VIOLAMAC MINES LIMITED

800903

GENERAL DESCRIPTION

The Slocan operations of ViolaMac Mines Ltd., Toronto, consist ~~primarily~~ of the producing Victor property and the Lone Bachelor development project. The Victor mine will be the main topic of this paper, although some reference to Lone Bachelor geology is required to develop inferences concerning principal bedding structures at the other mine. The two properties occupy parallel vein systems which are approximately 1200 feet apart with the Lone Bachelor lying to the southeast of, or in the hanging wall of the Victor vein.

The Victor mine produces a relatively high-grade silver-lead-zinc ore. The greater proportion of this is trucked to the Western Exploration custom mill at Silverton for treatment, and a minor sorted portion shipped directly to the smelter.

LOCATION, access AND PROPERTY

The property is approximately four miles due east of New Denver, situated on the north end of Queen Bess Ridge where it slopes into Carpenter Creek. A 2½ mile mine road, leaving the New Denver-Kaslo highway at Three Forks, provides access to the property.

The Victor-Lone Bachelor group is made up of nine Crown-grant claims and four fractional claims which are held as locations.

SURFACE DETAILS AND MINE WORKINGS

Topographically, the mine area occupies the east flank of a broad nose sloping northward into Carpenter Creek. The upper area slopes moderately and is almost entirely covered by a few feet of overburden. Most outcrops are found along road cut-banks and within old surface pits and trenches. The lower slopes, closely above Carpenter Creek, are steeper with frequent bluffy sections having more abundant bedrock exposures.

Much of the surface was burned over several years ago and is covered with thick brush and a sparse growth of small fir and hemlock, balsam, tamarack, etc. ~~Mine timber is obtained from local sawmills.~~

The mine workings range from No. 1 level, at the 4600' elevation, to No. 10 level at 3650 feet. All levels, with the exception of 3950 and 4150 sub-levels, are adits. The main working adits are No's 5, 7, and 9, with ore bins and timber-sheds at each. The compressor plant and main service shops are located at No. 9 portal site.

HISTORY

The Victor mine, in comparison to most Slocan properties, is a comparatively recent operation. It was discovered by G. A. Petty in 1921 by trenching and ground-sluicing operations along the easterly flank of Queen Bess Ridge. The original showing was a narrow vein of solid galena which was subsequently explored 50 feet below through No. 1 adit. From the first intersection the vein was drifted out for 200 feet to the southwest, and mineable sections stoped out to the surface. An additional 200 feet of drifting and crosscutting were done, but no important ore extensions were located. The oreshoot was then developed and mined through No's 2 and

3-levels, and an outer faulted segment mined from No. 4-level. This segment cut off at a porphyrydike to the northeast of the downward projection of the ore shoot at 3-level, and further drifting to the southwest on a weak fracture failed to pick it up. This completed the first operating phase. "Shipments between 1923 and 1929 amounted to 402 tons of sorted lead ore." Much of this carried several hundred ounces of Silver per ton -- generally associated with oxidized vein sulfides. From 1931 to 1947 the E. Doney lease produced over 1,000 tons of sorted ore. The initial 1400 tons of Victor ore had an average grade of about 0.09 oz. gold; 180 oz. silver; 45% lead, and 10% zinc.

The present operators purchased the property and lease in 1948 forming the original ViolaMac Mines (B.C.) Ltd. Production, on a small-scale selective mining and sorting basis, was continued. Further exploratory drifting and crosscutting on No. 4 level resulted in finding the expanded downward extension of the main ore shoot, and the production rate was stepped up -- at this point, [redacted], it might be mentioned that one of the leaser's crosscuts was stopped at only three feet short of an intersection with ~~an orebody of major importance~~. the main Victor orebody.

Development on No's. 4 and 5-levels was successful and much high-grade ore was shipped directly to the smelter. In 1950 a small mill was built and some lower grade material treated. This mill was abandoned late in 1952 when arrangements were made to mill an increased tonnage at the Western Exploration mill at Silverton. At present the monthly mine production is 1800 to 2000 tons with an average grade of 20 oz. silver, 15% lead, and 9% zinc, with a minor content of gold and cadmium. In addition one to two carloads of sorted lead ore are shipped to the smelter. By the end of 1955 the total production by the present company amounted to about 95,600 tons.

HISTORY OF GEOLOGICAL INVESTIGATIONS

The first technical account of the camp, by G. A. Carlyle, was published in 1896. The first systematic mapping program was accomplished by McConnell and included in the larger G.S.C. "West Kootenay Sheet." Several properties were described in the 1906 report of the Zinc Commission. Field studies by C. E. Cairnes, from 1925 to 1928, provided the material for his comprehensive memoirs describing the geology and properties of the camp. These are still basic reference works.

Detailed mapping by Kelowna Exploration Co. in 1940-41 in the Payne-Washington area, and the subsequent interpretations by Mayo and Billingsley outlined the broad structural ore controls. Further field mapping by this company, from 1946-51, covered much of the area between Carpenter and Silverton Creeks. At the same time a parallel program was conducted by the B. C. Dept. of Mines. This work was summarized in Bulletin No. 29 -- "Geology and Ore Deposits of the Sandon Area", by M. S. Hedley. This publication is the present reference for details of the structural geology of the camp.

