interpretation. Occasional sheared, brecciated, and carbonatized zones in volcanic rocks at the north end of Woman Lake may be associated with, or related to, the inferred Swain Lake fault zone. Faulting may be present at Springpole Lake to the east- a similarly oriented and equally pronounced topographic lineament. A pronounced, northwest, trending shear zone that crosses Grace Lake may be related to the inferred Swain Lake "break."

Highly sheared rocks are present in the area west of Richardson Lake and between Richardson Lake and Casummit Lake. Local faults of limited extent have been recorded on the property of Argosy mine at Casummit Lake and at Shabumeni Lake (Furse 1933, p. 29; Horwood 1937, p. 12).

VOLCANIC STRATIGRAPHY

General Statement

The stratigraphic interpretation of the area is based upon detailed cross-sectioning of the rock sequence in three key parts of the area (Fig. 3) supplemented by study of pertinent published data (see references). The main cross-sections studied in the field are located as follows: (a) in the south part, 12 miles long, from Leg Lake on the east to Woman Lake on the west; (b) in the centre part 12 miles long, from Grace Lake on the east to Woman Lake on the west; and (c)in the north part, 12 miles long, from Springpole Lake on the south to Richardson Lake on the north.

As a result of folding, each of the three cross-sections listed above contains two, or parts of two, stratigraphic sections. Thus, the south cross-section contains the Uchi Lake Section on the east and the South Woman Lake Section on the west: the centre cross-section contains the Grace Lake Section on the east and the North Woman Lake Section the west; and the north cross-section contains the Springpole Lake Section on the south and the Birch Lake Section on the north. In addition, supplementary stratigraphic segments were studied, as follows: (a) in the south part, the Wabunk Bay Segment, following the transmission line north of Wabunk Bay of Uchi Lake; (b) in the centre part, the Middle Woman Lake Segment, extending from the west shore of the middle part of Woman Lake to the narrows joining North Bay of Confederation Lake and Washagomis Lake; and (c) in the north part, the West Birch Lake Segment, crossing the centre-west part of Birch Lake (see Fig. 3). Rock exposures along traverse lines at Swain Lake, Shabumeni Lake and southwest of Springpole Lake were also examined but not sampled for chemical analysis.

The stratigraphic sections for field study were selected on the basis of regularity of spacing across the map-area, accessibility, and continuity of rock expsures. This last feature is particularly important to proper structural control. The sections studied varied considerably in these regards. The most detailed and continuous stratigraphic section was obtained in the south key part of the area, specifically, along the east-trending right-of-way of the transmission line between Woman Lake and Uchi Lake; along this right-of -way, almost continuous exposure of most rock units permitted construction of a detailed and accurate stratigraphic section. In the centre key part of the area, rock exposures are plentiful between Woman Lake on the west and Sundown Lake on the east; outcrops are intermittent east of this point to Grace Lake: swamp cover is extensive south and east of Grace Lake. It is noted that the section lines were not extended west of Woman Lake. In the north key part of the area, exposures are satisfactory near Richardson Lake, Casummit Lake, and Birch Lake and Springpole Lake; however, the drift cover is heavy between these lakes, particularly between Casummit Lake and Birch Lake.

Despite the incomplete stratigraphic record obtained, it is judged that sufficient data is available to provide a reliable, generalized stratigraphic framework of this area. Further stratigraphic studies would, of course, contribute substantially to this framework.

Stratigraphic Sections

In general, the volcanic stratigraphy of the area is characterized by alternations in the relative proportions of basic, intermediate, and acid components. In all stratigraphic sections studied, basic volcanic rocks predominate at the base of the section; they characteristically grade up to, and are overlain by, more acid volcanic rocks. Successive alternations of this type permit a division of the total volcanic succession into a number of specific volcanic sequences, or cycles, each with lower basic and upper acid parts.

The lithologic details along six stratigraphic sections are summarized in the accompanying stratigraphic sections (Fig. 4 a-f). In addition to lithologic data, all rock samples taken for chemical analyses are located on these sections. Estimated true thicknesses of the volcanic divisions are also shown; the same data is summarized in Table 1. The stratigraphic sections, necessarily generalized to some extent, illustrate the general nature of the established stratigraphic succession at various key places across this complex volcanic pile. The six stratigraphic sections are very briefly summarized below.

<u>Uchi Lake Section (Fig. 4a)</u>: Upon a basement complex of metasedimentary schists and gneiss (Slate Lake Sediments) estimated at 20,000-30,000 feet thick, rest 11,000 feet of Lower Basic Volcanic rocks, mainly massive basalt lava flows with numerous gabbro-peridotite sills and occasional, thin, dacite breccia zones. A thin zone of greywacke-argillite-cherty tuff marks the top of the division. It is overlain by 13,000 feet of Lower Acid Volcanic rocks, a predominantly pyroclastic division composed of andesite-dacite tuff and breccia, rare bands of cherty iron formation, and towards the top, numerous thin, rhyolite tuff bands intercalated with andesite and basalt lava flows. Overlying this predominantly acid fragmental division is a succession of mainly basalt flows and breccias approximately 8,500 feet thick (Upper Basic Volcanic rocks) containing thin zones of dacite breccia and cherty iron formation. Overlying in sharp contact is a succession of fine-grained acid pyroclastics and flows, mainly rhyodacite and rhyolite, of the Upper Acid

Volcanic division: these acid volcanic rocks are associated with numerous granite sills and dikes; the distinction between extrusive and intrusive forms is locally uncertain; hence, this division may contain considerably more granitic intrusive rock than is indicated on the accompanying stratigraphic section (Fig. 4a).

Grace Lake Section (Fig. 4b): A uniform succession of massive to pillowed basalt flows including gabbroic sills and dikes (taken largely from Harding 1936), approximately 14,500 feet thick (Lower Basic Volcanic rocks), contains occasional andesite lava and pyroclastic units particularly towards the top. The basic lavas are conformably overlain by a complex assoication, some 6,500 feet thick, of andesite-dacite tuff and breccia, spherulitic rhyodacite, rhyolite tuff and basalt flows which, together with a conformably overlying clastic group (3,500 feet thick) of volcanic conglomerate, impure arkose, quartzite and shale, form the Lower Acid Volcanic division. Overlying the metasediments of this division, in sharp contact, are 5,000 feet of uniform, dull, khaki-grey-green, pervasively zoisitized, basalt lavas containing approximately equal proportions of massive, pillow and breccia phases.

South Woman Lake Section (Fig. 4c): On the basis of previous mapping (Bruce 1929) the lowermost division of the section (Lower Basic Volcanic rocks), estimated at 19,000 feet thick, is composed mainly of basalt lava flows with massive, amygdaloidal and pillow phases, gabbro sills and dikes, and occasional, thin, magnetitic iron formations. A gradual transition upwards leads to a complex pyroclastic association, approximately 12,000 feet thick, of predominantly andesite-dacite composition (Lower Acid Volcanic rocks); included in the upper part of this division are spherulitic rhyodacites, dense rhyolites, and near the top of the division, adjoining sills of gabbro and younger intrusive granite. A uniform succession of basalt flows (Upper Basic Volcanic rocks), some 4,500 feet thick, overlies the acid pyroclastic rocks in sharp contact. They are, in turn, succeeded upwards by 3,000-4,000 feet of predominantly fine-grained rhyolite tuff (Upper Acid Volcanic rocks) associated with numerous granitic intrusive rocks.

North Woman Lake Section (Fig. 4d): Lower Basic Volcanic rocks, comprising mainly basalt flows, gabbro sills and thin bands of iron formation, together approximately 12,500 feet thick (taken from map 37h, Bruce 1929) and intruded by younger granite to the west, are gradationally overlain by an assorted group, approximately 18,000 feet thick (Lower Acid Volcanic rocks), of andesite - dacite tuff and breccias, rhyodacite - rhyolite tuff which is locally spherulitic, basalt flows, diorite-gabbro sills, and, towards the top of the division, some thin bands of dense, locally porphyritic, rhyolite tuff; included in this division are 2,000-3,000 feet of clastic sediments, mainly volcanic conglomerate, breccia, impure arkose and quartzite which resemble in lithologic composition the equivalent sedimentary band of the Grace Lake Section to the east (see Fig. 4b). Abruptly overlying is a uniform succession of basalt lava flows (Upper Basic Volcanic rocks) estimated at 6,500 feet thick.

Birch Lake Section (Fig. 4e): In contact with younger intrusive granite at the north shore of Richardson Lake is a succession of predominantly basalt-andesite lava flows, about 6,000 feet thick, containing massive, pillow and breccia phases, (Lower Basic Volcanic rocks). These rocks are overlain to the south by a succession of clastic sediments, approximately 2,500 feet thick, formed of well-bedded, locally graded, impure quartzite and arkose, conglomerate, and thick extensive bands of magnetitic iron formation. The metasediments are gradationally overlain to the south by rhyolitic tuff, which is in turn, overlain to the south by a thick succession of assorted, mainly pyroclastic, rocks, estimated at 17,000 feet thick, composed of andesite-dacite tuff, rhyolite tuff-breccia, and basalt flows (Lower Acid Volcanic rocks).

Springpole Lake Section (Fig. 4f): A folded succession of basic lava flows, mainly pillow basalt but including andesite flows, approximately 12,000 feet thick (Lower Basic Volcanic rocks), is overlain in sharp contact to the north, west and south by 4,000-7,000 feet of clastic sediments, mainly volcanic conglomerate, greywacke, tuff and shale. Brief inspection of this sedimentary succession at Birch Lake suggests that a substantial part is composed of volcanic tuff and breccia of either direct, or slightly re-worked, volcanic contribution.

Volcanic Divisions

As illustrated above, the number and thickness of basic-acid volcanic cycles varies from place to place across the area.

This reflects not only original variations in primitive volcanic construction but also the effects of differential erosion, both pre- and post-folding, and later intrusive activities. Briefly stated, parts of two volcanic cycles are present in the south part of the area (Swain Lake-Woman Lake-Uchi Lake) whereas only one distinct volcanic cycle together with substantial thicknesses of sedimentary rocks was recognized in the north half of the area (Swain Lake-Birch Lake-Springpole Lake).

Distribution

In the south half of the area (Swain Lake-Woman Lake-Uchi Lake) similar lithologic sequences, representing folded equivalents of the same rock succession, are present on the east and west limbs of the main, north-trending synclinal axis. Each limb contains two superimposed volcanic cycles referred to respectively as Lower and Upper cycles. On the east limb, a north-trending belt of Lower Basic Volcanic rocks extends from Leg Lake vicinity on the south to Grace Lake on the north (see Fig. 2); contiguous on the west, a parallel belt of Lower Acid Volcanic rocks extends from Uchi Lake vicinity on the south to the east end of Swain Lake on the north. Correspondingly, on the west limb, of the main syncline, a north-trending belt of Lower Basic Volcanic rocks, lying mainly west of Woman Lake, extends from the north part of Knott township on the south to Narrow Lake and thence northwestward; contiguous on the east, a parallel belt of Lower Acid Volcanic rocks extends from the southwest end of Confederation Lake in Mitchell township on the south to the north end of Woman Lake on the north. A central belt of Upper Basic Volcanic rocks, common to both fold limbs, follows the main syncline axis; it extends from Lost Bay on the south to Swain Lake on the north. Finally, a poorly defined, south-plunging nose of Upper Acid Volcanic rocks, considerably intruded by granite, lies immediately southwest of Lost Bay.

In the north half of the area (Swain Lake-Birch Lake-Springpole Lake) northwest-trending, southwest-facing volcanic rocks lying mainly north of Birch Lake contain an older belt of Lower Basic Volcanic rocks on the northeast and a younger, parallel belt of Lower Acid Volcanic rocks contiguous on the southwest. Folded extensions of these basic-acid volcanic rocks form southwest-trending volcanic belts between Shabumeni Lake on the west and Birch Lake on the east (see Fig. 2). At Springpole Lake, a west-facing nose of Lower Basic Volcanic rocks is directly overlain to the north, west, and south by assorted sedimentary and tuffaceous rocks, which underlie much of Birch Lake and adjoining bays to the south. Absence of younger acid volcanic rocks near Springpole Lake reflects either non-deposition, or, more probably, conversion of pre-existing acid volcanic rocks to the existing volcanic sediments of this vicinity.

Thickness

The estimated true thicknesses of the six stratigraphic sections studied are listed in Table 1. In converting apparent stratigraphic thickness to true stratigraphic thickness, the effects of folding, faulting, bedding attitude, etc. were considered. In addition to these normal allowances, a contingency deduction of 10 to 50 percent, depending on local structural reliability, was removed. As a result, the estimated true thicknesses are considered to be of the right order of magnitude at least.

Estimated thicknesses of complete stratigraphic sections in the area range from 16,000 to 39,000 feet, the average being 31,000 feet. The original volcanic pile, of which the present stratigraphic sections represent eroded, folded, and intruded remnants, was probably in the order of 40,000 feet thick.

The range in thickness of specific volcanic cycles and of their volcanic divisions are also listed in Table 1. Thus, Lower Basic Volcanic rocks range in thickness from 6,000 to 19,000 feet; Lower Acid Volcanic rocks from 10,000 to 18,000 feet; and Upper Basic Volcanic rocks from 4,500 to 8,500 feet. This wide range in the thickness of component parts reflects the combined influence of primitive, lenticular volcanic construction, intermittent erosion of expanding volcanic piles, and later intrusive, tectonic and erosional activities.

Lithology

The calculated lithologic composition of the six stratigraphic sections and of their volcanic divisions, as well as the composite average in the Birch-Uchi lakes area, are summarized in Table 2.

Considering the volcanic-sedimentary pile at large, basalt is by far the dominant constituent forming almost ½ the total. Andesite, dacite, rhyodacite and rhyolite are present in that order of decreasing proportions. Basic intrusions form 7.9 percent, granitic rocks 3.4 percent, and sedimentary rocks, 8.6 percent of the total volcanic-sedimentary pile in this area. The lithologic proportions present in the volcanic-sedimentary pile on the basis of the stratigraphic studies may be conveniently summarized as follows:

		Percent
Basic volcanic rocks (basalt)	-	47.0
Intermediate volcanic rocks (andesite and dacite)	-	22.5
Acid volcanic rocks (rhyodacite and rhyolite)	-	10.6
Sedimentary rocks	-	8.6
Basic intrusions (gabbro-peridotite)	-	7.9
Acid intrusions (granodiorite, granite)	-	3.4
		100.0

A planimeter survey of the Birch-Uchi Lakes area based on the geological map accompanying this report (Fig. 2) yielded the following proportions:

		Percent
Basic volcanic rocks	-	48.5 per cent
Acid to intermediate volcanic rocks	-	22.0 per cent
Sedimentary rocks	-	18.4 per cent
Basic intrusions	-	1.3 per cent
Acid intrusions	-	9.8 per cent
		100.0 per cent

A comparison of lithologic proportions derived from the planimeter survey and the stratigraphic studies respectively reveal significant differences. For example, acid to intermediate volcanic rocks form 33.1 per cent (22.5 per cent + 10.6 per cent) according to the stratigraphic studies but only 22.0 per cent according to the planimeter survey; similarly, sedimentary rocks form 8.6 per cent (stratigraphic studies) and 18.4 per cent (planimeter survey); and, acid intrusions form 3.4 per cent (stratigraphic studies) and 9.8 per cent (planimeter survey). These discrepancies reflect a biased selection of stratigraphic sections for field study in favour of those with substantial thicknesses of acid to intermediate volcanic rocks rather than sedimentary rocks, together with deliberate avoidance of the larger acid intrusive bodies.

