013326 W.J. McMillan

FISH LAKE DEPOSIT NTS 920

LOCATION 51°28' N; 123°38' W about 130 km southwest of the city of Williams Lake and about 10 km north of the north end of Taseko Lakes.

ACCESS Access is via the Bella Coola highway which is predominantly gravel to Lee's Corners, ~~which is~~ roughly 100 km from Williams Lake, then southward and westward across the Chilcoten River, through the Chilco Ranch and the Stoney Creek Indian Reserve and west to the Whitewater Bridge across the Taseko River. A branch road goes southward along the east side of the River and about 10 km along it another branch road leads 6 km eastward to the property and Fish Lake (Plate 1).

FISH LAKE DEPOSIT   NTS 920

REGIONAL GEOLOGIC SETTING

The Fish Lake deposit (Figure 1) lies within an embayment in the north contact of a northwest elongated fine grained, porphyritic quartz diorite stock (Wolfhard, 1976). The stock was emplaced into marine lower Cretaceous shale and graywacke and marine to non-marine lower to upper Cretaceous andesitic pyroclastic rocks with intercalated massive to porphyritic flows which occupy the Tyaughton Trough. The Tyaughton Trough is a successor basin infilled by both marine and non-marine sedimentary and volcanic rocks. Infilling of the Trough occurred from mid-Jurassic to mid-Cretaceous and the last marine transgression occurred in late lower Cretaceous time. Swarms of east-trending feldspar porphyry dykes, (Jeletsky and Tipper, 1968), north of the stock and northerly and northwest trending faults north and south of it disrupt the Cretaceous succession (Tipper, 1963). One of these, the Yolakom fault, had significant transgressive movement during late Cretaceous time accompanied by volcanism and continental sedimentation.

The Fish Lake deposit lies ~~in an~~ In the embayment of the northern contact of the quartz diorite stock where ~~(Wolfhard, 1976). There,~~ hornfelsed sedimentary, volcanic and pyroclastic country rocks were intruded by a complex of post-diorite dykes and small stocks. Mineralization at Fish Lake occurred 77 m.y. ago (Wolfhard, 1976) and may be genetically linked to later stages of this fault movement and volcanism. Subsequently, much of the area was veneered by Miocene lavas, or Pleistocene to recent alluvial deposits. Erosion has opened windows in the Miocene lavas and Fish Lake deposit is exposed in one.

LOCAL GEOLOGIC SETTING

The Fish Lake porphyry system (Figure 2) is within an area of volcanic, sedimentary and porphyritic intrusive rocks within a plication in the contact of a fine grained porphyritic quartz diorite stock. As a result of contact metamorphism dissociated with the various intrusions, the country rocks were pervasively converted to biotite hornfels. As is discussed later, the distribution of biotite is complicated, both by a superimposed wave of hydrothermal biotite alteration and by later overprinting of argillic-propylitic alteration assemblages.

The country rock was a mixed assemblage of massive to porphyritic volcanic and ~~rocks,~~ volcaniclastic rocks, graywackes and shales. Few original textures have survived the overlapping effects of the thermal and hydrothermal events. In many instances, where alteration is strong, it is difficult to distinguish volcanic country rock from altered finely crystalline intrusive rocks in this subvolcanic regime.

Rocks of the large quartz diorite stock are not exposed on the property but have been described by Wolfhard (1976). They are finely crystalline, but porphyritic with 20-40 percent, 1 to 2 mm, euhedral plagioclase phenocrysts and 10 percent hornblende phenocrysts in a matrix of plagioclase, quartz and 1 to 5 percent biotite. Plagioclase is typically reverse zoned An_{40-45} with some An_{50} overgrowths. Wolfhard also describes two younger pre-mineral porphyry phases and one post-mineral phase.

In this study, porphyries were grouped as pre-ore plagioclase porphyry and quartz plagioclase porphyry (QFP) and post-ore

2a (insert on page 3 ahead of PETROLOGY etc.)

