Province of Manitoba

DEPARTMENT OF MINES AND NATURAL RESOURCES

MINES BRANCH

PUBLICATION 53-4

GEOLOGY

of the

WEST HAWK LAKE - FALCON LAKE AREA
Lac du Bonnet Mining Division
Manitoba

by

J. F. Davies

Winnipeg
1954

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TABLE OF CONTENTS

GEOLOGY OF WEST HAWK LAKE - FALCON LAKE AREA

INTRODUCTION

This report deals with the results of a geological study made in the area immediately surrounding West Hawk Lake in southeastern Manitoba. The region, bounded on the east by the Manitoba-Ontario boundary, covers most of tp. 9, rge. 17E, and the eastern part of tp. 9, rge. 16E. Almost the entire area, about 35 square miles in extent, is underlain by volcanic and sedimentary rocks.

West Hawk Lake, on No. 1 highway, is situated 110 miles east of Winnipeg. Gravel roads, leading off from the highway, extend to Star Lake, Falcon Lake, and Barren Lake. The Manitoba section of the Trans-Canada Highway, now under construction, will pass between Barren Lake and Falcon Lake, extend northeast to the north end of Lyons Lake and thence eastward to the interprovincial boundary.

TOPOGRAPHY

The country around West Hawk Lake consists of rolling hills and ridges separated by areas of glacial drift and muskeg. Rock is usually well exposed on the hills and small low outcrops are plentiful in the areas of overburden. Maximum relief in the area is about 100 feet.

The whole countryside is dotted with a variety of evergreens, white poplar, birch, and oak. Generally, underbrush is not dense. Numerous sand and gravel plains, free of underbrush, are studded with pine and carpeted by a thin veneer of grass, lichen, and moss. Tree growth in the muskegs and swamps consist of spruce, tamarack, and cedar.

The area from Falcon Lake northward to the Winnipeg River lies within the Whiteshell Forest Reserve, administered by the Forestry Service of the Manitoba Department of Mines and Natural Resources. The southern part of the forest reserve is also a game preserve. As a consequence of the protection of wildlife, deer are particularly numerous in the area. Northern pike, pickerel, and lake trout occur in the lakes of the area. The Game and Fisheries Branch operates a trout hatchery at West Hawk Lake from which the lakes are stocked with lake trout and rainbow trout.

Game birds in the area are mostly varieties of grouse. Migratory waterfowl may be seen on the lakes during spring and autumn.

The accessibility of the area, its natural picturesque scenery, pleasant summer weather, boating, swimming, and fishing facilities combine to make the area a popular resort for tourists and campers. Privately-owned summer homes are numerous along the south and west shores of West Hawk Lake, the north shore of Falcon Lake, and the east shore of Star Lake. Cabins by the day or week are available for rent at all three lakes. The Forestry Service operates camping grounds at both West Hawk Lake and Falcon Lake.

PREVIOUS WORK

The most important of the early geological work done in the area was that by A. C. Lawson (1885)[1]. In 1883 and 1884 Lawson, working for the Geological Survey of Canada, conducted geological investigations in the Lake of the Woods region. The extreme west section of the region explored by him included the Falcon Lake area. Prior to Lawson's study, Bell has conducted a cursory investigation in the Lake of the Woods country. In 1881 Bell (1882) divided the rocks of the area into Laurentian gneiss and Huronian volcanic and sedimentary rocks. Lawson, observing distinct differences (in lithology, stratigraphy, and relation to intrusive granite) between Logan's typical Huronian of the Lake Temiskaming district and the volcanic-sedimentary rocks of the Lake of the Woods region, proposed the term "Keewatin" for the latter rocks. The Laurentian granitoid gneiss, which Bell considered to represent altered sedimentary rocks conformable with the Huronian (Lawson's Keewatin), was shown by Lawson to be younger than the Keewatin rocks; this conclusion was based on evidence that the Laurentian gneisses were injected into the Keewatin rocks.

The term Laurentian was originally used by Logan to designate the gneissic crystalline rocks of the Laurentian region of eastern Canada; these crystalline gneisses were presumably the oldest rocks of the shield. In subsequent usage the term Laurentian was restricted to granitoid rocks; in the case of the Lake of the Woods region Lawson showed that the rocks termed

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1 Numbers in parenthesis refer to date of publication of reports listed in bibliography.

Laurentian did not represent remnants of the earth's original crust.

Most present-day workers use the term Laurentian to refer to the period of igneous activity and orogeny between the Keewatin and Temiskaming. Granites known, or presumed, to intrude the Keewatin rocks and to be unconformably overlain by Temiskaming rocks are frequently called Laurentian. According to this usage, there are very few rocks which can be classified positively as Laurentian, and the term is no longer applied to the intrusive granitic rocks in western Ontario and eastern Manitoba.

Since the area covered by the present study is part of the type region for the Keewatin this designation is retained for the volcanic and sedimentary rocks.

Between the years 1916 and 1921 Bruce, DeLury, and Marshall investigated mineral deposits in the Falcon Lake-West Hawk Lake area. References to these investigations are listed in the bibliography. In 1942, a geological map by DeLury was issued by the Manitoba Mines Branch. This map was based on work done in 1937. Brownell made a petrographic study of the Falcon Lake stock in 1941. Springer (1952), of the Manitoba Mines Branch, mapped a large area including the region covered by the present study. Springer's map was published on a scale of one inch equals one mile.

Interest in the gold deposits of the area was first aroused during the 1890's, coincident with the early "boom" in the Lake of the Woods region. Numerous claims were staked and a few finally patented. During the 1890's attention was directed mainly towards the gold-bearing quartz veins in the district. Little development work other than trenching and the sinking of shallow prospect shafts was done on any of the veins till after 1930. During the thirties considerable diamond drilling was done by various companies. Shafts were sunk on two veins on the Sunbeam and Waverley claims, held successively by Sunbeam Kirkland Gold Mines Limited and Goldbeam Mines Limited. Considerable underground explanation was done and substantial ore reserves estimated. Work on this property closed in 1946.

Following the initial interest in the gold deposits, most of which occur along the margins of the Falcon Lake stock, attention was directed to the numerous shear zones mineralized with iron sulphides. Many of these were discovered in the vicinity of West Hawk Lake and Star Lake.

