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GEOLOGY

of

the Crow River Area

District of Kenora
(Patricia Portion)

by

E.G. Pye

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E.G. Pye,
Director, Geological Branch.

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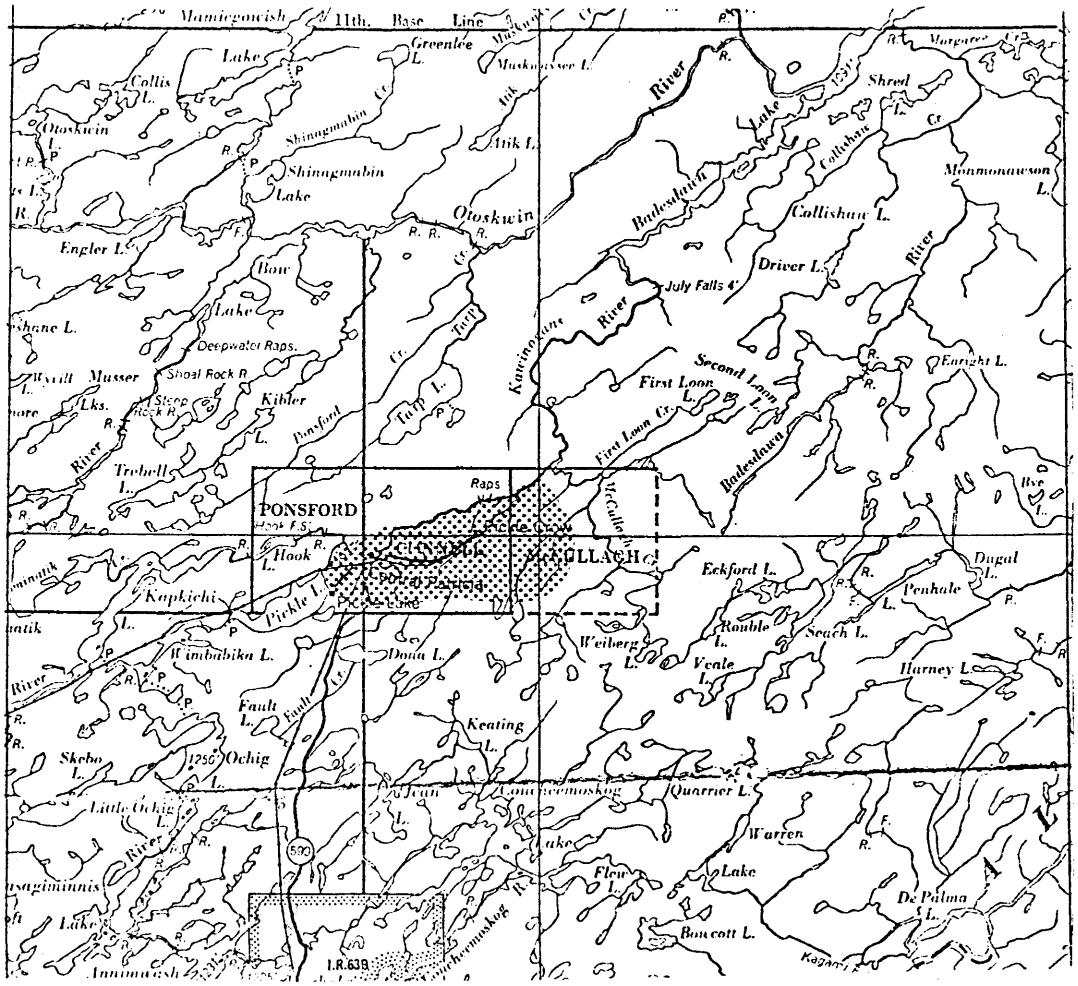


Figure 1 Location of Crow River Area, District of Kenora, Patricia Portion. Scale 1 inch to 8 miles or 1:506,880.

GEOLOGY OF THE

CROW RIVER AREA

DISTRICT OF KENORA (PATRICIA PORTION)

by

E.G. Pye[1]

INTRODUCTION

In 1951, the Crow River area ranked among the gold producing areas of the Province of Ontario. It was first actively prospected in 1928, when important discoveries were made by employees of F.M. Connell and Associates and of Northern Aerial Minerals Exploration Limited. These discoveries were investigated underground in 1930 and 1933, respectively. This work proved successful in outlining significant ore bodies at both properties. Milling of ore from the body located on the claims held by F.M. Connell, taken over by Central Patricia Gold Mines Limited, commenced May 27, 1934; milling on the Northern Aerial Minerals Exploration (N.A.M.E.) ground, taken over by Pickle Crow Gold Mines Limited, commenced April 17, 1935. Up to December 31, 1951, the total gold production from both mines, and from subsidiary operations in the area, had totalled 1,482,557 ounces.

During the summers of 1936 and 1937 a detailed geological map of the properties that were being actively developed was prepared by Jas. E. Thomson (1938) for the Ontario Department of Mines.

[1]Resident Geologist, Port Arthur (Thunder Bay), Department of Mines.

Thomson's work contributed a great deal to the understanding of the complex structural features of the area, and did much to fill in the sketchy picture presented by earlier reconnaissance mapping. However, subsequent to publication of Thomson's report and map, a large amount of diamond drilling and underground development have been done. The writer was commissioned in the spring of 1951 to assemble and correlate the results of this exploration.

The base map used for the writer's investigation was Map 47b (Thomson 1938a). This map has been brought up to date by illustrating all the latest (to 1951) diamond drilling data, bedrock exposures discovered since the publication, and the information made available by the underground mine developments in the area. It is to be noted that the locations of geologcial boundaries as shown on the revised map do not always agree with those shown on company plans. This is due to the fact that, in the case of company plans, the geological boundaries have been plotted by projecting drill intersections vertically to the surface, whereas in preparing the accompanying coloured map, they were projected up the dip and up the plunge of the rock formations wherever possible. For this reason no geology is plotted on the projections of the drill holes shown on the map.

Except for a few isolated outcrops, no surface mapping was attempted by the writer during the field season. But most of the exposures were examined in detail, and many new determinations of such features as schistosity, joints, drag folds, and pillows in lavas were made to assist in the interpretation of the structural geology. This work was supplemented by investigation of accessible mine workings, studies of all available diamond drill cores, reviews of all pertinent records and reports (to 1951), and subsequent laboratory work on samples of ores and of typical rocks.

LOCATION OF AREA, MEANS OF ACCESS

The Crow River area is made up of a group of mining properties extending along and on both sides of the Crow (Kawinogans) River east of Pickle Lake through Ponsford, Connell, and McCullagh Townships. It is located in the Patricia Portion of the District of Kenora, and lies approximately 125 miles northeast of Sioux Lookout on the transcontinental line of the Canadian National Railway. The north and south boundaries of the area lie along the east-west base lines surveyed by G.F. Summers in 1937.

In the early days of the mining camp, visitors reached the area by canoe from either Hudson or Savant Lake on the railway or by airplane from Allanwater (Hurst 1930, p2).

At the present time (1951), however, all passenger traffic is being handled by Central Northern Airways from Sioux Lookout. Landing facilities for pontoon-equipped aircraft are provided in the area by Pickle Lake, and for wheel-equipped aircraft by a landing strip located north of the Crow River on the property of Central Patricia Gold Mines Limited. Flights are scheduled to leave Sioux Lookout twice daily except Sunday.

ACKNOWLEDGMENTS

The writer is greatly indebted to the officials and staffs of the various mining companies in the area for their cooperation and generous assistance. Much of the information in this report was obtained from company maps and records, which were placed without reservation at the writer's disposal. Those to whom special acknowledgment is due and to whom the writer is especially grateful are: W.H. Connell, Vice President, and D.B. Angus, Mine Manager, Central Particia Gold Mines Limited; W.J. Anderson, President, Crowshore Patricia Gold Mines Limited; J.E. Hammell, President, and A.G. Hattie, Manager and Director of Mining, Pickle Crow Gold Mines Limited; R.E. Hore, Geologist, and D.B. Mulholland, Secretary-Treasurer, Kaw Crow Patricia Gold Mines Limited; and E. Warren, Secretary, PicPat Syndicate.

Several others interested in the area offered invaluable advice on many occasions, and added a wealth of information to supplement that obtained from company plans and reports. For this liberal counsel and generous assistance, the writer wishes to express his sincere thanks and appreciation to: T.T. Tigert, Assistant Manager, and E.W.M. Cockayne, Chief Engineer, Central Patricia Gold Mines Limited; H.H. Monette, Assistant Manager, W.R. MacQuarrie, Geologist, and J.M. Buesnel, Chief Engineer, Pickle Crow Gold Mines Limited; J.A. Reid, Consulting Mining Engineer; and E. Wilson, Manager, Central Patricia Hotel.

During the course of the field work the writer was assisted by E.H. Marvin, who proved himself to be a capable and efficient associate.

HISTORY AND DEVELOPMENT

The first mining activity in the Pickle Lake-Crow River region occurred in 1926, when two prospectors, George Simmons and Bill Seiger, located a band of mineralized iron formation south of the Crow River at the site of the Central Patricia No. 1 Shaft. Trenches were dug across the band and the deposit sampled. But the best section assayed only $3.00 ($20 per ounce) in gold per ton and the ground was not staked. However, in the following year, upon learning that chalcocite had been located along the north bank of the river a few miles east of Pickle

Lake, Louis Cohen, Fred MacLeod, Lorne Howey, and Jack Morrison formed a prospecting syndicate to undertake an investigation of the area. In December, 1927 Alex and Murdoch Mosher staked for this syndicate a group of 18 claims (Pa71-88 inclusive), which, in the summer of 1928, were optioned to F.M. Connell and associates. Arthur Cockshutt was immediately employed by Connell to investigate the showings. The chalcocite vein proved to be of no commercial significance and the mineralized iron formation located by Simmons and Seiger in 1926 panned poorly. Although disappointed, Cockshutt nevertheless decided to put a crew to work doing further trenching of the iron formation. One trench cut a zone of heavy sulphide mineralization. This mineralization assayed well. Connell's option, of course, was exercised, and in February, 1929, subsequent to the incorporation of Central Patricia Mines Limited, a diamond drilling program was started under the direction of J.C. Kirkland. This drilling indicated a possible ore body, and in the following spring a steam-powered mining plant was assembled at the property and underground development started. The work which followed proved successful, and by May 1934, a mill with a capacity of 50 tons per day had been brought into operation.

In the meantime, after the original discoveries had been announced, other claim groups were staked throughout the area. The first to be recorded were those of Albany River Mines, Limited, to be followed shortly by those of Northern Aerial Minerals Exploration Limited (N.A.M.E.), Mint-Ore Mines, Crow River Mines Limited, Huronian Belt Company Limited, Nipissing Mining Company, and others (Hurst 1930,p.15-30). Several promising mineralized zones were soon located. Of these, the most significant was the Howell Vein discovered by H.H. Howell and J. McFarlane on N.A.M.E. ground. This vein was tested by trenching and diamond drilling in 1929, and a small ore body was indicated. But pending financial arrangements, the property remained dormant for over 3 years, and it was not until September, 1933, that a steam-powered mining plant could be installed and shaft sinking started. Pickle Crow Gold Mines Limited, was incorporated in 1934 to take over the property, and in the summer of that year plans were drawn up for a mill with a rated capacity of 125 tons per day. Amalgamation and cyanidation of the ore commenced on April 17, 1935.

At the time of the discovery of the Howell Vein, other gold deposits were located on the Springer claims to the southwest and on the Albany ground to the northeast. Surface work on the Springer claims, which in 1929 were held under option agreement by F.M. Connell and at a later date were taken over by Central Patricia Mines Limited indicated a small gold-bearing quartz vein of unusual richness. Underground development commenced in 1935, when a three-compartment shaft was sunk and drifting was started on the 150-foot level. Subsequently, the shaft was deepened and the vein opened up to a vertical depth of 1,000 feet, and although two of the three ore shoots outlined were found to bottom above the 550-foot level, by 1940 the deposit had yielded 13,158.42 ounces of gold from only 18,886 tons of ore milled. A somewhat different history has been recorded at the Albany River Mine, for here actual mining of the ore was never started, and the reserves, although small, remain to be exploited at some future date. During the summer of 1929 a program of surface exploration under the direction of C. Matheson resulted in the discovery of a number of erratic discontinuous deposits of auriferous sulphides and quartz, near the contacts between tongues of porphyry and greenstones or iron formation. These deposits were drilled between 1933 and 1935. Promising gold values were indicated in several places. But the intersections proved difficult to correlate, and in February, 1936, the decision was made to go underground for a more thorough examination. During 1936 and the following year a shaft was sunk to a depth of 640 feet.

Levels were subsequently established at vertical intervals of 125 feet, and by 1940 the work had indicated several small ore shoots. These ore shoots were estimated by the management to aggregate 13,876 tons averaging 0.40 ounces of gold per ton.

Except in that the Springer Mine was closed after exhaustion of ore reserves in 1940, and the Albany River Mine, which had passed under the control of Pickle Crow Gold Mines Limited, was shut down in 1941, steady expansion at the producing mines and surface exploration at other properties continued. This was not without some success, for it resulted in the discovery of the No.2 vein system now (1951) being exploited by Pickle Crow Gold Mines Limited. But with the advent of "lend lease" in late 1941 and the entry of the U.S.A. into World War 2, many of the operations in the area were curtailed. Previous to these events, gold production in Canada was essential for the purchase of many war necessities from neutral countries. However, by early 1942, gold mining came to be classified as a non-war industry, and the attendant shortages of labour, increased costs, and high taxes did a great deal to retard normal development. With the cessation of hostilities in Europe, interest in the area was revived, and during 1945 and 1946 a considerable amount of work was done on several of the old claim groups, including underground development of a deposit located on the Crowshore property. However, this revival was short-lived, for the high costs and shortages of skilled labour continued to have an adverse effect. By the end of 1947 all surface exploration, except on the properties held by the two producing mines, had been brought to a halt. During 1951, the only work carried out was done by Pickle Crow Gold Mines Limited and, as a final effort before the cessation of operations in December, by Central Patricia Gold Mines Limited.

It must be admitted that the history recorded since 1941 is quite discouraging. But at the same time exploration in the area,necessary to the healthy growth of any mining camp, has been greatly retarded. Many possibilities remain to be tested. In view of the discovery within the past year (1951) of a new gold-bearing vein (No. 5 Vein) and a deposit of auriferous sulphides, both apparently of commercial grade, near the No. 1 Shaft on the Pickle Crow Gold Mines Limited property, and because there are many sections of the area which have not been examined in detail, the probability of finding new ore bodies appears to be good.

TRANSPORTATION

All supplies and heavy equipment for the camp are transported during the winter months by tractor train, over a winter road connecting Savant Lake with the mines. During the summer months materials are carried by scow from Hudson across Lost Lake, up the English River and across Lac Seul, up the Root River and overland by marine railway to Lake St. Joseph, and thence across Lake St. Joseph to Doghole Bay Landing, some 20 miles south of the area. From Doghole Bay Landing, transportation is by truck to the mines. During the summer of 1951 the freighting cost from Hudson to the mines was $41.60 per ton, and for the backhaul trip to Hudson $19.80 per ton (B.H. Wilson, The Patricia Transportation Company Limited, personal communication).

It is expected that transportation costs will be reduced materially upon completion of the new all-weather highway under construction from Savant Lake (completed in 1954).

TOPOGRAPHY

The general character of the terrain in the Crow River area is quite similar to that of many other parts of the Canadian Shield in Ontario. Viewed from a high hill, mine headframe, or forestry tower, the surrounding horizon is seen to be impressively flat, broken only here and there by a prominent hill. However, in detail the surface is very irregular, and knolls and ridges of rock or of glacial deposits alternate with swampy depressions. These knolls and ridges are generally very low, seldom rising more than 50 feet above the surrounding lowlands. They are characterized by a distinct northeast trend that reflects the course in which the Pleistocene ice sheet moved across the region, and accordingly impart a similar alignment to many of the creeks emptying into the Crow River. The highest part of the area lies north of the Central Patricia Mine, where broad ridges of till, gravel, and sand form an extensive plain dotted with small, more or less circular depressions that give rise to a characteristic knob-and-kettle topography. Other high points are Radio Hill, a ridge of glacial drift separating Pickle Lake from the remainder of the area; the conspicuous range of rock outcroppings extending north-eastward across the Main group of Pickle Crow Gold Mines Limited and the bedrock exposures on the Albany River group to the northeast. Conversely, the lowest section occurs as a large swampy depression trending north-south right across the central part of the map-area, extending from Laing Creek on the west to Buesnel Lake on the east. The average elevation of the area is about 1,200 feet above sea level (Hurst 1930).

All the creeks in the area empty into the Crow River, which flows northeastward to Badesdawa Lake. This lake is drained by the Kanuchuan River that joins the Attawapiskat River, which empties into James Bay opposite Akimiski Island (Hurst 1930).

PRODUCTION STATISTICS

The total gold and silver production for the camp up to December 31, 1951, is 1,482,556.872 and 163,865.80 ounces, respectively. If these figures are divided by the total number of tons of ore hoisted-3,588,893 - the average recovered grade is seen to be 0.413 ounces of gold and 0.05 ounces of silver per ton. The average gold-silver ratios for the Central Patricia and Pickle Crow Mines are 10.68 and 8.15, respectively.

CHAPTER II

GENERAL GEOLOGY

INTRODUCTION

All the consolidated rocks in the area are of Precambrian age. They make up three general groups or systems of rock formations, which have been assigned provisionally to one or the other of the Keewatin, the Algoman and the Keweenawan, not necessarily to imply time equivalence with, but to emphasize their striking similarity to, other rocks bearing the same names and having the same relative ages elsewhere in the Canadian Shield. The Keewatin rocks of the Crow River area are the oldest, and consist of a complex of extrusive lavas, pyroclastics, iron formation, other fine-grained sediments, and a few intrusive bodies termed meta-gabbro, and meta-gabbro porphyry. They have been intensely folded into northeast-plunging anticlines and synclines, and form a wide belt enclosed by later batholithic masses of Algoman age, principally granites and associated gneisses. Also of Algoman age are: (1) bodies of quartz sericite schist and sheared quartz albite porphyry, which appear to have been folded with the Keewatin formations; (2) dikes of comparatively massive albite (syenite) porphyry and quartz diorite porphyry, some of aplite, rhyolite, or felsite, and a few of meta-diabase and biotite lamprophyre. The late granitic and basic dikes have been found either intruding or to be cut by the gold-bearing quartz veins, and like them are believed to represent the closing stages of the period of granitic intrusion. The youngest consolidated rock exposed in the area is quartz diabase, which, because it forms dikes cutting transversely across the other rock formations, and because it is similar in many respects to the diabase of the Lake Superior region, is believed to be of Keweenawan age (Table 1).

KEEWATIN

Rocks that have been assigned to the Keewatin series underlie the greater part of the Crow River area. They have been divided by Thomson (1938a) into five groups, which are separated on the coloured map accompanying this report as: (1) extrusive lavas and their metamorphosed equivalents; (2) fragmental rocks, consisting of pyroclastics and flow breccias; (3) hydroclastic sediments such as greywacke, quartzite, and graphitic schist; (4) iron formation; and (5) metagabbro. The extrusive lavas are the most abundant of the various rocks making up these groups. The fragmental rocks are the next most abundant. They differ from the lavas in that they tend to be concentrated along the southeast side of the area close to the granite contacts, and hence, if the formations represent a regional synclinal trough enclosed by batholithic masses, also low down in the stratigraphic sequence. Conversely, the small amounts of hydroclastic sediments present show a preference for the central portion of the belt high up in . the stratigraphic sequence. This also appears to be the case as regards the iron formation. True, it may be found at many different horizons in the volcanics, but in general it forms narrow bands that appear to be most numerous and persistent in the upper parts of the Keewatin series close to the axial plane of the Pickle Crow syncline (Thomson 1938a, p.6). The metagabbros are of minor significance and outcrop in only a few localities. They are believed to be intrusive rocks developed as sill-like bodies and dikes cutting the flows during the Keewatin volcanism. But this is merely an assumption based upon lithologic similarity to coarse-grained portions of some of the lavas, and it is not impossible for them to be post-Keewatin in age.

Extrusive Lavas

Intermediate to Basic Lavas

Lavas presumed to have been originally of basaltic composition, and commonly called "greenstones" in the field, make up the bulk of the Keewatin rocks exposed in the area. Except in that they are all rather fine-grained, they vary considerably in character. Colours range from light to dark green and from grey to greenish grey; and structures, from massive to schistose. Most flows do not exhibit the primary features characteristic of their origin. It is true that pillows have been developed locally, and where shearing has not been too intense, such as south of the Central Patricia Gold Mines Limited No. 1 shaft and on the ridge south of the Springer Mine, they are sufficiently well preserved as to be useful in indicating the directions in which flow tops face. Porphyritic and variolitic lavas have also been noted in a few localities, and on the Kaw-Crow Patricia Gold Mines Limited property in the east part of the area Thomson (1938a, p.6) has mapped amygdaloidal greenstones. But such features are uncommon, and as a result of the severe alteration which the various extrusives have undergone, petrographic classification in most cases is exceedingly difficult. The lighter flow rocks, of course, may be regarded as andesitic, and the darker ones as basaltic, but such colour differences are dependent as much upon deformation and degree of metamorphism as they are upon original compositions. Thus highly schistose lavas are generally more green, consequent upon the presence of greater amounts of chlorite, than are the more massive varieties; some flows are lighter in colour as a result of carbonatization or silicification; and others are quite dark due to the presence of hornblende, formed instead of chlorite during regional metamorphism.

"Dioritic Greenstone"

At a great number of places in the map-area, the normal fine-grained greenstone has been found, either in outcrops or in diamond drill cores, to grade imperceptibly into a medium-grained, dark greenish grey, generally massive rock of similar mineralogical composition. Such rocks probably represent the coarser, interior parts of flows, for generally the fine-grained greenstone associated with them shows vestiges of primary flow structures indicative of an extrusive origin, and they themselves appear in every respect to be conformable with the banding of the adjoining lavas. They form good horizon markers, and the correlation of their exposures with known drill intersections, as shown on the coloured map of the area, has proved extremely valuable in helping to delineate the axial planes of some of the folded structures.

The "dioritic greenstones" are practically identical in appearance to the intrusive metagabbros described below. This is also true as regards mineralogical composition, alteration, and, except in rare cases where pillows have been recognized, also structure. Both consist essentially of fibrous amphibole, chlorite, and highly altered plagioclase with small amounts of carbonate, epidote, sericite, and quartz, and subordinate leucoxene, apatite, sphene, and sometimes pyrrhotite. The most abundant constituent appears to be amphibole, which makes up from 35 to 60 percent of the rock. In rocks farthest from the granite contacts, such as near the Central Patricia and Pickle Crow mines, it occurs as a fibrous, pale green variety along with chlorite and generally some carbonate in rounded patches up to about 5 mm in diameter, enclosed by a fine- to medium-grained matrix of the other minerals. But close to the granites it becomes hornblendic in appearance and assumes the form of large, dark green, subhedral crystals. This change is accompanied by the disappearance of chlorite, epidote, carbonate, and leucoxene, the constituents of which apparently help to form not only the hornblende but also a more calcic plagioclase and either magnetite or ilmenite. Red garnets also appear locally, and south of the Dona Patricia Gold Mines Property crystals of this mineral in places have diameters as great as half an inch.

Acid Lavas

In addition to the normal, fine-grained greenstones and associated medium-grained types there are also dacitic lavas with small rounded grains of primary quartz. One variety is exposed on claim Pa.628 south of the Central Patricia No.1 shaft, and occurs as a fine-grained, brownish grey, porphyritic rock with minute phenocrysts of both albite and quartz. Dacite has also been found near the Springer mine and on the Albany River group of claims. In the latter case it exhibits feldspar phenocrysts up to an eighth of an inch in length. However, in no case have outcrops been found to be sufficiently abundant or drill intersections sufficiently well defined as to permit positive correlations over distances great enough to be of value in determining geological structures. As pointed out by Thomson (1938a, p.7), dacite is "quite unimportant as a horizon marker in the greenstone complex."

At a few places in the area, on the Pickle Crow Main and Albany River claim group and on the Crowshore Gold Mines Limited property, there are exposures of pale grey, fine-grained, massive lavas that were termed "rhyolites" in the field and mapped with the dacites as acid lavas. Microscopic examination shows that their principal constituents are altered feldspar, quartz, and sericite, and that there are only subordinate amounts of chlorite, epidote, and leucoxene present. As in the case of the dacites, they are unimportant as horizon markers.

Chlorite and Hornblende Schists

Highly schistose rocks, designated 1 (d) on the coloured map, are very common in the area. Generally they have been formed from the lavas described previously. They are of two types, one consisting of chlorite schist, the other of hornblende schist. Chlorite schist is the more common, and occurs in narrow zones that are believed to have been the loci of fault adjustments during or after the regional folding. It has been found enclosed by relatively massive flows along the bed of the Crow River near the Central Patricia Gold Mines Limited No. 1 shaft, along the north side of the highway near the Pickle Crow Gold Mines Limited No. 1 shaft, and on the Albany River, Crowshore Gold Mines Limited, Winoga, and other properties. It is also locally well developed along the contacts between lavas and harder, competent rocks, such as the iron formation at the Central Patricia and Albany River mines (Thomson 1938a, p.8-9). Unlike the chlorite schist, the hornblende schist occurs only near granitic intrusives where processes of alteration and recrystallization were more intense and the development of a mineral assemblage representing a higher grade of regional metamorphism occurred. It is found associated with amphibolite and gneiss near granite contacts in the extreme southwest and southeast section of the map-area (Thomson 1938a, p.9).

Carbonatized Basic Lava

Carbonatized basic lava has been recognized at several places in the area: (1) west of the Central Patricia - Doghole Bay road on claim Pa 5447; (2) along the west side of the diabase dike cutting across the Dona Patricia property; (3) in the eastern part of the Atwater-Porcupine property; and (4) in the southeast part of the area west of the Hooker-Burkoski stock. The most extensive and typical exposure is found about 1400 feet south of Kishkap Falls on the Cohen-MacArthur group, where it forms a northeast trending body of irregular outline having a known length of 1,600 feet. The fresh rock is here "greyish-white in colour and consists of intermixed quartz and carbonate" (Thomson 1938a, p.9). The carbonate, as indicated by its indices of refraction, is a ferruginous dolomite, which weathers to form hydrous iron oxides and thus imparts to the outcrop a characteristic reddish brown surface gossan. Both it and the associated quartz are believed to be the result of hydrothermal replacement of greenstone, probably along a pre-existing sheared zone, in post-Keewatin time. They may have developed during the closing stages of the Algoman period of orogenesis, at about the same general time as the auriferous quartz veins.

Fragmental Rocks

Bands of fragmental rocks have been found in numerous localities. Generally they are very narrow and are not persistent enough along their strikes to be of use as horizon markers, in cases they have not been separated from the lavas on the coloured map. But in the southern part of the area, both east and west of the Hooker-Burkoski stock, the fragmental rocks are exposed over considerable areas, and occur in bands sufficiently wide and continuous as to permit delineation. These bands consist of agglomerate and interbedded tuff, laminated tuff, or flow breccia (Thomson 1938a, p.7).

Agglomerate and Tuff

The agglomerates are the most striking of the fragmental rocks from the lithological point of view. They consist of fragments, from a fraction of an inch to several inches in diameter, of from light to dark coloured rock material enclosed by a fine-grained, tuffaceous matrix. Two varieties are recognizable in the field, a rhyolitic agglomerate and one of more basic composition (Thomson 1938a, p.7). The rhyolitic agglomerate outcrops on the Dona Patricia claims along and south of Dona Creek, where it consists of elongated, contorted fragments of acid lava in a pale grey to pink, siliceous tuff. To the writer's knowledge it has only been found in this locality, and elsewhere in the area the agglomerates are the more basic type. Unlike the rhyolitic variety, they consist of elongated, rounded, and even angular fragments of one or more of basalt, dacite, rhyolite, and chert in a dark green, massive to schistose, highly chloritic matrix. Typical examples occur in the vicintiy of the diabase dike east of the Central Patricia Gold Mines Limited No. 1 shaft, on and east of the Winoga claims, and southwest of the shaft on the Albany River property.

Laminated Tuff

The matrices of the agglomerates frequently are found to grade along and across the strike into finely bedded or laminated tuffs, either acid or basic in composition as the case may be. The acid tuffs, like the agglomerates associated with them, appear to be of limited distribution. According to Thomson (1938a, p.7-8) a thin section of a typical sample showed it to consist of layers of chlorite with scattered magnetite grains alternating with laminae made up of quartz, siderite, and magnetite. This suggests that the rock is "a ferruginous greywacke or lean iron formation and as sort of transitional variety between the pyroclastics and the typical banded iron formation of the country." The more abundant basic tuffs, in the central part of the greenstone belt, also consist of alternating chlorite-rich and chlorite-poor laminae, but the overall chlorite content is much higher, carbonates are not abundant, and such other constituents as albite, epidote, sericite, and leucoxene are present. In effect, they approximate the dacitic lavas in composition. Like the lavas, they show distinct mineralogical changes as the granites to the south and southeast are approached. The first evidence of metamorphism is the replacement of chlorite and sericite by brown biotite, and the gradual disappearance of epidote. Closer to the granite contacts, first fibrous amphibole and then hornblende appears at the expense of biotite and any chlorite remaining, and the rock becomes coarser grained and somewhat gneissic in appearance. These transitions are evident in the large horizon of tuffaceous rocks extending northeastward along and close to McCullagh Creek in the southeast quarter of the map-area. Along the northwest side of the band a sample of finely laminated basic tuff was found to consist essentially of brown biotite, quartz, and plagioclase with relatively minor amounts of fibrous amphibole and magnetite. To the southeast, along the other side of the band, a second sample showed the rock to be somewhat coarser grained and gneissic, and to consist largely of hornblende and fibrous amphibole, quartz, and plagioclase. Biotite is present as before, but here this mineral is of only minor importance, and chlorite is absent.

The basic tuffs often appear to be highly schistose, with flakes of chlorite, biotite, or amphibole oriented parallel to the bedding; and since the individual laminae are commonly only a fraction of an inch in thickness, it is sometimes difficult in the field to distinguish these rocks from the sheared lavas. In such cases it is only when a fresh surface is examined carefully that the lamination becomes apparent to the unaided eye and the true character of the rock can be determined. Thus, along the power line south of the Central Patricia Gold Mines Limited No. 1 shaft, exposures of tuff were previously mapped as folded chlorite schist and included with the lavas. But careful examination indicates a distinct fine lamination, with thin layers of light coloured material alternating with others of dark greenish grey material, and occasional tiny rock particles. Diamond drilling, furthermore, has shown that the horizon is continuous with that represented by the agglomerate exposed to the northeast near the large diabase dike, where the origin is undisputed. Hence, the apparent schistosity is probably a primary feature, not a secondary one, due to the formation of the chlorite flakes in parallel position with respect to the bedding, and can be distinguished from a later false cleavage formed parallel to the axial planes of the drag folds during the regional deformation.

Flow Breccia

The flow breccias exposed in the area differ from the agglomerates and tuffs in that they are not pyroclastic in origin - they were formed not through processes of explosive vulcanism but rather simply by the shattering of a part of a flow during extrusion with subsequent cementation of the fragments by the consolidation of the still molten lava (Thomson 1938a, p.7). However, due to shearing and alteration it is not always possible to distinguish them from some of the basic agglomerates, and since they are of only limited distribution, and because their fragmental quality contrasts with the general character of the lavas, they have been grouped with the pyroclastic rocks on the coloured map. As regards their use as horizon markers they are not particularly significant. But they are important in another way, for in the underground workings at the Pickle Crow Gold Mines Limited No. 1 shaft their occurrence along the tops of some of the flows has facilitated the delineation of flow contacts and hence has permitted determination of the attitudes of the formations. Flow breccias also occur north of the Central Patricia mine east of the large diabase dike, on the Winoga claims, and on the Crowshore Gold Mines Limited and other properties. Their character may be ascertained from the definition given above. They consist of ovate to irregular-shaped fragments of fine-grained greenstone enclosed in a matrix of the same or nearly the same texture and mineralogical composition.

Sediments

In addition to the pyroclastic rocks and the iron formation described below, there are, as shown on the coloured map, several horizons of sediments interbanded with the lavas. One of them outcrops at a point 2,000 feet southwest of the Pickle Crow Gold Mines Limited No. 1 shaft near the northwest corner of claim Pa.729. It consists of a fine-grained, slaty greywacke with beds ranging from a fraction of an inch to about 6 inches in thickness. Under the microscope thin sections of the rock show it to consist of thin laminae made up of tiny grains and fragments of quartz and plagioclase in a schistose matrix of sericite, chlorite, carbonate, and leucoxene. It is similar to some of the basic tuffs in character, but contains much less chlorite, is lighter and more gray in colour, and its stratification is much more distinct on both fresh and weathered surfaces. The two rock types are easily distinguished in the field by any observer familiar with the geology of the area.

Sedimentary rocks also occur north and northwest of the Central Patricia Gold Mines Limited No. 1 Operation and in the extreme southeast corner of the map-area. These occurrences have been described by Thomson (1938a, p.9-10).

Iron Formation

The iron formation of the Crow River area is a strikingly banded, rusty weathering rock that consists of thin layers, in which iron carbonate, fine-grained quartz, and magnetite are present in varied proportions (Hurst 1930, p.8-10). It occurs as streaks, lenses, and narrow bands, from a few inches to over 100 feet in thickness, between the lava flows and tuffaceous sediments. Frequently, some of the bands can be traced continuously for miles along the strike; other bodies are lenticular in character. However, it is important to note that, although the lenticular bodies may extend for only a few feet, they are often arranged in linear patterns, thus permitting the delineation of stratigraphic horizons for structural studies (Thomson 1938a, p.11).

In some places the iron formation occurs as distinct lithological units. Elsewhere, such as at the Albany River mine, a single horizon may consist of several thin parallel bands separated by either thin lava flows or laminated tuffs (Thomson 1938a). Of significance is the fact that in both cases, the iron formation may vary appreciably in respect of its magnetite content. Some bands may consist almost entirely of this mineral; others, almost entirely of quartz and subordinate siderite. Such variations in composition, and hence in magnetic attraction, must be considered in the interpretation of dip needle and magnetometer surveys (Thomson 1938a, p.13-14).

The bodies of iron formation in the Crow River area, although locally showing small concentrations of magnetite, are too low grade to be of any value as a source of iron at the present time. But considered structurally, they are very important. Firstly, the horizons, because of their great persistence, have served as the principal markers and have permitted a reliable determination of the major structural features of the area. Secondly, fractured zones that have developed in and along the contacts of bands of iron formation have been found to contain large bodies of commercial fold ore. Thus, at the Central Patricia mine in the west part of the area, the ore bodies are zones of transverse, mineralized tension fractures in large lenses of iron formation; and, at the Pickle Crow Gold Mines Limited No. 1 Operation the fracture system now occupied by the rich Howell vein apparently originated in and along the contacts of a horizon of this rock. The reason for such localization is found in the relative competencies of the iron formation on the one hand and the enclosing greenstones on the other. The iron formation is a hard, brittle rock, which, when subjected to external forces, failed along narrow zones of fracturing. The greenstones, however, apparently failed in most cases by the development of a uniform schistosity over large areas, and experience has shown that in general highly schistose rocks were not particularly favourable to the local accumulation of the ore minerals.

Metagabbro, Metagabbro Porphyry

At a few places in the area igneous rocks lithologically identical to the "diorite greenstones" have been found cutting the lavas. They thus appear to be intrusive rather than extrusive rocks, and hence have been given a separate designation on the map. Other bodies of similar rocks occur in isolated outcrops where the origin is not known, either because contacts with enclosing formations are covered or becuase they grade into fine-grained phases which do not exhibit any structural features which might serve to indicate their mode of development. Such bodies are not separated from the "dioritic greenstones" on the map wherever an extrusive origin appears to be possible, with the reservation, stated here, that future detailed work may indicate them to be portions of intrusive bodies. Thus some of the rocks marked 1 (b) on the map, where they occur in isolated outcrops or where contact relations have not been found, have been tentatively correlated with the lavas, but all those metagabbros which are known, or have been reported, to show intrusive relations are shown as separate entities. As pointed out by Thomson (1938a, p.15) they conceivably could be of post-Keewatin age.

Possibly related to the intrusive metagabbros is a rock termed metagabbro porphyry. This rock does not oucrop, and has not been found only in the underground workings of the Crowshore mine, where it occurs as a small dome-shaped body about 30 feet in length and 15 feet in width. It is of unusual appearance, much like the so-called "leopard rock" found in other parts of the Province, and consists of white to cream-coloured phenocrysts, up to 2 inches in length, of highly altered plagioclase embedded in a dark green, relatively fine-grained matrix of feldspar, chlorite, amphibole, sericite, and accessory magnetite. Despite the fact that it is quite massive in character, the porphyry thus appears to have been subjected to the same processes of regional metamorphism as the greenstones which it intrudes. Because of this, and because the rock is similar to the metagabbros in composition, it has been assigned provisionally to the Keewatin. Again, of course, it must be emphasized that it is not impossible for this rock to be representative of a later period of igneous activity.

ALGOMAN

The post-Keewatin rocks of the Crow River area have been tentatively correlated by Hurst (1930,p.11) with the Algoman period.

The Algoman rocks of the area may be segregated for descriptive purposes into four groups, based in part upon lithological peculiarities, in part upon inferred age relationships, and in part upon the degree to which the various rocks have been sheared and altered. These groups are:

(1) highly sheared porphyries, including quartz-sericite schist and quartz albite porphyry;

(2) biotite granite (gneiss) and (porphyritic) albite granite;

(3) faintly sheared to massive porphyries, including albite porphyry and quartz diorite porphyry;

(4) acid dikes termed aplite, rhyolite, or felsite; and

(5) basic dikes, including meta-diabase and biotite lamprophyre.

Highly Sheared Porphyries

Quartz Albite Porphyry

From the economic point of view the sheared quartz albite porphyries are of considerable importance, for near the Pickle Crow No.3 shaft a large mass of this rock type has within it a zone of shearing and fracturing, along which is localized a large tonnage of quartz ore of commercial grade. They outcrop at a number of localities throughout the area, particularly in its eastern portion;(1) on the Albany River and Winoga claim groups; (2) near the highway on claims Pa. 636 and 655 of the Springer property; (3) at a few places a short distance northeast of the Central Patricia No. 1 shaft; and (4) in the extreme western part of the main Pickle Crow property. In those sections where delineation of contacts has been possible, the porphyry bodies appear to be more or less lenticular in form, and as a general rule tend to parallel in both strike and dip the enclosing formations. But locally some of them have been found transecting the banding of the lavas at acute angles. By definition, therefore, they are more properly dikes rather than sills.

The typical quartz albite porphyry is a sheared, fine-grained, greyish to greyish pink rock. It has a characteristic white to pinkish white weathered surface, upon which phenocrysts of quartz, in places up to a half inch diameter, stand up in marked relief above the less resistant groundmass. Feldspar phenocrysts are also present, but the large individuals are generally not recognizable on fresh surfaces due to alteration, and in the field the rock may be classified simply as a quartz porphyry. However, when the rock is examined microscopically it is found to contain, in addition to rounded to ovate phenocrysts of quartz, many small, stout, well-formed but fractured crystals of albite (Ab_{96}). These crystals are smaller than those of quartz, with lengths up to about three eighths of an inch. In general, they are somewhat more numerous, for Rosiwal analyses of typical sections indicated that all phenocrysts make up about 35 percent of the rock whereas those of quartz only constitute about 10 percent or less. The matrix of the rock is an aggregate of tiny anhedral grains of quartz and altered plagioclase with accessory amounts of magnetite-ilmenite, leucoxene, apatite, sphene, and rutile. In every thin section examined the groundmass was found to be schistose, and although the primary constituents of the rock themselves in most cases exhibit no linear parallelism, the structural feature is made quite evident by parallel wisps, flakes, and patches of sericite and chlorite. Chlorite occurs only sparingly in most sections. But locally it becomes prominent, where it imparts to the rock a distinct greenish cast. Its association with sericite suggests that the quartz albite porphyry, like the greenstones enclosing it, was subjected to only a low grade of regional metamorphism. Carbonate is also an abundant constituent, and like the sericite and chlorite replaces both the albite phenocrysts and the groundmass feldspars. The composition of the typical rock, as determined by chemical analysis by the Provincial Assay Office, is given in Table 2.

Table 2

Chemical Analysis of Typical Quartz Albite Porphyry, 55- Foot Level, Pickle Crow No. 2 Operation

Constituent Oxides	Weight Percent
SiO_2	70.50
Al_2O_3	16.21
Fe_2O_3	0.21
FeO	1.35
MgO	1.64
CaO	2.43
Na_2O	1.79
K_2O	1.38
H_2O	2.85
CO_2	1.22
TiO_2	0.18
V_2O_3	Tr.
P_2O_5	0.07
Cr_2O_3	0.01
MnO	0.02
Total	99.86
Loss on Ignition	3.78

The quartz albite porphyries have all been sheared to some degree. Because this cleavage parallels closely the attitude that was found in the enclosing greenstones, and because the porphyries frequently exhibit crenulations in drill cores and delineate structures in all respects apparently compatible with the Pickle Crow syncline, the writer is of the opinion that most of the porphyries were deformed with the Keewatin rocks during the regional disturbance. That the porphyries are altered sedimentary or extrusive rocks as might be supposed from these relations, however, must be discounted in most cases. For example, in the case of the porphyry exposed near the Pickle Crow Gold Mines Limited No. 3 shaft, cross-cutting relationships are evident in outcrops, chilled margins have been observed in several places, and irregular inclusions of greenstone are common near its contacts. Nor is it necessary to assume that they were all emplaced simultaneously. Rather, that some are more highly sheared than others and that the relatively more massive ones appear to be less contorted suggests that their intrusion commenced during the early stages of the regional deformation and continued until or nearly until the major folds had developed into their present expressions. This is of considerable significance, for while the folded porphyries have provided important structural controls for mineral deposition, the more massive varieties, such as the one found at the Pickle Crow Gold Mines Limited No. 3 shaft, are much more favourable host rocks than are those which are highly schistose.