Geometry and Reserves of the Deposit

The portion of the Fish Lake deposit with grade exceeding 0.25% copper (after Wolfhard, 1976) is ovalloid (Figure 2) with long and short axes about 450 metres and 250 metres respectively. The contacts of the zone are subvertical and the bottom has not been reached by drilling (Figure 3). Wolfhard gives a tonnage estimate of several tens of millions of tonnes with grades 0.3 percent copper and 0.5 g per tonne gold. No cutoff grade was quoted. A rough calculation can be made from the dimensions of the deposit. Assuming the average specific gravity of mineralized material is 2.70, tonnage of material with ± 0.25% copper is roughly 35 million tonnes to depth 150 m or 48 million tonnes to depth 200 metres. These figures are very rough and do not consider pit design, consequently they do not represent minable tonnages. Using the same calculation method, reserves of + 0.15% copper are 125 m tonnes to 150 m and 170 m tonnes to 200 metres depth. The deposit is open at depth and has limited potential for expansion along its western border.

mafic plagioclase porphyry. In pre-ore porphyries mafic phenocrysts are often but not always present; in all types mafic minerals are pervasively altered. There is very sparse bedrock exposure and drill holes are widely spaced so relative age relationships are not clearly defined. Tentatively, however, there appears to be an area of younger plagioclase porphyry cut by QFP more or less centrally located in the 0.15% copper isopleth ~~contour~~ (Figure 2). To the southwest and southeast are large and small bodies respectively of older (?) plagioclase porphyry in which the matrix has been biotitized. These probably correspond to Wolfhard's older porphyritic quartz diorite porphyry. An attempt was made to contour the upper surface of the QFP based on drill hole intersections. Too many interpretations were possible from the fragmentary data but generally it seems that there are several bodies of QFP with varying strikes, moderate to low dips and varying thicknesses (Figures 3,4). There does seem to be a body with northwesterly strike and perhaps one with northerly strike. These trends are speculative and at odds with those given by Wolfhard. He suggests easterly strikes and steep dips. Post-ore dykes appear to strike northeastward and dip moderately northwest (Figures 3,4); the strike accords with Wolfhard but he indicates that the dykes dip steeply where seen on surface.

check

PETROLOGY OF THE PORPHYRY PHASES AND COUNTRY ROCK

Texturally, the porphyries are all similar. Distinctions between them are made on the basis of alteration and relative percentage of quartz. Relative amounts of plagioclase and mafic minerals change in an apparently unsystematic way. As far as alteration is concerned, only the presence or absence of pervasive biotite alteration is considered, all other alteration types seem to be ubiquitous.

The "older" and "younger" plagioclase porphyries are mineralogically similar but the matrix of the "older" porphyry is biotitized. Phenocrysts in the rock comprise ~~are~~ 20 to 40 percent complex and oscillatory zoned plagioclase which varies from An_{37} to An_{43} in average composition; 0 to several percent wispy clumps of chlorite, iron carbonate with or without quartz, sericite and iron oxides or sulphides; and as much as 1% quartz. The primary mafic appears to have been largely pyroxene or hornblende. The quartzofeldspathic matrix is generally 50 to 80 percent altered. Plagioclase phenocrysts are generally about 60 percent altered. Phenocrysts average 2 to 3 mm but range from 1 to 5 mm across.

In hand specimen, quartz feldspar porphyries are distinguishable ~~separable~~ from younger plagioclase porphyry only because quartz is present in amounts from 2 to 5 percent. Plagioclase phenocrysts range from 2 to 5 mm across and have complex oscillatory zoning with average compositions ranging from An_{28} to An_{37}. Most plagioclase is more than 60% altered and much is totally replaced. Mafic phenocrysts are generally less abundant (than in plagioclase porphyry) and are similarly altered. Only locally has primary biotite escaped subsequent alterations. Quartz forms embayed, sometimes broken, usually rounded phenocrysts. Crystal borders are sometimes closely sutured and often have an external rim where overgrowths have incorporated matrix material (Plate). Crystals range from 2 to 5 mm across. The quartzofeldspathic matrix is often only 20 to 40 percent altered, which contrasts with ~~those~~ that of the plagioclase porphyries.

Post-ore dykes appear to be less altered ~~in drill core~~ and are characterized by chloritized, elongated mafic phenocrysts. Plagioclase phenocrysts are 2 to 4 mm across and generally comprise 20 to 30 percent of the rock.

