GEOLOGY, PETROLOGY AND MINERALOGY OF THE BRONSON CLAIMS NORTHERN BRITISH COLUMBIA

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B.AP.Sc. Thesis 1972

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May 10, 1972.

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Dear Sir:

I respectfully submit this thesis entitled "Geology, Petrology and Mineralogy of the Bronson Claims, Northern British Columbia" in partial fulfillment of the requirements for the degree of Bachelor of Applied Science from the University of British Columbia.

Yours truly,

A. W. Randall

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A thesis submitted during the fourth year of the course in Applied Science at the University of British Columbia

ABSTRACT

The Bronson claims are located in a belt of weakly metamorphosed, Precambrian sediments, east of the Rocky Mountain Trench in northern British Columbia. The sediments, mostly thin-bedded siltstones and mudstones of the Aida and Gataga Formations, have been cut by a complex of northwest and northeast trending diabase dykes. The copper sulphides occur in steeply-dipping quartz-carbonate veins which have been emplaced along a northeast trending fault zone which is related to the system along which the dykes have been emplaced. Ore mineralogy is simple with the primary minerals being chalcopyrite and bornite.

Mineralization was controlled by the faulting. Quartz-carbonate vein material was emplaced first, filling the fault zone and partially replacing brecciated wall rocks. Vein-emplacement was closely followed by introduction of ore solutions. The brecciated zone near the vein walls appears to have been the "plumbing system". Ore minerals have replaced both vein material and brecciated wall rock.

A theoretical model developed for the deposit indicates the mineralized zone to be bulb-shaped in cross-section and to have a southwesterly plunging extension.

A rough zonal pattern related to the sedimentary section has been noted. There appears to be a transition from minor chalcopyrite near the bottom of the Gataga Formation through to extensive chalcopyrite and some bornite near midsection, then into extensive bornite near the top.

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF PLATES

GEOLOGY, PETROLOGY AND MINERALOGY OF THE BRONSON CLAIMS, NORTHERN BRITISH COLUMBIA

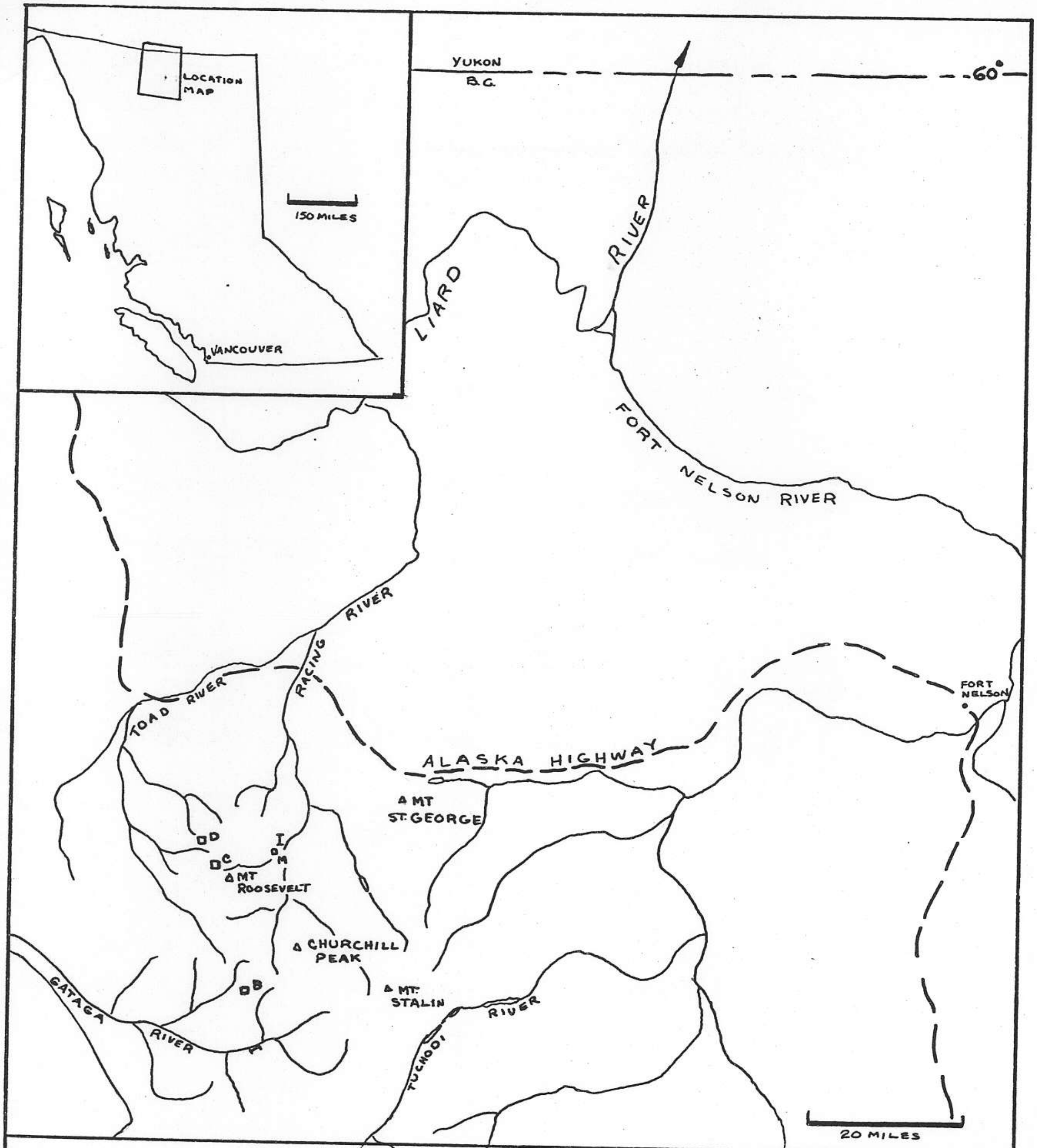
INTRODUCTION

The purpose of this report is to describe and discuss the geology, petrology and mineralogy of the sediments, dykes and veins found on the Bronson claims. Using the information available, a theoretical cross-section of the deposit is developed to attempt to show the original shape of the deposit and to suggest where an extension of the deposit might be found.

Location and Access

The Bronson group of mineral claims are located in the northern Rocky Mountains, about five miles southwest of Churchill Peak in northern British Columbia (Figure 1).

The nearest roads into the area end at Churchill Copper and at Davis-Keays mine sites,



LOCATION MAP

B - BRONSON CLAIMS

C - CHURCHILL COPPER

D - DAVIS KEYS

M - CHURCHILL COPPER CONCENTRATOR

I - AIR STRIP

FIGURE 1

approximately 30 air-miles distant. The only means of access to the area is by helicopter or a combination of fixed-wing aircraft and helicopter. A good air-strip is available at the Churchill Copper concentrator site and a short but serviceable strip exists in the Gataga River valley, about three miles southeast of the claim group.

Topography

The topography of the area is extremely rugged. Main valley floors are about two thousand feet A.S.L. and mountain peaks rise up to ten thousand feet A.S.L.. The main river valleys are mostly wide and U-shaped with hanging alpine valleys surrounding them. The alpine valleys are generally narrow with very steep walls. Relief in the alpine areas is often over two thousand feet. Ridge tops are generally narrow and jagged.