Some interest has been shown in deposits of scheelite occurring in Keewatin rocks west of Barren Lake. These were discovered in 1918 and a small amount of ore was cobbed and shipped from them at that time. During the last war the known deposits, and newly discovered ones, were thoroughly investigated but found to be too small for profitable working.

Occurrences of lithium- and molybdenum-bearing deposits have received some attention over the years. Work done on these occurrences to date has not indicated any deposits of economic value.

PRESENT WORK

Late in 1952 the discovery of gold in a sulphide zone east of High Lake in Ontario caused considerable activity. Numerous claims were staked on both sides of the inter-provincial boundary, and during the summer of 1953 various mining companies were active in the area east of High Lake.

In view of the interest shown in 1953, and of possible future activity, the need for a more detailed map of the area of volcanic and sedimentary rocks was apparent.

The present work consisted of mapping the geology on a scale of 1,000 feet to the inch, examination of mineral occurrences, and a special study of the Falcon Lake stock. Mr. R. D. House, senior assistant on the field party, is investigating the distribution of radioactivity and zirconium in the stock in order to determine their relationship to the gold deposits. The laboratory work is being conducted by House at Northwestern University, Chicago.

Field mapping was carried out with the use of vertical aerial photographs enlarged to 500 feet to the inch. Traverses were run at intervals of 400 to 500 feet.

Most of the Falcon Lake stock was mapped independently by Mr. House. In the course of his mapping, specimens were collected for laboratory study.

Capable assistance was provided by L. J. Peterson and D. R. Francis, geology students at the University of Manitoba.

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GENERAL GEOLOGY

General Statement

The rocks within the map-area are preponderantly volcanic flows and sedimentary strata. Fragmental and tuffaceous volcanic rocks are abundant in the vicinity of Star Lake. Some of the rocks mapped as sedimentary show unmistakable evidence of having been altered, with the introduction of silica. The degree of this alteration is not determinable but it is possible that many of the so-called quartzites and allied rocks are silicified basic tuffs. Along the north shore of Falcon Lake there is a band of thoroughly metasomatized volcanic rocks previously considered to be sedimentary.

Nearly all of the volcanic rocks are andesitic and/or basaltic in composition.

For the most part the sedimentary strata lie above the volcanic rocks. A narrow band of slate occurs between andesite flows at the south end of Lyons Lake.

The entire sequence of volcanic and sedimentary rocks belongs to the Keewatin Series as originally defined by Lawson for the Lake of the Woods district. All the evidence available indicates that the sedimentary rocks lie conformably upon the volcanic rocks.

A stock, termed the Falcon Lake Stock by Brownell (1941), consisting of a gabbro-diorite rim and a quartz monzonite core is intrusive into the volcanic rocks between Star Lake and Barren Lake.

The borders of the map-area are underlain by various granitoid rocks toward which little work was directed in the present study. Within, and near, the edge of the Keewatin rocks northwest of West Hawk Lake pink pegmatite intrusions are plentiful. A sill-like intrusive of quartz-feldspar porphyry is situated along the north shore and near the east end of Falcon Lake. A few outcrops of porphyry are also present south of Star Lake at the north margin of the Falcon Lake stock.

No evidence for determining the age relationship between the Falcon Lake stock and the major granitic intrusives was found.

The following Table of Formations indicates the classification of rocks in the area.

Table of Formations

ARCHAEAN or PROTEROZOIC		Quartz-feldspar porphyry Pink porphyritic granite Grey gneissic granite Quartz monzonite Gabbro, diorite, grano-) Falcon Lake diorite, syenodiorite) Stock
Intrusive Contact		
ARCHAEAN	KEEWATIN	Mixed Keewatin rocks and pegmatite Silicified andesite and tuff Clastic sedimentary, and related, rocks Basic tuff Basic agglomerate Slate Andesite, basalt

Keewatin Rocks

Andesite, basalt (1)[1]

The country between West Hawk Lake and Falcon Lake and that west of Barren Lake is largely underlain by dark basic flows. Specimens of these flows have the composition of andesite. A few are of basalt.

These volcanic rocks are characteristically fine-to medium-grained, dark green, and massive or moderately schistose. The andesite west of Barren Lake exhibits a crude sheeted structure on account of the squeezing or stretching out of the flows.

Much of the andesite is a fairly fresh-looking rock, often outcropping in well-exposed hills and ridges. Schistose andesite is generally exposed as low flat outcrops protruding through over-burden.

Ellipsoidal or pillow structures are common in the andesite. The pillows are usually somewhat deformed and only useful for top determinations in a limited number of places.

Typical fresh-looking andesite consists of about equal amounts of small plates and laths of andesine and blades of green hornblende. In schistose varieties fine-grained epidote, pale green chlorite, and granular epidote are common. In some specimens the amphibole is uralitic. Small amounts of quartz, magnetite, carbonate, biotite, sphene, and sulphides are generally present.

Along shear zones in the lavas, the andesite is recrystallized to a coarser rock, with long narrow leaves of hornblende oriented in all directions in the plane of the shear. Frequently the leaves are radiating. The matrix of the sheared rocks consists of fine plagio-clase and uralitic amphibole. Carbonate is generally abundant in these rocks.

In parts of the area lenses and bands of agglomerate and tuff are interbanded with the andesite. Beds of tuff are abundant in the andesite along the north shore of Falcon Lake.

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[1] Numbers in parenthesis refer to map units on the accompany-ing map.

Immediately north of Camp Lake there are some medium- to coarse-grained basic rocks resembling gabbro, but which are probably coarse-grained centers of thick flows.

Slate (2)

From the south end of Lyons Lake a narrow band of slate extends westward for about 2,000 feet. The band is 300 feet wide at the most. Andesite flows both overlay and underlay the slate. The slate is a fine-grained, thinly-laminated fissile, dark grey to black rock containing considerable finely-disseminated pyrite and small carbonate lenticles. A few beds of fine-grained dark cherty rock are interbedded with the slate.

Basic Agglomerate (3)

West and southwest of Star Lake a wide band of basic fragmental volcanic rock overlies the andesite. The contacts are gradational in the sense that andesite flows and agglomerate are interbanded at the base of the unit and similarly bands of agglomerate are intercalated with the overlying tuffs. Some flows of massive pillowed andesite and beds of tuff are present throughout the entire unit of agglomerate.