Only one such dyke was thin sectioned. In it, plagioclase phenocrysts were 80 percent altered to carbonate with lesser sericite, 10% of the rock was chlorite and iron carbonate pseudomorphous after hornblende and there were about 1 percent rounded quartz phenocrysts. The quartzofeldspathic matrix was 70 percent altered to carbonate, sericite, chlorite and clay minerals (?). Plagioclase in this sample was oligoclase (An_{15}) but Wolfhard reports a mean composition of An_{50} for samples he examined.

Apatite is an accessory mineral in all the porphyry dykes. Magnetite is common in less altered areas and uncommon zircon was noted. Disseminated pyrite is common but is probably an alteration mineral.

There is little difference between degree of alteration, composition and texture of plagioclase phenocrysts in the porphyries and those in rocks interpreted to be altered porphyritic volcanic rocks. This fact is not surprising because the porphyries are undoubtedly high level, sub-volcanic intrusions. Matrices were pervasively biotitized early and later partly bleached or chloritized to varying degrees; in some cases later alteration has left only scattered remnants ~~wisps~~ of earlier pervasive biotite alteration. ~~biotite-enrichment remain.~~

VOLCANIC Rx
① clasts

Porphyritic volcanic rocks are distinguishable from porphyries in two ways. First, clasts in volcaniclastic types are sometimes still recognizable; second, they are within and gradational into areas of non-porphyritic hornfels. Contacts of porphyry dykes in the country rock are generally sharp on centimetre-scale. With nebulous criteria such as these complicated by pervasive alteration, separation of porphyritic volcanic rocks and porphyritic intrusions becomes highly subjective. Consequently, only areas of spotted hornfels and fine grained hornfels on Figures 2 and 3 can be confidently mapped as country rock.

② gradnl to non-ppytic

SEDS
③ spotted + fg Hfls (metaseds)

METALLIC MINERAL, ALTERATION AND VEIN DISTRIBUTION

Patterns of metal distribution and alteration types were defined by examining drill core from all the 1973 and younger drill holes along an east-west and a north-south section through the deposit (Figure 2). This data was supplemented by examining core from all available drill holes as close as possible to the 4600 foot level across the deposit. Subsequently, 55 thin sections were cut from specimens across the east-west section to test visual interpretations and confirm alteration assemblages. From this work, annular zones of alteration and less well-defined sulphide zoning patterns emerged.

Metal Zoning

The relative abundance of pyrite and ratio of pyrite to chalcopyrite will be considered first. Subsequently, the abundance of copper sulphides, zinc sulphides and gold will be discussed.

Pyrite Distribution

Pyrite occurs both within and outside the 0.15% copper contour on 4600 level but it is most abundant in an area which overlaps the + 0.25% copper zone on the east and slightly more abundant than average in an arcuate area which partially envelopes the + 0.25% Cu zone elsewhere (Figure ~~5~~ 4). Visually estimated pyrite to chalcopyrite ratios range from ~~0:7~~ 1:0.7 to 5:1 in the + 0.15% copper zone but are generally 1:1 or 2:1; outside this area ratios range from 2:1 to 50:1 and are generally more than 20:1. These data are in reasonable accord with those reported by Wolfhard (1976). In section (Figure 5), pyrite distribution is also spotty but in a general way it forms overlapping halos on the better grade zone.

Copper Sulphides, Zinc Sulphides and Gold Distribution

Chalcopyrite is the predominant copper mineral in the deposit. Wolfhard (1976) reports that bornite comprises 5 to 30 percent of the copper present in the central part of the deposit but is absent in peripheral areas.

Sphalerite was encountered in quartz veins and in quartz-specularite veins with pyritic halos. It was seen once in each of two peripheral drill holes and in one hole within the + 0.25% Cu zone so is of little practical use in defining a metal zoning scheme.

X

In hole Q73-11 below the 0.25% copper zone (figure 5) arsenopyrite and tetrahedrite occur along with pyrite and chalcopyrite

Gold is reported by Wolfhard to have a ratio of 1:4000 with copper in the central zone but only 1:6000 in the peripheral area. In the area averaging 0.3% copper, he reports gold values are 0.5 ppm.

Alteration and Associated Veining

In this section, a discussion of the relative timing and mineral assemblages related to hydrothermal alteration based on thin section analysis is followed by a discussion of the distributions of biotite, sericite, chlorite, epidote and gypsum from drill core examination.