The Bronson showings are situated on a narrow, roughly east-west trending ridge (Bronson Mountain) between six and eight thousand feet elevation (Plate 1).

Climate

The climate of the alpine areas is sub-arctic with cool moist summers and cold dry winters. In summer the temperature may reach 70^{o}F although the average is around 50^{o}F. Annual precipitation varies from ten to twenty inches with most falling during the period May to September. Snow may be expected during any month of the year. Winter snowfall is generally four to six feet, however, great depths are built up by drifting and avalanches.

History

The first report of copper mineralization in the area was the discovery in 1943 of what is now the Churchill Copper Mine. Since then many similar deposits have been found in the area, among them the Bronson showings. Discovery of these showings occurred during a regional geochemical and prospecting programme carried out by Windermere Exploration between 1967 and 1969. Since then geological mapping, rock sampling and diamond drilling have been carried out.

Due to the topography, exploration of the prospect was extremely difficult and costly.

Helicopter transport was essential to the movement of men and equipment, however, even this was made difficult by the lack of safe landing sites. Many of the mineralized exposures could not be examined except by experienced rock climbers. Very costly drill sites had to be prepared before the diamond drilling could be conducted. On the north side of the mountain, it was found necessary to drive a short adit and drill from underground in order to be protected from avalanches and rockfalls. Similarly, on the south side, a platform and helicopter deck were built (Plate 2).

Plate 1: Bronson Mountain (looking west).

Plate 2: South side of Bronson Mountain showing drill site and helicopter deck.

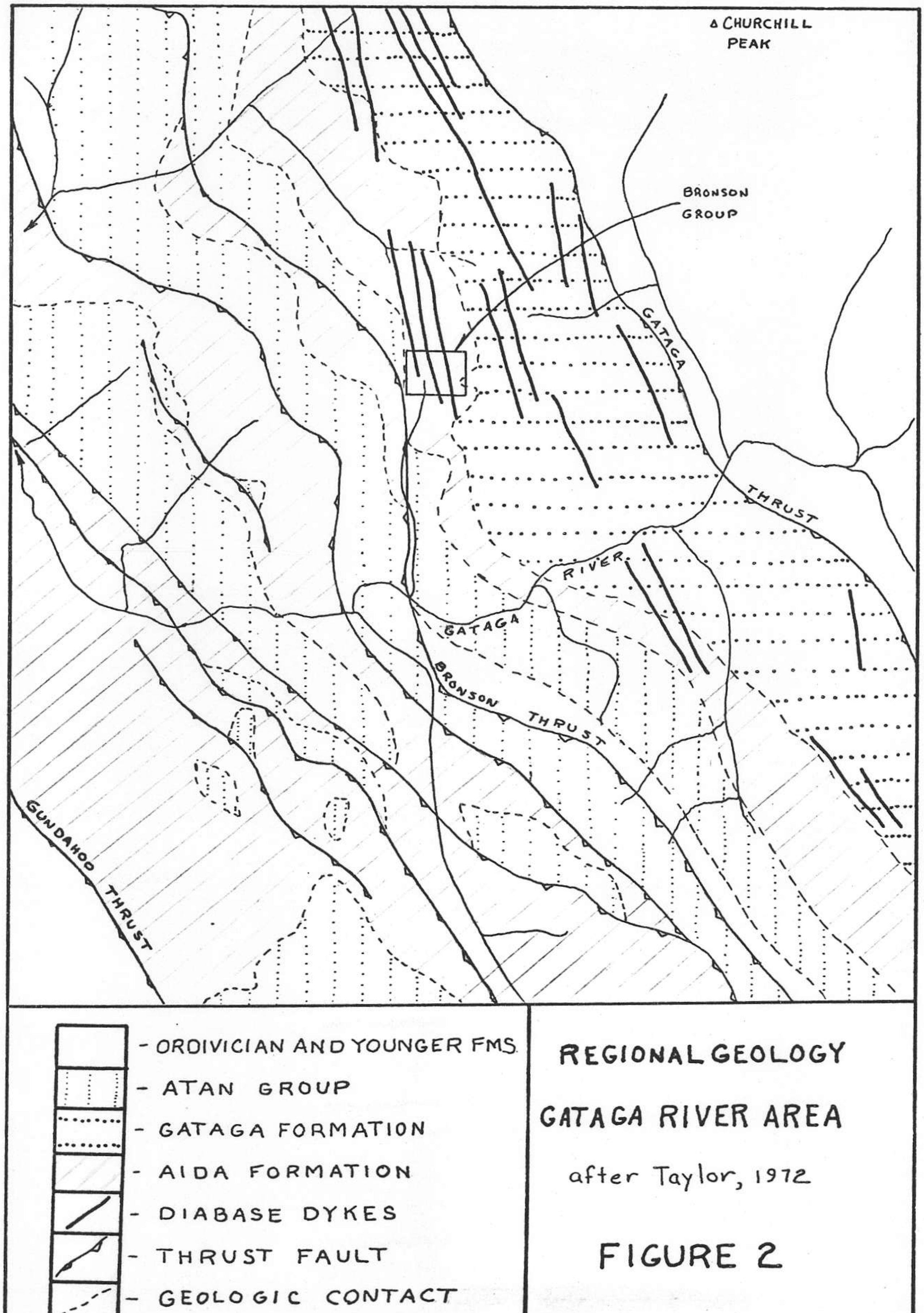
REGIONAL GEOLOGY
(after Taylor, 1972)

Sedimentary Rocks

The area, lying to the east of the Rocky Mountain Trench and stretching south from the Alaska Highway, is composed of a northwest trending belt of Proterozoic and Lower Paleozoic sediments. This sedimentary pile has been deformed and weakly metamorphosed by regional folding and thrust faulting. Figure 2 shows the regional geology and structure in the vicinity of the Bronson claims.

The geologic section for the region is shown in Figure 3. The units of interest, from the Tuchodi Formation through to the Atan group, are described below.

The TUCHODI FORMATION is not exposed in the vicinity of the Bronson claims. It is composed of a series of feldspathic quartzites, silty and argillaceous dolomites, and dolomitic siltstones.



REGIONAL GEOLOGY

GATAGA RIVER AREA

after Taylor, 1972

FIGURE 2

FIGURE 3

TABLE OF FORMATIONS

AGE	ROCK UNIT	THICKNESS
CAMBRIAN	ATAN GROUP	2000 - 6000 ft.
ANGULAR UNCONFORMITY		
PRECAMBRIAN	DIABASE DYKES	
	GATAGA FM.	4500+ ft.
	AIDA FM.	3,470 - 7,100 ft.
	TUCHODI FM.	5000+ ft.

(after Taylor, 1972)

The AIDA FORMATION, which rests conformably on the Tuchodi Formation, is composed of calcareous and dolomitic mudstones and siltstones with minor sandstone. It is approximately 6600 feet thick near Churchill Peak and thins toward the east.

The GATAGA FORMATION conformably overlies the Aida Formation. It is composed of greenish-grey to black, slaty-cleaved mudstones and siltstones interbedded with thin units of poorly sorted and graded sandstones. It is thought to be about 4500 feet thick although the top has not been observed as it has been truncated by erosion. An angular unconformity separates the Gataga Formation from the overlying Cambrian Atan Group.

