STIKINE RIVER FIELD PROJECT
1964

Blue File

825715 10 W B.

STIKINE RIVER FIELD PROJECT, 1964

Submitted by

Roy A. MacDiarmid
Associate Professor of Geology
Tulane University
December 15, 1964

TABLE OF CONTENTS

STIKINE RIVER FIELD PROJECT, 1964

INTRODUCTION

This report covers a $3\frac{1}{2}$ month exploration program in the Stikine River area, west and south of Telegraph Creek in northwestern British Columbia. Copper was the principal metal sought, but the field crews were alert for any other possibilities. The party consisted of six geologists (or prospectors), a helicopter pilot and his mechanic, a cook, and the party chief. A Bell G-4 helicopter provided transportation around the rugged terrain as well as the vehicle for an Elsec airborne magnetometer. There were three two-man teams working out of fly camps; they conducted geochemical surveys for copper, made reconnaissance geologic maps, prospected for economic minerals in outcrops, gravels, and moraines, and studied selected areas in detail with surface geophysical equipment. An area of some 1000 square miles -- as well as a few outlying localities -- was fairly well blanketed by both surface and airborne prospecting.

The logistics of the project should be of interest for similar operations during future field seasons. Supplies were brought in by river barge and charter aircraft. The Stikine River was not navigable all the way to Telegraph Creek until June 19, and the last trip downstream left September 7. Low water and flood stages prohibit river transport in the spring and fall. Camps that are not along the Stikine River must be supplied by airplanes or helicopters from the nearest river landing. At the beginning of the season, non-perishable supplies were brought to Telegraph Creek where the surplus was stored in a warehouse. Meat, vegetables, fruit, and other perishables were brought to the base camp at Kirk Landing each week; if the river boat was at Telegraph Creek when the food arrived there, it brought the perishables — otherwise the supplies were flown in by Piper Cub. At base camp, fresh meat could be preserved for only 3 or 4 days during the warmest part of the summer, but the fly camps were generally higher and had meltwater streams in which the meat could be submerged, keeping it fresh a week to 10 days. Because of the warmer conditions at Kirk Landing, it was necessary to distribute perishables to the fly camps as soon as they were received; thus it generally was not possible to combine servicing with other trips or camp moves. However, by keeping the camps aligned in a single direction, the expense of servicing the crews was minimized.

The fly camps were located near the upper reaches of valleys or at valley junctions, where possible. The accessibility of the field camps to surface prospecting was limited by the ruggedness of the terrain and the swiftness of the streams. Even the small creeks are incised and consequently impede traverses along their courses. Most of the streams indicated on the topographic map are too large to be forded. Thus, some camp moves were merely across creeks, but the helicopter was still necessary for the move. In general, however, successive fly camps were about 5 miles apart. Two fully loaded helicopter trips were needed for each camp move.

The weather did not affect the operation to any great extent. The beginning of the season was, of course, determined by the amount of thaw that had taken place, and the originally planned base-camp site was not used because it was not as free of snow as Kirk Landing. But, except for high winds and short sessions of rain or heavy fog, the weather did not interfere with progress. The field crews lost only a few days. Counting even half days, Party A lost a total of 8 days, and the other crews lost a comparably small proportion of the summer.

High winds prohibited flying the magnetometer along the close contour paths desired, but these winds generally did not keep the helicopter from reaching the fly camps. There were only a few days during the summer when inclement weather kept the helicopter on the ground; in fact, some flying was possible each day until the end of July.

Communication with the Vancouver office was made by mail and directly on a 100-watt Spilsbury and Tindall radio. Difficulties in setting up the radio kept it inoperative during the first half of the season, but once it was functioning, satisfactory contact could be made with Vancouver on nearly any day desired. Contact with the fly camps was made by field battery-powered radios, which proved to be about 70 percent effective. Telegraph Creek receives a mail flight each week, but the service is faster via Prince Rupert because the Telegraph Creek mail travels a very circuitous route. An average of more than one plane each week came in from Prince Rupert to some part of the Stikine River district, so the mail could be delivered directly to Kirk Landing with only a short detour in most cases.

SURFACE PROSPECTING

The area of concentration is outlined on the enclosed topographic map, Plate 1. The locations of fly camps, designated A1, A2, B1, C1, etc.

indicate the regions of most intense surface prospecting. There were three field teams. Party A and Party C each had 8 different fly camps plus one mutual camp, and Party B had 12 camps. Some of the country near Kirk Landing was studied by teams working out of the base camp.

Besides visual reconnaissance prospecting, the field crews analyzed stream silts and soils for copper, using the dithizone method. In local areas of interest, surface geophysical studies also were made.

The Stikine River district is truly an example of a metallogenetic province. Copper and molybdenum can be found nearly everywhere, and if supergene enrichment had been a significant factor, several large, low-grade deposits would undoubtedly have been found before the 1964 field season began. However, most of the mineralized zones are a little too lean for mining.

The geochemical prospecting did not lead to any previously unknown mineralized areas, although several restricted anomalous zones were detected. This technique was of value, though, for checking geophysical anomalies and delineating concentrations of copper in large, complex areas of mineralization. In general, the geochemical approach was considered a useful one, but it can easily be misguiding and consequently should be used with care and with the variables in mind. (See Appendix A for a more detailed evaluation of the geochemical technique.)

Plate 3 shows the results of the geochemical surveys. It is difficult to say what readings should be considered background, but tests that produced less than about 25 ppm cold-extractable copper (cxCu) are probably unimportant unless they are part of a sequence that points to an area of higher readings. The geochemical technique as used could not distinguish among values greater than 70 ppm Cu; hence these readings are all recorded as >70, a figure that is distinctly anomalous but may represent only a very local concentration of copper.

Each field member was made conscious of the significance of hydrothermal alteration as a guide to ore deposits, but in general this approach was discouraging. Epidotization is nearly ubiquitous in the Stikine River district and potash metasomatism is not rare. Pyrite and pyrrhotite are also abundantly developed over large areas, in places contributing to conspicuous zones of iron oxide at the surface. However, many of these areas were apparently formed during periods of barren hydrothermal activity. Argillization and sericitization are generally lacking in the district, even where base-metal sulfides are found. In contrast, the large copper deposit at Galore Creek has so much associated alteration products — notably silica and biotite — that the original rock type is difficult or impossible to identify.

AIRBORNE MAGNETOMETER SURVEYS

Plate 2 summarizes the results of the airborne magnetometer surveys. As the map shows, many areas of anomalous magnetism were found. Several of the anomalies proved to be mafic volcanic rocks or the border facies of stocks. However, the Galore Creek deposit has associated magnetite, and a test flight over this deposit proved the feasibility of the prospecting method. Also, a clear anomaly was developed over the Dok claims (Hudson Bay Mining and Smelting) on Dokdaon Creek, where there is a zone of disseminated copper and associated alteration products.

The airborne work was somewhat experimental, in that the best flight patterns, elevations, and sensitivity scales were undecided when the program started. The topography is too precipitous to permit flying straight-line grid patterns. Instead it is necessary to contour around the slopes, attempting to maintain an equal elevation above the ground at all times. It was found that an interpretable record could be made while flying 250-350 feet above the ground, with the recorder set at a full-scale value of 1000 gammas. Such a combination produced an anomaly of 500 gammas over the Dok claims. This setting, however, causes the recorder to go off scale or become erratic over highly magnetic rocks, and it also results in too many small anomalies. A strongly magnetic rock causes too steep a magnetic gradient for the apparatus and consequently is recorded as "hash." A more practicable scale is probably the 2000-gamma range. It was at the 2000 setting that the anomalies associated with the Galore Creek deposit were best delineated. Even on the 2000-gamma scale, massive magnetite would have to be flown at a higher elevation to produce a smooth curve. Thus, general reconnaissance for a large deposit should be flown on the 2000-gamma scale, but detailed work in local areas may be more significant on the 1000 scale.

Several scales were used during the field season, and the map unfortunately does not distinguish between large and small (in terms of gammas) anomalies. However, the records themselves make such a distinction, and areas of preference for field checking are therefore no problem to cull.

The airborne traverses are numbered on the map (Plate 2) and the key to the numbers is given in Appendix B. An attempt was made to check each distinct anomaly or each anomaly that was detected along two or more contiguous flight lines, but a few of the anomalies were not studied on the ground, due to a lack of time at the close of the season. The following is a description of each anomaly studied on the ground, starting from the north and progressing to the south.

Just south of camp A-8: This was a widespread anomalous zone that proved to consist of fairly strongly magnetic andesites. No signs of copper were found by the field crew.

Mt. Rowgeen anomaly: A pluton of very strongly magnetic pyroxenite (and/or peridotite?) with associated diorite produced the most intense anomaly detected all summer. Surface traverses with the magcrometer recorded magnetics of over 15,000 gammas, or an anomaly of over 9,000 gammas. There are small veins of magnetite in the pluton, but the iron concentration is probably not of economic value. Geochemical tests for copper were consistently negative or low.

Spann Creek area: Several anomalies are shown on the map. They seem to be related to magnetic facies of the granodiorite and (at least in one case) may be associated with copper-molybdenum mineralization. In general, the anomalies appear near the contact of the stock. The presence of biotite was noted in some of the most magnetic specimens found; this rock is a dark facies and may even be a biotite-bearing diorite rather than a monzonite or granodiorite. The wide anomalous zone near the center of the pluton (compare Plate 2 with Plate 4) may indicate that the stock was dome-shaped and has been only slightly unroofed. The strong anomaly shown just east of Spann creek across the Barrington River was not checked due to its inaccessibility and the ruggedness of the Barrington River canyon.

Anomalous magnetics were detected near the mineralized joint zone (see discussion of Spann Creek area, below), but the ruggedness of the terrain caused the anomaly to be inaccurately located on the base map. Moreover, the mineralized joints were so inconspicuous that they were not detected even when the anomaly was accurately located by a magcrometer survey on the surface. Old-fashioned surface prospecting finally revealed the zone.

Southern side of Rugged Mountain: The anomaly is developed over the Shakes Creek syenite, an orthoclase porphyry stock. It has been carefully prospected in the past by several companies, due to the presence of a similar syenite at Galore Creek. However, the Shakes Creek pluton seems to lack concentrations of ore minerals; Kerr (1948) suggested that erosion has removed any deposits that may have been present. Prospecting north of the syenite contact also was unrewarding.

Lower Yehiniko Creek: A narrow magnetic zone picked up along four flight lines proved to be mafic volcanic rocks.