Quartz Sericite Schist

Quartz sericite schist only occurs at or close to the No. 1 shaft of Central Patricia Gold Mines Limited in the western part of the area, where it makes up a number of sill-like masses and occasional narrow dikes cutting the greenstones. Both megascopically and microscopically it is very similar to the quartz albite porphyry, differing only in its more highly schistose character and in the absence of feldspar phenocrysts, which here have been reduced to aggregates of secondary minerals. The two rocks are intimately related in places, and diamond drilling southeast of the mine has shown that locally the one passes along its strike into the other. This genetic relationship is demonstrated by the chemical analyses presented in Table No. 3. Sample No. 1 is a quartz sericite schist, typical of that found north of the Central Patricia shaft; sample No. 2 is carbonatized and sericitized quartz albite porphyry from near the Pickle Crow No. 2 vein on the 550-foot level. Analyses are by the Provincial Assay Office.

TABLE 3

Chemical Analyses of Typical Quartz Sericite Schist and Altered Quartz Albite Porphyry

Constituent Oxides	Weight Percent	
	Sample No. 1	Sample No. 2
SiO_2	68.25	68.95
Al_2O_3	14.55	14.21
Fe_2O_3	0.54	0.60
FeO	1.84	1.08
MgO	1.12	1.17
CaO	2.50	2.50
Na_2O	3.68	3.88
K_2O	2.00	2.06
H_2O	2.01	0.80
CO	2.69	4.21
TiO_2	0.24	0.18
V_2O_3	Tr.	Tr.
P_2O_5	0.36	0.08
Cr_2O_3	Tr	Tr
MnO	0.05	0.02
Totals	99.83	99.75
Loss on ignition	4.89	3.78

As pointed out by Thomson (1938a, p.17) the occurrence in places of crosscutting relationships indicates that much of the quartz sericite schist at the Central Patricia mine is of igneous origin and was emplaced by intrusive action. However, the porphyry exhibits not only knife-sharp contacts but also in several places gradational ones with the enclosing greenstones;

and locally, it shows every variation, across a distance of a few feet, from a pale grey or greenish grey quartz sericite schist through greenish quartz chlorite sericite schist to sheared but recognizable lava. Similarly, along the north bank of the river east of the mine, one exposure showed recognizable vestiges of pillow structures. Despite the fact that some of the evidence appears to be in favour of an intrusive origin, it is also apparent that hybrid types, similar to the injected rocks in character, were formed by the action of porphyry magma and associated hydrothermal solutions on the volcanic rocks. Some of the horizons may even be held to represent altered sediments. In places there is a white, highly siliceous variety that, despite the presence of quartz "eyes", strongly resembles a quartzite in character. This "porphyritic quartzite" differs from the other porphyries in that it contains relatively little carbonate and practically no chlorite. A sedimentary parentage, furthermore, is indicated locally by the occurrence within it of bands of iron formation that are conformable in attitude with the greenstones and by the presence of a faint lamination suggestive of stratification (T.T.Tigert, personal communication). Finally, its occurrence along the south flank of a possible major syncline points out that it may represent the same horizons as the greywackes and quartzites located by drilling about one mile north of the mine.

Granites

Biotite Granite

Intrusions of biotite granite flank the Crow River area on the northwest and southwest, but no exposures of this rock have been found within the boundaries of the map sheet. However, representatives of these batholithic masses, as indicated by diamond drilling, underlie a portion of the Roeanor West group of Central Patricia Gold Mines Limited and an area along the east shore of Pickle Lake. Inspection of core sample from the Roeano West claims has shown that the granite is greyish pink in colour, medium-grained and generally massive. But some specimens show a faint gneissic structure, indicating a similar variation in character as was found by Hurst (1930) and Evans (1939) elsewhere. A typical massive variety was examined under the microscope, and was found to consist largely of microcline, oligoclase, and quartz, with minor amounts of brown biotite and accessory magnetite and apatite. Also present and replacing the feldspars, particularly the plagioclase, are some sericite, epidote, and a little carbonate. The granitic rock which outcrops along the highway near the Albany River shaft, is a slightly sheared, medium-grained, reddish rock with scattered quartz "eyes" on its pale pinkish-white, weathered surface; the other, which forms the Hooker-Burkoski stock dividing the area into its eastern and western parts, is very massive, finer grained, and brownish grey in colour. The former consists of well-formed phenocrysts of albite and ovate to rounded ones of quartz in a medium-grained matrix of feldspar, quartz, biotite, muscovite, magnetite and apatite. The feldspars have been highly altered to assemblages of sericite and carbonate, and the biotite to chlorite, so that both in structure and in respect of metamorphism the rock greatly resembles the quartz albite porphyries. Undoubtedly it has the same origin, and merely represents a coarse-grained facies that was intruded during the closing stages of the period of regional deformation. The albite granite forming the Hooker-Burkoski stock is of similar mineralogical composition, but quartz phenocrysts are not evident in the thin sections studied, the feldspars are much less altered, and chlorite is practically absent. The most striking feature about the rock is its completely massive quality. For the most it does not appear to be porphyritic. Toward the borders of the stock, however, large feldspar individuals become evident, not only in thin sections but in hand specimens as well. The results of chemical analyses of the albite granites, obtained from samples submitted to the Provincial Assay office, are as follows:

TABLE NO. 4

Chemical Analyses of Albite Granites

Constituent Oxides	Weight Percent	
	Sample No. 1	Sample No. 2
SiO_2	72.75	64.10
Al_2O_3	15.67	14.35
Fe_2O_3	0.42	1.26
FeO	1.27	1.73
MgO	0.47	1.10
CaO	0.35	3.41
Na_2O	6.54	4.88
K_2O	1.54	1.91
H_2O +	0.44	1.40
H_2O -	0.22	Nil
CO_2	0.33	4.47
TiO_2	0.22	0.49
V_2O_3	0.004	0.01
P_2O_5	0.15	0.29
Cr_2O_3	0.004	0.006
MnO	0.02	0.06
Totals	100.39	99.46
Loss on Ignition	0.64	5.48

Sample No. 1 is from the Hooker-Burkoski stock; sample No. 2 is from the Albany River property. It is apparent that the two rocks, although similar mineralogically, differ greatly in chemical composition, Sample No. 1 is a soda-granite or, according to Johannsen's classification, a sodaclase-tonalite. That exposed near the Albany River mine, on the contrary, has a chemical composition similar to that of Daly's average for 40 granodiorites (Daly, 1933).

Massive Porphyries

In addition to the highly sheared quartz albite porphyries, there are in the Crow River area numerous other bodies of porphyritic rocks which vary in character from faintly schistose to quite massive. These bodies, generally in the form of dikes, were emplaced long after the highly sheared masses and, as far as could be ascertained, either during the closing stages of or after the period of regional folding. They consist of either the one or the other of two rock types, albite porphyry and quartz diorite porphyry.

Albite Porphyry

The albite porphyries, like the sheared porphyries to which they may be genetically related, outcrop in a number of places throughout the Crow River area. They occur as small dikes and masses: (1) along Pickle Creek on the Gateway Patricia Gold Mines Limited claims; (2) near the Howell vein on the Pickle Crow Main group; (3) south of the highway in the vicinity of the Springer mine; and (4) to the east between

Winoga and Roeanor Creeks. They are grey or brownish grey rocks with distinct, well-formed phenocrysts of white plagioclase feldspar and occasionally scattered ones of quartz, up to about one eighth of an inch in diameter, in a dark, fine-grained matrix. Microscopic study has shown the larger feldspar individuals to be albite or sodic oligoclase in composition, and to be embedded in a groundmass made up of tiny anhedral grains of feldspar and quartz, some sericite, chlorite, and carbonate, and very minor amounts of apatite, magnetite-ilmenite, leucoxene, and pyrite. The feldspar phenocrysts are characteristically fresh in appearance. But locally they have been altered in much the same way as the feldspar of the matrix, and exhibit a little sericite and carbonate. The albite porphyries, in effect, are very similar to the sheared porphyries described above. They differ only in their characteristic massive quality and in their lack of abundant quartz phenocrysts, features which serve to distinguish them from the others in the field. At the Springer mine, the No. 6 vein cuts a body of albite porphyry, which accordingly is pre-ore in age.

Quartz Diorite Porphyry

Narrow, pre-ore dikes of quartz diorite porphyry locally cut across the folded structures without showing any deflection in attitude. They are definitely younger than the sheared quartz albite porphyries, but their relationships with the other igneous rocks in the area have not been determined. It is true that dikes of this rock are closely associated with the albite granite exposed near the Albany River mine, but contacts between the two have not been observed, so that no conclusive statement as to their relative ages can be made.

The typical quartz diorite porphyry is grey to dark grey in overall colour, with phenocrysts of white feldspar and quartz, up to about a quarter of an inch in diameter, visible on both fresh and pale greyish to rusty brown, weathered surfaces. Its most characteristic and distinguishing feature is the presence within it of large crystals and grains of lustrous, black biotite, which imparts to the rock a speckled appearance not too unlike that displayed by the biotite lamprophyres in the area. Microscopic examination of the rock shows that it consists of tabular, corroded phenocrysts of andesine, rounded ones of quartz, and occasional crystals and grains of biotite, locally with some amphibole. These minerals are embedded in a fine-grained, allotriomorphic aggregate of plagioclase, quartz, and biotite with accessory amounts of apatite, magnetite, and zircon. In most thin sections examined the biotite has been slightly altered to chlorite, and the feldspar to sericite, carbonate, and epidote.

In addition to occurring on the Albany River property, dikes of quartz dirorite porphyry have been found: (1) in the southeast corner of the claim Pa.2,064 of the Winoga group; (2) in the extreme eastern part of the area near McCullagh Creek; (3) on claim Pa. 2,151 about 500 feet west of Roeanor Creek; (4) on claim Pa. 2,017, just off the nose of the Hooker-Burkoski stock; and (5) in the northeast corner of claim Pa. 2,199 of the Gateway Patricia Gold Mines Limited property.

Acid Dikes

Narrow dikes of fine-grained, light grey or pinkish highly siliceous rocks, which have been variously termed aplite, rhyolite, and felsite, have been mapped in a few scattered localities. One such dike outcrops across a width of 50 feet south of the highway at the west end of the Albany River property, and has been traced by diamond drilling for about 1,800 feet to the southwest across the Winoga group. Another dike strikes N30^{o}E for a distance of 2,500 feet through a large outcrop area of volcanic fragmentals between McCullagh and Hooker Creeks in the extreme eastern part of the area; a third is exposed over a length of 200 feet in an outcrop about a half mile south of the second dike; and a fourth over a length of 400 feet along the west bank of Roeanor Creek near the east boundary of the Springer property. Other bodies of aplite, rhyolite, or felsite outcrop about 3,000 feet east of the Central Patricia Gold Mines Limited No. 1 shaft, on the Dona Patricia Gold Mines Limited claims, and farther west on the Gateway Patricia Gold Mines Limited property north of Pickle Lake. All are believed to be post-granite in age, for, although no intrusive relationships have been found in the map area itself, the work of Hurst (1930) and Evans (1939) has shown that pegmatite and aplite dikes of similar character cut both the grey biotite granite and the later pink variety found near the borders of the greenstone belt. Thomson (1938a) furthermore, describes an occurrence in which dikes of aplite cut across a gold-bearing quartz vein on the Dona Patricia Gold Mines Limited property, whereas D.B. Angus (personal communication) manager of the Central Patricia mine, reports that auriferous quartz veins have been located by drilling in the albite granite of the Hooker-Burkoski stock. It appears, then, that the massive acid dike rocks are not only later than the granites but are also post-ore in age.

Basic Dikes

Metadiabase

Small dikes of metadiabase are common in the underground workings at the Pickle Crow Gold Mines Limited No. 1 shaft, where they appear to be both pre-quartz and post-quartz in age. One dike, for example, occurs along the hanging wall of the later Howell vein, a second dike appears to cut the vein at its eastern extremity on the 1,350 foot level (Corking 1943). Both consist of fine-grained, dark grey rocks, rather massive but otherwise similar to the enclosing greenstones in character. The one along the hanging wall of the Howell vein is made up of a matted aggregate of chlorite, sericite, carbonate, magnetite, secondary quartz, and, on the lower mine levels, brown biotite. The post-vein dike is less altered. It consists of plagioclase, quartz, chlorite, carbonate, sericite, magnetite, and a little epidote. Dikes of similar appearance and composition transect the folded quartz albite porphyry near the Pickle Crow Gold Mines Limited No.3 shaft, where they are cut by the quartz of the No. 2 vein system. These tubular bodies are rather persistent along their respective strikes and down their dips. But they are very narrow, and, like those found near the Howell vein, either do not outcrop or are too small to be shown on the map of the area. The following analyses by the Provincial Assay office, of typical specimens of the metadiabase dikes, are given here as a means of illustrating the basic nature of these rocks (Table 5).

Biotite Lamprophyre

Dikes of biotite lamprophyre, most of them too small to be shown on the map, are numerous, and either outcrop or have been revealed by diamond drilling on most of the mining properties in both the east and west sections of the area. They cut sharply across the other rock formations and have been found to exhibit intrusive contacts against all other igneous rocks except the albite granites and dikes of albite porphyry and later aplite, rhyolite, or felsite. Generally they are younger than the gold-quartz deposits, a fact which lead Thomson (1938a) to suggest that the lamprophyres may be of Keweenawan age. But one dike of typical biotite lamprophyre near the Pickle Crow Gold Mines Limited No. 3 shaft is cut by the auriferous quartz and another located by drilling on the Picpat Syndicate claims west of the Cohen-MacArthur group, is mineralized with small amounts of pyrite and pyrrhotite. It appears that these dikes were formed at about the same general time as the mineral deposits

Table No. 5

Chemical Analyses of the Metadiabase Dike Rocks

Constituent Oxides	Weight Percent Sample No. 1	Weight Percent Sample No. 2
SiO_2	46.26	46.50
Al_2O_3	15.88	14.34
Fe_2O_3	0.83	Nil
FeO	7.32	10.70
MgO	3.92	5.00
CaO	8.42	8.45
Na_2O	3.24	1.99
K_2O	2.44	0.40
H_2O	3.16	3.65
H_2O -	0.23	0.07
CO_2	6.52	7.07
TiO_2	1.10	1.55
V_2O_3	0.07	0.02
P_2O_5	0.14	0.21
Cr_2O_3	0.03	0.02
MnO	0.18	0.17
Totals	99.75	100.22
Loss on Ignition	8.96	9.82

Sample No. 1 - Analysis of "vein dike" 2400-foot level, Pickle Crow No. 1 Operation.

Sample No. 2 - Analysis of metadiabase dike (greenstone "inclusion"), 1600-foot level, Pickle Crow No. 2 Operation.

in the area and represent the closing stages of the Algoman period of orogenesis.

The lamprophyres are massive, dark grey to black, medium-grained rocks with a distinct porphyritic texture due to crystals of biotite that in places exceed a quarter of an inch in length. Two varieties have been recognized. One, which cuts the Howell vein, is composed chiefly of biotite, orthoclase, chlorite, and carbonate, and may be an altered minette (Hurst 1930,p.12). A second post-ore dike which cuts the vein system at the Pickle Crow Gold Mine Limited No. 2 Operation, is made up of biotite, andesine, quartz, subordinate clinopyroxene, and accessory apatite and zircon. Lamprophyres of this composition, but containing no quartz, have been classified by Grout (1932, p.124) as kersantites. Perhaps the most appropriate name for the rock, then, is "quartz kersantite." The pre-quartz dike mentioned above parallels this one in attitude. It is of similar composition, but as the quartz vein is approached the biotite is found to have been replaced by chlorite and secondary magnetite, and the feldspar by sericite and carbonate.

KEWEENAWAN

Dikes of quartz diabase, strongly resembling the Keweenawan diabase found in other parts of northwestern Ontario, and here tentatively correlated with it, strike in a northwest-southeast direction roughly parallel to the axis of the Hooker-Burkoski stock in the west part of the area. One of these dikes, ranging from 200 to 270 feet in width, has been traced by geological mapping, diamond drilling, and magnetic surveying from outcrops in the east part of the Dona Patricia Gold Mines Limited property through a point 3,000 feet east of the Central Patricia Gold Mines Limited No. 1 shaft to the north boundary of Ponsford Township, a distance of about 5 miles. In the vicinity of the Central Patricia mine, underground diamond drilling has indicated a dip of 75° to 85°N E. (Cokayne 1949). But the dike swings about considerably, not only along its strike as shown on the coloured map, but down its dip as well, and makes any determination of its position at depth highly speculative. Two other dikes of quartz diabase, one over 150 feet and the other from 75 to 100 feet in thickness, have been revealed by diamond drilling north of the Crow River on the Waltricia property. The smaller of the two has been shown by magnetometer surveys to extend for at least 4,000 feet in a northwest direction. North of the Waltricia claims it appears to have been cut off abruptly and faulted about 500 feet to the east, after which it continues to extend with the same attitude for over a mile across the northwest corner of Connell Township; to the south, it appears to wedge out in greenstones along the north side of the Pickle Crow main property.

The quartz diabase is a well-joined but otherwise massive, brownish weathering, dark grey to black rock with small, interlocking, lath-like feldspar crystals. In places near the centres of the larger dikes it is rather coarse-grained, with crystals up to 5 and 6 millimeters in length, but as the contacts with the enclosing rocks are approached, the diabase becomes progressively finer grained, and at one point even grades into a dark glassy material with only tiny acicular microlites of plagioclase being apparent. Thin sections of the typical quartz diabase showed it to consist largely of andesine-labradorite, as an interlocking network of prismatic crystals, and both clinopyroxene and quartz, as anhedral grains filling the interstitial spaces between the feldspar laths. Magnetite or ilmenite, leucoxene, and apatite are also present in minor amounts. The rock has suffered slight hydrothermal alteration and some of the pyroxene has been converted to a mixture of uralitic amphibole and chlorite, but these products are not abundant. No micrographic intergrowths of quartz and feldspar were observed in the sections examined.

PLEISTOCENE

Much of the Precambrian formations are covered by a heavy mantle, locally more than 100 feet in thickness, of glacial deposits laid down in the Pleistocene epoch. These deposits consist of boulder clay, gravel, sand, and silt (Thomson 1938a). The gravel and sand predominate, and in one or two places are crudely stratified, suggesting that they represent morainal material that, upon the withdrawal of the glacial ice, was transported a short distance to its present site and sorted by stram action. They form extensive plains dotted with occasional small kettle lakes in the western part of the area. Drumloidal hills are also common. These trend northeast-southwest parallel to the direction in which the ice moved across the region. Together with occasional rock outcrops, they control the disposition and trend of most of the creeks and some of the smaller lakes. The effect of the Pleistocene glaciation was thus to modify the topography, in part by abrading and rounding off the higher ground, in part by filling or nearly filling depressions, in part by forming outwash knolls and ridges, and in part by disrupting the pre-existing drainage system.

RECENT

Recent deposits consist chiefly of organic material collecting in the lakes, swamps, and muskegs. They cover considerable areas, for the region as a whole is very poorly drained. Peat is thus accumulating widely. As most of the creeks are small, they have not given rise to any important deposits of sand or clay.

CHAPTER III

STRUCTURAL GEOLOGY

INTRODUCTION

The lack of outcrops in many parts of the Crow River area is a very serious deterrent to any satisfactory determination of the complex structural features displayed by the volcanic and sedimentary formations. Further, even the most useful horizon markers, the iron formation members of the Keewatin series, do not occur in bands sufficiently distinctive from one another to permit positive correlation between the few bedrock exposures available for study. It is true that many of the difficulties have been overcome, in some of the more critical sections, by the use of data made available in recent years by underground developments at the various mines, and by the extensive diamond drilling which has been done by companies interested in the area. Thus it has been possible to define, with a limited degree of accuracy, the major and some of the minor features which have a bearing on the localization of the ore deposits. But there still remain large parcels of ground where the bedrock geology is not known and can only be inferred. Much more exploration work is necessary before any complete understanding of the structural phenomena can be acquired.

The field criteria used in the determination of the regional and local structures, such as strikes, dips, and tops of flows, the strikes and dips of faults, sheared zones, and joints, and the attitudes of minor drag folds, are shown on the general geological map of the area. These features have proved to be of considerable value when used in conjunction with marker horizons of iron formation, dioritic greenstone, and volcanic fragmentals. They have shown that the formations in the area were first isoclinally folded into anticlines and synclines of general northeasterly plunge, then cross folded along north-south to northwest-southeast axes, and finally displaced by both strike and transverse faults. The structural features are described in the following pages under five headings: (1) folding; (2) cross folding; (3) shearing; (4) faulting; and (5) jointing.

FOLDING

Due to the fact that there is little structural data available in those areas lying close to the granites exposed along the margins of the Pickle Lake - Crow River greenstone belt, either because of lack of outcrops or because of metamorphism, it has not been possible to determine with any certainty whether the belt as a whole is monoclinal or synclinal. For example, it is quite possible that the formations face north on a regional scale and form merely the north limb of a major anticline having an axial plane some distance southeast of the belt (Hurst 1930 p.6). On the other hand, they could form a regional syncline in themselves, with an axial plane trending northeast through the approximate median line of the belt. This is thought to be the more reasonable interpretation, and follows from a consideration of the fact that north of the Central Patricia mine in the west part of the area the formations show a sharp convergence toward the west at a point approximately in the centre of the greenstone belt. This feature leads one to suggest a northeast-plunging syncline of greater magnitude than any of the other folds that have been defined to date. True, one should expect the greywackes and quartzites along the north flank of this supposed fold to be repeated south of the assumed location of the axial plane. But such is not necessarily the case, for they may grade into tuffaceous rocks along their strike, or they may even have been partly converted into porphyries , and these rocks, because they are mapped as separate units, may give a completely erroneous picture of the structure. Conversely, it may be that the hydroclastic sediments pinch out near the nose of the postulated syncline, thus again inhibiting a determination of the true relationships. Also indicative of a major synclinal structure is the fact that the greenstone belt itself appears to widen in the direction of regional plunge (N.65°E) from its extremity at Kapkichegimaga Lake (Hurst 1930, p.6) and finally, at its eastern extremity, to split into two branches separated by a southwesterly projecting tongue of granite (Evans 1939). It is to be emphasized, of course, that such major features are merely suggestive and not conclusive evidence of a regional syncline.

Aside from the possible Crow River syncline, there are in the area a few smaller folds of similar attitude. On a regional scale they are simply drag folds reflecting the major structure, but insofar as the map area is concerned they are the principal feature upon which any satisfactory geological studies can be based. Two have been recognized in the vicinities of the producing mines. They are the Pickle Crow syncline and the Central Patricia anticline.

Pickle Crow Syncline

The trace of the axial plane of the Pickle Crow syncline has been fairly well defined in the eastern part of the area through the efforts of Thomson (1938a, p.20). Thomson found it possible to follow three horizons of iron formation bands about the nose of the structure, and was able to determine that the syncline possesses a pitch to the northeast of between 45 to 70 degrees.

Other horizons similarly have been traced about the nose of the syncline. One of them consists of bands of iron formation revealed by magnetometer work and diamond drilling in the central part of claim Pa. 627. This horizon was considered by Thomson (1938a, p.21) to be the same as that extending along the south limb of the fold through the underground workings at the Pickle Crow No. 1 shaft. However, subsequent diamond drilling has shown that this is not necessarily the case, that the iron formation bands underlying the central part of claim Pa.627 probably represent those horizons found northwest of the Pickle Crow fault zone, and that the horizon southeast of this fault zone bends around the synclinal axis at a considerable distance farther west.

On the Pickle Crow Main group the trace of the axial plane of the syncline strikes about N 50°E and extends northeast beyond the limits of the map area with no great deviation in attitude. However, to the southwest across claim Pa.672, it strikes east-northeast and then gradually swings about to an east-west strike, where it apparently passes through a large saddle-like body of quartz albite porphyry. It thus appears to have been deflected from its normal course by cross folding about the Hooker-Burkoski stock.

In the west part of the area there may be another synclinal fold of general northeasterly pitch, possibly representing the extension of the Pickle Crow syncline. This fold has been delineated in the vicinity of the Central Patricia mine by tracing out, with the diamond drill, several bodies of "diorite greenstone" that appear to have been folded with the other formations during the regional deformation. The actual shapes of these bodies are not known with any degree of certainty. But if it is assumed that they are phacolithic masses in the trough of a northeast-pitching syncline, it is surprising how the assumed shapes conform to outcrop and diamond drill data with consistent regularity. Further evidence suggesting that a synclinal fold occurs south of the Central Patricia mine in the west part of the area is as follows:

(1) Strike and dip determinations of the lava flows, immediately south of the trace of the axial plane of the postulated syncline in the west part of the area, show that here the Keewatin formations converge on that plane toward the west.

(2) Pillow structures in outcrops north of the trace of the axial plane near the west boundary of Connell Township indicate that here the tops of the flows face toward the south.

(3) The regional schistosity developed in the lavas parallels closely the axial plane of the supposed structure.

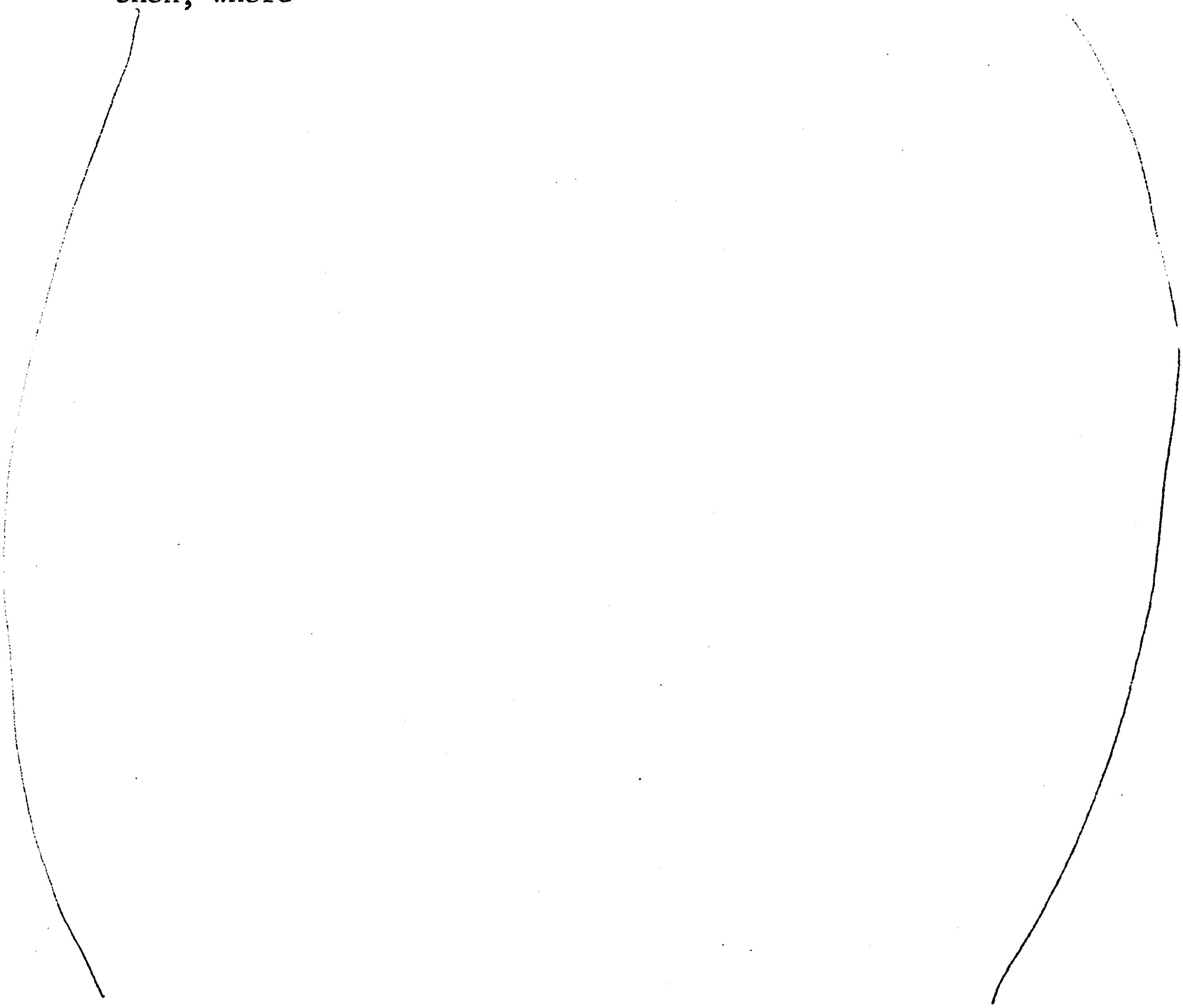
(4) An undoubted anticlinal axis to the north parallels the axis of the postulated syncline closely in attitude.

South of the Central Patricia mine and to the west, the axial plane of this inferred syncline appears to strike east-west. But to the east, as it approaches the Hooker-Burkoski stock, it swings abruptly to assume a northeasterly strike, again apparently as a result of cross folding.

The axial plane of the Pickle Crow syncline has been overturned such that throughout the greater part of the area it dips north at angles ranging from as low as 65° at the Albany River mine to as high as 80° near the Pickle Crow Gold Mines Limited No. 1 shaft, the average being about 75°. This is of considerable significance, for while the formations appear to plunge to the east or northeast parallel to the strike of the axial plane, they actually pitch steeply to the northeast or north-northeast in a direction making a considerable angle with the trace of the axial plane. This pitch, as indicated by dip measurements taken on the nose of the folds on claims Pa.706 and 750 is an angle somewhere between 45 and 70 degrees (Thomson 1938a, p.20). More reliable measurements on drag folds delineated underground at the Pickle Crow Gold Mines Limited No. 1 shaft indicate it to be approximately 70° in a direction of N 20° - 30°E. Similar results were indicated by diamond drilling on claim Pa.627, where the plunge is 65° in a direction of S 70°E , and the pitch, because of a northerly dip of 75°, is 63° in a direction of N 80°E Again, in the vicinity of the Central Patricia Gold Mines Limited No. 1 shaft, drag folds indicated the folded structures there to pitch to the north-east at angles of 60° to 65°.

Central Patricia Anticline

The occurrence of an anticlinal axis south of the Central Patricia Gold Mines Limited No. 1 shaft, as in the case of the Pickle Crow syncline, was first described by Thomson (1938a, p.23). The axial plane of the structure, which is overturned and dips north at about 75 degrees, strikes 77^{o}E., through a point 2,000 feet south of the No. 1 shaft. However, to the west, it swings to assume first an east-west strike and then, where



it appears to extend across the Gateway Patricia Gold Mines Limited claims west of the boundary separating Connell and Ponsford Townships, a west-northwest strike. Originally, Thomson (1938a,p.23) concluded that the axial plane curved southward from claim Pa.678 to unite with that of the Roeanor anticline, but this interpretation is not in accord with the following facts:

(1) the regional schistosity shows no marked deviation in strike from the trace of the axial plane as shown on the map;

(2) well-developed pillow structures in outcrops on claims Pa.1,083 and 1,084 indicate that here the tops of the flows face south;

(3) a geophysical survey of the Gateway claims showed that the lava flows traverse the property in a general west-northwest direction; and

(4) diamond drilling on Gateway claim Pa.2,194 has indicated horizons of sediments and dioritic greenstone in the same relative positions on either side of, and roughly the same distance from, the assumed trace of the axial plane as determined from the attitude of the regional schistosity.

North and northeast of the Central Patricia mine there are a few horizons of iron formation that bend around and run northeast to the Waltricia property, where the strike swings to the east. On the Atwater-Porcupine claims they strike somewhat south of east. It seems probable, therefore, that the axial plane of the Central Patricia anticline, like the formations on its flanks, curves around the nose of the Hooker-Burkoski stock in this part of the area.

In the east part of the area another anticlinal fold has been outlined by Thomson (1938a, p.20). Thomson interprets this structure, as shown on the Ontario Department of Mines Map No. 47b, as a minor drag fold on the flank of the Pickle Crow syncline, and suggest that the bands of iron formation, extending southwest from claim Pa.758, represent the same horizon as the band south of the synclinal axis at the Pickle Crow Gold Mines Limited No. 1 shaft. Subsequent work has shown this to be incorrect, and that the bands of iron formation do not bend around the nose of the syncline, but rather curve northward from Buesnel Lake to extend across the Atwater-Porcupine group and unite with those horizons traced northeast and east from the Central Patricia mine. With this conclusion as a basis of investigation, the writer devoted some time examining the structure on and near claim Pa.738. Except in the case of two critical isolated outcrops of iron formation near the east boundary of the claim, the writer's determinations agreed with those of Thomson. But in those two outcrops the bedding was found to strike east-west rather than northeast-southwest, and indicated that here the formations did not curve back to complete a synclinal fold, but rather continued about the nose of a northeast-plunging anticline. As a further check on this interpretation, it was decided to search outcrops of greenstone northwest of the supposed anticlinal axis for pillow structures and drag folds to provide top determinations. Suitable pillows were not observed, but in those outcrops extending across claim Pa.739 on the Pickle Crow Main group, and claim Pa.774 on the Cohen-MacArthur group, minor drag folds and contortions were found to be "Z"-shaped in plan. These crenulations are incompatible with a syncline, but are compatible with an anticline to the south, for they suggest that at these places the tops face north.

The trace of the axial plane of this anticlinal fold lies about 1,000 feet northwest of that of the Pickle Crow syncline in this area. In the vicinity of the Central Patricia mine the same relationship is found between the axial planes of the Central Patricia anticline and the inferred syncline to the south. It thus seems probable that the anticlinal folds of the east and west sections of the map-area are the same structures.

CROSS FOLDING

In addition to the principal northeast-plunging folds there are developed in the area a few cross folds which occur either about the noses of or between stock-like masses of granite. The most significant of them is the one formed by the deflection of the formations about the Hooker-Burkoski stock, which separates the area into its eastern and western parts. Its axis strikes about N 45°W across the Keewatin complex. Another cross fold, the Roeanor anticline, occurs between the Hooker-Burkoski stock and the granite exposed along the shores of Pickle Lake. Its presence was first indicated by Hans Lundberg, Limited, who was able to trace, with the magnetometer, a prominent horizon of iron formation northwest from Fault Creek for 1.6 miles to a point on the Roeanor West group of claims, where it was found to curve sharply about the nose of a fold. Subsequent drilling showed this fold to be anticlinal and to pitch north at about 40 degrees (Thomson 1938a, p.23). Due to the lack of outcrops it is difficult to determine the strike of the axis of this fold. If, however, the schistosity in the greenstones bears a simple relationship to the axial plane of the anticline as it does in the case of the other folded structures, it seems quite possible that the axis strikes either north-south or a few degrees west of north.

SHEARING

Several directions of shearing are evident in the area. Most important, of course, is the regional schistosity developed in some of the lava flows, fragmentals, and porphyries. As shown on the coloured map of the area, it parallels closely the assumed traces of the axial planes of the Central Patricia anticline and the Pickle Crow syncline, and thus has been used as a means of correlating the structures between the east and west parts of the area and elsewhere. Such a procedure, may be speculative. But it is not unreasonably so, for many structural geologists have pointed out similar relations in regions where the geological peculiarities are more fully known. Within the Crow River area itself, there is some evidence to support the assumption that the regional schistosity represents an axial plane foliation. In the vicinity of the Pickle Crow mine, where the syncline has been outlined in detail and its axial plane located within narrow limits, examination of outcrops and underground workings shows the expected parallelism to be the case. The same also applies for the anticline, where well defined, south of the Central Patricia mine, and for its supposed counterpart in the east part of the area. Thus, during the course of the field work, strikes and dips of schistosity were recorded on the map wherever possible, and were used, along with other lines of evidence, to delimit the major structural features in area covered largely by overburden, where the simple mapping of horizon markers is practically impossible from existing data. It remains for subsequent diamond drilling to test the applicability of the method.

Superimposed on the regional schistosity and frequently obliterating it is a later variety that strikes parallel to the axis of the Hooker-Burkoski stock and the cross fold associated with it. It is quite common to find it developed in outcrops over an area extending from the Central Patricia mine on the west to near the Springer and Pickle Crow mines on the east. It dips to the northeast at angles ranging from 60 to 75 degrees, and, where it transects the regional schistosity, locally gives rise to a distinct lineation of northeast pitch. Such a lineation is well developed in outcrops of quartz sericite schist along the north side of the Crow River near the Central Patricia Gold Mines Limited No. 1 shaft, where it has broken the rock into acicular prisms that pitch at an average angle of 63° in a direction of N 55° E. However, such lineation is generally not developed in surface exposures, and only one of the two cleavages is discernible. Thus, in one part of an outcrop only the regional schistosity may be evident, whereas in another part, or in a different exposure nearby, the cross cleavage may have completely obliterated the earlier variety. A similar situation is found to exist between the Pickle Lake and Hooker-Burkoski granites in the extreme southwest part of the map-area, although here the later schistosity tends to strike in a northsouth direction rather than northwest-southeast. As mentioned previously, it is thought to be related to the Roeanor anticline.

In addition to the regional schistosity and that believed to be associated with the cross folds there are also cleavages along narrow zones that probably have been caused by fault adjustments, and others related to the granite contacts. The former are easily recognized where they strike across any schistosity formed at an earlier date, as, for example, in the case of the vein fissures. But where they strike parallel to the earlier ones, they only serve to accentuate the previous structure, and if dislocated units are not apparent, are easily overlooked in the field. Those cleavages found near granitic masses tend to strike parallel to the intrusive contacts, and where outcrops are scarce they facilitate the extension of the geological boundaries on maps.

FAULTING

For descriptive purposes the principal faults may be classified, on the basis of their attitudes with respect to those of the volcanic and sedimentary formations, as either longitudinal or transverse. The longitudinal or strike faults appear to be the more significant insofar as the major structure is concerned. Generally they strike parallel to the formations, either west-northwest in the vicinity of the Central Patricia mine, or east-northeast near the Pickle Crow mines. The transverse faults, on the contrary, strike across the formations, generally in a northwest direction in both parts of the area.

Longitudinal or Strike Faults

Several possible strike faults have been located in the Crow River area from the occurrence of narrow but fairly persistent zones of highly schistose and altered volcanic rocks. These structures are described below as the Central Patricia, Crow River, Pickle Crow, (and Big Muskeg and Dona Creek Cohen-MacArthur) faults. But other strike faults, now unrecognized, are undoubtedly present. One, for example, may have offset the large diabase dike in the north part of the Waltricia property, and others may be represented by the sheared zones extending northeastward across the Albany and Crowshore claims. Such faults are easily overlooked in the field. This is due not only to the fact that they tend to parallel the formations such that offsets cannot be determined through lack of suitable structural units, but also because the fissile and altered rocks along them are soft and easily weathered. Hence, many strike faults may be obscured beneath swamps and overburden where there is little possibility of delineating them except through extensive drilling operations or underground developments. It is a safe assumption that others will become apparent in the future as our knowledge of the detailed structural geology of the Crow River area increases.

Central Patricia Fault

The Central Patricia fault has been traced by diamond drilling from the northeast corner of claim Pa. 2,193 on the Gateway Patricia Gold Mines Limited property southeastward across Fault Creek to beyond the axial plane of the Central Patricia anticline, which it appears to offset. To the west it strikes N 62°W parallel to the formations, and is represented by a zone, up to 10 feet in width, of massive pyrite and pyrrhotite replacing sheared lavas and laminated tuff. To the east it strikes N 80°W, showing only a slight deviation in its course; and since near the Central Patricia Gold Mines Limited No. 1 shaft the formations curve northward as a result of cross folding, the fault here does not parallel the folded structures but rather cuts across them. A further difference is that near the anticlinal axis the sheared zone attains widths of 30 feet or more, but does not contain massive sulphides and appears to be devoid of any significant mineralization. Throughout its known length it dips from 70° to 75°N.

The age of the Central Patricia fault zone is well established. Since the formations prior to cross folding probably extended in a northeast direction across the area, the localization of the fault along a lava-tuff contact of northwesterly strike suggests that it was formed after the cross folding. Indeed, if the fault had developed at an earlier date, it also would have been deflected in its course like the formations enclosing it. On the other hand, the fault must be pre-ore, not only because of the sulphide mineralization found along it, but also because the pyrite and pyrrhotite have been found to contain small amounts of gold, and there is only one epoch of gold mineralization recognized. There is no evidence that the fault offsets the large diabase dike to the east.

As mentioned previously, the axial plane of the Central Patricia anticline has been offset by the fault, the apparent strike separation being about 300 feet, the north side having moved east. However, the vertical displacement is not known, and the nature of the adjustment, whether normal or reverse, difficult to ascertain.

Pickle Crow Fault

A possible fault has been traced from the east boundary of claim Pa.626 on the Springer group northeastward for 12,000 feet to a point about 400 feet south of the Pickle Crow Gold Mines Limited, No.3 shaft. Its existence as an important entity of the geological structure is suggested by the following evidence: (Mawdsley 1937; Buffam 1938)

(1) the trace of the postulated fault is apparent on the surface by a deep, linear depression in the topography;

(2) diamond drilling on Springer claim Pa.630 indicated a strong sheared zone in the lavas, and 11 feet of core were lost in one hole, at a point through which the fault is believed to extend;

(3) along the strike of the supposed fault across the Pickle Crow Main group, several diamond drill holes have intersected a wide sheared zone at or near the south contact of a prominent band of iron formation, and near the east boundary of claim Pa.751, one hole intersected sheared lavas and brecciated iron formation; and

(4) along the strike of the supposed fault across the northwest corner of claim Pa.2,062 on the Winoga group, drilling indicated a strong sheared zone, about 30 feet in width, having approximately the same attitude as near the Pickle Crow Gold Mines Limited No. 1 shaft.