The ATAN GROUP is composed of limestones, conglomerate sandstones, siltstones and shales.

Structure

The major structure crossing the region is the Tuchodi Anticline, trending roughly southeast from Mt. St. George toward Tuchodi Lakes. The area of interest lies on the western limb of this fold.

An extensive, well-developed, northwest trending system of thrust faults transects the area. Most of these thrusts dip moderately to the southwest. Two major thrusts bound the zone of interest, the Gataga on the east and the Gundahoo on the west.

Igneous Rocks

A series of northwest trending diabase dykes, occurring singly and in swarms, cut all the Proterozoic strata of the region (Plate 3). The greatest concentration of these dykes occurs between the Gataga Thrust and a subparallel branch of the Gataga Thrust (called in this report, the Bronson Thrust). The dykes are generally more resistant to weathering and tend to stand out as ridges within the surrounding sediments.

Plate 3: Swarm of dykes crossing a ridge to the north of Bronson Mountain.

LOCAL GEOLOGY
(Figure 4)

Sediments

The Bronson claims are situated in the Proterozoic Aida and Gataga rocks. These sediments strike generally northwest and dip about 25^{o} to the west or southwest. They form part of the western limb of the Tuchodi Anticline. A few small anticline-syncline structures (drag folds?) were noted within them.

The contact between the Aida and the Gataga units is not well defined. Cooke, on his map of 1970, shows the contact near the Central Zone. He indicates that the contact can be distinguished by a change from brown- to grey- weathering coloration of the rocks. This apparent contact cannot be easily examined, however, it appeared to the writer that this boundary cross-cuts the bedding at a small angle with no apparent presence of an unconformity. In field examination, the rocks on either side of this boundary were essentially identical. A similar transition from brown- weathering to grey-weathering sediments was noted south of the Central Zone where the bedding was cross-cut at a large angle by the boundary. In this case the transition marked the upper boundary of a bleached area associated with the veins of the central zone. Thus, it is assumed that the contact shown by Cooke is of similar association.

Taylor, in his map of 1972, shows the contact to be near the eastern side of the claim group (Figure 2) however, the small scale of the map makes it difficult to say precisely where the contact lies. On examining the rocks, a transition may be noted from well-developed to poorly-developed fracture cleavage as one proceeds eastward across this contact. This transition may also be noted in the topography which changes from very jagged, hackley to smoother, more rounded outcrops.

The presence of well-developed fracture cleavage in the Gataga Formation and not the Aida Formation is one of the few distinguishing characteristics (Taylor, 1972). Thus, if the above described location of the contact is correct, then all the known vein mineralization of the Bronson group is contained within the Gataga Formation which is in agreement with evidence found at Davis-Keays and Churchill Copper (Trimble, personal communication, 1972).

The fracture cleavage which was probably developed during folding generally strikes northwest and dips 50° to 60° southwest. The more competent nature of the sediments produced by the weak metamorphism of diagenesis was probably the reason for its development.

Dykes

Proterozoic sedimentary rocks of the claim area have been intruded by a swarm of diabase dykes. These dykes trend in two main directions. The northwesterly set is better developed and parallels the regional trend. The northeasterly set is generally a series of short discontinuous segments which, although often quite wide, do not show up on the regional structure pattern. The northwest trending set dips to the southwest or west and the northeast trending set dips to the southeast. All dips are relatively steep varying from 60° to 80°.

The two prominent dyke trends, at first glance, seem to indicate a conjugate set, however, this theory does not fit in with the regional northwesterly trend. On the north side of Bronson Mountain, the northeast trending set of dykes appears to have been offset by the northwest trending set. It seems most probable that first, a northeast trending set of tension cracks were formed perpendicular to the major fold axis. Then, with subsequent folding, the northwest trending (parallel to the fold axis) set of faults was developed. These faults also experienced, during development or at a later time, right-lateral movement resulting in the offset noted. It appears that the dykes intruded these faults at a later time as there is no evidence of extensive movement within the dyke rocks at the intersection of the faults.

Veins

Cooke (1970) divided the Bronson mineralized areas into four zones; East, Central, North, and South. In this report, the North Zone has been combined with the Central Zone and the

South Zone has been called the West Zone.

The vein system found on the Bronson claims appears to have come up along a fault system similar to that intruded by the dykes. The most strongly developed set of veins strikes northeast and dips to the south. A less well-developed set strikes roughly northwest and dips to the west. The dip of these veins varies from 50° to 80°.

Some of these veins are closely associated with the dykes. Generally thin and slivery, they occur parallel to the dyke walls and occasionally within the dykes. Veins of this type are most commonly found in the East and West Zones.

Many of the larger more extensive veins are not closely associated with the dykes. These veins occur singly or in swarms. In the Central Zone, several veins occur separated by a multitude of thin branching veinlets forming a poorly-developed stockwork.

A characteristic of all these veins is an erratic pinch and swell nature along their length. This fact has been observed in many similar vein systems of the region, notably at Churchill Copper and, to a lesser extent, at Davis-Keays. Extensive minor faulting has broken and displaced many of these veins. This may, in part, explain the erratic widths observed.

PETROLOGY

Sediments

The Proterozoic sediments have been classified (Menzies, 1951) as argillites since they have undergone weak metamorphism exemplified by the development of fracture cleavage. The fracture cleavage has a tendency to obliterate all evidence of bedding on the outcrop surfaces, however, drill core specimens show a pervasive, well-developed bedding. Breakage usually occurs along fracture cleavage planes rather than bedding planes.

These sediments, composed of siltstones and mudstones, are generally thin-bedded with alternating grey and black bands. These bands are occasionally interspersed with grey, unlaminated sections of siltstone and fine sandstone. Cross-bedding and slump structures were occasionally observed. Most fractures and openings in the slump structures have been filled with calcite.

Due to their fine-grained nature, the sediments are difficult to study with the petrographic microscope, however, some general characteristics may be noted. They all have a dense groundmass of fine clay minerals. Dispersed through the groundmass, small, angular to rounded quartz grains of detrital origin are usually found. The layering of the clay minerals flows around these grains. Irregular, indistinct grains and masses of carbonate material are also present often forming a good proportion of the groundmass. Sericite is the primary alteration mineral found. It occurs as fine, wavy, fibrous bands which usually cross-cut the bedding and lie approximately parallel to the fracture cleavage planes. This orientation seems to indicate the sericite was formed during the development of the fracture cleavage.

Bleached sediments are found in irregular areas surrounding some of the veins, notably in the Central Zone. Bleaching is characterized by silicification and extensive sericitization giving the rocks a phylitic appearance. Hydrothermal solutions associated with the emplacement of the veins and ore minerals are the most probable cause. A similar development of bleached zones was noted in the Cour d'Alene district where vein deposits have intruded argillaceous sediments. Frykland (1959, p. 96) states that:

> "... bleaching in the Cour d'Alene district was a hydrothermal process that affected only a few minerals in the rock, and accomplished the alteration without the addition of significant amounts of new material and perhaps without removing a significant amount of material."
>
> "Conversion of silty-clay and mudstones to sericite is a common process in low grade regional metamorphism".

The bleached area in the Central Zone extends several hundred feet outward from the veins. In some cases boundaries are faults, however, the bleaching normally dies out with a transition from brown-weathering to grey-weathering argillites.