Spur south of Conover Creek and the Conover shear zone east of the Chutine River: This extensive anomaly was studied in detail. The association between the shear zone, which is known to be mineralized along Conover Creek, and the anomaly encouraged surface geophysical studies east of the Chutine River. The magcrometer, self-potential, and electro-magnetic techniques were all used, but nothing significant was developed. Geochemical analyses of the soils and silts were equally discouraging. The magnetic anomaly proved to be due to strongly magnetic basalts and diabases. The bedding and shear zone dip steeply in opposite directions and strike nearly parallel to one another; hence, the magnetic anomaly is slightly oblique to the shear zone.

Misterjay Creek: Although traces of copper minerals and anomalously high geochemical analyses were found in the area, the high magnetics seem to be related to mafic volcanics similar to those producing the anomaly near the Conover shear zone. No strongly mineralized zones were found in this area.

Strata Mountain, just north of Strata Creek: A wide zone of strongly magnetic volcanics produces this anomaly.

Spur between Strata and Dokdaon Creeks: A distinct anomaly of up to 500 gammas was picked up over an area nearly one mile in diameter. The anomaly was clearly developed along six traverses and faintly shown on a seventh. Although it was not realized at the time of flight, the area proved to be covered by the Dok claims, of Hudson Bay Mining and Smelting. Disseminated copper is widespread in the anomalous zone. The host is an altered syenite porphyry. The copper minerals include chalcopyrite, malachite, and chrysocolla, and the alteration consists of silicification, epidotization, argillization(?), and potash metasomatism. Most of the mineralized work is conspicuously non-magnetic; apparently the magnetic anomaly represents related, but not intimately mixed, mineralization. This deposit would not be evident from a distance, although a slight iron staining can be seen through the areas of sparse vegetation. Silt samples indicated greater than 70 ppm Cu. It is not known whether the Dok claims contain an economic deposit, though the Hudson Bay Mining and Smelting Company has drilled on the property.

Near the head of Strata Creek: Two small anomalous zones were found, one on each side of Strata Creek valley. The western anomaly trends along a narrow spur. Although the magnetic zone is narrow, it measures 400 gammas above background. A geochemical anomaly of 32 ppm was obtained from the creek just west of the spur. The magnetic anomaly was apparently caused by volcanic rocks and disseminated pyrrhotite. Traces of chalcopyrite are associated with the pyrrhotite, but there was not enough found to encourage further study in the area.

The anomaly east of the spur, on the opposite side of Strata Creek, is not quite as intense as the first. The magnetics seem to be produced by volcanic rocks. Disseminated copper in shears was found near the magnetic anomaly, but it is low grade and very local.

Northeast end of spur between Dokdaon and Brydon Creeks: A dike swarm of orthoclase porphyry cuts graywackes and volcanics. Some of the orthoclase porphyry is strongly magnetic and apparently causes the airborne anomaly. The amount of dike material increases near the base of the spur, where the magnetic anomaly was found. Traces of copper were found in sporadic pieces of float; none was found in place, but its scarcity and the absence of associated alteration products made the area seem unfavorable, in spite of the presence of the orthoclase porphyry and the nearby Dok claims.

North end of Devil's Elbow Mountain, 4000- to 5000-foot contours on spur: The anomaly was of small magnitude, but it was noted on both flanks of the spur and this is an area of known mineralization (Kerr, 1948, p. 72-73). Iron staining is conspicuous. The mineralization is in limestones; it consists of galena, sphalerite, chalcopyrite, magnetite, and pyrrhotite, associated with skarn minerals. Perhaps the low-magnitude magnetic anomaly results from a magnetite or pyrrhotite mass within the spur or from small concentrations of these minerals at the surface. A brief surface check did not settle the question. An old prospect, showing copper in skarn, is located directly over the magnetic anomaly.

Head of Dokdaon Creek, along east side: Three narrow magnetic anomalies were found, each along an east-west spur separating cirque valleys. These anomalies were not checked. They may be due to a heading error or to the fact that the helicopter invariably skims closer to the ground when rounding sharp spurs (see discussion below).

Phacops Mountain at mouth of Butterfly Creek: The anomalous zone is about a mile wide and the magnitude registered 400-500 gammas. The anomaly is directly across the contact between a quartz diorite and metasediments or metavolcanics. The border facies of the quartz diorite is abnormally mafic and apparently anomalously rich in magnetite. No signs of mineralization were found and geochemical analyses for copper were all negative.

West side of Cone Mountain: A zone of magnetic rocks extends along the nose of Cone Mountain from the 2000-foot level down to the Stikine River. A field party was stationed above this zone but was unable to check the anomaly. Kerr (1948, p. 74) reports magnetite float on the west side of Cone Mountain; perhaps the source of the float and the anomaly are the same.

Several of the anomalies are aligned along spurs, especially spurs that trend east-west. Although this relationship may be coincidental, other interpretations should be considered.

The anomalies on spurs may be due to heading error, thus explaining why they are generally on spurs that trond east-west. But, then, not all of the east-west ridges produce anomalies, nor are corresponding anomalies produced by sharp turns in valleys. Moreover, a magnetic high is produced flying both directions across the spur, rather than a high and a low in opposite directions.

Perhaps the anomalies result from flying closer to the ground across the spurs. Invariably the helicopter was closer to the ground when it passed around sharp spurs and farther from the ground when turning in valleys. Although this factor may have contributed to some of the anomalies produced along spurs, it does not explain the apparent selectivity of these anomalies along east-west spurs rather than all spurs.

Another possibility is that the spurs themselves consist of a resistant, magnetic rock type, such as steeply dipping lava flows or dikes. Resistant ore zones would seem unlikely as a common feature, but mafic volcanics or intrusives are clearly reasonable. Perhaps the preference for east-west ridges reflects a regional trend in dike swarms or bedding. The anomaly near the Conover Creek shear seems to be a product of these conditions, but the regional strike is not east-west near most of the other anomalies along spurs.

Actually, mafic rocks should contribute to sharp anomalies where the flight lines pass closer to the ground; hence the anomalies measured may be a combination of two of the hypotheses discussed. Accordingly, the spur anomalies would be developed only in areas of mafic rocks and the apparent east-west alignment would be fortuitous. No anomalies would be developed across spurs that did not contain abnormally magnetic rock types. This explanation seems to fit the field evidence fairly well.

In general, the airborne magnetometer is a very useful tool. It responds to sources of anomalously magnetic rocks and such rocks are associated with copper mineralization in places. When it is working properly and conditions are favorable for close contour flying, a large area can be carefully surveyed in a very short time. Faulty equipment and lack of technical know-how interfered with the success of the program this season, but the potential of the methed was clearly demonstrated. Technical difficulties with the magnetometer and recorder kept the apparatus out of operation during 60 percent of the field season. From the standpoint of pure economics alone, it probably would have been advisable for Kerr Addison to have invested initially in the most expensive magnetometer and recorder—assuming the maintenance needed would be inversely proportional to the cost of the equipment. Furthermore, the presence of a qualified technician in the field would have been more than justified.

DETAILED SURFACE STUDIES

Several areas were studied in relative detail by surface methods. The desire to concentrate on a given area was encouraged by geologic conditions, signs of mineralization, or an abnormally intense aeromagnetic anomaly. Each of the areas will be described separately.

Spann Creek Area:

Eighty claims were staked near the headwaters of Spann Creek, Cave Creek, Wimpson Creek, and Wilf Creek (the latter being a newly named tributary to Limpoke Creek). The area forms the northeastern quarter of Mount Barrington. The principal mineralized zone is some four miles across rugged terrain from an old road leading south to Chutine Landing on the Stikine River. The claim group ranges from 3500 to nearly 6000 feet above sea level and the road terminus is less than 1000 feet above sea level.

The Spann Creek area contains copper and molybdenum showings in outcrops and float at several places, but the principal discovery is a zone of closely spaced sulfide-bearing joints in a quartz monzonite-monzonite-granodiorite intrusive. The mineralization is largely confined to the border zone of a small oval stock. Two different intrusives can be distinguished, and it is only the apparently older one that contains base-metal sulfides. A subordinate amount of orthoclase porphyry is also present but the relationship between the porphyry and the granitoid rocks was not determined.

The intrusive of the principal mineralized joint zones, hereafter known as the host intrusive, is a medium- to dark-gray, medium-grained rock. Three facies of this intrusive were studied in thin section; each proved to be a different rock type -- one a quartz monzonite, another monzonite, and the third granodiorite. Each of these rock types contains andesine (An 35-45), orthoclase, pyroxene, hornblende, biotite, sphene, and magnetite. Quartz seems to be the most highly variable constituent; it was absent altogether in the monzonite, low in the granodiorite, and abundant in the quartz monzonite. Presumably the intrusive includes all gradations among these three types. The pyroxene exists only as cores within hornblende and biotite, indicating that it was out of equilibrium with the final rest melt. Similarly, the plagioclase shows strong corrosive effects. There is clear evidence that the magnetite crystallized early in the magmatic process and is thus not a product of hydrothermal or deuteric activity. Some of the magnetite occurs poikilitically (or glomeroporphyritically?) including small grains of plagioclase and pyroxene only slightly replaced by hornblende, but it does not envelop orthoclase or quartz. The plagioclase is selectively saussuritized, and the orthoclase is generally fresh.

Near mineralized joints the feldspars are pink. Epidote as well as chlorite contributes to a greenish color in many specimens. At the surface, the host intrusive is conspicuously rusty brown compared to the "younger" intrusive.

The second granitic rock type, forming the "younger" intrusive, is generally lighter colored than the host intrusive. It consists of quartz monzonite with a color index of about 20. Outcrops of this rock type are generally light gray. In hand specimen the "younger" quartz monzonite has the appearance of a medium-grained, non-porphyritic rock, but it contains phenocrysts of clear orthoclase that includes plagioclase, biotite, and hornblende poikilitically. The groundmass of the rock contains orthoclase, plagioclase, quartz, hornblende, magnetite, biotite, and sphene. The plagioclase is albite (An 5) in contrast to the andesine of the host intrusive. Evidence of apparent cross-cutting relationships, a different joint pattern, and the general fresh appearanoe of this rock type favor the interpretation that it is younger than the host intrusive.

A third type of quartz monzonite was seen beyond the claim group down Spann Creek. In hand specimen this rock is similar to the "younger" intrusive except that it contains clear to faintly pinkish, Carlsbad-twinned orthoclase phenocrysts. In detail, this quartz monzonite resembles that found in the host intrusive; for example, the plagioclase is andesine rather than albite, the rock is not strictly barren of copper mineralization, and its jointing is similar to that found in the host intrusive. Perhaps this rock type represents a separate intrusive distinct in age from the other two, but it could rationally be just a facies of either the host intrusive or the "younger" intrusive.

