PF 082GNW002
Bull River

Silver Queen

GEOLOGY OF THE BULL RIVER MINE

BULL RIVER, B.C.

PLACID OIL COMPANY

M.C. Chiang
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INTRODUCTION

This report covers the area from the Bull River reservoir to one mile west of Burntbridge Creek and includes the following claims:

Bonanza #5-25	Liz #1, 2, 3, 6 and 8-14
Big Bonanza #1-4	New Max #1-8
June #1-13	New Dam #1-6
Feb #1-4	

The geology and ore reserve of pit #1 and 2 and of the underground area were reported previously by myself and are omitted in this report.

Field mapping was carried out by myself as part of the 1972 field season. Aerial photographs (scale 1" to 200 ft.) were taken by McElhanny Ltd. at an elevation of probably less than 10,000 feet above sea level in 1969, were used as base maps. Some triangulation stations and ground objects were located to estimate the scale and azimuth of these photographs, but due to the rough, hilly terrane and low elevation photography, the aerial photos and topographic maps are fairly distorted.

GENERAL GEOLOGY

Rocks occurring in this area consist of the Moyie intrusive, the lower portion of the Creston formation, and the upper portion of the Aldridge formation of the

Precambrian age, and the Burnais formation of early Devonian age.

Aldridge Formation

The Aldridge formation in this area is mainly in the upper portion which can be subdivided into two members by their lithology and field occurrence.

(a) Middle member - It distributes from the Bull River reservoir to Burntbridge Creek and to the adit area, and consists mainly of medium to thick-bedded, and occassionally massive quartzite, intercalating thin to very thin-bedded argillite, and argillaceous quartzite. Quartz is commonly very fine-grained and it becomes fine-grained at the lower portion of each thick layer. Graded bedding of about 2 inches thick is very common in argillaceous quartzite. Usually in argillaceous quartzite or between quartzite and argillite layers, there is a turbulent bedding which consists of argillaceous fragments, slabs, and very thin folded layers in the matrix of silt and very fine-grained sand. Pyrite containing up to 3% of the rock occurs sporadically as patches or small aggregates of about ¼ inch in diameter in quartzite, and also it forms thin layers in argillite. Anhedral pyrrhotite is occasionally present in the centre of pyrite aggregate and becomes more abundant in the lower portion of this member.

Traces of chalcopyrite of sedimentary origin are observed in association with pyrite and pyrrhotite in the dark grey laminated argillite of the lower portion of this member. It can also be detected in the diamond drill core of BR-127 and BR-133. The maximum thickness of this member exposed in the mapped area is about 1,500 feet, estimated from the Bull River bank to the Silver Queen adit.

(b) Upper member - It consists predominately of dark grey to black, thinly laminated argillite and very occasionallly thin-bedded argillaceous quartzite. Black argillite is a better sorted and less laminated rock. Lamination is due to the repeating layers of very thin (1/16" to ½") graded bedding of which each layer consists of a mixture of silt and very fine-grained sand in the lower and muddy silt in the upper portion. When graded bedding becomes thicker, less sorted, and more sandy. Its color becomes lighter and can be called argillaceous quartzite. Pyrite, the recrystallized sulfide of sedimentary origin, generally occurs as coarse-grained euhedral particles sporadically distributed in the rock, or as thin layers about 1/8" in thickness parallel to the bedding plane. Pyrrhotite is hardly observed and probably absent in this member. Because it contains up to 3% pyrite, the rock becomes very rusty when weathered.

Ripple marks and elongated flutes commonly occur on bedding planes. Contemporaneous folding (scale equal to a few inches), due to gravitational slumping and turbulent current is commonly observed. Undulating strata by tectonic movement, as a result of the plastic nature of this member, is generally present in the whole area. Slaty cleavages are prevailing and have the same orientation which may be caused by the latest stage of movement. The estimated thickness of this member is from 400 to 700 feet, while the thickest section is located on the west end of the map.

Creston Formation

The boundary between the Aldridge and the Creston formations is drawn by lithology and pyrite content. The top of the Aldridge formation is pyrite-rich, dark grey, thinly laminated argillite which weathers into rusty fragments. The bottom of the Creston formation is greenish-grey, medium to thick-bedded siltstone containing a few patches of pyrite and brown stained when weathered. Mud cracks are very common in the rock of the Creston formation, but rarely in the Aldridge formation.