In the West Zone, bleaching is poorly developed. Sediments in this area have been sheared and altered and are pale, purplish-brown in color. The cause of the coloration is not evident in hand specimen or in thin-section.

Silicification is generally erratic. Extending outward from the veins, it replaces some beds and not others. Silicification was best observed near some small veins which could be examined under the microscope. Bedding was observed to disappear in a zone of fine-grained quartz adjacent to the vein. Some recrystalized carbonate was also noted in this zone.

Sections of grey, altered sediments found in drill core appear to be the equivalent of the bleached rocks found at surface. These sections were generally associated with the veins. Along with the fine-grained, unidentifiable groundmass, these altered sections were composed of quartz, carbonate and sericite plus chlorite which was not present at the surface. Some of the chlorite probably came from dykes located nearby.

Dykes

Dyke rocks which are diabasic in composition are generally greenish black in color and weather to greyish black. They are medium-grained and granular. No distinct chill margins were noted. They vary in width from about one foot to over one hundred feet.

The original composition was determined from an unaltered sample taken near the centre of a large dyke. Several specimens of altered dyke were also examined. Description of the original and altered compositions are given in Appendix I.

Hydrothermal solutions associated with emplacement of the veins have reduced much of the dyke rock to chlorite. Dykes examined in drill-core showed this particularly well with the most extensive development of chlorite near the veins. X-ray analyses carried out on several specimens indicated the chlorite to be an iron-bearing variety, thuringite. Occasional minor shearing along with the alteration has given the rock a phyllitic texture.

Epidote has developed extensively where faults have cut the dykes. It occurs as a thick, slickensided coating on the fault planes and extends into the dykes.

Veins

Veins are composed of quartz and carbonate. The ratio of quartz to carbonate varies but quartz is usually dominant. Samples of vein material taken from drill core generally contained a greater amount of carbonate than similar vein material from the surface. Carbonate has probably been weathered from the surface rocks.

There is evidence, from thin-section studies, of at least two and probably more injections of vein material. The earlier quartz and carbonate often show wavy extinction due to strain. Shearing has caused deformation and elongation of some grains. Secondary veins are generally small and lensy, cross-cutting the primary vein material. Grains of quartz growing in the secondary veins are generally elongated perpendicular to the walls of the vein. The lensy shape of the secondary veins and the mode of growth of the quartz grains seems to indicate that these veins fill tension fractures.

The primary quartz and carbonate commonly occur in large irregular grains. They frequently have a dirty appearance from impurities disseminated through them. Secondary quartz and carbonate generally are milky colored and lack the impurities present in the primary material. In both primary and secondary veins, the carbonate appears to have crystalized late, filling intersticies between the quartz grains and occasionally appearing to replace the quartz.

Carbonate minerals present are calcite and ankerite. Calcite is more common and appears to have formed during, and for a long period after, the vein emplacement. Ankerite is quite extensive in some veins and very minor in others. Too few samples were available to determine the distribution of ankerite, except that it seems to be associated with primary quartz in the larger veins. Staining techniques were used to identify the carbonates (Appendix II). Since no ankerite was found in the unaltered sediments, it may be assumed that these host rocks were not the source of primary ankerite. Probable origins are hydrothermal alteration of calcite or introduction along with the hydrothermal solutions which produced the veins.

In some of the micro-veins studied, it was found that their pinch and swell nature was related to the quartz-carbonate ratio. Wherever carbonate was in excess of quartz, the veins were narrow and vice versa (Plate 4). This may, in part, explain the erratic nature of the large veins.

The borders of many veins, and occasionally complete veins, are composed of quartz enclosing fragments of brecciated wall rock. Some of these fragments were only partially altered, notably in samples found in the drill-core, elsewhere the fragments were only relics, having been completely replaced by fine-grained quartz (Plate 5).

There is some question about the dyke-vein age relationship. Carr (1971) suggested that vein-emplacement preceeded dyke-emplacement in the Churchill Copper area. Banninger (1971) and others felt that the opposite is true. In many cases, slivers of veins are found parallel to dyke walls and intruding into the dykes. These would almost inevitably have been destroyed or at least broken and brecciated by the emplacement of the dykes. In thin-section examination of dyke-vein contacts, a diffused zone of dyke material incorporated into the veins is found. In almost all cases, dyke material immediately adjacent to veins has been partially or completely altered to chlorite, an indication of hydrothermal alteration associated with vein emplacement. Thus, in the opinion of the writer, the veins are post-dyke in age.

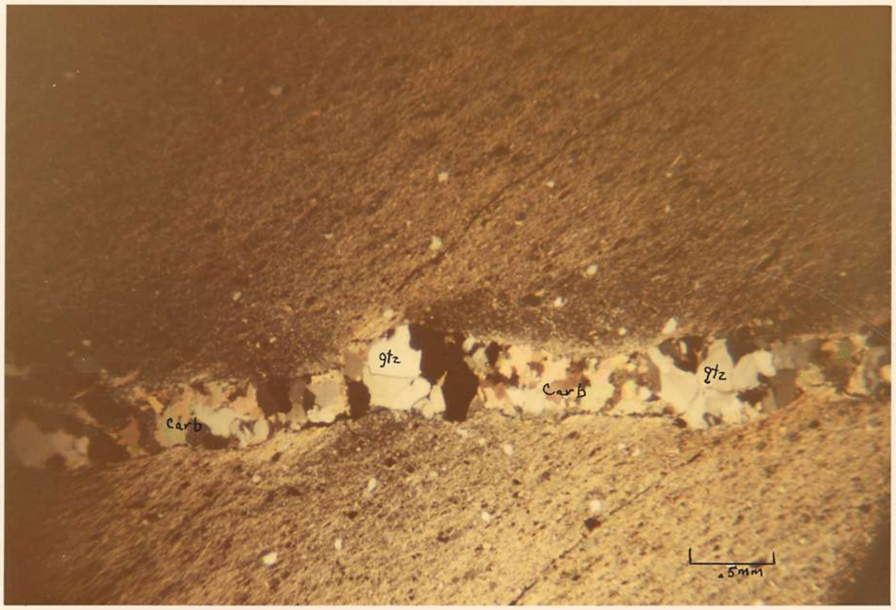


Plate 4: Photomicrograph showing pinching of veins where carbonate is dominant and swelling where quartz is dominant.

Plate 5: Relic fragments of wallrock (arrow) within quartz.

MINERALOGY

Ore minerals found on the Bronson claims are chalcopyrite, bornite, pyrite, sphalerite, galena, covellite, digenite and specular hematite.

The vein systems may be divided into three groups on the basis of dominant mineralogy: those containing mostly (1) chalcopyrite, (2) bornite, and (3) sphalerite. The East Zone veins contain low grade disseminated chalcopyrite. The West Zone veins are predominantly massive bornite. In the Central Zone, most of the veins contain massive and disseminated chalcopyrite; some smaller veins contain disseminated bornite. A fairly large vein containing almost exclusively sphalerite is located on the east side of the Central Zone.

CHALCOPYRITE is the main hypogene ore mineral. The most continuous, although not the highest grade occurrances, are found in zones near vein walls where sediments have been incorporated into the veins. Wallrock fragments are often preferentially replaced over quartz in these zones.

