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THE PIONEER MINE, HATCHES CREEK

by

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SUMMARY

The Pioneer tungsten-bismuth mine, Hatches Creek, was discovered in 1917 and worked on a small scale from then until a short time after the conclusion of World War I, when production ceased owing to a fall in tungsten prices. Prices rose again in 1937, and exploration was resumed. From June 1938 to December 1945, the recorded output was 249.94 tons of concentrate, estimated to contain 51 per cent WO_3 and 5 to 6 per cent bismuth. The estimated total production from the mine to the end of 1945 is approximately 290 tons of concentrate, obtained from 5,000 to 7,000 tons of ore. It appears that the ore has produced an average of 4.9 to 5.0 per cent. concentrate containing 51% WO_3. The ore has thus yielded approximately 2.5 per cent. WO_3.

The ore-bodies are quartz reefs, averaging, where exploited, 12 inches to 18 inches in width. A series of reefs can be traced in an east-west direction over a length of 1,600 feet, but only two reefs Nos. 1 & 2, which occupy the easterly 900 feet of the mineralised zone, have been extensively worked. A third reef, called the south-west line, has been tested to a depth of 70 feet and has yielded some high-grade ore. No. 1 reef has been exploited to a depth of 120 feet and No. 2 vein to a depth of 135 feet.

The veins exposed in the workings were sampled at 5 ft. intervals on the 88 foot and 120-foot levels (No. 1 Vein) and on the 88 foot and 135-foot levels (No. 2 Vein) with the following results (by panning) :-

No. 1 Vein Workings.

88-foot level.

Length sampled 370 feet, average width 13.8 inches, average grade 2.98 per cent. WO_3.

120-foot level.

Length sampled, 290 feet, average width 13.2 inches, average grade, 1.94 per cent. WO_3. The average tungsten content of the two levels as found by panning was 2.46 per cent. WO_3.

No. 2 Vein Workings.

88-foot level.

Main shoot has length of 175 feet, average width 17 inches, average grade, 4.55 per cent. WO_3.

135-foot level.

Length of shoot, 200 feet, average width 18 inches, average grade, 2.45 per cent. WO_3. The average tungsten content of the two levels as found by panning was 3.49 per cent. WO_3.

The localisation of the ore-shoots is controlled by structural features. On the basis of structural studies, a flat westerly pitch was predicted for the main ore-shoot in No. 2 vein and this was subsequently intersected by diamond drilling at a vertical depth of 500 feet. At the point of intersection the reef was 12 inches wide and contained 5.6 per cent. WO_3.

All tonnages in this report are in long tons (2,240 lbs.)

per cent. bismuth.

Some ore remains in No. 1 Vein above the 120 ft. level, but future production from Nos. 1 and 2 veins depends mainly on development below the present bottom levels. On the evidence of the sampling of these levels, from the information obtained in a winze to a depth of 54 feet below the 138-foot level on No. 2 vein and taking into account the drill hole at 300 feet vertical depth, it is estimated that, to the 235-ft. level proposed while the mine was operated by the Government, the main shoots on Nos. 1 and 2 veins would probably yield 6,500 tons of quartz containing 143.5 tons of WO_3 recoverable by the tabling methods practiced at Hatches Creek. This would be equal to a recovery of 2.2 per cent. WO_3. This compares with 3.5 per cent. WO_3 obtained by chemical assay of a bulk sample made up of portion of each sample taken throughout the mine, and with a recovery by pan sampling of 2.90 per cent. WO_3. The comparatively low recovery by tabling is partly due to the presence in the ore of copper sulphides and bismuth sulphides; the recovery could, no doubt, be improved by using more refined treatment methods.

Some additional ore could very probably be obtained from reefs sub-parallel to Nos. 1 and 2 veins and from the south-western line, but in the absence of adequate sampling, no accurate estimates of the value of these veins can be given. If tungsten prices were favourable additional ore could also be won from outside the limits of the main shoot in No. 2 vein.

With regard to extension in depth the deposit has been proved by drilling to a vertical depth of 300 feet. There is no reason to believe that the vein-system will not extend to 500 feet vertical depth, though individual veins within the system may lens out and others may make. There is no relationship between the tungsten content of the ore and the present land-surface. The vein system is passing, at depth, into amphibolite, which has been a favourable rock in the upper levels.

INTRODUCTION.

(a) General. The Pioneer Mine is situated near the northern end of the Hatches Creek field. It was worked on a small scale during World War I, but the output is not recorded. Between World War I, and 1937, tungsten prices were very low and very little mining was carried out. In that year, however, the onset of world rearmament and the loss of production from China resulting from the Japanese invasion, caused a sharp upward trend in prices, and a small company, afterwards known as Tantalite Limited, was formed to exploit the deposits on three leases, collectively known as the Pioneer Mine. Except for the period May, 1942 to February, 1944, when the mine was under the control of the Commonwealth Government, the company has operated the mine since 1937.

