GEOLOGY OF THE MINERAL KING MINE

SHEEP CREEK MINES LIMITED

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INTRODUCTION

The Mineral King Mine, owned and operated by Sheep Creek Mines Limited of Nelson, B.C., produces lead and zinc concentrates at Toby Creek, B.C. This paper describes the geology and presents some of the problems encountered. The general geology of the area has been described by Walker, Reesor and Fyles, (1), (2) and (3).

LOCATION AND HISTORY

The Mineral King mine is in the Purcell Mountains at the junction of Toby and Jumbo Creeks, about twenty-five miles south-west of Invermere, B.C. The showing was discovered by 1895 and early operators trenched and drifted in efforts to extend the high grade quartz-lead-silver stringers found on surface. In 1950, the property was examined and optioned by Sheep Creek Mines and diamond drilling from the open cut at 5,700 feet above sea level indicated larger bodies of lower grade lead-zinc ore. Lower tunnels and more drilling proved sufficient ore to justify construction of a plant, and the concentrator started up in April, 1954. Since then, 1,700,000 tons of ore have been mined and milled, and 22,000 tons of crude barite ore have been shipped.

OPERATION

The mine has been developed by eight levels of which four are adits and four are driven from internal shafts. The 7th level is the main haulage level, driven at 4,700 feet, the elevation of the coarse ore bins, and the 9th level was driven 300 feet lower, from the Jumbo

Creek side of the mountain. Mining is almost entirely open stope bench-ing and slashing, with some long-hole drilling used for pillar and sill recovery. Above the 3rd level, stopes are generally flat or gently plunging, with heights up to fifty feet, but lower stopes are usually thirty to forty feet wide, with heights of more than one hundred feet. Due to very competent walls no filling is necessary. The concentrator is currently treating 600 tons per day of ore assaying 2.6% lead, 5.8% zinc and 1.0 oz. silver per ton. The power plant consists of five diesel-electric units with a generating capacity of 1,275 k.v.a. Plant and townsite water is pumped from Stark Creek, a tributary of Toby Creek. About one hundred men are employed, of whom twenty-five travel daily from Invermere. More details on the plant and operation can be found in previous reports by Magee and Cummings (4) and Magee (5).

GENERAL GEOLOGY

The Mineral King area is underlain by moderately metamorphosed Proterozoic rocks of the Purcell and Windermere systems, with the Dutch Creek and Mt. Nelson formations of the Upper Purcell overlain unconformably by the Toby formation, the basal member of the Windermere system. There are no igneous rocks exposed closer than seven miles, except for minor dykes.

The major structure of the Purcell range is a broad geanticline plunging gently north-westerly. The Mineral King mine lies in a minor syncline on the west limb near the axial plane of the geanticline. Structure is complicated in detail by strike faults, both thrust and normal, and by lack of marker beds.

STRATIGRAPHY

The oldest rocks exposed in the mine area are dark gray to black slates or phyllites, which are the uppermost members of the Dutch Creek formation. In normal succession, the slates are overlain conformably by dolomites and argillites of the Mt. Nelson formation, the basal member being a prominent white quartzite.

The Toby formation, which overlies the Upper Purcell formations with marked angular unconformity, consists mainly of conglomerate, poorly sorted and highly variable in composition. In the mine area, the conglomerate contains angular quartzite pebbles and boulders, with minor dolomite and argillite, in an argillaceous or schistose matrix. Near its contacts, the conglomerate is difficult to distinguish from breccias which are found in the Mt. Nelson formation.

STRUCTURE

The orebodies at the Mineral King mine occur in the mine "limestone" which is by analysis a dolomite considered to be Mt. Nelson. This dolomite is in the form of a slightly overturned syncline plunging north-westerly at thirty to thirty-five degrees. There is no bedding visible in the moderately metamorphosed dolomite. Small local structures are shown by argillite lenses in the dolomite, but these are too distorted and discontinuous to be of much assistance. The Toby formation lies in an apparently tight anticline in the centre of the mine dolomite.

On the east or footwall side of the dolomite are black phyllites or slates of the Dutch Creek formation, and on the west or hanging wall side a succession of argillites and dolomites of the Mt. Nelson formation.

Both contacts are considered to be fault contacts, (Fyles' F2 and F6) by some geologists, an interpretation which is reasonable but difficult to prove or disprove in the mine. Near the bottom of the trough on the east side, a lens of quartzite conglomerate strongly resembling the Toby conglomerate occurs on the mine dolomite - Dutch Creek contact. The dolomite varies in thickness from sixty to four hundred feet; no rock resembling it closely is known to occur in the hanging wall series of dolomites and argillites.

The structural history is not obvious but can be assumed to have started with the mine dolomite lying in normal succession above the basal Mt. Nelson quartzite and the Dutch Creek slate. At the close of Purcell time, there was moderate folding and the Toby formation was deposited with angular unconformity on the eroded Purcell surface. Probably at the close of Windermere time, thrust faulting (F6) put the mine dolomite in direct contact with Dutch Creek slate. Further deformation warped the Toby formation and mine dolomite into a tight syncline, folding the F6 fault plane as well. A normal fault (F2) dropped the Mt. Nelson formation down on the west side of the mine.

Minor faulting within the mine is difficult to date, since most are strike faults. Sulphides are often found slickensided by post-ore movement, but most minor faults are thought to have been pre-ore.

In detail, several features of mine geology do not fit the theory outlined above. These features will be considered later.