Alteration Assemblages

Thin sections from 55 samples taken from drill holes in east-west section B were studied for petrologic data and alteration assemblages. Within the 0.15% copper contour, fine sericite occurs as a replacement of plagioclase feldspar, locally it also replaces mafic minerals. Almost invariably sericite is accompanied by carbonate, commonly by quartz and less often by kaolinite, chlorite, clay, and hydromica. In fringing holes, carbonate tends to be more abundant than sericite. In one hole (73-3) fine sericite was absent. Mafic minerals in various porphyries are replaced by chlorite often accompanied by iron carbonate, sericite and iron oxide or sulphide. In one fringing hole mafic minerals were replaced by actinolite. In areas of pervasive biotite alteration, biotite formation was early; ~~and all~~ all ~~most~~ other alterations ~~are retrograde and~~ are superimposed on it; most are retrograde. The main components of the younger alteration assemblage~~s~~ are the same regardless of whether the altered rock was biotite hornfels, older plagioclase porphyry, younger plagioclase porphyry or quartz feldspar porphyry. Minor components of the younger alteration vary somewhat across the section; for example hydromica was noted in every hole but kaolinite, gypsum and actinolite occurred only in holes outside the 0.25% copper contour.

Distribution of Secondary Biotite

The distribution of biotite flooding associated with hornfelsing and the distribution of vein biotite associated with mineralization should give some insight into the relative importance of hydrothermal versus contact metamorphic biotite formation. Except for ~~some of~~ the younger plagioclase and quartz plagioclase porphyries, pervasive biotite alteration was ubiquitous (Figure 2). It is unlikely that biotitized matrices in ~~these~~ older porphyries are due to contact metamorphism. In some areas much of the early biotite has been destroyed but its former presence is indicated by biotite remnants and relic textures (Figure ~~7~~ 6). Vein biotite on the other hand, has a similar but more restricted distribution. Partly this is probably the result of later chloritization so vein and fracture biotite was likely more widespread than ~~is indicated.~~ it is now. Veins and fractures carrying biotite typically have chlorite, often have sulphides and less often have flakey sericite. Pervasive and fracture controlled biotite are both widespread. It seems probable that contact metamorphic and hydrothermal influences were active, important and operated together. Initial pervasive biotite formation probably occurred during emplacement of the quartz diorite stock and perhaps some of the ~~younger~~ older porphyries whereas hydrothermal biotite formed as an alteration mineral and in veins in response to conditions in the hydrothermal system (potassic alteration) early in the mineralizing cycle.

Flakey Sericite Distribution

Flakey sericite occurs as fracture coatings, in veins, as vein halos, as zones of pervasive alteration, and replaces mafic minerals. Generally, where flakey sericite is found, grades exceed 0.15% Cu and it occurs more abundantly in and adjacent to areas where grades exceed 0.25% (Figures 7, 8). The ~~area~~ zone with occurrences of pervasive flakey sericite mantles the biotitized core zone and extends somewhat beyond the 0.25% copper contour. Vein and fracture controlled flakey sericite occurs within the pervasive sericite zone and extends beyond it. Its approximate outer limit nearly coincides with the 0.15% copper contour (see also Wolfhard, 1976, p. 321). There is an imperfect antipathetic relationship between flakey sericite and areas of pervasive biotite alteration.

early biotite retrograded!

Pervasive and Fracture Controlled Chlorite Distribution

Pervasive chloritization of mafic minerals is widespread and except in pervasively biotitized or sericitized zones ~~(except)~~ alteration is generally complete. Fracture controlled chlorite is best developed in the core of the + 0.25% zone in biotite hornfels and is spottily distributed in zones peripheral to it (Figures 7,9). Wolfhard (1976) has also defined a second zone of fracture controlled chlorite which lies generally outside but locally laps across the 0.15% copper contour. Pervasive chlorite alteration extends at least 100 metres beyond the 0.15% contour in section A. Consequently, distribution of chlorite is a weak but potentially useful guide to exploration.

Epidote Distribution

Epidote was found in trace amounts in only one drill hole during this study but Wolfhard (1976) outlined a zone of epidote alteration external to the zone of pervasive chlorite alteration.