Pods of massive chalcopyrite, up to fifteen feet in diameter, are also found. These are large scale replacements of the vein material with only a few small fragments of quartz being preserved within them. These pods, found only in the larger veins of the central zone, are sparsely distributed. Some chalcopyrite was also found disseminated through the veins as small massive blebs filling interstices between and replacing quartz grains. A little chalcopyrite occurs as fine stringers in the altered, chloritic sediments found at depth. Elsewhere chalcopyrite is found as exsolution from and replacement of sphalerite in the sphalerite bearing veins. It is also found as exsolution needles in some of the bornite.

BORNITE, the second most important hypogene mineral, occurs in both massive and disseminated form. The massive material is often vuggy and appears weathered. Some wallrock was found incorporated into these veins. As with chalcopyrite, bornite replaces incorporated wallrock fragments and vein material. The disseminated bornite veins are similar in character to the disseminated chalcopyrite veins. In polished section, the bornite showed a well-developed exsolution texture. Needles of chalcopyrite are exsolving along three crystallographic planes of the bornite (Plate 6).

COVELLITE and DIGENITE are secondary minerals chiefly associated with chalcopyrite and bornite (Plate 7). Some covellite is also found filling microfractures in sphalerite.

SPHALERITE and GALENA are primarily found in a single vein near the east side of the Central Zone. (This vein, from the samples taken, appears to have a gangue composed entirely of quartz.) Both sphalerite and galena occur as fine-grained disseminations in this vein.

Sphalerite is by far the more abundant of the two. Chalcopyrite is found exsolving from and replacing it while some very fine-grained primary pyrite is disseminated through it. This sphalerite is generally greenish-yellow in color and anisotropic indicating low-iron content. A few grains of darker more iron-rich sphalerite were found associated with

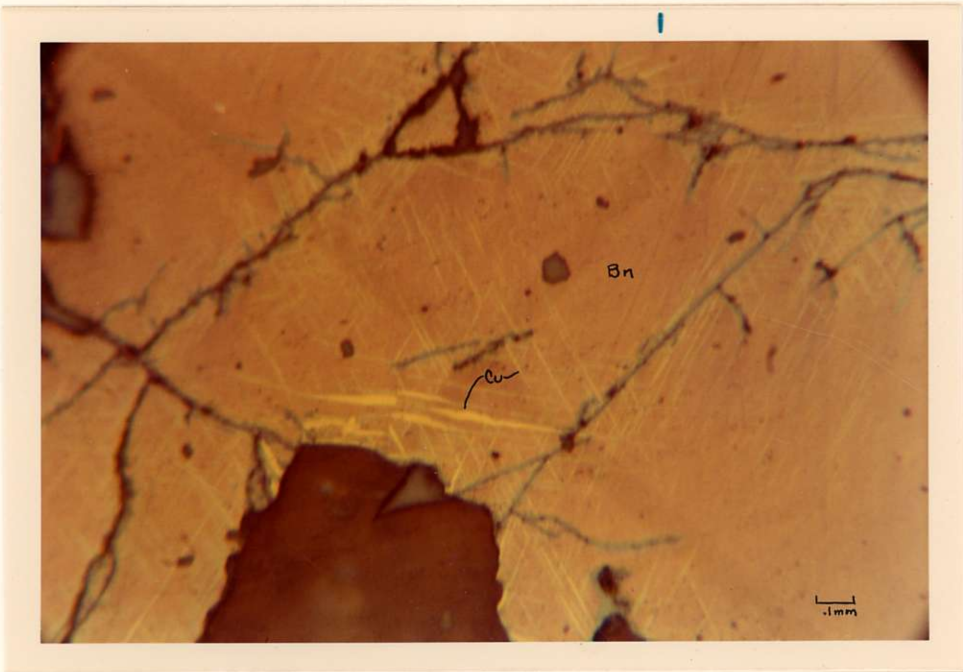


Plate 6: Photomicrograph of bornite with exsolution needles of chalcopyrite.

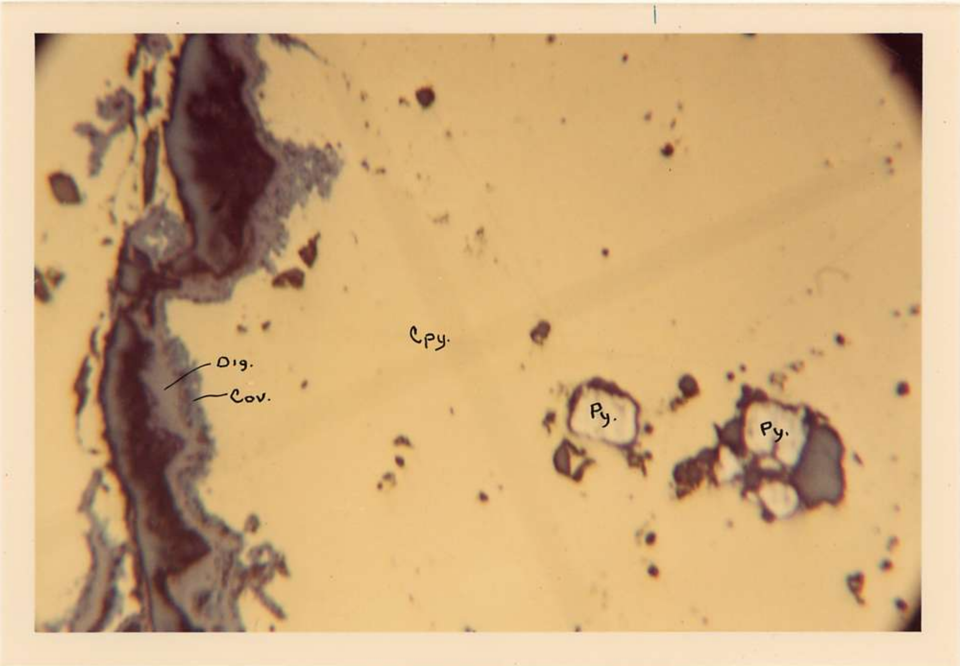


Plate 7: Photomicrograph of covellite and digenite along the borders of a chalcopyrite grain.

chalcopyrite in other veins.

Galena is minor, occurring as a few irregular grains associated with the sphalerite.

PYRITE is found within the sediments, occurring as irregular masses, disseminations and occasionally along bedding planes. It is generally fine-grained and granular. The pyrite does not appear to be detrital as the grains cross-cut the bedding. The more massive occurrences (never more than two inches across) appear to be replacing the sediments. Very little pyrite is found directly associated with the veins, only a few fine grains occur within spahlerite and chalcopyrite (Plate 7).

SPECULAR HEMATITE was found in some of the dykes where extensive shearing and faulting has occurred. It was found in elongated grains, along with quartz, growing perpendicular to the walls of tension fractures.