Siltstone is about 150 feet in thickness, and it then changes gradually into green, white, purple, or brown, medium to thick-bedded, fine-grained quartzite. The different color in quartzite is largely due to the various amounts of chlorite, hematite, sericite, calcite, and quartz.

Chlorite gives green, hematite purple, etc. Quartz grains in the quartzite are usually rounded to subrounded in the matrix of sericite, calcite and hematite. Occasionally it has suture contact between quartz grains which may be due to compaction by deep burial. Chlorite is more abundant in the lower portion of this formation, especially in siltstone.

Towards the middle and upper portions of this formation, white and purple quartzite become dominant. This is an indication of the change in depth of the depositional basin. It is reported that there is some blue copper stain on white quartzite in the upper portion of this formation, but it has not been found in this area. Sericite is more common in white quartzite and less in purple and brown quartzite. It generally orientates itself to parallel to the bedding plane. Hematite is abundant in purple quartzite and rarely in green and white quartzite. The thickness of this formation is not known as the map does not cover its whole sequence.

Meta-Diorite

Two roughly parallel meta-diorite dykes exposed by nature and human activity occur at the eastern bank of the Bull River reservoir to Burntbridge Creek. They generally strike in an E-W direction. The upper dyke branches off in two, sometimes, three places to the east and in two places to the west. Their thicknesses vary from 20 to 400 feet on the surface. The eastern two or three branches are almost vertical, whereas the two western branches are in a different dip angle. The northern branch dips to the south at 70°, and the southern one dips from 35° to 80°. Its thickness increases to 400 feet in the area between the two open pits. The lower dyke dips to the south 80° in the eastern area and 40° near pit #1. These branching dykes may join together in the deeper portion, because the diamond drilling shows that these dykes are thicker, and their distance is shorter than that on the surface. Since they cut across sedimentary strata and have irregular shape and thickness these igneous intrusive layers should be called dykes instead of sills.

In general, the centre of the dyke consists of dominately lath-like phaneritic plagioclase (An_{30-40} Ab_{70-60}) and chlorite mess, minor pyrite, and accessory sericite, apatite, siderite and chalcopyrite. Chlorite is the alteration product of the ferromagnesian mineral, either pyroxene or hornblende. Plagioclase is partly weathered into sericite. Euhedral fine-grained pyrite occupies up to 1% in volume. Occasionally a trace of chalcopyrite is observed. Euhedral elongated apatite is distinguishable under the microscope and it usually concentrates in certain portions of the dyke.

Away from the centre of the dyke, the rock becomes fine-grained porphyritic. Plagioclase and recrystallized siderite are the only minerals recognizable to the naked eye, and the other minerals like chlorite, sericite, apatite, calcite, and opaque are in very fine matrix and can only be identified under a microscope. The rock contains numerous inclusions of quartzite and argillaceous quartzite with the size ranging from very tiny particles up to a foot in diameter. But, most commonly these inclusions are between $\frac{1}{4}$" to 2" and were melted and metasomatized and become a flint-like texture. Greater portions of plagioclase crystal alters to sericite. Pyrite and siderite are more abundant than in the centre of the dyke.

There is a chilled zone about 2" to 10' in width. The rock is aphanitic and contains a large amount of very fine-grained country rock inclusions. Most of the original minerals of the rock alter into a messy mixture of chlorite, sericite, siderite, quartz, apatite, and opaque minerals. Euhedral pyrite and siderite are believed to be secondary. Quartz may be derived from country rock.

A contact zone in sedimentary rock is observed. It is dense, flint-like, pale to light grey and showing relic texture of sedimentary origin. Its thickness is from a few inches to 50 feet.

There are two types of quartz-siderite veins associating with meta-diorite dykes. One occurs in the dyke and has the same orientation as the dyke, and it usually contains some amount of galena and chalcopyrite. The other, cross-cutting the dyke and extending into country rock , is much thinner and does not have any mineralization. The mineralized veins will be discussed in detail in the economic geology section.

A thin meta-diorite dyke intruded into the Creston formation was observed in the upstream area of Burntbridge Creek. It is dark green, very fine-grained, free of rock inclusion, and containing some very thin quartz-siderite veins and veinlets. Original ferromagnesian minerals of the rock completely alter to chlorite, and most of the plagioclase to sericite. Euhedral pyrite and siderite and elongated apatite are abundant. No mineralization has been found.

Burnais Formation

There is no outcrop to show the contact of the Precambrian and Devonian formations, and it is assumed that there is a major fault between them.

