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Subject

The Mosquito Creek Gold Deposit

A Syngenetic Model

by

W. Don Sutherland

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The year of 1859 was a big year for the colony of British Columbia. That was the year that placer gold was first discovered in the Cariboo. By 1861, just two years later, Billy Barker had made his fabulous strike on Williams Creek and the Cariboo Gold Rush was in full swing. Miners were streaming into the Cariboo from California, Oregon, Upper Canada, Australia and China. By 1867, the year of confederation, Barkerville, on the south side of Williams Creek, had more people than either Vancouver or Victoria. It was the largest settlement in North America west of Chicago and north of San Fransisco.

The placer streams in the Cariboo were extremely rich, richer even than those of the famous California Gold Rush 10 years earlier. The richest stream of all in the entire Cariboo, per yard of length, was Mosquito Creek. The Mosquito Creek Gold Mine, that I wish to speak about today, straddles the drainage valley of this famous creek.

The mine is located at Wells, 5 miles north-west of Barkerville. It lies within a north-west trending belt of sediments called the Showshoe Formation. The two adjoining mines south-east along this belt are the former producers Island Mountain Mine and Cariboo Gold Quartz Mine. The two former producers had a combined production of 1¼ million ounces of gold from 1933 to 1966. This makes Wells the second largest gold producing camp in British Columbia, second only to the Bridge River District. All three mines are now owned by Mosquito Consolidated Gold Mines Limited. That company holds 4½ miles of strike length along the productive Snowshoe Formation.

Geological Map

The Snowshoe formation has been mapped over a strike length of 25 miles, as shown on this map sheet of the Barkerville Area by Sutherland-Brown of the British Columbia Department of Mines. The terrain lies 40 miles west of the Rocky Mountain Trench and roughly parallel to it. Most of the rich placer creeks in the Cariboo are sourced by drainage from the Snowshoe Formation. These include Antler Creek, Williams Creek, Lowhee Creek and Mosquito Creek.

At the Mosquito Creek Mine there are productive gold stopes that have been mined up-plunge to the Mosquito Creek Valley and high grade gold ore has been mined from bedrock in the bottom of the creek. It is a reasonable conclusion that the eroded portions of these ore zones contributed to the placer gold that was taken from downstream in the creek. It is also reasonable to conclude that there are other lode gold deposits waiting to be discovered elsewhere along the Snowshoe Formation - especially in the areas drained by other rich placer creeks.

Gold occurs in the mines at Wells in two distinct ore types. These are quartz veins and pyrite bands. The quartz veins mined in the Cariboo Gold Quartz and Island Mountain Mines averaged 0.38 ounces of gold per ton. This was with the benefit of hand sorting in the stopes which was possible in the 1930's but is not applicable today. The pyrite ore from the two mines averaged 0.66 ounces gold per ton. Controlled mining of pyrite ore in the Mosquito Creek Mine has returned similar grades for the pyrite ore. There has been practically no quartz vein mining in the Mosquito Creek Mine. Current exploration is targeted exclusively toward pyrite ore.

Cross Section

This is a diagramatic cross section through the Mosquito Creek Mine. Pyritic gold ore occurs in stratiform bands in association with two limestone units. These are the Aurum Limestone Unit shown here, and the Main Band Limestone unit shown here. The two limestone units diverge down dip and along strike to the south-east. Between the two there is a wedge of pelitic tidal flat sediments that includes sericitic quartzite, phyllite, argillite and dolomitic siltstone. At the top of the pelitic sequence there is an 8 ft. thick regolith. The interface between the regolith and the Main Band Limestone is probably an unconformity.

Of special interest from a genetic standpoint is the presence of a thin layer of pyrite that occurs in many places at the base of the Main Band Limestone. The pyrite band is fine grained and often quite high grade - around 2 ounces of gold per ton. In some places the pyrite layer is thick enough to make ore. The regolith below does not carry significant gold values.