Early workers in the area classified this as a conglomerate on account of the rounded nature of the fragments. Springer (1952) considered it to represent an agglomerate, the fragments of which were rounded by water action. This viewpoint is difficult to reconcile with the fact that, generally, sorting or bedding is unrecognizable in the groundmass of the rock. The matrix appears to be typically andesitic in composition and texture. It is commonly somewhat schistose. Fragments are an inch or so in diameter.

Close to Star Lake, the agglomerate contains numerous closely-packed fragments, westward the fragments become less abundant but are still numerous. Generally the fragments are coarser grained than the groundmass. Though the compositions of both matrix and fragments are similar, the fragments generally weather to a lighter colour than the groundmass. In some places the fragments are finer grained and darker than the matrix.

Both fragments and matrix consist of andesine and hornblende with variable amounts of biotite, clinozoizite, epidote, carbonate, quartz, magnetite, and sulphides. The plagioclase is, in many cases, in the form of laths and tablets. The hornblende is commonly leafy in appearance; in some instances the amphibole is uralite.

Scattered throughout the agglomerate are pebbly-looking fragments of quartz. These are an inch or so across and generally somewhat ellipsoidal. On account of their rounded nature they appear to be quartzite pebbles. However, certain features indicate that some, if not all, of these are small ellipsoids of quartz that were introduced between the foliation planes of the agglomerate. Though rounded in outline, the quartz in many places has minute irregular protuberances extending into the andesite. In some thin sections very narrow stringers of quartz can be seen extending from one quartz "pebble" to another. Commonly the composition of the "pebbles" is not pure quartz but rather quartz with feldspar grains which have extremely irregular edges as though corroded by the quartz. Much of the feldspar is interstitial and appears to be remnant in the quartz. The composition of the feldspar in these "pebbles" is the same as that in the agglomerate. These observations indicate that the quartz represents dilated injections.

There are other pebbly-looking pieces, of granitic composition and texture, in the agglomerate. These are very similar to some of the porphyry in the area. These "pebbles" may also be introduced.

Basic tuff (4)

In the northern part of the area, especially north of Star Lake and northwest of West Hawk Lake, outcrops of well-bedded dark green tuffs are abundant. These rocks are characterized by persistent bedding, each bed being 1 inch or less thick. There are slight differences in colour and sharp straight clean-cut bedding planes between the beds. Some beds of tuff are found within the andesite and others are widely scattered throughout both the agglomerate (3) and clastic sedimentary rocks (5). In places there are subangular to rounded fragments of andesite in the tuff.

The tuff consists essentially of andesine and amphibole, generally hornblende but in places tremolite-actinolite. In some specimens the feldspar is in the form of large irregular tablets in a fine streaky crusted groundmass of plagioclase with some quartz. The hornblende is in the form of ragged grains or in well-formed blades. In many cases considerable quartz is present. Part of the quartz, at least, has been introduced, since it occurs as narrow veinlets and small clusters throughout the rock. In addition to quartz occurring in the above manner, it is commonly distributed throughout the groundmass of the rock. Most specimens contain, in addition to the above minerals, some biotite, magnetite, and carbonate.

Examination of thin sections reveals that the banding of the rock is due to variations in the amounts of amphibole and plagioclase in different bands and to slight difference in grain size.

Some of the tuff has been thoroughly recrystallized. Recrystallized tuff consists of abundant small euhedral unoriented, more or less equidimensional hornblende grains averaging 0.05 mm. across, and fresh clear plagioclase and quartz grains. Other recrystallized tuff specimens have the hornblende in the form of aligned blades or needles. Dark red garnets are present in some of the recrystallized tuff.

North of Star Lake a few narrow bands of light-coloured rock are encountered in the tuff. These have the general appearances of beds in that they parallel the bedding and are about the same width as the regular tuff beds. The composition of these light-coloured bands is unusual. They consist almost entirely of medium-large grains of fresh-looking epidote and amphibole showing typical decussate texture. The rock also contains some quartz, magnetite, pyrite, and sphene. The amphibole is almost colourless with only a tinge of yellowish green, has maximum extinction of 20 degrees, and is very faintly pleochroic. These properties place the amphibole in the tremolite-actinolite series. The unusual feature of these bands is the absence of any aluminum-bearing minerals.

Clastic, sedimentary, and related, rocks (5)

The rocks of this map unit, composed largely of quartz, feldspar, and biotite aggregates, have the general aspect of clastic sedimentary rocks. Most of them are fine-to medium-grained, some are well banded, others are quite unbanded. Some bands of basic tuff (4) are interbedded with these rocks. Many of the quartzo-feldspathic rocks are probably sedimentary but some show evidence of the introduction of quartz and it is not certain that these are not silicified tuffs or even, in some cases, silicified andesites. It is impossible, in most doubtful cases, to determine how much of the quartz present in the rock is secondary and how much represents original quartz; thus it is not possible to decide what was the composition of the original rock.

On the island in Star Lake and on the shore north of the island there are irregular dark and streaky structures resembling flow features. In addition, there are small round areas and thin bands of dark epidote- and hornblende-bearing rock within the light grey quartzo-feldspathic rock. The grey quartzose rocks are unbanded there and the dark streaks, patches, and bands have the appearance of inclusions or remnants of lavas in a silicified rock. The light grey sedimentary-looking rock there consists of very fine-grained quartz (55 per cent) and biotite (30 per cent) with small amounts of sericite, epidote, and plagioclase. The biotite is in small aligned flakes. Epidote and plagioclase occur as an irregular thin band that passes gradually along its length into the quartz biotite aggregate. This epidote-plagioclase band has the aspect of a replacement remnant.

Many of the sedimentary rocks have the composition of greywacke and arkose. These are composed of variable quantities of quartz, plagioclase, microcline, and biotite, and are generally fine-grained brown to grey rocks. Where biotite becomes abundant, as it does in many places, the rocks are schistose. Some of the schistose high-biotite varieties contain abundant small red garnets. Small amounts of hornblende are present in some specimens.

There are certain features observable in thin section that indicate the introduction of quartz in many of the rocks of this unit. It is common to find large grains of plagioclase set in a fine matrix of quartz and biotite. The plagioclase has edges that are corroded by quartz and the body of the plagioclase crystals may be riddled with small quartz grains. In a few cases plagioclase crystals are cut in two by veinlets of fine granular quartz that fade into the groundmass. In addition round areas of coarse granular quartz are frequently found within the groundmass of the rock. Veinlets of quartz, some with straight edges parallel to the foliation, others with irregular protuberances, and still others diagonal to the foliation are present in many specimens. These veinlets commonly are composed of quartz of coarser grain than the rock itself. Carbonate, epidote, and coarse biotite flakes often accompany the quartz veinlets.