No index fossils have been found in the few isolated outcrops of gypsum, limestone, shale and shaly limestone occurring along the Bull River banks. These rocks are temporarily classified as belonging to the Burnais formation because only the Burnais formation contains gypsum horizons in the vicinity of this area.

Gypsum is a foliated mass in a white to dark grey color. A thin section shows that it contains 90% gypsum, 5% carbonaceous material, 4% dolomite and 1% quartz. The size of the outcrop is about 30 to 70 feet and is fractured and folded.

Limestones are silty to very fine grained and light brown to black. Nodular texture and ripple marks are common. Brown limestones are usually thick-bedded to massive with some molluska fossils. Dark grey to black limestones are thick-bedded with nodules, mud cracks and ripple marks, and overlain by thin-bedded shaly limestone.

Pleistocene Till and Glaciation

Pleistocene till is distributed on the southeastern corner of the mapped area and it consists of various sizes and irregular shapes, predominately Precambrian sedimentary and igneous rocks. There are a few erratics left behind by glaciation on the slope north of the plant site. Their sizes range from 5 to 15 feet in diameter, and most of them are of the Creston formation.

Two sets of glacial striations were observed. One strikes in a NE-SW direction and dips to the SW from 3 to 22 degrees and occurs at an elevation greater than 4,000 feet above sea level. At a lower elevation there is another set of striae striking in an E-W direction and dipping to the west from 2 to 16 degrees. The high elevation striae may indicate a broader glaciation which might originate from the Bull River upstream area and join with the main glaciation which runs along the Rocky Mountain Trench. Whereas, the low elevation striae could represent a narrow-glaciation flowing to the west along the Bull River valley to the open plain.

Holocene Fluviatile

The two types of fluviatiles that are distinguishable in this area are alluvial terrace and alluvial fan.

On the northern bank of the Bull River there are four steps of alluvial terrace which were formed by the deposition, downcutting and meandering of the river. The materials building these terraces consist of rounded to sub-rounded boulder, pebble, cobble, sand and clay of either sedimentary or igneous rock, derived from the upstream terrane of the Bull River. Coarse material in this deposit is usually coated by lime.

In the western portion of the map area, there are two alluvial fans overlain on the alluvial terrace and consisting of clay and angular to subrounded fragments of different sizes of rock which are mainly of the Aldride and the Creston formations and rarely of andesitic basalt. Most of the rock fragments are not coated by lime.

STRUCTURAL GEOLOGY

Various types of folding and faulting occur in this area. Some are exposed by either nature or mining activities. Jointings are numerous in quartzite and argillaceous quartzite, and slaty cleavages are well preserved in argillite and siltstone.

A major unsymmetrical syncline occurs between the lake and the hydro reservoir. It runs in a NEN-SWS direction and gently plunges to the north. Its eastern limb is steeper than the western. An anticline striking NE-SW occurs in the Creston formation on the northeastern corner of the map area. Its axial plane dips to the north 60^{o}. Along its axis there are two sets of quartz veins as fracture fillings. One set is parallel to and the other cross-cut the axial plane. Thickness of these veins varies from ¼" to 3", and no mineralization was found. South of the hydro dam, a small scale parallel syncline and anticline were observed. Their axis runs in a NEN-SWS direction and dips to the east 80^{o}. A small open syncline occurs between Burntbridge Creek and the adits. Minor foldings are numerous particularly where there are nearby major mineralized zones. Undulating strata is very common in argillite and siltstone. These minor folds and undulation are not shown on the geological map because there are too many and they are too small.

The Bull River and Burntbridge Creek faults are the major structures of the map area. Glacial and stream erosion might follow the Bull River fault, which separates the Precambrian and the Devonian formations to form the portion of the Bull River valley from the hydro plant to the west. Near the pump house by the river down-cutting erosion is heavy and is indicated by the 600 foot deep overburden. There is no outcrop to show the nature of the faulting, but according to Leech (1960) the Bull River fault is a high angle normal fault.

Along Burntbridge Creek a layer of ½ - 2' thick, well cemented, reddish brown fault breccia of the Burntbridge fault crops out, which generally strikes in a N-S direction and dips to the east 50°.