In addition to these features Buffam has also pointed out that in this area south of the highway there is a synclinal axis extending in a northeast direction across the Springer claims, and that (1) the iron formation horizon which trends southwest from the Pickle Crow shaft appears to swing southward west of the Springer mine, (2) to the northeast, two principal horizons of fragmental rocks may unite under drift-covered areas to form a "U"-shaped body with the limbs of the "U" separating in the direction of regional plunge, and (3) in one drill hole, bored from the surface of claim Pa.630 south of the fault, a band of sediments was intersected, and these sediments were found to face toward the south. Indeed, there is ample evidence for such a syncline, for on the ridge south of the Springer shaft the writer was able to follow the pillowed lavas right around the nose of the structure. Hence, if the tops of the formations face in opposite directions on either side of the supposed fault as Buffam states in his report, a vertical displacement of several thousand feet must have occurred in order to eliminate completely the anticline originally separating the two synclinal axes. However, careful examination of outcrops close to and along the southeast side of the supposed fault indicates that the tops do not face south. For example, in the outcrop of greywacke in the northwest corner of claim Pa.729 grain gradations in a few beds susggest that they face north, and in the underground workings at the Pickle Crow Gold Mines Limited No. 1 shaft drag folds developed in the iron formation are incompatible with a synclinal axis lying somewhere to the south. Similarly, Thomson (1938a,p.21) found that in the long ridge of greenstone south of this shaft pillow structures here also indicated tops to the north. Perhaps Buffam's determination was made on the south flank of the anticlinal part of a minor drag fold not recognized in the drill cores. In any event, the only place where structural data from surface outcrops has been reported to suggest tops to the south of the Springer mine, thus leaving a distance between the fault and the syncline of about 2,500 feet in which an anticline may be developed. It follows, of course, that there is no necessity for a fault to separate the Pickle Crow and Springer synclines, and since structural units have not been found to be dislocated by the sheared zone, it may be held that fault adjustments did not actually take place. But such a conclusion does not accord with the evidence listed above, and inasmuch as the sheared zone parallels the formations closely in attitude, separations of structural units need not be apparent. The commonly held opinion by those who have worked in the area is that the sheared zone represents a major strike fault.

The Pickle Crow sheared zone, like the Central Patricia fault in the west part of the area, was developed before the epoch of ore deposition, and in several drill holes sulphides, found replacing schistose greenstone and brecciated iron formation, contain gold in significant, although non-commercial, quantities. Thus, the core from a hole put down near the east boundary of claim Pa.751 on the Pickle Crow Gold Mines Limited property is reported to have assayed $11.00 per ton (gold at $35.00 per ounce). Ore bodies have not been located along this zone, but have been found in nearby faults that may be related to it.

Big Muskeg Fault

Several years ago it was suggested by B.S.W. Buffam (1938) that a major fault extended from the Roeanor West group in the extreme southwest part of the map-area in a direction of N 55°E , to the Cohen-MacArthur group. As evidence of such a fault it was pointed out that:

(1) on claim Pa.2,687 of the Dona Patricia Gold Mines Limited property a band of iron formation and horizons of fragmental rocks strike northwest across Dona Creek to end abruptly against outcrops of extrusive lava;

(2) brecciated and heavily mineralized iron formation has been located along the strike of the supposed structure on claim Pa.689;

(3) the granite underlying the Roeanor group may represent the faulted segment of that forming the Hooker-Burkoski stock; and

(4) on the Cohen-MacArthur group a zone of carbonatized basic lava lies along the strike of the postulated fault, and farther northeast a southward trending band of iron formation appears north but not south of its supposed location.

However, recent work by the writer has shown that much of this evidence has been interpreted erroneously. A fault probably does cut off the iron formation and fragmentals exposed on the Dona Patricia claims, and one may lie along the zone of carbonatized lava on the Cohen-MacArthur group, but the biotite granite in the extreme southwest part of the map-area certainly is not a faulted portion of the albite granite of the Hooker-Burkoski stock, for the two rocks are totally different in character. Further,there is very little evidence that the principal fold axes have been offset, as they should be if a major fault extended northeastward across them, and the supposed fault, north of the Hooker-Burkoski stock, does not dislocate, as might be expected, a body of sheared quartz albite porphyry outlined there in detail by diamond drilling. Rather, it seems more likely that the so-called Big Muskeg fault is really two distinct structures, having no direct relationship. This interpretation is shown on the map, the probable Dona Creek transverse fault occurring in the southwest part of the area, the possible Cohen-MacArthur strike fault in the northeast part.

The Crow River Fault

The Crow River fault has been described by Thomson (1938a):

"There is evidence of faulting through the porphyry body along the bed of the Crow River immediately north of the Central Patricia mine. In the early days of the camp it was thought that this faulting along the river was the cause of the offset of the diabase dike to the east on claims Pa.76 and 81. Drilling has indicated, however, that the porphyry has moved laterally in an opposite direction to the dike. In addition, the schisosity of the intensely sheared porphyry and greenstone near the dam on the river strikes about parallel to the regional schistosity and suggests that any faulting here is of the shear type coincident with general deformation of the country. A gold-bearing vein has also been found by drilling near the fault and may have some relation to it. If this faulting offset the diabase it would mean that the regional folding and possibly the mineralization was post-diabase or post-Keweenawan in age. This seems highly improbable and suggests that the Crow River fault is pre-diabase.

This interpretation appears to be quite correct, for diamond drilling from the underground workings indicates that under the bed of the river the diabase assumes a west-northwest strike, indicating that here it swings about in much the same way as detailed mapping has shown to be the case elsewhere along its general strike (E.W.M.Cokayne, personal communication). The pre-diabase fault strikes N80°E , roughly parallel to the river, and dips 75°N. According to Buffam (1935) the adjustments along it have caused a strike separation of from 100 to 150 feet, the movement having been right hand or north side to the east. The vertical displacement is not known.

Transverse Faults

In the Crow River area all the known transverse faults strike northwest, roughly parallel to the axis of the Hooker-Burkoski stock, and dip to the northeast at angles ranging from 60° to 75° much like the cross cleavage described on page 81. However, the relative directions of the displacements along them appear to be different in the two parts of the area. West of the Hooker-Burkoski stock the movements along each known transverse fault was right hand (i.e., east side south), whereas east of the stock it was left hand. The reason for this is not too apparent, although there is no doubt that the adjustments are related in some way, for both types of transverse fault were formed after the cross folding but before the epoch of ore deposition. Thus, in the west part of the area the transverse faults displaced the ore horizon at the Central Patricia mine but are themselves partly mineralized, and in the east part some of them have provided loci along which a few gold-bearing quartz veins were developed.

Jointing

In the underground workings at the several mines in the area, a large number of the more prominent joints have been mapped by company geologists. These joints strike in all azimuths, and dip at all angles from nearly horizontal to vertical. In general, however, two major joint sets are apparent in each case-one of general north-south strike, the other of east-west strike, both dipping at angles greater than about 55 degrees.

Similar joints are also apparent in most of the surface outcrops examined by the writer during the field season. Many of these joints were mapped, and are indicated on the coloured map accompanying this report.

CHAPTER IV

ECONOMIC GEOLOGY

INTRODUCTION

Gold is the only metal that has proved to be of economic importance in the Crow River area. Silver is recovered as a by-product of the gold ores, but the overall production is so low as to make the metal little more than a matter of metallurgical interest. Since tungsten was much in demand in the early years of World War II, a small amount of scheelite was obtained from the quartz veins of the Pickle Crow mines. By late 1943, however, over-production of this metal resulted in the loss of suitable markets, and the operation was discontinued. None of the deposits in the area contains sufficient scheelite to permit a profitable mining operation. The many bands of iron formation do not appear to contain iron-bearing minerals in concentrations of sufficient size and grade to make ore under present economic conditions.

Deposits of sand and gravel are widespread throughout the area. They have been of considerable value for road and air-field construction, and have provided a source of back-fill for mines.

GOLD MINERALIZATION

Classification of the Gold Deposits

The gold deposits in the Crow River area are very similar mineralogically. They differ considerably in respect of physical features, however, and may be classified on the basis of structure, shape, size, and continuity under four general types: (1) fissure or composite quartz veins (2) stockworks in iron formation; (3) silicified sheared zones; and (4) replacement bodies (Thomson 1938a). But the nature of the deposits is also dependent in some measure on the types and attitudes of the rock formations in which they occur. To increase the usefulness of Thomson's classification, the general types defined by him have been assigned to one or more of the following three major classes and their several subdivisions (Newhouse 1942).

The major structural associations which have been found to give rise to mineable ore bodies are marked by an asterisk, and their subdivisions by a dagger.

(1) Deposits in layered rocks, including both volcanic and sedimentary formations.

(a) Strike oblique or transverse to that of the layered rock.

(1) Fissure or composite quartz veins localized along narrow well-defined, sheared zones, such as the No. 5 vein near the Pickle Crow Townsite and the No. 6 vein at the Springer mine.

(2) Auriferous sulphides and quartz stringers occupying closely spaced tension fractures in iron formation, as at the Central Patricia No. 1 Operation, on Springer claim Pa. 627, and on the Crowshore property.

(3) Auriferous sulphides replacing folded iron formation, such as the 2403 W. Drift zone near the Pickle Corw No. 1 shaft.

(b) Strike parallel to that of the layered rock.

(1) Fissure or composite quartz veins localized along narrow, well-defined, sheared zones, such as the No.2 vein at the Albany River mine and the "C" zone at the Crowshore property.

(2) Silicified and mineralized sheared zones in greenstone, as on the Cohen-MacArthur group.

(2) Deposits in Intrusive Igneous rocks.

(a) Strike oblique to that of the intrusive rock.

Fissure or composite quartz veins localized along narrow, well-defined, sheared zones in folded quartz albite porphyry , such as the No. 2 vein system of Pickle Crow Gold Mines.

(b) Strike parallel to that of the intrusive rock.

Quartz stringers occupying broad, poorly defined sheared zones in folded quartz albite porphyry and quartz sericite schist, as on the Central Patricia main group.

(3) Deposits at and parallel to the contacts between layered and intrusive rocks.

Fissure or composite quartz veins occupying narrow, well-defined, sheared zones along the contacts between basic dikes and either iron formation or greenstone, such as the Howell vein at the No. 1 Operation of Pickle Crow Gold Mines.

Sequence of Mineralization

The sequence of mineralization in the Crow River area is a very simple one, for one, two distinct generations of quartz are recognizable. The older of these makes up the body of the auriferous quartz veins found in the east part of the area and, as suggested by similarity of relationships between metallic and non-metallic constituents in all deposits, probably also the stringers localized along transverse tension fractures in the iron formation at the Central Patricia mine. These veins and stringers are distinctive in that microscopic examination shows them to consist of two varieties of quartz. The one occurs as coarse, angular to subangular fragments which are highly fractured, filled with minute liquid-inclusions, and exhibit a pronounced oscillatory extinction between crossed nicols; the other occurs as a fine-grained mosaic of anhedral grains cementing the larger fragments and healing, as phantom veinlets, some of the fractures in these fragments. But the two are very intimately associated and do not occur in individual cross-cutting veinlets, so that rather than representing two distinct generations of quartz, the fine-grained variety is probably merely a phase of the original coarse quartz, the individuals of which have suffered fracturing and peripheral granulation as a result of intermineralization adjustments after deposition. This cataclastic modification is believed to have taken place subsequent to the formation of arsenopyrite and scheelite, for these minerals are themselves broken and healed by the vein quartz. On the other hand, it probably occurred before the introduction of the other metallic constituents of the ores, since pyrite, pyrrhotite, chalcopyrite, galena, and gold have only been found either filling fractures in the quartz or, in some instances, apparently molded upon the fine-grained variety. As a general rule, where the veins certain both coarse-grained and fine-grained quartz, especially where the latter predominates, the values in gold are higher than where only the coarse variety is present. This supports White's contention (1943) that cataclastic modification of vein quartz is essential to permit circulation of the metalliferous solutions from which gold is precipitated. However, it is necessary to point out that in the Crow River area evidence of cataclastic modification does not imply that gold, at least in commercial quantities is present. On the contrary, many veins which exhibit both varieties of quartz have been found to contain only low values, and others are practically barren of precious metal. At the Central Patricia No. 1 Operation, for example, the quartz is distinctly cataclastic, but most of the gold is found intimately associated with the sulphides. It appears that cataclastic modification is prerequisite to the occurrence of gold, but that the actual presence of gold in the quartz bodies is also dependent upon other factors, such as temperature and pressure conditions at the time of metallization, accessibility between the vein and the circulating auriferous solutions, and the absence of equally or more favourable loci for deposition.

All the quartz veins in the east part of the area and many of those in the west part are similar in appearance. It is true that certain variations, depending upon the degree of fracturing and granulation, are evident. For example, where the vein is made up largely of coarse-grained quartz it is somewhat glassy; and as the proportion of fine-grained quartz increases it takes on first an ill-defined, fragmental and finally a sugary appearance. However, these variations are not restricted to individual occurrences but rather may grade insensibly into one another along the strike or down the dip of any particular vein, and hence are characteristic features of practically all the known deposits. The only veins which show any marked difference from the normal type are some of those which fill transverse fractures in the iron formation at the Central Patricia mine. These are frequently quite dark, in places almost black, in colour. This dark colour does not appear to be due to inclusions in the quartz, for microscopic examination with high power objectives does not indicate the presence of a greater number of these here than in the lighter veins. Rather, it seems quite probable that the dark colour is due to the presence of sub-microscopic particles, perhaps of graphite (Robert Boyle, personal communication).

The second generation of quartz found in the Crow River area commonly takes the form of small veinlets, cutting sharply across the earlier auriferous type. These veinlets, which carry abundant white or pink calcite and rarely exceed half and inch in the thickness, are found locally in the Howell and No.2 vein systems of Pickle Crow Gold Mines. They are always oriented at or nearly at right angles to, and extend right across but rarely beyond, the principal veins. Metallic sulphides and gold do not appear to be associated with them. A possible second generation of quartz has also been recognized at the Central Patricia mine, for here barren masses of white quartz have been found in the sheared greenstone along the hanging-wall contacts of the ore-bearing lenses of iron formation, according to Thomson (1938a, p.41):

> This is thought to be a later generation of quartz than that in the iron formation. It is possible that the ore-bearing solutions arose near this contact and that the barren quartz is an end phase of this mineralization and "healed" the faulted contact.

Associated with this quartz below the 2,000-foot level is a little scheelite (D.B.Angus, personal communication).

Mineralogy of the Ores

Associated with the quartz veins at the different mines in the area is a wide variety of metallic and non-metallic minerals. All of them do not necessarily occur in any one ore body, and they show different degrees of prominence in the different deposits. Some were either present before the ore was deposited or were introduced later, and hence are merely accidental parts of the deposits. Those known to be present in one or more of the several ore bodies are listed in the accompanying table.

Albite ($NaAISi_3O_8$) - Albite has been found intimately associated with the quartz at the Pickle Crow Gold Mines Limited No. 2 Operation at or close to the vein walls. Here it is very erratically distributed, and generally is not sufficiently prominent as to permit recognition in the hand specimen. It is also abundant in a mineralized zone located near the north-east corner of claim Pa.774 on the Cohen-MacArthur property, and in a number of small quartz stringers intersected in diamond drill holes at several places on the Pickle Crow Main group. As a general but not infallible rule, where this mineral is present in recognizable amounts the quartz is barren or contains only low values in gold (W.R.MacQuarrie, personal communication).

In the thin sections studied by the writer it was found that albite either replaces the altered wall rock, including

TABLE NO. 6

The Metallic and Non-Metallic Minerals of the Ore Deposits in the Crow River Area

6

Minerals: Metallics	Minerals: Non-Metallics	Constituents of Host Rocks Prior to the Hydrothermal mineralization	Products Subsequent Hydrothermal Mineralization	Remarks
	Albite	XXXX	X	Abundant in greenstones an porphyry; very rare in quartz veins.
	Amphibole	XXX		Commonly preser in greenstones
	Biotite		X	
	Calcite		XX	
Arsenopyrite			XXXX	
Chalcopyrite			XX	
	Chlorite	XXXXX	XXXX	Abundant in greenstones
	Epidote and Clinozoisite	XXX		Occurs in small amounts in gree stones and Porphyry.
	Ferruginous dolomite		XXXX	
Galena			X	
Gold			XXX	
Iron oxides		XXXX		Abundant on iron formation.
	Leucoxene	XXX		Common in greenstones and porphyry.
Pyrite			XXX	
Pyrrhotite			XXXXX	
	Quartz	XXXX	XXXXX	Abundant in h iron formatio and porphyry.
	Scheelite		XXX	
	Sericite	XXX	XXX	Common in greenstones and porphyry
	Siderite	XXXX		Abundant in iron formation
Sphalerite			X	
	Tourmaline		XXX	

X

X -Very rare

XX -Rare

XXX Commonly present in small quantities

XXXX Abundant.

XXXXX - Very abundant

early ferruginous dolomite, adjoing the quartz veins or occurs as subhedral crystals enclosed by the quartz within a few millimeters of the contact. In addition, examination of a few wall rock samples has shown that it occurs with quartz in tiny gash-like veinlets, that cut across the schistosity and attest to a hydrothermal origin. The albite is believed to have formed in part in advance of and possibly in part during the quartz mineralization. However, its exact position in the paragenetic sequence is not known, for relationship with the various sulphides, scheelite, and tourmaline have not been determined.

Arsenopyrite (FeAsS) - Arsenopyrite has been found associated with most of the gold-bearing quartz veins, and is particularly abundant where those veins cut iron formation, the principal occurrence being found at the Central Patricia mine and the Pickle Crow Gold Mines Limited No. 1 Operation. Generally it is found as well developed crystals, up to one quarter of an inch across, replacing the iron formation, but locally it occurs in altered greenstone and in a few places as euhedra in the vein quartz. It is commonly fractured and broken, and the fractures may be healed by one or more of quartz, pyrrhotite, chalcopyrite, and gold but rarely by pyrite.

In the polished sections of ore examined by the writer pyrite was found as individual cubic crystals or as irregular grains either replacing or apparently molded upon arsenopyrite. It appears that arsenopyrite was the first sulphide that formed but was followed shortly by pyrite, and that this mineralization was terminated by fracturing and subsequent introduction of quartz.

Biotite-Flakes of biotite up to a quarter of an inch in diameter are found in the greenstones and the basic dike adjacent to the Howell vein in the lower levels at the Pickle Crow Gold Mines Limited No. 1 operation. It appears to have formed at the expense of early chlorite and sericite, but to have been replaced by a later white mica and tourmaline. This occurrence is a very unusual one.

Carbonates - The principal non-metallic constituents, other than quartz, of the several ore bodies are carbonates. Several varieties have been recognized. The oldest carbonate is siderite, and occurs as an original constituent of iron formation at the Central Patricia mine, The Pickle Crow Gold Mine Limited No. 1 operation, and the Albany River mine. In several instances it has been replaced by a later secondary carbonate, a ferruginous dolomite which is found in the host rocks along the walls of, and forming book and ribbon structures within, the quartz veins.

This secondary carbonate appears to have formed in advance of the quartz, and like the latter has been partly granulated during intermineralization adjustments preceeding the introduction of pyrrhotite, sphalerite, chalcopyrite, galena, and gold. Locally, it has been replaced by fractured scheelite, arsenopyrite, and early pyrite, and hence is probably one of the first minerals to have developed during the mineralization sequence. It must be distinguished from a third carbonate which occurs as thin filaments healing fractures in, or as irregular grains molded upon the quartz, and which in a few instances appears to be closely associated with gold (Thomson 1938a).

In addition to the siderite, the carbonate representing pre-vein wall rock alteration, and that closely associated with the gold, there is also a late calcite, which occurs with the white quartz healing transverse fractures in the principal gold-bearing veins in the east part of the area. It is post-gold in age.

Chalcopyrite ($CuFeS_2$) - Chalcopyrite is a subordinate constituent of the ore deposits. It generally is found with pyrrhotite either in the wall rocks or along fractures in the vein quartz, and occurs as irregular blebs and grain apparently replacing this iron sulphide. Less commonly it is observed alone as tiny filaments healing fractures in or molded upon quartz grains and rarely is found associated with sphalerite. In the 2-91E stope above the 975-foot level at the Pickle Crow Gold Mines Limited No. 2 operation it has been found to be replaced by gold, and is obviously older. Its relationships with arsenopyrite and pyrite are not known, but inasmuch as it replaces pyrrhotite that fractures in these sulphides, it may be presumed to have formed later in the paragenetic sequence.

Chlorite - Chlorite is present in all the known ore deposits. Some of it resulted from processes of regional metamorphism. But it also occurs as a product of later hydrothermal alteration, and is particularly abundant in inclusions or lava in the veins or along layers of volcanic or sedimentary material in the iron formation. Its most unusual occurrence is found at the Central Patricia mine, where it forms irregular patches along transverse fractures in the host rock. The origin of this chlorite is uncertain. The chlorite in all cases was formed before the development of both sulphides and quartz, and is replaced by early ferruginous dolomite, so that its age relative to most other constituents of the ore deposits is well established.

Galena (PbS) - Like chalcopyrite, galena is a very subordinate constituent of the ores, and has only been observed in samples from the Albany River mine and the No. 1 and No. 2

operations of the Pickle Crow Gold Mines Limited. It generally occurs as tiny grains enclosing, or closely associated with, gold along minute fractures in the vein quartz, and appears to exhibit mutual boundaries with the precious metal. In one polished section cut from the Howell vein it was found as grains encroaching upon and apparently replacing sphalerite. The relations with the sphalerite on the one hand and gold on the other suggest that it was formed late in the mineralization sequence. Because of the difficulties inherent in the interpretation of the relations however, the exact age relative to the other constituents cannot be definitely established. It is placed after chalcopyrite and before late carbonate in the table merely as a tentative measure.

Gold (Au.) - Gold is very erratic in its occurrence, as pointed out by Thomson (1938a, p.28-29).

"All the mines contain native gold, but it occurs in different degrees of finess and the distribution is not so uniform in some ore bodies as in others. At the Central Patricia mine visible gold is rarely found in hand samples, but a microscopic examination of the ore shows small grains and stringers of the metal. Rich samples of native gold are obtained at the Pickle Crow ...No. 1 Operation, but on the whole, it is finely divided and is not very abundant in the underground workings. The gold is uniformly distributed throughout the vein quartz. The Central Patricia No. 2 Operation shows spectacularly rich samples of coarse gold, but its distribution in the vein is spotty. Visible gold is found at the Albany River mine. In all the ores, gold occurs mainly along fractures in quartz and sulphides. It was largely deposited later than all associated minerals with the possible exception of carbonate materials. In general, visible gold is commonly found in the ore bodies that are bounded by greenstone but is rarely seen in the iron formation ore. This feature is particularly noticeable at the Pickle Crow No. 1 operation and Albany River ...mine, where both types of ore occur.

A feature of the mineralization in the area is the association of gold with different minerals at the various mines. The best values are obtained at the Central Patricia in heavy pyrrhotite-arsenopyrite ore, and the unmineralized quartz bodies are almost barren. At the Pickle Crow mine vein quartz with a low sulphide content contains the gold, while the heavily mineralized iron formation that adjoins the vein quartz in certain parts of the mine carries only low values. Pyrrhotite has replaced these areas in the iron formation, but there has been little fracturing and quartz-filling. Where the latter conditions exist in the iron formation parallel to the main vein, gold values are obtained. At the Central Patricia No. 2 Operation the metal is found in quartz that contains only a small amount of sulphides. At the Albany River mine the best values occur with pyrite; pyrrhotite is a less favourable host mineral."

Despite these broader relationships, however, it appears that the gold was formed at about the same time as the galena and late carbonate as pointed out above, and where these constituents are found a close relationship is apparent. As further evidence of this conclusion, microscopic study has shown that gold is molded upon, fills fractures in, or occurs as blebs replacing arsenopyrite, pyrite and quartz, and replaces pyrrhotite, sphalerite, and chalcopyrite, thus establishing its position late in the paragenetic sequence.

Magnetite (Fe_3O_4)- Variable amounts of magnetite are present in all ore bodies where the host rocks include iron formation. In no case has the writer been able to find evidence suggesting that this mineral may be of secondary origin.

Pyrrhotite ($Fe_{1-x}S$). Pyrrhotite has been found associated with quartz in all the ore bodies investigated, and, except at the Albany River mine, is probably the most abundant of the sulphides present. Generally it replaces altered greenstone of iron formation outward from quartz-filled fractures as irregular masses, disseminated small grains, and narrow seams along shear and bedding planes as the case may be. It also occurs along fractures, which may cut one or both of the quartz and the adjacent host rock, and as grains healing broken crystals of arsenopyrite and pyrite. Much of it, therefore, appears to be later than vein quartz, a conclusion corroborated by the fact that nowhere has it been observed to show evidence of cataclastic modification. It was also formed after a late variety of pyrite, the crystals of which it appears to replace along post-quartz fractures, but itself has been replaced by sphalerite, chalcopyrite, and galena where found in contact with these minerals. Its position in the paragenetic sequence is thus well established.

Pyrite (FeS_2). - Like gold, pyrite is also erratically distributed amongst the several ore bodies. Generally it occurs in small amounts, subordinate to arsenopyrite and pyrrhotite. But at the Springer mine it becomes prominent, and at the Albany River mine occurs as the principal sulphide. In the present study two ages of pyrite have been recognized. The one was formed before the vein quartz but after arsenopyrite, as mentioned above, and like these minerals was fractured before the introduction of pyrrhotite. This variety has been positively identified at the Albany River, the Central Patricia, and the Springer mines, where it is fractured and generally gold bearing (Thomson, 1938a, p. 35,44,49). The later pyrite occurs along fractures in the quartz at the Central Patricia mine and in that of the Howell and No.2 vein systems and the 2403 W. Drift zone of Pickle Crow Gold Mines Limited. Except in the case of the pyrite occurring as distinct crystals in vugs and fracturing in the vein quartz at the Central Patricia mine, however, it is generally barren of gold. This is particularly well emphasized by spectrographic analyses of the pyrite in the Howell vein and the 2403 W. Drift zone, for these analyses indicate in each case that gold is absent (E.H. Marvin, personal communication). The late pyrite, like the earlier variety, is replaced by pyrrhotite, and in the 1260 stope in the Howell vein, by sphalerite.

Scheelite ($CaWO_4$) - Small amounts of scheelite have been found at the Central Patricia, Springer, and the Pickle Crow mines where it either replaces altered greenstone or chlorite or occurs as fractured crystals cemented by the vein quartz. It replaces the pre-quartz carbonate, but its relationships with the sulphides and gold are not known.

Sericite - Sericite is present as a product of deuteric alteration or of regional metamorphism in all host rocks except iron formation. Like the chlorite described previously, however, it also occurs as a product of wall rock alteration, formed immediately prior to the sulphides and quartz. It is particularly abundant in the quartz albite porphyry at the Pickle Crow No. 2 Operation. It may have formed at about the same time as the chlorite, and, as in the case of the latter, is replaced by the early ferruginous dolomite. Sericite, often with chlorite, also forms ribbon structures in the quartz veins, and may represent vestiges of almost completely silicified inclusions of wall rock.

Sphalerite (ZnS). - Sphalerite has been found in small quantities only in the ore at the Albany River mine and in the Howell vein (Thomson 1938a, p.35,56).

Tourmaline.- Tourmaline is a common but minor constituent of all the ore deposits in the area, and generally occurs as aggregates of tiny lath-shaped crystals replacing altered greenstone and ribbon structures within the quartz veins. At the contact between the wall rock or ribbon and the quartz, the latter often contains inclusions of tourmaline. In such cases most of the crystals are fractured transversely and cemented by the quartz suggesting that the tourmaline is the older of the two minerals. But other lath-like crystals transect boundaries between individual quartz grains and obviously replace them. It would thus appear that the tourmaline started to form in advance of the quartz, probably crystallized contemporaneously with the quartz as suggested by Thomson (1938a, p.58) and continued to develop for a short time after the deposition of the quartz had ceased. This mineralization, however, was terminated by fracturing. The fractures subsequently were healed by late pyrite and pyrrhotite (Thomson 1938a,p.58).

Paragenesis

Based upon the evidence cited above, the following table is designed to illustrate the possible sequence of mineral deposition in the Crow River area. It will be noted that albite and scheelite have been omitted. This was done because the relations of these constituents to tourmaline and to the

Table No. 7

Possible Order of Mineral Deposition in the

Crow River Area

```
Biotite)  Wall Rock
Chlorite)Alteration ----
Sericite)
Carbonate            ----
Arsenopyrite           ----
Pyrite                   ----
Fracturing                 XXX
Tourmaline                   ---   ---
Quartz                        -------
Fracturing                           XXX
Pyrite                                 ---
Pyrrhotite                               -----
Sphalerite                                    --
Chalcopyrite                                  --
Galena                                           --
Carbonate                                         ??
Gold                                              --
Fracturing                                          XXX
Quartz-calcite                                         ---
```

metallic sulphides are not known. Albite was deposited at about the same time as the quartz; the scheelite before the quartz either before or after the early arsenopyrite-pyrite mineralization. Also omitted from the table are the "primary" constituents of the host rocks, which include, in addition to the siderite and magnetite previously mentioned, cherty quartz of the iron formation, the products of regional metamorphism found in the greenstone, and the constituents of any intrusive bodies that may be present in the ore zones.

The writer considers it advisable to point out that many of the criteria used in the determination of the age relations of the minerals listed are not necessarily diagnostic of the interpretations which have been placed upon them. For example, in the case of the replacement of one mineral by another, the criteria are such as to make it exceedingly difficult to determine which of the two is the "guest" and which is the "host." Mutual boundaries between grains, strongly suggestive of contemporaneous deposition, may be the direct consequence of replacement. Accordingly, subsequent evidence may show the actual paragenetic sequence to differ somewhat from that outlined in the table, especially in regard to the relationships shown between arsenopyrite and early pyrite, between the pyrite and pyrrhotite, and between sphalerite, chalcopyrite, galena, and gold. Nevertheless,the table has some significance, and is included here to demonstrate the following conclusions reached during the present investigation:-

(1) the hydrothermal alteration of the wall rocks preceeded the development of the metallic sulphides and the formation of the quartz veins.

(2) the gold was introduced very late in the mineralization sequence.

(3) Of the several sulphides present, gold is most closely associated with galena, which normally forms at relatively low temperatures. It follows that increasing abundance of hypothermal constituents, such as arsenopyrite, pyrite, scheelite, and tourmaline should have exerted little chemical influence on the distribution of the gold values.

(4) fracturing of the quartz prior to the introduction of the late pyrite and pyrrhotite permitted circulation of the metalliferous solutions from which gold was precipitated.

(5) late pyrite, unless it occurs along open fractures, as at the Central Patricia mine, was not favourable to the concentration of the gold.

Age and Origin of the Gold Deposits

The gold deposits in the Crow River area are believed to have formed during the closing stages of the Algoman period of progenesis, possible as a result of differentiation of the albite granites found associated with them. This matter has been discussed by Thomson.

VEIN STRUCTURES

Most of the quartz veins in the Crow River area are distinctly banded, due to the occurrence within the quartz of books of altered wall rock and ribbons of chlorite and sericite. These books and ribbons generally parallel the walls of the veins. However, in several instances the former have been seen to extend, over a distance of several feet, from one wall of a narrow vein to the other, and short crinkly ribbons occasionally are oriented at large angles to the strike of the vein. Both vary considerably in size. The books are the large of the two, and occasionally exceed 2 inches in thickness. Conversely, the ribbons are only a fraction of an inch wide, but these often grade along the strike into thicker book-like structures. In many places, both have been replaced by one or more of carbonate, scheelite, and tourmaline. Generally the books also show evidence of replacement by the quartz, as shown by irregular boundaries, frayed extremities and mineralogical and colour gradations over an inch or two into vein material. They are often bridged by the quartz, so that they may occur as persistent, but nevertheless discontinuous, horizons along the strike. These features, together with the occurrence of the ribbon structures, which are thought to represent vestiges of original books (McKinstry and Ohle 1949) suggests that the veins were formed through processes of replacement of the wall rock minerals. Conversely, other features suggest that fracture filling was dominant process of vein formation. Thus, in many places along the Howell and No.2 vein systems of Pickle Crow Gold Mines Limited, and along veins found elsewhere in the area, book structures may be absent entirely or, if present, have straight regular boundaries and knife-sharp contacts with the vein quartz. This is also true in most places of the contacts along the walls of the veins, which frequently match fairly well and thus show little evidence of silicification. In a few cases, thin sections of the quartz immediately adjacent to the wall rock show crystals oriented roughly perpendicular to the contacts, suggestive of comb structure. It is apparent from several observations that neither the replacement nor the filling process can satisfactorily account for all the features. The writer is of the opinion that the veins were formed by simultaneous or nearly simultaneous inflation by the quartz-bearing solutions of a system of parallel or sub-parallel fractures, and that as crystallization proceeded a limited amount of replacement took place. It follows that since the books occurred within the original zones of fracturing, they were more susceptible to the replacement process during the period of quartz mineralization than was the wall rock along the borders of these zones.

Aside from books and ribbons in the veins, their principal structural characteristic is their highly contorted appearance. The contortions appear to be compatible, as regards form and attitude, to the major folded structures, being "S"-shaped plan to the north and "Z"-shaped in plan to the south of synclinal axes, and having approximately the same pitch to the northeast or north-northeast as the case may be. They vary considerably in size, from structures with limbs merely a few inches apart to others comparable in size to come of the larger drag folds mapped in adjacent formations. Inasmuch as the book and ribbon structures of the vein bend around the "folds" with no particular disturbance and since the quartz shows no evidence of faulting or megascopic brecciation, they are believed to be the result of localization of the vein material along pre-existing, drag-folded, sheared zones (Thomson 1938a, p.21-22).

It is of interest to note that along the north flanks of the Pickle Crow syncline, the vein "folds" are "S"-shaped in plan; along the south flank of the syncline, they are "Z"-shaped in plan. In both cases, the vein "folds" pitch in about the same direction and at about the same angle as the major structure. In effect, they are compatible in every respect with the syncline. This lead Thomson (1938a) to suggest that the east-west fissures, along which the veins are localized, developed as features complimentary to the axial plane foliation of the syncline, and that these fissures were drag folded by differential movements between beds and flows during the regional folding.

STRUCTURAL CONTROLS OF ORE DEPOSITION

The attitudes of the ore structures in the area appear to be dependent upon their locations with respect to the cross developed about the nose of the Hooker-Burkoski stock. West of the stock at the Central Patricia Gold Mines Limited No. 1 Operation, they are tension fractures developed by normal-type adjustments along the east-west fault zone. These adjustments appear to have been complementary to others along transverse faults having the same attitude as the axial plane foliation of the cross fold. Northeast of the stock, the ore structures are fissures developed along either east-west fault zones or complimentary ones of northeast strike. In the immediate vicinity of the stock, the favourable structures are faults or sheared zones of northwest strike localized along the axial plane foliation of the cross fold. Several examples occur west of the Springer mine.

Aside from these broader aspects, the ore structures in the east part of the area appear to be located along the south flank of the Pickle Crow syncline, within a broad zone of disturbance about the pre-ore Pickle Crow fault zone. It is true that quartz veins occur along the north flank of the syncline notably the Big Dome and Lake Shore veins, but the gold contents of these veins are low. On the other hand, along the south flank of the syncline, in the general vicinity of the fault, are found the No.6 vein of the Springer mine; the No. 5, the Howell and the No.2 vein systems of Pickle Crow Gold Mines Limited; and the ore bodies and mineralized zones at the Albany River and Crowshore mines. All of these contain significant amounts of gold, and some highly productive.

Aside from location along the south flank of the Pickle Crow syncline and proximity to the fault zone, other conditions apparently have been of importance in the localization of ore deposits. A significant structural control appears to be the occurrence of one or more of drag folds, local thickenings of the favourable host rocks, and gentle curves in the adjacent formations. The Howell vein, for example, occurs, where the iron formation and adjacent flows have been highly crenulated; the No. 2 vein system occurs in a lenticular mass of intrusive porphyry near its thickest point; and the ore bodies at the Springer and Albany River mines were found where distinct curves or bends in the formations are evident. Another essential condition for the formation of ore bodies appears to be the presence, within the volcanic sequence, of relatively competent rocks, which tend to fail by fracturing rather than by shearing. Examples include the iron formation cut by the Howell vein, and the massive greenstone cut by the No.6 vein at the Springer mine. The folded quartz albite porphyry near the Pickle Crow Gold Mines Limited No. 3 shaft also falls into this category. True, the rock has been sheared parallel to the axial plane of the Pickle Crow syncline, and locally it exhibits a later but distinct east-west schistosity, but the fact remains that, in virtue of its acid composition, it is a far more competent rock than the greenstones that enclose it. A favourable location for the formation of fractures and the localization of ore bodies may well be found along the contacts of the intrusive igneous rocks, particularly the more massive of the folded porphyries; and although no economic deposits have been found in such an association, there is no reason why it should not provide the necessary suitable condition. During the life of the camp most of the prospecting work has been centred around bands of iron formation, and other possibilities have been largely neglected.

In the western part of the area, although development work to date has not indicated any major zones of disturbance, the same general principles discussed above should apply, and any future exploration should be based largely upon them. The location of the Central Patricia Gold Mines Limited No. 1 operation at the elbow, formed by the effect of cross folding on the Central Patricia anticline, indicates that a favourable locus of mineral deposition may occur at any place where the rock formations exhibit marked changes in strike consequent upon the two epochs of deformation.

DEPTH BEHAVIOUR

Inasmuch as no significant changes in the character of mineralization at any of the mines has been noted, the depth possibilities appear to be largely dependent upon the continuity of favourable structures. In most instances, the bottoming of the ore bodies in the area can be attributed to a tendency of the ore fractures to become weaker with depth, consequent upon changes in either petrographic or structural conditions.

At the Central Patricia Gold Mines Limited No. 1 Operation the decrease in tonnage both above and below the 750-foot level may be attributed largely to the fact that the iron formation lenses become smaller both above and below this horizon. However, this is not the only factor, for the grade of the ore shows a gradual decrease from the surface downward, irrespective of the changes in the sizes of the lenses. The ore fractures similarly change in character with depth - in the upper levels they are well-defined "breaks," striking nearly at right angles to the iron formation and are accentuated by a filling of quartz and sulphides, which exhibit relatively little replacement of the wall rock; on the lower levels they are ill-defined features tending to strike parallel to the bedding of the iron formation, and contain sulphides which replace the wall rock extensively. These changes may be attributed to a distinct variation in the petrographic character of the iron formation. Near the surface this formation is a typical one, with a large percentage of chert and siderite but with a low content of magnetite, and hence is a competent and brittle rock, favourable to intense fracturing and brecciation. However, with increasing depth, the content of iron oxide becomes greater, and on the lower levels the formation is composed essentially of fine granular magnetite with only a little chert and siderite. Here the rock tended to fall along its bedding planes rather than transverse to them. It is apparent, although the reasons are not fully understood, that this type of failure was not favourable to the deposition and concentration of the gold.

At the Pickle Crow Gold Mines Limited No. 1 Operation, the control over the decrease of tonnage and grade with depth is not a petrographic one, for no distinct changes in the character of the rock formations have been observed, but appears to be a structural one (Marvin 1952). Near the mine the lavas are intercalated with two bands of iron formation. The northern band, which is cut by the Howell vein, strikes southeast across the property and pinches out a short distance southwest of the No. 1 shaft; the other, the thicker and more continuous of the two, has been traced northeastward across the area to the Howell vein, where it also pinches out. Both have been highly deformed near the No. 1 shaft, but the southern band is unique in that it displays a large, tight "Z"-shaped drag fold south of the Howell vein. Due to the fact that the strike and dip of the vein are different than those of the iron fomration, with depth the vein migrates away from this fold; and this migration is accompanied by a general decrease in the grade and tonnage of the ore.

At the Pickle Crow Gold Mines Limited No. 2 Operation, it has been found that a decrease in the tonnage and grade of the ore occurs both above and below the 975-foot level. The vein system here trends east-west and dips to the north through a lenticular mass of quartz albite porphyry, the long axis of which strikes N. 48°E. As the vein extends from one intrusive contact to the other in vertical dimension, it passes through a zone of most intense fracturing and of its own maximum development at or near the geometric centre of the porphyry mass near the 975-foot horizon. Now the porphyry is enclosed by greenstone which, despite the fact that the intrusive igneous rock has been sheared, is the softer and more incompetent of the two. In effect, where the ore zone lies closer to greenstone, the stresses causing the failure of the host rock were taken up much more by shearing of adjacent, incompetent flows than where the zone lies farthest from them. Since the degree of fracturing of the porphyry determines the extent of mineralization within it, therefore, it follows that the vein system should be best developed at the point of greatest distance from the contacts, and should die out as those contacts are approached. This has been found to be the case.

At the Springer mine a somewhat different condition was encountered. Examination of assay plans shows that here the better widths and values occur where the vein is most highly contorted. The decrease in grade and tonnage with depth, therefore, can be attributed largely to the fact that the major "folds" in the vein decrease in intensity downward and all but die out before the 1,000-foot level is reached.

The factors controlling the depth possibilities at the Albany River mine are as yet not understood, for underground exploration has not reached a depth where conditions different from those on the upper levels are apparent. Perhaps the level of greatest ore tonnage, or of highest grade, has not been reached, and further devlopment below the 625-foot level will indicate more favourable conditions than have been found above it.

ADVICE TO PROSPECTORS

In the light of developments to date, the search for gold ore, within the map-area, should be based on a careful consideration of the following facts:-

(1) All the known ore bodies occur along the flanks and generally near the noses of the major, northeasterly-plunging folds.

(2) All the known ore bodies, with the exception of those at the Central Patricia Gold Mines Limited No. 1 Operation, occur along the south flank of the Pickle Crow syncline and close to but not within the Pickle Crow fault zone.

(3) The larger ore bodies occur in east-west fissures or related tension fractures, but others of smaller tonnage occur along sheared and fractured zones that tend to strike in a

northeasterly direction (across and perhaps beyond the Albany River group of claims).

(4) All the known ore bodies occur where there are drag folds, local thickenings, or curves in the enclosing formations.

(5) All the ore bodies occur in, or are closely associated with, relatively competent rocks that tend to fail by fracturing rather than by shearing. The most favourable host rocks for ore deposition, as indicated by development work to date, are iron formation, folded quartz albite porphyry but not related quartz sericite schist, and massive greenstone.

(6) At the Central Patricia Gold Mines Limited No. 1 Operation, the economic mineralization occurs in tension fractures oriented at large angles to the trend of the ore bodies and the east-west strike of the principal shear direction. Elsewhere, however, it is generally found along the principal shear directions. Where the favourable horizon is a band of iron formation, therefore, exploratory drilling operations should be directed to test for both types of occurrence.

CHAPTER V

DESCRIPTIONS OF PROPERTIES

ATTAWAPISCAT MINING SYNDICATE

Attawapiscat Mining Syndicate, Limited, was incorporated in 1945 to take over two claim groups, located north of Dona Lake near the southwest corner of Connell Township. These claim groups, known as the West and East, lie on either side of the Connell South property of Central Patricia Gold Mines Limited, and are readily accessible by way of trails leading from the Central Patricia-Doghole Bay road. The west group consists of 10 unpatented claims (Pa. 6889-6890, 6893-6896, 6901, and 7044-7045, inclusive); the East group, of 6 unpatented claims (Pa.6902-6906 and 6892).