(b) Past Production.

The Production from the Pioneer Mine prior to June 1938 has not been recorded separately from the rest of the field but is estimated to have been approximately 40 tons of concentrate. The production from June 1938 to December, 1945 was 249.94 tons of concentrates, estimated to have contained 51 per cent WO_3 and 5 to 6 per cent bismuth. The total production of the end of 1945 is thus estimated at approximately 290 tons of concentrate. There are no records of the tonnage of ore mined to obtain this amount of concentrate but, judging from the size of dumps and stopes, it would amount to from 6,000 to 7,000 tons. During the period of Government operations - June 1942 to December 1945 - 2414.9 tons of ore yielded 59.93 tons of concentrate assaying 51.01 per cent. WO_3, an average of approximately 2.5 per cent. concentrate. A little of the ore was from dumps. All ore contained at least 50 per cent. mullock.

GENERAL GEOLOGY

The rocks surrounding the mine consist of a number of roof pendants of thinly-bedded micaceous quartz hornfels, resting in a mass of epidiorite. The hornfels strike nearly east and west and dip to the south at 55 to 60 degrees. They are situated on the southern flank of a former anticline, pitching eastward. The epidiorite has apparently been derived by metamorphism from a quartz-dolerite and includes rocks consisting largely of hornblende - hence the field term amphibolite, given to the epidiorites. (See appendix I. for petrological description).

THE ORE BODIES

(See plates 1,2,3,)

The ore-bodies consist of quartz reefs ranging from 6 to 24 inches in thickness, containing, in the sulphide zone, scheelite, wolfram, bismuthinite, pyrite and chalcopyrite as well as some magnetite and hematite. The ratio of scheelite to wolfram is estimated to be approximately 60:40. In the oxidised zone (depth approximately 100 feet) copper carbonates are present and in the 88-foot level east[ø] drive from No.2 shaft (plate 3) - good deal of chalcocite (secondary copper sulphide) was endeavoured. This mineral on account of its relatively high specific gravity (5.7) finds it's way into the concentrate and has to be eliminated by chemical means.

A series of reefs extend at intervals over a length of 1600 in an east-west direction, but two reefs, known as No.1 and No.2, occupying the easterly 900 feet of the mineralised zone, have been worked to the greatest extent. These two reefs and the workings on them are shown in plan on plate I.

It will be noted from the plan and sections that No.1 vein has driven on at the 88-foot and120-foot levels and that No.2 vein has been explored at the 88-foot, 120-foot and 135-foot levels. It was the intention of the Government to sink the main shaft (two compartment) to 250 ft. and drive levels on both reefs at 235-feet vertical depth below the collar of the shaft. Of the development shown on plate I, the Government carried out 1028 feet.

Sampling. The 88-foot and 120-foot levels of No.1 reef workings and the 88-foot and 135-foot levels of No.2 reef workings were channel sampled where possible at 5 foot intervals. The channels were 6 inches wide and 2/3 in. deep. As assay facilities were not available, it was decided to pan the samples. The latter were pulverised in a Braun crusher, quartered and then screened through a 20 mesh sieve. The two products from the sieve were weighed and then panned separately in order to increase the recovery. The concentrate from each sample was dried and weighed. The concentrates from individual samples were grouped to represent the various drives and chemically assayed.

The tailings from the panning were again panned and it was found possible to recovery concentrates amounting to about 14 per cent. of the initial recover. This second concentrate however contained much pyrite and chalcopyrite and was estimated to contain only approximately 20 per cent WO_3, ø it was not considered in the ore-reserves calculations.

ø/ All directions in this report are relative to the arbitary mine meridian, which is 24° 40' magnetic.

The ratio of the total weight of samples from each reef to the total weight of concentrate obtained from them were also taken into consideration. These results are shown on plate I.

The portions of the samples obtained in the first quartering were made up into 9 bulk samples representing various sections of the mine. These were assayed for WO_3 content.

The results of the sampling are shown on plates 1, 2, and 3 and may be briefly stated as follows:-

No.1 Vein Workings.

88 foot level. Average width of quartz 13.8 inches, average recovery by panning 4.4 per cent. concentrate assaying 87.6 per cent. WO_3 3.7 per cent. Bi and 0.12 per cent. Cu. This is equivalent to 2.98 per cent. WO_3. Length sampled, 370 feet. Bulk samples representing the east drive (length 230 feet) assayed 4.9 per cent. WO_3.