There are many minor faults which can be grouped into two sets. One strikes in a N-S direction with a strike-slip in nature. Their fault planes are usually vertical. The other group generally runs in a NE-SW direction and is normally faulting with the fault plane dipping to the north-west at 45 to 70°. The faults usually have fresh gauge, uncemented fault breccia and unfilled tension fracture and are believed to be younger than the Burntbridge fault.

Slaty cleavages are well developed in argillite and siltstone, less in argillaceous quartzite and occasionally in meta-diorite. They generally strike in a N-S direction with an average dip angle of 50° to the west. The unique orientation of the slaty cleavages in the whole area may suggest that they were formed by the latest tectonic movement which may be in the form of compression from northwest to southeast.

ECONOMIC GEOLOGY

Two areas of mineralization in meta-diorite dykes were observed.

(1) Silver Queen Adit (Map 2) - A quartz-siderite-sulfide vein exposed in the adit by the previous property owners has a length of 265 feet and a thickness of 1'-2', with a copper content of up to 1.2%. On the average it consists of 55% quartz, 25% siderite, 15% rock fragments, 2% galena, 2% pyrite and less than 1% chalcopyrite. There are a few offshoot thin veins containing mainly quartz and siderite and a trace of galena and chalcopyrite. The main vein has the same orientation as the meta-diorite dyke which is almost vertical and strikes E-W in this portion. However, because of its thin vein, low grade, and limited extension, it has no economic value.

(2) North of reclamation berm between 05E and 30E section (Map 3) - There are two parallel quartz-siderite-sulfide veins in the northern branch of the upper meta-diorite dyke, and their exposed length is about 1,400 feet. The north vein has a thickness of 1'-5' and is estimated to contain (0.5%, trace to) copper and 1.0 to 4.0% lead. On the average the south vein

is ½-3½' thick and contains 0.2% copper and 0.5% lead. Their orientation is almost the same as the dyke. It is not known whether the grade and thickness of these veins will become better in the deeper portion.

Between the above two areas there are a few quart-siderite veins consisting of a trace of lead and copper minerals occuring in the intrusive meta-diorite dykes. Their outcrops are very sporadic and discontinuous and have no immediate economic interest.

ORE GNEISS

A fair amount of rock fragments in the lengthy meta-diorite dykes and the wide contact zone in the country rock may indicate that the dioritic magma might have a high mobility during intrusion. High P_{H_2O} in magma will not only continuously transfer and diffuse the heat from the bottom to the top and from the dyke into the country rock, but it will also make the magma more mobile and easier to pick up the country rock fragments. The close association of the meta-diorite dykes and mineralized veins suggests that the hydrothermal solution forming these veins was from sediments and heated by magmatic activity. Argillite of the Aldridge formation, which has much larger volumn and contains higher percentages of iron sulfide and the same amount of Cu, Pb, Ag, and Au as those in meta-diorite, is possibly the major source of ~~rock~~ metals, sulfur and lime in the mineralized veins, as iron sulfide can make the hydrothermal solution more acidic and easier to leach out metals from the rock.

Therefore, the mineralization story in this map area could be defined as follows:- Mud, silt, very fine-grained sand, iron sulfide and a trace of copper sulfide (about 0.01%) deposited in the close basin during the early Precambrian period. In the late Precambrian period there was igneous activity in this area. Magma intruded into argillite, heated up the underground water, which gradually dissolved iron sulfides and became very acidic. Acidic hydrothermal solutions would dissolve metals including Cu, mainly in argillite and partly in meta-diorite. Following intrusive dykes and prevailing fractures, the hydrothermal solution went up to the higher level where it gradually cooled down and the metals were precipitated with carbonate and quartz.

If the above hypothesis is correct, then the mineralization should take place where the main igneous body started to branch off into contact with pyrite-rich argillite which might contain abundant water at the time of magma intrusion. Because of the immiscibility between magma and metal-bearing hydrothermal solution and because igneous rock is more solid than sedimentary rock, major mineralization will tend to form in the fracture zones of country rock rather than in the igneous dyke. Therefore, I believe that the best location for mineralization is in the area between the plant site and Burntbridge Creek where the ore bodies have been uncovered, and that one could hardly find a high grade and large tonnage ore in the meta-diorite dyke.

CONCLUSION

The major ore bodies in this area have been uncovered by extensive exploratory works, and it is quite possible that there are some small ore bodies distributing along with meta-diorite dykes in the area west of the tailings pond and between pit #2 and the adits. However, these ore bodies can be expected to be located under very thick overburden or of low grade and low tonnage, and of no economic value.