R E P O R T

on

The Geological Status

of The

<u>ROCHER DE BOULE</u>

PROPERTY

BY

N.N. Kohanowski

December, 1951

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American Association of University Professors (M.1949)

Sigma Xi Research Society (M.1951)

Geological Society of America (M.1951)

Geological Society of North Dakota (M.1951)

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A plan of the 1200 level, showing its geology and the writer's sampling is attached to the original of this report.

December 12th, 1951,
1209 - 5th Ave. North,
Grand Forks, N.D.
U. S. A.

Mr. James Mackee,
604 Hall Bldg.,
Vancouver, B. C.,
Canada.

Dear Sir:

I am pleased to submit herewith my report of examination of the ROCHER DE BOULE mining property.

Yours very truly,

"Nicholas N. Kohanowski,"
Associate Professor of
Mining Geology,
University of North
Dakota, U.S.A.

Cc: J. MacKee - 2nd Mail,
A. L. Clark,
N.N.K. Files.

Object of Examination

The writer of this Report was engaged to examine the mining property ROCHER DE BOULE with a view of determining its economical possibilities and making suggestions as to its development in future.

Location

The property is situated in the Cassiar District, near Hazelton, B.C., Canada. It is connected with Skeena Crossing, a railroad stop by a truck road about 11 miles long.

The lowermost, 1200 level lies at an elevation of 4167 feet above sea level. The uppermost, 100 level has an elevation of 5302 feet above sea level.

Mining and Development in the Past

The Rocher de Boule mine consists of five levels and several small surface diggings.

Its history is known incompletely. The property was started in 1914 by the Montana Development Company, which continued its operations until 1918.

In 1929 the property was reopened for a short time, but no essentially important work was done during this second period.

Recently the property was taken over by the Western Uranium Cobalt Mines Ltd. Their work to date may briefly be summed up as having consisted of cleaning and rehabilitation of old workings, some sampling and a few drives. A considerable construction work was and is being done by this Company on surface. These constructions are so designed as to service the two adjoining properties as well - the Victoria and the Red Rose.

For purposes of this Report it is necessary to consider only the operations of the Montana Development Company, 1914 - 1918.

That company has done an enormous amount of underground development. As scaled off the map of 1918, the linear footage may be distributed as follows:-

Drifting and Crosscutting

1200 Level,	Drifting on Vein #2	2,100 ft.	
	Drifting on other veins	970 ft.	
	Crosscutting	3,200 ft.	
	Total, 1200 level		6,270 ft.
1000 Level,	Drifting on Vein #2	1,340 ft.	
	Drifting on other veins	290 ft.	
	Crosscutting	700 ft.	
	Total, 1000 level		2,330 ft.

500 Level,	Drifting on Vein #4	730 ft.	
	Crosscutting	140 ft.	
	Total, 500 level		870 ft.
300 Level,	Drifting on Vein #4	1,150 ft.	
	Crosscutting	910 ft.	
	Ttal, 300 level		2,060 ft.
100 Level,	Drifting on Vein #4	730 ft.	
	Drifting on other veins	20 ft.	
	Crosscutting	160 ft.	
	Total, 100 level		910 ft.
			12,440 ft.

Crosscutting represents 41% of the total lateral development. Almost all of it had to be done to reach the veins #2 and #4. Crosscuts to probe vein walls and the adjacent ground are insufficient.

The vertical development can be evaluated only insufficiently.

Raises and Winzes

1200 Level,	Raises, Vein #2	520 ft.	
	Other raises	180 ft.	
	Winzes	120 ft.	
	Total, 1200 level		820 ft.
1000 Level,	Raises on Vein #2	600 ft.	
	Raises, other	280 ft.	
	Total, 1000 level		880 ft.
500 Level,	Raises on Vein #4	1,000 ft.	
	Winze on Vein #4	50 ft.	
	Total, 500 level		1,050 ft.
300 Level,	Raises on Vein #4	600 ft	
	Total, 300 level		600 ft.
100 Level,	Raises on Vein #4	400 ft.	
	Total, 100 level		400 ft.
			2,750 ft.

Considering vein dips and interlevel spacings, the amount of vertical development is much too small to develop the drifted lengths of veins.

Stope Preparation

Stope preparation is altogether impossible of any estimate. Obviously, stopes were being prepared for mining by rill methods. However, some sudden and drastic change in plans stopped all such work at an early time. Subsequent mining and scavenging, desiged to tear out the best looking and the easiest to get at portions of ore, has destroyed any stope preparation.

Stoping

Vein #2	1200 level	4,000 cu.ft.	
	1000 level	60,000 cu.ft.	64,000 cu.ft.
Vein #4	500 level	150,000 cu.ft.	
	300 level	170,000 cu.ft.	
	100 level	100,000 cu.ft.	420,000 cu.ft.
			484,000 cu.ft.

In addition, some ore must have come out of development work. Most of that ore was probably mixed with waste and remains in dumps. It will not be considered here.

These figures are very a proximate, but afford some basis for estimation of potentialities.