Both groups are underlain by Keewatin lavas and intercalated, finely laminated, basic tuffs and iron formation. Near the southeast corner of claim Pa.6893 on the West group, the greenstones have been intruded by irregularly-shaped masses and dikes of quartz porphyry; and in the south portions of claims Pa. 6896,6900 and 6901, by biotite granite. The only mineralization discovered on the properties was located by D. Wright in 1945 along the west bank of Fault Creek on claim Pa.6893. The Wright showing is a quartz vein, about 5 feet in width, along the contact between sheared and contorted greenstone and quartz porphyry. The vein, which has been traced for about 15 feet in a north-south direction, consists of glassy white quartz with a little pyrite. The adjacent porphyry exhibits many small seams and stringers of quartz, and locally a little finely disseminated sulphides. Systematic sampling has indicated only traces of gold, although one specimen of quartz, taken by D. Wright was found to assay 0.41 ounces per ton (Lytle 1945).

ATWATER-PORCUPINE PROSPECTING SYNDICATE

Two Atwater-Porcupine claims are situated along the south side of the Crow River east of the Waltricia property and north of the adjoining Pickle Crow property. They were formerly held by the Crow River Development Company Limited, under whose direction some surface work and 5,000 feet of diamond drilling were done in 1938 (Thomson 1938a,p.50). That company became bankrupt in 1939, and the property subsequently was acquired by the Atwater-Porcupine Prospecting Syndicate. In 1941 and 1942 the 17 claims which at that time were recorded as Pa.5700-5715, were held under option by Central Patricia Gold Mines Limited. A diamond drilling program was carried out to investigate a 15-foot section of iron formation, cut in a drill hole put down earlier by the Crow River Development Company Limited. This intersection was reported to have assayed $5.60 in gold per ton, gold at $35.00 per ounce. But when 4 drill holes, aggregating 1,872 feet, had been bored without indicating any important mineralization, the option on the Atwater-Porcupine property was dropped. No further work has been reported by the Syndicate.

The Atwater-Porcupine Group, except for three scattered outcrop areas of greenstones, is covered by sand deposits and muskeg accumulations. The bedrock geology, therefore, is largely unknown. However, a dip needle survey conducted by the Crow River Development Company Limited in the winter of 1937-1938 and the subsequent diamond drilling has indicated the presence of two roughly parallel bands of iron formation, respectively about 2,000 feet and 3,000 feet south of the Crow River. These bands are bordered by grey and greenish lavas and intercalated pyroclastic sediments. They are cut by small bodies of sheared quartz feldspar porphyry and of biotite lamprophyre.

CENTRAL PATRICIA GOLD MINES, LIMITED

In the Crow River area Central Patricia Gold Mines Limited, holds six claim groups, which include 143 patented and 40 unpatented claims. These groups are known as:

(1) the Main group, comprising claims Pa.71-88, 619-624, 672-674, 678-683, 1,082-1,084, 1,996-2,004, 2,012-2,026, 2,456-2,458, and 2,692-2,700 inclusive;

(2) the Springer group, comprising claims Pa.625-636, 647-655, and 2005-2010 inclusive;

(3) The Connell South group, comprising claims Pa.2854-2874, 6, 775-6, 780, 6891, and 6,897-6,899 inclusive;

(4) the Northeast group, comprising claims Pa.641-643, and 645;

(5) The North Muskeg group, comprising claims Pa.2,449, 2455, 9897, 9900-9904, 9908-9914,9916-9922, and 9924-9931 inclusive; and

(6) the Roeanor West group, comprising claims Pa.5447-5,455 and 5453A.

The history and development, general and structural geology, and mineral deposits of each are described separately in the following pages in the order given.

MAIN CLAIM GROUP (NO. I OPERATION)

HISTORY AND DEVELOPMENT

As recorded by Thomson (1938a, p.36-37) and Cockeram (1949, p.70-71) early surface work and diamond drilling at the Central Patricia property resulted in the outlining of what appeared to be an ore body, and culminated in the decision to proceed with underground development. The sinking of a three-compartment vertical shaft was started on March 5, 1930. By September the shaft had been extended to a depth of 525 feet, and 3,000 feet of lateral work on four levels at 125-foot intervals, had indicated gold ore having a gross estimated value of $454,555 (Segsworth 1930).

Central Patricia Gold Mines Limited, was incorporated on April 30, 1931, to finance additional development. Such encouraging results were subsequently obtained that on December 12, 1932, an agreement was made with Globe Investments Limited, to provide funds sufficient to bring the mine into production. A cyanide plant with a capacity of 50 tons per day was designed, and the necessary machinery and supplies were ordered and delivered to Savant Lake station. Owing to transportation difficulties it took 15 months to assemble the mill and put it into operation. But finally, on May 27, 1934, eight years after the deposit had been located by George Simmons and

William Seiger (See page 5), precipitation commenced.

During the following five years the shaft was extended to 2,226 feet and new levels were established at depths of 625, 750, 875, 1000, 1150, 1300, 1450, 1600, 1750, 1900, and 2050 feet below the collar. This work increased the ore reserves to such an extent that the capacity of the mill was increased to 100 tons per day in 1935, to 200 tons per day in 1936, to 325 tons per day in 1937, and finally to 400 tons per day in November 1940. Subsequently, to open up the northeasterly raking ore shoots below the deepest workings, a four compartment winze was sunk from the 2050-foot horizon at a point 955 feet east of the No. 1 shaft, and by 1947 this had been deepened to 3425 feet and nine new levels had been opened up at vertical intervals of 150 feet.

As development work progressed on the lower levels it soon became apparent that the ore lengths and widths were becoming shorter with depth and that the grade was decreasing, a feature made doubly disappointing in view of the company's failure to find other commercial ore bodies elsewhere on its extensive holdings in the area. In 1949 the No. 2 winze (three-compartments) was started from the 3400-foot level at a point 48 feet north and 1543 feet east of the No. 1 winze, and during the following year the more persistent ore shoots were opened up by four levels at 150-foot intervals as before. But this work only served to confirm earlier predictions, for the economic limit of mining was reached at a point approximately 4,000 feet below the surface. The last of the ore broken in August and September, 1951, and milling operations ceased on December 22 of that year.

It is not to be construed from the above statements that the mine was short-lived and unprofitable, for history records it is one of the big gold producers of Northwestern Ontario. This becomes most obvious when it is realized that from 1930 through the following 20 years 4,517.7 feet of shaft sinking, 60,594.8 feet of drifting, 11,050.7 feet of crosscutting, and 28,188.6 feet of raising have been completed - a total of 104,349.8 feet or 19.76 miles of underground workings. Attesting to the importance of the operation is the fact that from the start of precipitation in 1937 to the cessation of milling in 1951, the mine had produced 608,650.140 ounces of gold and 58,229.94 ounces of silver from 1,715,498 tons of ore hoisted, and had netted the shareholders $4,575,000.00 in dividends.

General Geology

In the vicinity of the mine the rocks are largely greenstones. Some of them have been considered to be hydroclastic sediments and have been classified as greywackes. This thesis is discounted in most cases by the presence of pillow and vesicular structures recognizable in surface outcrops; by closely spaced contacts marked in places by flow breccias; by the general absence of such sedimentary features as bedding, cross-lamination and grain gradation; and by the fact that in the workings tongues of greenstones extend as dikes into iron formation. It is to be admitted that thin horizons of finely bedded rocks occur south of the ore zone, but this evidence does not detract from the conclusion that the greater part of the greenstones are flows and not sediments. The finely bedded rocks south of the ore zone, in view of their basic compositions, are probably water-sorted tuffs that formed as narrow horizons during the period of Keewatin volcanism.

Intercalated with the greenstones are several bands of iron formation. Most of them are narrow, and although somewhat lenticular, they appear to be fairly continuous and persistent along their respective strikes. However, the one in which the ore deposit occurs pinches and swells in short distances, varying in width from a few inches in some places to 70 feet or more in others. Neither does it constitute a continuous layer in the stratigraphic sequence, for as illustrated in Fig. 2, it occurs as a series of elongated lenses which have been separated from one another by adjustments along transverse sheared zones of northwesterly strike. These adjustments have imparted to the lenses *en echelon* arrangement - although the lenses collectively make up a discontinuous horizon of overall east-west strike, individually they appear to strike about 10^{o} off this direction (Tigert 1949, p.73).

The iron formation in which the ore shoots occur is typical of that found in the Crow River area in that it consists of alternating bands up to an inch or two in thickness and of various shades of grey, the colours ranging from almost white to almost black depending upon the proportions of silica, siderite, and magnetite present. But it exhibits a distinct change in character with depth, a change which is believed to be responsible for the general decrease in grade of the ore on successively lower levels. Near the surface the iron formation possesses a low content of iron oxide and is characteristically light in overall colour. With depth, however, the iron oxide increases in quantity and forms local concentrations of finely granular magnetite. These concentrations become larger and more numerous on each lower horizon, so that in the deepest workings the formation consists largely of magnetite with relatively small amounts of silica and siderite, is indistinctly banded, and is very dark, in places almost black , in colour.

Intrusive into the greenstone near and at the mine are several sill-like masses and dikes of sheared quartz feldspar porphyry and quartz sericite schist. These masses and dikes are pre-ore in age as shown by the fact that in places they contain stringers and lenses of gold-bearing quartz. However, it has not been demonstrated that they provide host rocks for important ore bodies. To the east of the mine they, as well as the greenstones, are cut by a north-south dike of quartz diabase.

Structural Geology

Folding

The principal structural feature in the vicinity of the mine is the Central Patricia anticline. The axial plane of this fold strikes N 80°E, through a point about 2,000 feet south of the No. 1 shaft, but to the east, as a result of cross folding about the nose of the Hooker-Burkoski stock, it curves sharply to the north, gradually assuming a strike of N 58°E. It dips steeply north with the formations, and hence has been overturned such that near the mine the fold pitches in a northeast rather than an east-west direction. The pitch, as indicated by the attitude of drag folds in bedded tuff and iron formation at and south of the shaft, is 60 to 65 degrees.

Shearing

Two prominent directions of shearing have been recognized in the vicinity of the mine. One strikes through greenstones and the porphyry roughly parallel to the axial plane of the major fold described above and dips 70° to 75° N. It is believed to represent a flow cleavage as a result of differential movements between beds and flows in the more incompetent horizons during the regional deformation. The other strikes about N 45°W , parallel to the axis of the Hooker-Burkoski stock and of the cross fold developed about the stock's nose, and dips 60° to 65° N E. It has been superimposed upon the schistosity associated with the Central Patricia anticline, and in many outcrops both can be seen to intersect at acute angles. This is particularly evident in exposures of porphyry along the north bank of the Crow River, where the two sets of shear planes give rise to a pronounced lineation that pitches at an average angle of 63° in a direction of N 55° E.

Faulting

Several faults and innumerable small slips have been encountered in the mine workings. The most significant is represented by zone of intense shearing in the greenstones along the north contacts of the iron formation lenses. This sheared zone strikes roughly east-west parallel to the regional structure and dips about 75°N. The relative displacement along it is not known, for there are no structural units by means of which offsets can be demonstrated. But the nature of the adjustments are well understood from features mapped in the workings. As pointed out by Thomson (1938a, p.41), at several places on the hanging-wall side of the iron formation the beds have been dragged to the west and cut off by the sheared zone. Further, drag folds in the iron formation are frequently "S"-shaped in plan, hence of opposite configuration to those compatible with the Central Patricia anticline; and as pointed out by Mawdsley(1937), they pitch to the east at angles of 65° or more. Finally associated tension fractures in the ore-bearing horizon have an overall strike of slightly east of north and an apparent average dip of 56°E. The three structures indicate a normal type movement along the fault or sheared zone of north side down and to the west.

Offsetting the hanging-wall sheared zone are faults of northwesterly strike that are localized along the schistosty which parallels the axis of the Hooker-Burkoski stock, at points where the ore-bearing band of iron formation pinches. These faults dip to the northeast at 60° to 65° and have effected strike separations in the east-west horizons of up to 125 feet, the east side having moved south in each instance (Figure 2). In regard to the cross faults the following facts are of interest: (1) the bedding in the iron formation has been dragged along the faults, indicating right hand displacements in each instance; (2) each lens of iron formation, near its extremities, has been broken up, and the fragments are distributed along the adjacent faults as "trails", connecting the lens with its faulted extensions to the east and west; and (3) longitudinal sections of the mine workings indicate that in place adjacent fragments of iron formation have matching walls (see Fig. 4).

In addition to the hanging-wall sheared zone and the cross faults which displace it, there are in the underground workings occasional minor faults which strike in a general north-north-east direction and dip to the west at angles of 40 to 70 degrees, with an average of about 55 degrees. These faults are minor slips along which the bedding shows strike separations of up to about 2 feet, the east side having moved north in many cases.

Ore Bodies

The ore bodies at the Central Patricia No. 1 Operation consist of auriferous sulphides localized along and replacing iron formation outward from closely-spaced transverse fractures. In the upper levels of the mine the fractures strike from N 35°E to N 40°W , the average of 72 determinations being N 4° E , and dip at all angles from 25° to 90° , with a mean of 56°E. They are generally gash-like in character and frequently extend from the hanging-wall contact southward across, but rarely completely through the iron formation (Figure 3). In plan and section the ore fractures succeed one another in parallel and en echelon arrangements. They are generally short in both dimensions, but some of the persistent ones have been followed in the stopes for vertical distances of up to 300 feet, (T.T. Tigert, personal communication). All contain metallic sulphides, chiefly pyrrhotite and arsenopyrite and dark green chlorite; and many, perhaps half, of them exhibit a central filling of smoky quartz. Frequently the sulphides send forth wedge-like tongues or "tentacles" extending outward from the fracture fillings along the magnetite-rich or siderite-rich laminae of the iron formation. In a few places, possibly due to their localization along fractures too closely spaced to be recognized as such, they occur as irregular large masses that have all but completely obliterated the bedding of the rock through processes of replacement (Hicks 1945). But more commonly the sulphides appear to be more or less confined to the fractures, as is the quartz and much of the chlorite. This feature, together with the occurrence of vugs lined with crystals of pyrite and pyrrhotite, suggests that the fractures were open at the time of mineralization and are therefore tensional in origin (Thomson 1938a,p.45). Inasmuch as they tend to be widest near the north contact of the iron formation band and to pinch out southward, they are believed to have been formed by adjustments along the hanging-wall sheared zone.

In the lower levels of the mine the ore fractures, while possessing an average dip of 56°E as before, tend to strike parallel to the bedding in the iron formation. (See Figure 3). The character of the mineralization has also changed. Although the same principal minerals are present, the sulphide-quartz fillings have irregular outlines with the enclosing rock as a result of extensive replacement outward from the fractures. This is probably due to the fact that the iron oxide content of the iron formation increases markedly with depth, for, as intimated above, the magnetite and siderite are much more easily replaced by pyrrhotite and the arsenopyrite than is the chert of the host rock. This is of special significance, for the changes in the character of the deposit with depth are accompanied by a decrease in both the gold contents of the veins and the ore tonnage.

The gold is associated with the principal sulphides rather than the quartz, and like the latter is largely confined to the ore fractures, only low values being found in the sulphides replacing the intervening iron formation. But the sulphide-quartz fillings are usually very rich, commonly assaying an ounce or more in gold per ton, so that where they are closely spaced the whole mass of mineralized iron formation may be broken and milled economically. Fortunately, the ore fractures occur in groups, thus permitting the delineation of shoots. It must be admitted that much of the iron formation between the ore shoots contains mineralized fractures, some very rich in gold. However, these are generally so scattered as to reduce a mineable section to marginal grade. Rarely an isolated fracture may be of sufficient length, width, and grade to permit selective mining. The "M" shoot on the 6th level is an example of this type of occurrence. Here a transverse fracture, up to 3 feet in width, was mined for an ore length of 48 feet across the iron formation. It is to be emphasized that the tonnage mined from such occurrences was only of minor significance. Well over 90 percent of the ore was broken by the bulk mining of a large number of closely-spaced rather than isolated veins.

The ore shoots vary greatly in shape and size. Where only one or two fractures occur, such as in the case cited above, the ore lengths must be considered as extending across rather than parallel to the iron formation and the widths as those of the fractures themselves. On the other hand, where stopes embrace a large number of closely-spaced fractures, the length of the shoot is considered the dimension parallel to the strike of the host rock; and the width, the distance between the assay boundaries determined by the gold contents of the individual sulphide-quartz veins. Ore shoots of this type, as mentioned above, are the most common. In longitudinal section (Figure 4) they appear as narrow, persistent lenses, with horizontal lengths up to 285 feet and apparent pitch lengths in the east-west plane of up to 3,260 feet. In plan they appear to be highly irregular in shape, as may be expected from the nature of the mineralization, and vary in width from a minimum of about 4 feet to a maximum of 40 feet. They consistently show a rake to the east of 56° co-incident with the average apparent dip of the ore fractures in this direction. This has been of considerable importance in the mine development, for by assuming a rake of 56°E and dip of 73°N, it has been possible to predict within a few feet the positions of any given ore shoot on successively lower horizons (T.T. Tigert, personal communication).

The position of the ore shoots with respect to the hanging-wall contact of the iron formation is variable. In some of the smaller shoots, the ore fractures may persist in parallel of *en echelon* arrangements from the hanging-wall to the footwall contacts of the host rock. Less commonly a few ore fractures, such as those in the "1910" shoot between the 1st and 2nd levels, are confined entirely to the footwall. In one instance, groups of ore fractures were found to angle across the iron formation. Hence, in the "K" shoot the ore section migrated across the band from its hanging wall on the 625-foot level to its footwall on the 875-foot level. But these occurrences are exceptional. As a general rule the best mineralization has been found close to the hanging-wall contact, as may be expected from a consideration of the origin of the ore fractures. The deposits making up all the larger ore shoots, for example the "A", "B", and "C", are of this type.

According to the hypothesis of Mawdsely (1937) the ore fractures are tension cracks formed by normal-type movements along the hanging-wall sheared zone, and that they were controlled in their attitude by the lines of intersection between the hanging-wall sheared zone and the cross faults which offset the iron formation band.

Mineralization

The mill feed at the Central Patricia mine is an assemblage of iron formation and subordinate greenstone with auriferous sulphides, chlorite, quartz, and a little secondary carbonate (ankerite). The metallic sulphides make up from 11 to 18 percent of the ore and include, in probable order of decreasing abundance, pyrrhotite, arsenopyrite, pyrite, and chalcopyrite (Thomson 1938a, p.42).

An interesting feature of the ore is the presence of chlorite. This mineral occurs as bands, streaks, and irregular patches alternating with the metallic sulphides and quartz in the ore fractures and as thin layers conformable to the bedding of the iron formation. Its origin has not been definitely established. Tigert (personal communication), suggests that where it occurs in the ore fractures it represents portions of altered basic lava broken off from the hanging-wall greenstone and transported to its present site by the ore solutions. Some of it may represent small injections of highly altered lava extending southward through the iron formation from its hanging-wall contact. Associated with and replacing the chlorite in the ore fractures and the siderite of the adjoining iron formation in many places is ankerite. This early carbonate is not found in the interiors of the quartz veins but only with chlorite along their margins or in ribbon structures, and must be distinguished from a possible later variety which appears to occupy interstitial spaces between the individual quartz grains.

After their formation the chlorite and ankerite along the ore fractures and locally the magnetite-rich or siderite-rich portions of the adjoining iron formation were replaced by coarsely crystalline arsenopyrite and possibly by a little pyrite. Recurrent stresses then re-opened the fractures and permitted the introduction of dark, vuggy, vein quartz. This is demonstrated by the fact that near the vein walls the quartz encloses well-formed crystals of arsenopyrite, some a quarter of an inch across, and by the fact that in polished sections the quartz is generally found to cement the fragments of broken crystals of this mineral. But the quartz itself has also been fractures, and in places is cut by tiny fissures and cracks, many of which are filled with one or more pyrite, pyrrhotite, and chalcopyrite.

Pyrite has only been found in significant quantities in the upper levels, becoming decreasingly abundant with depth, (T.T. Tigert, personal communication).

It has been found to occur as irregular grains replacing arsenopyrite, but most commonly it occurs in fracturing, vugs and open fissures in both the quartz and the iron formation. An interesting feature of some of the pyrite-coated, open fractures in the quartz is that they strike transversely to the veins but die out at the vein walls. This suggests that they are of tensional origin and may be the result of contraction on cooling subsequent to the intrusion of the quartz. Pyrrhotite locally replaces the pyrite in these fractures and is therefore later in the mineralization sequence. It also occurs as irregular patches and grains enclosed by chlorite, as narrow seams localized along and replacing the iron-rich bands of the host rock, as film and thread filling minute fractures in the quartz, and as grains cementing and replacing broken crystals of arsenopyrite. Intimately associated with it in places is a little chalcopyrite.

Visible gold is found rarely in hand specimens, only four or five occurrences having been reported during the mine's history. It is very finely divided and for the most part replaces the sulphides in or close to the ore fractures. As shown by a microscopic study of the ore, about 38 percent of the gold is associated with the quartz-chlorite-carbonate gangue, 28.3 percent with pyrite, and only 3.2 percent with chalcopyrite (Haycock 1936). This confirms the general experience at the mine that high grade ore consists of pyrrhotite-arsenopyrite mineralization associated with quartz and chlorite. According to Hicks (1945, p.9) the chlorite itself is quite barren. But the occurrence of gold is nevertheless related to it, for it has been found that the grade of the ore varies roughly with the chlorite content of the fractures, being highest where this mineral is most abundant.

Hanging-Wall Quartz

Related to the mineralization in the ore fractures are discontinuous veins, stringers, and lenses of quartz found at irregular intervals along the hanging-wall sheared zone. According to Thomson (1938a, p.41) this quartz is not gold-bearing, and may represent a later generation than that variety discussed above. The two are certainly distinct in appearance, for that occupying the ore fractures is generally dark in colour, whereas that in the hanging-wall sheared zone is characteristically white or pale grey. A further difference is that the hanging-wall quartz frequently contains broken crystals of scheelite, particularly below the 2000-foot level; and this mineral has not been found in the ore fractures.

Structural Controls of Ore Deposition

The ore bodies at the Central Patricia mine consist of gold-bearing sulphides, replacing lenticular bodies of iron formation along and outward from closely-spaced, quartz-filled transverse fractures. These fractures trend in a general north-south direction roughly normal to the east-west strike of the formations. As pointed out by Thomson (1938a, p.45) they are tensions fractures which are generally confined to the hanging-wall sides of the iron formation lenses, and which, in virtue of their average dip, impart to the ore shoots an average rake of about 55^{o}E. Their origin has been a subject of controversy, and three theories have been proposed to explain them.

Thomson (1938a, p.46) suggests that the ore fractures are due to tensional stresses set up in the brittle iron formation by fault adjustments along the latter's hanging-wall contact during the regional folding. This hypothesis explains the localization of the hanging-wall sheared zone along the north rather than along the south side of the iron formation horizon and the gash-like nature of the ore fractures. But relating the ore fractures to faulting along the hanging-wall contact during the period of folding is difficult. The Central Patricia anticline is a similar fold, for the formations have been thickened over its crest, and thinned proportionately along its flanks. Hence, any differential movement along the contact during folding, since the iron formation occurs along the north limb of the structure, must have been north side toward the east and crest. This is incompatible with the fact that the iron formation has been dragged to the west and cut off by the hanging-wall sheared zone (Thomson, 1938a, p.41), and with the fact that the tension (ore) fractures show a distinct tendency to strike, not at right angles to the iron formation, but in a north-northeast direction at a large angle to it on the upper levels, and in a northeast to east-northeast direction on the lower levels. These features indicate an adjustment of north side to the west rather than to the east.

A second hypothesis, proposed by T.T.Tigert (1949, p.75), is that fault adjustment, possibly along the bed of Crow River, offset the north-south diabase dike east of the mine, causing that segment of the dike south of the river to move east. According to Tigert, the maximum tensional force on the iron band during the adjustment was along a line at right angles to and at the south end of that segment of the diabase dike north of the river; and that the tensional force diminished in strength in an anti-clockwise direction from this line. This hypotheses explains: (1) the fact that the higher grade ore and the greater concentration of tension fractures have been found in the western half of the mine, where postulated maximum tensional force was operative; (2) the occurrence of the ore-bearing horizon of iron formation as a series of enchelon lenses, with their east extremities pointing toward the supposed fault; (3) the intense shearing along the hanging-wall rather than the footwall contact of the iron formation, indicating a concentration of movement along the north side of the band; and (4) the absence of ore bodies in those bands of iron formation both north of and south of the assumed fault, beyond the influence of the structural adjustments. But aside from this the theory fails to explain the following:-

(1) Diamond drilling from the deeper mine workings suggests that the diabase dike has not been faulted but merely shows a deflection in its course, possibly due to an attempt to follow a prominent sheared zone found along the bed of the Crow River at this locality (E.W.M. Cokayne, personal communication).

(2) If the diabase dike had been displaced by adjustments along the bed of the river, the porphyry to the west would also be offset in the same direction, but diamond drilling has shown that "the porphyry has moved laterally in an opposite direction to the dike (Thomson 1938a, p.24).

(3) The hpothesis assumes that the mineralization is post-diabase in age, and while no evidence to the contrary has been found, the massive quality of the rock suggests that this is highly improbable.

At the Central Patricia mine, two directions of shearing are evident. The one direction is represented by the sheared zone along the north contact of the iron formation horizon -

a normal fault along which the north side has moved down and the west. The other direction is represented by a flow cleavage superimposed upon the east-west schistosity, and trends in a northwesterly direction across this part of the area. In the mine workings it is quite prominent between the lenses of iron formation, which have been offset along it, the east side having moved to the south in each instance. According to J.B. Mawdsley (1937), the hanging-wall sheared zone and the transverse faults are complimentary, and resulted from either compression in a northeast-southwest direction or from tensional relaxation in a northwest-southeast direction . The movements along them produced the ore fractures, which developed with an attitude dependent upon that of the line of intersection of the two directions of shearing. Thus, if it is assumed that the cross cleavage strikes N 45° W and dips 60° N.E , its intersections with the hanging-wall sheared zone, which dips 75° N , almost coincides with the rake of the ore bodies (Thomson 1938a, p.45).

The principal criticism of this concept is that the obtuse angle between the principal shear directions faces the directions of maximum compression contrary to Harmann's (1896) law, and to the principles of the stress theory of failure. It is overcome, however, if the relationship between the shear directions and the folded structures is considered. The east-west schistosity, for example, strikes and dips roughly parallel to the axial plane of Central Patricia anticline, and may be considered a flow cleavage formed during the regional deformation. The northwest-southeast schistosity may be held to have a similar origin, for it closely parallels in strike the axis of the Hooker-Burkoski stock and the cross fold developed about the stock's nose. In effect, the two directions of shearing are not necessarily related to one another as such. However, if they have provided loci for structural adjustments subsequent to their formation, the relative movements along them may have been complimentary. It may be that, after the regional folding and the associated cross folding, tensional relaxation in the area resulted in the development of normal or gravity faults along the pre-existing flow cleavages.

Production and Operating Statistics

Table 8 (back pocket) gives a complete record of production and cost data for the entire life of the mine. Because the unit operating costs for each project were not broken down in the preparation of company accounts, this record also includes the production and cost data for the No. 2 Operation (Springer mine).

SPRINGER GROUP (NO.2 OPERATION)

History and Development

The No. 6 vein on the Springer claims about one mile southwest of the Pickle Crow No. 1 shaft discovered in 1929 by John McCallum. Stripping of this vein indicated a possible ore shoot with a length of 70 feet, an average width of 7 feet 9 inches, and a grade of $24.55 per ton. But little development work was done on the vein at the time, and it was not until the spring of 1935 that underground work was planned and shaft sinking started. By the end of the year drifting on the 150-foot level indicated four ore shoots with an aggregate length of 198 feet and averaging 2.35 ounces of gold per ton across a mean width of 14 inches (Anderson 1935). The shaft was extended to a depth of 420 feet in 1936 and two new levels were established at depths of 275 and 400 feet. Drifting at these horizons also proved successful, for here the vein was found to contain two ore shoots with a combined average length per level of 131 feet and embracing 8,326 tons of probable ore grading 0.97 ounces of gold per ton, calculated on a 36-inch mining width (Barnett 1937). The mine was closed in September, 1937. But after construction of a picking plant and an ore bin, it was re-opened June, 1938. Sinking of the three-compartment shaft was resumed late in the year, and by the end of 1939, it had attained a depth of 1,024 feet, with stations cut and levels established at 550, 700,850, and 1,000 feet below the collar. Development work at these horizons in 1940, however, gave unsatisfactory results, as did exploratory drifting beyond the ore zone on the 1,000-foot level. During the year the developed ore was taken out and the mine closed down.

In addition to the No. 6 vein many other gold occurrences have been reported on the Springer claims, but none has been shown to be of any commercial significance. The more important of these, the No. 5 or Hook vein and a quartz-sulphide deposit located by diamond drilling on claim Pa.627, are descr bed below.

General Geology

The Springer claims, like those of the Central Patricia Main Group, are underlain largely by Keewatin lavas of intermediate to basic composition. Narrow bands of iron formation occur between the flows in several localities, and exposures of hornblende diorite, sheared quartz albite and massive albite porphyries, and albite granite have been mapped. For the most part the lavas are fine-grained and dark green in colour. Many of them have been highly sheared to chlorite schists, and any original structures to a large extent obliterated. But massive flows are found locally, and in these vesicular structures and even flow breccias are occasionally evident.

In one outcrop area forming a ridge south of the shaft pillows are sufficiently well preserved that it has been possible to delimit the position of the axial plane of a minor, northeast-plunging syncline. Generally, the fine-grained lavas, when examined microscopically, are seen to consist merely of fine matted aggregates of secondary minerals, but in some thin sections vestiges of original diabasic textures are apparent. Porphyritic lavas have been observed in a few places, as have dacitic ones. However, such occurrences are rare, and do not provide horizons suitable for the interpretation of local structural features.

Iron formation outcrops at a number of places on the property but except in the case of a few fairly persistent bands, most of them cannot be correlated with any degree of certainty between the isolated exposures. The strongest horizon, which here attains a width of 100 feet, occurs as a series of disconnected lenses, collectively striking N 50° E., across claim Pa.648 in the extreme northeast portion of the property. It has been traced southwestward from the Howell vein on the Pickle Crow claims for about 5,000 feet, pinching out at a point approximately a quarter of a mile north of the Springer mine. Another horizon, having a maximum thickness of only about 3 feet, outcrops near the centre of claim Pa.647 and strikes N. 25°-30°E., through the workings, again as a series of lenses isolated by intervening areas of greenstone. Toward its north extremity it appears to curve slightly and may represent the folded extension of a third horizon of similar character, that strikes N. 70° E., across the claim about 500 feet north of the shaft . Iron formation bands also outcrop on claim Pa.627, where diamond drilling has shown them to be contorted about the nose of the Pickle Crow syncline, which here plunges at an angle of 65° in a direction of S. 70-80° E.

Associated with the lavas at a number of places are smaller bodies of massive, coarse-grained "greenstone," with compositions that permit classification as metagabbros. Some of these bodies are undoubtedly coarse phases of the flows, but others, in virtue of their highly irregular outlines, probably represent an extrusive facies of the Keewatin rocks. Also cutting the lavas are sill-like masses of sheared quartz albite porphyry, exposed in and close to the mine workings, and the porphyritic albite granite that forms that part of the Hooker-Burkoski stock underlying the southwest portion of the claim group. The oldest of these three acid rock types is the quartz albite porphyry. As pointed out in Chapter 11, it was in all probability folded with the enclosing greenstones during the formation of the Pickle Crow syncline and related structures.

The albite porphyry is very similar mineralogically. However, it differs in that where exposed on the surface it appears to be comparatively massive, suggesting that it was not subjected to the same degree of deformation and was intruded at a later date than the quartz albite porphyry. Nevertheless, it is pre-ore in age, for at the eastern extremity of the No. 6 vein a northwesterly trending dike is mineralized and cut by gold-bearing quartz (MacDonald 1940). Its age relative to the albite granite is not known. But the latter has also been found to contain gold-bearing quartz veins near its margin (D.B. Angus, personal communication). In view of their similarity in composition, therefore it seems reasonable to suppose that the two are of common parentage and were intruded at about the same time.

The youngest intrusive rock on the Springer claims is biotite lamprophyre, which forms two narrow dikes cutting the quartz albite porphyry along the northeast flank of the Hooker-Burkoski stock.

Structural Geology

Folding

In the eastern portion of the property the lavas and intercalated bands of iron formation have an overall strike of N.65°E. and dip of from 75° to 80°N. However, they have been folded locally and assume different attitudes. On the ridge south of the shaft, for example, the flows appear to extend around the nose of the northeasterly plunging Springer syncline; and north of the shaft they may reflect the occurrence of a minor but complimentary anticline. But the major structural feature is the Pickle Crow syncline, the axis of which lies on the Pickle Crow property to the north, so that these folds may be considered as merely minor expressions of the period of regional deformation, and as subordinate features compatible with the larger structure. Nevertheless, their presence here is of considerable significance, and serves to emphasize the often expressed opinion that drag folds are loci of structural weakness, favourable to the formation of sheared or fracture zone that permit concentration of ore-making minerals.

About 3,000 feet northwest of the shaft the axial plane of the Pickle Crow syncline extends, in a southwesterly direction, across the north boundary of the claim group. West of this point the plane first swings to an eastwest strike, then curves northward about the nose of the Hooker-Burkoski stock, again crossing the north boundary of the property through a large mass of sheared and apparently folded quartz albite porphyry (see map). Except where minor drag folds are to be found, the formations more or less parallel this plane in attitude, and as one walks westward from the shaft abrupt changes in strike are readily observed. These formations dip in a northerly direction at steep angles as before. On claim Pa.627 at a point where the axial plane strikes N.70°W, diamond drilling has shown that this northerly dip imparts to the major syncline a pitch of 63°in a direction of N. 80°E.

Shearing

In the eastern part of the property the flows have been sheared in a general northeast direction more or less parallel to the axial plane of the Pickle Crow syncline. However, since to the west this fold has been deflected about the Hooker-Burkoski stock, the flow cleavage associated with it swings with the strike of the formations so that along the northeast flank of the stock it trends in a west-northwest direction. Locally superimposed upon and obliterating it is a later cleavage which strikes northwest parallel to the axis of the stock. Another direction of shearing is seen in outcrops near the No.6 vein, where a prominent schistosity strikes north-south and dips steeply to the east.

Faulting

Evidence of the faulting on the Springer claims is difficult to find. This is not because faults are rare or non-existent but simply because suitable structural units which serve to indicate relative displacements simply have not been recognized. The only significant structure, along which a reliable measurable offset has been found, is the east-west fracture zone occupied by a portion of the No. 6 vein. Here, three thin bands of iron formation of north-northeast strike have been offset as much as 20 feet and dragged along the fault plane (MacDonald 1940). But in addition to this structure there are a number of zones of intense shearing which possibly represent loci of fault adjustments. The more prominent of these sheared zones strike in a northeasterly direction and dip 75° to 80° N. Buffam (1955) recognizes three with this attitude, pointing out that they are indicated by a discolouration of the formations which they cut, and by the occurrence of distinct depressions in the topography. One of them lies 150 to 200 feet southeast of the shaft, another about 500 feet northwest of the shaft, and the third 250 feet farther to the northwest. However, the most important northeasterly striking sheared zone is the Pickle Crow fault, a pre-ore structure which has been located by drilling along a deep valley extending from the Springer claims through the Pickle Crow main group to the Albany River property. Other sheared zones strike in a northwesterly direction parallel to the long axis of the Hooker-Burkoski stock, and dip 70° to 75°N.E. They are believed to represent faults localized along the axial plane foliation of the cross fold developed about the stock's nose, and to be due to compression in a westerly or west-northwesterly direction. The movement along them appears to have been left hand or east side north. Gold-bearing quartz veins have been found along a few of these sheared zones, which accordingly are also pre-ore age. Like the east-west faults, those now containing vein matter were apparently drag folded before the introduction of the quartz, and the veins following them southwest of the shaft exhibit contortions much like those so characteristic of other mineral deposits in the east part of the Crow River area.

Ore Bodies and Zones of Mineralization

No. 6 Vein

The No. 6 vein is exposed for a length of about 350 feet on the surface in the southwest corner of claim Pa.625. For the most part it strikes about N. 75°E. and dips 65° - 70°N. through massive greenstone (Figure 5). But it is highly contorted, exhibits numerous "Z"-shaped "folds", most of which pitch at an angle of 65° to 70° in a direction of N. 20° - 25°E., with the major folded structures. This section of the vein averages a little over a foot in thickness. It is, however, highly lenticular and pinches and swells in short distances, with widths varying from a fraction of an inch in some places to several feet in others. Nor is it continuous, for in many places it fades out along its strike, and sections or lenses greater than 80 feet in length are uncommon. Nevertheless, it has been followed in the workings for a total distance of about 500 feet on the 150-foot level, and to the west curves northward and unites with a related structure that strikes northwest for about 350 feet. The northwest trending part of the vein is very similar in character, but on the whole is somewhat narrower and of lower grade. It dips 70° to 75°N.E., so that its intersection with the segment of east-west strike pitches at about 65° in an east-northeast direction, as do the many contortions in the vein.

Ore Shoots: three ore shoots (MacDonald 1940) known as the West, Central, and East shoots, have been developed and mined. All occur in the east-west section of the vein and rake with it to the east-northeast. The West shoot was found to have a maximum horizontal length of 45 feet at the 400-foot level, an average width of about 11 inches, and a contained tonnage of 2,000 with an average grade of 0.75 ounces of gold per ton. It bottoms at the 5th level. The shoot is represented by a faint vein structure on the 6th and 7th levels, and occurrences of gold here coincide with its projection. But there are no ore sections at these horizons. Similarly, the ore dies out upward, at a point 210 feet below the surface, and on the 150-foot level there is little evidence of either quartz or gold. The Central shoot likewise was found to have little vertical extension. It was followed down from the surface to the fourth level with a remarkable persistency in grade, width, and horizontal length. However, at a point about 50 feet below the 4th level, at a depth of 590 feet, the vein began to decrease in width and value rapidly, and at the 5th level the structure was found to be weak and all but unrecognizable. It was found to have a maximum horizontal length of 35 feet on the 275 foot level, an average width of about 11 inches and an average grade of 0.95 ounces gold per ton. Both the West and Central shoots occur along relatively straight portions of the No. 6 vein. The East shoot, on the contrary, occurs where the vein forms a minor anticlinal fold, the north limb of which possesses a length of 100 feet and the south limb a length of up to 40 feet (MacDonald 1940). It was found to have a width of from 8 to 22 inches, and it yielded 6,524 tons of ore having a recovered grade of 0.63 ounces of gold per ton up to May 11, 1940 (MacDonald 1940).

Structural Controls: Development work at the Springer mine indicated a decrease with depth in both the aggregate horizontal ore length and the grade. Examination of assay plans shows that the better widths and values occur where the vein is most highly contorted, which is to be expected because a sinuous vein is more susceptible to fracturing than a straight one. The decrease in grade and tonnage on successively lower horizons, therefore, can be attributed to the fact that with depth the major "fold" in the vein decreased in intensity and all but died out before the bottom level was reached. A second factor which may have exerted some control over the distribution of the gold is that at its eastern extremity the vein cuts, but dies out within, a northwesterly trending dike of syenite porphyry.

Mineralization: Inasmuch as the Springer mine was closed and flooded at the time of the writer's examination of the area, only samples from the dump could be collected, and no serious study of the mineralization has been attempted. However, this subject has been treated by Thomson (1938a, p.49), and the reader is referred to his report. Suffice it to mention here that the vein material consists of white quartz, with some tourmaline, chlorite and carbonate and subordinate pyrite, pyrrhotite and arsenopyrite. Gold occurs, sometimes in spectacular amounts, in fractures in the quartz along ribbons of chlorite and tourmaline and in fractures in pyrite and arsenopyrite. Its distribution is erratic.

The No. 5 or Hook Vein

The No. 5 or Hook vein lies in greenstone about 1,000 feet northwest of the shaft. It is the strongest of the several veins found on the property, averaging over 3 feet in width throughout an exposed length of 470 feet. However, like the other veins, it is contorted in places and variable in thickness. Throughout the greater part of its length it strikes a few degrees west of north and dips 62°E., but at its north end it curves sharply to the west and at its south end sharply to the east, so that in a general way it superficially resembles an open "Z"-shaped flexure. In general appearance and composition the Hook vein does not differ greatly from the No. 6 described above. Values are generally low, the best assays being obtained from samples cut from the north-south section of the vein within 70 feet from the sharp westerly bend. Four diamond drill holes have been bored to intersect this vein at its south end, but these served to confirm the surface sampling in indicating only a low gold content.

Quartz-Sulphide Deposit, Claim Pa.627

Diamond drilling in 1949 from the surface of claim Pa.627 disclosed the presence of a small body of quartz-sulphide mineralization, in fractured iron formation in the trough of a minor drag fold at or near the nose of the regional Pickle Crow syncline. This deposit was found to be similar to the ore at the No. 1 Operation in that here, as at the No. 1 mine, quartz veinlets, auriferous sulphides (pyrrhotite, arsenopyrite, and pyrite), and some chlorite occur along fractures that strike normal and obliquely to the bedding of the rock. According to the management, drilling indicated, at a depth of 90 feet, 120 tons of ore per vertical foot averaging 0.361 ounces per ton over a width of 8.0 feet (D.B. Angus, personal communication). Originally it was thought that this body was a northwest-trending structure dipping steeply northeast, and when drilling near its south extremity indicated a flattening and decrease in grade with depth, work was suspended. Later re-investigation of plans and sections, however, indicated that the deposit was a saddle-shaped body in the trough of a syncline and plunged northeast, and that the flattening of the dip was only an apparent one because of intersection in the drill holes of the mineralized zone along the south limb of this fold beyond the limit of the "ore" section. Further drilling in 1951 corroborated this interpretation and showed the deposit to plunge 65°E., and its bisecting plane to dip about 75°N. But again the drill intersections were disappointing, and once more work on the deposit has been suspended.

Production and Operating Statistics

Table 9 (back pocket) gives production and operating data for the life of the Springer mine. This table was prepared for the writer by J.T. Ward, mine office manager, Central Patricia Gold Mines Limited.