Slide 1

Here is a picture of the Aurum Limestone. It is a well marbleized rock unit that varies from a siliceous limestone to a limey chert. In this particular location the band is only a couple of feet wide. It may thin out rapidly and in some places is absent altogether. Pyritic ore may occur in this depositional time interval in the stratigraphic column whether limestone is present or not. When there are gaps in the Aurum Limestone, the position of the critical horizon may be fixed by reference to a marker bed of laminated chert, which persists throughout the mine workings, and is always within thirty feet of the top of the Aurum Limestone.

Slide 2

This slide shows the Main Band Limestone. Note the light and dark banding. It is referred to locally as a "Zebra Limestone". This is in sharp contrast to the more massive and marbleized Aurum Limestone we saw in the previous slide. The Main Band Limestone is more continuous than the Aurum Limestone and it is a lot thicker. Pyritic ore may occur at the base of the limestone unit or near the top of the unit. Most of the pyrite ore found in the mine since 1980 has been at or near the top of the Main Band Limestone. This is the primary search plane for the present operations.

Cross Section

Looking at the remainder of the Mine Sequence: Above the Main Band Limestone we have a poorly defined sedimentary pile consisting of dolomitic siltstone, argillite, quartzite and some limestone units. The extent of the limestone units is unknown as is the potential for pyritic gold ore in association with them.

Below the Aurum Limestone there is a thick band of carbonaceous quartzite with graphitic parting planes. This is the host rock for the quartz veins that were mined extensively in the Cariboo Gold Quartz Mine, to a lesser degree in the Island Mountain Mine, and hardly at all in the Mosquito Creek Mine. Most of the mining in the Mosquito Creek Mine was done near the top of the Main Band Limestone, well above the host stratigraphy for the quartz vein ore.

Underneath the black quartzite there is a 40 to 50 ft. thickness of green metatuff. This unit has a very high geochemical gold clarke. Percussion test holes into the metatuff have returned gold values up to 2,200 ppb over 20 ft. and values over 1,000 ppb gold are common. The tuff unit is not exposed in the present workings but we hope to put a cross cut through it later in this year's development program.

Below the metatuff is another limestone band. As far as we know there is no gold associated with this limestone horizon. It may be that gold was first introduced into the system by the volcanic activity that produced the metatuff. If that is so, gold would be available to the tuff and the younger sediments above but would not be available to limestone deposition that preceded it.

At the bottom of the mine sequence there is an unknown thickness of pale argillitic quartzite. This is also barren of gold values. I should caution you however that gold camps are full of surprises. Some of the surprises are pleasant and it is always wise for exploration geologists to keep an open mind in these matters. One of the surprises in the Wells camp is the amount of gold that has been produced, considering the limited amount of exploration work that the camp has received.

Longitudinal Section

This is a vertical longitudinal projection of the pyritic ore stopes that have been mined in the Island Mountain and Mosquito Creek Mines. Development drifting along the Aurum Limestone Unit is shown in solid blue below the levels, shown here along a horizontal distance of 5,600 ft. and a vertical range of 1,700 ft. Drifting along the Main Band Limestone Unit is shown as hatched blue below the levels. This is shown here in the upper left hand corner of the longitudinal section. It covers a horizontal strike distance of about 1,000 ft. and a vertical range of 300 ft.

The long axes of the pyritic stopes are parallel to the plunge direction of the corrugated cleavage that is pervasively present throughout the mine. This cleavage is often mistaken for bedding by first time visitors to the mine. It does not conform to either the strike or the dip of the mine rocks but forms a diagonal along the bedding planes with reference to the usual horizontal and vertical co-ordinates.

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The limestone units are sub parallel to the plane of projection and dip away from the observer at 70° in the case of the Aurum Limestone and 55° for the Main Band Limestone. In looking at the longitudinal section it should be noted that all of the Aurum ore lenses shown occur in the same geological plane and all of the Main Band ore lenses also occur in a common geological plane - a plane that is similar to, but distinct from, the Aurum plane. What we are looking at is a geological phenomenon that has been repeated many times along a fixed depositional plane at two distinct geological time intervals.