Gypsum Distribution

The elevation of the first appearance of gypsum veins was plotted on a plan of the deposit (Figure ~~8~~ 10). Data is partly from drill holes along sections A and B and partly from Quintana Minerals drill logs. The contoured surface so defined consists of two en echelon west-northwest elongated domes. Data is too dispersed for detailed analysis but in general the surface is not obviously related to present topography and the generalized gypsum zone forms a northwest elongated dome. In section (Figure 9), gypsum is generally fairly common below its level of first appearance. The exception is seen in section B where there is an isolated gypsum zone above the main zone in holes Q73-15 and Q74-4. If the "perched" zone is a remnant which has escaped being removed by leaching then ~~it seems likely that~~ the original upper surface of the gypsum zone was higher than at present but has been lowered by groundwater action. A similar but much better documented model of gypsum leaching has been postulated for the Berg deposit (Panteleyev et. al., 1976). At Berg, the depth of leaching is more strongly influenced by the effects of fracture density on the groundwater table level than by topography.

Therefore in spite of the poor correlation between the "gypsum line" and topography at Fish Lake gypsum distribution is not inconsistent with a leaching model.

Gypsum at Fish Lake may have been derived from anhydrite (Wolfhard, 1976). Conversely, it may have been deposited directly from calcium and sulphate-rich hydrothermal fluids as they cooled. Alteration of plagioclase during main stage mineralization would be expected to generate suitable Ca-rich solutions and would account for the relative age of the gypsum and later, when sulphur was depleted, calcite veins. A similar model was postulated for Valley Copper (Jambor and McMillan, 1976).

Age Relationships and Typical Mineralogies of Veins and Fracture Fillings

Emplacement of porphyritic intrusive bodies at Fish Lake was accompanied by extensive biotite hornfelsing of the volcanic country rocks. The earliest vein and fracture filling minerals cut hornfelsed rocks but were probably deposited very shortly after their formation. These veins carry magnetite with quartz, hematite, some pyrite and chalcopyrite and lesser chlorite. As the hydrothermal system became established and evolved, the mineralogy of fracture and vein fillings changed (Figure ~~10~~ 12). For example, carbonate joined magnetite and its associated minerals prior to main stage mineralization. During main stage mineralization chalcopyrite, pyrite and molybdenite along with quartz, biotite, chlorite and ~~serictie~~ sericite were deposited. Pervasive country rock alteration of varying intensity also occurred during main stage mineralization. During this pervasive alteration, particularly in altered mafic minerals, disseminated magnetite, pyrite, chalcopyrite and minor amounts of bornite were deposited.

Magnetite in altered mafics may be a simple byproduct of alteration but sulphides required addition of sulphur to the system.

Typical vein and fracture assemblages include:

quartz + pyrite (often with quartz + flakey sericite envelopes)
quartz ± pyrite ± chalcopyrite ± MoS_2 (many with quartz + flakey sericite envelopes)
chalcopyrite ± pyrite
pyrite ± chalcopyrite
biotite + chlorite ± pyrite ± chalcopyrite
sericite ± chlorite ± biotite ± pyrite ± chalcopyrite
sericite + quartz ± pyrite ± chalcopyrite ± carbonate

Sulphide deposition ~~deposition~~ gradually ~~tailed off~~. During the waning period barren quartz veins and quartz + sulphide ± carbonate ± hematite veins and fractures predominated. Minor amounts of gypsum + chlorite and gypsum + pyrite were also deposited. Formation of gypsum and anhydrite (Wolfhard, 1976) ± carbonate and lesser carbonate-hematite veins was followed by deposition of carbonate and finally graphitic carbonate in veins and fractures. These mark the collapse ~~end~~ of the hydrothermal system. The sequence outlined is in general agreement with that described by Wolfhard (1976, Table 1) although in detail there are differences in interpretation.

Fracture and Vein Orientations

Orientations of mineralized fractures and veins were measured from vertical drill holes in the deposit. Most dip between 70 and 90 degrees and a less well-developed set of structures dips about 45 degrees (Figure 13 ~~12~~). When the relative ages and mineralogy of the veins and fractures was considered, it became evident that fracture orientations changed slightly with time. Most of the oldest, magnetite-rich veins are subvertical, although there are lesser concentrations with dips near 65 and 15 degrees. Similarly, pyrite and chalcopyrite-bearing veins are also dominantly steeply inclined. Late stage gypsum veinlets have dip maxima of 45 and 25 degrees. Carbonate, which is calcite in part, occurs in veins with minor amounts of chlorite. These have dip maxima of 75 and 45 degrees but a significant number also dip between 10 and 40 degrees. Younger carbonate + graphite (?) veins have steep orientations again.