The country rocks surrounding the plutonic complex consist of sediments, volcanics, and several kinds of intrusives, including granodiorite that is not readily distinguished from the darker facies of host intrusive. The sediments and volcanics are metamorphosed to quartzites, marbles, semi-schists, and greenstones. The joint system in the host intrusive continues uninterrupted through the overlying country rocks.

Good exposures are found only along the steep ridges and cirque walls. The lower slopes are essentially blanketed with talus, moraines, turf, or vegetation. Moreover, there are some small glaciers in the claim area, a small tarn lake, and -- except during the month of August -- extensive snow.

The country rocks are tightly folded and generally steeply dipping; no attempt was made to map the fold structures, though they apparently trend east-west. Within the plutonic rocks, the joint patterns were found to be very consistent in attitude (see Plate 5), especially throughout the mineralized area.

Where it can be observed, the contact of the plutonic rocks dips beneath the country rocks at an intermediate angle. It may be that the oval-shaped stock, which is about 5 miles long and 4 miles wide, represents a breached dome.

Most of the known mineralization in the Spann Creek area occurs along joints. Chalcopyrite and molybdenite are the ore minerals, accompanied by appreciable gold and silver values; the veins also contain pyrite, pyrrhotite, quartz, calcite, and heulandite(?). Near the surface, chalcopyrite has been selectively leached from the joints, leaving a boxwork of iron oxide in places. The principal mineralized joint set strikes N50-60E and dips 70-85°NW (Plate 5). Other sets are present, but they are rarely mineralized.

In general the mineralized joints are bordered by a narrow zone of wall-rock alteration. The alteration zone is typically thin and gives the impression that hydrothermal activity was not extensive. Feldspars are pinkened and hornblende is chloritized and epidotized in the thin alteration zones. Also, traces of pyrite and chalcopyrite disseminations can be found in the wall rocks a short distance from the joints.

The best mineralization seems to be associated with pinkened joints and joints that contain quartz. The joints average about 1-1½ inches apart in the zones with the highest joint density. These joints probably average less than 1/20 inch in thickness and only about 1/3 of the joint filling can be expected to be chalcopyrite. Disregarding the minor amounts of chalcopyrite that occur disseminated a short distance from the joints, these figures would give only about 1-1½% chalcopyrite in the rock, or 0.3-0.5% copper. Actually, this should be considered an optimistic estimate of the mineralization, even for the better zones. Although some of the joints are spectacularly coated with molybdenite, most of the joints contain no molybdenite; hence the average molybdenum content is expected to be low. It is not known how much molybdenite has been leached from the surface exposures. Although geochemical treatises emphasize the mobility of molybdenum in surface waters and imply that molybdenite should be relatively unstable, the field evidence in the Stikine area supports just the opposite conclusion. Fresh molybdenite is common right at the surface even where chalcopyrite has been leached away. Thus, the optimistic view that a significant amount of molybdenum has been removed from detection at the surface is not encouraged. Low assays of "splashy" specimens are further cause for pessimism. It would seem that a significant contribution to the value of the rock will have to be made by accessory gold and/or silver before the deposit will classify as ore; the potential for such values is fortunately encouraging.

The principal zone of mineralized joints includes essentially the entire peak that separates the headwaters of Spann, Cave, and Wilf creeks. The true extent cannot be determined because of masking by overburden, but the zone is exposed along 700-800 feet of strike with a known width of about 400 feet. The extent of mineralization at depth is completely unknown.

In addition to the principal mineralized-joint discovery, some mineralized float consisting of bleached silicic intrusive rock containing disseminated chalcopyrite was found in the mineralized area.

"The grab samples which were obtained from the principal zone and from several other outcrop and float localities in the mineralized area have given the following range of grades: 0.15 to 5.80% copper; trace to 1.03% molybdenum; nil to 4.41 oz. silver; and trace to 0.06 oz. gold. There appears to be a 3/4:1 ratio of silver to copper. An abandonned gold dredge hulk on the Barrington River near the mouth of Spann Creek is support for there being a significant gold content in the mineralization." (Data from Kavanagh)

Both soils and silts were tested geochemically for the cold-extractable copper content. Many of the samples tested over 100 ppm cxCu, and the jointed zone characteristically gave high readings. Some of the best readings were obtained in the northwest corner of the claim group, near the contact between the stock and the overlying metavolcanics. Only sporadic traces of oxidized copper were found in this area, though it may deserve further prospecting.

The airborne magnetometer measured an anomaly near the mineralized joint zone, but since the magnetic high occurs on a peak and associated crests, it was not accurately located on the map. Surface traverses with the magcrometer delineated the anomaly over the jointed zone.

Electromagnetic and self-potential surveys also were made, though in only a preliminary manner due to the lateness of the season. Electromagnetic traverses across the mineralized joint zone failed to produce any anomalous readings, so the self-potential technique was emphasized to the exclusion of further EM work.

Several anomalies were found with the self-potential method. The largest of these is southwest of the mineralized joint zone, beyond the contact of the pluton. This large anomaly is probably due to disseminated pyrite and pyrrhotite, as evidenced by abundant float in the area. A graphitic unit also may have contributed to the anomaly. Disseminated chalcopyrite was found with pyrrhotite in other parts of the Spann Creek claim group, making this anomaly attractive as an area for further study.

As a general evaluation of the Spann Creek area, from the surface impression, it perhaps should be called "teasingly attractive" but probably too lean to make a mine under present economic and logistic conditions. The above calculation of theoretical grade is independent of surface leaching, so it should be fairly realistic and probably optimistic.

If the deposit is to be drilled to test its continuity and unleached grade at depth, the drill site should probably be set up near the position marked "heliport" on the detailed map (Plate 5). The heliport is a natural landing site on a saddle. The drill site would be on the same saddle, if possible over the snow and ice about 150 feet northeast of the heliport. Water for drilling is available in a tarn lake to the southwest; the lake is approximately 1050 feet (slope distance) away from the proposed drill site, at 320 feet lower altitude. A horizontal hole from this drill site would pass under the peak of the mineralized hill at a depth of about 150 feet; a hole inclined down at 20° would pass beneath the peak of the hill at a vertical depth of 370 feet. The expected lengths of the flat and 20-degree holes would be 600 and >1000 feet respectively before passing through the mineralized zone (or through the hill in the case of the flat hole). An inclined hole would be best because it probably would be able to probe the ground beneath the granodiorite-country rock contact on the south side of the mineralized zone. Ideally, the hole should be drilled on a strike of S35°E and a dip of about 10° in order to penetrate the mineralized zone normal to the joints. However, drilling at this angle may not be possible nor will such a direction pass under the peak of the hill. Assuming the peak of the hill is not critical, and using 10° as an ideal dip figure, a S35°E hole would pass south of the crest at a vertical depth of 180-200 feet and pass through the hill and the mineralized zone at a length of about 1050 feet (and a 20° hole in this direction would be 1850 feet long before penetrating the hill).

Hankin Peak Area:

Hankin Peak is located west of the Iskut River and south of Ball Creek, some 43 miles east of the Stikine River. Sixty claims were staked on the northwest corner of Hankin Peak, but after a surface study it was decided not to record the claims.

The Hankin Peak area contains Mesozoic sediments and volcanics, intruded by a granodiorite stock. The layered rocks are folded and, through there are wide local variations, strike roughly north-south. Orthoclase porphyry and aplite dikes are abundant; they trend generally north to northeast. In places the porphyry dikes form a grid pattern with two prominent sets nearly normal to one another. The aplite forms irregular masses as well as simple dikes.

Five types of dike rocks were distinguished. The age relationships and genetic associations could not be ascertained in the limited time available, but it is probable that at least some of these five types are merely facies of a single episode of igneous activity.

Type One is a gray-brown feldspar porphyry with large pink and gray orthoclase phenocrysts. The phenocrysts are very conspicuous and reach several inches in length; they are generally euhedral and apparently were originally gray-brown in color like the groundmass. In places the rock has gray phenocrysts rimmed in pink. Most of the orthoclase phenocrysts are lath shaped and oriented parallel to flow directions. The groundmass is gray-brown and fine grained (though not aphanitic), containing pink and gray-brown feldspars as well as hornblende and, in most cases, magnetite. Pyrite is fairly abundant in places, and traces of chalcopyrite also were noted. Some specimens are strongly magnetic -- especially near signs of copper mineralization.

Type Two is a dark-gray feldspar porphyry, containing purple (or dark red-brown) phenocrysts. The phenocrysts exhibit Carlsbad twinning and are nowhere altered to other colors. This rock is similar to Type One except that the groundmass is finer grained and a darker gray color, and the phenocrysts are not pinkened. In general this rock is non-magnetic or only weakly magnetic, except near copper mineralization where it may be strongly magnetic. Disseminated pyrite is found in places.

Type Three is intermediate in character between types One and Two. Large phenocrysts of flesh-colored orthoclase and small phenocrysts of chloritized hornblende(?) are present in a dark-gray, aphanitic groundmass. Magnetite can be found along small fractures, but the groundmass is non-magnetic.

Type Four is aplite. It is flesh colored and fine grained. The bulk of the rock consists of pink orthoclase and white quartz. Less than one percent of the rock is made up of chloritized mafic minerals.

Some specimens exhibit small specks of disseminated chalcopyrite.

Type Five is a hornblende-feldspar porphyry. The groundmass is dark gray and contains white phenocrysts of orthoclase that are generally less than $\frac{1}{2}$ inch long and much smaller (but abundant) phenocrysts of euhedral hornblende. On weathered surfaces the white orthoclase phenocrysts take on a rusty pink color. Pyrite is fairly abundant in the groundmass. This rock type is not magnetic.

Geochemical analyses blocked out the zones of mineralized rock. The talus beneath areas of copper mineralization characteristically read >70 ppm cxCu. Along most -- but not all -- of these zones, float with visible copper was found.

Sporadic signs of mineralization are widespread in the Hankin Peak area. The volcanics are widely chloritized and both epidote and rhodonite(?) are not uncommon. Malachite and chrysocolla are concentrated along joints and shears, typically within the gray-brown feldspar porphyry (Type One). In places, chalcopyrite and pyrite can be found along joints or disseminated within the groundmass of the porphyry. The copper seems to be associated with the pinkened feldspars. The chloritized country rock near these mineralized porphyry dikes is also mineralized with copper in places; it is an altered volcanic rock with the appearance of the groundmass of porphyry Type Five. Veinlets cutting the country rock contain chalcopyrite with associated pink alteration. This chloritized country rock is strongly magnetic in some places; strong magnetism was noted near copper mineralization, but it is possible that the chloritized volcanics in general are abnormally magnetic.

Chalcopyrite and pyrite also were found in the Type Two porphyry. There is no change in the purplish feldspar phenocrysts even where chalcopyrite is present. Magnetite seems to be associated with the copper mineralization and is especially abundant in brecciated zones of this prophyry.