The first ore encountered in the Main Band Limestone Unit was discovered in 1980, when a drift was put out from the Mosquito Creek shaft on the second level to reach the up-plunge extension of the Aurum stope being mined up from the level below. Drifting on the Main Band since that time has yielded 7 ounces of gold per foot of development. This is exactly twice the yield from the development drifting on the Aurum Limestone Unit in the Island Mountain Mine, which was 3½ ounces of gold per foot of development.

As far as our present knowledge of the Main Band Limestone is concerned, if you were to position yourself anywhere in the plane of the limestone unit, you would be within 200 ft. of ore. In other words, as long as you can keep close to the Main Band Search Plane with your development openings, you will be close to ore.

What is <u>important to the future of the camp</u> is that here is another ore plane that is practically unexplored that could be as extensive as the Aurum Ore Plane. If the Main Band Limestone Unit <u>is</u> as extensive the Aurum Limestone Unit, it is reasonable to project that at least another 1¼ million ounces of gold will be mined from the Main Band.

Mosquito Consolidated Gold Mines Limited is presently driving a new adit which will provide another level for the Mosquito Creek Mine and will access the Main Haulage Level of the old Island Mountain Mine. The adit is being driven to intersect the Aurum Search Plane at this location. On the way in it should cross the Main Band Limestone Unit about 900 ft. before it gets to the Aurum Limestone. The plan is to drift along both the Main Band Search Plane and the Aurum Search Plane once they have been reached by the adit. This will provide access for ore search on the 4,000 ft. level in the Aurum Unit over this area and for ore search in the Main Band over the entire panel.

Slide 3

This slide shows a short section near the top of the Main Band Limestone. Note the alternate layering of fine grained pyrite and limestone. This is typical of the pyritic ore associated with the Main Band Limestone. It is diagnostic of cyclical deposition in a sedimentary environment. The ore grades depend on the thickness of the pyrite layers, how close they are together, and how fine the pyrite is.

Moderately fine pyrite grades about one ounce gold per ton and extremely fine pyrite grades up to 8 ounces gold per ton. Coarse pyrite, above 3 mm in grain size carries practically no gold - normally less than 1/50th of an ounce per ton. Coarse pyrite bands are sometimes found near the ore shoots but the fine pyrite bands and the coarse pyrite bands are always distinct from each other and coarse and fine pyrite do not co-exist in the same band.

Electron Microprobe studies show that the gold is present between the pyrite grains and it is likely that the amount of gold in any particular band is directly proportional to the surface area of the pyrite grains that form the band. The gold is very easy to recover. In the mill circuit the pyritic ore is ground to 70% minus 200 mesh. Cyanide is introduced into the circuit in the ball mill, and 80% of the gold goes into solution before it leaves the ball mill. It would appear from this, that once the pyrite is liberated, the gold is accessible to the cyanide.

Of particular importance in mining the ore is the fact that the ore bands always thicken in the down-dip direction and thin out in the up-dip direction. They are aileron shaped in cross-section perpendicular to the plunge. The system used in mining is to subdrift up-plunge in the ore lense and then to slash the walls into the sub-drift and scrape the muck out to the level below with slushers. Because all of the ore bands have similar geometry we know when we are advancing up plunge that the ore bands in the left wall will thicken down dip in that direction until they end abruptly on the leading edge of the aileron. When a stope is finished, the left hand wall (as you face up plunge) is usually mined clean. The right hand wall usually has a few ore bands left that are too thin and too far apart to carry grade.

Following this known geometry to the development mode, we will always chase narrow pyrite bands in the down-dip side of a drift and more or less ignore narrow pyrite bands on the up-dip side.

The bands you are looking at in this picture are on the up-dip side of the opening. They widened into excellent ore in the direction of the opening. The aileron shapes are frequently stacked one above the other, but not necessarily straight up and down and they may be staggered in cross-section.