It is interesting to note that the calculated lithologic proportions of basic volcanic rocks derived by both methods are almost identical (47.0 and 48.5 per cent). Furthermore, the sums of acid to intermediate volcanic rocks plus sedimentary rocks derived by both methods are very close, namely, 41.7 per cent (stratigraphic studies) and 40.4 per cent (planimeter survey); this correspondence may be attributed to and supports the interpretation that the acid to intermediate volcanic rocks (pyroclastics) and the sedimentary rocks (clastics) represent lateral stratigraphic equivalents, the clastics having been derived largely by erosion of adjacent and subjacent pyroclastic piles; thus, the relative proportions of the two rock types present along a particular stratigraphic section is a measure of the degree of conversion of the one rock type to the other.

When considered in detail, it may be seen that the lithologic proportions of complete stratigraphic sections are by and large similar to the composite average of the entire pile. Thus, the proportion of basalt ranges from a high of 52.5 percent (Grace Lake Section) to a low of 38.0 percent (Birch Lake Section). Although there is considerable variation within complete sections in the relative proportion of the several intermediate to acid volcanic rock types, particularly andesite and dacite, the aggregate is approximately 30 percent in all sections. However, the proportions of intrusive, and sedimentary rocks present do vary considerably between sections.

A great variation in lithologic proportions is present in the respective divisions of the six stratigraphic sections. Thus, the percentage basalt in the basic volcanic divisions ranges from 57.5 percent in the Lower Basic divisions of the Springpole Lake Section to 100 percent in the Upper Basic division of the Grace Lake Section. There are corresponding variations in the proportions of other volcanic and intrusive rock types(see Table 2). For example, sedimentary rocks range up to a maximum of 35 percent (Lower Acid division of the Grace Lake Section). In general, the thicker sedimentary zones are intercalated with, overlie, or represent stratigraphic equivalents of the acid volcanic divisions; this is particularly so in the north part (Swain Lake-Birch Lake-Springpole Lake) of the area.

The salient lithologic features of this area, in stratigraphic terms, are briefly summarized below.

Basic Volcanic Rocks: In the Lower Basic Volcanic division, as, for example, near Leg Lake in the south part of the area and at Richardson Lake and Springpole Lake in the north part, massive to pillowed lava flows and breccias and associated intrusions predominate. Basalt is most common; andesite locally prevails; and dacite is present. Massive, gabbroic and dioritic layers represent either central parts of thick flows or intrusive sills. Ultrabasic sills and sub-concordant masses are present at Leg Lake. Lavas in the vicinity of Springpole Lake contain considerable epidote, magnetite and carbonate; those marginal to younger granitic intrusions have undergone considerable metamorphic recrystallization.

Individual lava flows are up to several hundred feet thick, but average 20 to 50 feet. Pillow structures are locally abundant. Flow breccias are common particularly at Leg Lake in the south and Richardson Lake in the north.

Higher up in the stratigraphic sequence, basalt flows occur both interstratified with prevailing acid pyroclastic rocks as in the Lower Acid Volcanic division, and as thick, independent lava sequences as in the Upper Basic Volcanic division. For example, basalt flows are interstratified with rhyolite and rhyodacite tuff-breccia units near the Uchi mine and at the north end of Woman Lake. A thick, uniform flow sequence of prevasively zoisitized basalt with minor dacite-rhyodacite intercalations is present at Washagomis Lake and south and west of Lost Bay.

<u>Acid to Intermediate Volcanic Rocks</u>: Acid to intermediate pyroclastic rocks, ranging from fine-grained tuff to moderately coarse breccia, predominate in all acid volcanic divisions of

the area. In fact, the mutual association of fragmental form and relatively acid composition is the salient characteristic of the acid volcanic divisions. Within the pyroclastic rocks, lithic volcanic fragments are common as are amygdaloidal and vesicular types, all indicative of highly explosive derivation. Dacite and andesite pyroclastics, by far the most common, form thick and extensive units west of Uchi Lake, at Woman Lake, and north and west of Birch Lake. Rhyodacite units, locally spherulitic, are widespread.

Rhyolite and other highly siliceous volcanic rocks are restricted in amount and distribution. Thin rhyolite units, 10 to 100 feet thick, occur interstratified with prevailing dacite-andesite extrusives at Uchi mine, between Washagomis Lake and Woman Lake, at Sundown Lake, at Casummit Lake, and in the north-west part of Birch Lake vicinity. Highly silicified rhyolite units are present in the rock sequence at Uchi Mine in the south, at Hudson Patricia mine in the centre, and at Birch Lake and Casummit Lake in the north.

Sedimentary Rocks: Sedimentary rocks, present both as thick, extensive zones and thin, lenticular bands, form up to 25 percent of a stratigraphic section. The sediments are characteristically, though not exclusively, associated with acid to intermediate volcanic pyroclastic phases; the sedimentary zones may occur at the base (e.g. Casummit Lake), within (e.g. Woman Lake), or at the top (e.g. Sundown Lake) of the associated pyroclastic sequence.

Conglomerates and breccias with a high proportion of volcanic rock fragments are present at Lost Bay, along the west (lower) side of the sedimentary zone at Woman Lake, along the east (lower) side of the sedimentary zone at Sundown Lake, and at Birch Lake. Coarse arkose and impure quartzite are prominent components of the sedimentary zones at Woman Lake and Sundown Lake. Greywacke and argillite are present in all the main sedimentary zones of the area; in addition, they form thin, restricted bands distributed indiscriminately throughout the volcanic succession. Considerable tuffaceous material is associated with the sedimentary rocks particularly at Birch Lake. Magnetite-bearing quartzite is present at the south bay of Washagomis Lake.

A limited amount of banded iron formation is present in the area. The thicker, more persistent bands, present at Birch and Casummit lakes in the north part of the area, are associated with fine-grained sedimentary rocks. Occasional, thin, lens-shaped dominantly cherty bands of iron formation are interstratified with andesite and dacite tuff breccia west of Uchi Lake and south-west of Woman Lake. Lean, interbanded chert and siliceous magnetite is the common rock type; sideritic chert is present in the main band at Birch Lake.

Relationship

Within a stratigraphic section, the upward transition from a basic volcanic division, formed largely of thick, uniform basalt flow sequences, to the overlying acid volcanic division, formed largely of pyroclastics, is generally gradational over a few thousand feet of stratigraphic thickness; the transition is first marked by the appearance in the dominant basic sequence of occasional, disseminated, lithic and amygdaloidal fragment of intermediate to acid volcanic rock; such fragments and associated layers increase upwards in size and proportion to a position of dominance, the basic volcanic rocks, in their turn, being reduced to a subordinate proportion.

In contrast to this gradual transition from basic volcanic division to overlying acid volcanic division, the upward transition from acid volcanic division to overlying basic volcanic division is abrupt, typically occuring within a few hundred stratigraphic feet. For example, immediately west of Uchi mine, a sharp contact separates underlying rhyolite-dacite tuff-breccia from the overlying thick sequence of basalt lava flows. These features indicate that, in general, the supply of acid extrusive material relative to basic effusive material gradually surged to an explosive climax, then ceased abruptly.

The stratigraphic record indicates, in brief, that the extrusive theme was one of cyclical outpourings of basic and acid to intermediate components: early predominantly basic effusion gave way gradually to later, predominantly acid to intermediate extrusion; this was succeeded by sudden reversal to predominantly basic effusion of the next volcanic cycle, and so on. Cyclical volcanic outpourings of this type produced the volcanic pile of the Birch-Uchi lakes area.

CHEMICAL COMPOSITION

Introduction

This part of the report is based upon chemical analysis of 126 volcanic samples taken under stratigraphic control across the area. All rock samples are located geographically in Fig. 5, and stratigraphically in Figs. 4 a-f; the corresponding chemical analyses are listed in Table 3. Additional compositional data are presented in Tables 4-5.

The chemical results demonstrate that the volcanic rocks of this area belong, in general, to the normal basalt-andesite-rhyolite association common to orogenic regions of the world. The volcanic rocks that were sampled may be readily classified as one or other of basalt, andesite, dacite, rhyodacite or rhyolite. Compared to the normal worldwide calc-alkali suite, the rocks are characterized by low TiO_2, low alkalis (particularly K_2O), and high loss on ignition (CO_2 + H_2O).

The chemical results are consistent with derivation of the volcanic rocks of the Birch-Uchi lakes by a process of differentiation of a common parent magma of general tholeiitic composition. Since the time of extrusion, the volcanic rocks have undergone mild chemical alteration involving mainly introduction of CO_2 and H_2O and, probably, selective removal of minor amounts of alkalis and silica.

Sampling Technique

Particular care was taken in selecting suitable volcanic units for sampling as well as in the actual sampling technique itself. Consistent with the main purpose of the sampling, namely, to determine the general sequential character of the volcanic sequence, sampling of diverse volcanic types in stratigrapnic order was emphasized rather than systematic and regularly spaced sampling along the section lines. Disproportionate attention was accordingly paid to the highly varied, rapidly alternating, acid to intermediate volcanic successions in preference to the relatively thick but lithologically uniform, basic volcanic successions.

Most volcanic units sampled are of uniform composition on the basis of field examination. Hybrid rocks, such as mixed volcanic breccias, were avoided where possible; instead, nearby acid and basic equivalents were sampled. Despite precautions, some of the sampled tuff units may well be of mixed composition, the corresponding chemical analysis thereby representing a blend of rock types. However, because the rock types are probably coeval derivatives, this is not considered to be a serious obstacle.

In sampling a particular volcanic unit in the field, the greatest exposed width of rock was selected; sample widths ranged from a few feet up to 200 feet; the average was 50 feet. Chips of fresh rock were broken off with the aid of pick, moil and 4-pound hammer, at regular intervals, generally 12 inches apart, across the exposed width. Occasionally, an adjacent, parallel section across the same volcanic unit was included in the sample. By this means, a 5 to 10 pound sample, composed of small chips of fresh rock, was secured. This procedure, repeated 126 times across the area, afforded the rock samples for subsequent chemical analysis.

Classification

A simple volcanic classification, based primarily on SiO_2 content, has been employed, as follows:

Rock Type	SiO_2 Percent
Basalt	less than 52 percent
Andesite	52-58
Dacite	58-64
Rhyodacite	64-71
Rhyolite	greater than 71 percent

The only exceptions made were with some samples classified as andesite with SiO_2 contents slightly less than 52.0 percent and substantial CO_2 content; some original SiO_2 has almost certainly been leached out of these rocks.

Volcanic Rock Types

The following breakdown shows the number of samples taken in the field of each rock type according to the above classification:

Rock Type	No. Samples	Percent of Total
Basalt	54	42.9
Andesite	20	15.8
Dacite	18	14.3
Rhyodacite	17	13.5
Rhyolite	12	9.5
Gabbro-peridotite	5	4.0
Total	126	100.0

When the percent rock types sampled (above) is compared with the percent rock types present in the entire area (Table 2) it may be seen that basalt and gabbro-peridotite were undersampled whereas andesite, dacite, rhyodacite, and rhyolite were oversampled relative to their proportionate presence in the area. Granitic and sedimentary rocks were not sampled at all.

The average chemical composition of volcanic rock types in the Birch-Uchi lakes area are presented in Table 4. The basalt of the Birch-Uchi lakes area generally resembles normal tholeiitic basalt (Turner and Verhoogen, p. 180-188) except for somewhat low TiO_2 content and high loss on ignition (H_2O and CO_2). The other volcanic types of the Birch-Uchi lakes area are generally similar in chemical composition to calc-alkali rocks of the andesite-rhyolite association (Turner and Verhoogen, 1951, p. 212-224) as present in orogenic regions of the world.

In general, the chemical compositions of the volcanic types are consistent with their derivation by a process of differentiation from a parent magma of general tholeiitic character.

Volcanic Divisions

In Table 5 the average chemical compositions of the six stratigraphis sections and of their volcanic divisions are presented. A salient feature is the close chemical similarity of the six stratigraphic sections to each other and, thereby, to the calculated composite average of the entire volcanic pile in the Birch-Uchi lakes area.

The respective acid and basic volcanic divisions of the stratigraphic sections are comparatively similar in chemical composition across the area. The averages are characterized by somewhat low TiO_2 and alkalis, particularly K_2O, and high loss on ignition (H_2O and CO_2) compared to average worldwide calc-alkali equivalents. The uniform chemical composition of the volcanic divisions across the area suggests a uniform source of volcanic material, possibly from a single parent magma.

The weighted averages and percent differences between (1) the Lower Basic volcanic divisions and (2) the Lower Acid volcanic divisions of the six stratigraphic sections studied in the area, together representing 75,000 feet of combined stratigraphic section are give in Table 6.

The calculated average of the Basic Volcanic divisions (1 above) is particularly significant in that it represents the least differentiated igneous phase present in significant volume in the Birch-Uchi lakes area. As such, it probably bears close chemical similarity to the parent magma from which it was derived.

A chemical comparison of basic and acid volcanic divisions, as summarized above, indicates that, in order to derive the acid volcanic phase from the basic volcanic phase, a process of differentiation involving exchange of chemical constituents in the order of 8 to 10 percent would be required. Specifically, gains in SiO_2 and minor Na_2O and K_2O with corresponding losses in Fe, MgO, CaO and minor Al_2O_3 would, it is indicated, effect the required compositional change. Such a chemical change could have resulted from a process of differentiation, such as crystal fractionation, in a parent magma chemically similar to the average of the Basic Volcanic divisions.