Taking the weight of ore in place at 180 pounds per cubic foot, some 43,560 short tons of ore must have been broken out in stoping and scavenging operations.

Official production data are:

"Shipped in 1914-1918 - - 39,833 tons with 4.214 ozs.gold, "62,865 ozs. silver, 5,746,306 lbs. copper ..."

"Shipped in 1929 - - tons, assaying 0.14 ozs. gold, 40 ozs. "silver, 4% copper ..."

Shipments of 1914-1918 may be re-calculated to have assayed:

0.106 ozs. gold, 1.53 ozs. silver, 7.2% copper.

Gold content is comparable in both sets of shipments. Silver values are higher in the 1929 shipments, while copper is lower in 1929 shipments.

This indicates the different types of ore sorted for each set of shipments. It also shows that silver values are not exclusively associated with bronze colored copper minerals.

Altogether there were shipped 39,905 short tons of hand sorted copper ore. Subtracting this figure from the estimated tonnage of broken ore, there remains 3,655 tons. These should be in stopes as backfills and on dumps.

The writer could not see thedumps for the thick covering of snow. In any case, he would not have had time to test such dumps accurately. Various estimates of ore in dumps made in the past were:

1) 7,800 met. ts. of 3.8% Cu on 1200 level.
   4,400 met. ts. of 5.0% Cu on 1000 level.
2) 2,000 tons of 15% Cu on all dumps.
3) 12,000 tons of 4% Cu on all dumps.

The writer further estimates that he has seen at least 2,000 tons of backfills in stopes, which are worth milling.

Averaging various estimates of ore on dumps and weighing in the 2,000 tons of backfills, thetotal is much larger than 3,655 tons estimated from stoping and shipping in the past. This difference is due to ore derived in drifting operations or to larger mining widths than those reckoned, or to both.

Lack of sampling data on existing maps, therefore, should not be taken as an indication of absence of ore.

The following summary may be made on the past operations on the property -

The Montana Development Company has originally planned a large operation. The shape of workings and the modes in which they were driven indicates that the drifting was continuous, while raising as done largely to provide ventilation. Before raising for stopes preparation could start, there must have happened sudden changes in decisions.

Firstly, there was a spurt of crosscutting, when they decided to cut #4 vein on the 1200 level.

During this crosscutting, there began hurried preparations for stoping of ore that could be hand sorted. Then came a shutdown.

The curve of copper prices suggests that the decisions to start stoping and the final shutdown might have been due to drop in prices.

Having postponed the building of themill until the last, that company was actually forced out by the drop of prices.

When an attempt was made to reopen the mine in 1929, whoever did it, did not have time for anything but the very initial trial shipment. The price curve again indicated that the prices crashed at just about that time and may have caused the shutdown.

During the 1929 operations, the bulk of their shipped ore may have come from dumps or backfills. There were found their drilled rounds in stopes. Evidently the shutdown happened so fast that the last rounds were never blasted.

Had there been no drops in copper prices, either group of operators would have been confronted with two large expenditures; construction of a mill and an improvement in ore handling.

Present status of The Mine

The present operator, the Western Uranium Cobalt Mines, Ltd. has now a fairly large mine. There is no immediate need for an extensive development program, although some development - say to the amount of 10 to 15% of total underground work, should be carried on for best results. This would keep development ahead of exploitation.

Stope preparation should be started immediately. Such work will largely pay for itself, since all the preparation will be on veins.

Owing to the fact that 90% of ore will be milling ore, a mill is necessary at the very start. Furthermore, the climate is such that ore should not be stored outside over a prolonged period of time. Ore would freeze in bins, unless it is constantly moved. There is no provision underground to store large tonnages cheaply. Therefore, the mill should be in condition to run, before the mill bins are filled.

Freezing of wet ore in mill bins, while the mill is being sampled, would inevitably result in serious damage to the already existing bins.

It may be argued that production should start before the mill construction is decided upon. In this case, there is no risk whatsoever.

While not all the ore has been sampled, sampled portions contain a sufficient amount to pay for the mill and other constructions. Also the equipment can also be used in treating of ores from other properties held by the Company.

There will eventually be a need of enlarging the proposed 150 ton mill, but for the present purposes it is the economic size and is well warranted.

Sampling

No sampling data were available to the writer from the time of the Montana Development Company.

Sampling done in the recent years has been limited in extent. This was partly due to a high cost of shipping samples and to a high cost of custom analyses.

To do a complete job of sampling the accessible working, some 2,000 samples should be taken over 6,600 feet of drifting, 2,350 feet of raises and winzes and over an undeterminate footage of stope backs. Sampling of dumps would also be an expensive proposition. Backfills can never be sampled reliably, since trial mill runs are best for backfills. Considering salaries of supervision, labor, shipping costs and costs of analytical work, the job would easily cost $30,000, i.e. about one-quarter to one-third of the projected mill expenditure.

Since there has never been enough vertical development done, the results of that expensive sampling would still be questionable.