CONNELL SOUTH GROUP

The Connell South Group is located along the east side of the boundary between Ponsford and Connell Townships and south of the Dona Patricia Gold Mines Limited property. Originally it was made up to 21 claims (Pa.2854-2874, inclusive). In 1938, 14 exploratory diamond drill holes aggregating 2,561 feet, were bored on these claims for assessment purposes. This drilling proved unsuccessful in locating any significant mineralization and operations were suspended. However, in June 1945, J. Masakayash found gold in a band of iron formation exposed north of but trending across the south boundary of the claim group. Diamond drilling under the direction of L.K. Lytle was started in October, and by the end of November four holes, totalling 415 feet, were bored along the strike of the showing. Despite the fact that surface samples assayed as high as 0.40 ounces of gold per ton over 12 inches and 0.23 ounces over 23 inches, the drill intersections were found to contain only traces of precious metal.

As drilling operations were being carried out to test the Makayash showing, D.Wright located a gold-bearing quartz vein to the west of the claim group, on ground now held by Attawapiscat Mining Syndicate. A specimen from this vein, brought to the Central Patricia mine by Wright, was found to assay 0.41 ounces per ton (Lytle 1945). Subsequent examination of the vein showed that as a whole it is located on the property and occurs in either the lavas or the iron formation. In the case of the lavas, carbonatized zones contain considerable quartz as short irregular stringers and lenses with a little pyrrhotite and pyrite; in the case of the iron formation, veinlets of quartz and carbonate with associated pyrrhotite, pyrite, and chlorite occupy fractures, in much the same way as the Central Patricia Gold Mines Limited No. 1 Operation. But gold, as pointed out previously, appears to be scarce in both types of occurrence tested (Johnston 1941).

NORTHEAST GROUP

The Northeast group of Central Patricia Gold Mines Limited, adjoins the Cohen-MacArthur group to the west and the Albany group to the south in the northeast part of the map-area. It is readily accessible from the Crow River, which flows eastward, through the northern part of the property, and by way of the old Albany tote road, which runs south from the river along the west boundary of the claims to the Albany mine.

In the early days of the camp a limited amount of trenching was done on the property. These trenches were cleaned out and the showings were sampled in 1941, after which 11 diamond drill holes, aggregating 8,049 feet, were bored from the surface of claims Pa.641 and 645. But this work was unsuccessful in locating any economic concentrations of gold, and both the surface showings and drill intersections indicated the presence of only traces of precious metal. No further work has been reported.

The property is underlain by fine-grained, light to dark green and greenish grey lavas, all more or less schistose in character, with a few apparently discontinuous bands of cherty iron formation, tuff, and graphitic schist. Intrusive igneous rocks indicated by the drilling are sheared quartz albite porphyry and biotite lamprophyre. Of these, the sheared quartz albite porphyry is the more important, for the large lenticular body in which the Pickle Crow No. 2 vein system was discovered extends northeastward onto the southern portion of claim Pa.641. However, the only mineralization has a very low grade, but at the same time attention was drawn to the fact that the iron formation band at the Makayash showing extended southeastward across the Connell South Group into a portion of Wright's ground. In May, 1946, Central Patricia Gold Mines Limited purchased claims Pa.6891 and 6897-6899 inclusive, from Wright. Four drill holes, aggregating 322 feet, were bored in the northeast corner of claim Pa.6891 to complete assessment work requirements in 1948. These holes all intersected highly schistose, fine-grained greenstone with occasional quartz-carbonate stringers, but assays of core samples indicated only traces of gold. No further work has been reported.

NORTH MUSKEG GROUP

The North Muskeg Group of Central Patricia Gold Mines Limited consists of 36 claims located north of the Main Group, along and west of the boundary between Connell and Ponsford Townships in the northwest portions of the map-area. With the exception of claims Pa.2,449-2,455, it was staked in October and November, 1945. Late in the following year and during the first three months of 1947, a magnetometer survey was made of the property under the direction of L.K. Lytle, with readings taken at 100-foot intervals along north-south picket lines spaced 600 feet apart. This survey indicated three linear magnetic anomalies to strike northeastward across the property, one extending along a band of sediments from claim Pa.2,191 on the west to claim Pa.2,453 on the east, the second and third along roughly parallel zones about 3,000 feet and 4,000 feet to north of the first, respectively. No further work was done at this time, however, and the unpatented claims were allowed to lapse in 1948. Subsequently the possibility was realized that the ore fractures at the Central Patricia mine to the south may have been caused by faulting of a large diabase dike outcropping to the east of the workings, at a point where the dike crosses the Crow River.

It was noted that the ore bodies occurred entirely within the right-angled projection of the "gap" between the two segments of the dike, and on the assumption that similar conditions might exist farther north, the decision was made to trace out the extension of the dike with the aid of a magnetometer. A similar sharp bend or "gap", known as the first "gap", was located on claims Pa.2,453 and 2,454. The area to the west was surveyed with the magnetometer, with readings taken at 50- to 100- foot intervals along picket lines cut 200 feet apart. Subsequent drilling of the anomalies disclosed indicated bands of mineralized iron formation similar to that at the mine. Following this work, although no ore sections were outlined, the North Muskeg claims (Figure 6) were re-staked along and west of the projected northward strike of the dike. In 1949 the magnetometer survey was continued, first to delineate the diabase dike, and then, when two sharp bends or "gaps" were located, to locate any anomalies to the west of the dike in the general vicinities of these "gaps". Subsequent drilling to test the anomalies, however, only showed bodies of metagabbro. Between June, 1949, and March, 1950, 21 diamond drill holes, aggregating 11,935 feet, were bored without success. Work on the claims has been discontinued.

Due to the scarcity of outcrops the geology of the North Muskeg Group, particularly its northern portion, is imperfectly known. The principal rock types are Keewatin lavas, which as shown by the geophysical surveys, strike northeasterly across the property. Interbanded with them in the southern part of the property are narrow, discontinuous horizons of iron formation and wide, persistent ones made up of interbedded greywacke, quartzite, and graphitic schist. Laminated tuff is also abundant at least in so far as diamond drilling has indicated. In most cases the tuffs have been logged as greywackes, but the high content of chlorite, fine lamination, and fragmental character of these rocks suggests that they are more properly referred to as pyroclastic rather than strictly hydroclastic sediments. They bear no resemblance to the relatively coarsely bedded, greyish green greywackes which outcrop near the Pickle Crow No. 1 shaft.

The Keewatin complex has been intruded by diorite or gabbro quartz porphyry, and quartz diabase. It is not certain what proportions of the dioritic rocks are intrusive, and what proportions are extrusive. In the sourthern part of the property, a body of diorite strikes north-northwest across a wide band of sediments, and obviously is intrusive. But in the northern part, where it apparently gave rise to the geophysical anomalies in or near the projections of the "gaps", it occurs in bodies that follow the trend of the regional structure. Here they form the coarser, interior parts of flows. The quartz porphyry occurs as narrow dikes or sills that tend to reflect the attitude of the flows much like some of the diorite masses. It is most abundant in the southern part of the property, but also was found in some of the diamond drill holes near the second and third "gaps." These bodies, however, are too small to be shown on the accompanying plan. The youngest rock exposed on the property, is the quartz diabase forming the large dike that strikes north-northwest across the folded structures.

ROEANOR WEST GROUP

The Roeanor Group of Central Patricia Gold Mines Limited was formerly held by Roeanor Gold Mines Limited. It consists of 10 claims (Pa.5447-5454 and 5453A) located west of the Central Patricia-Dog Hole Bay highway in Ponsford Township in the extreme southwest corner of the map-area. These were explored by trenching and diamond drilling during the years 1936 and 1937, and a geophysical survey of the more easterly claims was made by Hans Lundberg, Limited. Although 17 drill holes, aggregating about 6,300 feet in length, were put down along the more favourable zones, the results were not encouraging. Work on the property was discontinued in the summer of 1937 and eventually the claims were allowed to lapse. In August, 1940, they were staked for Central Patricia Gold Mines Limited. Between April and May 6, 1941, two drill holes, one 660 feet and the other 440 feet in length, were bored from the surface of claims Pa.5447 and Pa.5454 respectively for assessment work. Neither hole intersected anything of value. In 1944, to complete the work necessary to patent the claims, two further holes were drilled. One of them, collared on claim Pa.5448, was completed to a length of 451 feet; the other, located on claim Pa. 5450, to a length of 458 feet. But again nothing of commercial significance was disclosed, and although the claims were subsequently patented, no further work has been reported.

The general geology of the property has been described by Thomson (1938a) and the reader is referred to his report for further information.

ACKNOWLEDGMENTS

The writer is deeply indebted to Mr. F.M. Connell, president and Mr. D.B. Angus, mine manager, for their complete co-operation with the present investigation. No maps, reports, or company files were withheld, and every request was granted. Much credit for this report is also due to Mr. T.T.Tigert, assistant manager, amd Mr. E.W.M.Cokayne, chief engineer, who assisted the writer on several occasions and supplied much valuable information not recorded in company reports and on maps. The writer is also grateful to Mr. J.T.Ward, mine office manager, for aiding in the preparation of the tables of production statistics for the No. 1 and No. 2 Operations.

CROWSHORE PATRICIA GOLD MINES LIMITED

Introduction

Crowshore Patricia Gold Mines Limited holds a group of 8 patented and 27 unpatented claims in the area. They are located on either side of the Crow River northeast of and adjoining the Albany River property, and are serviced by a good motor road and hydro-electric power. Their numbers are as follows: Pa.2157-2163 and 2586, acquired from Crowshore Gold Mines Limited, at incorporation in May, 1944; and Pa.5458-5459, 5927-5834, 5915-5918, 6038-6043, 6126-6129, and 6614-6616 inclusive, acquired in November, 1946. Claims Pa.5831-5834 and 6128-6129 were formerly held by Canadian Patricia Gold Mines Limited (Thomson 1938a, p.35-36).

History and Development

Crowshore Gold Mines Limited, was organized in October, 1936 to finance prospecting and development work on a group of 7 claims located along the strike of the ore zone discovered on the Albany River ground. Surface exploration under the direction of D.A. Mutch, consulting engineer, and J.F. Sutherland, mine superintendent, was carried out during the field season of 1937. Two zones of iron formation bands with scattered quartz-sulphide mineralization were located near the southwest boundary of the property, and in that and the following year these were tested by diamond drilling. Both the "A" zone, which was traced for about 400 feet across claim Pa.2,161, and the "B" zone, tested for a length of approximately 3,500 feet across claims Pa.2161, 2162, and 2163, were found to contain encouraging gold values.

With incorporation of the present company in May, 1944, a new surface program under the direction of O.D. Salkeld was initiated, and within a few months several sheared zones, containing auriferous quartz veins and stringers, were located in various parts of the property. The most significant of these is the "C" zone, which lies 250 feet to the north of and parallels the "B" zone near the Albany-Crowshore boundary. According to the management channel sampling here indicated a possible ore shoot, 150 feet in length, averaging $10.50 in gold per ton (Gold at $35.00 per ounce) across a mean width of 40 inches. Good values were also found at intervals along an additional length of 300 feet to the east of this shoot, and after drilling also gave encouraging results, the management decided to proceed with underground work. The sinking of a three-compartment shaft commenced in October,1945, and by the following year it had been advanced to a vertical depth of 575 feet. Crosscuts to the three zones were completed on the 550-foot level by the spring of 1947. A total of 1,710 feet of crosscutting and 5,387 feet of underground drilling was done, but no commercial ore was outlined and June, 1947, all underground operations were suspended. Little additional work on the property has been reported.

General Geology

The Crowshore Patricia Gold Mines Limited property is underlain largely by greenstone flows and interbanded iron formation of the Keewatin series, which has here been intruded by masses of hornblende diorite and feldspar porphyry and by dikes of fine-grained diabase. The predominant rock is dark green, fine-grained greenstone. It is generally somewhat massive in character within individual flows, but locally it has been sheared along east-west or northeast-southwest zones to chlorite schist, and in a few places well-developed pillows, suggesting tops to the north, are evident. Tuffs and agglomerates have been recognized in outcrops. On claim Pa. 2,157 and 2,158, however, exposures of flow breccia, consisting of rounded fragments of lava, up to 5 inches in diameter, in a fine-grained groundmass of similar composition, have been located. Interbanded with the greenstones along the south boundaries of claims Pa.2,162 and 2,163 is a zone, up to about 200 feet in horizontal width, of more acid flows of pale grey colour. Dioritic greenstone has been located by diamond drilling north of and more or less parallel to this zone.

The most important rock exposed on the property is banded iron formation. It occurs in four different horizons, referred to as the south, "A", "B", and north zones. The south band, the lowest stratigraphically, strikes N.55°E., across the south part of claim Pa. 2,159 and dips 75°N. It has been traced for about 400 feet, possesses an average thickness of about 4 feet, and is characterized by a high content of magnetite. Quartz veins and stringers, up to a foot in width, occur in a body of schistose greenstone localized along its northwest contact. The "A" zone iron formation underlies the west part of claim Pa. 2,161, where diamond drilling and underground development indicated several narrow, discontinuous and highly contorted bands in schistose greenstone striking N. 30°E., and dipping steeply northwest. The "B" zone iron formation, on the contrary, consists of parallel, highly persistent bands up to 30 feet in width that have been traced, by diamond drilling and geophysical work, from the Albany-Crowshore boundary in a direction of N.48°E., for a length of approximately 3,500 feet. This zone is believed to be continuous with the horizon of iron formation crossing the Albany claims and extending southwestward to the vicinity of the Howell vein on the Pickle Crow Main Group. The north zone of iron formation bands strikes N. 40°E., across claims

Pa.6614-6615, 6042, and 6127, and continues northeastward across the adjoining Bankur Patricia ground.

As mentioned above, the only intrusive rocks found on the property are metagabbro, feldspar porphyry, and diabase. The first is exposed at the west end of a large outcrop area north of claim Pa.6040, where mapping suggests it occurs as a narrow dike of northwesterly strike. Its contacts with the enclosing lavas have not been observed, however, so that it may be merely a coarse-grained phase of the greenstones in that area. The most striking rock on the property is feldspar porphyry ("leopard rock"), which was cut in the shaft at a depth of 480 feet and found by underground mapping to represent "the apex of what is probably a large intrusive body at depth (Waisberg 1947,p.4). It consists of phenocrysts, up to 2 inches in length, of highly altered plagioclase in a fine-grained, dark green matrix of feldspar, amphibole, chlorite, sericite, and accessory magnetite. It may be termed a meta-gabbro porphyry. Believed to be the youngest of the three intrusive rocks is a narrow dike which strikes N.10^{o}W., for 150 feet across claim Pa.6040. This dike, according to Waisberg (1947, p.5) corresponds to the diabase dikes of the area in composition, and hence may be of Keweenawan age.

Structural Geology

Except for minor contortions, the lava flows and the iron formation strike uniformly across the claim group. They occur along the flanks of the Pickle Crow syncline, the axial plane of which extends in a northeasterly direction through the property. The location of this plane has not been determined, for although drag folds in the north and south zones of iron formation bands suggest that it lies somewhere between, these zones are about 3,000 feet apart, and no reliable determinations within the area which they enclose have been made (Figure 7). It is of interest to note, however, that pillow structures in the vicinity of the shaft suggest tops to the north, so that the axial plane lies farther north than the "A" and "B" zones. It may, as suggested by Waisberg (1947,p.5) occur a short distance northwest of the Crow River.

Several zones of intense shearing have been mapped on the property. The most significant of these is that which is represented by the highly schistose greenstone interbanded with iron formation of the "A" zone. This zone as a whole strikes about N.30^{o}E., and dips steeply northwest, but underground mapping has indicated that within it the shear planes occur in sets which show slight divergencies in strike and dip, and tend to truncate one another, thus suggesting more than one period of movement. Slickensides along the individual shear planes indicate that these adjustments, or at least the latest ones, were predominantly vertical (Waisberg 1947,p.5). A second zone of intense shearing, narrower but perhaps more persistent than the first, occurs in the flows associated with, and parallels in both strike and dip, the "B" zone iron formation. The movements along it effected the development in the iron formation of transverse fractures, now filled with quartz, dipping northeast at about 60 degrees. Other sheared zones of general easterly or northeasterly strike have been discovered in various sections of the property, and along them gold-bearing quartz veins have been localized. Of these, the most important are those of the "C" zone south of the shaft, the "D" zone near the north boundaries of claims Pa.2,157 and 2,158, the "E" zone near the west boundary of claim Pa.2,586, and the "G" zone in the south portion of claim Pa.2,159.

Zones of Mineralization

"A" Zone

The "A" zone, as discussed previously, consists of narrow, discontinuous bands of iron formation in schistose greenstone in the west part of claim Pa. 2,161. The gold values appear to line up with two of these bands and occur in either the iron formation itself, where they are associated with quartz stringers filling transverse fractures, or in adjacent portions of schist that has been mineralized with pyrite, and pyrrhotite. The gold is erratically distributed, and whereas core samples according to the management have assayed up to $25.90 per ton over 1.5 feet (gold at $35.00 per ounce), the richer intersections are separated by much low grade or even barren material so that the value of the zone as a whole is low.

"B" Zone

The "B" Zone is the strongest and most persistent structure found on the property. It has been tested for a length of 2,400 feet by diamond drill holes, and found to contain gold values over the narrow widths as indicated in the accompanying table. The character of the zone has been described by Waisberg (1947,p.6), as follows:

> Underground the "B" zone was intersected by a crosscut, and was tested by drilling over a length of 1,200 feet. Seven drill holes cut the zone. Low gold values were obtained in all the holes. These were in the order of 70 cents to $1.40 for widths up to 5 feet. The most easterly intersection gave a value of $5.60 for 1 foot and several tiny specks of visible gold were observed in narrow quartz stringers in the iron formation here.
>
> The iron formation on the 550-foot level is in three parallel bands about 10 feet wide separated by sheared greenstone for a total width of about 70 feet. The iron formation itself consists of dark and light bands up to six inches wide. The (iron formation illustrated by the photograph on page 12

TABLE NO.10

Results of Surface Drilling on the "B" Zone of Crowshore Patricia Gold Mines, Limited[1]

1. Table prepared by writer from data recorded on company assay plans.

Diamond Drill Hole Number	Location	Dip at the Collar	Core length	Assay Value (Gold at $35. per ounce)
2		45°	5.3 feet	$3.22
8	230 feet N.E. #2	45°	5.7 feet	0.76
7	80 feet N.E. #8	45°	1.9 feet	1.40
6	150 feet N.E. #7	45°	4.2 feet	1.92
3	200 feet N.E. #6	45°	3.0 feet	1.17
5	100 feet N.E. #3	45°	4.2 feet	4.59
4	200 feet N.E. #5	45°	--------	nil
15	300 feet N.E. #4	40°	2.8 feet	4.00
16	250 feet N.E. #15	40°	1.8 feet	Tr.
17	250 feet N.E. #16	40°	3.2 feet	7.83
18	200 feet N.E. #17	40°	3.3 feet	Tr.
19	200 feet N.E. #18	40°	4.1 feet	4.06
20	200 feet N.E. #19	50°	1.8 feet	0.35

of Volume XLVll, part lll, of the Ontario Department of Mines), is very similar to the iron formation of the "B" zone as seen at the 550-foot level.

The iron formation has been fractured and small quartz... veins (of gash-like character) up to four inches thick cut across the formation and dip about 60 degrees to the northeast. Considerable pyrrhotite mineralization occurs in the iron formation ..... and while some is associated with the quartz much of it merely replaces the host rock and exhibits little relationship to fractures. The fracturing observed is suggestive of that which... (occurs) at the Central Patricia (No.1 Operation), and is probably the results of the shearing which has taken place along the bands, producing tensional cracks in the iron formation as described by Thomson for the Central Patricia occurrence.

The gold values encountered by surface drilling suggest the possible existence of ore shoots of limited extent in the "B" zone. It was not advisable to try to explore the "B" zone area for its full length underground, and much of the area has indicated gold values is thus still unexplored.

"C" Zone

The "C" zone was located in the summer of 1934 near the southwest boundary of the property approximately 250 feet north of and parallel to the "B" zone, and was explored by trenching and stripping for a length of 900 feet. The results of channel sampling recorded in Table No. 11, suggested the occurrence of a possible ore shoot about 150 feet in length near the west end of the zone; and after diamond drilling during 1935 had indicated the values to persist with depth, the management decided to proceed with

TABLE NO. 11

Results of Surface Sampling of the "C" Zone,

Crowshore Patricia Gold Mines,[1]

Limited

1. Table prepared by writer from data recorded in issues of The Northern Miner, dated Aug. 24 and Sept. 28, 1944.

Sample	Approximate Length Represented by the Sample	Width	Ounces of Gold Per Ton
1	10 feet	24 inches	1.28
2	10 feet	36 inches	0.37
3	10 feet	48 inches	0.75
4	10 feet	120 inches	0.33
5	10 feet	132 inches	0.04
6	10 feet	84 inches	0.03
7	10 feet	Not recorded	Trace
8	10 feet	24 inches	2.03
9	10 feet	48 inches	0.02
10	10 feet	30 inches	0.84
11	10 feet	36 inches	0.74
12	10 feet	30 inches	0.84
13	10 feet	36 inches	0.41
14	10 feet	36 inches	0.18
15	10 feet	36 inches	2.93

underground development. According to Waisberg (1947, p.7) however, the "C" zone on the 525-foot level, while containing narrow quartz stringers and some pyrite, was found to be of low grade where intersected in the crosscut.

The "C" zone consists of highly contorted quartz veins and stringers, up to 2 feet in width, localized along a sheared zone cutting pillowed but otherwise massive, fine-grained greenstone. This sheared zone possesses an average width on the surface of about 7 feet, but like the quartz veins within it, it is somewhat lenticular in form and varies in widths from 3 feet to a maximum of 27 feet at one point near its western extremity. Other than quartz, there is very little mineralization present, but in a few places the veins exhibit scattered grains and threads of pyrite, pyrrhotite, and chalcopyrite, and, along ribbon structures, a little carbonate and tourmaline. Visible gold has been observed in the trenches in one or two places, and is reported in logs of diamond drill holes.

<u>"B" Zone Hanging Wall Vein System</u>

One hundred feet north of the "B" zone on the 550-foot level, a strong sheared zone in greenstone was found to contain short, irregular lenses of quartz across narrow widths.

Sampling of this zone indicated values up to 0.14 ounces of gold per ton across a width of 1 foot (Waisberg 1947, p.7). According to Waisberg, this zone was also cut in three diamond drill holes, but these also indicated a low gold content, the best intersection averaging 0.11 ounces per ton across 1.5 feet.

"D" Zone

The "D" zone is located along the boundary between claims Pa. 2,157 and Pa. 2,162, about 400 feet south of the "B" zone. It is represented by a horizon of schistose greenstone containing veins stringers, and irregular lenses of quartz up to 10 feet in thickness. It has been traced on the surface for about 300 feet in a direction of N.50^{o}E., and has been found to dip about 75^{o}N.

Seven hundred and fifty feet northeast of the exposure, a second sheared zone, of similar character and in line with the first, has been picked up in outcrops. This zone has also been traced for about 300 feet, so that if the two are continuous beneath the intervening drift cover, a total length of about 1,400 feet is indicated. The "D" zone and its possible northeast extension have been found to contain only low values in gold.

"E" Zone

The "E" zone, located in greenstones outcropping in the west part of claim Pa. 2,586 northwest of the shaft, has been traced for a length of 350 feet and across widths up to 30 feet. It is similar to the "D" zone in character, and, like the latter, is of low overall grade.

"G" Zone

The "G" zone was discovered in the fall of 1944 in the south part of claim Pa.2,159. It consists of sheared and brecciated iron formation with quartz veins and stringers across a width of about 200 feet. The gold content is said to be low.

Acknowledgments

The writer is indebted to Mr. W.J. Anderson, president of the company, for permission to examine all plans, sections, and diamond drill logs necessary for the preparation of this report.

Dona Patricia Gold Mines Limited

Dona Patricia Gold Mines Limited, was incorporated in September, 1936, to undertake development work on a group of 18 claims south of the Main Group of Central Patricia Gold Mines Limited in the west part of the area. In 1936, surface trenching resulted in the discovery of a gold-bearing quartz vein on claim Pa. 2493, and a few short diamond drill holes were put down to test it. The results were not encouraging, however, and work was soon discontinued. Further surface work and diamond drilling was carried out between 1943 and the early part of 1946, but again without finding anything of commercial interest. No further work has been reported.

The geology and the exposed mineral deposits have been described by Thomson (1938a, p.51).

GATEWAY PATRICIA GOLD MINES LIMITED

Gateway Patricia Gold Mines Limited, was organized in March, 1936, to finance development work on a group of 38 claims adjoining the Central Patricia Main Group to the east. Early geological mapping on the claims showed that a very large part of the property was covered by a heavy mantle of glacial deposits, and a geophysical survey, under the direction of Hans Lundberg, Limited, was initiated in August, 1936. The results of this survey indicated 5 zones of major electrical conductivity. Subsequently, 44 diamond drill holes, aggregating about 17,000 feet in length, were bored to test these zones and to complete a north-south section along the east boundary of the property. This work indicated some sulphide mineralization in siliceous sediments underlying the north part of the claim group. But although these were found to contain gold, assay returns indicated only low or erratic values. Work on the property was discontinued in 1939.

The Gateway claims are underlain chiefly by Keewatin greenstones with intercalated bands of fine-grained sediments consisting of quartzite, greywacke, and graphitic schist. Sericite schist, intersected in drill holes along the east boundary of the property, has been traced to the vicinity of the Central Patricia Gold Mines Limited No. 1 shaft where it appears to be a highly altered quartz albite porphyry and aplite. Bands of iron formation have not been located.

KAW-CROW PATRICIA GOLD MINES LIMITED

Kaw-Crow Patricia Gold Mines Limited, was incorporated in January, 1936, to take over the Kawinogan Gold Limited, a group of 57 claims located east of the Winoga group and south of the Albany River and Crowshore properties. Subsequently additional ground was acquired, and in 1937 the Kaw-Crow property comprised 67 surveyed claims. A geophysical survey was made of the western part of this large property in 1936 by Hans Lundberg, Limited, and the anomalies indicated were tested by diamond drilling. However, this work did not reveal anything of interest, and the company's attention was directed to a program of surface trenching and diamond drilling across the strike of the formations in order to complete a continuous section from outcrop to outcrop. From the start of operations until drilling was suspended in the winter of 1937, a total of 47 diamond drill holes aggregating 21,635 feet in length, were drilled without locating anything of commercial significance (Thomson, 1938a, p.52). Further surface work was done in 1938, but again without success. Subsequently all the claims, with the exception of the 10 presently retained, were allowed to lapse.

The geology of the original property has been described by Thomson (1938a).

PICKLE CROW MINES LIMITED

Pickle Crow Gold Mines Limited started gold production in April 1935, when a mill with a rated capacity of 125 tons per day was brought into operation. The ore presently is being mined from two quartz vein systems, known as the Howell and the No. 2 from which, up until December 31, 1951, the company reports a total recovery of 860,748,312 ounces of gold and 105,635.86 ounces of silver, having a gross value of $31,726,254. The average grade of the ore mined was 0.465 ounces of gold and 0.057 ounces of silver per ton.

In the Crow River area the company holds four properties which include 97 patented claims. These properties, as shown on the generalized geological map of the area, are referred to as the Main Group, including the No. 1 and No.2 mine operations, the Albany River Group, the Cohen-MacArthur Group, and the Winoga Group. The history and development, general and structural geology, and mineral deposits of each are described separately in the following pages in the order given.

MAIN PROPERTY

The Main Group is located north of the Central Patricia claims and east of the Waltricia property, mainly in the east part of the map-area. From east to west it extends for a total distance of about 4 miles, and from north to south, up to approximately 1.9 miles. For the most part it is underlain by Keewatin lavas with interbanded horizons of tuff, agglomerate, and iron formation. These formations make up a complex which has been intruded in turn by sill-like masses of metagabbro and quartz albite porphyry, and dikes of massive syenite porphyry, quartz diorite porphyry, and biotite lamprophyre. The principal structural features are the Pickle Crow syncline and a complementary anticline to the north, both of which plunge at about 65^{o} in a direction of N. 45^{o}E., to N. 60^{o}E. These folds have been dislocated by transverse faults of small magnitude and possibly by major strike faults, of which the Pickle Crow sheared zone is the most extensively developed.

Both the No. 1 (Howell) and No. 2 vein systems were discovered on the Main property, the former by prospecting work on claim Pa. 747, the latter by diamond drilling from the surface of claim Pa.744. The Howell vein lies entirely within the Main property, but the No. 2 system, due to its dip and rake, extends into claim Pa. 2071 of the Cohen-MacArthur

Group and claim Pa.2062 of the Winoga Group. In addition, other deposits of commercial significance have been found. They are: (1) the 2403 W. Drift zone, a body of auriferous sulphides in highly crenulated iron formation located about 300 feet north of the No. 1 shaft on the 2,450-foot level; and (2) the No. 5 quartz vein, discovered by drilling 1,700 feet southwest of the No. 1 shaft. Underground development of these two deposits has begun and mining operations should commence in the near future. Other occurrences, as yet not shown to be of economic importance but which merit mention in this report, include the No. 3, No. 4, Big Dome, Riopelle, and Lake Shore.

NO. I OPERATION

History and Development

The claims which formed the nucleus of the company's holdings in the area were staked for Northern Aerial Minerals Exploration Limited (N.A.M.E.) in 1928 by H.H. Howell and J. McFarlane. These claims made up two groups, on the eastern one of which several promising gold discoveries were quickly made. The most significant find was the Howell vein, and in 1929 this structure was opened up by trenching and tested by diamond drilling. A possible ore body, 420 feet in length and estimated by the management to average $8.78 in gold per ton over widths up to 10.8 feet (Hurst 1930; p.32) was indicated. Pending adequate financing work at the property had to be suspended and it was not until 1933 that a steam-powered mining plant was installed and underground operations got under way. In September of that year, the sinking of a 3-compartment shaft was started, and within a few months the ensuing development work outlined an ore body larger and of much better grade than the surface work in 1929 had suggested.

Pickle Crow Gold Mines Limited was incorporated in 1934 to take over the property from N.A.M.E.'s successor, Northern Aerial Canada Golds Limited, and to undertake the construction of a suitable mill to treat the ore. Erection of a 125-ton mill was completed in April 1935. Later in the year the mill's capacity was increased to 150 tons per day; the following year it was stepped up to 200 tons per day; in 1937 it was raised to 400 tons per day. This increase in capacity was accompanied by further development of the vein on successively lower levels and the No. 1 shaft has been deepened to 2,950 feet, with 16 levels established at vertical depths of 125, 250, 375, 500, 625, 750, 900, 1050, 1200, 1350, 1500, 1650, 2200, and 2450 feet below the collar. There has been a gradual decrease in grade with depth below the 1050-foot horizon, but the management is of the opinion that the Howell vein will yet yield at least three more levels of ore.

General Geology

In the vicinity of the No. 1 shaft the principal rock formations are Keewatin lavas which, although highly altered, are believed to have been mainly of basaltic composition. Most of them have been highly sheared, and any original structures have been obliterated to a large extent. Vestiges of pillow structures are locally evident, however, and at several places in the underground workings flow breccias, indicating tops to the north, have been recognized. They are generally dark grey, dark green, and greenish black in colour, are very fine-grained, and consist of varying proportions of chlorite, uralitic amphibole, sericite, plagioclase, quartz, epidote, carbonate, and leucoxene. A few flows are coarser grained and resemble the metagabbros in appearance; others are buff-coloured due to the presence of considerable carbonate. All strike northeast across the property and dip to the north at angles of 75^{o} or more.

The most important rock from the geological point of view is iron formation, which occurs as several bands up to about 100 feet in thickness in the volcanic sequence, and provides horizon markers invaluable to any study of the folded structures. Two of the bands are exposed in the workings. The northern one, which is cut by the Howell vein, is highly lenticular in form, and pinches out only to reappear several times along its strike. It has been traced southwestward from the Albany property to near the No. 1 shaft. The other band of iron formation is thicker and more continuous, and has been traced for about 5,000 feet from a point 1,450 feet north of the shaft at the Springer mine northeastward to but not beyond the Howell vein, where it also appears to pinch out. Unlike the other it is more highly crenulated and forms a large "Z"-shaped drag fold of northeasterly pitch a short distance southwest of the ore body. However, it is very similar in character, and both consist of beds and laminae, up to 2 inches in thickness, of pale grey cherty quartz alternating with others composed largely of one or both of siderite and magnetite. In many places thin strips of volcanic or sedimentary material, now essentially chlorite in composition, are also present, so that the rock is a beautifully banded one with alternating layers of various shades of green, grey, buff, and black. This rock shows no change in character with depth and hence differs noticeably from that at the No. 1 Operation of Central Patricia Gold Mines Limited where the content of magnetite was found to increase markedly in the lower levels.

Aside from a narrow dike of albite porphyry striking N. 10° - 27°W., through the flows about 1,450 feet southwest of the No. 1 shaft, the only intrusives of any significance in the vicinity of the Howell vein are dikes of basic composition. These dikes are both pre-ore and post-ore in age. One of them, a pre-vein dike up to 15 feet but averaging only about 2 or 3 feet in thickness, occur along the hanging wall of and in contact with the Howell vein throughout much of its length. It is highly contorted in plan, and the suggestion arises that it was formed during Keewatin time and was folded with the enclosing lavas. But this is not necessarily the case, for there is no reason why the dike could not have been emplaced toward the closing stages of the regional deformation during the Algoman period of orogenesis, and hence be of about the same general age as the post-vein dikes. It seems quite possible that after its intrusion its south contact served as a locus of faulting movements, and that, prior to the introduction of the quartz, both the dikes and the vein fault were drag folded by final differential movements between beds and flows. Conversely, in view of the massive character of rock compaired to the schistose nature of some enclosing flows of similar grain and composition, it may be that both the dike and the Howell vein were localized along the same system of folded fractures, the one following the other closely in time.

The "vein" dike is highly altered, which is to be expected in consideration of its position relative to that of the Howell vein, and consists of a fine-grained matted aggregate of chlorite, sericite, magnetite, and secondary quartz (Thomson 1938, p.55). Biotite is also present locally, particularly in the lower levels, and the rock becomes lamprophyric in character. A second dike, much similar in character, is depicted on plans as cutting the Howell vein near the east end of the 1350-foot level (Corking 1943), and hence is post-ore in age (see Figure 9). This rock appears to be somewhat less altered and coarser grained than that forming the "vein dike", and in addition to the constituents making up the latter also contains a little recognizable plagioclase and epidote. A third dike, also post-ore, strikes N.56°W., through the Howell vein west of the shaft and dips to 80° to 90°S.W. It differs from the others in that it is a typical biotite lamprophyre, possibly an altered minette (Hurst 1930, p.12).

Structural Geology

Folding

The principal structural feature in the vicinity of the Howell vein is the large "Z"-shaped synclinal drag fold in the southern of the two overlapping bands of iron formation. This is highly complex in detail, with the iron formation doubling back on itself several times before resuming its normal attitude, and contains innumerable minor contortions which invariably reflect the attitude of their parent. Insofar as underground mapping and diamond drilling have indicated, it pitches in a direction of about N.30°E., at an angle of about 70°, with the axial plane striking N.45°E., and dipping to the north at 80° roughly parallel to that of the major Pickle Crow syncline.

The northern of the two iron bands, although highly crenulated as before, does not appear to exhibit any such large drag fold near the Howell vein. Like the greenstone flows enclosing it, it strikes northeast and dips 75° - 80°N.

Faulting

In addition to the postulated fault passing through the greenstones a few hundred feet north of the shaft, others of relatively minor importance have been observed in the underground workings. The most significant of these is the one of east-west strike along which the vein appears to be localized. Possibly related to it are minor slips which strike in a northeast or north-northeast direction. They are localized, at least in part, along the axial plane foliation of the major folded structures and indicate an adjustment of west side to the northeast.

Other faults are post-ore. They usually strike in a general north-south direction and dip to either the east or the west at angles of 75° or more. Along some of them the movement has been east side north, but none offsets the Howell vein more than 10 feet or causes any difficulty in mining operations. Other post-ore faults strike east-west and dip flatly to the north. The most significant of these cuts the vein in the 1510 stope below the 1350-foot level. This fault was first encountered in the 1301 N. crosscut and again in the 1301 E. drift at a point about 500 feet to the east, and these intersections, together with data from diamond drill holes, indicated a structure with a strike of N.65^{o} - 87^{o}E., and a dip which varies from about 10^{o}N. It is a thrust fault which has caused that segment of the vein above it to be moved to the south a distance of 3 to 5 feet and, as indicated by diamond drilling, a distribution of rock formations suggesting a strike separation of about 20 feet, the north side having moved west (see Figure 9), (Corking 1943).

Jointing

Two prominent sets of joints have been mapped in the underground workings. One set roughly parallels the major fold axis, strikes N.45^{o}-70^{o}E., and dips to the northwest at angles of 35 to 60 degrees; the other strikes N.45^{o}- 65^{o}W., and dips vertically or steeply southwest. Other joints of relatively minor importance strike east-west and dip steeply north, while still others strike north-south and dip either to the east or to the west at angles less than 45 degrees.

The Howell Vein

The most productive of the several quartz ore bodies found in the Crow River area has been the rich Howell vein. This vein has been trenched and tested by diamond drilling on the surface for a total length of 2,900 feet (Monette 1949, p.101) and has been opened up on all levels to the 2,450-foot horizon with no indication of a discontinuation with depth - it is, in consideration of its overall average width of only about 3 feet, a remarkably persistent structure (Figure 8). It occurs throughout much of its length along the south contact of the "vein dike", and like the latter passes indiscriminately through both extrusive igneous rocks and iron formation. For the most part it is enclosed by greenstone flows. But near its central section it is found on each level for a length of approximately 200 feet in part along one or both contacts of, and in part within, the northern of the two overlapping iron bands - a significant feature indeed, for as will be pointed out in a subsequent paragraph the localization of the ore body appears to have controlled in large measure by the presence within the volcanic sequence of this highly competent sedimentary rock.

For descriptive purposes the Howell vein may be considered as being made up of two segments; the one passing through the iron formation and the lower greenstones to the east, the other passing through the upper greenstones to the west. The two segments, are continuous with one another, and natural line of demarcation serves to separate them. They do in a general way, however, exhibit several distinguishing features. The eastern segment is highly contorted in both plan and section (Figure 9), and although an average width of about 3 feet is maintained on all levels, it pinches and swells in short distances, varying in thickness from a few inches in some places to several feet in others. The western segment, on the contrary, possesses a much more uniform attitude, is less lenticular in form, and exhibits on the whole much narrower widths. The eastern segment, despite the many contortions, has an overall strike of N.83°E., cuts across the formations at an angle of 30 to 40 degrees, and possesses an average dip of 73°N.; the western segment has an overall strike of N.58°E., transects the formations at angles of 10 degrees or less, and dips about 75°NW. A further difference is found in the gold contents of the two parts of the vein - in the eastern segment, where the vein maintains its greater width, the values in gold show a gradual decrease outward from the iron formation; in the western segment, where the vein becomes quite narrow, the grade characteristic of the central section persists for some distance beyond that point where the narrow width offsets the gold content sufficiently that the vein no longer makes ore (Monette 1949, p.103).

Very characteristic features of the Howell vein, as mentioned previously, are the numerous contortions most evident in its eastern segment. These contortions vary in size from minor crenulations with limbs merely a few inches apart to structures comparable in size to some of the major drag folds mapped in adjacent iron formation bands. Except for minor variations all the contortions pitch at about 70^{o} in a direction of N. 25^{o} - 30^{o}E., and all are apparently compatible with the Pickle Crow syncline, along the south limb of which they occur. However, as pointed out by Thomson (1938a, p.60), the Howell vein has not been folded as the contortions might persuade one to believe, but rather is localized along structures which reflect to all outward appearances the folded pattern induced during the regional deformation of the rock formations. Thomson believes that the vein follows a sheared zone, formed complimentary to the axial plane foliation of the Pickle Crow syncline, and drag folded by differential movements between beds and flows during the regional deformation.

The No. 1 ore body is a shoot of variation within the Howell vein, its boundaries being determined by the gold content of the quartz to the east and by the width of the vein to the west. In longitudinal section it is a continuous, somewhat lenticular body - stope lengths increase from 1,092 feet on the 125-foot level to a maximum of 1,388 feet on the 750-foot level, but then decreases to a known minimum

TABLE NO.12

ORE DEVELOPMENTS, HOWELL VEIN[1]

Level	Ore Length	Average Width	Oz. Au/Ton[2]
125	1,092 feet	32 inches	0.68
250	1,120 "	25 "	1.12
375	1,306 "	27 "	1.01
500	1,093 "	29 "	0.63
625	1,114 "	34 "	0.69
750	1,388 "	32 "	0.63
900	1,120 "	31 "	0.64
1,050	1,166 "	35 "	0.66
1,200	1,235 "	29 "	0.52
1,350	1,147 "	29 "	0.50
1,500	1,113 "	32 "	0.46
1,650	972 "	40 "	0.41
1,800	1,005 "	36 "	0.37
1,950	831 "	36 "	0.35
2,200	709 "	42 "	0.23
2,450	590 "	36 "	0.20

1. Information from Company's annual reports.
2. Average grade based on results of channel samples.

TABLE NO. 13

ORE DEVELOPMENTS, NO. 2 'VEIN'

Level	400	550	750	850	975	1,100	1225	1475	1600
ORE? LENGTH, FEET	545	854	810	1045	1954	755	360	531	45
AVGE WIDTH, INCHES	34	33	69	48	64	39	30	32	17
OZ. AU per TON [1]	.45	126	.57	.51	.53	.38	.37	.29	.29

1. Avge grade based on results of channel samples.

of 590 feet on the 2,400 foot level. Between the surface and the deepest workings, it has an average strike and dip of N.83^{o}E. and 73^{o}N., respectively, and like both the drag folds in the adjacent formations and the zone near the centre of the ore body where the vein passes through iron formation, rakes at about 70^{o} in a direction of N.25^{o} - 30^{o}E. The highest grade section lies about the 2nd and 3rd levels, where sampling indicated an average value of more than an ounce of gold per ton, but otherwise depth of approximately 1,000 feet. Below this horizon, however, the grade drops, as do the stope lengths, showing a decrease from 0.66 ounces per ton on the 1050-foot level to 0.20 ounces per ton on the 2,450-foot level. It is to be emphasized, of course, that the average values estimated from channel sampling and recorded in the accompanying table cannot be considered as representative of any one small section of the vein along a particular level. Rather, they fluctuate with changes in the strike of the vein, the better grade ore having been found about the noses of the many contortions, and with the width of the dike rock found along the hanging wall of vein, being lower than average where the dike pinches and higher where the dike thickens (Corking 1948, p.375). Where the vein passes through the iron formation values are somewhat lower than where the vein cuts the greenstones. In this case, however, the decrease in grade is more than offset in many places by a marked increase in general stoping width consequent upon the occurrence in the walls of parallel fractures filled with quartz veins and stringers. This feature of the ore body is a significant one, for the average width of that part of the ore shoot in greenstone is only about 3 feet, whereas stopes in the iron formation frequently exceed 10 feet and occasionally 20 feet in width.