Several mining companies, such as Western Exploration Co., Carnegie Mines Ltd., Violamac Mines Ltd., and Cody-Reco Mines Ltd., have made local detailed studies within their respective areas.

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GEOLOGICAL SETTING OF SLOCAN MINING CAMP. FIG. 1

The system of northeasterly-trending veins and lodes is situated within an intensely-folded group of ~~predominantly~~ sedimentary rocks which extends for several miles east of the Silverton-Rosebery shore of Slocan Lake. This group of Upper Triassic argillites, quartzites, limestones, or admixtures of these, forms an arcuate corrider between Slocan and Kootenay Lakes, and is bounded on the north and south by the Kuskanux and Nelson batholiths, on the east by the Kaslo greenstone formation, and on the west by gneissic hybrid phases of the granitic rocks. In general, the formations trend northwesterly except where they are warped or bent into parallelism with the bounding rock units. Local variations in the trend of structural bedding units appears most pronounced within the westerly part of the area. From south to north the pattern of strikes is easterly to northeasterly out of the Nelson granite, swinging northerly to northwesterly across Silverton Creek and the main part of the camp; then westerly across Wilson Creek and the head of Slocan Lake. In more open form, a similar curvature appears up the easterly edge of the area. From the Keen Creek re-entrant bedding emerges on a northeasterly strike, bends westerly around a bulge in the granite, to assume a northwesterly trend parrallel to the course of the Kaslo greenstones.

Within both granite masses, on the north and south, the continuity of bedding trends is maintained by gneissic structures or inclusions of altered sediments. Within the Nelson body southwesterly-striking elements persist for several miles before bending back to a normal southeasterly trend. The apparent continuity of lineations in sedimentary and granitic rocks together with the presence of altered bedding remnants and hybrid gneisses in the latter, suggests a process of regional folding, intrusion, and assimilation.

Although the greater complexity of folding appears in vertical cross-section, normal to the general formational trend, a strong fold pattern is apparent in plan view. The broad pattern is that of an assymetric U-fold open to the west with structures on each flank resuming a normal regional strike to the north and south of the map area. Within this pattern folding appears most extreme at the throat of the U close to Slocan Lake, passing to a broader and less distorted pattern towards the Kootenay Lake section of the fold. The general pattern appears to have developed by the application of regional buckling stresses centered upon the camp area. These may have been closely related to the more apparent tangential stress-couples producing the recumbent fold structures of the vertical section, and which were possibly of a differentially-compressive nature. Judging by the continuity of structural trends from the sediments to the bordering granitic rocks, the intrusion of the sediments on the flanks of the U-fold was an accompanying factor in its development.

CROSS-SECTIONAL FOLD PATTERN: FIG. 2.

In broad form, the major fold structure appears as a composite drag-fold, overturned from northeast to southwest. The full vertical extent of this fold must be inferred as the roots are nowhere exposed, and much of the upper section has been removed by erosion. However, enough of the original structure remains to provide evidence of its origin. It is probable that the fold originated by differential tangential stressing of a thick synclinal ~~area~~ deposit, with the higher component being directed to the southwest from the Kootenay Lake area, and the lower to the northeast from the vicinity of Slocan Lake.

The actual shape of fold elements is only seen locally. For the greater part the symmetry was deduced from the variation in bedding dips throughout the mine area. Interpretation of these observations involved determinations of bedding tops by primary structures and the correlation of minor drag-folds with certain dip-panels. Lithological correlations are generally impractical, because of the generally gradational character of the mixed assemblages of argillaceous, quartzitic and limey rocks involved.

Within the major recumbent fold, generally opening to the southwest, are three or more lesser folds which form key structural horizons for ore deposition. These have roughly-horizontal axial planes. ~~parallel to that of the major structure.~~ From higher to lower these are:

(1) The Mammoth-Hope-Richmond flexure, opening to the southwest. Q.B.
(2) The Silversmith-Victor flexure, opening to the northeast. PAYNE
(3) The Carpenter Creek flexure, opening to the southwest. SUB-PAYNE

In addition, another higher flexure, is suggested by the variable pattern of bedding structures and tops along Silver Ridge. This is tentatively labelled the Silver Ridge flexure. Approximate crestal separations of these mine folds ranges around 1,000 feet. Closely related to the above are minor, but often locally important bedding flexures and drag folds with symmetries in accordance with inter-bed movements along the limbs of the larger flexures.

FAULTING

A roughly-conjugate fault system is composed of a northwesterly-trending formational set; and a northeasterly-trending vein-and-lode set. The former group appears to have been developed by localized inter-bed adjustments consequent ~~to~~ upon extreme folding. They generally parallel local bedding structures in strike and dip, but frequently exhibit cross-cutting relationships where bedding is tightly folded or dips are abruptly reversed. Displacements are generally normal, and in harmony with the average inter-bed movement within a particular limb of a fold.