It has been previously noted that the Basic Volcanic divisions are composed largely of lava flows and associated intrusions whereas the Acid Volcanic divisions contain a high proportion of volcanic fragmental forms such as tuff, breccia and agglomerate. This change from dominant flow form to dominant pyroclastic form corresponds to the chemical change between Basic and Acid Volcanic divisions presented above. Thus, an average increase in SiO_2 content of 7 to 8 percent with corresponding loss of mafic constituents apparently raised the average magma viscosity from a state of dominant lava effusion to one of dominant pyroclastic extrusion. It is interesting to note that the high proportion of fragmental material in the Acid Volcanic divisions is not directly attributable to increased CO_2 content (loss on ignition) on the basis of available chemical evidence.

VOLCANIC HISTORY

The parent magma, the source of the Uchi volcanic rocks, was of general tholeiitic character; presumably it was close in chemical composition[1] to the calculated average of the Basic

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[1] Preliminary chemical surveys of six other greenstone belts widely distributed across the Superior province of the Canadian Shield indicate that a uniform basic volcanic composition, similar to that of the Uchi basic volcanic rocks, prevails throughout. This leads to the inference that a widespread magma source, common to the region at large, such as an Archean sub-crustal layer, was being tapped as a primary source of volcanic material.

volcanic divisions(see Table 6). Large quantities of this material found their way from parent source by way of volcanic vents and fissures to the prevailing subaqueous environment; there it outflowed and intruded to form thick, lava-sill sequences of monotonous uniformity. Periodically during the later stages of this volcanic phase, limited compositional differentiation in the magma resulted in andesitic intercalations.

The Lower basic volcanic rocks of the Birch-Uchi lakes area must have accumulated during a very long period of time, probably measured in 10^4 - 10^6 years. Absence of significant sedimentary zones or other evidence of erosional activities suggests a quiet, stable, subaqueous environment undisturbed by surficial tectonic disturbances of note.

Chemical disequilibrium, possibly related to deep-seated tectonic disturbances or large-scale magma contaminations, gradually promoted compositional differentiation in the parent magma. As a result, those parts of the magma reservoir feeding the volcanic channelways, either the parent reservoir itself or inter-connected, high-level, satellite chambers, became increasingly felsic in composition. Rising SiO_2 content caused increased magma viscosity; this resulted in explosive discharge at surface of intermediate to acid pyroclastic material. Widespread extrusion of vast quantities of andesite-dacite tuff and breccias, limited rhyolite, pyroclastics, and subordinate lava flows, all presumably by way of the same or neighbouring volcanic vents and fissures as previously employed, produced the Lower acid volcanic rocks.

Essential uniformity of chemical composition throughout this division across the area suggests either a single, or closely related, magma source. This volcanic activity- a positive, constructional volcanic phase involving explosive discharge of vast quantites of acid to intermediate material- resulted in a highly irregular, varied, subaqueous - subaerial, volcanic terrain of substantial relief; volcanic discharge was undoubtedly accompanied by tectonic activity of substantial scale including local folding, faulting, subsidence and collapse. The combined effect of substantial relief and subaerial protrusion promoted normal erosion and clastic sedimentation; this produced the thick and persistent sedimentary zones of the Lower acid volcanic divisions. Sedimentation probably occurred both during and following the long period of acid to intermediate pyroclastic discharge; by this means, subaerially exposed parts of the acid volcanic zone - the erosional "bearing points" - were converted mainly or entirely to volcanic sediments.

With the parent magma chamber emptied of readily available felsic differentiates, the volcanism resumed a quieter phase of activity involving mainly gentle, subaqueous lava outflow, again of general tholeiitic character. Upper basic volcanic rocks accumulated during this period. The present stratigraphic record does not establish whether Upper basic volcanic rocks completely blanketed Lower acid volcanic rocks or were restricted in distribution to low-lying, subaqueous tracts.

Scanty evidence, confined to the extreme south part of the area, suggests that volcanism entered a second felsic explosive phase resulting in distribution of Upper acid volcanic material. Whether originally of widespread or strictly limited distribution is not known.

This brings to a close the preserved volcanic record of the Birch-Uchi lakes area. It is considered that subsequent to the events cited above, continuing erosion and sedimentation further sculptured this dominantly volcanic terrain prior to the long series of intrusive, tectonic, and erosional activities which together, have reduced this once-noble, Archean volcanic pile to its present highly folded, extensively intruded, and deeply eroded state.

ECONOMIC GEOLOGY

Introduction

Gold is the only significant mineralization so far located in the area. Of approximately 50 recorded prospects and occurrences 5 reached production during the period 1933-43. There is no regular gold production at present.

Production Record

The five mines produced 245,582 ounces of gold and 42,612 ounces of silver from 1,150,690 tons milled. The production record of individual mines is given in Table 7.

In addition, 362 ounces of gold and 29 ounces of silver from an undisclosed mill tonnage were produced at the Bobjo property in

1929. Some manual production of high grade material at Richardson Lake has also been undertaken in recent years.

Location of Mineral Occurrences

Of the 50 recorded occurrences, 10 are located in the immediate vicinity of Lost Bay in the southeast part, 18 in the Woman Lake - North Bay - Washagomis Lake vicinity in the centre-west, 5 in the Grace Lake - Springpole Lake vicinity in the centre-east, and 15 in the Birch Lake - Casummit Lake - Mink Lake vicinity in the north part of the area. The names and locations of the occurrences are shown in Table 8 and Figure 6 respectively.

Description of Mineral Occurrences

Summary Statement

Most mineral occurrences are associated with volcanic rocks of acid (rhyolite) to intermediate (andesite) composition. A rapid alternation of acid tuff breccia and andesitic lava flows is a common association, the mineral deposits occurring in one or other of the volcanic components. Dioritic masses are commonly present, as are narrow porphyry dikes and sills. Silicification of the host rock is a common feature as is the presence of inter-stratified chert, iron formation, and siliceous clastic sedimentary rocks. Some occurrences are in normal clastic sedimentary rocks. Specifically, of 50 mineral occurrences, 30 are directly enclosed in, or closely associated with, acid to intermediate pyroclastic rocks, 11 with massive lavas of intermediate to basic composition, 4 with porphyry dikes, and 5 with clastic sedimentary rocks.

Most occurrences consist of quartz veins and associated minerals (see Table 8). The mineralogy of the veins is generally simple. Many contain small amounts of metallic constituents. Pyrite is the most common and abundant. Traces of one or more of pyrrhotite, chalcopyrite, galena, and sphalerite are commonly present. The sulphides occur both in the quartz and impregnating the walls. Gold occurs both as the native metal and as tellurides. Alteration of the wall rocks is not very apparent; where observed, epidote and biotite have been formed and pyrite and arsenopyrite introduced. Calcite, ankerite, siderite, and tourmaline are locally present.

The Uchi, J - M Consolidated, Hudson Patricia, Sol D'Or, and Argosy mines are taken as examples of mineralization in the southeast, southwest, centre west, centre east, and north parts respectively of the area.

Uchi Mine

The geology in the vicinity of the Uchi mine, taken largely from Thomson (1938) and Bateman (1939a), comprises an alternation of intermediate to basic lava flows, diorite, and felsitic pyroclastics locally associated with cherty tuff. The rock units strike north-south and dip almost vertically. Stratigraphic tops are to the west. A considerable part of the diorite present appears to represent coarse-grained phases of thicker lava flows; other diorite units may represent intrusive sills. Fragmental flow tops and pillow structures are present. Most of the interbanded felsitic rock is highly silicified rhyolite; locally, it is finely bedded and resembles cherty tuff; disseminated pyrite is commonly present. A few, narrow aplite dikes cut across all other rock types.

The Uchi orebodies are composed of a number of quartz veins and stringers. The main ore zone lies in a sequence of predominantly intermediate to basic lava flows adjacent to the contact with diorite. In detail, the lava sequence consists of narrow andesite and basalt flows, each 50 to 100 feet thick, which are interbedded with thin layers of siliceous tuff and rhyolite, each 1 to 3 feet thick. Much of the ore zone lies between the principal quartz vein and one of these siliceous tuff beds.

The quartz is white and vitreous in appearance. It contains some carbonate and a small amount of sulphides. Visible gold is present. The rock adjacent to the quartz stringers is impregnated with fine-grained pyrite reported to carry gold values.

<u>J - M Consolidated Mine</u>

As reported by Bateman (1939b, p. 45) the vein lies in a folded series of basic lavas intruded by a number of narrow porphyry and granite dikes. A large mass of granite outcrops to the south. Observations made by the present writer in 1963 on the extension of this volcanic sequence 1 mile to the north suggests that considerable interbanded dacitic pyroclastic rock is present.

The ore vein at No. 2 shaft occurs in a northward-striking shear zone in a greenstone flow adjacent, and parallel, to a vertical quartz porphyry dike. A massive, parallel, granite dike occurs nearby. In a number of places the porphyry dike lies in the shear zone and has itself been altered to a schist.

The gold-bearing quartz veins range from a few inches to approximatately 6 feet in width. Quartz is associated with calcite and ankeritic carbonate. Disseminated pyrite, some chalcopyrite and sphalerite, free gold and tellurides are associated. Most of the free gold occurs in fractures in the quartz, particularly near the contact with silicified and chloritized wallrock either within, or at the border of, the vein.

Hudson - Patricia (Metals Development Limited)

The geology in the vicinity of the deposit comprises an alternation of acid to basic lava flows and pyroclastics, cherty tuff, and diorite. The rock units strike north-south and have steep to vertical dips. Stratigraphic tops are to the east. In detail, the rock sequence at the shaft, based on 1963 field observations, made by F. H. Hubbard, comprises a succession of dark grey-green, pyrite - impregnated, lava flows successively overlain to the east by (1) crudely bedded, fine-grained, sulphide-impregnated, dacitic tuff-breccia, approximately 30 feet thick, (2) a band of white to pale green, cherty tuff, 3 to 6 feet thick, (3) dacitic tuff-breccia, and finally, (4) dark grey-green lava flows similar to those at the base of this sequence. Porphyry dikes and diorite sills are present in the vicinity.

Development was carried out on a gold-bearing quartz vein ranging in width from a few inches to over 3 feet (Harding 1936, p. 23). The vein at depth is reported to occur largely in basic volcanics and diorite. Pyrite, galena, sphalerite, chalcopyrite and gold are present in the quartz. Intricate faults are reported to have complicated mining operations at this property. Pyrite is found in chlorite, which appears to be an alteration product of diorite. Pyrite also appears in schistose zones in diorite.

Sol D'Or Mine (Bathurst Mines)

The rock sequence in the vicinity of the mine consists of interbanded intermediate to basic lavas, acid tuffs and breccias, dark coloured, graphitic, cherty and slaty rocks, and fine- to medium-grained diorite. In general, the rock units strike in a northeast-southwest direction and dip steeply to the northwest. However, the rocks have been considerably folded and faulted. A northwest-trending fault zone is inferred to pass along a similarly-oriented arm of Grace Lake, situated $\frac{1}{2}$ mile north of the mine; highly schistose, acid, tuffs are exposed on the southwest shore of this arm.

A number of east-trending, north dipping, gold-bearing, quartz veins are present at the mine (Furse 1933, p. 43). The veins occur mainly in acid pyroclastic rocks and associated cherty tuffs near the contact with massive lavas and diorite. The veins are up to 1,000 feet long, and 2-3 feet wide. Glassy, light grey quartz is typically cemented by finer-grained quartz and ferruginous carbonate. Traces of chalcopyrite, pyrite, arsenopyrite and free gold are present. The wallrocks contain small amounts of pyrite, arsenopyrite and tourmaline. Number 3 vein reportedly (Furse 1933, p. 43) contains inclusions of diorite which, in turn, contain inclusions of rhyolitic wallrock.

Argosy Mine (Jason)

The rock sequence in the vicinity of the Argosy mine comprises an assemblage of intermediate to basic lavas successively overlain to the south by (1) impure quartzites, arkose, greywacke-argillite, and siliceous iron formation, (2) rhyolite pyroclastics and cherty tuffs, and (3) dacitic flows and breccias. These rocks have been intruded by occasional granite porphyry dikes. The rock units trend in a general east-west direction. Although considerably folded, the volcanic-sedimentary assemblage, based on 1963 field observations, by the present writer, forms a south-facing, monoclinal succession.

The most important veins occur in north-south fractures in fine-grained, siliceous sediments and banded iron formation at the north shore of Casummit Lake (Horwood 1937, pp. 19-21). Two quartz veins, Nos. 2 and 3, were opened up in underground workings. No. 2 vein ranges from a small stringer to a continuous vein with a maximum width of 7 feet. No. 3 vein is up to 4 feet wide. The veins follow a sinuous course in plan view and have been locally offset to the northeast.

The quartz veins range in colour from white to grey and in texture from massive to highly fractured. Quartz is associated with variable amounts of carbonate, arsenopyrite, pyrrhotite, pyrite, chalcopyrite, sphalerite, galena, and native gold. The walls of the veins are altered for distances up to 12 inches out from the vein. Alteration has taken the form of carbonatization, sericitization, and silicification, together with addition of pyrite and arsenopyrite.

Relation of Mineralization to Volcanism

Introduction

Gold occurrences in the Birch-Uchi lakes area are preferentially distributed with respect to the volcanic succession. In stratigraphic terms, most occurrences are located in the upper acid part of the Lower volcanic cycle. In lithologic terms, most occurrences are intimately associated with interbanded rhyolite-dacite pyroclastics and andesite-basalt lava flows. In structural terms, most gold-bearing quartz veins either lie at the contacts of enclosing lithologic units or occupy cross-cutting fractures within one or more adjacent litholologic units.

Distribution

In Figure 6 recorded gold occurrences of the area are plotted in relation to the distribution of acid to intermediate volcanic rocks and associated sedimentary rocks of the Lower volcanic cycle. It is immediately apparent that most occurrences lie within rocks of this particular assemblage. Specifically, of 50 recorded occurrences, 34 or 70 percent, are so distributed. Furthermore, this number includes all former producers and other significant occurrences. Of the remaining 16 occurrences, 10 are situated in underlying basic volcanic rocks, 3 in overlying volcanic rocks, and 3 in sedimentary rocks.

At Lost Bay, in the southeast part of the area, all occurrences but two lie in the uppermost 5,000 stratigraphic feet of the Lower Acid Volcanic assemblage. Most occurrences lie along three stratigraphic contact zones involving acid and basic volcanic layers and diorite sills. One such zone, situated at the upper contact of a thin cherty rhyolite unit (Thomson 1938, p. 79; map No. 47c) is apparently continuous along strike for more than 8,000 feet.

In the Woman Lake - North Bay - Washagomis vicinity to the west, the majority of occurrences are, again, situated within a few thousand feet of the stratigraphic top (east margin) of the Lower Acid Volcanic assemblage. Many of the gold-bearing quartz veins similarly follow the contacts of specific volcanic units, or are restricted to relatively narrow stratigraphic zones.

