

WESTERN EXPLORATION COMPANY, LTD

MONARCH TUNNEL and HECLA 5000 LEVEL  
May 1955

Refer to Mr. M.C. Robinson's Questions and Notes of  
July 1954

(1) PORTAL SECTION TO STA. 7.

- (a) The bedding in D.H. A 44 seems to average about ten degrees flatter than the corresponding bedding in the crosscut.

In D.H. A 57 the bedding, assuming that the strike is the same, appears to be some 20° flatter than in the crosscut.

I have not received a table or diagram from which the attitudes of bedding in D. Holes of varying dip could be compared with those in the tunnels.

I finally dug a method of obtaining the required data out of a Descriptive Geometry text-book, but it is too involved and slow to use much.

- (b) Note additional data on the map herewith.
- (c) There seems to be a reasonably good check between the portal-crosscut and the surface except near the portal, where there has evidently been more contortion on the surface than in the tunnel. This is also true of the Kelowna mapping.

(2) Sta. M7 to Old Face

- (a) E W Section- conflicting dips. Bedding attitude between these is approximately vertical, and there is apparently a small tight anticline. The axis strike is about N 45° E; the pitch is apparently quite flat. This anticline is also indicated on the Kelowna map of the tunnel.

(3) Sta. M7 - M10

- (a) Lack of any NW dip is undoubtedly due to faulting along the lode.
- (b) No attitudes are discernable in #1 crosscut. There are vague traces of striations on the H.W. in #1 crosscut which trend 45° downward to the SE.

No evidence was noted bearing on the direction of movement along the lode in #2 crosscut hanging wall. On, or near the footwall, there are faint vertical striations, probably too weak to be of much importance.

(4) M10 - M16 & (6) M10 - M16

The "major swing" in the lode here, it seems reasonable to assume, is caused by the swing in the bedding strike. Bedding attitudes on the surface are not obtainable from the Monarch gulch to four or five hundred feet westward, on account of no outcrops.

Up to, and including, #3 crosscut sharp or obtuse angular relations do not seem to affect the mineralization much. However there is more mineralization in the portal crosscut, and in a drill hole east of it, than in #1, #2 or #3 crosscuts, or, in other words, there is more mineralization in this section where the strike of bedding and lode are nearly parallel. However in the mineralized area west of #5 crosscut the bedding strikes are at obtuse angles to the lode, except close to the vein-shear where they are bent toward parallelism with the lode.

(5) M16 - M18 and #3 crosscut

(a) and (b) I spent nearly a week breaking rock and looking for rock-changes to definitely determine the bedding attitudes and rarely found clear cut changes in the grain or color of the rock. Those I found usually required the use of some imagination to read them. However, I believe that from Sta. M15 to M18 and in the #3 crosscut the revised attitudes are essentially correct. (I have yet to find in this section as clear bedding as you (Robinson) found in almost the first rock broken in #1 HW crosscut. In these notes I have called this "grain-bedding.")

On the map bedding attitudes marked "G", "F", "W" or "T" indicate that "grain-bedding" found was Good, Fair, Weak or Trace; when no letter is shown no grain was found.

In #3 crosscut I checked the original attitudes and added a few more. Also I have checked attitudes between Sta. M17 and M18 and find them approximately correct. This indicates a small syncline whose axis is approximately along the weak fracture dipping NE just NE of Sta. 17 and having a pitch to the SE.

The more or less E-W faults dipping north appear to change the bedding attitudes slightly between Stas. M15 and M16. Occasionally I found weak "grain" bedding at an obtuse angle to the majority which probably represents a local crumple.

There is no evidence in #3 crosscut bearing on the direction of movement along the lode unless it be the weak swing of bedding from E-W to NW-SE near the lode, indicating movement of the HW westward.

(8) M18 - 20

At Sta. M19 there is a small nearly E&W and N dipping fault close to a change in the bedding attitudes which may be responsible for the change although the evidence is somewhat indefinite.

(9) #4 Crosscut

I spent a lot of time in this crosscut. "Grain" bedding or any other is obscure; grain is rarely plain enough to read without using some "imagination." I am quite sure, however, of the swing of attitudes from NE to NW but not so sure of the swing back to the NE though I believe it is there, making an "S"; it seems strongly indicated by "Fair" grain close to the shear E.W.

(10) M20 - 22

The re-check of the bedding attitudes has practically eliminated the formerly conflicting strikes at this point.

It seems quite probable that the swing in the lode is related to the change in strike.

At, and west of #5 crosscut, the general strike of the bedding seems to make an obtuse angle with the course of the lode, although close to the lode the bedding strike has been dragged around to approximately parallel to the lode. Between #5 and #3 crosscuts the angle gradually diminishes until at #3 it is approximately parallel to the lode. Thence to the eastward the lode in general follows the curve of the bedding to the Portal crosscut, although in detail it must cut across ~~the~~ a few beds occasionally.