Along No. 1 highway about 500 feet north of Penniac Bay well-banded sedimentary-looking rocks are exposed in the road cut. These rocks are fine-grained, thinly-banded quartzofeldspathic rocks, typical of clastic sediments. These same rocks exhibit abundant evidence of the introduction of quartz.

The rocks are composed essentially of quartz plagioclase, biotite, and orthoclase. These minerals vary in quantity between different bands of the rock; this, together with variations in grain size, is responsible for the bedded nature of the rocks. Nevertheless, in many cases, neither varying proportions of the mineral constituents nor the variation in grain size are primary bedding features.

In one section the rock consists of a fine-grained mosaic of quartz and andesine. Other constituents are biotite, epidote, carbonate, sphene, apatite, and pyrrhotite. The feldspar has the appearance of being riddled by fine-grained quartz. The proportions of quartz and feldspar in the fine-grained mixture vary across the slide. There are numerous stringers of coarse-grained quartz, some of which split irregularly and enclose wedges of the fine quartz-feldspar mosaic. Some large feldspar grains, apparently corroded, occur with the coarse quartz of the veinlets. The occurrence of coarse feldspar is restricted to the bands of coarse quartz.

Another fine-grained section contains irregular clusters of coarse quartz often with embayments into the fine quartz-feldspar mixture.

In the third section coarse interlocking carbonate grains accompany the veinlets of quartz. Some veinlets consist entirely of carbonate. In this section pyrrhotite is closely associated with the carbonate. Both the biotite and hornblende in the rock are more abundant in the bands containing carbonate veinlets.

In several thin sections there are thin bands less than 1 mm. wide that consist almost entirely of feldspar with little or no quartz. These show a definite elongation and alignment of the small feldspar grains. The feldspar grains in the quartz-bearing groundmass are irregular in shape and interstitial to the quartz.

The study of these rocks north of Penniac Bay leaves the impression that they are silicified. There is little doubt that the quartz veinlets and clusters of coarse quartz represent introduction of silica. This introduced quartz was apparently accompanied by the introduction of carbonate and crystallization of coarse biotite. The coarse feldspar in some veinlets may represent remnants of original feldspar or may be recrystallized feldspar. The corroded and riddled nature of the plagioclase throughout the body of the rock is suggestive of replacement by fine quartz. The varying proportions of quartz in different bands may be due to selective replacement, the banding having been originally due to bedding or metamorphic foliation, or a combination of the two.

If silification has been an important factor in these rocks it is difficult to determine its degree, and consequently, the nature of the original rock. If the bands that consist almost entirely of aligned plagioclase grains represent the closest approach to the composition of original rocks they may well have been banded basic tuffs. The dimensions of the bedding in the tuff, some of which are found with the quartzo-feldspathic rocks at Penniac Bay, are of the same order as in these latter rocks.

Silicified andesite and tuff (6)

Along the north shore of Falcon Lake there is a band of rock part of which has the appearance of a rhyolite flow and part of a delicately banded chert. The rocks are very fine grained, hard, dense, light cream-coloured, and siliceous. The rhyolite-like rock is generally massive; the banded chert-like rock has bands 5 to 15 mm wide. Besides the main zone of these rocks near the centre of the north shoreline of Falcon Lake, thin bands of identical rock occur at the north and south margins of the porphyry intrusive near the east end of the lake. A few outcrops of similar rock are found east of West Hawk Lake.

These "cherty" rocks at Falcon Lake make an interesting study of the results of metasomatic replacement. It can be stated with confidence that the rocks in question owe their present aspect to the silification of massive andesite, giving rise to "rhyolite", and thinly bedded tuffs, resulting in delicately banded "chert". Both field and microscopic examination provide evidence for this conclusion.

Most of the rhyolite-like rock is massive and without flow features. However, in some places pillow structures are present. These structures are not unknown in acid flows but they are unusual in such rocks. It was this feature which first attracted the writer's attention and prompted a more careful examination of these rocks. Just east of Toniata Beach "rhyolite" outcrops were found that in addition to containing pillows also had irregular roundish blocks of dark green hornblende-bearing rock similar in appearance to the andesite adjacent to the rhyolite-like rock. The margins of these dark blocks faded into the light acid rock.

Considering that light cream "rhyolitic" rock occurred along the margin of the porphyrv near the east end of Falcon Lake and that the "rhyolite" zone described above occurred along the strike of the porphyry it appeared probable that the "rhyolitic" rocks represented andesites silicified by solutions originating in the porphyry and that the pillow structures originally present in the andesite were perfectly preserved during replacement. The deli- cately banded chert-like rock was thought to represent silicified tuff beds, many of which occur in the andesite just north of Falcon Lake.

Microscopic evidence supports the conclusions reached in the field.

A series of 7 specimens was collected across a dark green andesitic inclusion about 3 feet wide. The specimen from the core of the inclusion consists of andesine-labradorite feldspar, horn- blende, and quartz, with magnetite disseminated throughout. The andesine occurs as narrow laths, up to 0.2 mm. long, thoroughly intermingled with quartz which appears to have corroded the plagi- oclase to a small degree. The proportions of the main minerals are: plagioclase 50 per cent, hornblende 30 per cent, quartz 20 per cent. Average grain size of quartz in this specimen and in others of the series is 0.02 to 0.04 mm.

Outward from the core the plagioclase in the rock becomes thoroughly riddled, cut up, and corroded by fine granular quartz, up to 35 per cent in the two specimens on each side of the one des- cribed above. The amount of hornblende varies considerably from place to place in these sections. Still closer to the margins of the inclusions the feldspar becomes "slivery" and aligned. Lenses of coarse quartz are present. Abundant small biotite flakes or shreds appear, with the hornblende disappearing rather rapidly. Unlike the "slivery", apparently crushed and stretched feldspar, the quartz is more or less equidimensional and unstrained.

There are some bands in the marginal sections consisting entirely of stretched plagioclase with abundant magnetite and no quartz. These may alternate with veinlets of quartz 0.5 mm. or less in width.