In the Birch Lake - Casummit Lake - Mink Lake vicinity to the north, most of the recorded gold occurrences appear to lie in the lower stratigraphic portion of the Lower Acid volcanic-sedimentary assemblage. This is particularly so in the east part, near Casummit Lake and Birch Lake; in the northwest part, near Mink Lake, where the stratigraphic succession is poorly defined, mineral occurrences may be more widely distributed in the acid pyroclastic assemblage.

Lithology

Although gold-bearing quartz veins are present in a variety of host rocks the large majority occur in acid pyroclastic rocks, lava flows of intermediate composition, and associated intrusive sills. Specifically, of 50 recorded occurrences, 30 occur within, or marginal to, acid (rhyolite-dacite) pyroclastics, 11 in andesite or andesite-basalt lavas and associated sills, 5 in clastic sedimentary rocks, and 4 in, or at the contact of, acid porphyry dikes and sills.

The principal lithologic hosts of 50 recorded occurrences are listed in Table 8. A firm impression gained by the present writer during the 1963 field season is that gold mineralization is preferentially associated with dense, siliceous host rocks, whether cherty tuff, silicified shale or quartzite, or bedded chert and iron formation.

Structure

Mineralized quartz veins display both concordant and discordant relations to enclosing host rocks. Concordant relations are displayed by the Hill - Tivy - Sloan vein at Lost Bay in the southeast part of the area (Thomson 1938, p. 79). The vein is located at the contact of underlying siliceous rhyolite to the east and overlying andesitic lava to the west. The vein is remarkably continuous and of uniform width. It is about 2½ feet wide and 1,300 feet long on the one property; however, the total length of the vein, traced across adjacent properties, probably exceeds 8,000 feet (Thomson 1938, map No. 47c).

Discordant structural relations are well displayed at the Argosy mine, Casummit Lake (Horwood 1937, pp. 19-21; map No. 46f). A series of north-south oriented, gold-bearing quartz veins are present in east trending sedimentary units. The productive veins are restricted to an east trending, stratigraphic zone approximately 600 feet wide.

Origin of Gold Deposits

Two main theories of origin have been proposed for this type of gold deposit - the classical hydrothermal theory and the direct volcanic theory. The two theories refer the gold to different sources and periods of emplacement relative to accumulation of the volcanic host rocks. Because exploration techniques and practices are influenced to a considerable extent by genetic considerations, the two theories are briefly described and appraised with respect to the Birch - Uchi lakes area (for a fuller discussion, see Goodwin, 1965, p. 9-11).

According to the classical hydrothermal theory, gold-bearing solutions of deep seated, igneous source migrated through the host rocks and deposited gold in favourable structural sites. The nature of the host rocks influenced mineralization as follows: brittle rocks such as rhyolite and chert fractured readily, and, being thereby structurally prepared, invited local gold precipitation; in addition, rocks of favourable chemical composition were locally replaced. The role of the host rocks, accordingly, was essentially passive, and the resulting metal distribution largely structural. General ore search is thereby strongly influenced by regional structural considerations.

The second theory of origin relates the source and period of mineralization directly to volcanism. This theory is receiving increasing attention in explanation of intimate metal-volcanic relationships in younger volcanic assemblages, such as those of Tertiary age. According to the theory, valuable metals and volcanic hosts represent sister products of common magmatic derivation. These products travelled from magmatic source to volcanic, or sub-volcanic, site during one general period, of activity, or series of closely related events.

Valuable metals were precipitated either at the volcanic or sedimentary surface (syngenetic deposits) or in the nearby, sub-volcanic environment (epithermal deposits). Deposits so formed were subject to mineral alteration, mobilization, and migration in response to later structural amd metamorphic events; mineral and textural features diagnostic of surface or near-surface deposition may, thereby, have been blurred or obliterated. The host rock, according to this theory of origin, played an active role, and the resulting metal distribution considered on a regional scale, is stratigraphically zonal. Ore search is guided by general volcanic-stratigraphic relationships, in conjunction with local structural controls.

Important features about the Birch - Uchi lakes area which merit consideration in this connection are:

(1) Gold occurrences are preferentially distributed in lithologic units that are products of a particular volcanic episode dominated by, discharge and accumulation of acid to intermediate volcanic products (Lower Acid Volcanic assemblage);

(2) Most gold occurrences are located in, or intimately associated with, closely interstratified siliceous pyroclastic rocks, sedimentary rocks, and andesitic flow units.

(3) In the south half of the area, most gold occurrences are restricted to a few, narrow, stratigraphic zones that lie in the upper 5,000 stratigraphic feet of this particular volcanic assemblage.

Conclusions and Recommendations

Available evidence does not warrant a final choice regarding ore genesis. However, it is felt that the features are more compatible with the second theory which relates gold mineralization directly to volcanism and associated igneous activities. Contemporaneous metal emplacement more readily explains the fact of selected metal distribution with respect to volcanic stratigraphy and lithology than does a theory whereby later, genetically distinct, gold-bearing solutions sought out and selected particular lithologic units of a particular stratigraphic assemblage.

Further studies of volcanic-metal relationships in this and other greenstone belts are required to reach firm genetic conclusions of practical importance to successful ore search.

In the meantime, irregardless of the precise mode of origin of gold deposits the best exploration targets in the Birch - Uchi lakes area would seem to be in the acid to intermediate volcanic zones, composed of interstratified siliceous pyroclastic rocks, siliceous sedimentary rocks, and andesite-basalt flows, as delineated in Figure 6.

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Table 1 Estimated True Thickness of 6 Stratigraphic Sections and their Volcanic Division in the Birch Lake-Uchi Lake area

	South part of area				North part of area	
	East Limb		West Limb			
	Uchi Lake section (feet)	Grace Lake section (feet)	South Woman Lake section (feet)	North Woman Lake section (feet)	Birch Lake section (feet)	Springpole Lake section (feet)
Sediments	----	----	----	----	2,000	4,000
Upper acid -	4,500	----	3,500	----	----	----
Upper basic -	8,500	5,000	4,500	6,500	----	----
Lower acid -	13,000	10,000	12,000	18,000	17,000	----
Lower basic -	11,000	14,500	19,000	12,500	6,000	12,000
Total	37,000	29,500	39,000	37,000	25,000	16,000

Average total stratigraphic thickness - 31,000 feet

Table 2 Lithologic Composition of Six Stratigraphic Sections and Composite Average in the Birch-Uchi Lakes Area

Stratigraphic Section & Divisions	Lithology																Total Thickness	
	Basalt		Andesite		Dacite		Rhyodacite		Rhyolite		Gabbro-Peridotite		Granite		Sediments			
	Feet	%	Feet	%	Feet	%	Feet	%	Feet	%	Feet	%	Feet	%	Feet	%	Feet	%
Uchi Lake Section(including Wabunk Bay Segment):																		
Lower Basic	8,000	72.8	-	-	600	5.4	-	-	-	-	2,400	21.8	-	-	-	-	11,000	100.0
Lower Acid	1,200	9.2	4,000	30.8	5,000	38.4	900	6.9	700	5.4	1,000	7.7	-	-	200	1.5	13,000	100.0
Upper Basic	7,500	88.4	600	7.0	-	-	-	-	400	4.6	-	-	-	-	-	-	8,500	100.0
Upper Acid	-	-	-	-	-	-	2,200	49.0	-	-	-	-	2,300	51.0	-	-	4,500	100.0
Total	16,700	45.0	4,600	12.5	5,600	15.0	3,100	8.4	1,100	3.0	3,400	9.2	2,300	6.2	200	0.5	37,000	100.0
South Woman Lake Section:																		
Lower Basic	13,800	72.6	-	-	1,100	5.8	-	-	-	-	4,100	21.6	-	-	-	-	19,000	100.0
Lower Acid	2,400	20.0	1,000	8.3	1,800	15.0	3,900	32.5	-	-	1,700	14.2	1,200	10.0	-	-	12,000	100.0
Upper Basic	3,900	86.6	350	7.8	-	-	-	-	250	5.6	-	-	-	-	-	-	4,500	100.0
Upper Acid	-	-	-	-	-	-	-	-	1,700	48.5	-	-	1,800	51.5	-	-	3,500	100.0
Total	20,100	51.5	1,350	3.5	2,900	7.4	3,900	10.0	1,950	5.0	5,800	14.9	3,000	7.7	-	-	39,000	100.0
Grace Lake Section:																		
Lower Basic	9,500	65.5	3,100	21.3	400	2.7	-	-	-	-	1,500	10.5	-	-	-	-	14,500	100.0
Lower Acid	1,000	10.0	1,000	10.0	-	-	4,000	40.0	500	5.0	-	-	-	-	3,500	35.0	10,000	100.0
Upper Basic	5,000	100.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,000	100.0
Total	15,500	52.5	4,100	13.9	400	1.4	4,000	13.6	500	1.7	1,500	5.0	-	-	3,500	11.9	29,500	100.0
North Woman Lake Section(including Middle Woman Lake Segment):																		
Lower Basic	8,500	68.0	1,800	14.4	400	3.2	-	-	-	-	1,800	14.4	-	-	-	-	12,500	100.0
Lower Acid	3,000	16.7	4,800	26.6	3,500	19.4	1,300	7.2	-	-	1,900	10.6	-	-	3,500	19.5	18,000	100.0
Upper Basic	5,900	90.8	-	-	-	-	600	9.2	-	-	-	-	-	-	-	-	6,500	100.0
Total	17,400	47.0	6,600	17.9	3,900	10.5	1,900	5.1	-	-	3,700	10.0	-	-	3,500	9.5	37,000	100.0
Springpole Lake Section:																		
Lower Basic	7,000	57.5	5,000	42.5	-	-	-	-	-	-	-	-	-	-	-	-	12,000	100.0
Sediments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,000	100.0	4,000	100.0
Total	7,000	43.8	5,000	31.1	-	-	-	-	-	-	-	-	-	-	4,000	25.1	16,000	100.0
Birch Lake Section(including West Birch Lake Segment):																		
Lower Basic	3,500	58.4	2,400	40.0	-	-	-	-	-	-	-	-	-	-	100	1.6	6,000	100.0
Lower Acid	6,000	35.1	1,500	8.8	3,000	17.7	500	2.9	2,500	14.8	-	-	1,000	5.9	2,500	14.8	17,000	100.0
Sediments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,000	100.0	2,000	100.0
Total	9,500	38.0	3,900	15.6	3,000	12.0	500	2.0	2,500	10.0	-	-	1,000	4.0	4,600	18.4	25,000	100.0
Composite Average	86,200	47.0	25,550	13.9	15,800	8.6	13,400	7.3	6,050	3.3	14,400	7.9	6,300	3.4	15,800	8.6	183,500	100.0

Footnotes 1-6, as per Table 1

Table 3 Description, classification and chemical composition of rock samples collected in the Birch-Uchi lakes area, Ontario

Sample[1] Number	Description	Classification	Chemical Analysis SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	P_2O_5	L.O.I.	Sp.Gr.
Uchi Lake Section (including Wabunk Bay Segment)															
63-21	Massive lava	basalt	49.3	14.3	4.74	8.65	7.60	7.58	2.13	0.21	0.82	0.15		4.30	2.93
-22	Massive sill (or thick flow)	peridotite-pyroxenite	38.1	4.98	6.40	4.47	32.9	1.67	0.39	....	0.22	0.16		10.91	2.73
-23	Massive sill (or thick flow)	gabbro-norite	46.4	16.4	0.83	3.96	11.1	13.9	0.71	0.05	0.27	0.11		5.16	3.03
-24	Tuff	rhyodacite	65.1	15.0	1.79	2.16	5.10	2.58	4.16	0.73	0.48	0.02		2.83	2.65
-25	Massive sill (or thick flow)	peridotite-pyroxenite	37.4	5.03	3.65	6.51	32.8	1.19	0.35	....	0.15	0.13		13.35	2.70
-26	Massive lava: green; feldspathic	basalt	49.6	15.3	1.85	10.00	7.55	7.14	2.76	0.39	0.85	0.22		4.66	2.87
-28	Massive lava: grey-green, medium-grained	basalt	48.2	14.1	1.67	10.30	8.47	9.83	1.74	0.43	0.83	0.23		2.48	2.99
-27	Massive lava: grey-green	basalt	47.2	16.7	3.84	10.23	4.35	9.36	2.52	0.34	1.66	0.21		3.55	3.00
-29	Tuff: dense, massive	dacite	63.6	15.1	1.59	2.68	2.65	5.40	4.35	1.18	0.54	0.09		1.86	2.75
-30	Tuff: dense, grey	rhyodacite	68.8	15.1	0.78	1.80	1.29	3.42	5.77	1.65	0.37	0.07		2.19	2.69
-33	Tuff: massive to finely, fragmental in hand specimen	dacite	61.4	17.6	1.03	3.90	3.09	5.13	4.13	0.20	0.59	0.06		3.03	2.76
-32	Breccia: grey-green fragments and matrix	andesite	54.8	13.2	1.32	6.42	8.00	8.06	2.17	0.44	0.70	0.13		5.06	2.86
-31	Massive lava: green	basalt-andesite	50.1	16.1	1.44	5.48	6.20	6.08	2.92	1.88	0.84	0.15		7.41	2.76
- 6	Tuff breccia: white to green fragments and matrix	basalt-andesite	50.7	15.3	1.57	6.54	4.59	6.15	3.19	0.97	0.92	0.13	0.28	7.88	2.74
-15	Massive sill	gabbro	49.8	12.4	5.09	7.39	6.25	9.95	2.12	0.02	1.28	0.20	0.16	3.63	3.00
-14	Dike rock: fresh, dark green	diorite	52.5	11.2	1.03	4.77	9.20	8.33	1.40	3.14	0.73	0.12		7.97	2.70
- 5	Pillow lava: well-formed pillows	andesite	51.4	12.4	3.25	8.86	4.09	6.73	2.98	0.57	1.24	0.22	0.20	6.11	2.87
-40	Amygdaloidal lava	basalt	51.1	14.0	1.42	10.38	2.88	6.49	3.32	0.85	1.29	0.18		8.31	2.73
-13	Tuff or flow: banded	rhyolite	71.2	13.7	0.41	2.67	2.33	1.67	5.80	0.53	0.46	0.05	0.16	1.70	2.67
-39	Tuff or flow: silicified	rhyolite	75.8	12.1	0.68	1.59	0.60	0.30	3.64	2.80	0.28	0.02		0.25	2.65
-38	Massive lava	basalt	49.5	20.1	6.32	1.57	1.00	14.2	1.85	0.02	0.41	0.23		2.80	3.10
-10	Tuff or flow	rhyodacite	69.3	14.8	0.66	2.59	1.70	2.25	4.14	1.56	0.49	0.04	0.04	1.42	2.65
- 4	Tuff or flow	rhyolite	72.6	13.7	1.12	1.76	1.22	0.83	3.58	2.33	0.43	0.04	0.05	2.20	2.60
- 9	Tuff breccia	rhyolite	73.5	11.5	1.13	2.31	0.89	1.29	4.81	0.44	0.41	0.06	0.09	3.30	2.66
- 3	Pillow lava	andesite	53.3	12.4	2.74	9.83	3.53	5.98	3.45	0.51	1.30	0.21	0.22	6.13	2.87
- 2	Vesicular lava: grey-green	dacite	59.3	14.3	1.11	6.41	2.99	4.99	3.15	1.68	0.99	0.21	0.25	6.14	2.84
- 1	Massive lava	basalt	50.0	13.9	1.25	10.23	5.45	6.95	2.70	0.68	1.40	0.17	0.21	7.74	2.70
- 8	Breccia	basalt	50.4	12.9	2.12	8.31	6.00	10.28	2.50	0.31	1.19	0.17	0.21	6.90	2.89
- 7	Massive sill	gabbro	50.5	12.8	3.54	10.30	5.90	9.12	2.01	0.09	1.07	0.19	0.10	4.52	2.92
-11	Tuff	basalt	48.0	15.6	2.48	8.93	6.98	9.80	1.57	0.23	1.06	0.17	0.07	5.41	2.98
-16	Breccia	andesite	56.0	12.6	8.58	6.30	1.63	6.10	2.24	0.28	1.61	.22		4.09	2.82
-12	Tuff or flow: dense, fine-grained	rhyodacite	69.8	10.1	3.61	4.11	0.86	2.75	2.27	0.93	0.58	0.15	0.10	3.72	2.73
South Woman Lake Section															
63-37	Massive lava: grey-green	basalt	47.5	16.6	2.29	7.88	6.60	9.11	2.70	0.27	0.87	0.19		4.17	3.01
-36	Tuff or lava: spherulitic	rhyodacite	69.5	10.5	2.12	5.34	0.69	2.88	3.17	0.51	0.49	0.13		3.68	2.65
-35	Massive lava: dense, fine-grained	basalt	47.0	18.3	2.67	7.56	6.13	11.2	2.22	0.21	0.85	0.21		3.34	3.00
-34	Tuff or flow: spherulitic	dacite	63.3	14.5	1.07	3.46	3.14	6.31	4.95	0.06	1.11	0.16		2.49	2.71
-19	Tuff or massive lava	rhyolite	74.1	10.2	1.14	3.67	0.17	1.28	3.87	1.63	0.47	0.10		1.42	2.70
-20	Tuff breccia	rhyolite	72.4	10.7	2.33	4.29	0.83	1.63	4.14	0.51	0.55	0.15		1.80	2.71
-18	Tuff or lava: dense, fine-grained	rhyodacite	68.5	11.4	2.37	5.25	0.81	2.58	4.20	0.75	0.44	0.18		2.29	2.72
-17	Tuff breccia	rhyolite	75.7	10.7	0.75	2.59	0.26	1.38	4.06	1.47	0.37	0.04		2.55	2.69
Middle Woman Lake Segment															
63-64	Amygdaloidal and pillowed lava	dacite	58.5	13.7	1.15	4.56	4.05	4.99	3.13	1.46	0.71	0.09		6.81	2.69
-63	Vesicular lava	dacite	63.6	14.7	0.98	4.46	2.39	3.06	3.60	1.48	0.59	0.09		4.92	2.70
-65	Massive lava	andesite	51.2	12.5	2.52	10.55	4.28	7.22	1.83	0.25	1.48	0.22		6.72	2.86