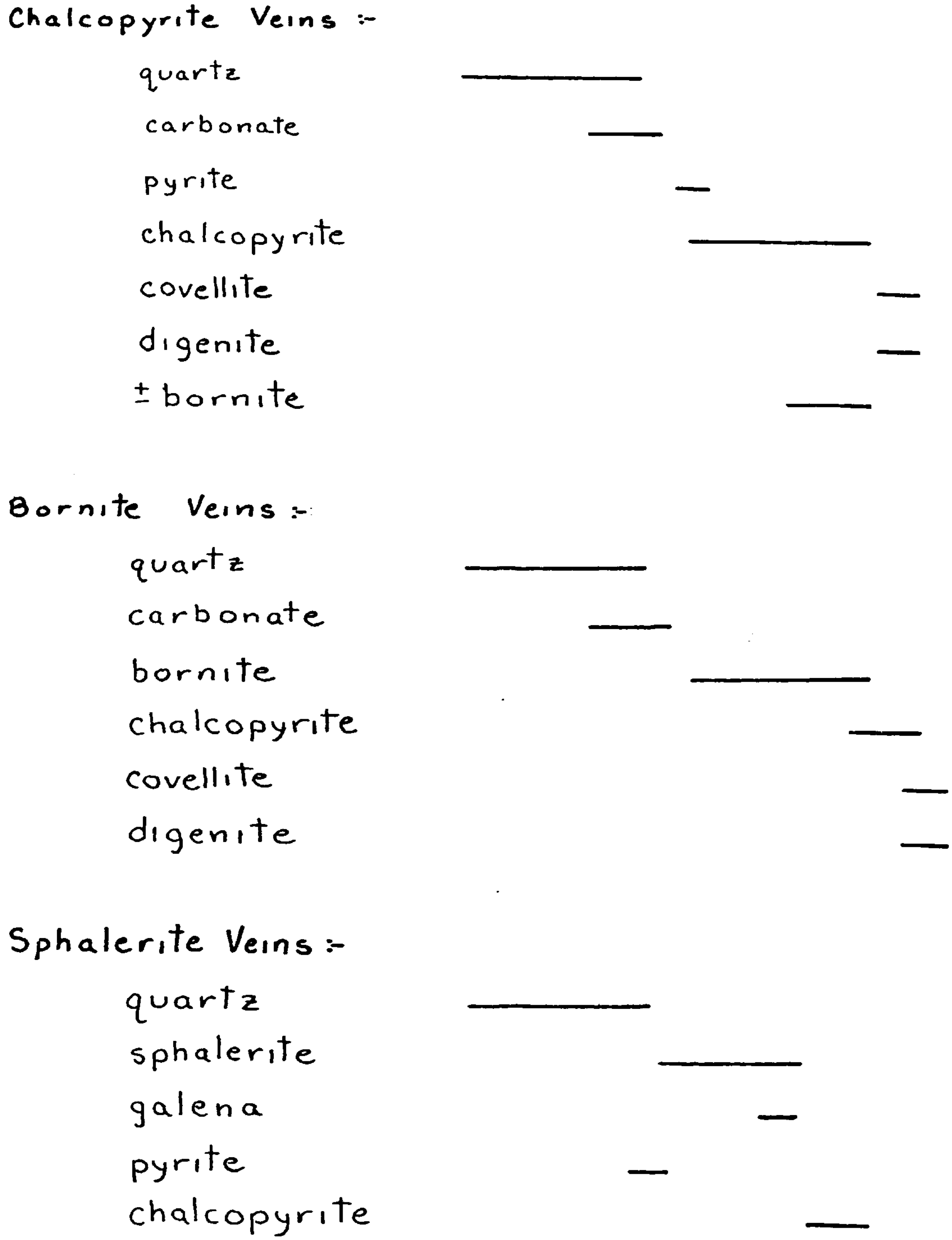
MINERALIZATION

As has been discussed earlier, the main control for the emplacement of the veins was the northeast trending fault zone. The primary veins were mostly formed by replacement although some open-space filling may have occurred. Hydrothermal solutions of unknown origin probably brought about formation of the veins.

The better grade and more continuous concentrations of sulphide minerals, aside from the few pods of massive sulphides, occur in the zones of brecciated wallrock near the boundaries of the veins. Concentrations of sulphides were found to increase near bends in the veins (Carr, 1971; Banninger, 1971). Textures of the ore minerals indicate they were emplaced after the vein minerals as they are found filling space between vein minerals as well as replacing both vein minerals and incorporated wall-rock fragments. These facts point toward the brecciated zone near the vein walls as the "plumbing system" along which the orebearing solutions entered. Paragenetic sequences for the three systems of veins are shown in Figure 5.

FIGURE 5

PARAGENESIS OF VEINS



Textures of the vein and ore minerals give some idea of the environment of formation of this ore deposit. The coarse-grained nature and random orientation of primary quartz and carbonate indicate moderately high pressures existed during their formation. In a high pressure environment, replacement would be the dominant means of vein formation. The dirty, inclusion-filled grains of quartz are evidence of this. In contrast, many of the late veinlets appear to be open-space fillings with clean quartz grains growing perpendicular to the walls.

Exsolution textures in the bornite and sphalerite are further evidence of emplacement at depth. Complete miscibility of bornite, depending on composition, is attained at a temperature somewhat greater than 200°C (Ramdor, 1969). In a discussion on exsolution chalcopyrite in sphalerite, Ramdor (1969, p. 486) states that:

> "transparent sphalerites (ie. low-iron content) can be produced where there is a high sulphur pressure in the fluids from which deposition has taken place. Such sphalerites can contain a considerable amount of chalcopyrite if the temperature is high."

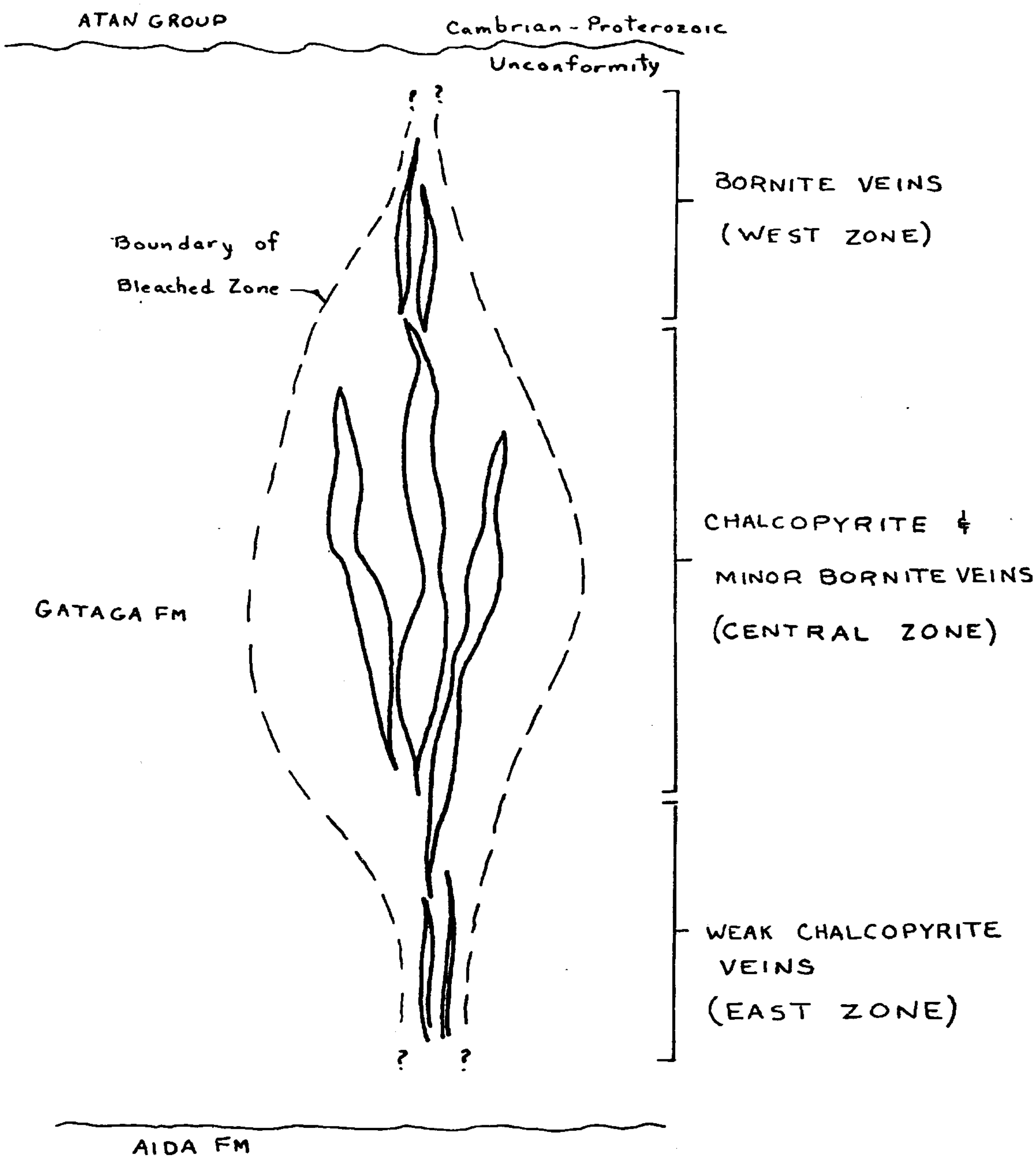
Thus, exsolution chalcopyrite found in bornite and low-iron sphalerite indicate that the sulphides as well as the veins found on the Bronson group were probably formed at temperatures and pressures which could only have been attained in an environment equivalent to the "mesozone".