ECONOMIC GEOLOGY

The ore above 3 level occurred in four troughs varying from tight, "V"-shaped on the west to open on the east. These were called "A", "B", "C" and "D" zones, although the horizon was also mined between zones in some areas. Only the "A" zone outcropped at surface (1 level); the others appeared as mining proceeded down the plunge, and the "D" zone can be traced to where it fingered out in argillite to the south and east. Mineralization in this area consists of galena, some sphalerite in siliceous gangue in the "A" zone, grading to minor galena and higher sphalerite in barite gangue in the "C" and "D" zones. Banding in the ore indicates replacement of apparent synclines, but whether this was a stratigraphic horizon or a folded shear zone is not clear.

The "A" zone as it passes through 3 level loses its "V"-shaped appearance and becomes replacement along a major fault which can be traced for 500 feet in length and depth. What is thought to be a cross-warp limited the "C" zone near 3 level and the "D" zone below 3 level. Other ore bodies were found down the projected plunge of the upper zones and these have been called "B", "C" and "D" although they are mainly replacement along essentially vertical fault zones and have no connection with the upper zones.

The trend in mineralization has been to higher grade, with the mill heads at 2.6% Pb., 5.8% Zn., up considerably from 1.4% PB., 4.0% Zn., in 1957. Barite, when found with insufficient sulphides to make ore, is mined and shipped to Alberta for the drilling mud market. Apart from pyrite, the only significant sulphide minerals are bournonite, a lead-copper-antimony sulphide, found mainly in barite, and meneghinite, a lead-antimony sulphide found in siliceous ore. Sphalerite varies from

yellow to greenish to brown and a reddish-brown form which is very distinctive is now being found in the lowest levels.

The only orebodies which are definitely not the replacement type found down to 6 level are: (1) a replacement of bedded quartzite found at the angle between the Dutch Creek slate and hanging wall argillite on 7 level and (2) a quartz stringer zone found in the narrowest part of the mine dolomite, also on 7 level. Ore occurrences on 8 level and below 9 level are not sufficiently well known to classify as yet.

PROBLEMS IN MINE GEOLOGY

Exploration to date has been fairly straightforward. When the main sources of ore were the large replacement zones above 3 level, very little diamond drilling was done. Locating and developing the lower ore zones required increasingly more drilling on a more systematic basis. Roughly 2,000 feet of drilling per month is now done with holes on east-west cross sections at 100 foot spacing. Detailed geology is shown on linen plans and vertical cross sections at a scale of 40 feet to one inch, and a mine model has been made, showing geology on east-west sections on plexiglass at 80 feet to one inch. Problems which seemed academic a few years ago are now very important for long range exploration.

The basic problem is the relationship of the mine dolomite to the hanging wall Mt. Nelson formation. It cannot be assumed that the mine dolomite is upper Mt. Nelson because of the Toby formation above it, since the Toby formation has been mapped in contact with all Purcell rocks including Dutch Creek. Similarly, the relation to the base of the Mt. Nelson formation is not clear because of the absence

of the basal quartzite, which is presumed due to faulting (F6). The positive evidence for calling the mine dolomite Mt. Nelson in age seems to be that it lies between the Dutch Creek slate and the Toby conglomerate.

An attempt was recently made to discover repetitions, if any, of the mine dolomite in the hanging wall argillite-dolomite series, by drilling a long hole from the hanging wall contact on the 9th level. This hole, unfortunately, encountered a flow of gas including methane, at 1,175 feet and had to be plugged. However, no formation similar to the mine dolomite was seen, and the hole was probably within 400 feet of the basal quartzite.

The hanging wall contact itself is a problem, since it must be Fyles' F2 fault. However, the shape of an apparent drag fold on the 9th level is the reverse of what would be expected from normal faulting. The relation between the hanging wall formations and the Dutch Creek slate where they meet is not at all clear, partly because of a white quartzite found only here. This quartzite has been folded into a syncline, which may also be a drag structure. Due to the presence of a major ore body, the details of this structure are now being explored. The other major problem is that conditions controlling the deposition of ore are discontinuous and highly variable, so that exploration for favourable structures is difficult. The mine dolomite at surface is very limited in extent, becomes about 800 feet wide on the 4th and 5th levels and narrows to 300 feet on the 9th level. Since there is a pronounced change in structure north of Jumbo Creek, the effect on the mine dolomite becomes important. Correlation between surface and mine geology has been very difficult, but must eventually be worked out.

SUMMARY

The Mineral King mine has produced lead and zinc concentrates and barite ore from a deposit in the Upper Purcell formation west of Invermere since 1954. The ore bodies are mainly due to replacement in the "mine dolomite", a formation which presents many problems as to age relationships, structure, and ore control. Long range exploration planning will depend largely on the solution of these problems.

REFERENCES: (1) Walker, J.F.: Geology and Mineral Deposits of Windermere Map-Area, B.C., Geol. Surv., Canada, Mem. 148 (1926).

(2) Reesor, J.E.: Lardeau (East Half), Geol. Surv., Canada, Map 12-1957, (1957).

(3) Fyles, J.T.: Annual Report, 1959, Minister of Mines, B.C. (1959).

(4) Magee, J.B. and Cummings, W.W.: The Mineral King Mine, Can. Inst. of Mining and Metallurgy, Trans. Vol. LXII, (1960).

(5) Magee, J.B.: Operating Techniques Developed by Sheep Creek Mines Ltd., Can. Inst. of Mining and Metallurgy, Vol. LVI, (1963).