Mineralization

The Howell vein consists largely of white or greyish, coarse-grained to fine-grained, almost sugary quartz, a little ankerite, tourmaline, and scheelite, and subordinate amounts of metallic sulphides. The ankerite, tourmaline, and scheelite, although locally occurring as patches completely enclosed by the quartz, generally occur in thin seams replacing chloritized greenstone in book and ribbon structures or in the walls, and so help accentuate the banded character of the vein. The sulphides, as mentioned previously, occur only sparingly in the quartz, and while frequently found as disseminated grains in the altered lavas bordering the vein, the most favourable locus for their development appears to have been in the iron formation close to the main vein and separating it from the parallel stringers. In such an association the wall rock has been highly replaced along both bedding planes and irregular fractures, particularly where laminae rich in siderite are common, and occasionally narrow lenses and bands of even massive sulphides are evident. The principal sulphide appears to be pyrrhotite, but pyrite is also abundant, and arsenopyrite, sphalerite, chalcopyrite, and galena have been recognized. The gold occurs largely as native metal in the vein quartz. It is true that some is closely associated with the sulphides and that traces are found in the altered wall rock, but in general the gold is free and occurs alone as thin filaments filling minute fractures in the quartz. Particularly favourable loci for its deposition were along ribbons of chlorite and sericite, with or without carbonate, scheelite, and tourmaline, developed within the vein. These ribbons are highly schistose, locally even slickensided, so that they readily provided channels for the circulation of the gold-bearing solutions. Spectacular samples of visible gold have been observed in a number of places in the mine. As a general rule, however, the gold is very finely divided.

The sequence mineralization is a simple one, for only two distinct generations of quartz are recognizable, the one gold-bearing and making up the body of the Howell vein, the other barren and occurring along the calcite in narrow transverse veinlets that cut sharply across the earlier type. Admittedly thin sections of the earlier material generally exhibit two varieties of quartz, one coarse-grained and the other fine-grained. Inasmuch as they are intimately associated, do not show cross-cutting relationships, and exhibit every possible gradation from one to another, they are considered to be of the same generation, the fine-grained quartz in all probability being a phase of the coarser variety that was granulated and possibly recrystallized during intermineralization adjustments. Such adjustments undoubtedly occurred prior to the introduction of all the metallic constituents with the possible exception of the arsenopyrite, for the other sulphides and gold occupy distinct fractures in the quartz. The paragenetic sequence appears to be as follows: chlorite; carbonate and sericite; scheelite and arsenopyrite; tourmaline and quartz; pyrite; pyrrhotite; sphalerite and chalcopyrite; and carbonate, galena, and gold. Periods of intermineralization fracturing occurred; (1) after the formation of scheelite and arsenopyrite but before the introduction of the quartz; and (2) after the introduction of the quartz but before the formation of pyrite.

Wall Rock Alteration

Except in so far as the greenstone has been sheared to chlorite schist in many places throughout the mine, wall rock alteration products generally are conspicuous by their absence. Locally, and particularly along books, ribbons, and irregular inclusions in the quartz, however, the development of greenish mica is apparent, and in rare instances even flakes of biotite have formed. Sericite and chlorite probably representing ribbons of greenstone that have been almost completely replaced by the quartz, are frequently found developed along slips in the vein, but are not abundant; and disseminated sulphides are evident in a few places. The most pronounced effect produced by the mineralizing solutions appears to have been the partial replacement of book structures and occasionally narrow selvages along the vein walls by carbonate, tourmaline, or, rarely, scheelite.

In the iron formation, the mineralization has resulted in the development of abundant sulphides along both bedding laminae and irregular fractures, and pyrite and pyrrhotite frequently form parallel seams alternating with cherty beds in the rock, imparting to the whole a beautifully banded effect. Less frequently, the iron formation between the main vein and its parallel stringers has been almost completely replaced. Aside from this, however, wall rock alteration is even more pronounced than where the Howell vein cuts the greenstones. It is true, of course, that the same products are present, which is to be expected inasmuch as narrow bands of greenstone-like material are present, but as a general rule they occur in much smaller quantities. This is particularly noticeable in the case of both chlorite and tourmaline, which appear to have little capacity for replacing the chert, siderite, or magnetite of the iron formation.

Structural Controls of Mineral Deposition

The close relationship which exists between the pitch of the intersection of the vein with the iron formation, the pitch of both the contortions in the vein and the drag folds in the wall rocks, and the rake of the ore shoot itself, serves to emphasize the strong controlling influence which the iron band exerted over the localization of the vein and the body of ore within it. Inasmuch as the iron formation is the most competent and brittle rock in the stratigraphic sequence, it is apparent that vein fractures in all probability originated in and along the contacts of this member and extended laterally into the greenstones (Thomson 1938a).

On a previous page it was pointed out that, what was once considered to be a single continuous band of iron formation, has been found by detailed mapping and diamond drilling to be actually two bands which overlap near their extremities. Both have been highly deformed near the No.1 shaft, and the southern band has given rise to a large, tight, "Z"-shaped fold immediately south of the Howell vein. Consequent upon the fact that the general strike and dip of the Howell vein are different than those of the enclosing formations, with depth the vein actually migrates farther away from this fold, and the question immediately arises as to the effect this may have had on the general decrease in grade encountered on successively lower levels. If it is assumed that the migration of the vein away from the fold was actually a principal factor in controlling the distribution of the gold, a possible explanation, advanced by E.H. Marvin (1952), may be outlined as follows:

> Because the Howell vein migrates farther away from the drag fold in the iron formation with depth, it must be associated with more greenstone and less iron formation on each successive lower level. It has been noted by the writer that the occurrence of gold in the quartz is dependent on the degree of minute fracturing that has taken place therein. Occurrences of sulphides indicate that intermineralization adjustments were taken up by fracturing in the iron formation, fracturing of the brittle quartz, and shearing in the greenstone, it is apparent that the iron formation is the more competent rock. Hence, where the vein

is associated with more iron formation than greenstone, i.e., where it lies within or close to the large mass of drag-folded iron formation, it is more highly fractured than where, at depth it migrates farther and farther away from the mass of drag-folded iron formation and is associated with more of the relatively incompetent greenstone. The quartz of the vein, in effect is less fractured with depth and hence was less favourable to the passage of the mineralization solutions and the deposition of the gold.

This hypothesis can be applied in lateral dimensions, for the farther the vein is from the iron formation the less fractured is the quartz. Thus the gold content of the vein would decrease east and west away from the iron formation. This has been shown to be the case, for the grade decreases eastward in the Howell vein until low values prohibit economical mining. Westward along the Howell vein away from the iron formation the ore grades persist for some distance past the point where widths become too narrow to permit economical mining. This is consequent upon the fact that the west limit of the ore shoot lies closer to the iron formation in the west workings than the east limit in the east workings, and also because the vein in the western section is more highly contorted.

The question arises as to why the gold is more highly contorted, enclosed by the iron formation, although resulting in ore of good grade, are lower than those in the vein in the adjacent greenstones. Gold is also found in the parallel quartz stringers in the iron formation, and greater stoping widths are obtained, which result in a much higher overall gold content than in any other section of the vein. Had the gold been confined to one narrow vein within the iron formation, it is likely that much higher assays would have resulted than sampling has indicated.

Mining and Milling

In the upper levels the principal stoping method was flatback shrinkage system. Consequent upon ground conditions, however, this soon proved unsatisfactory, and below the 375-foot level a resuing cut-and-fill method was used in the narrow, high-grade portions and a standard cut-and-fill method in wider sections.

As pointed out by Thomson (1938a, p.62) "the ore is comparatively free-milling, and grinding to 80 percent minus 200 mesh is sufficient for good extraction. Gold is extracted in part by amalgamation and in part by canidation, the former accounting for about 40 percent of the overall recovery.

NO. 2 OPERATION

History and Development

As development of the Howell vein progressed during the early years in the life of the mine, diamond drilling operations were carried out elsewhere on the property in the hope that similar occurrences would be discovered. During 1937 and the first few months of the following year this work resulted in the location of several promising quartz veins near and at the south contact of a large, lenticular body of quartz albite porphyry underlying claims Pa.725 and Pa. 744 close to the old Albany River property (see pages 292 to 307). The 738 N. crosscut was started immediately from the east end of the 7th level workings at the No. 1 shaft to carry out underground investigation of the possibilities disclosed. Crosscutting proceeded until 1940, when, at point approximately 4000 feet N. 30° E., of the No. 1 shaft, a strong gold-bearing vein zone (No. 2 vein system) was intersected. Subsequent lateral work soon indicated, in the 738-648 E. drift, 130 feet of possible ore averaging 0.16 ounces of gold per ton across a width of 114 inches, and, in the 738-649 E. drift, 539 feet of possible ore averaging 0.34 ounces across 61 inches (Figures from annual reports of the company). Later, in 1941, the 648 E. and the 649 E. drifts were connected and the latter extended additional 228 feet in ore. Diamond drilling below the level proved a continuation of the ore zone with depth, and toward the end of the year preparations were made to sink a three-compartment winze (No. 2 shaft) from the 750-foot horizon to open up 5 levels at vertical intervals of 125 feet.

The sinking of the winze commenced in December 1941, and by 1943 had been advanced 797 feet, with stations cut and levels established at depths of 1225, 1350, and 1475 feet below the surface. This work proved highly successful, for large tonnage of good grade ore were quickly blocked out, and in June, 1944, to open up the No. 2 vein system from the surface to the 750-foot horizon, a three-compartment shaft (No.3 shaft) was started in the footwall at a point 640 feet south and 1, 100 feet east of the winze. By the winter of 1946 this shaft had been extended to a depth of 1,631 feet and stations had been cut at elevations of 250, 405, 550, 700, 850, 975, 1100, 1225, 1350, 1475 and 1600 feet below the collar. With completion of crosscuts to the vein system on all levels, the winze to the northwest gradully lost its purpose. It was finally abandoned, and since December of 1950 all ore and supplies have been handled through the No. 3 shaft. At present, the ore is being trammed along the 750-foot level to the No. 1 shaft and hoisted to the surface for milling.

General Geology

The No. 2 vein system occurs within a zone of fracturing and shearing in a large lenticular mass of quartz albite porphyry that intruded greenstone flows in the northeast section of the main property. This intrusive mass has been traced along its strike of N.48^{o}E. (Dip, 75^{o}N. to 80^{o}N.) for approximately 6000 feet, and in the vicinity of the ore body has a maximum horizontal width of 700 feet. It consists essentially of a greyish green to grey porphyritic rock with rounded to ovate phenocrysts of quartz up to half an inch in diameter and broken ones of altered albite imbedded in a fine-grained, schistose matrix composed of quartz, carbonate, sericite, chlorite, leucoxene, apatite, and zircon in order of decreasing abundance. Except insofar as the rock is somewhat more greenish in colour consequent upon the presence of chlorite, it strongly resembles in both composition and texture the quartz sericite schist which is exposed in the vicinity of the Central Patricia Gold Mines Limited No. 1 Operation and which has been assigned provisionally to the Early Algoman as a result of its having been folded with the enclosing greenstone flows. The porphyry mass in which the No. 2 vein system occurs has also been folded, as illustrated by numerous crenulations which the rock frequently exhibits in samples of diamond drill core and by its pronounced schistosity which strikes about N.60^{o}E., and dips 70^{o}N. to

75°N. parallel to the axial plane foliation developed in the adjacent greenstones. That the porphyry is an altered sediment or extrusive as might be supposed from these relations, however, must be discounted, for crosscutting relationships are evident in outcrops east of the No. 3 shaft, chilled margins have been observed at several places in the mine, and irregular inclusions of greenstone are common near its borders.

Perhaps the most peculiar feature of this mass of quartz albite porphyry is the occurrence within it is four long but thin bands of fine-grained, basic, greenstone-like material. Three of these bodies have been traced from the 750-foot level to below the 1225-foot level, attesting to a great continuity despite their narrow widths. They strike roughly parallel to the vein system and dip 75° to 80° N. The fourth band also has been traced between the two levels, but this one strikes N. 45°E., and dips steeply northwest, and so angles across the others (Figure 12) . That these narrow bodies are similar in appearance and composition to the extrusive rocks intruded by the porphyry, and in the case of one of them diamond drilling has suggested continuity with the footwall greenstone, the assumption has been made that they are not dikes but rather inclusions that "fell" into the porphyry magma at the time of its implacement (Monette

1949, p.105). The mechanism of intrusion that would leave inclusions in the form and attitude now shown by these bodies, however, is difficult to comprehend. It is true that the porphyry may have insinuated itself into different portions of the greenstone, and the septa so formed worked into the central portion of the mass through successive injections of magma. But such an hypothesis fails to explain the fact that three of the "inclusions" extend diagonally across the porphyry whereas the fourth strikes in a widely different azimuth, roughly parallel to the borders of the porphyry mass. It is for this reason, although no reliable intrusive relationships have been observed underground, that the writer prefers to think of them as dikes rather than as inclusions.

Later than the greenstone "inclusions" are narrow, roughly parallel dikes of biotite lamprophyre (Quartz kersantite), which intrude the porphyry in a general west-northwest direction and dip to the north through it at steep angles. Two of these dikes, the ones usually shown on level plans in virtue of their widths, cut sharply across the quartz veins and are distinctly post-ore. The northern one pinches out to the east in the 2-91 E. stope above the 975-foot level with a characteristic wedge-shaped termination, but a short distance beyond its end, and almost in line with it, a similar dike appears and continues across the stope. However, this dike appears to be cut by the quartz. Evidence suggesting that this dike is pre-ore in age may be summarized briefly as follows:

(1) the lamprophyre, while in most places quite massive, is highly sheared near the vein whereas the quartz itself exhibits no evidence of having been sheared:

(2) at the contacts with the main quartz vein, the latter exhibits tiny, gash-like apophyses that project into the lamprophyre and obviously cut it;

(3) at the contact of the dike, the lamprophyre occurs in the quartz as narrow books, and in these as well as in the body of the dike proper it shows the development of chlorite, carbonate, and sericite at the expense of biotite and feldspar as a result of action by hydrothermal solutions;

(4) as the dike is approached, in much the same way as the greenstone "inclusions" are approached, the quartz becomes exceptionally rich in chalcopyrite, galena, and visible gold --- it forms the highest grade ore in the mine (Monette, H.H. personal communication):

(5) thin section studies indicate that near the vein the lamprophyre has been replaced in part by fine-grained aggregates of anhedral quartz grains; and

(6) the lamprophyre near the vein has been mineralized with small amounts of pyrite and chalcopyrite.

It would thus appear that the lamprophyre dikes are both pre-ore and post-ore in age and were intruded into the country rocks at about the same general time as the quartz veins were forming.

Structural Geology

Folding

The principal structural feature in the vicinity of the No. 2 Operation is the Pickle Crow syncline, along the south flank of which the vein system occurs. Here, however, little is known about this structure, for the lack of rock exposures near the assumed axial plane precludes any possibility of determining its attitude. If the contortions in the No. 2 vein system bear the same relationship to the major structure as they do in the case of the Howell vein, it may be that near the No. 3 shaft the major fold, like the contortions, pitches at an angle of 40 to 45 degrees in a direction of N. 45^{o}E. That this is the case is certainly indicated by the gradually increasing parallelism of the formations on either limb of the fold in this part of the area. Also, if the regional schistosity developed in the porphyry and the enclosing greenstones parallels the axial plane of the fold as it should, it is reasonable to suppose that the axial plane strikes about N.60^{o}E., and dips to the north at about 75 degrees. Its location, however, cannot be predicted with any degree of exactness from the data presently available, and the interpretation shown on the map of the area must be considered speculative.

Faulting, Fracturing, Shearing

There is very little evidence of faulting in the mine workings - a few northeasterly trending faults have been recognized but none offsets the veins more than a foot or two or causes any difficulty in mining operations. The most important faults from the geological point of view are those zones along which the quartz veins, where they strike N.60°-70°E., and dip 60° - 75°N., have been localized. These faults, of course, are pre-ore, and have been made evident from the fact that they have effected strike separations of the greenstone "inclusions" up to 100 feet, the north side having moved west in each instance known.

As mentioned previously, the quartz albite porphyry appears to have been highly sheared during the regional deformation. Superimposed upon this regional schistosity is a secondary one which accompanied the pre-ore faulting, and in the mine workings both are frequently observed along the strike of the vein system, first one predominating and then the other. This is indeed a significant feature, for the quartz may follow one or both of these structures as it migrates across the porphyry. Thus, in many places quartz stringers following the axial plane foliation terminate abruptly against others that follow the more easterly trending sheared zones.

Jointing

Several prominent sets of joints are encountered underground. One set, oriented approximately at right angles to the major fold axis, strikes N.45^{o}W. to N.60^{o}W., and dips to the southeast at steep angles up to 85 degrees; a second set, which lies more or less parallel to the fold axis, strikes N. 40^{o}E. to N.50^{o}E., and dips to the northwest at 40 to 50 degrees. A third set of joints strikes east-west and dips 75^{o}N. to 80^{o}N, and is commonly accompanied by a fourth which strikes north-south and dips to the east at angles of 25 to 30 degrees.

The No. 2 Vein System

With the depletion of the reserves in the Howell vein, the No. 2 vein system received gradually increasing attention until at present it is considered the most important ore structure being developed and mined on the large Pickle Crow property. This structure has been opened up for a total drift length of about 2,400 feet on the 975-foot horizon, and has been developed on 9 levels to a vertical depth of 1,600 feet (Figure 10). It has throughout the mine an average strike of N.80^{o}E., and, consequent upon the effect of numerous flat rolls on an otherwise steep attitude, an average dip of about 45^{o}N. Unlike the Howell vein, however, it is not a single continuous structure, for toward its eastern extremity on the 400-foot and 550-foot levels and near its central portion below the 850-foot level it breaks up into several branches of irregular strike and dip. This peculiarity of pattern is particularly well displayed in the 975-foot level workings, where branching structures, with the principal veins, form one small continuous loop and one larger, discontinuous loop, enclosing lenticular bodies of quartz porphyry with long diameters of 120 feet and 290 feet and short diameters of 50 feet and 140 feet, respectively (Figure 11). These cymoid loops are especially important, for in and close to them the best grade ore has been found. It is of interest to note, however, that in the vertical dimension they are not as readily apparent as on the level plans - in all instances so far encountered in the mine the southern branch of any two forming a loop in horizontal section pinches out in a short vertical distance and does not appear to roll over with depth to connect with the northern branch. In point of fact, it appears that the main vein in each case assumes an abrupt roll to the north, and that at the point where the change in dip first becomes apparent a branch from it extends downward without any marked change in attitude (Figure 12).

The pattern presented by the No. 2 vein system is further complicated by the occurrence, at many places in the workings, of small but typical "Z"-shaped contortions similar in many respects to those so characteristic of the Howell vein. As before, these pitch in a northeasterly direction and appear to be compatible with the Pickle Crow syncline. However, a few of the vein "folds" are "S"-shaped in plan, and although many of these pitch to the northeast, a few have been found to pitch at relatively flat angles to the west. This suggests that vein was localized along a dragfolded sheared zone, but locally follows lines of weakness that were developed subsequent to the regional deformation. Again, as in the case of the Howell vein, it is to be emphasized that the quartz itself could not have been folded with rock formations, as it exhibits no evidence of faulting or brecciation about the noses of the many contortions.

The different segments of the No.2 vein system exhibit varying degrees of regularity. In some places, and particularly toward the west where the structure shows the greatest uniformity in attitude, the quartz appears to occupy well-defined sheared zones that may be followed along the back of a drift or stope for relatively great distances; in other places the vein pattern is complicated by numerous contortions and rolls such as those characteristic of the cymoid loops; and in still other places, where brecciation of the porphyry has occurred, the quartz forms irregular stockworks of considerable width. In general, where the vein is of fairly uniform strike, it averages about 3 feet and rarely exceeds 5 feet in thickness. Sharp contacts with the wall rocks, the relative scarcity of book and ribbon structures and lack of evidence of replacement of the porphyry by the vein quartz, suggests that here at least metasomatism played only a minor role during the mineralization and that the dominant process of vein formation was fracture filling. Along the strike where stockworks are encountered and frequently about the noses of the contortions, however, books of altered porphyry are abundant and locally become highly silicified and discontinuous such that merely ill-defined patches and streaks remain, and the contacts between the quartz and the wall rock become indistinct. It seems evident, therefore, that here fractures filling has given way to replacement processes, which were undoubtedly facilitated by the presence in these sections of innumerable tiny cracks and fractures that permitted the quartz-bearing solutions to circulate through the rock mass much more easily than if only the straight parallel fractures had been present.

The ore body, inasmuch as its boundaries are determined by a drop in the gold content of the quartz, is a shoot of variation within the No. 2 vein system. In longitudinal sections it appears as a simple, lenticular body with a proven pitch length of 2,200 feet and maximum horizontal length, on the 975-foot horizon, of 1,018 feet. Consequent upon the occurrence of branching structures, however, stope lengths are frequently much greater than lateral dimensions and ore reserves accordingly larger than such longitudinal sections indicate. From the 405-foot level to the deepest workings it has an average strike and dip of N.80°E., and 48°N., respectively,

TABLE NO. 14

ORE DEVELOPMENTS, NO. 2 'VEIN'

Level	400	550	750	850	975	1,100	1225	1475	1600
ORE LENGTH,FEET	545	854	810	1045	1954	755	360	531	459
AVGE WIDTH,INCHES	34	33	69	48	64	39	30	32	17
OZ.AU per TON[1]	.45	126	.57	.51	.53	.38	.37	.29	.29

1. Avge grade based on results of channel samples.

and rakes at about 40 degrees in a direction of N.35°E. The highest grade section lies between the 750-foot and 975-foot horizons, where channel sampling indicated an average of 0.54 ounces of gold per ton across a width of 61 inches. Both above and below this section, however, the grade decreases on the 400-foot level the average is 0.45 ounces per ton across a width of 34 inches, and on the 1,600 foot level it is only 0.29 ounces per ton over 17 inches. Aside from these gradual overall changes, other variations in the gold content of the ore have been noted.

On any one level, for instance, the grade appears to be better in the highly contorted sections, particularly where branching structures form cymoid loops, such as those on the 975-foot horizon, where flat pitching rolls occur, and at points where the quartz cuts across the greenstone "inclusions" in the porphyry. A particularly rich section occurs where the quartz cuts a narrow lamprophyre dike in the 2-91E stope. Low grade sections, on the other hand, occur where the quartz occurs in stockwork patterns, and in general where, beyond contortions in the vein, evidence suggests a greater than normal amount of replacement of the porphyry by the quartz. The grade, in effect, varies considerably - the average values estimated from channel sampling and recorded in the accompanying table cannot be considered as representative of any one small section along a particular level.

Mineralization

The No. 2 vein system consists largely of greyish white, coarse-grained to fine-grained sugary quartz, small amounts of carbonate, tourmaline, and scheelite, a little metallic sulphides, and gold. As in the case of the Howell vein, the carbonate, tourmaline, and scheelite while locally occurring in irregular small patches enclosed by the quartz, generally form thin discontinuous seams replacing altered porphyry in the walls or in books and ribbons within the veins. The sulphides occur only sparingly in the deposit, and appear to be more or less equally distributed between the altered phases of the host rock on the one hand and the quartz on the other. As before, the principal sulphide is pyrrhotite, although pyrite is again an abundant constituent, and both chalcopyrite and galena have been recognized. Gold is everywhere present, but does not occur in spectacular concentrations as might be imagined from grade estimates - most of it is finely divided and invisible to the unaided eye. The gold, as well as the sulphides, heals fractures in the quartz, and in several places is closely associated with galena. The paragenetic sequence is believed to be as follows: carbonate and sericite; scheelite; tourmaline and quartz; pyrite; pyrrhotite; chalcopyrite; and galena and gold. Periods of fracturing appear to have occurred: (1) after the formation of scheelite but before the introduction of the vein quartz; and (2) after the introduction of the quartz but before the development of the sulphides.

As in the case of the Howell vein, the quartz of the No. 2 vein system is cut by transverse veinlets, up to a half inch in thickness, of quartz and calcite. These veinlets do not appear to be gold bearing.

Wall Rock Alteration

The quartz albite porphyry in the mine workings is normally greyish green in colour, possibly as a result of the presence of chlorite. But as the quartz veins are approached, the rock loses its greenish cast and becomes progressively lighter until, in many places, it forms a highly altered material almost as white as the quartz itself. Zones of altered porphyry seldom exceed 8 feet in thickness, and pinch and swell in short distances, being most narrow where fracture filling has been the dominant process of vein formation. The greatest widths of altered porphyry appear to occur where the veins are highly contorted, and where branching structures occur the whole mass of wall rock enclosed by a cymoid loop may show evidence of intense alteration.

Microscopic examination shows that the change in the colour of the porphyry as the veins are approached is due to a decrease in the amount of chlorite and increases in the amounts of albite and carbonate. No significant increase in the sericite is apparent. In order to acquire some quantitative data on the nature of the alteration, the writer had samples of both the typical and the highly altered quartz albite porphyry analyzed by the Provincial assay office. The results of these analyses are shown in Table No.15 .

Table 15

Chemical Analyses of Typical Quartz Albite Porphyry and Altered Porphyry, No. 2 Operation, Pickle Crow Gold Mines

Constituent Oxides	Weight Percent Sample No. 1	Weight Percent Sample No. 2
SiO_2	70.50	68.95
Al_2O_3	16.21	14.21
Fe_2O_3	0.21	0.60
FeO	1.35	1.08
MgO	1.64	1.17
CaO	2.43	2.50
Na_2O	1.79	3.88
K_2O	1.38	2.06
H_2O	2.85	0.80
CO_2	1.22	4.21
TiO_2	0.18	0.18
V_2O_3	Tr.	Tr.
P_2O_5	0.07	0.08
Cr_2O_3	0.01	Tr.
MnO	0.02	0.02
Totals	99.86	99.75
Loss on Ignition	3.78	3.78

Sample NO. 1- Typical Quartz Albite Porphyry, 550-foot level, Pickle Crow No; 2 Operation.

Sample No. 2- Highly altered, Quartz Albite Porphyry, 550-foot level, Pickle Crow No. 2 Operation.

TABLE NO. 16

Additions and Subtraction as a Result of Wall Rock Alteration

Cation	Cation Proportions		No. Cations in Standard Cell		Cations Added	Cations Taken Away
	Sample No. 1	Sample No. 2	Sample No. 1	Sample No. 2		
Si	1.1175	1.151	58.8	58.4		0.3
Al	0.318	0.279	15.9	14.2		1.8
Fe	0.003	0.008	0.2	0.4	0.2	
Fe	0.019	0.015	1.0	0.8		0.2
Mg	0.041	0.029	2.0	1.5		0.6
Ca	0.043	0.045	2.1	2.3	0.2	
Na	0.058	0.125	2.9	6.4	3.5	
K	0.029	0.044	1.5	2.2	0.7	
H	0.316	0.089	15.8	4.6		11.2
C	0.028	0.096	1.4	4.9	3.5	
T	0.002	0.002	0.1	0.1		
P	0.001	0.001	0.1	0.1		
Cr						
Mn						
Totals	2.033		101.85	95.9	8.1	14.1
			Valencies Represented		19.2	19.1

If it is assumed that the change in composition took place without appreciable change of volume, the number of oxygen ions present in porphyry must have remained more or less constant (Barth 1952, p.82-85). By setting the number of oxygen ions at 160 for each analysis, it thus becomes possible to determine the equivalent amounts of the other elements present in the two samples for isovolumetric comparison.

The equivalent numbers of the ions of the various elements associated with 160 oxygen ions in the typical and the highly altered porphyries are listed in Table No.16 . Comparison of the two standard cells indicates a slight gain in potassium and significant gains in sodium and carbon and losses in aluminum, hydrogen, and magnesium. The increase in sodium indicates albitization, possibly at the expense of anorthite molecule in original plagioclase and of chlorite; the increase in carbon indicates carbonization, which may have been introduced as carbon monoxide and reacted with the calcium set free by the albitization process to form calcite; the slight increase in potassium suggests minor sericitization. The losses in aluminium and magnesium may have resulted from the replacement of anorthite and chlorite by albite; the loss in water from the replacement of chlorite.

Structural Controls of Ore Deposition

The structural controls over the localization of the No.2 vein system are not nearly so evident as in the case of those that determined the locus of occurrence of the Howell vein, for there is no iron formation band within the porphyry to determine the site and attitude of the ore body. It is nevertheless significant that the intrusive igneous rock is more competent, consequent upon its composition, than the enclosing greenstones, and that the vein system occurs in the intrusive body near its widest point. In the first place, in view of its greater brittleness, the porphyry in all probability would more easily fracture along well-defined zones than would the greenstones; secondly, where the intrusive body is narrow and stresses acting upon it would be taken up more by shearing of adjacent greenstones than elsewhere, so that any fracturing developed in the porphyry would be most pronounced at its widest point and would tend to die out laterally.

The latter of these two principles also serves to explain the nature and grade variations of the vein system itself in both horizontal and vertical dimensions. The vein system angles across the intrusive body at about 35^{o} in a general east-northeast direction, and as it "extends from contact to contact, it passes through a zone of more intense fracturing near the centre of the porphyry, where it branches into many veins of irregular strike and dip ...." (Monette 1948, p.105). In effect, where the ore zone lies closer to greenstones, the stresses causing the failure of the host rock were taken up much shearing in adjacent, relatively incompetent flows than where zone lies farthest from them. The same also holds true in the vertical dimension, for the vein system migrates across the porphyry with depth and is strongest and carries the best values in its central section where farthest from the intrusive contacts, the veins decreasing in average width and grade both upward and downward from this section.

Ore Reserves

As of December 31, 1950, ore reserves were estimated by the management at 473,000 tons having an average grade indicated by channel sampling of 0.40 ounces of gold per ton.

Mining and Milling

All mining in the No.2 vein system is being done by a cut-and-fill as in the Howell vein. Consequent upon the presence of flat rolls, typical contortions, and branching structures, however, stope widths vary considerably within short distances. As pointed out by Monette (1949, p.110) "where the vein is dipping at an angle approximately the average, the horizontal stoping width between four and eight feet. Where folding is monoclinal, or gives repetition, the horizontal width may be as great as

30 feet. This also applies where splits occur in the vein."

The ore, as in the case of the No. 1 ore body, is free milling and amenable to amalgamation, which accounts for about 45 percent, of the recovery, and to cyanidation.

2403 WEST DRIFT ZONE

History and Development[1]

1. All assay values, widths, and averages quoted herein were secured from company plans and reports.

In July, 1942, a diamond drill hole put out from the No. 1 shaft on the 2,450-foot level in the direction of the Howell vein intersected a small body of sulphide-quartz mineralization in the drag-folded portion of the southern of the two overlapping bands of iron formation . However, assays indicated only values, and the zone was by-passed in driving the crosscut to the Howell vein. Later, in January, 1947, a second hole was bored as a further test of the possibilities. This proved more successful and gave some encouraging intersections. After further drilling had attested to lateral persistence of values, the 2403 W. drift was started in 1949 from the west wall of the 2401 N. crosscut at a point 290 feet north of the shaft. This drift was completed in the following year and, from the time it first cut the zone a few feet west of the crosscut, it supplied 2,452 tons of ore having an average grade of 0.17 ounces of gold per ton. Encouraged by the results of the development work, the management undertook a second diamond drilling program to investigate the zone below the level. Of 20 holes drilled, 16 indicated ore intersections averaging according to the management 0.29 ounces gold per ton over a width of 13.0 feet.

Most of these intersections were encountered at depths of up to 200 feet below the 2403 W drift, but one, which returned 0.34 ounces per ton over 15.0 feet, cut the zone at a depth of 475 feet.

Mineralization

The 2403 W drift zone, as mentioned previously, occurs in the large dragfold southwest of the Howell vein. It has been traced for a total length of 190 feet in an east-west direction, and, insofar as present development work indicates, has a maximum width of 65 feet. But its attitude is not known, although it seems probable that the zone will be found to rake parallel to the pitch of the folded structures in which it is localized. It is highly irregular in outline, and consists of highly contorted iron formation and occasional conformable strips of chlorite schist, both of which have been impregnated with sulphides and cut by small quartz veins and stringers.

The quartz veins in the zone tend to be localized along the limbs of minor drag folds or along east-west zones of shearing and fracturing. Those associated with the chlorite schist interbanded with the iron formation are highly lenticular in form, attaining widths of 3 feet or more but pinching out in short distances, and contain irregular patches, short books, and diversely oriented ribbons of altered wall rock. However, in the iron formation they are narrower and more persistent, and somewhat more uniform in width, and locally contain, in places of book structures, angular fragments of wall rock suggesting pre-vein brecciation. Associated with the quartz are small amounts of scheelite, carbonate, and tourmaline. The gold is localized for the most part in the accompanying sulphides (pyrrhotite and pyrite), which occur as: (1) irregular streaks and small masses replacing both iron formation and chlorite schist within and along the walls of the veins; (2) thin seams localized along bedding laminae in the iron formation and planes of foliation in the chlorite schist; (3) stringers healing fractures of various attitudes that cut both the quartz and the wall rocks; and (4) fine disseminations in the iron formation. It is of interest to note that a few feet from the quartz veins the wall rocks are only sparsely mineralized and finely divided pyrrhotite and pyrite, so that, considering the zone as a whole, the sulphides collectively do not make up more than about 10 to 15 percent of the whole.

No. 3 Vein System

In 1931, when the drive from the Howell vein on the 750-foot level to the No.2 Operation had reached a point 2,665 feet north and 1,660 feet east of the No. 1 shaft, flat drill holes put out from the south wall intersected a mineralized zone with gold values of sufficient promise that development work was decided upon. A cross cut was advanced 97 feet, and from both walls near the face drifting was started on a sheared zone containing quartz stringers and sulphides. The 738-462 E and the 738-462 W drifts were extended 33 feet and 40 feet, respectively, along the zone. However, despite the presence of visible gold in the quartz, channel sampling indicated only a low average grade; and when, in 1940, additional work again gave inconclusive results, development was discontinued. It was found that the best values are associated with the sulphides, and these, due to their uneven distribution, preclude the possibility of economically recovering the gold. In 1945, 4 diamond drill holes were bored from the surface to investigate the upward extension of the No. 3 vein system, but these cut only low grade material, the best assay indicating 0.17 ounces per ton over a width of 2.0 feet.

The No. 3 vein system has, at the end of the crosscut, a maximum width of 13.5 feet, both west and east decreases gradually to a minimum of about 4 feet. West of the centre line of the crosscut it has been followed for 65 feet. Here it has an average strike of N.70^{o}E., roughly parallel to the contact of a band of iron formation a few feet to the north. However, to the east it diverges from the contact and strikes easterly for a known distance of 80 feet. It is a zone of numerous,irregular, and highly contorted veins and stringers in a band of altered, schistose greenstone. The veins and stringers average about 2 inches and rarely exceed 2 feet in thickness. They are highly lenticular in form. One prominent vein decreases over a length of 200 feet from a banded structure 1.5 feet wide to a mere stringer only half an inch wide. They consist of from greyish, relatively coarse-grained to sugary-textured, fine-grained quartz with abundant pyrrhotite, pyrite, and carbonate, some tourmaline, local patches of scheelite, and fine but visible specks of gold.

NO. 4 VEIN SYSTEM

At a point 2,900 feet north and 2,130 feet east of the No. 1 shaft, the drive between the Howell vein and the No.2 Operation on the 750-foot level intersected a narrow quartz vein and a few parallel stringers striking, in a general north-northwest direction, through schistose greenstone close to the south contact of a large mass of quartz albite porphyry. In 1940, the 738-58 N. drift was advanced along this zone and back sampling indicated the first 55 feet to average 0.19 ounces of gold per ton across a mean width of 80 inches. However, the next 35 feet contained only low values, so that development was soon suspended. Little additional work has been done. But it is of interest to note that one recent drillhole cut the vein 125 feet above the 750-foot level. Assaying of the core indicated 4.0 feet to average 0.21 ounces of gold per ton (Northern Miner 1951a, p.9)

At the time of the writer's examination of the area, the backs along the 738-58 N. drift were broken and the vein system hidden by timbers.

NO. 5 VEIN

History and Development

In 1944 the 1302 W drive was started from the end of the 1350-foot level at the No. 1 shaft to explore the Howell vein to the west, to investigate mineralization located by surface drilling on claim Pa.729, and to test the Riopelle vein at depth. When this drive had been advanced to a point 743 feet west of the old workings, a drill hole was put out S.17^{o} W from the face, and at a depth in the hole of 945 feet, a quartz vein assaying 0.145 ounces of gold per ton across 20 feet of core, was intersected. In 1947 a crosscut was driven from the 1302 W drive to examine the possibilities indicated by this intersection, and, approximately 1,700 feet southwest of the Howell vein, drifting outlined 465 feet of possible ore, of which 367 feet averaged 0.31 ounces per ton across a mean width of 36 inches (Northern Miner 1951b,p.1). The No. 5 vein was subsequently stripped on the surface for approximately 150 feet and tested by diamond drilling at the 300-foot and 700-foot horizons over a length of 600 feet. This work, according to A.W. Johnson, consulting geologist, indicated, between the surface and the 1350-foot level, a minimum of 100,000 tons with a grade of 0.29 ounces of gold per ton or better (Northern Miner 1951b, p.1).

Mineralization

The No. 5 vein, like the Howell, is a narrow persistent structure with numerous small, typical "Z"-shaped contortions and characteristic banded structure. It is highly lenticular in form, and varies in width from less than 2 inches in some places to over 3 feet in others, with an average of from 1 to 1.5 feet. Between the surface and the 1350-foot level, it has an average strike and dip of N.80°E., and 65°N., respectively, and, as far as can be ascertained from the data now available, a rake of 52° in a direction of N.45°E. For the most part the vein lies in greenstone flows, which near the quartz are bleached somewhat as a result of minor sericitization and carbonatization. At the west extremity of the present surface and underground workings, however, the vein enters the horizon of iron formation traced southwestward from the No. 1 shaft, and here it is accompanied by thin seams and irregular masses of sulphides, chiefly pyrrhotite and pyrite, replacing the wall rock.

The vein itself consists of fine-grained quartz, with which is associated a little pyrrhotite, pyrite, chalcopyrite, and arsenopyrite. Carbonate, is abundant, but like the chlorite, sericite, and tourmaline, tends to follow and replace books of greenstone-like material in the quartz. Visible gold has been observed in several places, particularly in the surface exposures.

BIG DOME VEIN SYSTEM

The Big Dome vein system occurs near the west boundary of claim Pa.706, where it has been uncovered by trenching for a length of about 150 feet. It consists of contorted veins and patches of barren quartz along a zone striking N. 2°W. through schistose and sparingly pyritized greenstone. The quartz contains a little gold, for samples assaying up to 0.40 ounces per ton across widths up to 4 feet 8 inches have been reported by the management, but the zone as a whole is below ore grade. To the south it may have been cut off by an east-fault, for it terminates abruptly at the contact between sheared greenstones and iron formation.

RIOPELLE VEIN

The Riopelle vein has been described by Thomson (1938a, p.62) and the reader is referred to his report for full information.

LAKE SHORE VEIN

The Lake Shore vein is located on claim Pa.705 along the south shore of Buesnel Lake. It was discovered in 1928, and during that and the following year it was opened up by trenching and sampled for a total length of 450 feet. This vein is highly lenticular in character, and varies in width from a few inches in some places to a maximum of 3 feet at one point. It is quite similar to other veins in the area in that it is twisted and contorted, but here the vein "folds" are "S"-shaped in plan, and hence differ from those characteristic of the Howell and other veins discovered on the Pickle Crow property. These contortions reflect a much larger one which controls the overall attitude of the vein. To the east the vein strikes about N.45°E., roughly parallel to the regional schistosity in the enclosing greenstones, and dips 52°N.W. Going west it swings sharply and assumes a strike of N.45°W., and a dip of 50°N.E. However, this attitude is maintained for only about 45 feet, after which the vein again curves sharply, this time to the south, thus tending to complete a large "S"-shaped pattern compatible with the smaller contortions mentioned above.

The Lake Shore vein consists of white banded quartz with some chlorite, carbonate, tourmaline, and subordinate pyrite and pyrrhotite. Visible gold has been reported, but the grade of the vein as a whole is below ore standards, the average of scattered surface samples being 0.17 ounces of gold per ton across a width of 31 inches for a length of 350 feet.

(unpublished company report, 1935). During September, 1935, five diamond drill holes, aggregating 661 feet, were bored to test the downward extension of the vein, but these also indicated only low gold values. The best intersection assayed 0.23 ounces per ton over a core length of 12 inches (unpublished company report, 1935).

PRODUCTION STATISTICS

Table 17 sets forth complete production statistics for the No. 1 and No.2 Operations from the start of milling on April 17, 1935, to December 31, 1951. These figures were obtained or calculated from data recorded in issues of the Canadian Mines Handbook.

ALBANY RIVER GROUP

History and Development

The Albany River Group consists of 8 patented claims (Pa.63 to Pa. 70, inclusive) located northeast of the main property of Pickle Crow Gold Mines and southeast of the Crowshore holdings. Originally the claims were staked in 1928 for Albany River Mines Limited, and were first to be recorded in the Crow River area. The first work to be done on the property was in 1929, when the ground was optioned by F.M. Connell and associates to undertake an investigation of a deposit of goldbearing sulphides, with quartz-carbonate veinlets, in chlorite schist and iron formation near and at the south contact of a mass of porphyritic albite granite outcropping on claim Pa.64. However, it was not until 1933 that a diamond drill was moved on to the property, and during the following two years 42 holes, with aggregate footage of 6,616 feet, were bored to test the main vein zone. Interesting gold values were indicated. But the intersections were difficult to correlate between holes, and, in order to determine the actual value of the zone, underground work became imperative. The sinking of a three compartment vertical shaft commenced in June, 1936, and by early 1938 this had been extended to a depth of 640 feet, with four levels established at 125-foot intervals. During 1937 this work opened up, on the 375-foot level, four shoots aggregating 340 feet of ore averaging 0.47 ounces of gold per ton across a mean width of 40 inches (Annual report, Albany River Mines Limited, Sept. 30, 1937), and in the following year comparable tonnages and values were indicated on the 500-foot and the 625-foot horizons.