The northeasterly-trending faults generally cross-cut bedding planes at fairly large angles. Locally they swing into parallelism with bedding planes and formational faults within local panels of soft, flatly-dipping beds, but seldom cross a bedding fault without being offset from a few inches to several tens of feet. Right-hand offsetting of vein and lode fractures is typical at intersections with major formational faults. It is possible that this pattern is related to general inter-bed strike-slip adjustments related to the regional ~~major~~ U-Fold. The general easterly strike-slip component of displacement of hanging-wall ground along the major lodes could be related to the same inter-bed adjustments.

That the lode fractures and formational fault were developed within the same general period of deformation is suggested by certain details of their intersections. Frequently a vein will bend to follow the course of a bedding fault for a short distance, or minor link-fractures will pass from a lode to a fault without interruption. In certain cases mineralization continues from lode to fault by way of link-veins-with zinc rather than lead mineralization persisting farthest from the lode. However, some post-ore displacement usually occurs at these intersections.

The northeasterly-trending fractures vary in size from joints to simple open fracture-veins, to lodes systems up to 100 feet in width.

On the smaller structures (typically the narrow filled fracture-veins of the Victor type) wall-rock displacement amount to only a few inches or feet. These are often completely filled with massive or banded aggregates of ore minerals, although the usual filling consists of a number of sulfide bands or brecciated sulfides in a gangue of quartz and siderite.

Along stronger lodes net displacements are such that hanging walls move downward and eastward, with the net direction of displacement frequently along a line pitching a little below horizontal. Along these structures curved or warped sections, fault-lode intersections, or intersecting lode strands create structural conditions favorable for ore deposition.

GENERAL ORE CONTROLS

The form and character of vein structures favorable to ore deposition varies somewhat in accordance with the amount and direction of wall-rock displacement attending their formation. In general, along the stronger lode systems, large displacements, having strong strike-slip components, have promoted the development of internal shear, breccia, and flexure forms. Within smaller veins, the correspondingly weak normal displacements apparently restrict structural development to simple fracture forms of either a tight or open nature. Shear, breccia, and flexure structures are of only local occurrence within the productive parts of such veins.

To amplify, the following factors appear, singly or in combination, as ore controls within major veins and lodes.

(1) Wall rocks composed of mixed assemblages of hard and soft beds. Conditions for shattering are optimum in such formations and promote the development of permeable breccia fillings. On the other hand, thick sections of uniformly hard wall rocks restrict vein development to narrow, gauge-filled fractures; within sections of soft, thinly-bedded wall rocks vein forms tend toward a wide zone of ~~sinuous,~~ braided, narrow shears.

(2) Curved or warped sections of the lode. At such localities wall-rock displacements create areas of differential compression or tension, the latter naturally being more favorable for the development of permeable breccia and fracture structures with a minimum of impervious gauge. Curved vein sections appear most frequently where formations of variable dip and competency are traversed, or at intersections with strong formational fault.

(3) On vein sections where wall rock displacements act squarley across the beds. Where the general downward and eastward relative hanging-wall movement is associated with westerly-dipping bedding panels this condition is fulfilled.

(4) At intersections of individual lode strands.

(5) On relatively steep-dipping vein sections: Usually, in this case, a late normal displacement has opened up pre-existent structures and vein-fillings, or has developed an additional set of open fractures.

The above factors, usually acting in some degree of combination, are typical of the larger shear-lodes. However, within the small fracture-vein structures such as the Victor, conditions which produce simple open vein patterns are of most importance. Some geological factors which enter into the development of these are:

(1) Sections of bedding composed of rather uniform lithologic types of ~~with~~ intermediate hardness and competency. Typically these include medium-thick bedded assemblages of ~~intergradational~~ mixed argillaceous and quartzitic rocks. Sections of thickly-bedded quartzites or very thinly-bedded soft argillites are precluded.

(2) Steeply-dipping vein sections are generally favorable, although local exceptions indicate the entrance of other factors.

(3) Where veins transect bedding sections at large inter-planar angles. In such circumstances a minimum fraction of the displacive movement is bled off along bedding planes.

(4) Where frequent small bedding faults or slips interrupt the course of the vein. This condition appears to be optimum for the development of open vein-fractures formed through relatively minor wall-rock displacements, in that open-fracturing is facilated by restricting individual vein segments and displacements to relatively thin, fault-bounded bedding panels.

(5) Where wall rock formations are involved in recumbent fold patterns. This particular bedding structure apparently facilitates open fracturing at steep dips. A prominent feature of such sections is the presence of many regular joints paralleling the vein, with many of those close to the vein being cleanly filled with ore or ~~or~~gangue minerals.

(6) At sections of bedding intruded by numerous porphyry sills and dikes. In themselves porphyries form generally unfavorable host rocks except where they occur immediately within recumbent fold structures. Apparently they exert a wider structural control throughout larger bedding sections, in that they assist in maintaining deeply-penetrating solution channels through otherwise soft plastic formations.