In future, it will be necessary to install a laboratory at the property, capable of turning out 30 to 40 samples per day. The cost of analyses would thus be cut down considerably.

Then the cost of sampling will become a part of mining and milling, while at the present it is not a procedure chargeable to operating expense.

The writer has taken only 12 samples, which later were analyzed for gold, silver, copper, cobalt and tungsten trioxide. Some of these samples were taken to check previous sampling. Other were taken on the "unknown" stretches of veins.

The writer is in a complete agreement with the sampling results on Mr. Jasper's map. Furthermore, presence of ore values has been established on stretches hitherto unsampled. Fluctuations in ore values shown by this sampling are only a normal phenomenon proper to any ore deposit.

Ore values were found to exist in several bands flanking the main ore filling. This increases likely mining widths and also indicates that in future mining walls must be probed frequently by drill holes and stoping widths should be determined by assaying.

The 12 samples totalled about 100 to 120 pounds. These were channel samples across the veins and included all the flanking black bands. Sites were thoroughly cleaned and shipped before taking of samples. Waste intervening between various mineralized bands was always included into a sample.

Shortness of time and lack of sampling facilities precluded taking a large number of samples. However, additional sampling at this stage would have only added to the cost without altering appreciably the results.

Samples taken by the writer are described at the continuation and are located on the accompanying map, -

<u>S a m p l e s</u>

#1. Lev. 1200. Vein #2. 35 ft. east of mark 260 (last crosscut). Check sample: 52" - 0.05 Au - 3.40 Ag - 6.40 Cu - 0.04 Co- 0.03 WO_3.

#2. Lev. 1200 Vein #2. 25 ft. east of winze. New sample: 28" - 0.12 Au - 8.05 Ag - 6.30 Cu - 0.02 Co - 0.08 WO_3.

#3. Lev. 1200. Vein #2. 35 ft. east of winze. New sample: 29" - 1.54 Au - 5.90 Ag - 6.10 Cu - 0.17 Co - Tr. WO_3.

#4. Lev. 1200. VEIn #2. 45 ft. east of winze. New sample: 25" - 3.88 Au - 11.10 Ag - 9.30 Cu. - 0.11 Co - 1.42 WO3.

#5. Lev. 1200 Vein #2. 55 ft. east of winze. New sample: 44" - 0.64 Au - 7.35 Ag - 10.90 Cu - 0.03 Co - Tr. WO_3.

#6. Lev. 1200. Vein #2. 65 ft. east of winze. New sample: 23" - 0.17 Au - 2.40 Ag - 4.80 Cu - 0.04 Co - Tr. WO_3.

#7. Lev. 1200 Vein #2. East wall of a cutout near the Rocher Fault. NO VISIBLE ORE. New Sample: 23" - 0.06 Au - 0.75 Ag - 0.30 Cu - 0.07 co - Tr WO_3.

#8. Lev. 1000. Vein #2. West face in sedimentaries. New Sample: 6" - 0.10 Au - 24.05 ag - 2.80 Cu - Tr. Co - 0.05 WO_3 NO VISIBLE COPPER BRONZES.

#9. Lev. 1200. Vein #2. 15 ft. east of winze. New Sample: 25" 0.17 Au - 9.50 ag - 3.10 Cu - 0.10 Co - Tr. WO_3.

#10. Lev. 1200. Vein #2. Mark 260. Check samples: 17" - 0.005 Au - 4.80 Ag - 1.10 Cu - 0.02 Co - Tr. WO_3.

#11. Lev. 1200. Vein #2. Mark 235. Check sample: 0.11 Au - (66") 22.85 Ag - 10.50 Cu - 0.03 Co - Tr. WO_3.

#12. Lev. 300. Vein #4. Between the last two stopes. NO VISIBLE BRONZES. New sample: 17" - Tr. Au - 0.70 Ag - 1.40 Cu - 0.04 Co - Tr. WO_3.

The average for the new "block" on the vein #2, 1200 level is calculated at:

65 feet long - 34" - 0.7506 Au - 7.5 Ag - 7.1% Cu - 0.07% Co. On the west this "block" merges with the ground sampled by Mr. Jasper. On the east, sampling was stopped for lak of time and facilities. Upwards the ore extends to 1000 level. Below this 1200 level, the ore is known to extend throug all the length of the winze. However, there, the vein is wider than the cross-section of the winze and sampling there would have been inconclusive.

Returns on tungsten trioxide content of these twelve samples are misleading. While scheelite is contained in the main vien filling and in various bands flanking the main body of the vein, the sampling included more width than necessary. Also, the fact that scheelite is erratically distributed, accounts for low results. Sampling of scheelite is very difficult, unless it is done by bulk sampling.

The visual appraisal of scheelite content on the lower workings of #2 vein was fixed by the writer at 2% WO_3. Later, an analysis arrived from Wah Chang on the 500 lbs. bulk sample. That sample was analysed to contain 1.93% WO_3.

In actual mining, scheelite will have to be mined somewhat separately from copper. Say, scheelite will be taken out in narrow cuts, which later might be widened to take out the remainder of copper ore.