SYNOPSIS OF ALTERATION AND VEINING HISTORY

Rocks of the Fish Lake prospect have a complex history of alteration. The volcanic to sedimentary country rock appears to have been subjected to at least two periods of pervasive biotite alteration; one resulted from intrusion of a large porphyritic quartz diorite stock, the other from intrusion of "younger" plagioclase porphyry and quartz plagioclase porphyry bodies. Matrices of "older" plagioclase porphyry was flooded with biotite during the latter event or events. Vein associations, formation in earlier intrusions, grade distribution and the alteration zoning patterns indicate that some of the biotite alteration was of hydrothermal origin and was associated with metallization. The zone of best mineralization in the deposit has a core area of pervasive biotite alteration which is the zone of potassic alteration after the usage of Jambor and Carson (1974) or phyllic after the usage of Guilbert. Guilbert restricts the term potassic to assemblages with K-feldspar. Here, the simple term biotite alteration zone will be applied.

From thin section work, it is evident that early biotite alteration was later partially or, in places, totally destroyed by younger alteration characterized by formation of sericite, quartz, carbonate, with lesser clay, hydromica, and some gypsum and actinolite.

The distribution and relative intensity of the younger alteration has produced a zone of ~~propy~~-argillic alteration which is apparently fringed by a ~~prophlitic~~ zone. The younger alteration laps onto the biotite core and has pervasively altered large areas of hornfelsed rocks outside the 0.25% copper contour. Despite the differing ages of alteration, there are coherent grade, alterati~~ng~~ion and metal zoning patterns which appear to be controlled by the younger porphyries, particularly the quartz plagioclase porphyries. It is in and more commonly adjacent to these porphyries that the best copper grades occur.

The earliest veining at Fish Lake post-dates pervasive biotite alteration and consists of quartz, magnetite, hematite, sulphides and chlorite. With time, carbonate was added to the assemblage. During main stage mineralization, sulphides were deposited along with quartz, biotite, chlorite and sericite. The biotite phyllic and propy-argillic alteration associated with the porphyry system apparently also formed at this time. Late main stage veining comprised barren quartz, quartz with sulphides, carbonate and hematite, and gypsum with chlorite or pyrite. Gypsum with minor amounts of anhydrite, sulphate then carbonate veining marked the collapse of the hydrothermal system.

Mineralization occurred in an area of ongoing igneous activity and this is reflected in the orientation of veins and mineralized fractures. Through time dips of dominant fracture orientations varied from steep to moderate or low and back to steep. In part they probably reflect regional stresses but in part they are related to intrusive activity, evolution of magmatic fluids and pressures generated by the hydrothermal system.

SUMMARY AND CONCLUSIONS

In summary, alteration at Fish Lake is related to ~~and~~ metals may have been derived from younger porphyritic intrusions which cut a country rock comprised of older porphyritic intrusions and hornfelsed volcanic and sedimentary rocks. The best mineralization is in zones of biotite alteration adjacent to and in bodies of ~~young~~ the younger quartz plagioclase porphyry. The hydrothermal system was maintained some time after the younger porphyries and somewhat beyond the time when post-ore hornblende plagioclase porphyry dykes were emplaced. All have been subjected to carbonate-sericite dominated propy-argillic alteration.

While main phase veins and fractures were grouped and treated as a unit here, in fact several ages of, for example, quartz + pyrite + chalcopyrite veins occur in a single piece of drill core. Mineralization obviously took place over a significant time span which saw many episodes of fracturing, healing and refracturing. The porphyry intrusions may have acted as a heat "engine" to drive a convective cell of metal-bearing hydrothermal fluids. Whether the metals in the system were scavenged from the country rock or supplied by the porphyries is open to speculation.

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Figures - Fish Lake Writeup

Plates

Province of British Columbia

Ministry of Energy, Mines and Petroleum Resources

MEMORANDUM

To: Dr. A. Sutherland Brown
Chief Geologist

Date: 17 March 1981

Our File:

Re: Fish Lake Deposit visited
March 10 to 13, 1981

I spent several days on the property to discuss the geological and alteration histories, controls of mineralization, and to look at some of the new core. Another visit will be needed next summer to complete the core study.