[1] arranged in stratigraphic order from base to top of stratigraphic sections.

Table 3 (cont.)

Sample[1] Number	Description	Classification	Chemical Analysis SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	P_2O_5	L.O.I.	Sp.Gr.
63-66	Massive lava: dark green, locally amygdaloidal	dacite	61.2	12.6	2.38	7.35	2.35	4.42	4.74	0.33	1.26	0.20		2.64	2.76
-67	Tuff or lava: spherulitic	rhyodacite	67.1	11.7	2.38	8.48	0.95	2.20	1.58	1.38	0.65	0.17		4.02	2.73
-68	Pillowed and amygdaloidal lava	andesite	53.0	13.2	1.08	8.80	3.49	8.52	3.42	0.27	1.30	0.24		5.84	2.63
-69	Massive lava: grey-green, dense	basalt	49.9	13.5	2.83	8.80	5.15	8.00	3.27	0.13	1.01	0.18		6.28	2.94
-70	Massive lava: dark grey-green	basalt	50.6	13.8	2.40	9.15	5.15	7.10	4.08	0.02	1.28	0.28		4.81	2.77
North Woman Lake Section															
63-41	Feldspar porphyry lava	rhyodacite	68.3	16.0	0.91	2.24	1.55	1.92	0.77	3.15	0.49	0.05		5.07	2.63
-42	Tuff: schistose	andesite	57.5	17.7	0.72	5.40	4.37	2.50	0.51	3.68	0.71	0.08		7.54	2.77
-43	Massive lava: grey-green	basalt	48.0	17.2	2.22	8.45	6.75	9.27	1.00	0.02	0.65	0.24		5.53	2.97
-44	Pillowed and brecciated lava: bottle green	basalt	45.2	17.1	0.51	9.52	6.90	6.26	2.74	0.23	0.70	0.29		9.78	2.72
-45	Pillow lava	basalt	49.0	18.6	1.74	11.30	2.94	6.71	2.64	0.02	0.79	0.24		5.63	2.89
-71	Massive lava: schistose	basalt	44.8	19.5	0.45	15.15	4.70	2.68	0.59	2.05	0.77	0.32		8.81	2.96
-52	Tuff or lava: fine-grained, spherulitic	rhyodacite	65.7	11.6	3.29	4.67	1.13	6.48	1.28	0.76	0.64	0.16		2.77	2.90
-53	Tuff: fine-grained	andesite	52.3	11.9	5.32	10.05	3.29	7.06	2.17	0.12	1.89	0.25		4.13	2.90
-54	Pillow lava	basalt	47.0	15.4	1.86	9.80	5.96	11.0	1.53	0.08	1.18	0.20		4.22	3.04
-46	Pillow lava: locally brecciated	basalt	45.0	18.7	1.97	8.73	6.52	10.8	1.95	0.02	0.77	0.18		4.55	2.97
63-47	Massive lava: local pillow and breccia zones	basalt	46.7	16.3	1.84	8.00	6.06	11.2	2.74	0.02	0.63	0.17		5.54	2.98
-50	Lava or tuff: prominently spherulitic, light grey	rhyodacite	67.7	11.2	1.51	6.56	0.99	2.77	3.83	0.19	0.67	0.16		4.68	2.71
-49	Lava or tuff: prominently spherulitic, light grey	rhyodacite	67.3	12.6	1.63	6.20	0.91	2.03	4.75	0.07	0.66	0.16		3.50	2.79
-48	Massive lava: local breccia zones	basalt	48.3	16.3	3.08	7.94	5.30	10.3	1.95	0.02	0.83	0.18		5.52	2.86
-51	Massive to pillowed lava: grey-green	basalt	47.2	16.2	2.61	8.22	6.17	10.5	1.92	0.02	0.72	0.20		6.03	2.85
-61	Lava flow: mainly massive, in part spherulitic	basalt	48.4	14.9	2.50	9.44	4.47	8.95	3.07	0.02	1.31	0.19		5.52	2.88
-72	Massive to vaguely pillowed lava	basalt	46.7	17.1	2.54	7.74	6.15	10.73	2.17	0.13	0.76	0.19		4.46	2.91
Grace Lake Section															
63-122	Massive lava	andesite	53.4	15.2	3.10	5.17	5.80	6.73	3.06	2.15	0.64	0.14	0.46	3.97	2.89
-118	Massive volcanic rock	andesite	57.2	16.6	1.88	5.68	3.49	4.86	2.70	2.27	0.76	0.11		4.16	2.82
-117	Massive volcanic rock	basalt	47.8	16.7	1.46	7.75	8.20	10.93	1.48	0.02	0.74	0.15		4.20	2.83
-121	Lava or tuff: dense, pale grey	rhyodacite	67.4	14.7	0.21	1.87	1.48	1.80	5.45	1.38	0.42	0.04	0.46	3.11	2.67
-119	Massive volcanic rock	dacite	58.3	13.3		5.77	5.40	4.28	3.04	0.97	0.60	0.12	0.14	6.59	2.66
-116	Lava or tuff: fine-grained, spherulitic	rhyodacite	70.6	11.4	1.54	5.70	0.93	2.03	3.61	0.84	0.59	0.10		2.52	2.72
-120	Massive lava: apple green	rhyodacite	69.7	15.7	0.26	2.34	1.59	1.50	5.32	1.06	0.44	0.07	0.08	2.38	2.66
-115	Massive lava or sill: gabbroic texture	andesite	56.3	12.4	4.29	9.65	3.17	4.77	2.19	0.45	1.55	0.24		4.48	2.81
63-58	Massive lava: grey fine-grained	basalt	48.0	16.4	1.18	7.06	7.10	10.91	1.72	0.36	0.44	0.14		4.90	2.91
-56	Massive to porphyritic lava	basalt	47.6	20.0	0.65	5.55	7.10	10.60	1.58	0.82	0.41	0.12		4.47	2.85
-57	Massive lava: grey fine-grained	basalt	48.5	17.5	1.00	7.00	6.60	11.95	1.50	0.51	0.46	0.16		3.35	2.91
-123	Lava or tuff: dense, grey, quartz porphyry	rhyolite	72.3	14.6		1.50	0.38	1.54	5.45	1.58	0.30	0.04		2.03	2.65
-59	Lava or tuff: light grey, spherulitic	rhyodacite	66.6	11.8	2.00	6.63	1.01	2.00	4.16	0.43	0.82	0.18		2.75	2.70
-55	Lava or tuff: grey spherulitic	rhyodacite	68.1	11.4	1.99	5.16	0.74	2.95	2.64	1.62	0.54	0.12		4.09	2.67
-74	Massive to pillowed lava flow	basalt	47.0	15.0	2.04	8.96	7.03	11.60	1.78	0.02	0.81	0.18		4.12	2.94
-73	Massive lava: locally porphyritic	basalt	46.9	17.2	2.13	6.48	7.10	12.60	1.62	0.23	0.51	0.16		3.83	3.00
-62	Amygdaloidal lava flow	basalt	50.9	15.6	2.46	9.66	4.04	6.15	3.00	0.51	1.17	0.28		5.45	2.76
Springpole Lake Section															
63-78	Massive lava: slightly schistose	dacite	58.4	15.7	2.90	6.00	4.08	5.80	3.66	0.61	0.92	0.16		1.84	2.85
-77	Pillow lava	dacite	59.6	15.0	0.88	6.05	3.95	6.03	4.04	0.87	0.97	0.13		1.47	2.81
-75	Sheared tuff (or greywacke)	dacite	60.9	15.3	1.80	3.69	4.03	4.91	2.36	2.45	0.58	0.11		4.14	2.71

Table 3 (cont.)