<u>Ore Reserves</u>

The problem of evaluation of ore reserves is complicated by a number of factors.

Veins are complex shear fractures, consisting of overlapping lenses. Drifts prospecting these veins deviate from one lens on to another. Thus four such lenses were drifted upon on the 1200 level without an apparent discontinuity. Raises likewise shifted from one lens on to another. There are not enough raises to divide the veins into some form of "blocks".

Therefore, it is necessary to speak of i n d i c a t e d ore, rather than probable and possible.

The following assumptions are made here:

1. All ore is a milling ore.

2. Combined values of gold, silver and cobalt should increase the value of ore by US $10.00 per short ton.

3. Tungsten content is left to be the same as estimated before - 31,680 tons of 2% WO_3, contained in the lower portion of the #2 vein.

4. In view of generally high copper recoveries and because of various approximations, all copper content mentioned in the tabulation below is r e c o v e r a b l e .

Ore reserves are calculated at:

Vein	Short Tons Reasonable Assured	Short Tons Indicated	Short Tons Total
#2	47,808	267,192	315,000
#4	20,000	44,000	64,000
	67,808	311,192	379,000

Lack of samples (some 2,000 samples would have been necessary) and the fact that many samples cannot represent the full vein width preclude precise estimates of tenor. It is believed nevertheless, that the 47,808 short tons of reasonably assured ore on the #2 vein should average better than 6% Cu. Reasonably assured ore on #4 should be very much the same.

An overall tenor of the total reserve should fluctuate closely to 4% Cu recoverable.

To estimate the values and the costs, the last November's metal quotations are taken - 54 US cents per pound of foreign copper and US $72.00 per unit WO_3. It may be that the prices have risen since. There is a definite and rapid upward trend in metal prices.

The value of 4% Cu ore plus US $10.00 for gold, silver and cobalt, less the premium for WO_3, is calculated at US $53.20 per short ton.

The value of tungsten trioxide contained in ore should be US $3,421,440.00 assuming 75% recovery and no penalties.

The total value of ore reserves sums up to:

67,808 ts reas. assured	US	$ 3,607,385.60
311,192 ts indicated		16,556,414.40
Scheelite content		3,421,440.00
GROSS VALUE	US	$ 23,584,240.00

Cost of mining, milling, $17.00/ton ...... $ 6,443,000.00

Cost of shipping & smelting, prorated @ $17.00/ton 6,443,000.00

$12,886,000.00

Profit in perspective: US $10,698,240.00

In figuring costs, data on a similar operation in 1949 were taken as a basis. 40% was then added to allow for increase in costs of materials and labor.

Under the "reasonably assured" ore the writer lumps various blocks sampled. Estimates of ore on the #4 vein do not include ore possibly existing in the flooded portion of the mine.

Since vein widths are at times wider than raises or the winzes, sampling does not represent the correct width in all cases, of the veins. Presence of ore minerals in black bands flanking the main vein fillings may appreciably add to the tenor of ore. It is estimated that certain black bands may add up to 25% to the widths of veins.

Assuming that a 150 ton mill is ready at the very start of mining, the tonnage estimated should be worked out in 8 years. However, there exist good possibilities for finding additional extensions of ore.

Geology of The Rocher de Boule Deposit

The deposit occurs within and near a granodiorite intrusion. This intrusion - a stock - lies in sedimentaries of Jurassic - Lower Cretaceous age, which have become metamorphosed during the intrusion.

Petrography of the stock and of the surrounding strata was worked out by members of the geological staff of the Department of Mines and Technical Surveys of Canada. Nothing essentially important can be added to their descriptions at this time.

The contact between granodiorite and adjoining sedimentaries is exposed in main drifts of the 1000 and the 1200 levels. There it shows an intense metamorphism of stratified rocks, characterized by:

a. silification,
b. development of amphiboles.
c. development of chlorites, particularly - clinochlore. biotite
d. development of magnetite.

Ages of granodiorite intrusion and of other events cannot be fixed accurately. In any case, the intrusive body had cooled off completely by the time mineralizing solutions arrived.

Phenomena subsequent to intrusion of granodiorite are in agreement with the general structural pattern of Canada of late Tertiary - Pleistocene.

The second igneous activity must have taken place at the close of Tertiary. The new intrusive was termed "fine grained granite" by the Canadian Survey. The writer has collected a specimen of rhyolite, which may represent a chilled border of the Rocher de Boule Dyke.

Rocher de Boule dyke is the largest dyke known on the property, but not the only one. It strikes approximately N 10° 30'E. Its generalized dip is calculated at 56° 55' West, although the walls would give very variable direct readings. Rocher de Boule dyke is definitely pre-mineral and has suffered displacements by faults. Thus, in an exposure of the Rocher dyke at the end of the crosscut 1003 on the 1000 level, the horizontal displacement of the dyke by the fault-vein is about 60 feet to east. Due to this displacement the eastern face of #3 vein drift is still within the dyke, while the western face of the longest drift there is in granodiorite. The dyke may be seen in the footwall of #3 fault-vein through the whole extent of the drift but the last 10 to 15 feet.