GENERAL GEOLOGY OF THE MINE AREA. FIG. 1.

The Victor Mine lies within a broad panel of thin-to medium-bedded mixed argillites and quartzites locally intruded by zones of porphyry dikes and sills. Within the limits of the mine workings bedding formations are bounded on the northeast and southwest by the Cinderella porphyry stock and the West Porphyry body.

The Cinderella stock is exposed on the surface from No. 10 portal across Carpenter Creek, giving it a width of over 2,000 feet. It's mapped length is comparable, although the total extent will probably include long sill-like terminations.

The West body, where pentrated by 9-level is upwards of 400 feet thick and may be related to a zone of thick sills outcropping above along Queen Bess Ridge.

Surface exposures of bedding above 9-level strike northwesterly and dip southwesterly at varying angles, with frequent local reversals and contortions. The actual pattern of bedding-folds was deduced mainly from information gained through underground mapping.

Above 7-level beds are involved in a complex recumbent fold generally opening to the northeast. This structure lies at approximately the same horizon as the Silversmith and Ruth mine folds and is similar in general outline. In less complex form the structure is exposed above 3-level ~~within~~ of the Lone Bachelor Mine closely to the southeast.

Below Victor 7-level, bedding dips generally to the northeast except within the outer part of 9-level where southwesterly dips steepen to vertical attitudes through 10-level. As far as is known beds below 10-level roll under to flat northeasterly dips -- the whole forming a major drag-fold below lying closely below the Victor fold. – this combination fairly typical.

A system of northeasterly-striking, steeply-dipping joints transects mine formations. A large proportion of these are quartz - or calcite-filled, or with siderite, pyrite, and occasionally, ore minerals, close to the vein. The Victor vein is sub-parallel to the system of joints. The initial fracture appears to have formed through a concentration of displacive movements along certain continuous members of the joint system.

VEIN SYSTEM FIGS 6 &

Throughout the greater part of the mine the vein dips steeply southeast, with a refraction to near-vertical dips, or even northwesterly dips through the crestal sections of the mine fold.

Certain aspects of the vein structure appear closely related to specific panels of bedding encountered. Within bedding sections closely involved in the mine fold, and in westerly to vertically-dipping sections immediately above and below this structure, segments of the vein are typically straight filled-fracture structures, cutting squarely across bedding sections. ~~Typically~~, Vein fillings are composed of medium-to fine-grained galena and sphalerite with a gangue of siderite, quartz, calcite, and pyrite-singly or together. The filling may consist entirely of massive or banded ore sulfides, but usually includes variable amounts of gangue minerals. Minor parallel veins occur rather generally. However, multiple-vein or lode structures are apparently restricted to closely-folded and strongly-jointed bedding units lying between strong cross-faults.

Vein widths range from a few inches to ~~over six~~ eight feet of solid sulfides, with a general average of about 16 inches.

Within easterly-dipping bedding sections, the angle between vein and bedding is generally more acute -- locally amounting to only a few degrees. Vein patterns and fillings suggest that fracturing was accompanied by relatively larger shearing movements than are apparent within the favorable crestal areas. Some typical shear-vein characteristics within these sections are curved vein segments, branch fracturing and veining along convergent bedding planes and faults, and the presence of more abundant gouge and breccia fillings. Of the ore minerals, sphalerite is generally more prominent than galena, which is in reverse ratio to the usual proportion of ore sulfides. Siderite and pyrite are present in increasing amounts and, locally quartz becomes an important vein constituent. Wall-rock alteration-generally by moderate silicification-occurs more frequently within these lower sections than elsewhere.

Numerous bedding faults intersect the vein on strike and dip. Some minor fractures cause no apparent displacement, although the width and character of the vein filling may change across them. Other stronger cross-fractures or fault zones effect offsets ranging from a few inches to several feet within the central mine section. Evidence of the conjugate nature of vein and cross-fractures is illustrated by the frequent spreads of ore at intersections and the local deflections of the vein along some cross-fractures. The first-mentioned feature appears to have been due to the action of rather impermeable fault fillings in the path of the ore solutions. The impermeability of these fillings is occasionally demonstrated where dry raise headings break through flat-lying structures and into reservoirs of ground water in overlying beds.

Individual segments of the Victor ore body are bounded by stronger formational faults and pitch in accordance with them, tending to produce westerly pitches within the upper levels and easterly pitches through the lower.

WEST VICTOR MINE SECTION. FIG

GENERAL

This part of the mine is in a preliminary stage of exploration and development, so that only a few general details of the structural pattern are known. However, as lateral exploration on and below 7-level is fairly complete, some ideas concerning structures of the lower half of the section may be presented.

WORKINGS

Exploration drifts were driven on 9- and 7-levels and connected through the 959 raise. Development drifts were then driven from the 3950 stations of 959 raise and No. 3 winze.

GEOLOGY

Within the west section wall rocks are composed of silty to quartzitic argellites, with the better vein sections occurring within assemblages of rather soft blocky argillites. A few porphyry sills are present, becoming more frequent towards the main West porphyry body. These porphyry intrusions are generally associated with zones of strong cross-faulting.