The mineralization seen at Hankin Peak is low-grade and very sporadically located. Narrow shear zones carry the best grades, but no extensive zones of shearing could be found. Accordingly, this area was abandoned and the claims were not recorded.

Butterfly Creek Molybdenite Zone:

A large boulder of quartz monzonite containing coarse flakes of molybdenite was found near the headwaters of Butterfly Creek. The molybdenite occurs as rosettes about $\frac{1}{4}$ inch in diameter and constitutes up to nearly 10% of the rock. The quartz monzonite is a distinctive rock type in the Stikine area -- gray where unaltered and pink where affected by deuteric or hydrothermal fluids. Only a small area could have supplied the piece of float found, so a concentrated effort was made to locate the source. In spite of the fact that the source was along a very steep cirque wall, it was located on the first day of the search. It proved to be a pod-shaped zone, only three feet in longest outcrop dimension. Only one such zone was found; others may exist, but their scarcity negates the possibility of exploiting the molybdenum.

Although this occurrence of high-grade mineralization proved to be too localized for commercial recovery, its presence in the quartz monzonite should be of special interest. Kerr (1948) considered the quartz monzonites, which are supposedly the youngest of the Coast Range intrusives, to be barren of ore minerals. He states that the quartz monzonite plutons are characteristically speckled with pegmatites, suggesting that the mineralizers were unable to escape. No pegmatites were observed by our field team in the Butterfly Creek area, but the molybdenite pod(s) may represent an analogous feature. These plutons are reportedly steep-walled with flat roofs. Perhaps there was no doming to provide fissures for escape of the volatiles, as considered important by Wisser (1960) and Mackin (1947, 1954). If such is the case, domed quartz monzonites may prove more rewarding; it is accordingly recommended that future field parties be alerted for domed structures. (In support of this line of reasoning, the intrusive complex at Galore Creek is described as a domed pluton by the Kennco geologists.)

Conover Shear Zone:

Detailed surface geophysical studies were made across the Conover shear east of the Chutine River. The results are discussed above in the section on airborne magnetometer surveys. Known mineralization along the Conover shear to the west and an airborne magnetometer anomaly encouraged the detailed work, but no signs of copper were encountered. Mafic volcanics apparently caused the magnetic anomaly.

Mt. Rowgeen Area:

The strong magnetic anomaly detected over the Mt. Rowgeen area has already been described. Evidently, the magnetic high results from a mafic pluton. The anomaly is abrupt and of large magnitude, implying a steep-sided intrusive with appreciable magnetite. Pieces of float and rare outcrops indicate that the abnormal magnetics are produced by magnetite-bearing diorite and pyroxenite (and/or peridotite). Veinlets containing coarse-grained magnetite were found in biotite-bearing (deuteric?) diorite, and both veinlets and fistsized patches of magnetite were found in the pyroxenite. The pyroxenite is strongly magnetic even where magnetite cannot be detected megascopically as a separate mineral phase. This rock type is granular and very dark green in color, looking on casual inspection like magnetite--especially in light of its strong reaction to the magnet. Optically the dark green mineral appears to be augite or titanaugite, containing disseminated magnetite as well as hair-like inclusions of an unidentified opaque, or nearly opaque, mineral in a sagenitic pattern. A spectrographic analysis of this rock type indicated that it contains 12% Ca, 9% Al, 8% Mg, and 0.7% Ti, in addition to iron and silica. These components would be expected in augite (though the Al-content seems a little high) and argue against titanaugite. Another sample of this rock was identified independently as predominantly olivine (R. M. Thompson to Sirola, personal communication); although the spectrographic analysis could not represent olivine, it is possible that olivine is prominent in other samples. Thus, peridotite may be an important rock type in the area.

Tatsamenie Area:

A breccia or "pebble" dike was investigated six miles east of the elbow in Tatsamenie Lake, Tulsequah Quadrangle (northwest of the Telegraph Creek Quadrangle). The breccia zone, which is vertical, can be traced down the side of a valley for more than a half mile and about 2000 feet vertically; throughout this distance it is mineralized with pyrite, chalcopyrite, and molybdenite. The host rock is feldspathic gneiss, showing widespread alteration to epidote, actinolite, chlorite, and calcite; locally orthoclase seems to be an additional alteration product. The breccia zone is at least 60 feet wide in places. It grades from crackled edges, through angular rotated fragments, to a central zone of rounded, rotated fragments. Most of the rounded fragments are several inches in diameter and so thoroughly altered that identification of rock types is difficult. The identifiable fragments proved to be gneiss, similar to the host rock, and rotation is evidenced by anomalous orientations of the foliation. Some of the highly chloritized fragments may be altered mafic volcanics.

Massive magnetite-chalcopyrite-serpentine rock was found as float in the talus. The source for this rock should be easy to locate with surface or airborne magnetometer traverses. Furthermore, disseminated chalcopyrite can be found in mafic volcanics just north of the breccia dike.

The mineralization seen in this district is all low grade, but the genetic significance of a mineralized breccia dike makes it an attractive area for further studies. Unfortunately, the writer did not realize the urgency of staking before asking, so while we waited to learn if the property was open, another company (Newmont) moved in. They stayed on the property all summer and reportedly did some drilling.

Whether or not the Tatsamenie mineralization ever becomes a mine, it was recognized as a zone of interest in which further work should be done. Claim tags are cheap; accordingly, the breccia zone should have been staked immediately. The matter is recorded here as a lesson to future projects.

CONCLUSIONS

1. An area of approximately 1000 square miles was reasonably well covered by general prospecting with support from geochemical and aeromagnetic surveys.
2. The dithizone geochemical technique was successful in detecting zones of copper mineralization. Readings of >25 ppm cxCu can be considered significantly above background to warrant further investigation.
3. The airborne magnetometer proved useful, but mechanical difficulties detracted from its success during this season. Nevertheless, many anomalies were detected and the association between magnetic anomalies and copper mineralization was clearly demonstrated. Contour flying with the helicopter is not difficult and a single operator can manage the instrumentation adequately. Future projects, with a properly working magnetometer and recorder, should provide more rewarding results.
4. The most promising area discovered is on Mount Barrington. It is called the Spann Creek group and was covered by 80 claims. A mineralized zone some 400 feet wide and 700-800 feet long can be traced on the surface, though its depth and true limits are unknown. Copper and molybdenum mineralization, with associated silver and gold values, occurs along joints. The spacing of joints and concentration of sulfides appears to be slightly sub-economic in grade. Detailed surface studies — physical, geophysical, and geochemical — were carried out in anticipation of further work in the area.
5. The Stikine region is a true metallogenetic province. Copper and molybdenum mineralization is widespread — so much so that it is rare not to find traces of these metals in a given area. The

Stikine region is also large, and only a small corner of it was covered during the 1964 season. Many other companies were combing the other corners, but few of them had the advantage of an airborne magnetometer. In country that has already been visited by prospectors and geochemical crews, the airborne magnetometer should provide a critical advantage. There is still more than enough wilderness left for future programs employing an airborne magnetometer. It should be emphasized, however, that the ground geological support is essential and should be retained in such future programs.

APPENDIX A

COMMENTS ON DITHIZONE GEOCHEMICAL TEST FOR COPPER

The dithizone test for copper was the principal geochemical method used in the Stikine project. This technique is a rapid field test for determining the cold-extractable copper (cxCu) in soils or stream silts (Hawkes, 1963; Holman, 1956; Bloom, 1955). By comparison with a known standard, the results can be converted to parts per million copper. However, there are several variables in the process, so the final figure produced may depend upon the techniques employed and the nature of the materials. Among the factors that may be significant are 1) the determination of the conversion factor for calculating ppm cxCu from a quantity of dithizone solution, 2) the possibility that the field strength dithizone solution may change in time, 3) the size fraction of silt or soil used and the presence or absence of possible diluents or complexing agents, 4) the time lag in extracting the soluble copper from the sample, 5) the effect of variations in the pH of the buffer, and 6) in general the adherence of the prospector to careful analytical procedure.

The final number recorded in a geochemical test is assumed to represent -- with meaningful accuracy -- the cold-extractable copper in the sample in terms of parts per million. This number is determined by multiplying the units of field-strength dithizone used by a factor previously established on comparing the same batch of dithizone to a known copper standard. The geologist working in the field must accept on faith the stated concentration of copper in the standard. Then, assuming no analytical mistakes are made in the process (a hazardous assumption, judged by our experience during the field season), the amount of copper measured by each milliliter of dithizone is easily established, but only within fairly wide limits of accuracy.

Several variables will affect the conversion factor determined. First, the copper standard must be diluted to 4% of its stock strength, and, since only a small amount is needed, the percent of error introduced in this step may be relatively large (possibly 15-20%). Table 1 shows the results of a test to establish the differential in conversion factor caused by failing to dilute the copper standard in precisely the correct proportions. The test shows the results if, instead of one milliliter of copper standard, either 1.2 ml or 0.8 ml were measured.

TABLE 1. Effect of not diluting the copper standard in precisely 1:25 proportions.

Test	ml Cu concentrate in 25 ml H_2O solution	ml dithizone added	conversion factor calculated
1	1.2	3.3	6.06
2	1.2	3.7	5.4
3	1.2	3.7	5.4
4	0.8	2.6	7.7
5	0.8	2.5	8.0
6	0.8	2.4	8.3

The effect of measuring out the diluted copper standard in the test tube may result in an additional 15% error, principally because the meniscus of the standard is five times as pronounced as the meniscus of the dithizone. According to the system used, five milliliters of the diluted copper standard should be tested to determine the conversion factor. Table 2 shows the conversion factor produced if four or six milliliters of the standard are used. Since the amount of dithizone added is read as a total minus the amount of copper standard, there are actually two answers possible, one using the true amount of dithizone added and a second using the apparent amount added (assuming there had been five milliliters of copper standard regardless of how much had actually been used).

TABLE 2. Effect of errors in measuring out the diluted copper standard.

Test	ml of Cu standard	apparent amount dithizone added (ml)	actual amount dithizone added (ml)	apparent conversion factor calculated	actual conversion factor calculated
General	5	2.9	2.9	7	7
1	4	1.9	2.3	10.5	8.7
2	6	5.0	3.8	4	5.25

The dithizone geochemical test for copper is a colorimetric method. Recognizing the neutral point (blue-gray, or the mid-point between red and green) is a third source of error that can result in a 15% variation in the conversion factor. The general range of indecision is indicated by the tests shown in Table 3. This range

TABLE 3. Range of indecision in recognizing the neutral point in color.