The outermost sections, essentially the rhyolitic rock, contain 40 to 50 per cent granular quartz, much of it in narrow veinlets, the rest mixed with andesine. There are also some quartz- free bands in these sections and the magnetite in the specimens is concentrated in these bands. Some tourmaline and clinozoisite are also present. Generally biotite in the section is very fine grained but that in the quartz veinlets is in fairly large flakes, apparently recrystallized.

A specimen of the light cream crypto-crystalline rock at the south margin of the porphyry sill near the east end of Falcon Lake consists entirely of quartz and micas, both fine biotite and sericite. The quartz occurs as a mosaic of more or less equidimensional equigranular grains 0.02 to 0.04 mm. across. No feldspar is recognizable in the thin section of this rock.

The delicately banded rock is seen to owe its banding to thin streaks composed of fine dirty green micaceous material, magnetite, carbonate, and epidote, running parallel to the foliation; to variations in the amounts of shreddy brown biotite and plagioclase in different bands; and to narrow parallel veinlets of quartz. Some specimens of the banded rock contain no feldspar and are composed of 60 to 70 per cent quartz and 30 to 40 per cent micas, mostly sericite. These seem to represent the extreme degrees of silicification.

The stretched and crushed nature of the feldspar in several sections suggests considerable deformation prior to silicification. On the other hand, the preserved pillows are relatively undeformed. Nevertheless it appears that the andesite was sheared along this zone and that silica-bearing solutions migrated up the shear and outwards into the surrounding rocks, silicifying the andesite and healing the shears so that evidence of deformation in the original feldspar is recognizable only under the microscope.

Mixed pegmatite and Keewatin rocks (7)

In the northern part of the area near the granitic intrusives there are exposures consisting of coarse pink pegmatite with numerous inclusions of older Keewatin rocks. In places the outcrops are dominantly Keewatin rocks with abundant intrusive pegmatite.

The pink pegmatite is very coarse grained and massive. It is composed essentially of microcline, quartz, and biotite. Some of the inclusions are recrystallized andesite or tuff; most of them are quartz-feldspar-biotite gneiss, a fine- to medium-grained brownish or grey rock with abundant aligned flaky brown biotite. These inclusions consist of about 40 per cent andesine and 30 per cent each of quartz and biotite with accessory epidote, apatite, and magnetite. Texturally, the inclusions are composed of a mosaic of more or less equidimensional grains about 0.2 mm. in diameter;

it is completely recrystallized, the grains exhibiting well-fitted boundaries without interstitial material. Though the macroscopic and microscopic aspect of these inclusions is that of a recrystallized sedimentary rock they may equally well represent silicified and recrystallized andesite inclusions.

Intrusive Rocks

Falcon Lake Stock (8, 9)

The study of this stock by Brownell (1941) indicated that it is a composite stock consisting of an outer margin of diorite and gabbro (8) and an inner core of quartz monzonite (9). The contacts determined in the present mapping differ only slightly from those of Brownell.

The outer zone of the stock consists dominantly of a coarse-grained mottled black and white diorite in which white plagioclase crystals comprise about 75 per cent of the rock, the remaining, dark, constituents, largely coarse-grained hornblende, giving the rock a mottled appearance. The plagioclase, in grains up to 1/2 inch long, is andesine, Ab_{55} to Ab_{60}. Gabbro is confined largely to the extreme outer edges of the stock and to the long protuberance at the northeast side, south of Crescent Beach. The gabbro is a coarse-grained black rock consisting essentially of labradorite, about Ab_{45}, and hornblende, this mineral being more abundant than in the diorite.

Study of numerous thin sections, taken at intervals across the stock, revealed to Brownell that a ring of syenodiorite and granodiorite completely surrounds the quartz monzonite core of the stock. It is not possible to locate a contact between this ring and the outer zone of diorite. The syenodiorite-granodiorite rim extends to the northwest and southeast edges of the stock.

The syenodiorite and granodiorite consist of plagioclase ranging from Ab_{55} to Ab_{70}, microcline, quartz hornblende, and biotite. The microcline and quartz surround and corrode the plagioclase.

Where exposed, the margin of the quartz monzonite core of the stock is marked by a zone containing round and angular dark inclusions of older rock, some of which are recognizable as diorite, whereas others apparently are remnants of a fine-grained rock. It is impossible to place the contact of the quartz monzonite very accurately as the granodiorite is gradational into the quartz monzonite.

The typical quartz monzonite is a somewhat finer-grained, lighter-coloured rock than those of the outer ring. In places the quartz monzonite is porphyritic on account of microcline phenocrysts. The quartz monzonite contains a smaller proportion of ferromagnesian minerals than the granodiorite ring. Biotite is the common ferromagnesian mineral.

The plagioclase in the quartz monzonite varies from Ab_{70} to Ab_{80}. In places microcline is as abundant as plagioclase. Quartz content averages 10 to 15 per cent. The microcline and quartz show evidence of having replaced the earlier-formed plagioclase.

Brownell showed that there is a gradual increase in acidity towards the centre of the stock. This increase in acidity, marked by increase in albite content of plagioclase and by increasing amounts of microcline, continues right to the centre of the quartz monzonite core.

Brownell suggests that the monzonite core originated by the intrusion of an acid differentiate from the magma which had partially crystallized (and simultaneously differentiated) to form the outer diorite rim. The inner part of the stock into which the acid differentiate intruded was considered to consist of a network of plagioclase crystals and interstitial fluid; the latter supposedly was forced out by the acid liquid. The granodiorite and syenodiorite were thought to have originated by the partial replacement of diorite by microcline and quartz from potash- and silica-bearing fluids that diffused into the solid diorite from the acid differentiate. This hypothesis involves crystallization differentiation, intrusion of an acid differentiate from below, and diffusion.

The origin of the component parts of the stock can be equally well explained by a simple process of crystallization differentiation in place, accompanied by slight movement while the stock was only partially solid, giving rise to fragments of early-crystallized rock in the monzonite at the margin of the core.

Grey gneissic granite (10)

To the north the volcanic rocks are intruded by coarse- to medium-grained grey gneissic granite consisting of quartz, microcline, oligoclase, and biotite. The biotite is in small aligned flakes. A few garnets and small amounts of carbonate, muscovite, sausserite, and carbonate are generally present in the rock.

According to Springer, who mapped a large area of this grey gneissic granite, some phases of it are granodiorite and quartz diorite.