Slide 4

Here is a slide of an offset aileron of pyrite that was too small to warrant mining by itself. The picture was taken to show the cross-sectional form of the pyrite bands. Note how the bands thin out gradually in the up-dip direction and terminate abruptly on the leading edge of the aileron shape on the down-dip side.

Slide 5

This is a picture of the right hand wall of a stope we mined last year. You can see several ore bands in the wall. The stope itself was about 12 ft. high and 28 ft. wide in this location. The pyrite bands you are looking at widened towards you and made excellent ore over the full width of the stope. The left hand wall of the stope does not show any pyrite banding, as the maximum width of each band was mined clean to the left wall.

Slide 6

This is another picture of the right hand wall of the same stope, again with the observer facing up the plunge. This shows a normal fault displacing a pyrite band. The band is fairly fine grained and assays about 1½ ounces gold per ton. It was stacked with other pyrite bands and was mined as ore. When the fault first showed in the face of the stope there was no ore at all in the face. Note that the upper segment here is narrower then the lower segment. That tells us that there is lateral movement along the fault as well as the vertical displacement that we see in the picture. Since the top segment is the narrower of the two, it must have shifted toward us relative to the bottom segment. With this in mind we drilled a test hole up and to the left from the barren face of the stope. The test hole caught 18 ft. of ore grading 1.25 ounces gold per ton.

Slide 7

Here is a picture of the down-dip side of the same stope. The picture was taken at the top of the stope, just 7 ft. below the bedrock interface with the surface gravel. This is where the stope is located on the longitudinal section. It is on the west side of the valley that sources Mosquito Creek. The face we are looking at made ore grade, about 0.65 ounces of gold per ton over 6 ft. Because we are looking in the down-dip direction we know that the pyrite bands will thicken beyond the face and both width and grade will improve in that direction. We stopped mining however, because we did not wish to divert the surface drainage away from Mosquito Creek and into the mine.

For those of you who are interested in the origin of placer gold, you are looking at conclusive evidence that at least some of the gold in the Mosquito Creek gavels was sourced by the erosion of stratiform pyritic ore shoots.

For the lode miners, it is important from an ore search perspective, that the physical shape and the geological position of the ore bodies are understood. This permits systematic exploration and development in the most effective way.

The genetic model can also be of assistance provided that it doesn't obscure the obvious. There is no real evidence for assuming a hydrothermal origin for the pyritic ores as previous operators and authors have done. The ore is unquestionably pre-faulting. There are no known intrusives. There is no alteration around the ore bodies. The pyrite bands have sharp boundaries and there is no dissemination of the gold associated pyrite into the adjacent limestone. There are no minerals that impact the gold content other than pyrite. The pyrite is of uniform grain size across the full width of the bands.

cf. 'New zone'

The evidence points to cyclical bedding during the late phases of limestone deposition with a pre-limestone deposition layer thrown in for good measure.

The present genetic model that is being used successfully in ore search at the mine is that the pyrite bands are syngenetic and that they formed during cyclical interruptions in limestone deposition. It is postulated that the pyrite formed as algal mats in a near shore lagoonal environment.

The climate was warm and there was an abundance of iron and sulphur available for organic digestion. Rainfall was minimal so there was little land sourced sedimentation to disturb the algal colonies. The pyrite forming algae coated their outer surface with a thin film of gold derived from sea water. The gold was introduced into the sea water by the same volcanic activity that sourced the high gold clarke tuff.

The algae died when advancing seas inundated the lagoons and buried the colonies with a new layer of limestone. The process of pyrite generation began again when the seas receded. The cycle was repeated over and over again as the seas advanced and retreated. It ended with a climatic change with abundant rainfall. This produced pelitic deposition from the landward side that buried the algal colonies under a thick layer of tidal flat sediments.

At some later time, the entire sedimentary pile was tilted and crumpled by compressive forces acting normal to the now plunge direction of the pyritic ore shoots. The crumpling of the sediments produced plastic flow in the pyrite layers, resulting in their present shape, with the long axes of the pyrite bodies conforming to the regional plunge.

W. Don Sutherland
Geological Engineer

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