THEORETICAL CROSS-SECTION OF THE ORE DEPOSIT

A theoretical cross-section (Figure 6) was drawn in an attempt to define the shape of the ore deposit and its associated alteration zone at the time of formation. This model is based on evidence from maps, drill hole intersections and observations on the ground. In developing the cross-section, several assumptions were made and are discussed below.

First, it was assumed that the mineralization was confined to the Gataga Formation. (Definition of the Aida-Gataga contact was discussed earlier) This assumption may seem unnecessary, however, it gives a lower boundary from which to work. No concrete evidence was available as to why the mineralization should have been confined to the Gataga Formation. It may be related to the Cambrian-Proterozoic unconformity which could have acted as a barrier to the mineralizing solutions.

Secondly, it was assumed that the three mineralized zones are all part of the same system. The West and Central Zones are more or less



THEORETICAL CROSS-SECTION OF
BRONSON OREBODY LOOKING SOUTHWEST

FIGURE 6

continuous except for a dyke and a fault crossing between the two. The East Zone appears to have been offset although no fault or faults have been found which would give the amount of offset observed. Each of the three zones has a more or less northeasterly trend.

Finally, it was assumed that the dykes were only indirectly related to the emplacement of the veins. Veins found along dyke margins or within dykes occur there because zones of permeability were available for the mineralizing solutions to enter.

The cross-section represents a plane perpendicular to the bedding planes of the sediments, striking northwesterly and dipping northeasterly. The East Zone is positioned nearest the bottom of the Gataga Formation and the West Zone closest to the top. This represents their approximate positions in the stratigraphic section. The mineralized zone is narrow and weak at both the eastern and western ends and is widest near the central zone resulting in the bulb shape of the cross-section. Weak vein intersections encountered deep beneath the Central Zone have probably intersected the equivalent of the East Zone vein system. Veins shown in the cross-section represent the major northeast trending vein system. The minor northwest trending veins would fall roughly in the plane of the section.

Using the cross-section, a zonal pattern for sulphide mineralization has been determined. Starting at the bottom, only minor chalcopyrite was observed. Progressing upward into the equivalent of the Central Zone, veins become more numerous and chalcopyrite more extensive. Bornite also begins to appear in the upper part of the central section. Moving higher still, bornite becomes dominant, however, veins become less numerous and the mineralized zone eventually pinches out.

The Bronson deposit appears to be elongated parallel to the northeast trending fault zone. An axis for the deposit oriented perpendicular to the cross-section would plunge toward the southwest. Thus, the main implication of this theoretical model is that an extension of the deposit may be found plunging toward the southwest. Diamond drilling in the vicinity of the West Zone would be necessary to support or reject this theory.

SUMMARY

The ore-bearing quartz-carbonate veins found on the Bronson claims are situated in Proterozoic sediments of the Gataga Formation. These veins are mainly found intruding a northeasterly trending fault zone. Diabase dykes, which were emplaced prior to the veins, have entered a fault system related to the one in which the veins are found. The dominant trend of the dykes is to the northwest.

Distribution of sulphides in the various veins is often erratic, with sections of good grade mineralization interspersed with barren sections. The most continuous mineralization is related to zones of brecciated sediments near the vein walls. The veins also have a tendency to be erratic, pinching and swelling at random. The irregular nature of sulphide distribution and variable vein widths are apparently typical characteristics of deposits in this area. Churchill Copper and to a lesser extent Davis-Keays ore bodies exhibit these characteristics.

The main ore minerals are chalcopyrite and bornite. A zonal pattern for these minerals was worked out using a theoretical cross-section of the ore deposit and distribution of minerals noted in the field. This pattern is related to the sedimentary section. The transition was from minor chalcopyrite near the bottom, to more extensive chalcopyrite with some bornite about midsection and into bornite at the top.

A theoretical model of the mineralized zone was used to show a possible southwest plunging extension of the mineralized zone.

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APPENDIX I

Composition of the Diabase Dykes

1. Average Original Composition (determined from a sample taken near the centre of a large dyke)

Sample No: AR - 71 - 4

Minerals :		
	pyroxene	45%
	plagioclase	35%
	magnetite	10%
	quartz	5%
	chlorite	3%
	sericite	2%

Description:

Texture is generally subophitic to ophitic. Pyroxene was determined to be pigeonite from optic properties. Plagioclase determination was made using the Michel-Levey method. Anorthite content was determined to be An_{34}(andesine) which is somewhat low for plagioclase in diabase. Albitization may have occurred removing some calcium and thus lowering the anorthite content. Quartz occurs as small individual grains. Very little silicification of the dykes has occurred even immediately adjacent to the veins.

2. Average Altered Composition (range of several samples)

Sample Nos: AR - 71 - 1, 3, 10, 34

Minerals :	plagioclase	0 - 30%
	pyroxene	0 - 10%
	quartz	5%
	magnetite	0 - 5%
	chlorite	25 -100%
	sericite	0 - 5%
	epidote	0 - 60%

Description:

Extensive development of chlorite has occurred especially immediately adjacent to the veins. Plagioclase and pyroxenes are usually altered beyond recognition. Texture is occasionally phyllitic where shearing has deformed the chloritized rock.

Epidote is extensively developed near faults which have cut the dykes. It forms a thick slickensided coating on fault planes and extends a few inches to a foot or more into the dykes. It gives the rock a granular texture.