Due to lack of capital, an agreement was made in the summer of 1938 with Pickle Crow Gold Mines Limited whereby the latter assumed direction of a new company, Albany River Gold Mines Limited, incorporated to take over the property and, in addition, 9 claims acquired from Winoga Patricia Gold Mines Limited. Under the terms of this contract, Pickle Crow Gold Mines Limited agreed to finance future operations, to bring the mine into production, and to increase its mill capacity whenever necessary to treat the Albany ores. Except for several months in 1939, when a power shortage forced a temporary suspension of operations, underground work continued under the new management until February, 1941. Several new possible ore zones were discovered, the most significant being the "D" zone north of the shaft and the "E" zone west of the shaft; and considerable lateral work was done on the 125-foot and the 625-foot levels to test these underground. The ore shoots, however, consisted mostly of isolated lenses, and as yet actual mining operations have not been initiated. At the time the mine was closed the probable ore reserves were estimated at 13,876 tons averaging 0.40 ounces of gold per ton (Financial Post 1951).

In 1945 Albany River Gold Mines Limited surrendered its charter and the property was taken over by Pickle Crow Gold Mines Limited. Six drill holes, aggregating 2,201 feet, were bored from the surface of claim Pa.70 in that year. These intersected an auriferous quartz vein cutting pyritized chlorite schist, along the south contact of the same mass of quartz albite porphyry in which the ore of the No.2 vein system is located, and in 1947 a drive was put out from the No. 3 shaft on the 750-foot level to explore its downward extension. This drive was advanced to a total length of 1,431 feet in 1948, with the heading stopped below the Albany 625 W drift, but nothing of commercial significance was encountered. The 2-72 E drive, however, has served a dual purpose, for while no new ore bodies were discovered, it will permit at some future date entry into the old Albany workings, and so facilitate the exploitation there of the ore developed prior to February, 1941.

In July, August, and September of 1950, another drilling program, under the direction of W.R. MacQuarrie, was carried out on claims Pa. 69 and 70. Twelve holes, aggregating 4,339 feet, were bored from the surface, but although interesting values were encountered, these were confined to silicified and mineralized greenstone forming lenses of non-commercial proportions.

General Geology

The rocks on the Albany River group of claims (Figure 13) include lavas of intermediate to basic composition, interbanded iron formation, agglomerate and tuff, and intrusive bodies of hornblende diorite or gabbro, quartz albite porphyry, porphyritic albite granite, quartz diorite porphyry rhyolite or aplite, and biotite lamprophyre. The lavas make up the greater portion of the Keewatin complex. They are generaly dark green in colour, and vary in character from fine-grained to coarse-grained, from massive to schistose, and from even-textured to porphyritic. A few more acid flows of greyish colour have been observed, and in one or two places vestiges of amygdaloidal and pillow structures may be recognized. Near and parallel to the highway the lavas are intimately associated with narrow, discontinuous bands of iron formation, basic tuff, and agglomerate, which collectively constitute a horizon traceable southwest toward and perhaps continuous with that band of iron formation in which the Howell vein at the No. 1 shaft has been localized. An interesting feature of this horizon is that where the iron formation and the bedded tuff are intimately associated, as on claim Pa. 69, the two frequently grade into one another.

The oldest intrusive rock on the property is hornblende diorite or gabbro, a dark green, fairly massive rock which cuts the lavas north of the highway as elliptical shaped bodies up to 1,500 feet in length and 230 feet in width. Later than the hornblende diorites are two large irregular bodies of porphyritic rocks. The two differ greatly in appearance. The rock exposed near the shaft is not greatly altered, has been faintly sheared, has a granitic appearance, and weathers to a pinkish surface. It may be classified as a porphyritic albite granite. The other, a quartz albite porphyry, is highly altered and schistose, is pale greenish grey in colour, and weathers to a pale grey, almost white, surface upon which large ovate phenocrysts of quartz stand up in marked relief above the less resistant groundmass. Both rocks, however, are very similar under the microscope in that they consist of phenocrysts of both albite and quartz embedded in a matrix of plagioclase, quartz, sericite, chlorite, and carbonate, with subordinate amounts of magnetite and apatite; but they do differ in that the one exposed near the Albany workings contains, in addition, large crystals of muscovite showing phenocrystic relations, has a much coarser matrix, and is much less altered. It is therefore apparent that there is no necessity for considering the two as being the same age. Rather, the one outcropping near the No.3 shaft, in consideration of its schistose nature throughout and the presence within it of minor contortions, must have been folded with the enclosing greenstones; the other, on the contrary, is fairly massive and undoubtedly was emplaced during the closing stages of the regional deformation. In point of fact, it seems reasonable to suppose that the intrusion of the soda-rich porphyries in the area commenced before the folding stresses became intense and continued throughout the period of deformation until after the Pickle Crow syncline had developed and tensional relaxation occurred.

Associated with the granite exposed near the Albany shaft is a plexus of narrow porphyritic dikes that cut sharply across the greenstones and iron formation. These dikes are also massive in character, but differ again in that they have a speckled appearance due to the presence of numerous large grains and crystals of biotite and, consequent upon their mineralogical compositions, show distinct phenocrysts of white feldspar in a dark grey to almost black matrix. They are quartz diorite porphyries, and consist of phenocrysts of andesine, and a few scattered ones of quartz, in a groundmass of plagioclase, quartz biotite, chlorite, carbonate, sericite, and accessory magnetite and apatite. In view of their massive qualities and their distinct crosscutting relationships, they are believed to be younger than the quartz albite porphyries and related albite granite.

The youngest intrusives in the mine area are rhyolite or aplite, which occurs as a massive dike or sill, 50 feet or more in width, south of the highway near the boundaries of claims Pa.70, and biotite lamprophyre, which outcrops in the northern portion of claim Pa.64. One of the lamprophyre dikes cuts the quartz of the "D" zone and is obviously post-vein in age.

Structural Geology

For the most part the volcanic and sedimentary formations underlying the property strike more or less uniformly in a direction of about N. 45°E., and dip 65-70°N.W. But locally, as in the vicinity of the shaft, where they are truncated by the large irregular mass of porphyritic albite granite, the iron formation bands exhibit broad curves convex toward the southeast, and in several outcrops minor drag folds of north-northeasterly pitch are evident. These drag folds are generally "Z"-shaped in plan and indicate that the formations lie along the southeast flank of the major Pickle Crow syncline. Unfortunately, due to lack of rock exposures, it was not possible to delimit the location of the axis any closer than assuming it to lie a short distance north of the claim group.

There is very little evidence of faulting on the Albany claims. Narrow east-west sheared zones along which fault adjustments may have occurred have been mapped in many localities, however, and along some of them mineral deposits have been localized. An interesting feature of these zones is that they frequently exhibit distinct curves which apparently reflect the type of adjustment accompanying the major folding (see Figure 23) . But these curves, unlike the real "Z"-shaped drag folds, are open flexures. The sheared zones cut the axial plane foliation of the Pickle Crow syncline, and could have formed only after or during the closing stages of the regional deformation. A strong sheared zone referred to as the Albany "fault," is believed to extend northeasterly through the depressions south of the shaft. This structure was cut in drill holes to the southwest near the boundary of the claim group, where it is represented by a zone of highly schistose greenstone over widths up to 120 feet.

Ore Bodies and Zones of Mineralization

No. 1 Vein

The No. 1 vein on the Albany River Group has been described by Thomson (1938a, p.33).

No. 2 Vein

The No. 2 vein does not outcrop. It was first discovered by diamond drilling about 70 feet northwest of the No. 1 vein described above, and consequent upon the encouraging intersections, resulted in the sinking of the shaft in 1936. A small ore shoot, 25 feet in length and averaging $9.92 across 18 inches, was indicated on the 125-foot level, but little work has been done at this horizon, and exploration has been confined largely to the 375-foot, 500-foot, and 625-foot levels. The vein has an average strike of N. 35°E., and a mean dip between the three levels of 65°N.W. It has been opened up for a maximum length of 410 feet on the 375-foot level and traced to the east by diamond drilling for an additional 600 feet. The locations of the ore sections found on each level are shown on the accompanying composite plan (Fig. 14) and their grades in the following table:

At the time of the writer's examination of the area the Albany workings were full of water, with the result that the No. 2 vein could not be investigated. A description of the occurrence, however, has been published by Thomson (1938a, p.34).

Zone "D"

During the summer of 1940 a strong gold-bearing vein zone (Figure was discovered on the surface about 600 feet north of the Albany shaft. Trenching indicated the presence of an ore shoot, 140

TABLE NO. 18

Ore Developments, No. 2 Vein, Albany River Mine[1]

Level	Ore Section	Length in Feet	Average Width in Inches	Average Value in Dollars per Ton	Total Length in Feet	Avge Width in inches	Average Grade in Dollars Per Ton
375-foot	A	27	23	68.25			
	B	142	35	10.73			
	C_1	25	23	10.93			
	C_2	17	58	74.20			
					214	34	24.50
500-foot	A	70	42	22.05			
	B	30	37	11.55			
	C	200	45	14.00			
					300	44	13.90
625-foot	A	30	18	11.00			
	C_1	45	11	16.40			
	C_2	63	35	9.82			
					138	23	11.00

1. Information obtained from Company composite assay plan (Gold at $35.00/ounce).

feet in length and averaging 0.342 ounces of gold per ton (All grade estimates quoted from company assay plans), cut grade, across a mean width of 24.6 inches. A drive was immediately put out on the 125-foot level to test this structure. This also proved successful, for a body of ore averaging 0.240 ounces per ton across 26.0 inches for a length of 193 feet was indicated. Continuation of the shoot to a vertical depth of approximately 250 feet has been demonstrated by diamond drilling.

Zone "D" consists of two principal branching structures. The main branch strikes slightly north of east and has been traced on the surface for a distance of about 500 feet. At its western extremity it is represented by several lenticular quartz veins and stringers, up to 2 feet in thickness, across a width of approximately 4 feet along the folded contact between flow breccia on the south and sheared pillow lava on the north. To the east the veins and stringers depart from the "Z"-shaped drag fold and are localized along a strong sheared zone of more uniform strike and steep northerly dip, and cutting sharply across the faint axial plane foliation in the enclosing greenstones. Here the veins are more narrow and less lenticular in character, and in only one place does the main leader exhibit a contortion like those so characteristic of other veins in the Crow River area.

Near the central section of the zone, the veins split, with offshoots extending along a second sheared zone, about 5 feet in width, branching northward from the first, so that 330 feet east of the junction the centre lines of the two are approximately 120 feet apart. The northern branch also splits up to the east, and near its extremity attains a known maximum width of narrow quartz veins and stringers and intervening bodies of sheared greenstone of about 35 feet.

The veins and stringers are fairly massive in appearance, with only occasional books and ribbons of altered wall rock, and consist essentially of sugary-textured white quartz with a little carbonate and subordinate pyrrhotite and chalcopyrite. Tourmaline and sericite are developed locally along the walls and along ribbon structure in the quartz. Visible gold has been observed in several places. However, the grade of the vein as a whole is rather low, and it is only near the junction of the two branche that values of economic significance were indicated by channel sampling. The best grade occurs in the southern branch near the junction, along a length of 140 feet, and the highest values near the east end of the shoot where the main vein is contorted. Between the surface and the 125-foot level this shoot possesses an average strike and dip of N.80°E and 88°N., respectively, and rakes eastward at an angle of about 65 degrees.

Zone "E"

Zone "E" is located on the surface 550 to 1,050 feet west of the shaft. It is a narrow sheared zone with contorted quartz veins and stringers, from 1 inch to 3.2 feet in width, in massive, dark green, fine-grained lava, and possesses an average strike of N.75°E. Its attitude in the vertical dimension is not known. Drill intersections suggest a rather flat dip to the south, and it was upon this indication that the 625-foot level workings were extended southwestward in 1940. The underground work indicated, 800 feet west and 660 feet south of the shaft, a zone of irregular and discontinuous stringers of low gold content. At this horizon the zone was followed in a direction of about S.65°W. for over 600 feet, but of this length only two sections, one 103 feet in length and averaging 0.65 ounces of gold per ton across a mean width of 15 inches, the other 30 feet in length and averaging 0.63 per ton over 11 inches, were found to be of ore grade.

The quartz of zone "E" is sugary-textured and white to greyish white as before, and like that of Zone "D" contains small amounts of carbonate, tourmaline, sericite, pyrrhotite, pyrite, and visible gold.

Other Mineralized Zones

Two other zones of mineralization that are worthy of brief mention have been located on the Albany River Group. One is located about 1,800 feet southwest of the shaft along the boundary between claims Pa. 69 and Pa. 70. It has been described by Thomson (1938a, p.34) as follows:

> The showing .....occurs in a silicified sheared zone in greenstone near a 2-foot band of iron formation. The sheared zone strikes N. 70°E., and dips about 60°N.W. On the surface, values are reported at the places where there is heavy sulphide mineralization. (A) report by John A. Reid (Unpublished company report, January, 1936) averaging $9.19 over an assumed true width of 3.4 feet, a length of 80 feet, and at depths varying from 10 to 102 feet.

The diamond drill holes bored in the summer of 1950 were spotted to test this mineralization. One hole drilled on claim Pa. 70 at 45° indicated a zone of sheared greenstone with quartz stringers and pyrite averaging 0.168 ounces gold per ton over 10.0 feet of core (uncut average computed by writer from assays recorded in company diamond drill logs). A second hole, located 73 feet east of the first, however, returned only low values. A similar lens of silicified and mineralized greenstone was located on claim Pa. 69 along the north side of narrow tongue of pinkish albite granite, but again, although good values were cut in one hole, the grade proved to be low.

These lenses appear to be of east-west strike and northerly dip. They consist of silicified, and locally highly carbonatized, lava that has been mineralized with pyrite and cut by veins and stringers of white quartz. The quartz contains small amounts of metallic sulphides and scattered crystals of tourmaline. Assays range up to a maximum of 0.39 ounces gold per ton across widths up to 2.5 feet. Visible gold has not been reported.

The other mineralized zone occurs a short distance southwest of the No.2 vein on the 375-foot level. It consists of narrow sinuous quartz stringers along the contacts of but mainly within iron formation in the volcanic series. The zone exhibits an average strike of N.40°E. At its southwest extremity it lies only 30 feet from the No. 2 vein, but to the northeast the two structures diverge, and in the vicinity of the shaft lie more than 100 feet apart (See Figure 16). Gold has been found in this zone, but no ore sections have been indicated.

COHEN-MACARTHUR GROUP

The Cohen-MacArthur group of 22 patented claims lies northwest of the No.2 shaft on either side of the Crow River in the vicinity of Kishkap Falls. It was purchased from the original holders, Louis Cohen and J.A. MacArthur, in 1942 after the management of Pickle Crow Gold Mines Limited came to realize that an interest in the group was necessary for protection along the strike and down the dip of the No.2 vein system. It is underlain mainly by massive to schistose greenstones of from fine to coarse grain and by a few narrow horizons of contorted iron formation, both of which occur along the north flank of northeasterly plunge. The most striking rock is silicified and highly carbonatized greenstone. This rock weathers reddish brown in colour due to the formation of hydrous iron oxides resulting from the decomposition of the ferrodolomite or ankerite composing it, and hence is easily recognized in the outcrop. Exposures indicate, its occurrence in two large lenticular bodies trending in a north-northeast direction across claims Pa.777 and Pa.774. One of these bodies can be followed on the surface for a length of 1,150 feet, the other for 500 feet. The youngest rock exposed on the property is biotite lamprophyre, which occurs as narrow dikes cutting the greenstone flows.

Two gold-bearing deposits have been found. One of them. the original discovery made by J.A. MacArthur in March, 1933, is located in massive, fine-grained greenstone on the east boundary of claim Pa.773 about 300 feet north of the No.2 post. This deposit was opened up by trenching and test pitting in 1934, and in 1936 was tested by three diamond drill holes aggregating 360 feet in length, but with inconclusive results, the best intersection assaying 0.25 ounces of gold per ton over a core length of 16 inches (Assay and width quoted from company diamond drill logs). It consists essentially of greyish green, silicified schist along discontinuous, narrow sheared zones, of irregular but overall east-west strike, in which quartz veins and stringers up to about 15 inches in width are localized. The quartz is white and is mineralized with small amounts of arsenopyrite, pyrite, and chalcopyrite. A little carbonate is also present, and both chlorite and tourmaline occur sporadically along, and replace, inclusions of greenstone in the quartz. Visible gold has been found in the deposit, but the overall grade appears to be low.

The other deposit is located along the north side of the larger of the two lenticular bodies of carbonatized lava outcropping on claim Pa.774. It was also trenched in 1934 and subsequently tested over a length of 600 feet by 11 diamond drill holes aggregating 1,578 feet in length, but again the results did not prove encouraging. One hole returned a sample assaying 0.75 ounces of gold per ton over a core length of 68 inches, and another indicated 3.59 ounces over a core length of 14 inches (Values quoted from company assay plan) but these intersections are widely separated. In view of the proportion of low-grade to high-grade samples, the deposit cannot be classified as ore, at least at present time. The occurrence has been described by Thomson (1938a, p.48).

WINOGA GROUP

The Winoga group consists of 9 patented claims (Pa.2,061-2,069) located south of the Albany River group in the east part of the area. Formerly it was owned by Winoga Patricia Gold Mines Limited, incorporated in January, 1936. This company carried out extensive exploration work on the property, and was responsible for the boring of 73 diamond drill holes, aggregating 33,129 feet in length. In addition, some surface trenching was done, and in the summer of 1936 a geophysical survey of the claims was made by Hans Lundberg, Limited. However, nothing of commercial interest was discovered, and in 1938 the property was sold to Albany River Gold Mines, Limited. Subsequently, it came under the control of Pickle Crow Gold Mines Limited.

The geology of the property has been described by Thomson (1938a, p.65).

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PICPAT SYNDICATE

The Picpat Syndicate was organized in February, 1949, by E.S. Wilson, L.H. Mitchell, and E. Warren to carry out prospecting work in the Pickle Lake-Crow River region. On April 6, 1950, the members of the syndicate staked a group of 8 claims (Pa. 10,016-10,123 inclusive) west of the Cohen-MacArthur property of Pickle Crow Gold Mines Limited in the northeastern portion of the map-area. No rock outcrops were found on the claims, with the result that the members decided the best course of action was to carry out a dip needle survey in the hope of locating bands or iron formation. Except in that a slight magnetic "high" was indicated on claim Pa. 10,116, however, the survey did not reveal any persistent horizon markers. Later, in the months of May and June 1950, the dip needle work on claim Pa. 10116 was supplemented by a potentiometer survey, but again nothing of interest was disclosed. Finally, in October a short diamond drill hole was bored to test the magnetic "high". This indicated the presence of finely laminated basic tuff with interbedded cherty iron formation, both of which were found to be cut by several lamprophyre dikes. The iron formation is fractured and is sparsely mineralized with pyrrhotite, occuring as both diseminations and as replacement seams along bedding planes. A little arsenopyrite was noted in a few places in the core. Assays of the core indicated only a low gold content (up to 0.06 ounces per ton). One section, at a depth in the hole of 192.5 feet, however, was found to assay 0.27 ounces per ton over 2.5 feet (E.Warren, personal communication). No further work on the property has been reported.

The writer would like to thank Mr. E.Warren for his co-operation in supplying the results of the dip needle and potentiometer surveys, logs of the diamond drill hole, and an account of the Syndicate.

WALTRICIA GOLD MINES LIMITED

The Waltricia property consists of a group of 14 unpatented claims (Pa. 2609-, and Pa. 2622-2624, inclusive) north of the Central Patricia and Pickle Crow properties in the northwest portion of the map-area. Originally, the claims were held by Walker Patricia Gold Mines Limited, which was incorporated in February, 1937, to finance exploration and development work. In 1938 a dip needle survey was made, and a diamond drill hole was put down under the direction of A.J. Anderson. This hole, located in the eastern part of claim Pa. 2612, is reported to have cut 115 feet of iron formation, the last 20 feet of which assayed $5.40 in gold per ton (gold at $35.00 per ounce) Thomson (1938a, p.65). But other drill holes, put down to test this mineralization along the strike failed to uncover anything of commercial interest, and work at the property was finally suspended in 1940. Late in 1945, the property was optioned to Miami-General Development Mines, Limited, a magnetometer survey was carried out, and a second diamond drilling program was started. Waltricia Gold Mines Limited, was incorporated by Miami-General in July, 1946, and geological mapping, trenching, stripping, and diamond drilling was continued throughout the year. This work did much to clarify the geological relations of the formations underlying the claims, but again nothing of commercial importance was located and work was suspended for a second time.

The Waltricia property is underlain principally by Keewatin greenstone and narrow, apparently discontinuous horizons of intercalated iron formation. In the west part of the property these formations strike in a northeasterly direction, but toward the east they change strike and gradually acquire an east-west trend. They dip 75° to 80° to the northwest and north, respectively. Near the centre of the claim group they are cut transversely by two prominent dikes of quartz diabase, both of which strike N. 37°W.

WILSON GROUP

History and Development

The Wilson group consists of 17 unsurveyed mining claims, immediately north of the Waltricia property in the northwest quarter of Connell Township. The number of these claims, before the ground was allowed to come open for staking, were Pa.7,768 - 7,775 and Pa. 9,624-9,632, inclusive. They are accessible by a lumber road suitable for motor traffic, extending north from the Central Patricia Gold Mines Limited No. 1 shaft along the eastside of the airport to the north boundary of the Waltricia property, from which point a poorly marked trail leads to claim Pa. 9,630 (Figure 16).

The Wilson group was staked in May, 1946, by L.H. Mitchell and E. Wilson because of work being carried out about 2 miles to the northeast on the Metcalfe vein by Norpick Gold Mines Limited (Hurst 1930, p.26-27). During staking, Mitchell observed a quartz vein on claim Pa. 9,630, exposed in trenches reported to have been dug by Picador Mines in 1935. Grab samples of the vein gave interesting assays, ranging up to a half ounce of gold per ton, and in summer of 1947 approximately 1,300 feet of diamond drilling was carried out in the vicinity of the showing. This drilling did not outline any commercial ore. But although the overall gold content was found to be low, the best intersections returned 0.32 ounces per ton over a core length of 4.0 feet and 0.24 ounces per ton over 12.0 feet (Lytle 1948) and in 1948 Central Patricia Gold Mines Limited accepted an option agreement on the property to undertake further work. The claims were transferred on February 8, 1949, and in May of that year 5 diamond drill holes, aggregating 316 feet, were bored to test the Mitchell showing. This drilling, however, again proved unsuccessful in locating anything of economic significance, and in June, under the terms of the option agreement, the property was returned to E. Wilson. No further work on the claims has been reported.

General Geology

The bedrock formations underlying the Wilson group are largely concealed, in part by sand hills of northeasterly trend and in part by muskeg accumulations. But exposures have been found locally, and from these it may be presumed with some conviction that the principal formations are extrusive lavas, all of which have been metamorphosed to greenstones. Bands of iron formation are also present, for R. Thomson (1946) observed an outcrop in the northeast corner of claim Pa.7,768, and reported magnetic attraction at the No. 3 post of claim Pa. 9,624. Intrusive into the Keewatin complex are small bodies of sheared quartz porphyry, which outcrops at a few points along the south boundary of claim Pa. 9,630.

The Mitchell showing occurs approximately 500 feet east of the No. 3 post of claim Pa. 9,630. It consists of a quartz vein, up to about 1 foot in thickness, and a few parallel stringers striking north-south through porphyry and pillowed lava. The quartz is a fine-grained variety and contains a little pyrite, as do the wall rocks adjoining it. Like the other quartz veins in the area, the Mitchell vein is highly lenticular in plan and exhibits typical "S"-shaped contortions. Ribbon structures, essentially seams of sericite in the quartz, occur here and there and tend to parallel the vein walls. The best assays were obtained from samples cut from the vein and adjoining altered wall rock, where the host is quartz feldspar porphyry rather than greenstone.

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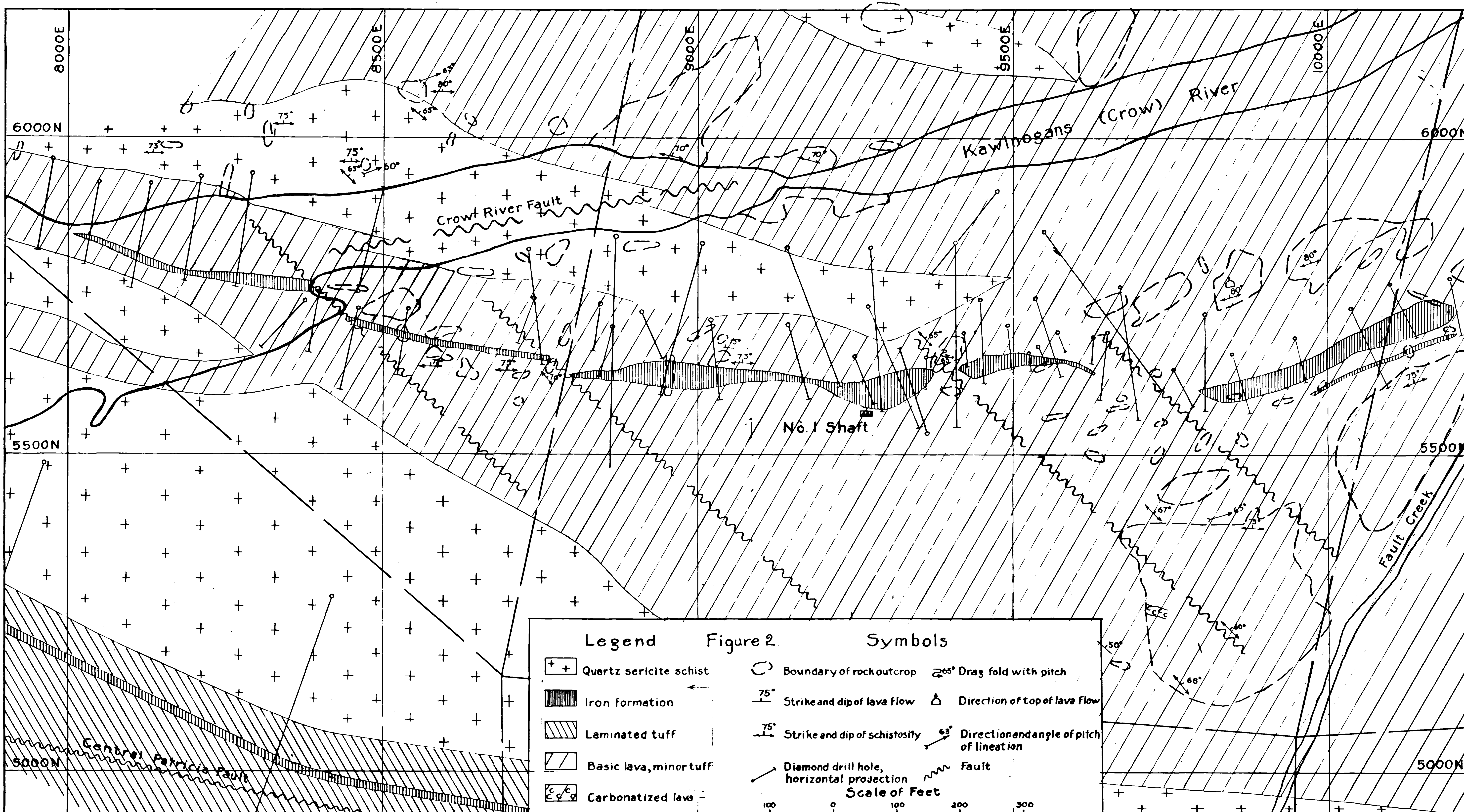
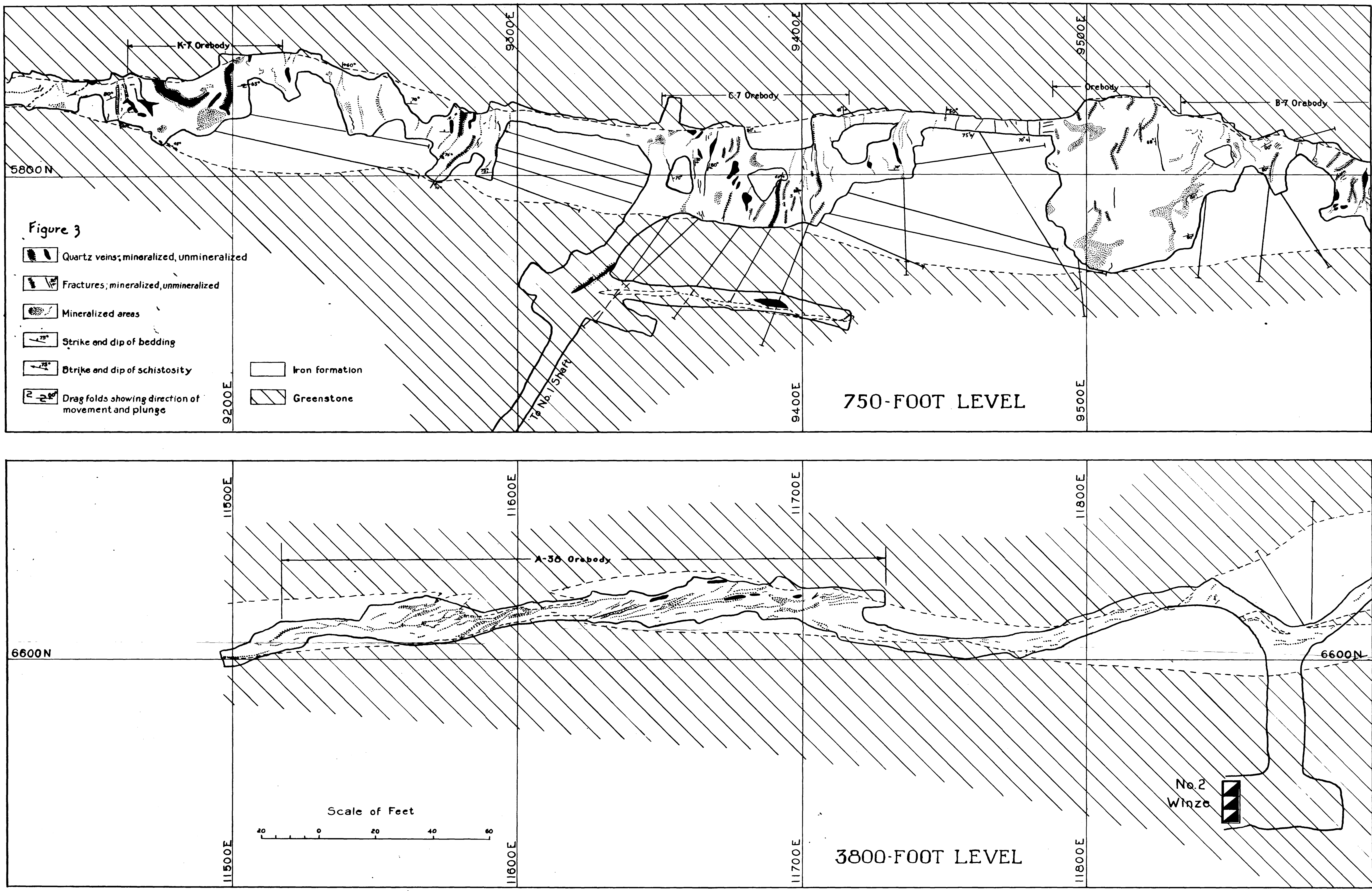


May extend title block to this line

Iron formation may be shown in solid black for reduction.
EGP.

A C B

~~Reduce AB to AC EXACTLY~~


K-7 Orebody
C-7 Orebody
Orebody
B-7 Orebody
9200E
9300E
9400E
9500E
5800N
To No. 1 Shaft
Figure 3
Quartz veins; mineralized, unmineralized
Fractures; mineralized, unmineralized
Mineralized areas
Strike and dip of bedding
Strike and dip of schistosity
Drag folds showing direction of movement and plunge
Iron formation
Greenstone
750-FOOT LEVEL
11500E
11600E
11700E
11800E
6600N
A-38 Orebody
Scale of Feet
20 0 20 40 60
No. 2 Winze
3800-FOOT LEVEL

A C B

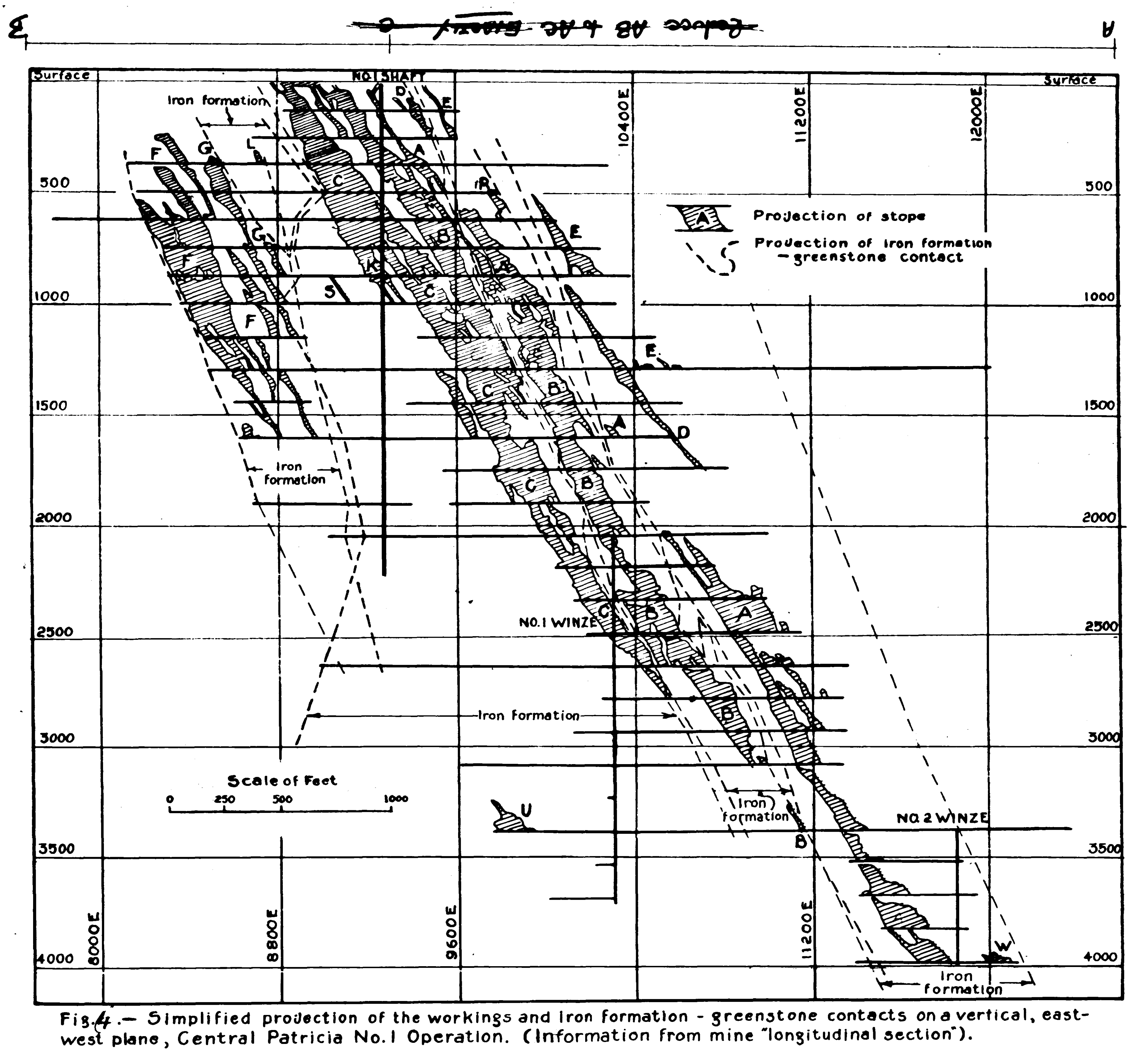


Fig. 4.— Simplified projection of the workings and iron formation - greenstone contacts on a vertical, east-west plane, Central Patricia No. 1 Operation. (Information from mine "longitudinal section").