Sample[1] Number	Description	Classification	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	P_2O_5	L.O.I.	Sp.Gr.
63-79	Massive lava	basalt	50.5	13.0	7.82	7.00	5.70	7.21	2.68	0.82	0.97	0.25		2.18	3.02
-80	Pillow lava: magnetite-bearing	basalt	47.9	14.8	7.18	5.40	5.25	10.93	2.72	0.61	1.06	0.21		4.01	3.04
-81	Pillow lava: magnetite-bearing	basalt	51.0	12.8	7.66	7.00	5.80	7.65	2.97	0.28	0.99	0.26		3.82	2.88
-82	Vesicular lava with sparse pillows	basalt	49.0	14.9	2.28	6.17	4.52	8.91	4.77	0.08	0.96	0.15		8.85	2.75
-83	Porphyritic lava	basalt	48.1	16.8	2.20	7.78	7.78	6.68	2.61	0.27	0.89	0.14		7.47	2.75
-84	Massive lava: moderately sheared	andesite	51.5	16.2	1.83	8.75	3.02	6.51	2.56	1.55	1.16	0.16		7.43	2.72
-85	Massive lava	andesite	52.9	15.5	1.25	7.10	3.68	7.08	2.39	1.59	0.92	0.15		8.71	2.70
-86	Pillow lava	andesite	53.6	15.5	1.40	7.04	3.67	7.26	3.61	0.64	0.92	0.19		7.95	2.72
Birch Lake Section (including West Birch Lake Segment)															
63-88	Massive lava: schistose	basalt	51.5	14.3	2.26	8.16	4.27	10.47	1.89	0.19	0.69	0.25		5.65	2.93
-93	Tuff: dense, massive	andesite	54.2	14.4	3.76	6.08	5.32	6.21	3.64	0.94	0.71	0.21		3.84	2.95
-94	Flow breccia	andesite	56.5	15.6	2.22	5.90	3.38	4.71	4.37	0.54	0.68	0.16		4.36	2.72
-89	Pillow lava	basalt	49.4	14.5	2.11	8.07	4.88	9.99	2.34	0.19	0.65	0.24		5.79	2.83
-90	Pillow lava	basalt	51.0	14.8	1.55	7.66	4.45	10.19	2.89	0.34	0.59	0.21		7.08	2.72
-91	Sill or thick flow	basalt	47.8	14.5	4.52	8.45	6.20	9.81	1.78	0.05	0.79	0.22		4.11	3.02
-92	Pillow lava	andesite	55.1	13.7	3.36	7.70	3.97	5.20	2.51	0.72	0.79	0.24		5.34	2.87
-95	Massive lava	basalt	48.3	13.4	3.97	11.45	4.38	8.90	1.87	0.02	1.38	0.24		4.88	2.99
- 98	Breccia: white to light grey	rhyolite	71.3	15.6	0.52	0.65	0.34	2.41	4.22	1.66	0.43	0.02		1.95	2.67
- 96	Tuff or flow: dense, yellow-green	rhyolite	74.2	14.2	0.23	0.46	0.19	0.52	4.03	3.89	0.21	0.03		1.27	2.61
- 97	Pillow lava	basalt	48.5	17.8	2.18	9.56	4.80	6.27	3.62	0.32	1.43	0.17		5.10	2.86
-124	Sill or thick flow: in part porphyritic	basalt	48.3	15.7	1.96	9.12	6.73	10.4	1.96	0.08	0.80	0.17	0.05	2.89	3.04
-125	Tuff: dark grey, fine-grained	dacite	58.6	14.9	0.34	6.67	3.00	4.70	3.16	1.00	0.71	0.09	0.19	5.26	2.72
-126	Lava flow: sparse pillows	basalt	49.3	13.6	1.66	10.01	7.15	7.23	2.12	0.05	0.77	0.20	0.06	6.21	2.91
-127	Massive volcanic rock: schistose	basalt	46.3	14.4	0.75	9.86	5.38	8.90	2.20	0.05	0.70	0.17	0.06	9.49	2.86
-130	Massive volcanic rock: schistose	basalt	46.6	14.2	1.90	11.7	6.40	9.00	1.93	0.05	1.01	0.21	0.11	5.05	2.95
-129	Pillow lava flow grey-green	basalt	49.3	15.6	1.74	10.2	4.82	8.77	2.54	0.05	1.00	0.21	0.07	4.83	3.10
-102	Tuff: grey schistose	dacite	61.5	14.8	1.07	3.49	2.00	4.22	2.47	1.58	0.49	0.06	0.13	7.86	2.71
-103	Tuff: grey-green, schistose	dacite	62.3	14.3	0.23	2.53	1.63	6.33	4.11	0.50	0.33	0.07	0.07	6.82	2.68
- 76	Massive volcanic rock	basalt	50.1	14.4	2.42	8.45	5.45	9.17	2.10	0.02	0.65	0.23		6.64	2.85
-101	Tuff: medium grey, fine-grained	dacite	62.3	15.4	0.81	3.79	1.41	3.68	3.79	1.51	0.52	0.06	0.17	5.38	2.72
-100	Massive lava flow	andesite	58.4	14.9	1.45	4.38	4.35	5.40	3.63	1.42	0.63	0.09	0.22	3.53	2.82
- 99	Tuff: schistose	andesite	52.7	15.2	2.34	5.97	5.60	7.25	3.16	1.02	0.74	0.13	0.33	4.81	2.84
-104	Tuff: grey-green, porphyritic	rhyodacite	66.1	16.2	2.00	1.42	1.66	1.76	4.73	2.38	0.42	0.04	0.20	2.97	2.72
- 87	Tuff	andesite	51.4	16.9	4.55	6.05	5.95	6.69	3.55	1.67	0.99	0.19		3.54	2.86
-105	Massive lava: pale green	basalt	48.6	13.9	1.75	10.5	6.78	9.40	2.00	0.05	0.97	0.20	0.06	3.86	3.02
-106	Tuff or lava: dense, white to pale green, quartz porphyry	rhyolite	76.4	14.6	nil	0.47	0.38	0.60	3.16	2.54	0.31	0.05	0.05	1.99	2.66
-128	Tuff breccia	rhyolite	72.1	15.6	0.61	2.04	0.43	0.62	4.84	1.18	0.40	0.02	0.08	2.19	2.69
-107	Tuff breccia: green, chloritic	andesite	56.2	16.6	0.83	6.13	4.28	4.45	4.22	0.72	0.62	0.16	0.15	5.61	2.78
-109	Tuff: grey	dacite	59.3	14.2	2.00	3.08	2.53	4.27	5.52	3.42	0.71	0.06	0.42	3.80	2.75
-110	Tuff: vesicular, felsitic	dacite	60.0	14.2	2.73	2.32	2.52	4.00	5.28	3.75	0.66	0.07	0.42	3.63	2.71
-111	Tuff: feldspar-amphibole porphyry	basalt	49.4	12.9	1.47	12.00	8.80	5.72	2.52	0.32	1.07	0.16	0.17	4.99	2.87
-108	Tuff breccia	basalt	49.9	13.8	4.08	9.64	3.84	5.42	3.79	0.17	1.59	0.16	0.21	6.29	2.87

Table 4 Average Chemical Composition of Volcanic Rock Types in the Birch-Uchi Lakes Area

	Basalt	Andesite	Dacite	Rhyodacite	Rhyolite	Gabbro-Peridotite
SiO_2	48.6	54.0	60.6	67.9	73.5	44.4
Al_2O_3	15.5	14.5	14.7	13.0	13.1	10.3
Fe_2O_3	2.51	2.81	1.31	1.71	0.75	3.90
FeO	8.84	7.37	4.47	4.27	2.00	6.53
MgO	5.80	4.20	3.09	1.37	0.67	17.81
CaO	8.79	6.19	4.88	2.58	1.17	7.17
Na_2O	2.35	2.83	3.84	3.63	4.30	1.12
K_2O	0.30	1.02	1.38	1.08	1.71	.03
TiO_2	.89	.99	.72	0.54	0.38	.60
P_2O_5						
MnO	.20	.18	.11	0.11	0.05	.16
Loss on Ignition	5.39	5.49	4.35	3.18	1.89	7.51
Sp. Gr.	2.89	2.81	2.75	2.71	2.66	2.87
No. of Samples	52	20	18	17	12	5

Table 5 Chemical Composition of Six Stratigraphic Sections and Composite Average in the Birch-Uchi Lakes Area

Volcanic Division	Estimated True Thickness (feet)	Chemical Composition											
		SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	L. on I.	S.G.
Uchi Lake Section (including Watunk Bay Segment):													
Upper Acid Volcanics	4,500	69.8	10.1	3.61	4.11	0.86	2.75	2.27	0.93	0.58	0.15	3.72	2.73
Upper Basic Volcanics	8,500	51.2	13.9	2.81	8.72	5.63	8.57	2.22	0.30	1.15	0.17	5.66	2.88
Lower Acid Volcanics	13,000	58.9	14.7	1.76	4.71	4.08	6.11	3.48	0.96	0.71	0.12	3.93	2.79
Lower Basic Volcanics	11,000	50.0	14.6	3.58	8.82	7.27	7.81	2.29	0.32	0.89	0.17	3.82	2.92
Total Section	37,000	55.8	13.9	2.77	6.78	4.99	6.77	2.69	0.61	0.85	0.15	4.27	2.84
South Woman Lake Section:													
Upper Acid Volcanics	3,500	72.7	10.8	1.65	3.95	0.52	1.72	4.07	1.09	0.46	0.12	2.01	2.70
Upper Basic Volcanics[1]	4,500	51.2	13.9	2.81	8.72	5.63	8.57	2.22	0.30	1.15	0.17	5.66	2.88
Lower Acid Volcanics	12,000	59.7	13.5	2.34	5.45	3.39	5.99	3.12	0.46	0.75	0.16	3.73	2.80
Lower Basic Volcanics[2]	19,000	50.0	14.6	3.58	8.82	7.27	7.81	2.29	0.32	0.89	0.17	3.82	2.92
Total Section	39,000	55.2	13.9	2.94	7.33	5.28	6.79	2.70	0.43	0.84	0.16	3.84	2.86
Grace Lake Section:													
Upper Basic Volcanics	5,000	48.2	15.8	2.34	8.69	5.58	9.67	2.42	0.19	0.96	0.21	4.78	2.89
Lower Acid Volcanics[5]	10,000	63.3	13.4	1.68	5.75	2.38	3.60	3.36	0.85	0.70	0.13	3.52	2.74
Lower Basic Volcanics[3]	14,500	51.5	15.3	3.01	7.31	5.94	7.49	2.64	0.85	0.86	0.16	4.65	2.85
Total Section	29,500	53.8	14.9	2.55	7.19	4.98	6.94	2.78	0.72	0.84	0.16	4.39	2.83
North Woman Lake Section (including Middle Woman Lake Segment):													
Upper Basic Volcanics	6,500	49.0	16.0	2.28	8.20	5.48	10.0	2.28	0.04	0.79	0.18	5.24	2.91
Lower Acid Volcanics[5]	18,000	56.3	15.6	1.68	6.78	3.85	5.08	1.85	1.71	0.79	0.15	6.01	2.80
Lower Basic Volcanics[4]	12,500	51.1	14.5	3.23	8.40	5.83	7.89	2.53	0.33	0.85	0.19	4.44	2.89
Total Section	37,000	52.9	15.3	2.37	7.66	4.91	7.08	2.19	0.87	0.81	0.17	5.27	2.85
Springpole Lake Section:													
Lower Basic Volcanics	12,000	51.4	15.2	3.37	6.94	4.94	7.37	3.22	0.69	0.97	0.17	6.02	2.80
Birch Lake Section (including West Birch Lake Segment):													
Lower Acid Volcanics[5]	17,000	56.5	15.0	1.56	5.50	4.12	5.79	3.28	1.00	0.75	0.13	4.55	2.83
Lower Basic Volcanics	6,000	52.1	14.5	2.89	7.98	4.39	7.96	2.76	0.35	0.81	0.22	5.05	2.87
Total Section	23,000	55.4	14.9	1.91	6.15	4.19	6.36	3.14	0.83	0.77	0.15	4.68	2.84
Composite Average[6]		54.4	14.5	2.62	7.06	4.93	6.84	2.70	0.67	0.83	0.16	4.56	2.84

1 Assumed to be equivalent to Upper Basic Volcanics of the Uchi Lake Section.

2 Assumed to be equivalent to Lower Basic Volcanics of the Uchi Lake Section.

3 Assumed to be equivalent to 1/3 Lower Basic Volcanics of each of Uchi Lake Section and Springpole Lake Section plus 1/3 Lower Basic Volcanics of Grace Lake Section as sampled in the field.

4 Assumed to be equivalent to equal parts of Lower Basic Volcanics of the South Woman Lake and Birch Lake Sections.

5 Sediments excluded in calculating compositional average.

6 Weighted with respect to total stratigraphic thicknesses.

Table 6

Average Chemical Composition of Basic and Acid Volcanic Divisions

	SiO_2	Ai_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	L.O.I.[1]	S.G.
1) Basic Volcanic Divisions	50.8	14.8	3.32	8.66	6.16	7.70	2.58	0.48	0.88	0.18	4.54	2.87
2) Acid Volcanic Divisions	58.2	14.1	1.80	5.65	3.73	5.51	2.97	1.04	0.75	0.14	4.50	2.80
Difference	+7.4	-0.7	-1.52	-3.01	-2.43	-2.19	+0.39	+0.56	-0.13	-0.04	-0.04	-0.07

1. Loss on ignition corrected for oxidation of FeO.

Summary of Differences

Gain (+)	Loss (-)
SiO_2 - 7.4 percent	Fe_2O_3 - 1.5 percent
Na_2O - 0.4	FeO - 3.0
K_2O - <u>0.6</u>	MgO - 2.4
Total- 8.4	CaO - 2.2
	Al_2O_3 - <u>0.7</u>
	Total 9.8

Table 7

Gold and Silver Production, 1939-1952

Mine	Period	Tons milled	Gold ounces	Silver ounces
Uchi	1939-43	757,074	114,467	14,345
J - M Consolidated	1934-40	105,357	27,125	18,141
Hudson Patricia	1936-37	11,228	1,857	305
Sol D'Or	1933-36	458	258	33
Argosy	1934-52	276,573	101,875	9,788
Total		1,150,690	245,582	42,612
Average Grade	-	0.21 ounces of gold per ton 0.037 ounces of silver per ton		

Table 8

Mineral Occurrences in the Birch - Uchi Lakes Area

No.	Name	Location	Vein Material	Host Rocks	Reference
1	Argosy (Casey Summit, Jason)	Casummit Lake, K.R.L.9681-9686, 9733-9740, 9758-9763.	Au,asp,py,cp, gn,q.	Tuffs,rhyolite, breccia,slate, quartzite, greywacke,iron formation.	Furse, p.30; Horwood, p.17-25.
2	Hatch	Joneston Lake, K.R.L.10445.	py,sid,q,Au	Chloritic tuff, agglomerate.	Furse, p.34.
3	Hatch	Mink Lake group, K.R.L.9259,9260.	py,sid,q.	Greenstone, feldspar porphyry.	Furse, p.35.
4	Hatch	Mink Lake,south side of narrows.	cp,py,gn,sid,q.	Dark green tuff.	Furse, p.36.
5	Blondin	North of Mink Lake, K.R.L.10636-38.	Au,py,sid,q.	Tuffaceous rock.	Furse. p.36.
6	Finn	Northwest of Joneston Lake, K.R.L.9679.	sp,gn,py,cp, q,calc,ank.	Green tuff.	Furse, p.36.
7	Richardson	North shore of Richardson Lake, K.R.L.10218.	Au,sp,py,gn, asp,tour, carb,q.	Greenstone.	Furse, p.37.
8	Graham	Joneston Lake, K.R.L. 9038.	Au,cp,sid,py,q.	Agglomerate, intermediate to acid.	Furse, p.37.
9	Graham	Richardson Lake, south shore, K.R.L.9746.	asp,py,q,calc.	Tuffs and agglomerate.	Furse, p.38.
10	Graham	South of Richardson Lake, K.R.L.9748.	carb,py,q,asp.	Iron formation in silicified chlorite schist.	Furse, p.39.
11	Hewitt & Zyone	East of Casummit Lake,K.R.L.9687.	cp,asp,py,q.	Dacitic tuff,basic lava.	Furse, p.39.
12	Dynes	South of Casummit Lake,K.R.L.8965.	sid,asp,py,q.	Arkose,slate.	Furse, pp. 39-40.
13	McIntyre	North Bay,Birch Lake, K.R.L.8596.	Au,asp,py,cp,sid, tour.	Basalt,tuff, iron formation.	Furse, pp. 40-41.
14	Boylen	North Bay,Birch Lake,K.R.L.8791.	py,asp,q,carb.	Chlorite schist, iron formation.	Furse, p.41.
15	Boylen	West group,Birch Lake.	asp,py,q.	Acid tuff.	Furse, p.42.
16	Sol. D'Or (Bathurst mine)	Grace Lake,K.R.L. 10790,10791, 10788.	Au,sid,py,asp,cp, gn,sp,tellurides, tour,q.	Basalts,acid tuff, diorite,rhyolite.	Furse, pp. 42-45. Harding,p.18.
17	Metals Development Ltd.	West of Confederation Lake. K.R.L.3889.	py,sp,q.	Andesite,basalt, diorite,granite; veins in diorite, altered greenstone.	Furse, p.45.

Table 8 (cont.)