The bedding section is moderately east-dipping, with local interuptions by flat or steep rolls. Occasional drag folds, over-turned down-dip, reflect a local adjustment to stresses produced by folding. These adjustments were accomplished through inter-bed creep or slip with westerly sections moving upward towards a major fold axis with respect to those lying immediately east. The general spread of mineralization within the section extends roughly from the 3880 fault zone on the east to the West fault zone.

More locally, commercial ore shoots occur at two sections, one lying to the west of and under the 3880 fault zone, and the other similarly situated with respect to the 958 fault zone. On both, the vein steepens as it crosses through a broad bedding flexure which has the shape of large open drag fold. This flexure, apparently centering at about the 3950 horizon, is formed by a local steepening of bedding dips between 7- and 9-levels. The structural feature which appear to have localized ore deposition is the combination of the bedding flexure and a blanketing cross-fault. The steepening of the vein was accompanied by the development of open spaces through normal hanging wall displacements. The fault apparently has had the effect of maintaining an open vein fracture and of restricting the spread of ore solutions to the vein between this structure and 9-level. Both ore shoots extend from 9- to 7-level with the greatest strike-length probably occurring near the 3950 horizon.

VEIN STRUCTURES AND MINERALIZATION

The general pattern of vein fractures differs across the section. Within the easterly segment adjacent to the 3880 fault zone, much of the vein appears similar to the filled fractures within crestal areas of structurally higher folds. The vein cuts squarely across bedding structures and walls are regular and sharply defined. The filling is typically one of massive, occasionally gneissic, ore sulfides with sphalerite more abundant than galena.

Along the westerly vein segment, between the 958- and West fault zones, the vein exhibits the pattern of fracturing usually associated with easterly-dipping, overturned bedding sections. A marked feature is the generally acute interplanar angle between the vein and bedding. This relationship has locally induced a branched vein pattern, in that frequent splits from the main structure swing off along bedding planes. These continue for only a short distance into the walls. A few of these locally appear stronger than the parent structure, and it is quite easy to drift off the main vein unless the pattern is quickly recognized. In some places this branching occurs at a cross fault giving an appearance of a left-hand displacement when the continuation lies directly across the fault or to the right.

In plan view, bent bedding-ends next to the vein appear related to a westerly component of hanging wall displacement. However, fault striae which generally plunge steeply eastward, together with evidence supplied by bedding offsets, show that vein fracturing was accompanied by a relative downward and eastward movement of the hanging wall.

Vein minerals in this west ore shoot are slightly crushed or broken by post-ore movements.

Sphalerite exceeds galena in the usual distribution. However, secondary fracturing along certain zincy sections apparently re-opened parts of the vein for a later stage of lead-mineralization. These galena shoots occur most frequently within closely cross-faulted vein segments.

To the west the Victor vein is known to extend as far as the West fault zone. On the 3950 sublevel it bends southward as it approaches the fault and probably merges with it completely beyond the end of the drift. As this junction is approached there is an accompanying decrease in vein-mineralization.

THE EAST VICTOR ORE BODY

The East Victor ore body to date has supplied most of the production from Violamac's property at New Denver. The extreme upper portion of this ore body constituted the original discovery on the Victor claim. From this point ore has been mined down dip to the 3950 Sub-level, over a vertical range of 700 ft. Along the strike the vein has been mined over 1400 feet.

THE HOST ROCKS.

The ore lies within the Victor lode where it crosses a series of thin to moderately thick (1/8" to 1') bedded argillites and quartzites. The sediments trend northwesterly normal to the lode and they are folded into what is locally called the Victor recumbent fold. This fold is open to the northeast and its crestal plane lies between 7 level and the 4150 sub-level. The main ore sections lie in and close to this crest.

The host rocks where they can be seen unaltered are similar in appearance across the entire section. Where folding is intense, however, the sediments are changed physically. Here close spaced bedding slips and cross fractures are developed and these are filled with a heavy graphitic gouge. The degree of this softening is, in part, directly proportional to the intensity of the folding. As folding, particularly in the East Victor panel, is extensive the original character of the associated sediments cannot be determined. Because of this a lithological subdivision of the sediments is impossible.

However, there are marked variations in the fold pattern. In all, four distinct structural divisions are outlined by the present mine workings with each of these occurring within a certain panel of sediments. The individual panels involve sediments several hundreds of feet thick and each is bounded by zones of intense interbed slippage. These structural units are shown on figure "5" and they are lettered east to west A, B, C & D.

The separate development of structures within local sections of the sedimentary series was probably caused by an initial variation in the competency of these rocks. While unequal response to stress during folding was possibly another contributing factor.

~~Peyshysitic~~ Porphyritic sills and dykes occur throughout the mine and these are particularly common in the eastern part of the workings. These intrusions are almost entirely sill-like although to conform with local contortions in the sediments they may have extremely irregular outlines. Sills are from a fraction of an inch up to several tens of feet wide. It can be seen in the longitudinal section (figure 5) that they seldom traverse the entire vertical section and they appear as local lenses and swells. In general the number and the width of the intrusions increase toward the crest of the Victor fold with local thickenings forming at the crest of subsidiary drag folds.