Several samples were taken to have K/Ar analyses run for check purposes.

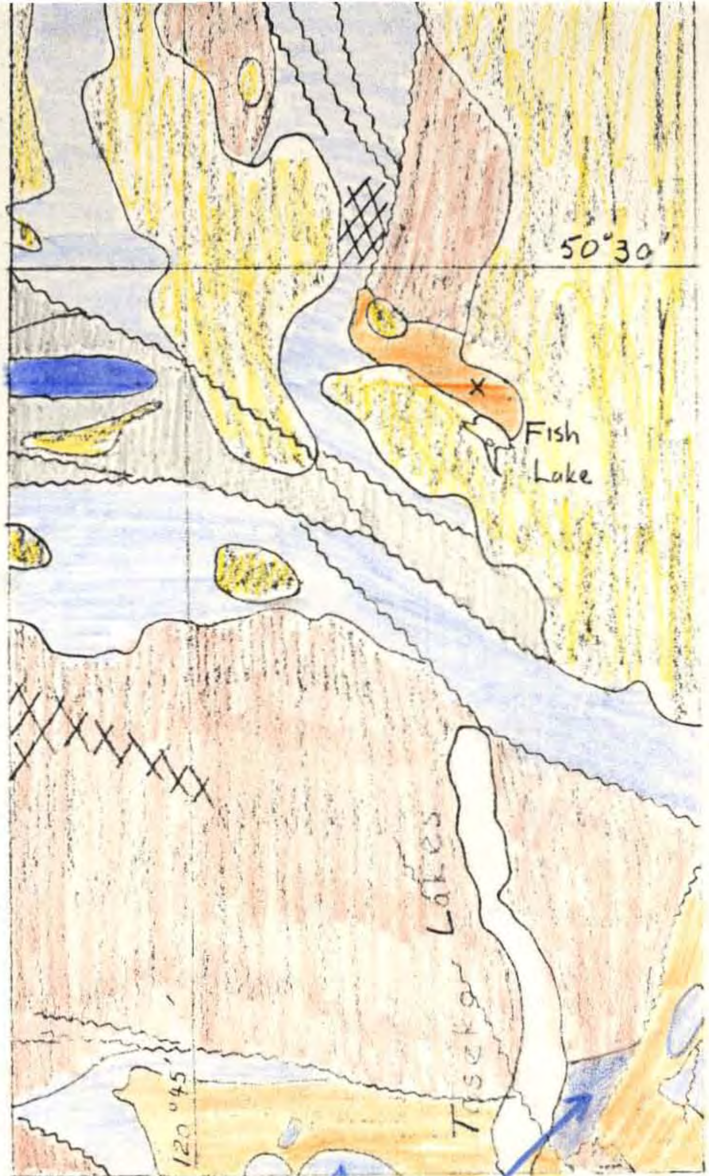
The new drilling consisted of deepening existing holes and drilling new angle holes (-60°N) to check the extent and tenor of the mineralization to a depth of 1,000 feet. Presently, the last stages of the program are testing a Cu-Au (the Albert) and an Au (the Renner) zone. Both are east of the main deposit. These programs are follow-ups of a percussion drill program.

Good communication was established with Andre Panwells and Norma Wilson, the geologists running the program.

The new program has more or less confirmed grade and tonnage figures quoted in CIM Special Volume 15. Reserves are 156 million tons grading 0.25% Cu and 0.014 oz/ton gold.

W. J. McMillan
Senior Geologist

WJM:nhc



LEGEND

Tertiary

Basic flows, tuffs, breccia

Cretaceous or Tertiary

Diorite to Granite

Dyke swarm area

Cretaceous

Pyroclastic volcanic rocks some flows

Shale, graywacke, conglomerate

Jurassic

Argillite, tuff, graywacke, conglomerate

Triassic

Limestone

Scale

0 4 8

Miles

0 4 8 12

Kilometres

Figure 1: Regional Geological Setting of The Fish Lake Deposit NTS 92O (after Tipper, 1963).

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Be sure these are corrected on the originals