Test	ml dithizone added	conversion factor computed	average conversion factor
1	2.8-3.3	7.15-6.06	6.5
2	2.7-3.1	7.4-6.45	6.9

was determined by recording the first approach to a neutral color and adding dithizone until the green dithizone definitely began to dominate, but any point within this range is close enough to the neutral color to be picked as neutral gray. It should be emphasized that the test was conducted with clear copper standard to determine the conversion factor; a further -- and possibly greater -- error should be expected when attempting to establish the neutral point in a sample of mud.

Table 4 lists the results of nine repeated measurements of the conversion factor. Three separate dilutions of both dithizone and copper standard were used. The results show a variation of 10-15% around the mean of 6.6. Similar tests run later in the season (when the stock dithizone and concentrated copper standard were older) averaged slightly lower for the conversion factor.

TABLE 4. Repeated measurements to establish the factor for converting ml dithizone to ppm cxCu.

Test	Dithizone Batch	Cu Standard Batch	ml Dithizone	Conversion factor calculated
1	1	1	3	6.6
2	1	2	3	6.6
3	1	2	3	6.6
4	1	2	3	6.6
5	1	3	2.9	6.9
6	1	3	2.8	7.15
7	2	1	3.5	5.7
8	3	2	3	6.6
9	3	3	2.9	6.9

The reagents used in the geochemical method will change in time if not carefully preserved. For example, the dithizone decomposes to other organic compounds. Decomposition is accelerated by heat and sunlight, so the solution is best preserved in a dark, cool place. If the field crews do not dilute fresh amounts every few days, they may begin introducing an error into their readings. The stock dithizone concentrate will also deteriorate, but it is not subject to such rapid changes. A batch of the field-strength (diluted) dithizone was preserved with no change for 25 days in the field by keeping it in a cardboard box that was wrapped in a plastic bag and then lowered into a shallow hole in a shaded area of soil. The hole was covered with a piece of tar paper. This sample of dilute dithizone tested to the same conversion factor both before and after the 25-day storage period. However, the field crews could not preserve their dithizone so carefully, and some of the solution was discovered in a deteriorated state.

The pH of the "buffer," or extracting reagent (a mixture of ammonium citrate and hydrochloric acid), may also be critical. Stanton (1964) states that the efficacy of extracting copper is markedly reduced below a pH of 3.0. Above a pH of 4.6, zinc extraction may contaminate the results. Hawkes (1963) also emphasizes the fact that controlling the pH is critical.

The extractant used in the Stikine area was slightly more acidic than the optimum of 2.0 called for on the instruction sheet, which in turn is below the 3.0 limit considered critical by Stanton. (Although a means was available for measuring the pH, no chemicals were supplied for adjusting the acidity. Future projects should include a small container of concentrated ammonium hydroxide for increasing the pH and another container of concentrated hydrochloric acid for lowering the pH.)

All workers who have studied geochemical techniques emphasize the importance of using a standardized grain size of soil or silt. Accordingly, a simple stainless-steel tea strainer was used in the field. The sieve was slightly finer than 35 mesh (U. S. Standard Sieve Series) or 500 microns (but definitely coarser than 45 mesh or 350 microns), and only the fine-grained fraction was tested for copper. Most of the samples were wet when collected, so sieving was done into a cup of water. After sieving, the water was decanted and the silt sample collected in a plastic spoon. Decanting naturally causes the finest fraction -- the material in suspension -- to be discarded, but it was felt that standardization is achieved in spite of losing this fraction. Moreover, a test was run on the fines collected from the decanted fraction of a cupriferous wet-sieved sample, and it contained essentially the same proportion of cxCu as the material that settled to the bottom of the cup.

According to Hawkes (1963, p. 585), "The principal analytical source of error in the dithizone field tests is in standardizing the time of shaking. The so-called 'extractable' metal content of a sample is not an absolute quantity. It is normally greater the longer the extractants stay in contact with the sample. Thus the time between the beginning of the extraction and the time the colors are estimated is very critical and should be carefully standardized." If we had been aware of this variable before the field season began, our results would be much more meaningful. It was late in the season when the importance of reaction time was fully appreciated. In general, the samples were agitated vigorously for 15 seconds or until there was no further reaction, but recognizing a delay in reaction time encouraged much longer treatment in many cases. Late in the season, when the time factor was appreciated, it was discovered that over 50% of the Spann Creek samples were influenced by a time lag in the reaction. Consequently, the tests as recorded during the entire field season cannot be considered strictly comparable to one another; in fact, the geochemical map in general should be classified as dubious.

Several long-term tests were performed to investigate this time-lag factor. Table 5 shows the results of one of these tests. The sample

TABLE 5. An example of delayed reaction.

Time	cxCu measured (in ppm)
30 seconds	36
15 minutes	54
1.5 hours	78
2.5 hours	81
4.5 hours	87
8 hours	105
24 hours	117
48 hours	129
55 hours	138

used for the data in Table 5 was collected in the Spann Creek area; it would have been considered significantly copper-rich in the normal short-duration test, but may give misleading results where trends in ppm cxCu are sought. If the sample could be constantly shaken, the reaction would proceed faster; for example, the reading of 117 ppm cxCu in 24 hours (Table 5) could have been achieved in much less time with continuous agitation of the mixture.

A slight reddish hue just above the sediment after the test tube has been standing for a few minutes or more indicates a slow reaction. Also, a purplish color, instead of the neutral blue-gray end point, will generally develop within a few minutes if the tube is re-shaken.

Several samples would have been recorded as 0 ppm cxCu if shaken for only 15-30 seconds but gave reactions equivalent to >70 ppm cxCu after several hours. In one case, a sample that was initially negative measured 54 ppm cxCu after an hour. Conversely, many of the negative samples remain negative even after 24 hours. Some of the samples that were initially negative were discovered to be delayed-reaction types when a reddish fringe formed at the dithizone-sediment interface after standing for about 5 minutes. For this reason, samples tested at the end of the field season were standardized by routinely allowing them a 5-minute time limit for signs of a reaction.

The delayed reaction in some samples and not in others is undoubtedly due to the manner by which the copper is held in the sediment. Copper that is merely adsorbed onto clay, organic matter, or limonite, and copper contained in carbonate minerals, is readily taken into solution by the extractant. But oopper contained in detrital sulfide minerals is removed slowly and only incompletely. It has been estimated

(Hawkes, 1963) that only about 5% of the total copper content is extracted by this cold technique during the normal time-limited test.

In addition to the above-mentioned factors, further errors may be introduced by careless analytical techniques and failure to acknowledge some of the known variables. For example, the conversion factor is computed for a two-milliliter sample; even with conscientious attention, it is difficult to measure precisely this amount of wet silt in the bottom of a test tube. Measuring the proper proportions of extractant and dithizone is less difficult, but not all prospectors are convinced that such accuracy is important. The possibility of collecting colluvium as a diluent is another problem; the analyst must select stream-transported silt that contains no contribution from the nearby stream bank if he hopes to develop a meaningful geochemical picture in a given drainage basin. Finally, the presence of organic matter should be avoided or, where unavoidable, recorded by the analyst. Anomalously high concentrations of readily extractable copper may be adsorbed by organic matter. Moreover, organic material is known to cause fading of the dithizone solution, resulting in deceivingly high readings (Hawkes, 1963).

In order to check the reliability of analyses made by the field parties, a random positive sample was tested in the base camp, taking special care with analytical procedures. The standard agitation time was employed. The sample selected was recorded as >70 ppm cxCu by the field analyst. At the base camp the same sample measured 48 ppm cxCu. It was subsequently learned that the field party 1) did not sieve the sample, 2) was not careful in measuring out the amounts of sample and reagents, and 3) had not been conscientious about preparing fresh field-strength dithizone every few days. Furthermore, the sample showed a slight delayed reaction (reading 55 ppm after an hour and 66 ppm after two hours), which may have contributed to the discrepancy in measurements. Rather than make further checks on tests already performed, the field parties were briefed on the variables and need for more careful work, in the hope that subsequent analyses would be more carefully regulated.

In conclusion, it is evident that the reliability of the geochemical analyses is increased in direct proportion to the standardization of analytical procedures. In other words, if relative amounts of cxCu are to be determined, each sample should be given an equivalent treatment. The prospectors must be informed of the variables and must be made aware of the need for conformity to a standard procedure and to careful analytical techniques. Occasional checks at base camp on samples run by field parties would be one method of overseeing the adherence to standardization. If such a program should still prove inadequate, perhaps a special technician should be hired to run all samples at the base camp, thereby eliminating the major problem caused by having analyses run by different men, using different batches of dithizone, and operating under different attitudes of analytical license. Used intelligently, this geochemical method can be considered crude but meaningful. Relative concentrations of cold-extractable copper are determined; the conversion to parts per million introduces a note of false accuracy, but it provides a useful symbol to indicate relative amounts. As long as these limitations are understood, there is no reason why the dithizone method should not provide a useful exploration tool.

APPENDIX B

TRAVERSES WITH AIRBORNE MAGNETOMETER

1. Junction of Strata & Dokdaon Creeks to NW across Stikine R.
2. NW bank of Stikine R. to NW up side of Conover Mt.
3. 3500-foot and 4000-foot contours, S side of Conover Mt., and 4000-foot contour on NE side.
4. SE from Chutine R.-Wriggle Cr. junction to Chutine R.-Stikine R. junction.
5. Circuitous traverse from Kirk landing up Stikine to mouth of Yehiniko Cr., NW to Kink Cr., along 3000-foot and 4000-foot contours over Shakes Creek syenite (Rugged Mt.), down Wriggle Cr. to the Chutine R., and back to Kirk landing.
6. NW up the lower Chutine valley, from the Stikine R. to Wriggle Cr.
7. SE along 1000-foot contour, just NE of 6 .
8. NW along 1500-foot contour, just NE of 7 -- battery faded.
9. Kirk Cr. to Dokdaon Cr., on 2000-foot contour.
10. Strata Cr. valley and Strata Cr. to Kirk Creek on 2500-foot contour.
11. Kirk Cr. to Strata Cr. and Strata Cr. valley on 3000-foot contour.
12. Strata Cr. valley, 3500-foot contour.
13. Strata Cr. valley, 4000-foot contour.
14. Strata Cr. valley, 4500-foot contour.
15. Strata Cr. valley, 5000-foot contour.
16. Strata Cr. valley, 5500-foot contour.
17. N slope Dokdaon Cr., 3000-foot contour.
18. N slope Dokdaon Cr., 2500-foot contour.
19. E shore Stikine R. & mouth of Butterfly Cr., 500-foot contour.
20. E shore Stikine R. & mouth of Butterfly Cr., 1000-foot contour.