AGE RELATIONSHIP

From the relationship between the porphyries and the other structural features it is inferred that the following hypothetical sequence of events occurred.

(1) Folding ended. At this point the fold structures together with the consequential formational faults were formed and the development of the lodes had started.

(2) Porphyries intruded. These largely paralleled or formed in the formational faults. Where they cross the lodes their shapes often change; that is the hanging and footwall traces do not match. From this it is evident that both elements of the conjugate fault system were developed prior to the intrusions and that the formational faults had developed low confining pressure and were therefore receptive to them. On the other hand intrusions along the lodes are rare suggesting that they were in compression at this time.

(3) Further faulting. Faulting along the conjagate faults continued with a further development of the lodes. The porphyry intrusions probably occurred early in a period of relaxation of the fold forming stresses. Faulting continued throughout this period but in response to changing stresses. At the culmination of this re-adjustment veins were formed and these favoured the lodes which had now become the tensional member of the conjugate fault system.

FOLD STRUCTURE:

The Victor recumbent fold as mentioned previously, is the major fold structure in the mine area and its form is outlined on figure 5. Here also can be seen the local variations which occur in the A, B, C & D sections.

The simplest outline of the Victor fold occurs in the "B" panel. The crest is well marked and lies about 40 feet above 7 level. The upper limb between three and four levels dips 20 to 30 degrees to the west and the lower limb at 7 level is dipping 45 degrees to the east. Drag folding is relatively minor with most of the dragging confined to the crest zone.

In panel "A" the fold pattern is seen in detail only above the Victor crest in what is the equivalent to the west dipping beds seen in the "B" section. The "A" structure consists entirely of close packed recumbent, isoclinal drag folds. On the lower and eastern limits interbed faulting and crest rupturing is so marked that the detail of the minor folding is almost entirely destroyed. Further to the west the faulting is not so extreme and the outlines of several large drag folds can be seen. Of these the folds open to the east are broader than those that are open to the west. The crestal planes of the drags are recumbent in the central part of the section and these roll over to moderate west dips as they approach their contact with the "B" block. This rotation of the drag folds is a feature of the strong interbed movement between the two panels.

In Section "C" the main fold crest is much broader than that seen in section "B" and there is very little drag folding in the region of the axial plane. There is, however, a large dragfold developed above the Victor crest within the west dipping beds above 5 level. The axial plane dips about 15° to the southwest, While only the lower half of this drag is seen it is evident that the entire C panel is involved and that the wave length will exceed 100 feet.

Below the Victor crest 9 level encountered a section of west dipping beds in what is generally a horizon of east dips. These west dips occur, in part, on the downward projection of the "C" sediments and they suggest that drag folding in the "C" block is prevalent in the lower as well as the upper limb of the main fold.

The "C" block is bounded on the east and west by zones of bedding faults. This block is also crossed by the east dipping 41 P fault. This is an anomalous structure because it is a thrust fault and because it crosses local bedding panels at right angles. The fault while it has a small actual displacement it is the center of zone of intense dragging.

The 41 P fault is a formational fault which originated in the lower east dipping limb of the Victor fold. It was strong enough that it carried up through the fold, cross-cutting west dip beds. At five level it flattens as it comes into a second panel of east dip beds and here where last seen it has become fully bedded.

The bedding detail within the D panel is to be seen only between 7 and 5 levels and in that section of those sediments adjacent to the C Block. At the Victor fold crest these beds form a broad arc as they roll from steep east dips on 7 level into steep west dips on the 4150 sub-level. As they approach 5 level the beds first roll back to steep east dips and then enter into a series of drag folds. In the extreme western part of the section the axial planes of the drag folds rake gently to the east but as the drags approach the 41 P fault they are rotated so that the axial planes have flat west dips reflecting the upthrust along this fault.

The general bedding dips at first suggest that the section above the 4150 sub level has moderate to steeply easterly dips. However, a sill in the western part of the section shows that there at least the average dip is nearly vertical.

The drag folded section in the "D" Panel lies on the westward projection.of the large drag fold seen in the "C" Panel and the two appear to be related.

The individual structural sections show that there is a sudden change of shape in the Victor fold within the mine area. The relatively tight crest which occurs in the D section opens quickly into a broad flexure as it progresses through the C & D blocks. The drag pattern verifies this.

In the A & B blocks there is typical "similar" folding. That is folding in which a section of beds are appreciably "thickened" when they are in the crest zone. The thickening results largely through the transport of material from the limbs pf the fold to the crest by the action of drag folding: In this particular case the thickening is augmented by dyke and sill intrusions.