Veins #2 and #4 do not appear to have displaced this dyke horizontally, but may have done so vertically.

Width of the Rocher dyke varies upward of 40 feet. On the 300 level this dyke was cut but not completely traversed. In the region of the vein #2 Rocher dyke does not show any apophysae. In the region of the fault-vein #3a on the 1000 level a nearness of an intersection of dykes.

A second dyke, only 2 to 4 feet wide, was encountered on the 1200 level near exposures of the Juniper fault. The rock of this second dyke is identical with the rock of the Rocher dyke. This second dyke is cut by the Juniper fault at a small angle and must be displaced by it. The intersection is in solid ground and could not be seen. However, the calculated displacement of this second dyke by the Juniper fault shows to be much smaller than the presumed displacement on the vein #2 (also by the Juniper fault).

The two dykes should intersect at about 270 feet north of the north face of the crosscut 1003 on the 1000 level.

Syenite porphyry is found on the hanging wall of the vein #3 on the 1200 level. Its significance and genetic relationships cannot be worked out from that exposure alone.

The above described assembly of igneous rocks become sheared at a still later date, shearing resulting in vein formation.

There are several veins known to exist on the property and several more may be expected to exist in unexplored blocks of ground.

The known veins have the following elements:-

Vein	Widths	Strike	Dip	Remarks
"Calcite"	1½ ft.	S 61° W.	56° NW	1200 Level
#2 (W. of Juniper)	1½ to 6 ft.	S 72° W.	51°NW	Calc.dip
Vein E. of Juniper	2 ft.	S 86° W.	39°N	
#2-a	1 ft.	S 82°30' W.	34°N	Water Raise
Fault-vein #3-a	8"	S 80° W.	36°N	1000 Level
#3	1 ft. plus	S 73° W.	38°N	1200 Level
#4	1½ to 9 ft.	S 77° W.	52°N	

Vein #2. This vein is a complex shear zone containing a number of overlapping mineralised lenses. Individual lenses are apparently arranged in an echelon-like formation. At least three such lenses may be seen in the western drift on the vein on the 1200 level. The shape of the drift indicates that the original crew must have had difficulties of finding a new lens each time the old lens pinched out. In driving eastward, the correct lens was lost in the very crosscut. Then driving eastward proceeded on some lens to the Juniper fault.

The tentative rule for finding new lenses as the old one pinches out is:

> "when driving westward, a new lens should be in the hanging
> "wall. Correspondingly, in easterly drives another lens
> "should lie in the foot - or southern wall."

The vein in the drift east of the Juniper fault on the 1200 level may not be the faulted section of #2 vein at all. Several evidences support such a view. The strike ofthe vein east of the Juniper fault is larger than the generalised strike of the #2 by some 14°. This cannot be explained by shifts in faulting. On the other hand, the vein #2-a, known under the water raise in the main crosscut has a similar characteristic.

Another supporting evidence is furnished by the intersection of the Juniper fault and the second, narrow dyke of fine grained granite. As it plots out on the map, the horizontal displacement of the dyke due to Juniper faulting should be 30 to 40 feet. The presumed horizontal displacement on the #2 vein is 100 feet, if the vein east of the Juniper fault were the lost #2 vein.

Reconstructing conditions as they existed before Juniper faulting the picture appears to be as follows:-

The #2 vein is split up into a number of narrow and widely separated stringers in the region between the main crosscut and narrow dyke. All known intersections of dykes with the veins on the property show to be barren of ore minerals, vein continuing through the dykes in form of paper thin fractures. Impoverishing ofthe vein is not restricted to the dyke width alone but extends for some distance around. Thus the already split stringers of the #2 vein should have become even more barren in the vicinity of the dyke.

Juniper fault cut the barren stretch of #2 vein just two to four feet west of the dyke. It is entirely possible that fractures corresponding to the faulted portion of the #2 vein had actually been cut in the winding drive within a short distance from the Juniper fault. Such fractures could not have been told apart from other fissures on a casual examination.

It will be a worth while drive to put in a crosscut to south, i.e. into the footwall at about 100 feet east of the Juniper fault. At a spot like that the vein should again be consolidated. This crosscut may cut the lens within 10 to 30 feet.

The lens assembly of the vein #2 and the vein #2-a appear to come to a junction at a point 160 feet east of the easternmost face. The "calcite" vein should join them some 500 to 600 feet further, if it continues that far.

Junctions themselves are expected to be poor to barren, but there is no reason whatsoever why there should not be more workable ore lenses within each vein - as long a s veins are separated.

The succession of overlapping lenses is also noticeable in raises and in the winze. All such workings show "rolls" that have caused deviations in drives. In each such roll the drive had to follow only one stringer or lens in order to maintain the contract dimensions of the drive. In each case stringers had to be left off in a wall. The new stringer to be followed was probably the widest of the set, but not necessarily the best. Again the same rule applies here - junctions are poor.