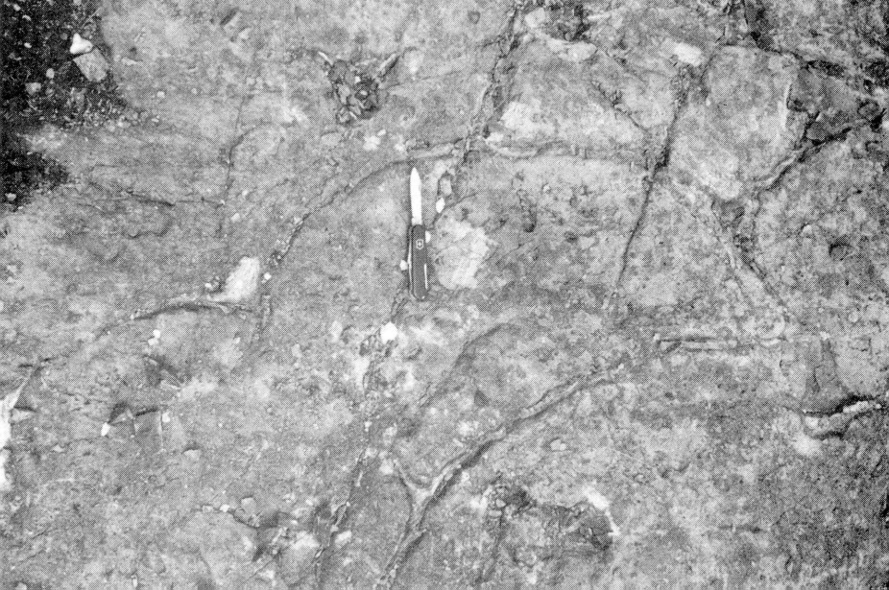
No.	Name	Location	Vein Material	Host Rocks	Reference
18	Metals Development Ltd.(Hudson Patricia).	West of Confederation Lake, K.R.L.5603, 2-compartment shaft.	Au,py,gn,sp,cp.	Keewatin basic volcanics, acid tuff, diorite.	Furse, p.47. p.12 of this report.
19	Rouillard group.	North end Confederation Lake, K.R.L.4101,4092, 4094.	Au,sid,py, asp,cp,po,q.	Andesite,rhyolite.	Furse, p.47.
20	Hurley - McDonald.	Woman - Washagomis Lakes, K.R.L.10269.	Au,gn,py,asp(?),q, carb.	Andesite,dacite,rhyolite tuffs and flows. Silicified rhyolitic tuff or breccia.	Furse, pp.47-48.
21	Swain,Harris & Cavano.	West of south bay of Birch Lake, K.R.L.12258.	Au,py,cp,asp, tour,q.	Conglomerate,greywacke,arkose, slate.	Harding,p.19.
22	Wagner & Melanson	West of Wagner Bay, Birch Lake, K.R.L.11149.	Au,py,q.	Conglomerate, greywacke,slate.	Harding,p.20.
23	Dunkin	North shore of Springpole Lake.	Au,cp,gn,sp, asp(?),tour, ank,q.	Keewatin lavas and thin-bedded sediments.	Harding,p.21.
24	Bergstrand	West of Bergstrand Lake, K.R.L.11344-11346.	Au,cp,gn,py,q.	Greywacke,quartzite,slate, conglomerate.	Harding,p.21.
25	Dole Bros.	North shore,east arm,Springpole Lake,K.R.L. 12591.	Au,cp,py,ank, tour,q.	Keewatin lavas, diorite,granite, syenite.	Harding,p.21-22.
26	Corless Patricia	East of Tims (Smith) Lake, K.R.L.5521.	Au,mo,py,cp, asp,q.	Andesitic lavas, diorite, granite.	Harding,p.25.
27	Bathurst Gold Mines Ltd.	Bathurst Lake.	Au,py,cp,sp,asp, gn,q.	Greenstone, diorite,granite.	Harding,p.26.
28	J - M Consolidated	Rowe and Belljoe Lakes, K.R.L. 3894,3817.	Au,petzite,py, tour,q.	Basic lavas, pillow lavas, diorite, granite, porphyry.	Bateman, pp.44-52.
29	Tripp-Gutcher	North of Rowan Lake, K.2020.	py,q.	Amygdaloidal lava weathering light green.	Bruce,p.33.
30	Woman Lake Centre Syndicate	West shore of Woman Lake, K.1829.	Au,py,sp,cp, ank,q.	Acidic flows and tuffs.	Bruce,p.34.
31	Costello	South of Woman Lake & Corless Lake,K.R.L.5501.	cp,gn,q.	Chlorite schist.	Bruce,p.35.
32	Woman Lake Goldfields Development	West of Shanty Bay, Woman Lake, K.1749-1772.	q.	Massive greenstone, pillows,iron formation.	Bruce,p.36.
33	Picard	North part of Woman Lake, K.R.L.3794-3796,6000,6001.	py,asp,gn,sp,q.	Acid lavas and volcanic fragmentals, amygdaloidal lavas.	Bruce,p.36.

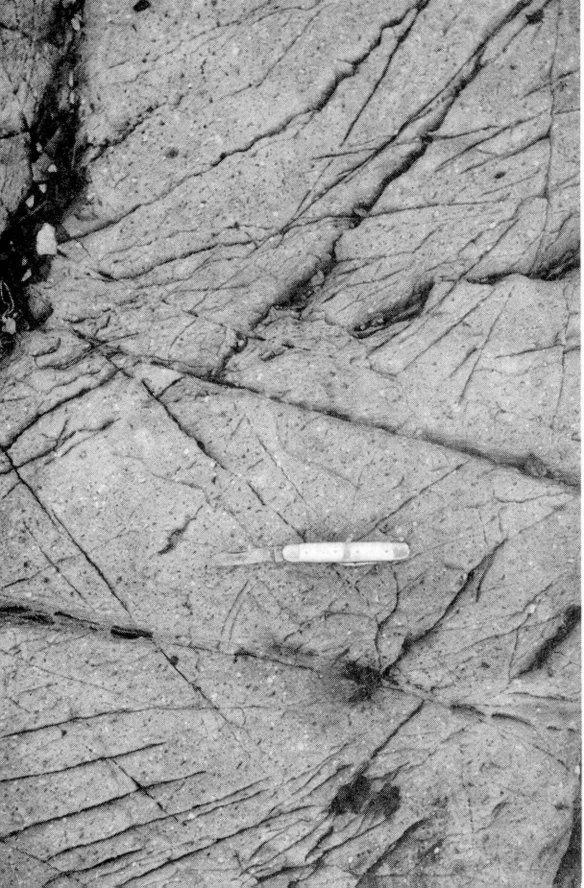
Table 8 (cont.)

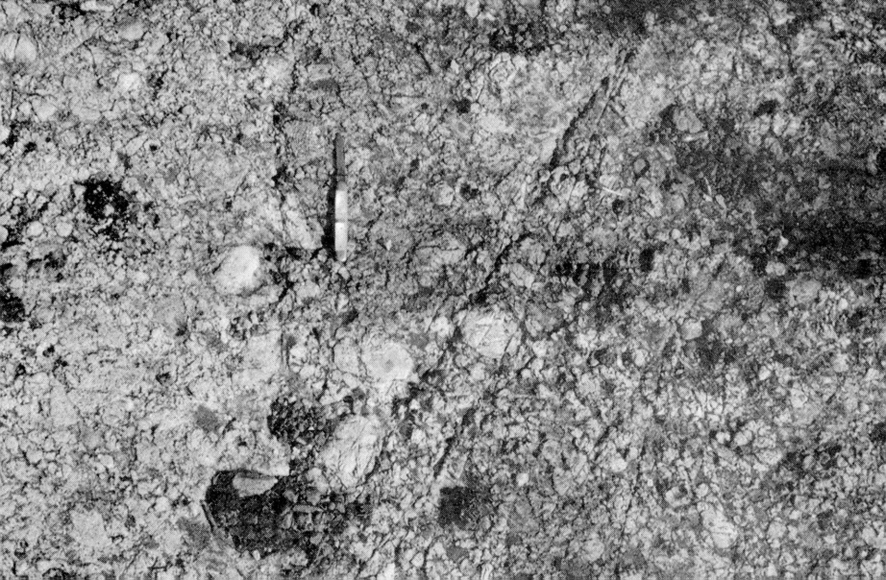
No.	Name	Location	Vein Material	Host Rocks	Reference
34	Ontario - Woman Lake Gold Mines.	K.1919-1922.	gn,q.	Acid flows,tuffs.	Bruce, pp. 36-37.
35	Dunkin.	West end of Narrow Lake,	Au,q.	Diorite porphyry.	Bruce, pp. 37-38.
36	Narrow Lake Mining Co.	North west of Narrow Lake,K.R.L.4647 etc.	Au,sp,q.	Greenstone.	Bruce,p.39.
37	Leonard Narrow Lake Mines.	South of Leonard Lake,K.R.L.4841.	Au,asp,q.	Acid volcanics, diorite.	Bruce,p.44.
38	Sullivan.	Confederation Lake,K.R.L.5092, 5093.	Au,asp,sid,q.	Granite.	Bruce,p.44.
39	Heine, Levesque, & Rouillard.	North Bay, Confederation Lake, K.R.L.4089,4134.	Au,sp,py,q.	Greenstone, feldspar porphyry, granite.	Bruce,p.45.
40	Bobjo Mining.	Lost Bay, Confederation Lake,K.R.L.6631.	Au,q.	Spherulitic greenstone, quartz-feldspar porphyry dike.	Bateman, pp. 40,41.
41	Jalda (Conwo).	Lost Bay, Confederation Lake.	Au,py,q., Hill-Sloan-Tivy vein.	Pillow flows,tuffs, rhyolite,greenstone.	Bateman,pp. 25,37-39.
42	Uchi Gold Mines	Uchi Lake.	Au,py,q.	Basic lava flows, rhyolite, silicified tuff, cherty tuff, diorite.	Thomson, p.74.
43	Woco Gold Developments.	South west of Uchi Lake.	Au,py,po,cp, altaite,tour, q.	Interbedded greenstone, diorite, rhyolite.	Bateman, p.41. Thomson, p.77.
44	Hanalda (Kenelda).	Lost Bay, Confederation Lake.	Au,q.	Interbedded greenstone, diorite, rhyolite.	Thomson,p.80. Bateman,p.39.
45	Raingold Mines Ltd.	West of Uchi Lake.	Au,q,carb,tour.	Interbanded rhyolite, greenstone, diorite.	Thomson,p.81.
46	Berrigan Claims.	Lost Bay, Confederation Lake,K.R.L. 12047,12048.	Au,py,cp,gn, tour,carb,q. Hill-Sloan-Tivy vein.	Interbanded rhyolite, greenstone.	Thomson,p.81.
47	Grasett claims.	Lost Bay, Confederation Lake,K.R.L. 4505,4506, 4568.	Hill-Sloan-Tivy vein.	Interbanded rhyolite, greenstone, diorite.	Thomson,p.81.
48, 49	Tremblay	Lost Bay, Confederation Lake.	-	Interbanded greenstone, diorite, rhyolite.	Thomson,p.82. also Figure 2, facing p.74.
50	Mining Corp. of Canada.	Fly Lake	Au,py,sp,tour,q.	Quartz porphyry.	Bateman, pp. 41,42.

Vein Materials Reference

Au --Gold	cp - Chalcopyrite	q - Quartz
ank - Ankerite	gn - Galena	sid - Siderite
asp - Arsenopyrite	mo - Molybdenite	sp - Sphalerite
calc- Calcite	po - Pyrrhotite	tour- Tourmaline
carb- Carbonate	py - Pyrite	







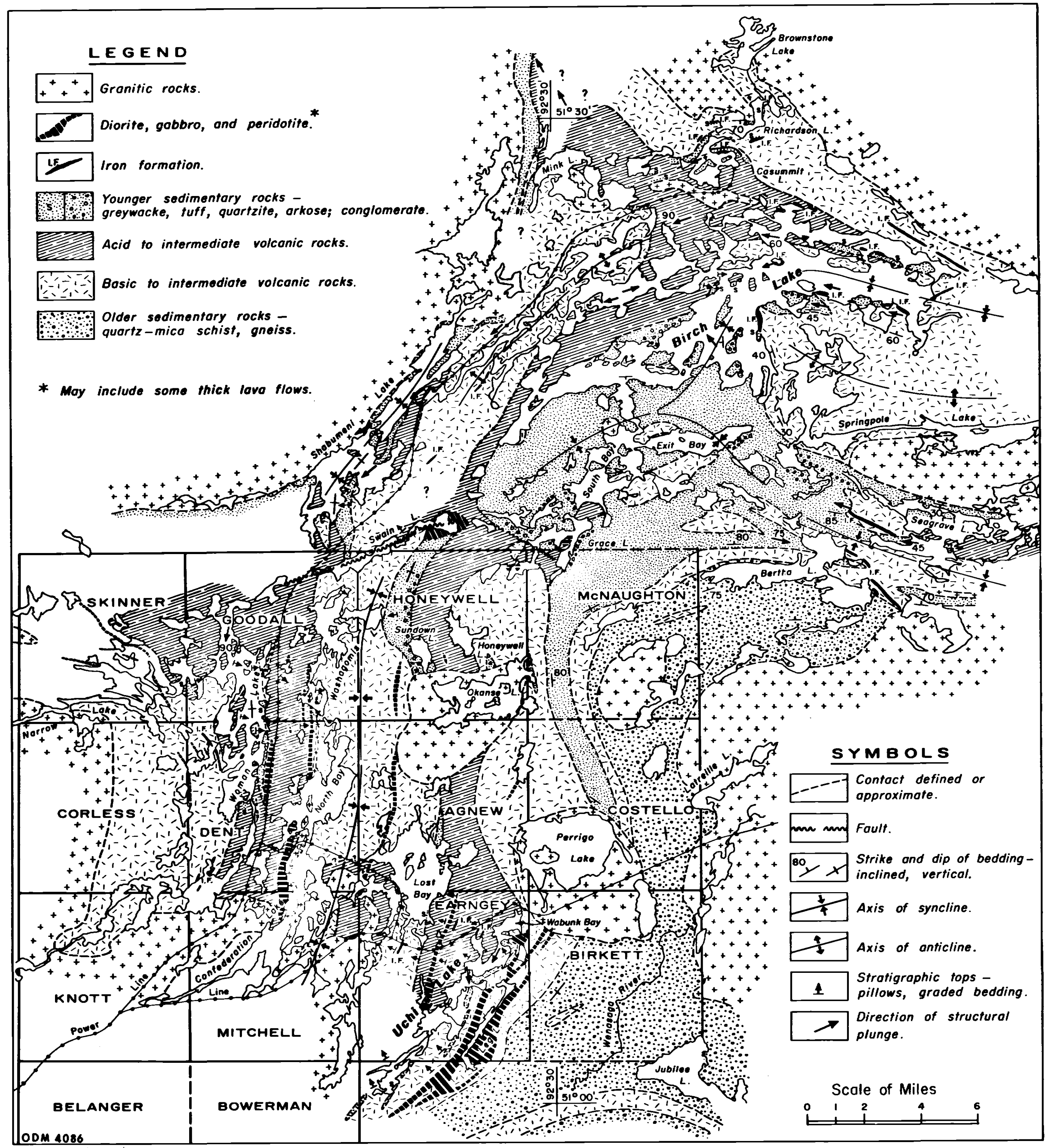


Figure 2 – General geology of the Birch-Uchi Lakes Area.