In sections C and D there is little crestal thickening while from the location of drag folds it is evident that the fold limbs are thickened instead. This type of redistribution of material is to be expected to be associated with a sudden broadening of the fold. If this broadening were to continue to the west the Victor fold would die out. However, such a sudden ending of the structure would contradict the fact that the Victor fold is a persistent structure which is recognized in the Sandon area 2 miles to the south east. It is also the member of a series of folds which persist south west as far as the Standard Mine. (Reference Structural sections Bull. 23 B.C. Dept. of Mines)

<u>FAULT STRUCTURES:</u>

The bedding faults together with subparallel bedding faults originated directly from the action of the folding and these are termed the formational faults. The formational faults together with the lodes form a set of conjugate faults.

The formational faults tend to be bedded. The general exceptions occur with faults which strike with the beds but down slip migrate across them at acute angles. For example below 7 level a common feature is easterly dipping faults which dip slight flatter than do the beds and above 3-level there is a set of moderately steep west dipping faults which cross down through flat westerly dipping beds. The formational faults, in areas of intense drag folding, may be flat. These form both in the bedding planes and along the axial planes of ruptured drag folds. The Victor lode forms the second member of the conjugate fault system. In the East Victor it strikes north easterly crossing the trend of the sediments at nearly right angles. The lode generally is a single break which dips steeply to the south west. However, it is a weak structure crossing through a complex environment and exceptions to this general form are frequent.

Along the lode the hanging wall block has moved down with horizontal shift to the east. The total movement and ~~to~~ the ratio of the dip slip to the strike slip varies with local conditions. The displacement is never greater than 15' with the average being considerably less than this. Where parallel veins occur this movement is spread amongst the various strands. The lode, particularly where multiple strands exist, often appears as a joint or as a series of parallel joints.

The lode is offset on strike and dip by past ore movement along all the major members of the formational faults. The horizontal displacement will vary from a fraction of an inch upward to 80 feet. In general offsets on all dipping faults are right hand and all offsets on the flat faults carry the upper segment into the foot wall. That is the upper block moves north west if the vein dips south east or it moves to the south east if the vein dips to the north west. The magnitude of the offsets tend to increase away from the fold crest with the greatest offsets occuring along the extreme upper eastern section of the Victor ore body. The pattern of dislocation indicates a post ore shift of the sediments in a direction approximately parallel to the axis of the Victor fold with beds to the east moving southeast in relation to those to the west. The variation in magnitude indicates some rotation occurred.

Complications in this general offset patterns are indicated because left hand displacements occur frequently in the east dipping beds. These represent offsets arising from normal faulting. This type of dislocation would be the natural one that would arise during the relaxation of stresses after the folding had ceased. It is thought that, in the east dipping beds, left hand offsetting was a general occurrence in the immediate post ore stage and that those remaining are remnants left after most were cancelled or changed to right hand offsets during the later lateral shift described above.

That opposing offsets have occurred along the same faults is also suggested by the fact vein drag occasionally goes both to the right and to the left within an offsetting fault.

<u>LODE DETAIL</u>:

The productive section of the East Victor lode is framed on the lower and eastern sides by a zone of strong flat and flat westerly dipping faults. Their relation to the other structures is not clear. The lode spreads out into these faults ~~and~~ eventually loses its identity.

To the west throughout the East Victor section the lode shows peculiarities in form other than those imposed on it by post ore faulting. In general it tends to take on a uniform ~~xxx~~ dip and strike. This uniformity is upset when the lode follows sub parallel joints, or is warped along local bedding structures, or is refracted by compentent panels of the host rocks. When this occurs the lode will adjust back along the formational faults and revert to its original course.

The variations in lode form reflect the influence of the local structures and patterns are developed which are peculiar to the individual structural blocks.

In section A the vein heavily faulted along close spaced formational faults.(see cross sections 24 to 28) Offsetting follows the right hand rule with horizontal displacements of upward to 50 feet occurring in the east end of 5 level.

As seen in the cross sections the lode takes on a unique shape which occurs at 5 level elevation. Above the level the vein dips steeply to the south east and at the level it rolls flat for about 35 feet and then it steepens to a moderate dip which is again to the south east.

A post ore shift occurs along a horizontal plane which coincides with the flat roll. This readjustment tends to balance out part of the horizontal offset. The flat portion of the vein in the eastern part of the block is dragged forming assymetric folds which indicate a post ore movement with the upper block moving to the south east. In the west adjacent to the B block the roll over section is no longer flat but it plunges to the west following formational faults. However, the readjustment with the hanging wall moving to the south east still follows the horizontal plane and in this section it takes place along a flat fault. This displacement is anomalous as it does not agree with the offset pattern usually associated with flat faults. It appears to be a feature which is related entirely to the flat roll in the lode.

The original vein structure illustrates the form a weak lode can take while passing through a complex structural environment. In section 26 the lode passes through two minor fold crests. The upper one lies above 5 level and it is open to the east. ~~This~~ A segment of the lode apparently was refracted in going through the crestal area from its normal moderate south easterly dip to a much steeper south easterly dip. The lower fold crest is open to the west and the segment of the lode through it assumed a moderate south easterly dip. The vein filled both these segments and also a weak flat formational fault through which these two were connected.