120 foot level. Average width of quartz 13.2 inches., average recovery by panning 4.61 per cent. concentrates assaying 41.94 per cent. WO_3, 2.96 per cent. Bi, 3.30 per cent. Cu. equivalent to 1.94 per cent. WO_3. Length sampled 290 feet. The bulk samples representing this level assayed 2.48 per cent. WO_3. The recovery by panning is thus 78 per cent. of the value obtained from the bulk sample by chemical assay.

The whole of the above ore is considered to be of mineable grade.

No. 2 Vein Workings.

88 foot level. In sampling this level, which was 390 feet in length it was found that over 80 per cent. of the total tungsten present was confined to a shoot 175 feet long in the western part of the level. The average width of quartz in the shoot was 17 inches and the average recovery by panning, 6.63 per cent. concentrates assaying 68.5 per cent. WO_3, 1.81 per cent. Bi and 0.12 per cent. Cu, equivalent to 4.55 per cent. WO_3. A bulk sample representing a 70 foot length of the shoot assayed 4.9 per cent. WO_3.

135 Foot level. In the above shoot on this level (length 200 feet) the quartz averaged 19 ins. in width and the recovery by panning averaged 4.79 per cent. concentrates assaying 51.94 per cent. WO_3, 3.95 per cent, Bi, 2.20 per cent. Cu, equivalent to 2.43 per cent. WO_3. The bulk samples representing the same ore assayed 3.24 per cent WO_3(average). The recovery by panning is thus 75 per cent. of the value obtained from the bulk sample by chemical assay. It was not possible to sample some sections of the vein which had been underhand stoped for a few feet below the 135' level, the stopes having been filled. These sections were presumably high-grade.

The average WO3 content of ore from all parts of the mine as found by bulk sampling was 3.5 per cent. WO3 and the average of No.1 shaft workings and the main shoot in No.2 shaft workings obtained by pan sampling was 2.90 per cent. WO_3.

Remarks on the Sampling Results.

The distribution of values in tungsten-bearing veins is normally erratic and the Pioneer veins are no exception. In No. 1 shaft workings, 64 per cent. of the total concentrate was obtained in 4 out of total of 38 samples and in No.2 shaft workings, 60 per cent. of the concentrate were obtained from 7 out of a total of 44 samples taken during the initial sampling campaign. The portions of the reef giving very high value were check sampled. This distribution caused some uneasiness regarding the calculation of average values, but it was found that if the high samples were cut, a figure well below the mill recovery was obtained. A large proportion of the mine output of concentrate apparently comes from rich patches of ore comprising a few tons only, which may yield a ton

or more of concentrate. Thus 1,869 tons of ore treated for the year ended 30th June, 1943 yielded an average of 2.63 per cent. concentrates. The dilution by barren rock was approximately 50 per cent. so that the recovery from the quartz was approximately 3.3 per cent. concentrates. This compares with a sampling average for the whole of No. 1 shaft workings and the main shoot in No.2 shaft workings of 4.97 per cent. concentrate of similar grade.

It will be noted from the preceding statements, that for the bottom levels (sulphide ore) the recovery by panning amounted to about 75 per cent. of the total tungsten content of the bulk samples as revealed by chemical assay. Similarly, a mill test showed that the recovery of WO_3 was approximately 65 per cent. Sampling indicated that the tailings dump contained 0.65 per cent. WO_3.

Considering the various results obtained, it is believed that the average of the reefs exposed in the bottom levels as obtained by pan sampling are a reliable, perhaps slightly conservative, estimate of their recoverable tungsten content. They are almost the only indication we have of the ore that can be expected below these levels, and ore reserve calculations shown on Plates 2 and 3 are based on these figures. Only reserves of quartz are shown as the dilution factor will vary considerably with the type of mining adopted.

Ore Reserves.

When the Government handed back the mine to the leaseholders at the end of 1943, there were about 300 tons of quartz containing 2.0 per cent. WO_3 developed in the main shoots above the present levels. It is probable that some of this ore has since been removed and the future of the mine depends on extensions below the present levels. The ore reserve calculations shown on plates 2 and 3 are those estimated to be present to the proposed 235 foot level. There is only limited direct evidence that the ore-shoots continue to this level. No.1 inclined shaft (plate 3) has been sunk 54 feet below the 135 foot level and fair values were obtained to this depth while a diamond drill hole intersected No.2 reef at a depth of 300 feet below the collar of the main shaft. At the point of intersection, the reef was 12 inches wide and contained 5.5 per cent. WO_3 (scheelite) and 1.13 per cent. bismuth in the form of bismuth sulphide. The individual veins which are narrow and have a limited strike length cannot be expected to extend indefinitely in depth, but there is no reason to suppose that the vein system would not extend to a depth of (say) 500 feet.