21. E shore Stikine R. & mouth of Butterfly Cr., 1500-foot contour.
22. E shore Stikine R. & mouth of Butterfly Cr., 2000-foot contour.
23. E shore Stikine R. & mouth of Butterfly Cr., 2500-foot contour.
24. E side Dokdaon Canyon, 3500-foot contour.
25. E side Dokdaon Canyon, 4000-foot contour.
26. W side Devil's Elbow Mt. & Butterfly Cr., 3000-foot contour.
27. W side Devil's Elbow Mt. & Butterfly Cr., 3500-foot contour.
28. W side Devil's Elbow Mt. & Butterfly Cr., 4000-foot contour.
29. W side Devil's Elbow Mt. & Butterfly Cr., 4500-foot contour.
30. W side Devil's Elbow Mt. & Butterfly Cr., 5000-foot contour.
31. 2000-foot contour N from Klootchman Canyon up E Stikine into Dokdaon.
32. E side Dokdaon valley, 4500-foot contour.
33. E side Dokdaon valley, 5000-foot contour.
34. E side Dokdaon valley, 5500-foot contour.
35. E side Dokdaon valley, 6000-foot contour (incomplete; battery pooped).
36. W side Dokdaon valley, 2500-foot contour.
37. W side Dokdaon valley, 3000-foot contour.
38. W side Dokdaon valley, 3500-foot contour.
39. W side Dokdaon valley and Brydon valley, 4000-foot contour.
40. W side Dokdaon valley and Brydon valley, 4500-foot contour.
41. W side Dokdaon valley and Brydon valley, 5000-foot contour.
42. Mountain spur, N peak, between Brydon & Dokdaon Creeks, 4250-foot contour.
43. Mountain spur, S peak, between Brydon & Dokdaon Creeks, 4250-foot contour.
44. Brydon Cr. Canyon, 3500-foot contour.
45. Brydon Cr. Canyon, 3000-foot contour.
46. Brydon Cr. Canyon, 2500-foot contour.

47. NW flank Devil's Elbow Mt., 1000-foot contour.

48. NW flank Devil's Elbow Mt., 1500-foot contour.

49. NW flank Devil's Elbow Mt., 2500-foot contour.

50. NW flank Devil's Elbow Mt., 3000-foot contour.

51. NW flank Devil's Elbow Mt., 3500-foot contour.

52. NW flank Devil's Elbow Mt., 4000-foot contour.

53. W side Stikine Valley, 1000-foot contour, Jackson's Landing to Donnaker Cr.

54. W side Stikine Valley, 1500-feet to 1000-feet, Missusjay Cr. to Patmore Cr., and into Deeker Cr., 1100-feet to 1700-feet.

55. 800-foot contour N from Patmore Cr. to traverse upstream along Deeker Cr.

56. Oksa Creek, 800-foot contour.

57. Oksa Creek, 1200-foot contour.

58. Oksa Creek, 1600-foot contour.

59. Oksa Creek, 2000-foot contour.

60. Along Stikine Valley, Cone Mt. to Cinema Cr.

61. Missusjay Cr. & Conover Mt., 1000-foot contour.

62. Missusjay Cr. & Conover Mt., 1500-foot contour.

63. Missusjay Cr. & Conover Mt., 2000-foot contour.

64. Missusjay Cr. & Conover Mt., 2500-foot contour.

65. Missusjay Cr. & Conover Mt., 3000-foot contour, part of traverse n.g.

66. Missusjay Cr. & Conover Mt., 3500-foot contour, part of traverse n.g.

67. Missusjay Cr. & Conover Mt., 4000-foot contour, part of traverse n.g.

68. Missusjay Cr. & Conover Mt., 4500-foot contour, completely useless.

69. E side of Mt. Barrington, 1500-foot contour.

70. E side of Mt. Barrington, 2000-foot contour.

71. E side of Mt. Barrington, 2500-foot contour.

72. E side of Mt. Barrington and Limpoke Cr., 3000-foot contour.

73. E side of Mt. Barrington and Limpoke Cr., 3500-foot contour.

74. E side of Mt. Barrington and Limpoke Cr., 4000-foot contour.

75. Mt. Rowgeen, 3000-foot contour.

76. Mt. Rowgeen, 3500-foot contour.

77. Mt. Rowgeen, 4000-foot contour.

78. Mt. Rowgeen, 4500-foot contour.

79. Draw SW end Mt. Rowgeen along swampy creek on 1000, 2000, and 4000 ranges, flying at 4000-feet.

80. NE of Mt. Rowgeen, 3000-4000-foot contours.

81. NE of Mt. Rowgeen, 4500-foot contour.

82. NE of Mt. Rowgeen, along crest at 5000-feet.

83. Along Conover shear.

84. Mt. Barrington & S side Limpoke Valley, 4500-foot contour.

85. S side Limpoke Valley (Wilf Cr.), 5000-foot contour.

86. S side Limpoke Valley (Wilf Cr.), 5500-foot contour.

87. S side Limpoke Valley & E Mt. Barrington, 5000-foot contour.

88. E side Barrington Valley, 2000-foot contour.

89. N side Barrington Valley, 2500-foot contour.

90. N side Barrington Valley, 3000-foot contour.

91. N side Barrington Valley, 3500-foot contour.

92. N side Barrington Valley, 4000-foot contour.

93. N side Barrington Valley, 4500-foot contour.

94. Mountain between Barrington & Tahltan Rivers, 5000-foot contour.

95. N side Barrington Valley, 5500-foot contour.

96. E side Barrington Valley, 2500-foot contour.

97. N side Hankin Cr., 5000-foot contour, 1000 scale.

98. N side Hankin Cr., 5500-foot contour.

99. S side Hankin Cr., 5000-foot contour.

100. N side Hankin Cr., 5000-foot contour, 2000 scale.

101. W side Hankin Peak, 5000-foot contour, plus dido.

102. W side Hankin Peak, 5500-foot contour.

103. N end Mt. Helveker, 1500-foot contour.

104. N end Mt. Helveker, 2000-foot contour.

105. N end Mt. Helveker, 2500-foot contour.

106. N end Mt. Helveker, 3000-foot contour.

107. N end Mt. Helveker, 3500-foot contour.

108. N end Mt. Helveker, 4000-foot contour.

109. SW Mt. Barrington, 1500-foot contour.

110. SW Mt. Barrington, 2000-foot contour.

111. SW Mt. Barrington, 2500-foot contour.

112. SW Mt. Barrington, 3000-foot contour.

113. SW Mt. Barrington, 3500-foot contour.

114. SW Mt. Barrington, 4000-foot contour.

115. SW Mt. Barrington, 4500-foot contour.

116. SW Mt. Barrington, 5000-foot contour.

BIBLIOGRAPHY

1. Bloom, Harold, 1955, A field method for the determination of ammonium citrate-soluble heave metals in soils and alluvium: Econ. Geol., v. 50, p. 533-541.
2. Hawkes, H. E., 1963, Dithizone field tests: Econ. Geol., v. 58, p. 579-586.
3. Kerr, F. A., 1948, Lower Stikine and western Iskut River areas, British Columbia: Geol. Survey of Canada, Memoir 246.
4. Mackin, J. H., 1947, Some structural features of the intrusions of the Iron Springs district, Utah: Utah Geol. Soc., Guidebook to the Geology of Utah, no. 2.
5. Mackin, J. H., 1954, Geology and iron ore deposits of the Granite Mountain area, Iron County, Utah: U. S. Geol. Survey, Mineral Invest. Field Studies Map MF 14.
6. Stanton, R. E., 1964, Dithizone field tests -- discussion: Econ. Geol., v. 59, p. 1178-1179.
7. Wisser, Edward, 1960, Relation of ore deposition to doming in the North American Cordillera: Geol. Soc. America, Memoir 77.

PLATE I

NATIONAL TOPOGRAPHIC SERIES

CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

FIRST EDITION

CANADA SHEET 104 G

LEGEND

x A-5 = Camp site

= General areas studied

TELEGRAPH CREEK

BRITISH COLUMBIA

Scale 1 : 250,000

1 Inch to 4 Miles Approximately

THE DECLINATION OF THE COMPASS NEEDLE, 1954

Surveyed, compiled, drawn and printed by the ARMY SURVEY ESTABLISHMENT R.C.E., 1950-54. Aerial photography by the R.C.A.F., 1949.

Universal Transverse Mercator Projection

REFERENCE

Contour Interval 500 Feet
All Elevations in Feet above Mean Sea Level

North American Datum 1927

Copies may be obtained from The Map Distribution Office, Dept. of Mines and Technical Surveys, Ottawa, at 25 cents each.

TELEGRAPH CREEK
SHEET 104 G
FIRST EDITION

PLATE 2

Flight lines with magnetometer
Positive magnetic anomalies
Telegraph Creek
GRAND CANYON OF THE STIKINE
DODJATIN MTN
GRASS MTN
BREWERY MTN
MT GLENORA
Glenora
Three Sisters Islands
MT ROWGEEN
RUGGED MTN
ISOLATION MTN
MT BARRINGTON
CHUTINE RIVER
Chutine
ZAGODDETCHINO MTN
MT GORDON
NIGHTOUT MTN
Dagaichess
Klastline
Mess Creek
EDZIZA PEAK
Nuttlude Lake
Kakiddi Lake
COCOA CRATER
COFFEE CRATER
Mowdade Lake
ARMADILLO PEAK
MT HELVEKER
MT CONOVER
MT KIRK
STRATA MTN
CUTEYE MTN
MISSISSAUT MTN
CINEMA MTN
KLOOTCHMAN CANYON
DEVILS ELBOW MTN
CIRQUE MTN
DONNAKER
PHACOPS MTN
TRILOBITE MTN
DOKDAON MTN
ENDEAVOUR MTN
AMBITION MTN
HAMPER MTN
CONE MTN
MT JONQUETTE
LITTLE CANYON
C A S S I A R
SPECTRUM RANGE
M O U N T A I N S
COMMANDER MTN
PERSLESHIN
HICKMAN
RANKIN PEAK
SADDLEHORN MTN
SADDLE MTN
Flood Glacier
ALBUM MTN
CORNICE MTN
STIKINE
RIVER
Porcupine
Mud Glacier
ISKUT