APPENDIX II

Staining of Carbonates

Ankerite, in hand specimen, is generally light yellow to tan in color, has curving cleavage planes and is somewhat harder than calcite. It does not effervesce with cold HCl.

The objective of staining was to identify fine-grained, disseminated ankerite and to see how it was distributed. A flow chart for identifying carbonate minerals by staining was used (Warne, 1962).

A control specimen of ankerite with a little quartz was tested first (Plate 8), then several specimens of vein material was tested. Stained dark purple, ankerite stood out in relief against the more easily etched calcite (Plate 9). Ankerite was also noted in the grey altered sediments, however, it was not present in the unaltered sediments or in the material filling fractures and slump structures away from the main veins.

Plate 8: Control Test for ankerite, before (left) and after (right) staining.

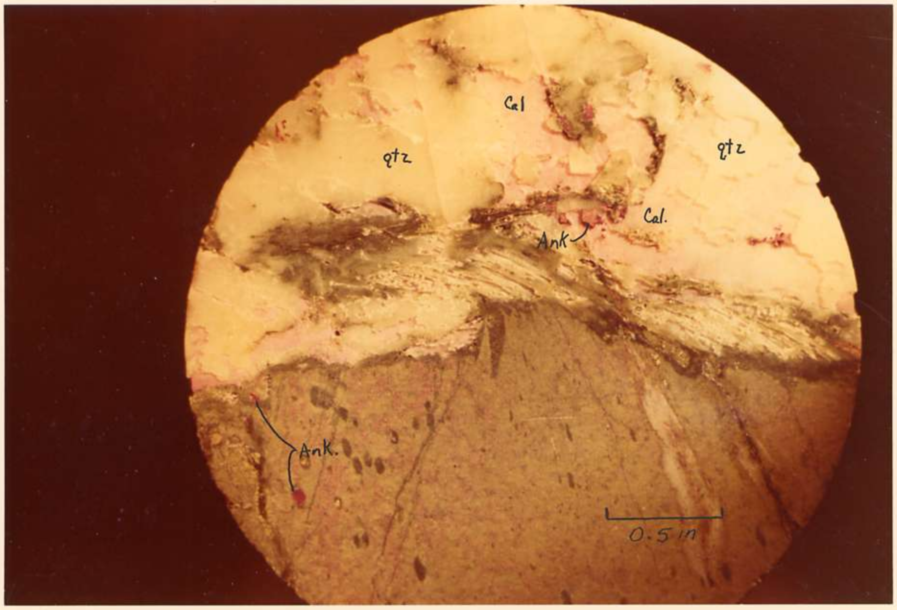
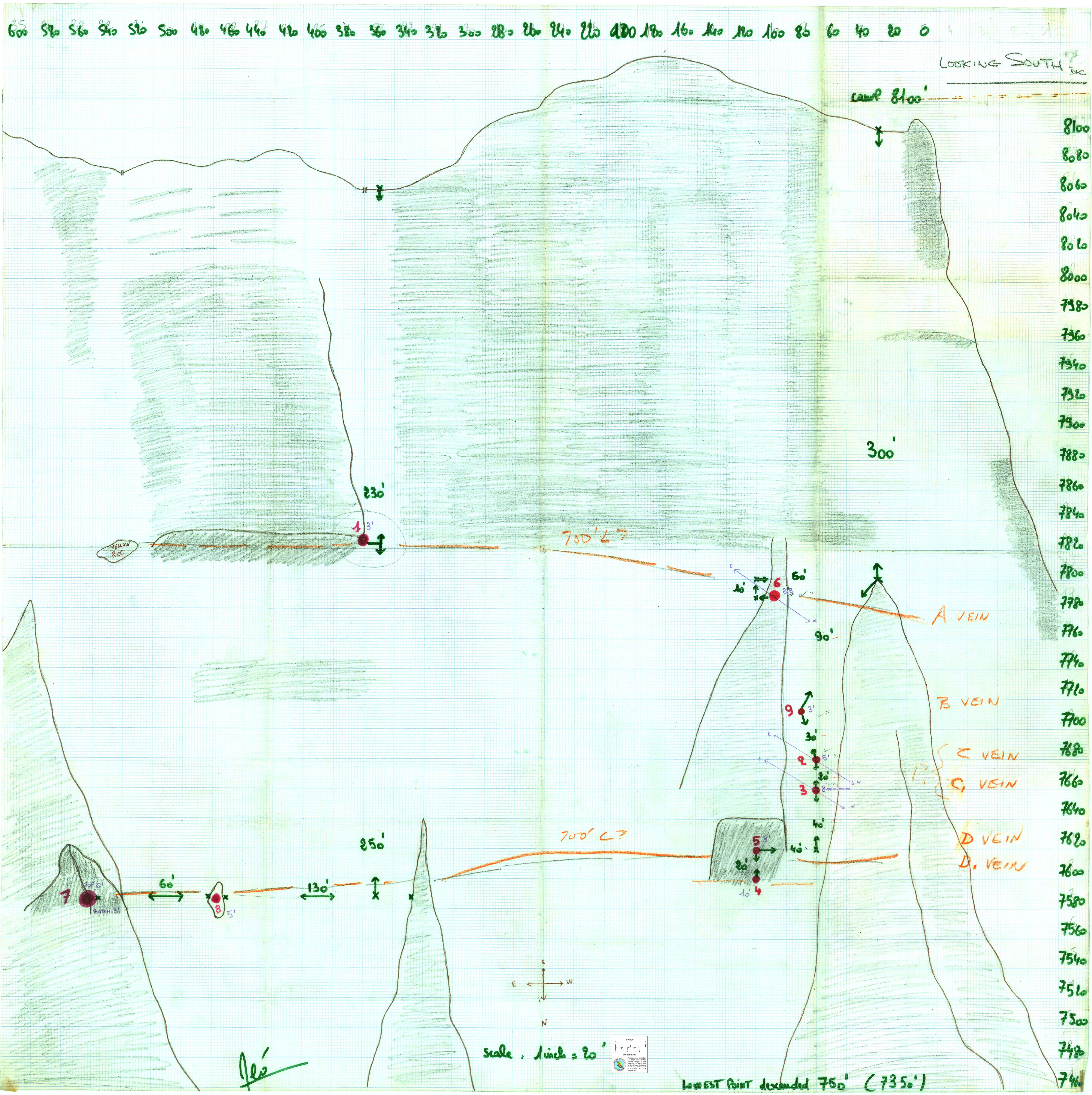


Plate 9: Purple stained ankerite in relief against pinkish calcite (pinkish color due to stain), and also in the altered sediments.

FIGURE 4

GEOLOGY OF THE BRONSON CLAIMS

(after Cooke, 1970; Modified after Banninger, 1971; Modified by Randall, 1972)



LOOKING SOUTH
CAMP 8100'
300'
230'
700' L?
YELLOW ROC
A VEIN
B VEIN
C VEIN
C, VEIN
D VEIN
D. VEIN
60'
10'
90'
30'
20'
40'
8 minimum
250'
130'
TOP 6'
BOTTOM 3'
S
E
W
N
Scale : 1 inch = 20'
inches
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.
LOWEST POINT descended 750' (7350')