The lode passes into the "B" block through a series of west dipping formational faults with a 5 to 10 foot right hand displacement. In this panel the lode is relatively simple.(see cross sections 28 to 36) It has been subjected to only moderate right hand offsetting. Some fraying of the lode occurs where wedges of vein matter are carried a few feet into the walls along bedding planes and small gash fractures. Also the lode which generally is a single strand splits at the eastern limits of the panel into several diverging veins. Of these only the hanging wall vein carries appreciable ore. In cross section the vein displays a regular south easterly dip ~~immediately~~. except immediately below five level where it takes a local roll over to north west dips. (See cross section 30).

To the west the lode passes through a zone of strong formational faulting into the C block. Here the lode is best described as a zone of parallel and sub parallel joints. (See cross sections 36 & 38). Of these the hanging wall strand has been productive from 7 level up to 4 level.

A second split called the foot wall vein became productive 50 feet below 5 level and its vertical extent above 5 level is not yet known. In the same section as the foot wall one or more of the intermediate joints may also carry ore. This ore is usually confined to a 15 to 25 width of sediments with the ore being fairly persistent up the dip of the beds but cutting off sharpely against minor bedding slips along the strike.

In cross section the multiple veins are nearly joined 50 feet below 5 level and these diverge going up dip . The foot wall vein dips steeply to the south east and the hanging wall vein rolls over and dips to the north west.

The workings in the west end of 3 level and in 2 level also lie in the C Panel and display much the same pattern that was seen below 5 level. (See sections 28 & 30) The vein still consists of a series of parallel joints. However, the total vein filling has decreased. The hanging wall vein again changes to northwest dips as it proceeds higher into the structure.

In the C panel both right and left hand offsets of the lode are common. These are often ambiguous indicating the conjugate relationship between the lodes and the offsetting faults. In an instance in the west end of 5 level the foot wall vein passes through a fault with little dislocation while the hanging wall vein was offset 35 feet to the right along the same fault.

A series of joints nearly but not quite parallel to the general lode trend apparently existed in the C Block prior to the lode formation. On 5 level (see figure 6) the lode is seen to be spread into these joints and deflected along them. In the west it readjusts to its normal course by taking an 80 foot left hand offset along the 41 P fault. On 7 level the lode passes through the same fault with no appreciable offset.

The lode in the D Block is a more regular structure and it maintains a regular dip and strike. Right hand offsets are common in the western stope limits and normal flat faulting occurs in the drag folded area.

<u>ORE DISTRIBUTION:</u>

The lode in the East Victor is almost entirely vein filled. Gauge along the lode is rare and brecciation of the wall rock occurs only in the lower limites of the ore section. The average width of the vein in the stoped areas is less than 16 inches, however, the width varies from a fraction of an inch up to over 8 feet.

Within the vein the metal content varies. In general galena is the predominant filling in the wider sections and sphalerite is the predominant filling in the narrower sections. The ~~gague~~ gangue minerals, siderite, quartz, ~~si~~ calcite and pyrite are present in all portions of the vein and they may fill the entire vein particularly in the narrowest sections. There is one exception in the lower eastern part of the ore body siderite veins up to 7 feet wide accur as sheathings around lenses of ore.

The silver occurs with the galena. The value of the ore then, as a rule, increases as the width of the vein increases.

The East Victor ore shoot can be described as a series of high grade x swells within a narrower relatively low grade vein.

The variation of the metal content is probably controlled by the vein's structure, (Hedley (Bull. 23 B. C. Dept. of Mines) suggests that the lead deposition favoured the more open structures while the tighter parts of the lodes do not. These instead were filled with the more mobile, less selective zinc and gangue minerals. There is a suggestion in the Victor Mine that this pattern of mineral distribution was supplemented, by a period of lead mineralization which came shortly after an earlier zinc, lead gangue deposition. This lead found access only in the most open parts of the structure and here it was deposited replacing much of the earlier deposits.

ORE CONTROLLS:

Localization of ore in the East Victor section occurred at the coincidence of:

(1) The Victor lode where it cross cuts the sediments nearly at xxxxxx right angles.

(2) A series of thin to moderately thick bedded argillites and quartzites.

(3) The crest of the Victor recumbent fold.

The largest part of the ore is centralized along the crest of the fold with the ore, in general, progressing furthest into the west dipping limb.

Within the ore zone high grade shoots are localized by one or more of the following structures:

(1) Formational faults. High grade vein swells lie under and over various members of the formational faults. Probably these occur as a result of increased lode tension on one side of the cross faults. Fault damming may be an associated control.

(2) Drag fold. The ore sections in general are wider where the lode crosses the crests of the larger drag folds.

(3) Changes in dip. Where the vein varies sharpely in dip it may widen either above or below the point of flexure.

(4) Rotation panels. In the A block the vein widens where it xxxxxx crosses small bedding panels which rotated from the general flat dips into west dips.

(5) Close jointing. In the C Block wide sections of ore are formed across closely spaced joints. This width is restricted to narrow bands of sediments.