PLATE 3


Telegraph Creek
GRAND CANYON OF THE STIKINE
DODJATIN MTN
GRASS MTN
BREWERY MTN
MT GLENORA
Glenora
Three Sisters Islands
MT ROWGEEN
RUGGED MTN
ISOLATION MTN
BARRINGTON
CHUTINE
RIVER
Dagaichess
TSODDETCHINO MTN
MT GORDON
NIGHTOUT MTN
EDZIZA PEAK
Nuttlude Lake
Kakiddi Lake
COCOA CRATER
COFFEE CRATER
Mowdade Lake
ARMADILLO PEAK
MT CONOVER
QUTEYS MTN
MISSISSIPPI MTN
VALHALLA MTN
CINEMA MTN
MT HELVEKER
MT KIRK
STRATA MTN
Yehiniko Lake
KLOOTCHMAN CANYON
DEVILS ELBOW MTN
CIRQUE MTN
MT DONNAKER
BUTTERFLY MTN
DOKDAON MTN
ENDEAVOUR MTN
AMBITION MTN
MT JONQUETTE
LITTLE CANYON
HAMPER MTN
CONE MTN
SPECTRUM RANGE
COMMANDER MTN
HICKMAN
PERESLESHIN
Flood Glacier
SABLEHORN MTN
SADDLE MTN
CORNICE MTN
ALPINE MTN
RANGE
STIKINE
SCOTCHMAN
Mud Glacier
HANKIN PEAK
MOUNTAINS
CASSIAR
Porcupine
Iskut
Klastline
Mess Creek

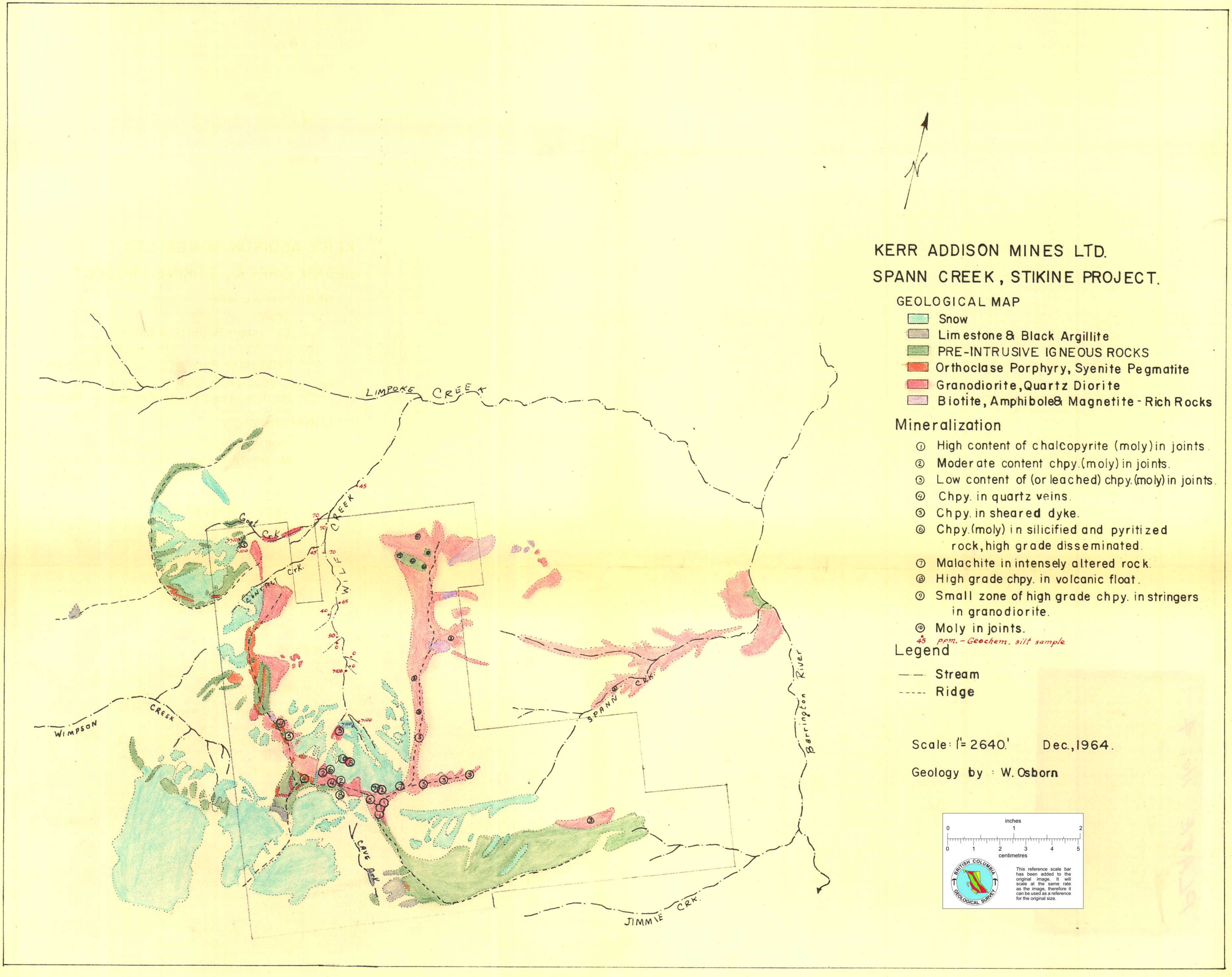
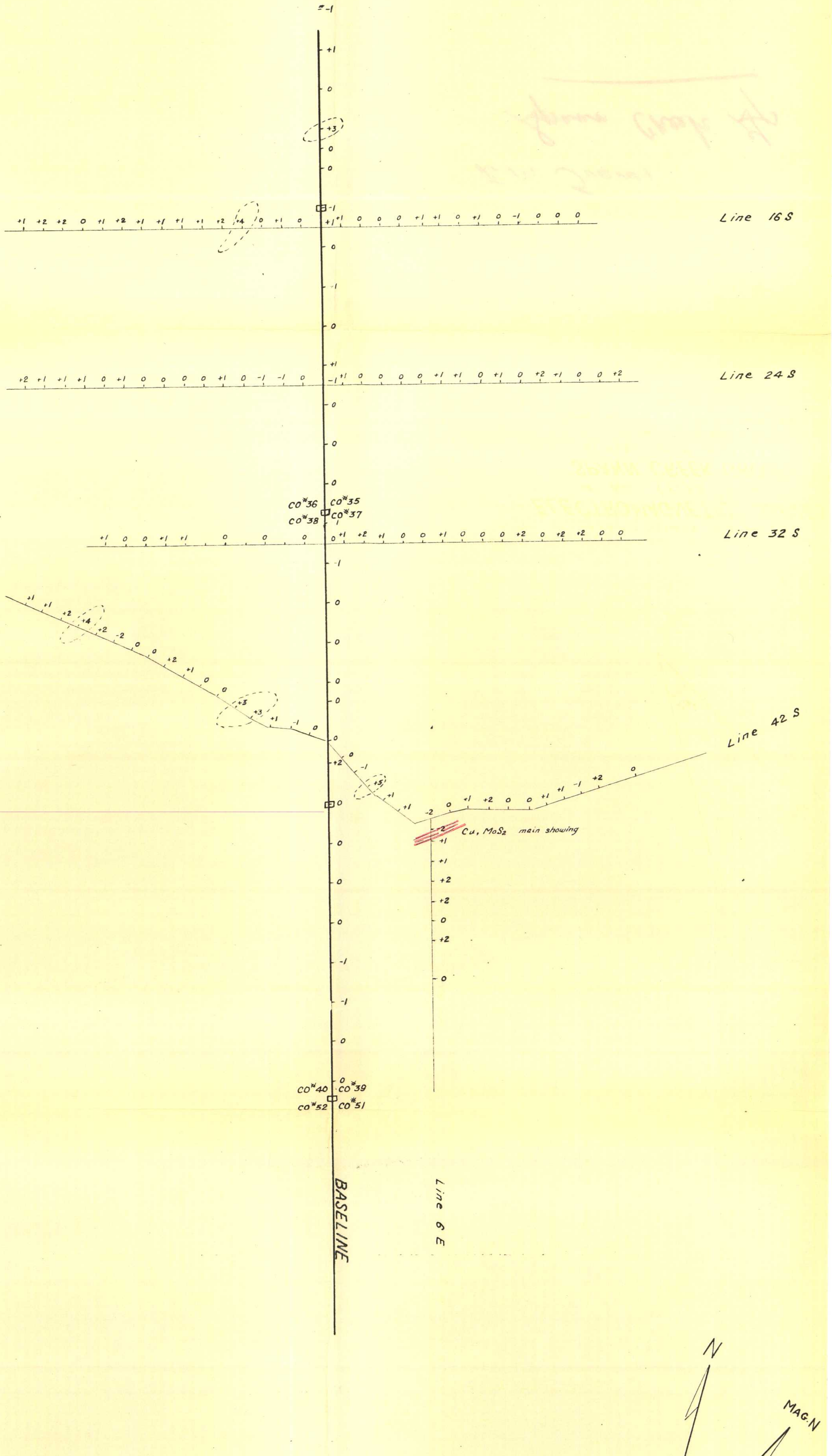

KERR ADDISON MINES LTD.
SPANN CREEK, STIKINE PROJECT.
GEOLOGICAL MAP
Snow
Limestone & Black Argillite
PRE-INTRUSIVE IGNEOUS ROCKS
Orthoclase Porphyry, Syenite Pegmatite
Granodiorite, Quartz Diorite
Biotite, Amphibole & Magnetite - Rich Rocks
Mineralization
① High content of chalcopyrite (moly) in joints.
② Moderate content chpy. (moly) in joints.
③ Low content of (or leached) chpy. (moly) in joints.
④ Chpy. in quartz veins.
⑤ Chpy. in sheared dyke.
⑥ Chpy. (moly) in silicified and pyritized rock, high grade disseminated.
⑦ Malachite in intensely altered rock.
⑧ High grade chpy. in volcanic float.
⑨ Small zone of high grade chpy. in stringers in granodiorite.
⑩ Moly in joints.
45 ppm. - Geochem. silt sample
Legend
Stream
Ridge
Scale: 1" = 2640'
Dec., 1964.
Geology by : W. Osborn
LIMPOKE CREEK
WILF CREEK
Goat Crk.
Contact Crk.
WIMPSON CREEK
SPANN CRK.
Barrington River
CAVE Creek
JIMMIE CRK.
N
inches
centimetres
BRITISH COLUMBIA GEOLOGICAL SURVEY
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

PLATE 5


LEGEND
SNOW and ICE
"YOUNGER" INTRUSIVE
HOST INTRUSIVE
COUNTRY ROCKS
Geophysics station
Claim post
Strike and dip of bedding
Strike and dip of joints
Strike and dip of foliation
Strike and dip of faults
Trends of mineralization
ppm. Geochem. soil sample
SCALE IN FEET
Contour interval 100 feet. Base: Kirk Landing = 400 and station 425 = 5735.
Tarn
EL. 5368
HELIPORT
EL. 5686
Knob
EL. 5679
Saddle
EL. 5621
Saddle
EL. 5619
42S12W
EL. 5930
42S18E
EL. 5604
Line 6W
Line 3W
Baseline
Line 9E
Line 12E
MO#9 CO#38
MO#11 CO#40
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.