A-17

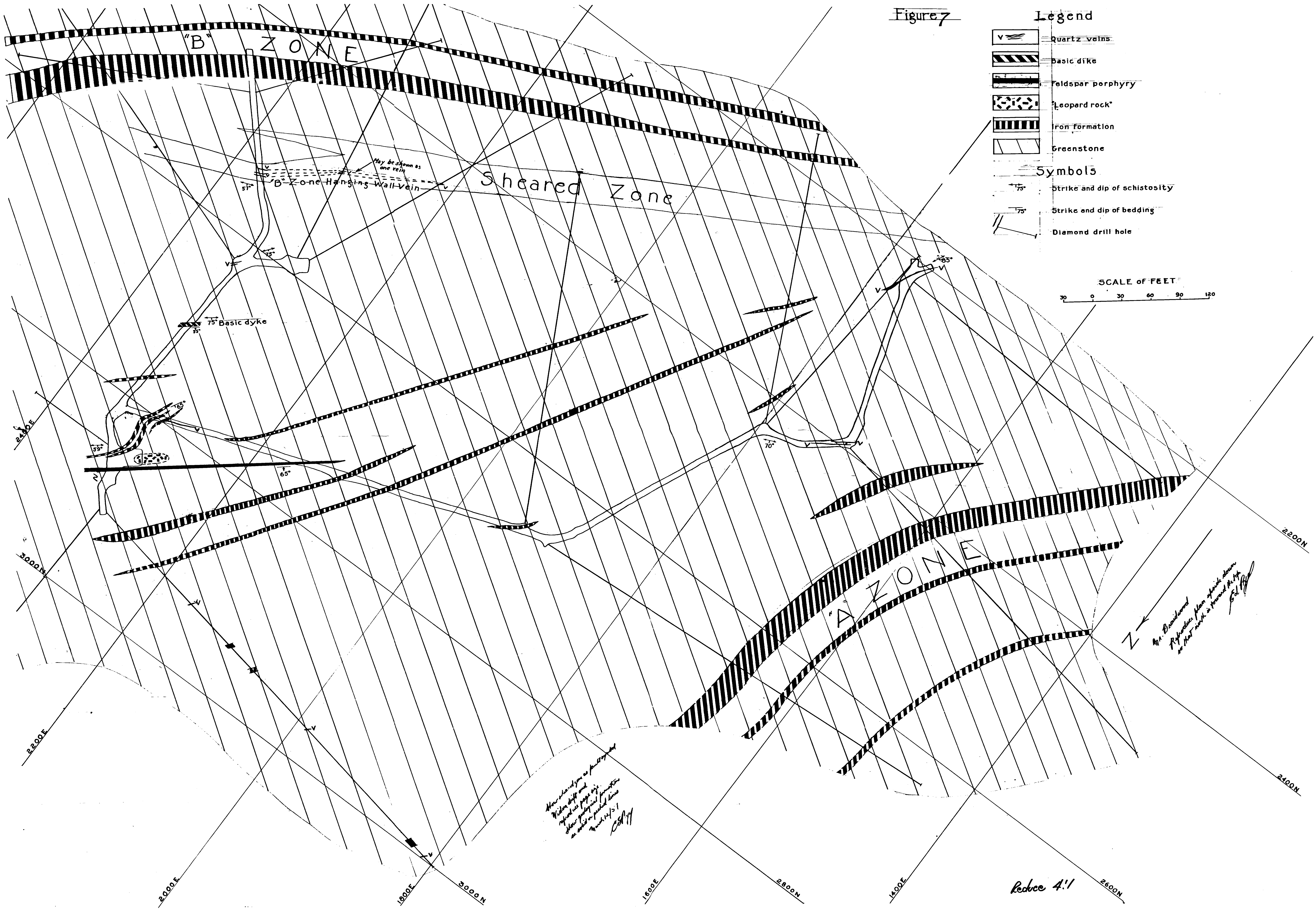


Figure 7
Legend
Quartz veins
Basic dike
Feldspar porphyry
"Leopard rock"
Iron formation
Greenstone
Symbols
Strike and dip of schistosity
Strike and dip of bedding
Diamond drill hole
SCALE of FEET
30 0 30 60 90 120
"B" ZONE
May be shown as one vein
"B" Zone Hanging Wall Vein
Sheared Zone
75° Basic dyke
"A" ZONE
2400E
2200E
2000E
1800E
1600E
1400E
3000N
2800N
2600N
2400N
2200N
Show sheared zone as fault symbol
Widen drift and reproduce page size.
Show geological formations as solid or peched lines
March 12/51
Mr. Braidwood
Reproduce plan upside down so that north is toward the top
Ed
Reduce 4:1

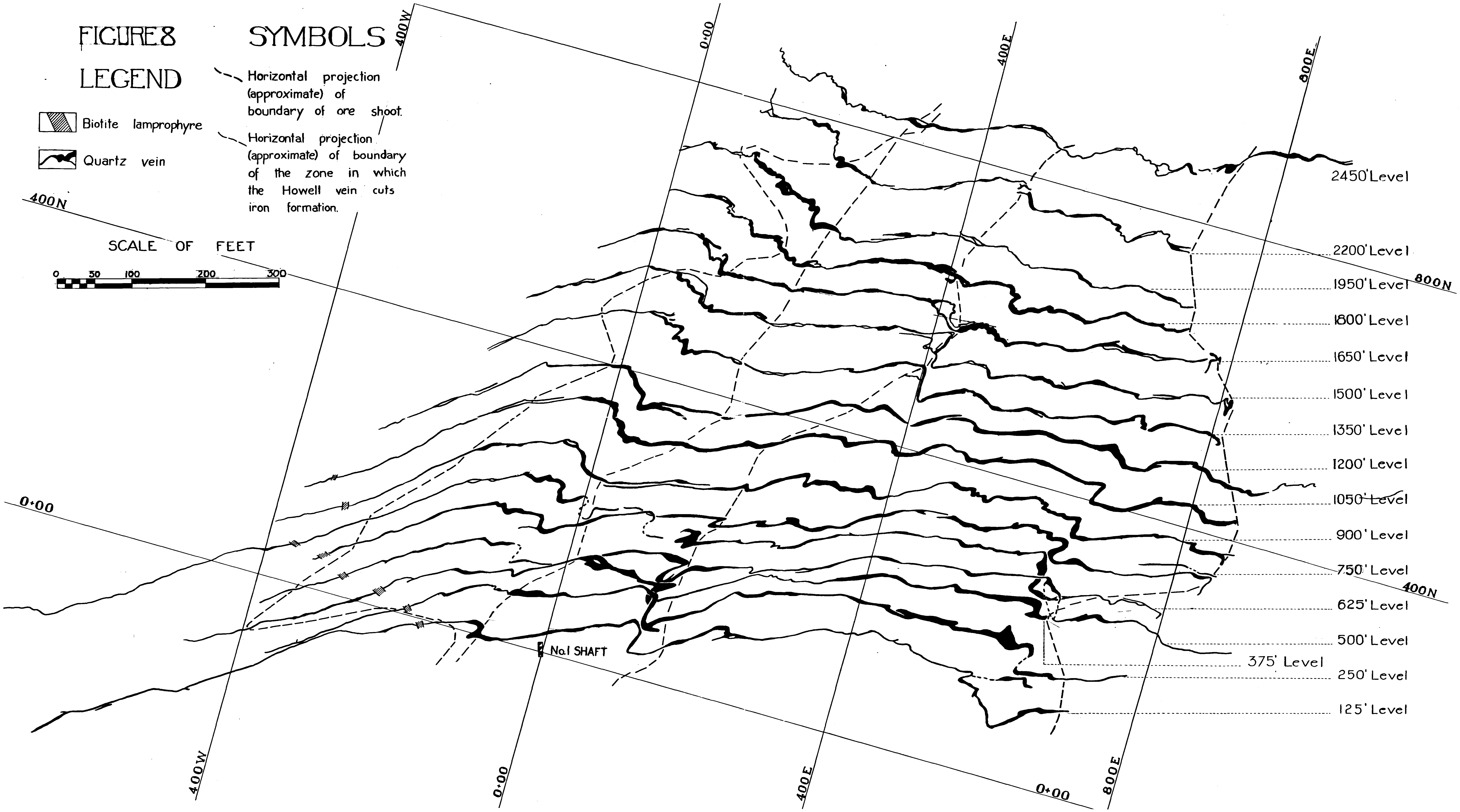


FIGURE 8
LEGEND
Biotite lamprophyre
Quartz vein
SYMBOLS
Horizontal projection (approximate) of boundary of ore shoot.
Horizontal projection (approximate) of boundary of the zone in which the Howell vein cuts iron formation.
SCALE OF FEET
0 50 100 200 300
400W
0+00
400E
800E
400N
800N
2450' Level
2200' Level
1950' Level
1800' Level
1650' Level
1500' Level
1350' Level
1200' Level
1050' Level
900' Level
750' Level
625' Level
500' Level
375' Level
250' Level
125' Level
No. 1 SHAFT


750-FOOT LEVEL
EAST SIDE
FIGURE 9
Symbols
Geological boundary
Flow contact
Number of lava flow
Legend
Quartz Vein
"Vein" dike
Iron Formation
Greenstone
Scale of Feet
Petrography of Greenstones
7 Dark grey, medium-grained, dioritic lava.
10 Greenish-black, fine-grained, laminated schist
11 Greenish-black, fine-grained, massive lava
12 Dark grey, fine-grained, schistose lava
13 Grey, fine-grained lava with red, cherty lenses
14 Green, medium-grained, schistose lava
15 Green, fine-grained, schistose lava.
15' Flow breccia, possibly represents top of 15
16 Black, fine-grained, massive lava with considerable pyrite in form of crystals.
17 Brownish grey, fine-grained lava.
1350 FOOT LEVEL
EAST SIDE
Symbols
Geological boundary
Flow contact
Number of lava flow (These numbers do not necessarily correspond with those on 750' Level)
Strike and Dip of Joint
Strike and Dip of dike
Diamond drill hole
Legend
Aplite dike
Diorite dike
Quartz vein
"Vein" dike
Iron formation
Greenstone
Petrography of Greenstones
7 Dark grey, medium-grained, dioritic lava
10 Grey, fine-grained, massive lava
11 Green, fine-grained, massive lava, locally silicified
12 Green, fine-grained, massive lava
13 Green, medium-grained, dioritic lava.
14 Brownish, fine-grained, massive lava.
Scale of Feet
Post-Vein Fault

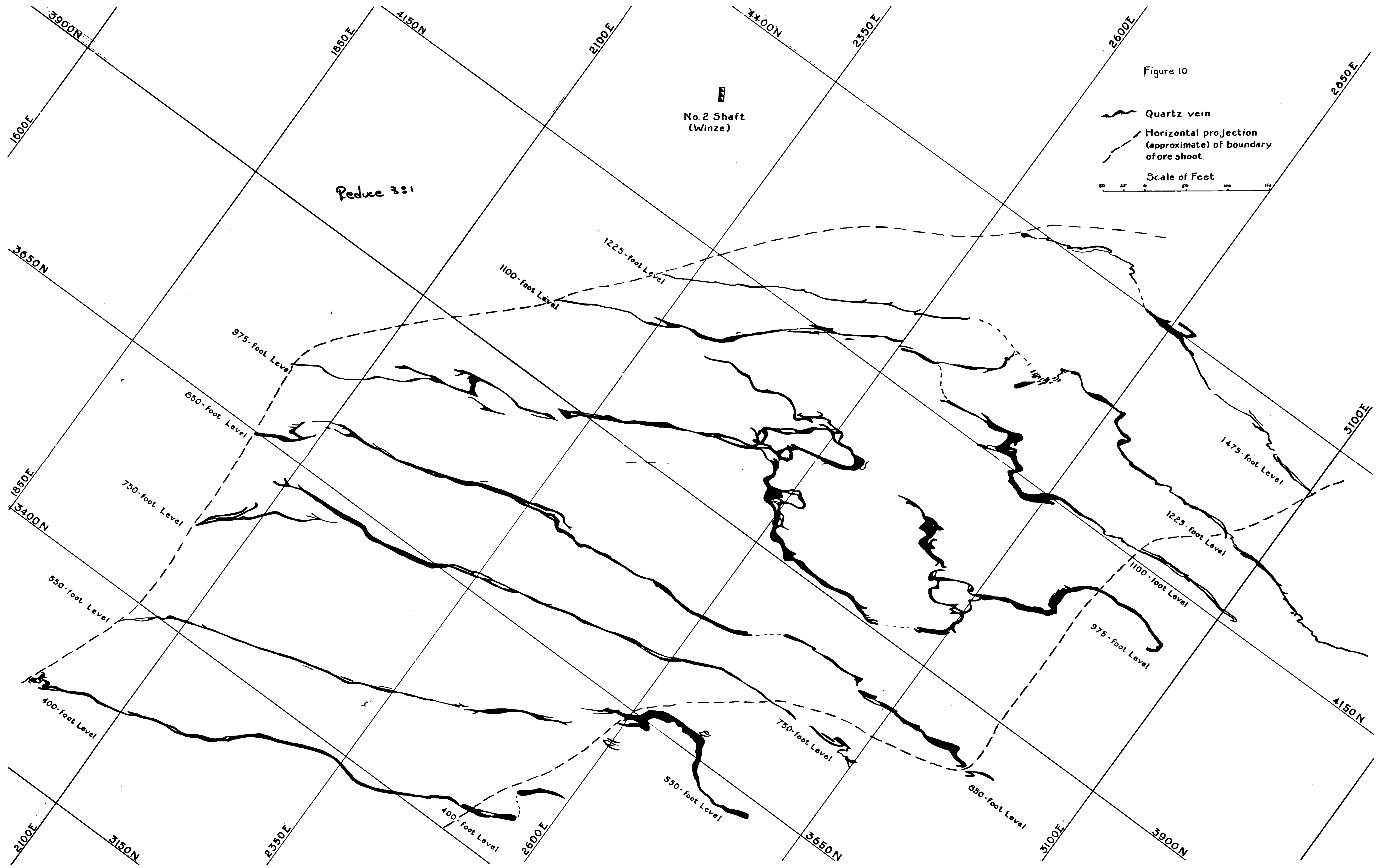
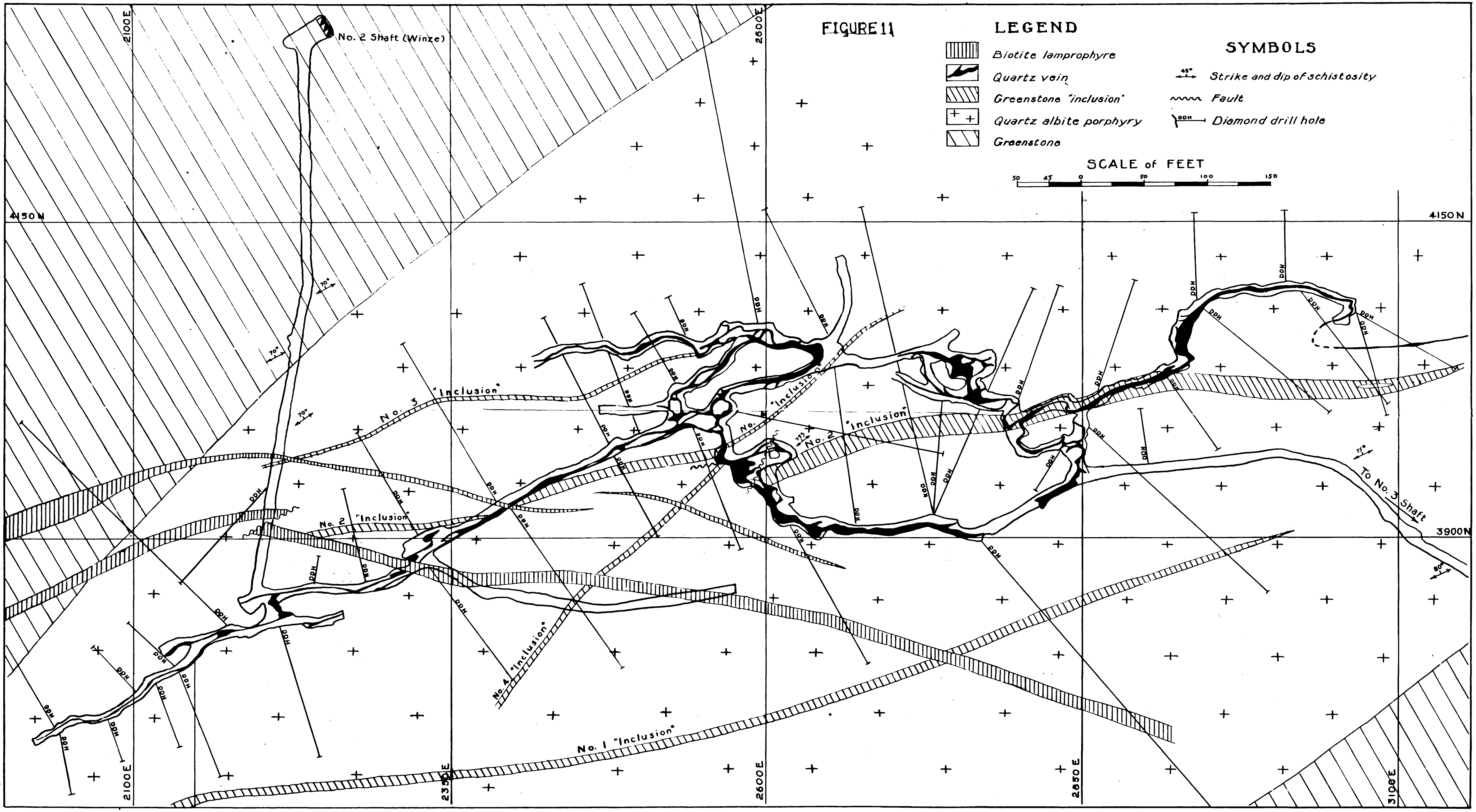


Figure 10
Quartz vein
Horizontal projection (approximate) of boundary of ore shoot.
Scale of Feet
No. 2 Shaft (Winze)
Reduce 3:1
3900N
4150N
4400N
3650N
3400N
3150N
1600E
1850E
2100E
2350E
2600E
2850E
3100E
400-foot Level
550-foot Level
750-foot Level
850-foot Level
975-foot Level
1100-foot Level
1225-foot Level
1475-foot Level



LEGEND
Biotite lamprophyre
Quartz vein
Greenstone "inclusion"
Quartz albite porphyry
Greenstone
SYMBOLS
Strike and dip of schistosity
Fault
Diamond drill hole
SCALE of FEET
50 25 0 50 100 150
No. 2 Shaft (Winze)
2100E
2350E
2600E
2850E
3100E
4150N
3900N
No. 3 "Inclusion"
No. 2 "Inclusion"
No. 1 "Inclusion"
No. 4 "Inclusion"
To No. 3 Shaft
DDH
70°
75°
80°

FIGURE 11

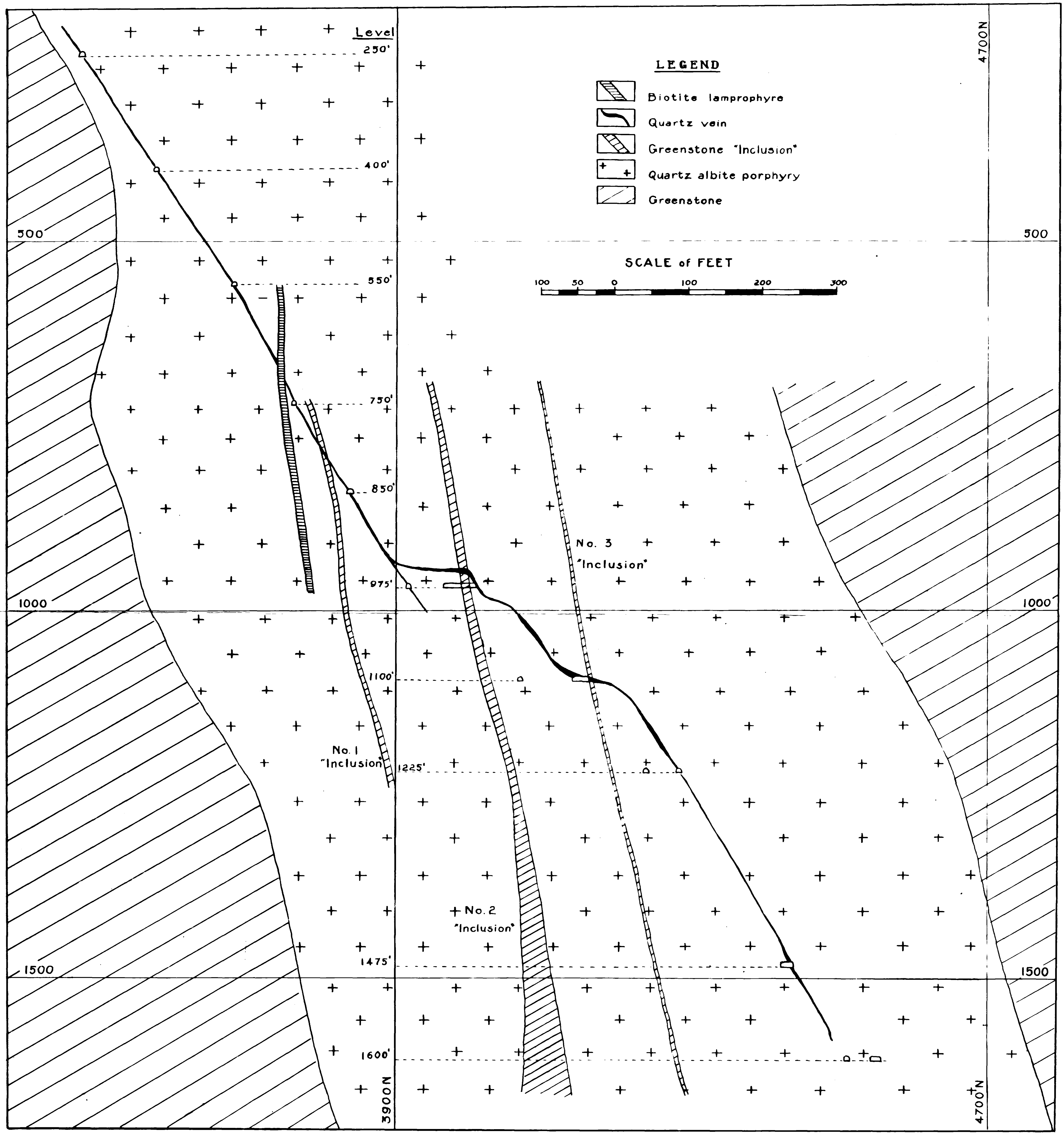
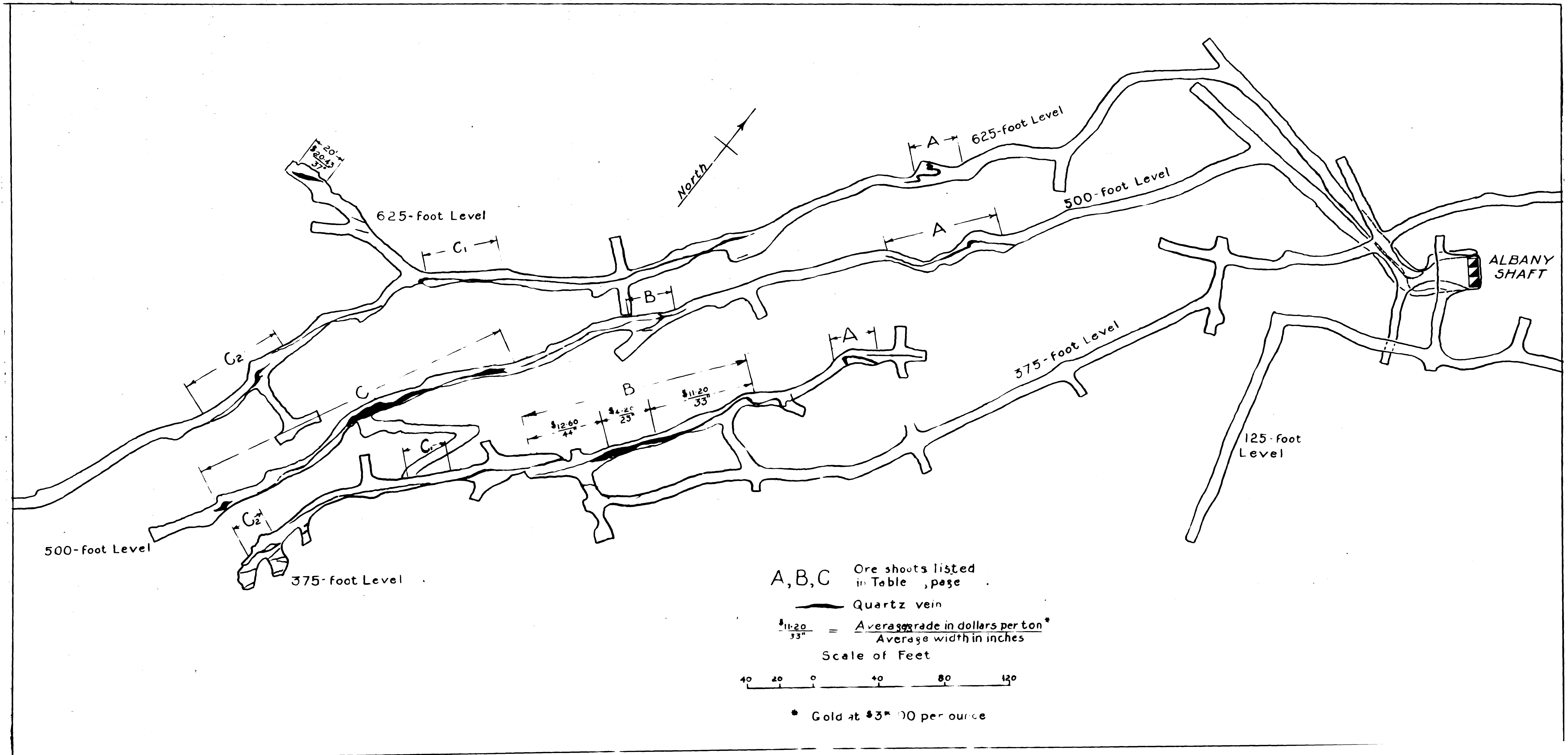


Fig. 12. Vertical north-south section along the 2800E co-ordinate, No 2 Operation, Pickle Crow Gold Mines. (After W. R. MacQuarrie.)



North
625-foot Level
625-foot Level
500-foot Level
500-foot Level
375-foot Level
375-foot Level
125-foot Level
ALBANY SHAFT
A
A
A
B
B
C
C1
C1
C2
C2
20'
$20.43
37"
$12.60
44"
$4.20
25"
$11.20
33"
A, B, C Ore shoots listed in Table , page .
Quartz vein
$11.20 / 33" = Average grade in dollars per ton* / Average width in inches
Scale of Feet
40 20 0 40 80 120
* Gold at $3 00 per ounce

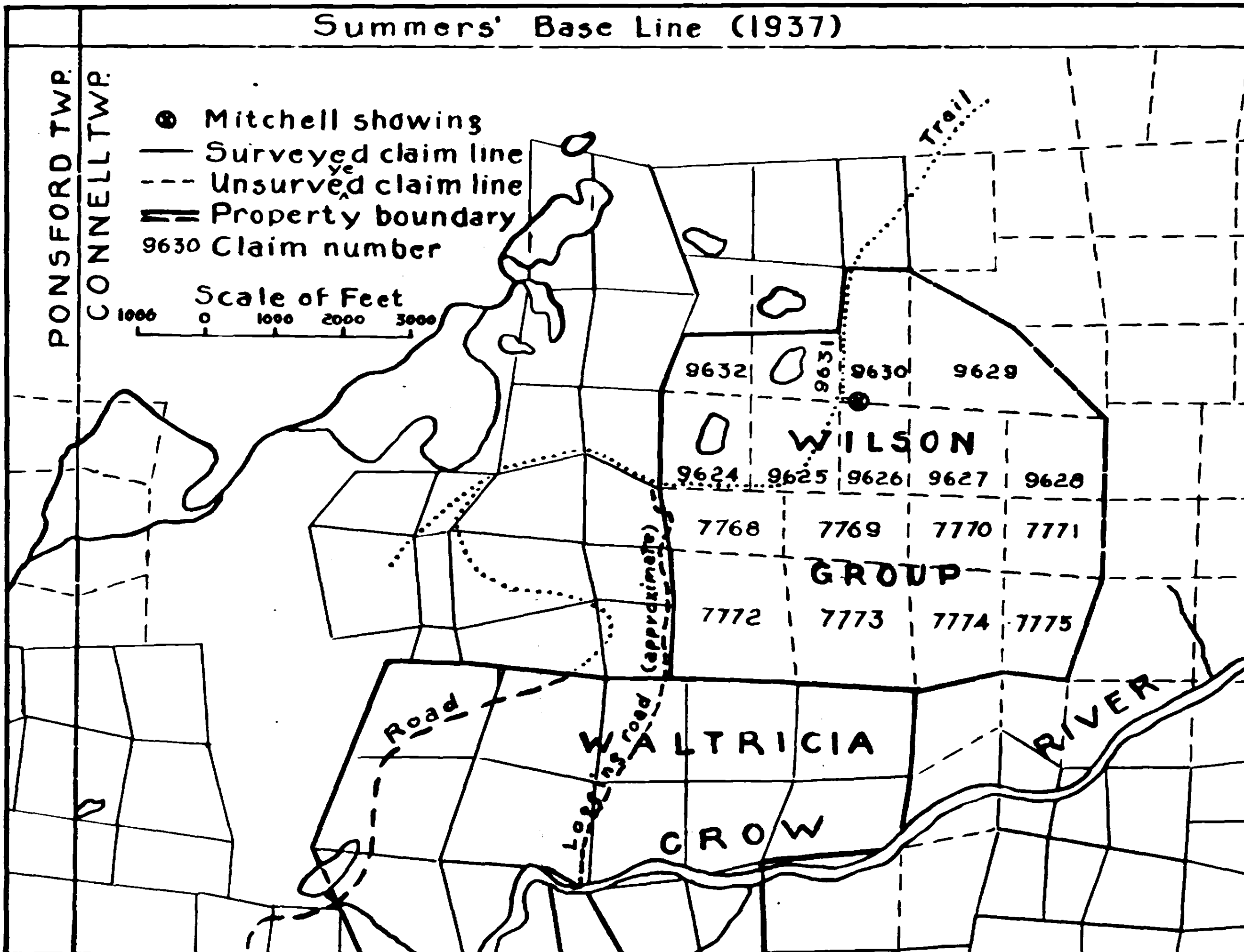
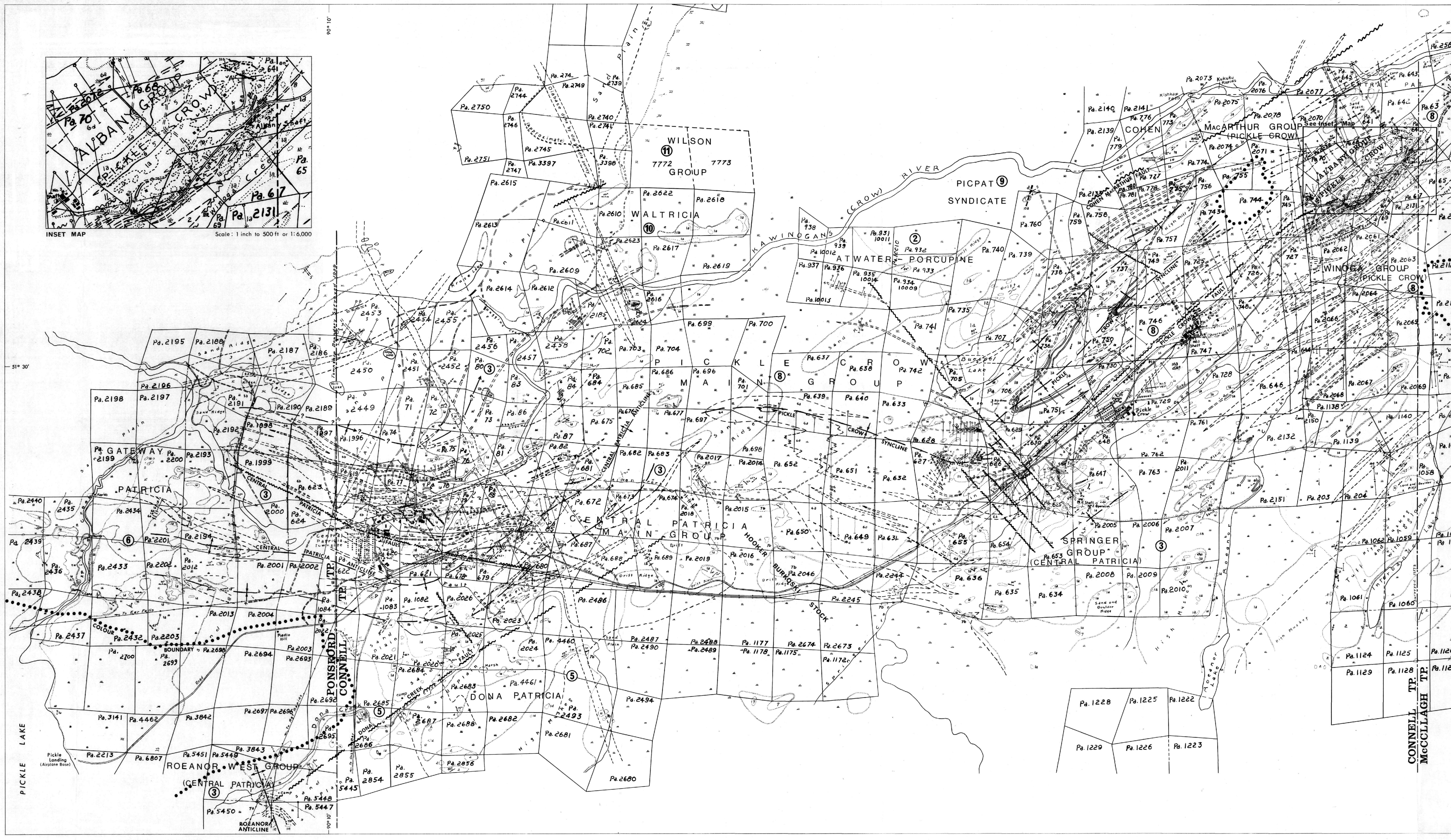


Fig. 16 - sketch map showing location of the Wilson group. [redacted]



MARGINAL NOTES

By 1942, gold mining was classified as a non-war industry. By the end of 1947, all surface exploration, except, on properties held by the two producing mines, had been brought to a halt.

In 1951, a gold-bearing vein (No. 5 vein) and a deposit of auriferous sulphide were discovered near the No. 1 shaft on the Pickle Crow property.

GENERAL GEOLOGY: The map-area is underlain by metavolcanics, metasediments and intrusive rocks of Precambrian age.

The metavolcanics of Early Precambrian (Archean) age constitute over 60 percent of the map-area. The extrusive lava, the most abundant, is andesitic to basaltic in composition, massive to schistose. Colours range from light to dark green and from grey to greenish grey. Generally primary features are not exhibited but in places pillows, developed locally and not destroyed by shearing, indicate directions in which flow tops face. Porphyritic and variolitic lavas have been noted in a few localities (Thomson 1938, p.6).

The fine-grained intermediate and mafic lava grades imperceptibly into medium-grained, dark greenish grey metadiabase. The metadiabase, which appears to conform with the banding of the adjoining lavas, forms good horizon markers.

The metadiabase is practically identical to the metamorphosed mafic intrusive rocks in appearance, mineralogical composition, alteration and except in rare cases, where pillows have been recognized, also structure. Both consist essentially of fibrous amphibole, chlorite, and highly altered plagioclase with small amounts of carbonate, epidote, sericite, and quartz and subordinate leucoxene, apatite, sphene, and sometimes pyrrhotite.

The felsic lavas are dacitic in composition. On the Pickle Crow Main and Albany River claim groups and on the Crowshore property there are exposures of rhyolite.

Chlorite schist occurs in narrow zones believed to have been the loci of fault adjustments during or after regional folding. Hornblende schist occurs only near granitic intrusions where processes of alteration and recrystallization were more intense.

The most extensive and typical exposure of carbonatized lava is found 1,400 feet (420 m) south of Kishkap Falls on the Cohen MacArthur claim group. It consists of intermixed quartz and ferruginous dolomite.

Rhyolitic agglomerate outcrops on the Patricia claims along and south of Dona creek; elsewhere in the area the agglomerate is more mafic. Rhyolitic agglomerate consists of elongated contorted fragments of felsic lava in a pale grey to pink siliceous tuff, whereas the mafic agglomerate fragments are elongated, rounded, angular in shape and consist of one or more of basalt, dacite, rhyolite, and chert. The matrix is highly chloritic, massive to schistose.

A typical sample of tuff consists of layers of chlorite schist with scattered magnetite grains alternating with laminae made up of quartz, siderite, and magnetite. The more abundant mafic tuff has a much higher chlorite content, carbonates are not abundant and albite, epidote, sericite, and leucoxene are present.

Flow breccia consists of ovate to irregular-shaped fragments of fine-grained "greenstone" enclosed in a matrix of similar texture and mineralogical composition.

Small bands of fine-grained metasediments are interbedded with lava flows at a few places in the map-area.

The iron formation is a strikingly banded, rusty weathering rock that consists of thin layers, in which iron carbonate, fine-grained quartz, and magnetite are present in varied proportions (Hurst 1930). It occurs as streaks, lenses, and narrow bands, from a few inches to over 100 feet (30 m) in thickness. Frequently some of the bands can be traced continuously for miles along strike; other bodies are lenticular, extending for only a few feet but they are often arranged in linear patterns permitting the delineation of stratigraphic horizons for structural studies.

The metamorphosed mafic intrusive rocks are represented by gabbro and porphyritic gabbro. The latter, which does not outcrop, consists of white to cream-coloured phenocrysts, up to 2 inches (5 cm) in length, of highly altered plagioclase embedded in a dark green, and a relatively fine-grained matrix of feldspar, chlorite, amphibole, sericite, and accessory magnetite.

The felsic intrusive rocks may be segregated into 5 groups:
1) highly sheared porphyries, including quartz-sericite schist and quartz albite porphyry
2) biotite granite (gneiss) and (porphyritic) albite granite;
3) faintly sheared to massive porphyry, including albite porphyry and quartz diorite porphyry;
4) felsic dikes termed aplite, rhyolite or felsite; and
5) mafic dikes, including metadiabase and biotite lamprophyre.

The typical quartz-albite porphyry is a sheared, fine-grained, greyish to greyish pink rock with phenocrysts of quartz and feldspar. Some are more highly sheared than others and the relatively more massive ones appear to be less contorted which suggests that their intrusion commenced during the early stages of the regional deformation and continued until or nearly until the major folds had developed into their final forms. This is of considerable significance, for while the folded porphyries have provided important structural controls for mineral deposition, the more massive varieties, such as the one found at the Pickle Crow No. 3 shaft, are much more favourable host rocks than are those which are highly schistose.

Quartz-sericite schist differs from quartz-albite porphyry only in its more highly schistose character and in the absense of feldspar phenocrysts which have been reduced to aggregates of secondary minerals. Diamond drilling, southeast of No. 1 shaft of Central Patricia Gold Mines Limited, has shown that locally one rock type passes into the other along its strike. Crosscutting relationships, in places, indicate that much of the quartz sericite schist at the Central Patricia mine is igneous in origin, emplaced by intrusive action.

Intrusions of biotite granite flank the Crow River area on the northwest and southwest, but no exposures of this rock have been found within the boundaries of the map-sheet. In drill core section the granite is greyish pink, and generally massive. Some specimens show a faint gneissic structure. It consists of microcline, oligoclase, and quartz, with minor amounts of brown biotite and accessory magnetite and apatite. The feldspars, particularly the plagioclase, are replaced by sericite, epidote and a little carbonate.

The albite granite (porphyritic) resembles the quartz-albite porphyry in structure and metamorphism. The former represents a coarse-grained facies.

The albite porphyry is grey or brownish grey with distinct, well-formed phenocrysts of white plagioclase and occasionally quartz phenocrysts. The albite porphyry is very similar to the sheared porphyries differing only in its characteristic massive quality and in lack of abundant quartz phenocrysts.

Quartz diorite porphyry is younger than the sheared quartz albite porphyry. The former is grey to dark grey in over-all colour, with phenocrysts of white feldspar and quartz. Its most distinguishing feature is the presence of large crystals and grains of lustrous, black biotite.

Aplite, rhyolite and felsite dikes are believed to be post-granite in age, for although no intrusive relationships have been found in the map-area itself, the work of Hurst (1930) and Evans (1939) has shown that pegmatite and aplite dikes of similar character cut the biotite granite. Thomson (1938) describes an aplite dike crosscutting a gold-bearing quartz vein on the Dona Particia property so the massive felsic dikes are post-ore in age.

Small metadiabase dikes are common in the underground workings at the Pickle Crow No. 1 shaft, where they appear to be both pre-quartz and post-quartz in age.

Biotite lamprophyre is massive, dark grey to black, medium-grained, with a distinct porphyritic texture due to crystals of biotite that in places exceed a quarter of an inch (0.6 cm) in length. Most dikes of biotite lamprophyre are too small to be shown on the map. It appears that these dikes were formed at about the same general time as the mineral deposits (Pye in press, p.46).

Dikes of quartz diabase, strongly resembling the Keweenawan diabase found in other parts of northwestern Ontario, and here tentatively correlated with it, strike in a northwest-southeast direction. The quartz diabase is a well-jointed but otherwise massive, brownish weathering, dark grey to black rock with small, interlocking, lath-like feldspar crystals.

STRUCTURAL GEOLOGY: Formations in the area were first isoclinally folded into anticlines and synclines of general northeasterly plunge, then cross folded along north to northwest axes, and finally displaced by both strike and transverse faults.

Thomson followed three horizons of iron formation bands about the nose of the Pickle Crow Syncline, determining a pitch to the northeast of between 45 and 70 degrees (Thomson 1938, p.20). The axial plane has been overturned (Pye in press, p.55).

On the Pickle Crow Main group the trace of the axial plane of the syncline strikes about N50E and extends northeast beyond the limits of the map-area with no great deviation in attitude. However, to the southwest across claim Pa. 672, it strikes east-northeast and then gradually swings about to an east-west strike, where it apparently passes through a large saddle-like body of quartz albite porphyry. It thus appears to have been deflected from its normal course by cross-folding about the Hooker-Burkoski Stock. In the western part of the area there may be another synclinal fold of general northeasterly pitch, possibly representing the extension of the Pickle Crow Syncline.

The anticlinal axis (Central Patricia Anticline) south of the Central Patricia No. 1 shaft has an overturned axial plane, north at about 75 degrees, and strikes N70E. However, to the west it swings to assume first an east-west strike and then where it appears to extend across the Gateway Patricia claims it assumes a west-northwest strike (Thomson 1938). It seems probable that the axial plane of the Central Patricia Anticline curves around the nose of the Hooker-Burkoski Stock.

In the eastern part of the area another anticlinal fold has been outlined by Thomson (1938, p.20). He interprets this structure as a minor drag fold on the flank of the Pickle Crow Syncline. The trace of the axial plane of this anticlinal fold lies about 1,000 feet (300 m) northwest of that of the Pickle Crow Syncline in this area. In the vicinity of the Central Patricia Mine the same relationship is found between the axial planes of the Central Patricia Anticline and the inferred syncline to the south. It seems probable that the anticlinal and synclinal folds of the east and west parts of the map-area are the same structures.

Several directions of shearing are evident in the area. Most important is the regional schistosity developed in some of the lava flows, fragmentals, and porphyries. The schistosity closely parallels the assumed traces of the axial planes of the Central Patricia Anticline and the Pickle Crow Syncline. Superimposed on the regional schistosity is a later variety that strikes parallel to the axis of the Hooker-Burkoski Stock and the cross fold associated with it.

The principal faults may be classified as either longitudinal or transverse; the former are more significant. Generally they strike parallel to the formations, with a west-northwest strike in the vicinity of the Central Patricia Mine or an east-northeast strike near the Pickle Crow Mine. The transverse faults strike across the formations, generally in a northwest direction.

The major longitudinal faults are the Central Patricia, Crow River, and Pickle Crow Faults. Big Muskeg Fault is really two distinct structures, the Dona Creek and Cohen-MacArthur Faults, which have no direct relationship.

All the known transverse faults strike northwest, roughly parallel to the axis of the Hooker-Burkoski Stock and dip to the northeast at angles ranging from 60 to 75 degrees. West of the Hooker-Burkoski Stock the displacement along each known transverse fault is right hand whereas east of the stock it is left hand. Both types of transverse fault were formed after the cross folding but before the ore deposition.

ECONOMIC GEOLOGY: As of 1951, gold was the only metal that proved to be of economic importance. The silver that was recovered as a by-product of the gold ores was low in overall production. Since tungsten was in demand in the early years of World War II, a small amount of scheelite was obtained from the quartz veins of the Pickle Crow mines. None of the deposits in the area were found to contain sufficient scheelite to permit a profitable mining operation. The many bands of iron formation did not appear to contain iron-bearing minerals in concentrations of sufficient size and grade to make ore.

The gold deposits were classified by Thompson (1938, p.25) according to structure, shape, size and continuity as
1) fissure of composite quartz veins
2) stockworks in iron formation
3) silicified sheared zones
4) replacement bodies

The author (in press, p.75,76) has assigned these general types of deposits to one or more of three major classes and their several subdivisions.

Attawapiscat Mining Syndicate Limited was incorporated in 1945 to take over 2 unpatented claim groups (West and East), located north of Dona Lake near the southwestern corner of Connell Township. The only mineralization discovered was located by D. Wright in 1945 along the western bank of Fault Creek on claim Pa.6893. The vein (about 5 feet [1.5 m] wide) consists of glassy white quartz with a little pyrite. Systematic sampling indicated only traces of gold although one specimen of quartz, taken by D. Wright assayed 0.41 ounce gold per ton (Lytle 1945).

Ontario
Division of Mines

HONOURABLE LEO BERNIER, Minister of Natural Resources
Dr. J. K. REYNOLDS, Deputy Minister of Natural Resources

PRELIMINARY MAP P.1009
GEOLOGICAL SERIES

CROW RIVER AREA

Scale: 1 inch to 1,000 ft. or 1:12,000

LEGEND

PHANEROZOIC
CENOZOIC
QUATERNARY
PLEISTOCENE
Boulder clay, gravel, sand

GREAT UNCONFORMITY

PRECAMBRIAN
LATE PRECAMBRIAN
MAFIC INTRUSIVE ROCKS (KEWEENAWAN)
11 Quartz diabase

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)
MAFIC INTRUSIVE ROCKS
10 10a Biotite lamprophyre; 10b Metadiabase

FELSIC INTRUSIVE ROCKS
9 Aplite
8 8a Quartz diorite; 8b Massive albite porphyry
7 Biotite granite
6 6a Quartz-albite porphyry (sheared); 6b Quartz-sericite schist

INTRUSIVE CONTACT

METAMORPHOSED MAFIC INTRUSIVE ROCKS
5 Gabbro, porphyritic gabbro

METAVOLCANICS AND METASEDIMENTS
4 Iron formation
3 Quartzite, greywacke, graphitic schist, and some interbedded lava

METAVOLCANICS
Fragmental Rocks
2 Agglomerate, tuff, flow breccia
Extrusive Rocks
1 1a Fine-grained intermediate and mafic lava; 1b Metadiabase; 1c Felsic lava; 1d Chlorite and hornblende schist; 1e Carbonatized lava

LIST OF PROPERTIES (as of December 31, 1951)*

1. Attawapiscat Mining Syndicate
2. Atwater-Porcupine Prospecting Syndicate
3. Central Patricia Gold Mines Limited
4. Crowshore Patricia Gold Mines Limited
5. Dona Patricia Gold Mines Limited
6. Gateway Patricia Gold Mines Limited
7. Kaw-Crow Patricia Gold Mines Limited
8. Pickle Crow Gold Mines Limited
9. Picpat Syndicate
10. Waltricia Gold Mines Limited
11. Wilson, E.

*Location of properties approximate

SOURCES OF INFORMATION

Geology and compilation by E.G. Pye and assistant, 1951.

Magnetic declination approx. 1°E, 1951.

Issued 1975