A few narrow dykes of white pegmatite containing the same minerals as the grey granite occupy fractures normal to the foliation in the latter rock.

In places numerous bleached inclusions of older rock are present in the grey granite. These are of fine-grained grey rock, darker than the granite. The inclusions consist of a fine-grained aggregate of quartz, albite, orthoclase, shreddy biotite, and blades and needles of hornblende.

Pink porphyritic granite (11)

The western portion of the map area is underlain by a coarse-grained pink porphyritic granite characterized by large microcline phenocrysts. The rock is generally massive but a faint foliation of biotite is visible in places. This granite consists of microcline, quartz, and biotite with a little albite, muscovite, pyrite, apatite, and sausserite.

Quartz-feldspar porphyry (12)

The two porphyry intrusives, one south of Star Lake, the other along the north shore of Falcon Lake, are of the same composition though the Star Lake porphyry is generally a little finer grained. At both localities the rock is massive to somewhat schistose.

The porphyry is characterized by numerous stubby feldspar tablets and small commonly bluish quartz eyes. The rock is composed essentially of quartz, oligoclase-andesine, and biotite. A little microcline is invariably present. Other constituents are carbonate, muscovite, apatite, zircon, and magnetite.

Because of the absence of porphyry dykes in the granitic rocks and of the schistose nature of some of the porphyry Springer (1952) regarded the porphyry as older than other intrusives in the area. The reasons for this belief can be seen to be unconvincing. The porphyry south of Star Lake is in contact with diorite of the Falcon Lake stock but the rocks at the contact are sheared and occupied by a mineralized zone obscuring any possible evidence of intrusive relationship. The porphyry does not come in contact with other intrusives at any other place in the area.

The writer is unaware of any useful evidence found by himself or other workers suggestive of age relationships amongst any of the intrusive rocks. The order in which they occur in the map legend is entirely a matter of personal preference.

STRUCTURAL GEOLOGY

Folding

The Keewatin rocks in the vicinity of West Hawk Lake are folded into an easterly-trending anticline, the axis of which is situated south of the lake. Top determinations were not plentiful enough to locate the axis very precisely. The westerly extension of the fold seems to swing to the southwest and the volcanic rocks along that section of the anticline have been removed by the intrusion of the Falcon Lake stock.

North and west of Star Lake the general trend of the Keewatin rocks changes from westerly to southwesterly. In the vicinity the volcanic rocks have been closely crumpled into a series of minor folds some of which are overturned. The determination of these folds was based on strike, dip, and plunge of linear features. The folds plunge about 35 degrees to the northeast.

It is interesting to observe that the dip of the volcanic rocks becomes less than normal close to the intrusive granite. Normally dips are rather steep, up to 80 degrees, but next to the granite the rocks dip at angles as little as 35 degrees.

The crumpling of the rocks north and west of Star Lake may have accompanied or followed the intrusion of the granite as there appears to have been a squeezing of the strata by, or against, the intrusive. Foliation in the granite generally is parallel to the bedding in the tuff.

Northwest of West Hawk Lake the Keewatin rocks adjacent to the grey gneissic granite are warped. Here again, the foliation in the granite is parallel to the bedding of the older rocks.

Shearing, faulting, and fracturing

Between West Hawk and Falcon Lakes are a number of narrow shear zones trending in an east or northeast direction.

These are usually less than 10 feet wide. They all dip steeply northward at angles of 70 to 80 degrees. Slickensides on some of the shears plunge easterly at angles of 50 to 70 degrees. Step-like depressions on the slickensided surface indicate that they were formed during relative upward movement of the south wall of the fault zone. Apart from this it is not known how great, or in what direction, are the net movements of these shear or fault zones. Some of the shears contain small quantities of barren white quartz.

Most of the mineral deposits in the area occur along short shear zones. Some occupy small fractures. The shears and fractures in which the mineral deposits occur strike in two general directions, east and northeast. Most of them dip steeply northward. There are a great number of these sheared and mineralized zones west of the Falcon Lake stock, around Star Lake, and around West Hawk Lake.

MINERAL DEPOSITS

Mineral deposits within the area are of three types, a) gold-quartz deposits, b) scheelite deposits, c) sulphide deposits.

Most of the gold occurrences are closely associated with the Falcon Lake stock. A few occur some distance from the stock. The scheelite deposits are found in the band of andesite east of the pink porphyritic granite at the west edge of the map-area. The sulphide deposits, characterized by pyrrhotite and pyrite with small amounts of nickel and zinc, are abundant in two localities, around Star Lake and West Hawk Lake. Most of the sulphide deposits occur in the sedimentary rocks of map unit 5. Nearly all the sulphide zones which are present within the lavas occur in bands of sedimentary-looking rock intercalated with andesite.

Gold-bearing quartz veins

Gold-bearing quartz deposits associated with the Falcon Lake stock occur in either the granodiorite ring, or quartz monzonite core near the contact between these two phases of the intrusive, or in the volcanic rocks around the edge of the stock. Most of those around the edge of the stock are situated along the west margin of this body.

Most of the gold deposits associated with the stock are not quartz veins in the usual sense of the word. Generally vein quartz is not particularly abundant. Instead the deposits consist of zones of silicified and mineralized rock with subordinate vein quartz. Some of the deposits, outside the stock, follow shear and fracture zones. Those within the stock are generally irregular areas of silicified rock with no definite vein pattern.

There are no major, large-scale shear or fracture zones in the vicinity of any of the gold deposits. The deposits within the stock are not visibly controlled by any well-defined structure. Those that lie in short narrow zones of shearing outside the border of the stock dip very steeply, east or west, and strike more or less parallel to the margins of the intrusive. Their distribution and attitude suggest that their formation was closely related to the stock. There are three possible mechanisms whereby the shears could have originated; first, by the effects of forceful intrusion of the stock, second, by contraction and subsidence upon cooling and crystallization of the intrusive, and third, by the buttressing effect of the stock during deformation subsequent to its solidification.

Sulphide mineralization in the gold-quartz deposits consists mainly of pyrite, pyrrhotite, and chalcopyrite. Sphalerite and arsenopyrite are present in some deposits but neither mineral is at all plentiful. The sulphides are generally disseminated throughout the gangue of silicified country rock and quartz. Sulphide mineralization is not heavy in any of the deposits. In most, sulphides are rather sparsely distributed.