The recently received assay map made by Messrs. Hill and Legg shows a great copper content in the winze below the 1200 level on the #2 vein, than was expected by the writer on basis of visual appraisal. The copper content there must be largely due to grey minerals like chalcocite and covellite. At the same time, it is obvious that in driving the winze, the main lens was left off in the footwall.

In view of this finding by Messrs. Hill and Legg, the writer is inclined to expect a somewhat greater downward extent of ore on the #2 vein than he originally figured on. While Messrs. Hill and Legg did not average up their samples in the winze, the assays look very attractive. This winze certainly deserves attention as one of the places to start first operations.

Appraising possibilities on the drifted stretches of the #2 vein, it is suggested that short crosscuts should be put in at intervals to probe the walls for additional bands and lenses.

An indication of lens succession in horizontal plan is given by a presence of crossfaulting. Several such crossfaults have been seen on each level. For example, there are two crossfaults in the western drift on the #2 vein on the 1200 level. One lies at about 17 feet west of the main crosscut and appears to be faulted by the #2 vein. Another crossfault lies within the Rocher dyke further west in the same drift.

In the last place, the crossfault seems to cut off the vein. Actually it cut off a southern split, while the northern split has deviated into the northern wall before reaching the Rocher dyke.

Nothing much is known about continuity of ore into sedimentaries. Such a possibility, however, must be considered in future. Sample #8 has yielded a better ore value than was expected, ore minerals changing to gray copper, high in silver and gold. An increase in scheelite may well be significant - since it is accompanied by a higher gold content.

Vein #4. Is apparently of the same age and characteristics as the #2 vein. Widths appear to be greater.

The succession of lenses is well defined. A roll was found just above the long sublevel between 300 and 100 level. A considerable quantity of ore was left there in the hanging wall as the raise followed the roll into footwall. Near the eastern face of the long sublevel a crossfault terminated that particular lens. The new ore should be looked for in the southern wall and at apoint some 20 feet ahead of the cross-fault. On the east, the Rocher dyke was reached but not traversed on the 300 level. At the intersection the vein impoverishes, as expected, and splits on to two fractures. Going on the same theory as before, the northern split should become mineralised some 25 to 30 feet on the other side of the dyke.

Workings of the 500 level are flooded, water standing at about 2 feet below the 300 level. The writer, however, talked with Mr. C.F. McKenzie, the Manager of the Columbia Drilling Co. Mr. McKenzie recollects something about that flooded level. According to "im, ore widths were good throughout. Also he says, there was a winze sunk on the vein, about 50 feet deep. All of the winze was in a good ore.

The vein #4 was apparently cut on the 1200 level, i.e. some 800 feet vertically below the 500 level. Ore evidently ends above the 1200 level, but no samples nor detailed examination were taken or made. The air is bad in that portion of the 1200 level and those drifts need being blown out.

However, the proximity of the Rocher dyke might have had something to do with an impoverishment on the #4 vein on the 1200 level. A more detailed study is necessary there.

#3 Vein: This vein is a fault of large displacements. It is known only on the 1200 level, where it shows syenite porphyry in the hanging wall. Its study would require more time than could be allotted to it during the writer's visit.

The fault vein #3-a, cut by the crosscut 1003 on the 1000 level is very much similar in its characteristics to the #3 vein. However, dips measured actually on each vein do not check with the calculated average.

The same discrepancy is true in other cases - of the veins #2 and #4. On these veins discrepancies between measured and calculated dips are due to the veins consisting of a number of lenses. This may be true for the #3 vein, although the discrepancy is too great.

Other veins: Several small dark veins have been noted west of the Juniper fault on the 300 level, Structurally, onlyone of these belongs to the pattern of veins known on the property. It is possible though that the compass survey was wrong. These veins contain a large amount of magnetite and the workings should be surveyed with a transit to avoid undue magnetic declinations.

Recently a diagonal drive was made off the main crosscut on the 300 level to find the faulted section of the #4 vein. This diagonal drive cut the Juniper fault and shortly afterwards a barren vein. The strike of this barren vein was read at N 18° E, corrected north. However, the compass readings are not reliable in that ground.

The doubts about the displacements by the Juniper fault on the 1200 level apply here as well. This new vein cannot be the faulted section of the #4 vein.

These veins and the #3 and #3-a do not fit into the structural pattern of the region and may indicate a superimposition of another - local structural pattern. A more detailed study, both underground and on surface is advisable.

Mineralization

The discussion of veins on previous pages was made on basis of their structural characteristics. In this section, peculiarities of mineralization will be taken up, which apply to all the veins in general, on the property.

About four pounds of small samples were taken for purposes of microscopic examination. A number of sections were prepared and studied by optical and microchemical methods.