KERR ADDISON MINES LTD.

ELECTROMAGNETIC SURVEY

of WILF CREEK AREA

SPANN CREEK GROUP

STIKINE RIVER AREA, B.C.

Scale : 1" = 400'

Survey by: Sept., 1964


Line 16 S
Line 24 S
Line 32 S
Line 42 S
BASELINE
Line 12 W
Line 9 W
Line 6 W
Line 3 W
Line 3 E
Line 6 E
Line 9 E
Line 12 E
Line 15 E
N
MAG. N
29°
KERR ADDISON MINES LTD.
MAGNETOMETER SURVEY
of WILF CREEK AREA
SPANN CREEK GROUP
STIKINE RIVER AREA, B.C.
Scale: 1" = 400'
Survey by: W. Osborne, Sept., 1964

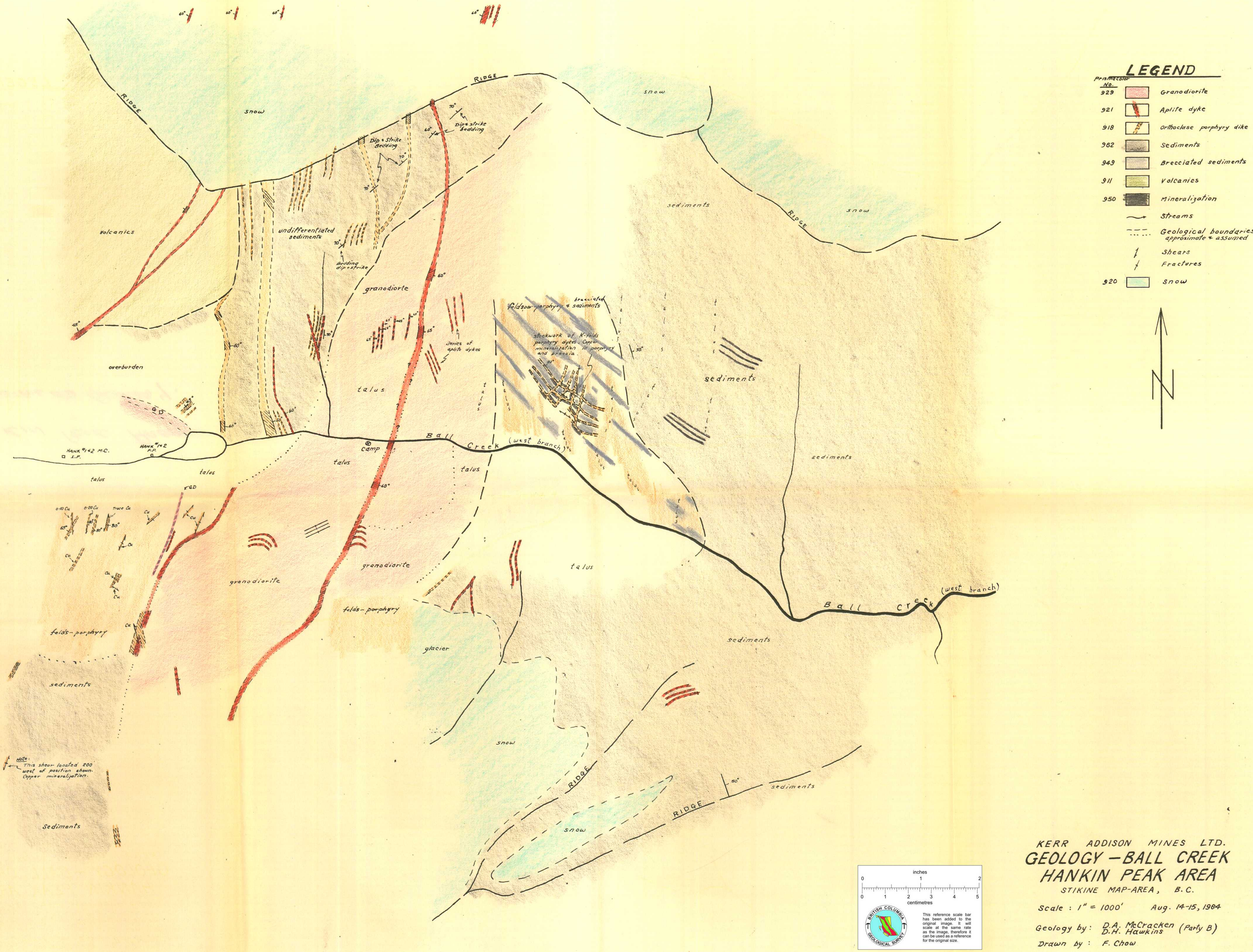
KERR ADDISON MINES LTD.

SELF POTENTIAL SURVEY
of
SPANN CREEK GROUP

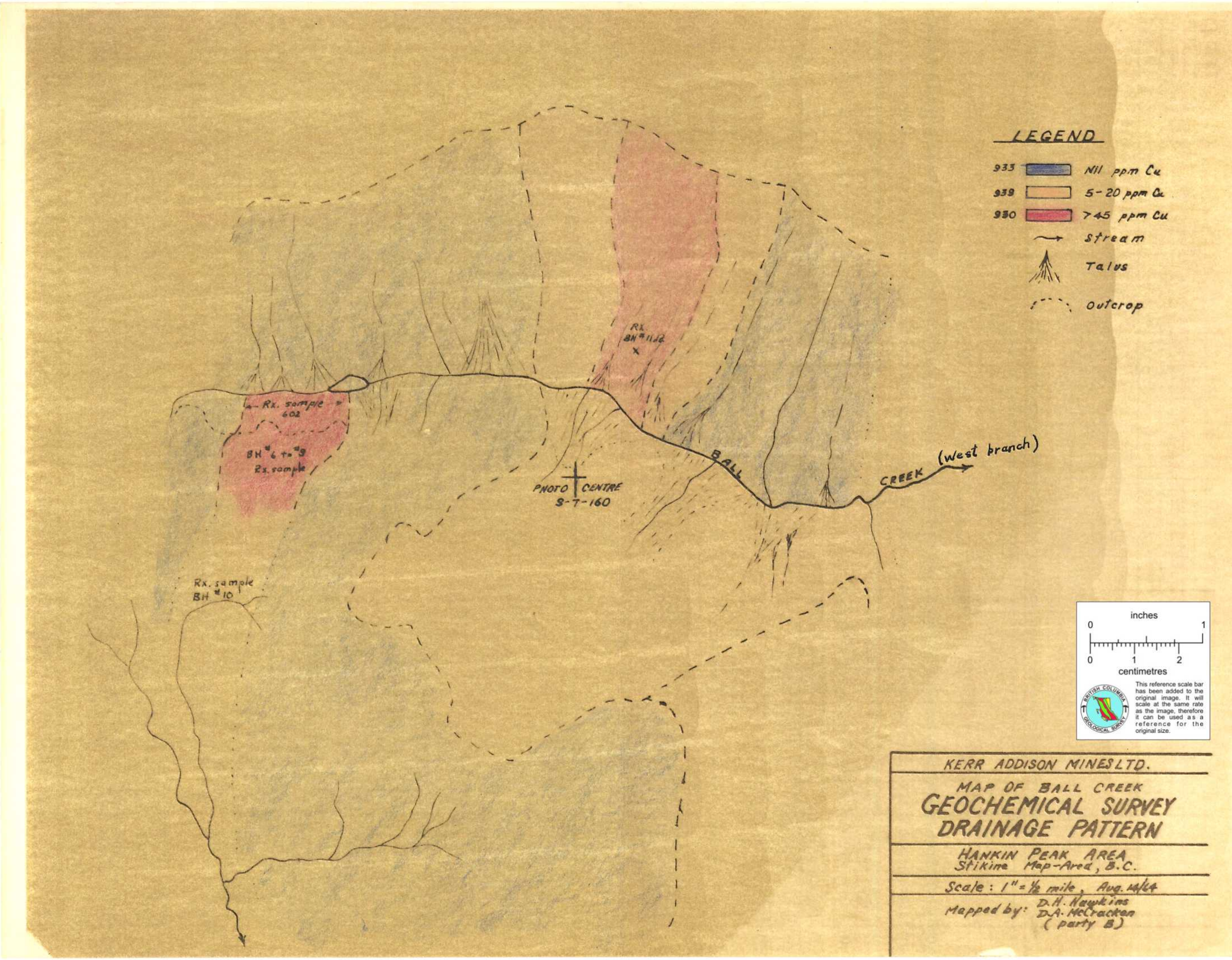
STIKINE RIVER AREA, B.C.

Scale : 1" = 400'

Survey by: V. W. Shuttleworth, Sept. 14, 1964



LEGEND
Prismacolor No.
929 Granodiorite
921 Aplite dyke
918 Orthoclase porphyry dike
962 Sediments
949 Brecciated sediments
911 Volcanics
950 Mineralization
Streams
Geological boundaries approximate + assumed
Shears
Fractures
920 Snow
N
RIDGE
snow
volcanics
undifferentiated sediments
Dip + Strike Bedding
granodiorite
Series of aplite dykes
Brecciated feldspar porphyry + sediments
stockwork of K-felds porphyry dykes. Cupper mineralization in porphyry and breccia
sediments
overburden
talus
Ball Creek (west branch)
Camp
HANK #142 M.C. S.P.
HANK #142 F.P.
granodiorite
felds-porphyry
glacier
sediments
Note: This shear located 200 west of position shown. Copper mineralization.
Sediments
KERR ADDISON MINES LTD.
GEOLOGY — BALL CREEK
HANKIN PEAK AREA
STIKINE MAP-AREA, B.C.
Scale : 1" = 1000'
Aug. 14-15, 1964
Geology by: D.A. McCracken (Party B)
D.H. Hawkins
Drawn by: F. Chow
inches
0 1 2
0 1 2 3 4 5
centimetres
BRITISH COLUMBIA GEOLOGICAL SURVEY
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.


LEGEND
933 Nil ppm Cu
939 5-20 ppm Cu
930 >45 ppm Cu
Stream
Talus
Outcrop
Rx. sample 602
BH#6 to #9 Rx. sample
Rx. BH#11 & 12
PHOTO CENTRE 8-7-160
BALL CREEK (west branch)
Rx. sample BH#10
inches
0
1
0
1
2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
BRITISH COLUMBIA GEOLOGICAL SURVEY
KERR ADDISON MINES LTD.
MAP OF BALL CREEK
GEOCHEMICAL SURVEY
DRAINAGE PATTERN
HANKIN PEAK AREA
Stikine Map-Area, B.C.
Scale: 1" = 1/2 mile, Aug. 14/64
Mapped by: D.H. Hawkins
D.A. McCracken
(party B)