The vein quartz that occurs in these silicified zones usually is present as short stringers and lenses running parallel to the length of the zone. Apart from silicification, production of a little chlorite in the volcanic rocks, and sericite in the intrusives, alteration of the country rock is inconspicuous.

Trenches, pits, and prospect shafts are found on many of the gold deposits. Records reveal that most of this work was done between 1900 and 1920. A limited amount of diamond drilling has been done on a few veins in the area.

It is difficult to obtain reliable estimates of the gold content of many of the deposits. Records of individual assays from samples of unknown character, size, and distribution are available. Some of the results indicate high gold values; others are very low. However, little is known regarding distribution of values in individual deposits. One might surmise that on the whole the overall gold content of most veins must be rather low, otherwise so many properties would not have lain idle for so long. On the other hand, it is well known that several of the companies once active in the area were forced to cease work on account of lack of funds.

Homestake Explorations Limited

Gold-bearing deposits on the Sunbeam, Moonbeam, Waverley, and adjacent claims have been investigated intermittently since the early part of the century. Between 1936 and 1941 Sunbeam Kirkland Gold Mines Limited diamond drilled a deposit on the Sunbeam claim and sunk a shaft to a depth of 400 feet. In 1941 Goldbeam Mines Limited acquired the assets of the former company and did further diamond drilling and surface work on other deposits within the Falcon Lake stock. This work outlined a gold deposit on the Waverley claim. In 1945 and 1946 a shaft was sunk to 500 feet on this deposit. In 1946 the company estimated reserves of 550,650 tons of ore averaging 0.293 ounces gold per ton before dilution. These reserves were contained in the deposits on which the two shafts were sunk. In addition gold-bearing zones are known to occur on the Moonbeam, Gold Coin, and Sundog claims.

No work has been done on any of these gold deposits since 1946. In 1950 the property was sold to Homestake Explorations Limited.

The deposit on the Sunbeam claim consists of a pipe-like body of silicified quartz monzonite situated near the edge of the inner core. On surface the deposit is roughly circular in outline with an area of about 2,200 square feet, and increasing with depth. The pipe plunges at angles of 55 to 65 degrees in a direction north 30 degrees east. Around the margins of, and concentric with, the pipe the quartz monzonite exhibits a faint banding. A flat-lying fault between the third and fourth levels of the mine displaces the lower part of the orebodv northward for 65 feet. Several other NE-trending fractures displace the deposit for distances of a few inches to several feet. Some ot them are filled with quartz. Pyrite is the main sulphide mineral and is disseminated throughout the silicified quartz monzonite. In addition to pyrite, Brownell (1941) reports pyrrhotite, arsenopyrite, sphalerite, galena, tennantite, and chalcopyrite.

On the Waverley claim the deposit at the site of the shaft is covered by the rock dump and little information regarding the character of the occurrence is available. However, figures reveal that several hundred thousand tons of material approaching ore grade have been outlined in three closely-spaced bodies. These all occur in the granodiorite a few hundred feet from the quartz monzonite core of the stock.

There is a northeast-trending shear zone on the Waverley claim just outside the core of the stock. The shear is silicified and carries small amounts of pyrite. Vein quartz is scarce. Gold values from trace to 1.48 ounces gold per ton are reported by early workers (Bruce 1919, Marshall 1918).

On the Moonbeam claim at the contact of the core a silicified zone in granodiorite contains considerable pyrite. A grab sample taken by the writer gave an assay of 0.01 ounces gold per ton.

Veinlets of quartz a few inches wide occur in granodiorite on the Gold Coin claim. The granodiorite is silicified and contains arsenopyrite and pyrite. Bruce (1919) reports an assay of 0.08 ounces gold per ton and Marshall (1918) 2.30 ounces gold and 0.10 ounces platinum per ton.

Star Lake Gold Mines Limited

This company holds a group of patented claims formerly owned by Penniac Reef Gold Mines Limited. These claims are situated southeast of Star Lake along the west side of the Falcon Lake stock. Before 1915, when the present company acquired the property, Penniac Reef Gold Mines Limited had sunk a shaft to 65 feet on the Moore claim and had done about 100 feet of lateral work. Old company reports show high values in gold and small quantities of silver, platinum, and iridium. No work was done on the claims between 1915 and 1938. In 1938 Star Lake Gold Mines Limited did about 1,600 feet of diamond drilling and reported encouraging results. Since that time the property has been inactive.

The deposit on the Moore claim consists of scattered stringers of vein quartz in a zone of dark silicified and mineralized agglomerate. The main sulphide is pyrite which is disseminated throughout the silicified rock. Small amounts of arsenopyrite and pyrrhotite are also present.

Another vein, in porphyry on the Denmark claim, is reported to have yielded low to moderate values in gold.

Other veins related to Falcon Lake stock

Veins similar to that on the Moore claim occur on the Gem and Sheba claims. The gold content of these is unknown to the writer. Trenches were sunk on these many years ago.

On the Rad claim there are two intersecting shears containing small lenses of quartz. Along the shears the country rock is silicified and mineralized for widths of 5 to 20 feet. The veins and silicified rock carry notable quantities of chalcopyrite and pyrite. A grab sample of mineralized rock, taken by the writer, contained 0.09 ounces gold per ton.

A vein on the Boyes claim on the west shore of Barren Lake contains white sugary quartz and pyrite. Bruce (1919) reports 2.48 ounces gold per ton from a vein on the Boyes claim but it is not certain if this was from the same vein as seen by the writer.

On the Jewel claim there is a shear zone 5 to 10 feet wide exposed for a length of 750 feet. The mineralized zone is a foot or so wide and consists of lenses and stringers of quartz. The quartz and wall-rock are mineralized with pyrite, arsenopyrite, and some chalcopyrite, sphalerite, pyrrhotite, and galena. Two prospect shafts were sunk on this vein around 1900. Old records reveal that 2 samples taken by the mining recorder in 1912 gave assays of about 2 ounces gold per ton as well as some silver. A sample taken by the writer, and consisting of mineralized grey glassy quartz containing disseminated pyrite gave 0.04 ounces gold per ton.

South of Star Lake a shear zone at the contact of porphyry and quartz diorite is exposed in a number of trenches. The shear is restricted to the porphyry side of the contact. The porphyry is silicified and contains many small lenses of quartz. Pyrite and arsenopyrite are widely scattered throughout the quartz and silicified porphyry. The mineralized zone can be traced for a distance of 400 feet and passes beneath overburden at both ends. Nil assays for gold were obtained from two samples of mineralized porphyry taken by the writer.