The following minerals were identified:-

A. Metamorphic Minerals (Contact and Dynamic)
   - Hornblende (in part Mn brg)
   - Quartz
   - Magnetite

Clinochlore
Unidentified chlorite
Chloritoid
Hydrobiotite

B. "<u>Primary Mineralization</u>"

Chalcopyrite, $CuFeS_2$
Cubanite, Cu_2S, Fe_4S_5, magnetic, platy,
Galena, PbS
Sphalerite, ZnS, dark brown
Molybdenite, MoS_2
Safflorite (Co.Fe) As_2
Arsenopyrite, FeAsS
Pyrrhotite, $Fe_{1-x}S$
Pyrite, FeS_2
Uraninite, UO_3, identified by Geiger Counter
Quartz, SiO_2
Hornblende
Magnetite
Chlorites

C. "<u>Secondary Enrichment</u>"

Bornite, Cu_5FeS_4
Chalcocite, Cu_2S
Covellite, CuS
Sphalerite, ZnS, light colored
Gold, native - inferred from assays
Marcasite, FeS_2
Scheelite, $CaWO_4$, fl. bluish white
Powellite, $Ca(W.Mo)O_4$ - fl. golden yellow
Lardite, $mSiO_2$, nH_2O, fl. white
Chalcedony, SiO_2, fl. greenish when fresh
Quartz, SiO_2
Magnetite, Fe_3O_4
Calcite, $CaCO_3$, sometimes fl. orange red
Siderite, $FeCO_3$
Chlorites

D. <u>Alteration-Oxidation Minerals</u>

Chalcanthite, $CuSO_2O$
Melanterite, $FeSO_4$, $7H_2O$
Erythrite, 3CoO, As_2O_5. $8H_2O$
Tenorite, CuO
Limonite
Goethite, Fe_2O_3. $2H_2O$
Hydrohematite, Fe_2O_3. $3H_2O$
Manganese Hydroxides, undifferentiated - Wad.

Undoubtedly some minerals were missed. There is a possibility that in addition to chalcocite, stromeyerite (Cu_2S. Ag_2S) is present. Some other sulfates of copper and iron might have been present in samples but were not differentiated.

On the whole sulfates of copper are found only in wet portions of stopes and then in unimportant amounts.

The following annotations are of interest to both a minerand a millman:-

Chalcopyrite does not show any graduation into cupriferous pyrite, and, therefore, should contain the maximum of copper. Cupriferous pyrite, on the other hand, would have had predominant iron.

Cubanite (chalmersite) is somewhat later than chalcopyrite and is magnetic. A care should be exercised in using magnetic separators. Cubanite is also distinguished by its cleavage and intense yellow color with shimmering luster.

Chalcocite is a grey mineral when rough, silvery grey when polished.

When contrasted with megnetite, chalcocite has a brownish tinge. When crystalline, it is orthorhombic but may appear in hexagonal rosettes because of twinning. Magnetite is mostly octahedral in this mine. When with chalcopyrite, it replaces the latter and then may appear silvery gray because of color contrast. When in black bands with magnetite, it is difficult to distinguish, unless the sample is pulverized and magnetite is picked off with a magnet. The writer's sample #8 contained entirely chalcocite and covellite.

Covellite - bluish dark gray, sooty or platy. Replaces both chalcocite and chalcopyrite. May give a small trouble in flotation, since it reacts differently from chalcocite.

Sphalerite and galena are spotty in occurrence.

Hornblende is coarser on upper levels then it is on lower. A pseudomorph of chalcopyrite after a corroded hornblende was found in one specifmen. This bears out a theory of E.D. Kindle of replacement.

Scheelite was found only in the secondary enrichment zone. A speck of scheelite was seen on the 300 level, but was not studied under microscope. There appears to be two generations of scheelite, but the primary tungsten mineral was not established.

Powellite occurs in very small amounts.

Lardite and chalcedony are abundant in the zone of secondary scheelite only.

Calcite has evidently been produced in two ways. In sedimentaries it may have been derived from the calcareous content of strata during the metamorphism.

Within igneous rocks, it is the result of intersection of mineralizing solutions with the plagioclase of granodiorite. This may partly be the reason for impoverishing of veins when traversing dykes, the latter being poor in calci plagioclases.

Other reasons for an impoverishment of mineralisation around dykes are: Impermeability of microgranite, etc.

The deposit obviously has undergone a succession of mineralization. Formation of ore lenses and of black bands flanking the main vein fillings were the results of those successive mineralizations.

The core of each ore lens consists of quartz-chalcopyrite filling. It is flanked on both sides by black bands of hornblende and magnetite, with variable amounts of chalcopyrite, chalcocite and covellite. This assembly is surrounded on edges by an envelope of quartz, calcite and chlorite.

Intermittent additions of material caused intermittent extensions of veins both in length, width and on dip. Thickening of ore lenses led to crossfaulting, which relieved the strain.

Such crossfaults are not necessarily younger than the nearby ore lenses. Rather the development of ore lenses and of crossfaults concurred in time. Crossfaults may not be long at all, extending only slightly beyond the extreme lenses of each vein. Wherever seen, these crossfaults ranged from an assembly of paper thin fractures to gouge filled faults up to 6 inches in width.