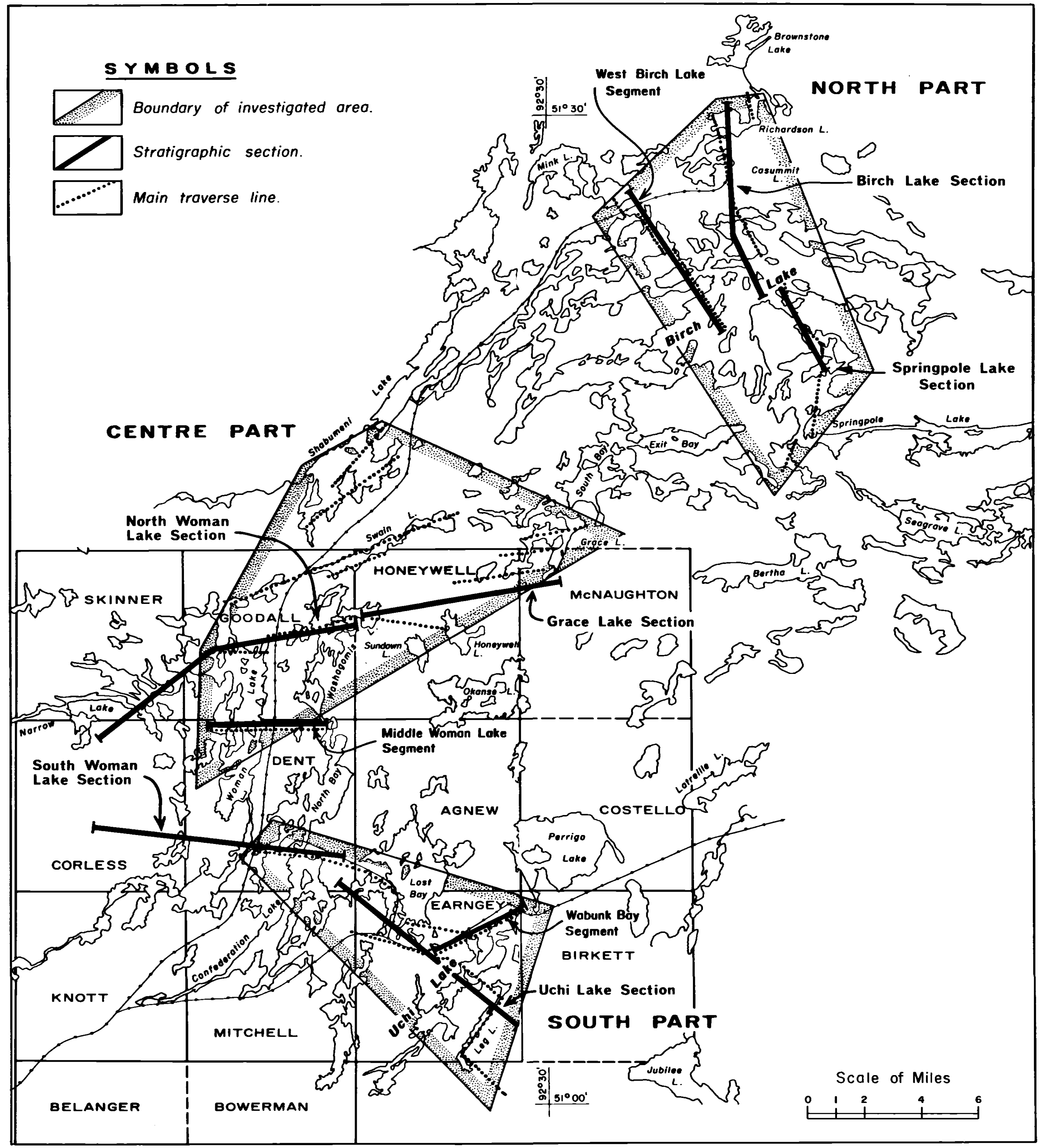


Figure 3 – Location of stratigraphic sections and main traverse lines in the Birch-Uchi Lakes Area.

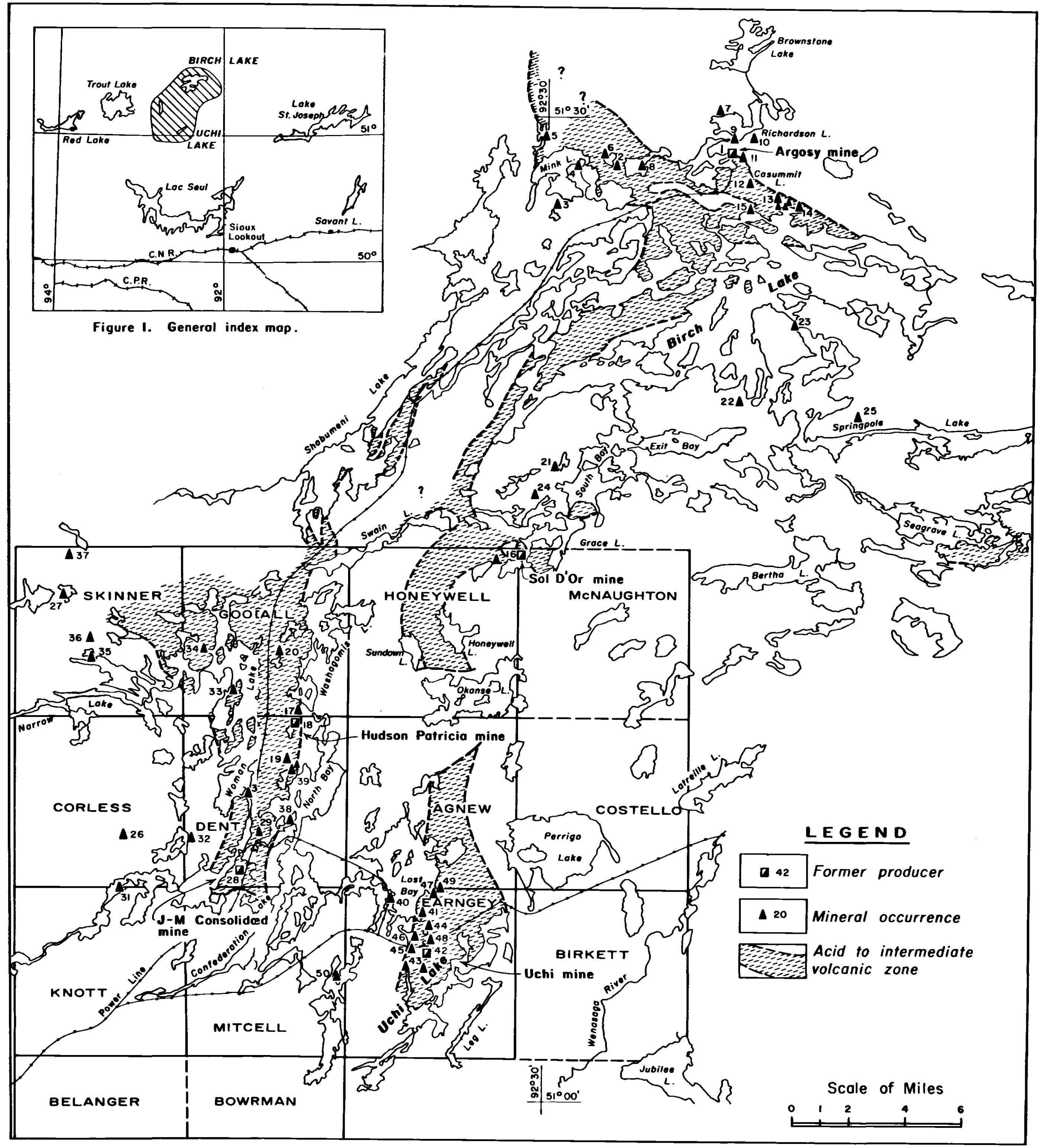


Figure 6 – Location of mineral occurrences and main acid to intermediate volcanic zones in the Birch-Uchi Lakes Area.

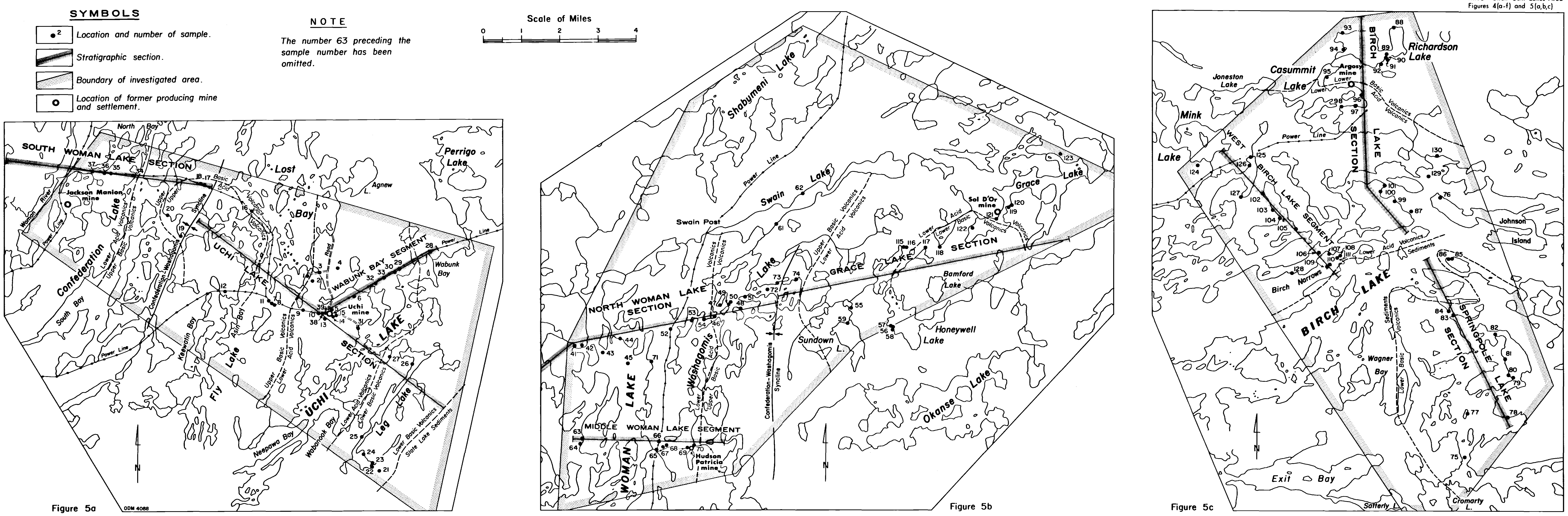


Figure 5(a,b,c) – Location of rock samples taken for chemical analyses in the Birch-Uchi Lakes Area.

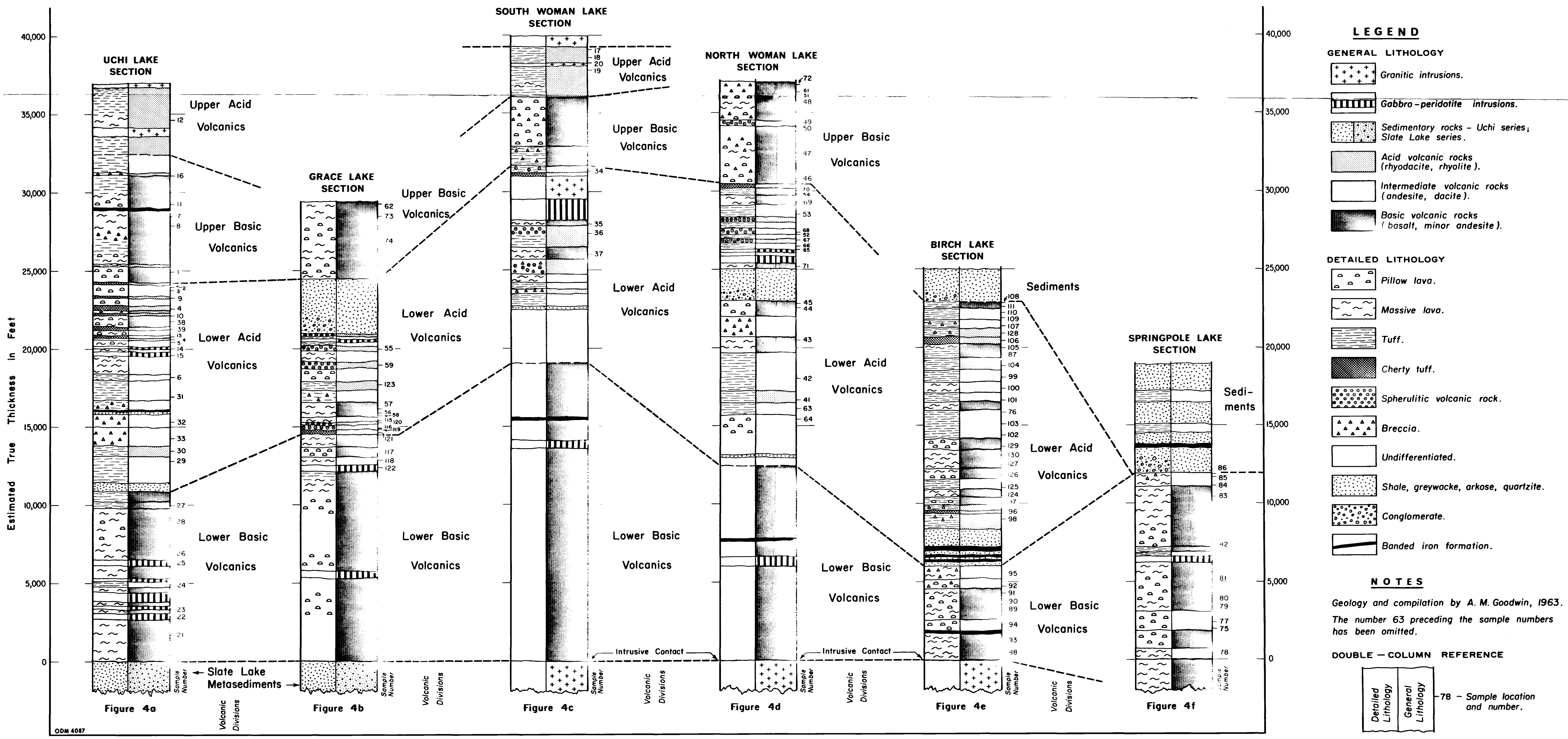


Figure 4(a-f) – Stratigraphic sections in the Birch-Uchi Lakes Area.