Taking the widths and grades found on the bottom levels, it is estimated that the following quantities of ore could be reasonably anticipated to the proposed 235 foot level.

No. 1 Reef Workings.

Between the 120' and the proposed 235' levels

Quartz Tons.	Grade c/c Concs.	Tot. Concs. (Tons)	Grade of Concs.	Total WO_3 Tons.	Approx. Value at 110/- per unit £
3,550	4.61	164	41.94	69	38,000

Further ore could probably be developed by extending the 88-foot and 120-foot levels to the eastward.

No. 2 Reef Workings - Main Shoot.

Between the 136' and the proposed 235' levels

Quartz Tons.	Grade c/c Concs.	Tot. Concs. (Tons)	Grade of Concs.	Total WO_3 Tons	Approx. Value at 110/- per unit £
3.000	4.97	143.7	51.94	74.5	41,000

Totals for Nos. 1 and 2 Reefs (main shoots)

Quartz (Tons)	Tot.Concs. (Tons)	Tot. WO_3 (Tons)	Total Value at 110/- per unit £
6,550	207.7	143.5	79,000

No. 2 Reef Workings (contd.)

Smaller tonnages of tungsten-bearing quartz could certainly be won outside the limits of the main shoot. Thus, some ore remains in the stope above the eastern part of the 88 foot level. However, the reef normally has a maximum width of 9 inches and a good deal of chalcocite is present. As shown in plate 5, the 130 length feet of reef exposed immediately east of the main shoot has an average width of 9.3 inches and a grade of 0.71 per cent concentrates. East of this again, in the same level, the reef averages 9.6 inches in width over a length of 80 feet and yielded an average of 6.1 concentrates assaying 23 per cent. WO_3. Some ore could probably be obtained by underhand stoping from this level. The chalcocite, which contaminates the concentrate from this section of the mine, could be expected to cut out at 20 to 30 feet below the level.

Bismuth content of ore.

As shown on plates 2 and 3, the bismuth content of the concentrates obtained by panning grabs from the bottom levels varied between 3 and 5.5 per cent. The concentrates from the mill usually contain 5 to 6 per cent. bismuth. Two mill tests showed that the bismuth recovery was about 45 per cent and it was also found that the tailings dump averaged, by sampling, 0.26 per cent. Bi. It therefore appears likely that the run of mine ore averages approximately 0.5 per cent Bi and that less than half of this is normally recovered by tabling the final extraction of bismuth from the concentrate is estimated to be approximately 65 per cent. Bismuth sulphide is prominent where the reefs are exposed in the deeper workings of the mine.

Features Controlling Ore Localisation.

As shown on the accompanying plans and sections there are a number of features pitching to the westward at angles of 45 to 60 degrees. These features include:-

1. The eastern end of vein 1A (Plates 1 & 2)
2. The locus of intersection of veins 1A & 5 (Plates 1 & 2)
3. The locus of change of dip and strike (Plates 2 & 3)
4. The eastern limit of widths greater than 12 inches (Plate 3)
5. The trace of the intersection of the reef fissure with a given bed of sandstone (Plate 5)

Most of the above features result from the fact that the stress which gave rise to the fissuring now occupied by the reefs, was relieved partly by open breaks which crossed the bedding planes of the fine grained sandstone for example, at angle of 5 to 15 degrees along the strike and from 5 to 25 degrees down the dip, and partly by movement along the bedding planes themselves. The open breaks dip more flatly than the bedding and also have a more southerly strike when facing west. These conditions result in a westerly pitch for the intersection of the breaks and the bedding planes.

A considerable part of the high-grade ore-shoot in No. 2 vein (Plate 5) occurs where the fissure cuts an epidiorite (amphibolite) intrusion. In this competent rock, fissures tend to be open and the reef is strongly developed. It was suspected during the geological examination that No. 2 vein was passing entirely into amphibolite at depth and this was confirmed by drilling.

At both the eastern and western ends of the 135 foot level, No.2 shaft, (Plate 3) the reef tends to split and diminish in size where it enters a dense quartzite rock. The fall in vein width at the eastern end of this level is disconcerting in view of the relative continuity of the vein in the 88' level above. The split may be of a temporary nature, but for the present has been regarded as the limit of the shoot.

Taking the above factors into account it was concluded that the shoot of ore revealed by sampling in the No.2 shaft workings, would be likely to pitch to the westward at angles of 45 to 50 degrees. Assuming this pitch, a drill hole was designed to intersect the shoot at 810N., 890E., R.L. 700-300' below the collar of the main shaft - (Plate 3). As previously indicated this diamond drill hole was intersected high-grade ore, thus strongly supporting the conclusions reached above.