The quartz vein on the Four Leaf Clover 5 claim occurs in massive slightly fractured andesite. Small quartz stringers and lenses are scattered over a width of 4 to 5 feet. The wall-rock is neither silicified nor mineralized. Only minute quantities of pyrite are present in the vein. The gold content is not known.

Falnora Gold Mines Limited

This company holds a group of claims at the east end of Falcon Lake. On the Thompson 2 claim there is a gold deposit on which considerable surface work and some diamond drilling had been done prior to its acquisition by the present company. Falnora Gold Mines Limited drilled a few holes into the deposit in 1949.

The deposit occurs in a zone of sheared tuffaceous rock interbanded with andesite. A narrow porphyry dyke cuts the rocks a few feet north of the shear. The mineralized zone occurs along the western 500 feet of the shear. Very little vein quartz is present. Instead, the ore-bearing section consists of a hard, dense grey siliceous rock that may be a felsite sill or silicified volcanic rock. The mineralized siliceous rock varies in width from 2 to 4 feet. The shear is up to 12 feet wide. The eastern 250 feet of the zone is well mineralized with disseminated pyrite and seams of this mineral. Considerable pyrrhotite and some chalcopyrite are also present. The western part of the zone is not as well mineralized as the eastern, but sulphides are present there as well. The easterly section of the deposit is reported to average 0.44 ounces gold per ton across a width of 2.1 feet for a length of 250 feet. Two shipments of ore taken from an open cut along the length of the deposit averaged 1.95 ounces gold per ton (38 tons) and 2.38 ounces gold per ton (18 tons). Some drill holes are reported to have intersected sections with high gold content; others gave indifferent results.

Unconfirmed reports state that a long hole drilled years ago intersected a wide quartz vein under the lake 300 feet north of the zone on the shore. At the east side of the Thompson 3 claim a mineralized zone which could be the extension of the one under the lake strikes east and passes outside the boundaries of the claim group held by Falnora Gold Mines Limited. The zone at the east end of the lake consits of sheared silicified and pyritized rock cut by numerous small quartz stringers. The exposed width is 12 feet. A specimen of mineralized rock taken by the writer assayed 0.03 ounces gold per ton. Apart from the one long hole mentioned above the possible extension of the mineralized zone at the east end of the lake has not been drilled.

Scheelite Deposits

Deposits of scheelite occur at several localities along a northeast-trending zone passing west of Barren Lake. Some of these deposits were discovered in 1918 at which time a small amount of cobbed ore was shipped from the area. During the early part of World War II other deposits were discovered and in 1942 a thorough investigation of all the known deposits was made by J. D. Bateman of the Geological Survey of Canada and A. S. Dawson of the Manitoba Mines Branch.

Bateman's work (1943) indicated that the deposits known to date are of little economic interest, mainly on account of their small size.

The deposits occur in shear and fracture zones along the belt west and north of Barren Lake. Scheelite may be present in small lenses of sugary quartz. These lenses measure a foot or so in width and only a few tens of feet in length. They strike northeast, dip steeply southwest, and plunge northward at angles of 60 degrees or more. Abundant small brown garnets are found in the quartz. Epidote and calcite are commonly present in the scheelite-bearing quartz lenses. Other deposits consist largely of secondary pale amphibole and olive-green epidote, with some garnet, calcite, and quartz. The scheelite in both types of deposit occurs as disseminated grains. In places it is concentrated in small pods.

Descriptions of individual occurrences may be found in reports by Bateman (1943) and Springer (1952).

Sulphide Deposits

A great number of sulphide deposits, some of considerable size, are present throughout the map area. They are particularly numerous in the sedimentary rocks of map unit 5 around Star Lake and West Hawk Lake. The deposits west of Howe Bay occur along an east-trending zone of restricted width but considerable length. There are some deposits within the larger areas of andesite; these deposits are largely confined to beds of sedimentary rocks interbanded with the lavas. Thus there appears to be a definite relationship between the occurrence of sulphide deposits and the sedimentary types of rock. In addition to the deposits proper there are several places where sulphides are widely scattered throughout the sedimentary rocks, resulting in pronounced rusty weathered surfaces.

The sulphides occupy shear zones in the sedimentary rocks. Most of the shears are strike shears, i.e. they strike parallel to the bedding of the rocks in which they occur.

Most of the sulphide deposits show evidence of having had considerable trenching done on them. Shallow prospect shafts were sunk on some. Records show that most of this work was done between 1900 and 1920. Little attention has been paid to them since that time.

The sulphide bodies consist largely of pyrrhotite but some also contain considerable pyrite. These minerals occur as pods, lenses, and stringers of solid sulphide and as disseminated grains in schist. Variable amounts of quartz are present in some deposits. There do not appear to be sufficient concentrations of valuable metals in any of the sulphide zones to make them of economic importance. Very small amounts of nickel, zinc, copper, and tin have been reported by previous workers (De Lury 1921), Bateman 1943, Springer 1952). In view of the large amount of work done on these zones in earlier times and the consistently disappointing results, it appears that the sulphide deposits provide little incentive for future investigation.

Summary of Economic Possibilities of the Area

As stated in the previous paragraph there is little likelihood that concentrations of valuable metals will be found in the sulphide zones.

The occurrences of scheelite discovered to date are all too small and too low in tungsten content to offer much promise of future development.

Of the gold deposits known to date only two properties appear at all promising, the Sunbeam-Waverley deposits and that on the Thompson claims. Early reports indicate some very high and some very low gold assays from other gold deposits in the area. A perusal of early reports both by government geologists and by parties interested in the properties seems to indicate that the high assays were obtained from selected specimens. Other samples from the same veins as those from which high assays were obtained gave discouraging results seemingly indicating erratic distribution of gold.

Samples taken in more recent years have given consistently discouraging results. Twenty grab samples taken by Springer (1952) gave assays ranging from trace to 0.08 ounces gold per ton. Eleven grab samples taken by the writer from the best mineralized portions of veins gave assays ranging from nil to 0.09 ounces gold per ton.

Most of the gold-bearing deposits are rather small, and especially, narrow.

It would thus appear that most, though not all of the gold deposits known in the area are of little economic importance. It is possible that new deposits may be discovered if activity in gold exploration is renewed.