<u>Leaching and Secondary Enrichment</u>

Leaching near the surface could not be studied because of a thick covering of snow.

Secondary enrichment was sufficiently extensive to be reckoned with in mining operations.

<u>Summary</u>

Ore reserves at the Rocher de Boule property are estimated at
67,808 short tons of reasonably assured ore,
311,192 short tons of indicated ore,
which total 379,000 tons and should contain 4% recoverable copper plus certain values in gold, silver, cobalt and tungsten.

The gross value of this tonnage is estimated to be US $23,584,240.00.

The net profit to be expected is in the neighborhood of US $10,698,240.00.

There exists a good possibility that the metal prices would keep on raising, this rise being ahead of rising costs.

There are good chances of finding extensions of ore on the known veins, as well as of finding new veins on the property.

Tonnage of reasonably assured ore fully justifies an immediate construction of a 150 ton mill, shops and camps.

Assuming a 150 ton mill size, the life of the mine should be at least 8 years. Should more ore be found, life expectations would change accordingly.

The property is very attractive as a "re-habilitation" project.

Development work, done and paid for by a previous operator, is a good asset to the present company.

A number of stopes may be prepared in a short time, ore paying for such preparations. The number of stopes to be thus prepared for exploitation is dependent largely on the equipment available and on the completion of the mill.

While old dumps were not examined by the writer, such dumps were favorably reported upon by others. They should contain some 12,000 tons of 4% ore.

In mining within the known areas it is advisable to probe vein walls for additional ore lenses.

Possibilities of finding ore on both ends of both #2 and #4 veins have not been exhausted.

Tungsten mineralization appears to be restricted to the known lower portions of the #2 vein. It should yield a handsome profit, even though the ordinary sampling failed to give good results. In mining, narrow cuts should be taken first to remove tungsten ore. Stopes may be widened afterwards to take the remaining copper bearing bands.

February 27, 1952.

Comments on the KOHANOWSKI REPORT on the
ROCHER DE BOULE MINE,

by S. S. Holland.

Page 3 — I do not think that his data is sufficiently accurate to say that because 39,905 tons of ore were shipped that a remainder of 3,655 tons must exist as backfill or on dumps. In the first place he does not know how much waste was sorted from the ore as originally mined. Consequently this calculation cannot be used to support the belief that there is any tonnage of ore on the dumps. The only way to prove that the dumps contain copper ore is to sample them.

Page 4 para. 2 — Statement that "lack of sampling data on existing maps, therefore, should not be taken as an indication of absence of ore", is not a logical conclusion from the argument that precedes it. The fact of the matter is that there are no proper assay maps of the property.

Pages 4 and 5 — The whole section on "Present Status of the Mine" is predicated on the existence of large tonnage of milling grade ore.

"No immediate development is needed" - if the ore is present.

"Stope preparation should be started immediately" - if the ore is present.

"Such work will largely pay for itself" - if the vein material is of ore grade.

Page 5
Para. 5

I doubt whether the statement "sampled portions contain a sufficient amount to pay for the mill and other construction", is correct.

Page 5

It is true that a large number of samples should be be taken and that it would entail considerable expense, yet that is the only firm basis for an estimate of ore tonnage and grade.

Page 7

The sampling done by Kohanowski serves only to establish that on the 1200 level, #2 vein, east of the winze, that a short oreshoot exists. This corresponds to one oreshoot where tonnage was estimated by Hill and Legg.

Page 7

The content of tungstic oxide by assay is exceedingly low and is difficult to reconcile with the visual estimate of Kohanowski of 2% WO_3. The result of the bulk sample must be ignored unless the method of its taking is known.

Pages 7,
8 and 9

Ore Reserves - The assumption that "all ore is milling ore" cannot be substantiated by assays or by visual estimates of the grade of the vein mineralization.

No vein width, average or assumed, is stated. On #2 vein it would appear that he has estimated the "reasonably assured ore" as constituting blocks 15, 16, 17, 5, 6, 12, 13, 14, and 3 on the attached section. He includes in this block far more vein area than the available information warrants.

The balance of the "indicated ore" in #2 vein includes a vein area west of the sedimentary contact that is extremely uncertain.

The rest of the vein area in the estimate may be of somewhat higher order of certainty but is still far from being "indicated" ore according to accepted standards.

Page 8 The statement that the "overall tenor of the total reserve should fluctuate closely to 4% recoverable" cannot be supported by assays or by estimated grade of ore in the workings that have not been sample. It is a ridiculous statment when the shipments of sorted ore from the #4 vein averaged only about 7% copper. As a consequence the gross value of the ore, based on 54¢ U.S. per pound of copper, is completely unreasonable.

Pages ~~5~~ ~~15 and~~ 17 9 to On geology are reasonably good and show his interest in the vein structure and mineralogy.

Page 17 Summary - The only additional point that needs comment is the statement that the dumps "should contain some 12,000 tons of 4% ore". I am sure that if they did the presence of 4% copper ore would be far more apparent than it is.