I do not think that this swing of the bedding nor the change in strike of the lode can be picked upon the surface on account of insufficient data due to few outcrops. Also #5 crosscut is a long distance, 1100 feet, on the dip of the vein from the outcrop and 600 feet vertically below the surface directly above it. Also what attitudes of bedding show in the vicinity of the vein on the surface bear little similarity to the bedding in the tunnel.

It is probable that the swing in the strike of the bedding is the cause of the sharp turn in the strike of the vein-shear, and that in turn is largely responsible for the locus of the ore.

From #4 crosscut to the end of the tunnel the bedding strikes make obtuse angles with the lode, except where dragged around more or less parallel to the lode by the movement along it. West of #5 crosscut there is a very noticeable increase in the extent and intensity of rock brecciation and in the amount of quartz, calcite and metallic minerals as compared to the section east of #5.

(11) #1 H.W. Crosscut

A lot of new bedding attitudes were taken here and unmistakable "grain" was more common than in any other working; it was however, difficult in some cases to get an accurate dip and strike from it. The two bedding attitudes marked "T" about 15 feet south of Sta. M38 are questionable.

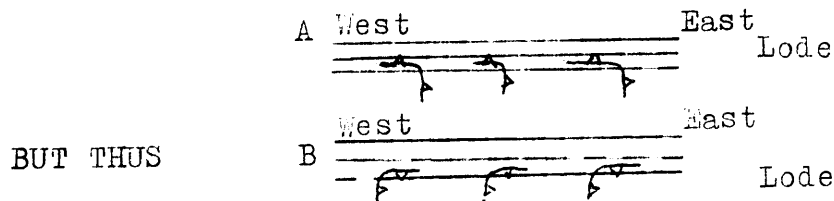
Your "impression" of swings in the bedding at the north dipping quartz vein and at the face are entirely correct.

Such swings are not in evidence on the surface, so far as mapped, and I believe there is little chance of finding them.

I kept in mind your suggestion to map E.N.E. trending joints and faults in the tunnel similar to the one in the crosscut (#1 HW crosscut) but found few with the above strike and a north dip, either with or without quartz. There are a few of that strike and a southerly dip, some of them with quartz and occasionally traces of zinc. They seem to be mostly in a mineralized area, but not all of them.

(12) M38 - M31

There is no doubt in my mind that the bedding in this section is dragged against the lode, but the evidence mostly indicates that it has been dragged in the opposite direction to the one expected. In other words not



The bedding between Sta. M39 and M25 is indeterminate; the variations could be due to local convolutions

or to the occasional difficulty in getting accurate attitudes from a small face of "grain", especially in broken ground.

From Sta. M25 to #6A crosscut the bedding leans slightly toward "A" type (above) but not definitely so.

From #6A crosscut to Sta. M20 the bedding attitudes seem to slightly favor "B" type. From Sta. M28 to M29, where the hanging wall of the lode is lost, the bedding definitely favors "B". From Sta. M29 to M31 the drift is in the lode-shear and no bedding was found. This section is so crushed and broken, that it is difficult to obtain a fresh face rock of more than a half square inch in area.

In the vicinity of this area on the surface outcrops are widely scattered, with widely varying strikes and mostly westerly dips; there are no signs of a similar structure to that in the tunnel and there is little or no suggestion of what the structure may be.

(13) M30 - 31

No "grain" or other indications of bedding were found in this area. There appears to be a fairly wide and strong shear-zone, striking about S 80° E and dipping around 70° south which joins the main vein-shear between Stas. M42 and M31. I doubt if the bedding has much to do with the observed shear strands.

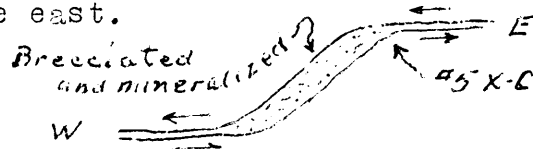
The curved east dipping fractures just west of Sta. M32 have the general appearance of dragged bedding, but I was unable to find any "grain." At the south side of the drift their attitudes check well with those in #2 H.W. crosscut, but not with bedding attitudes to the westward. I am inclined to think they are bedding planes along which there has been some slipping.

GENERAL:

The most important result of the checking of the Monarch Tunnel geology is that it strongly suggests that the horizontal component of the movement along the lode-shear is in the opposite direction to that previously supposed; more specifically that the hanging wall of the lode has moved westward as compared to the footwall. The data, pro and con, is listed below.

Data indicating Eastward Movement of Hanging Wall.

1. The wide brecciated and partially mineralized area west of the sharp bend in the vein, between #4 and #5 crosscuts, as compared to the narrow, tight, gougy area to the east.



2. In #1 F.W. crosscut - A vague groove in the H.W. pitching to the south east at  $45^{\circ}$ .
3. In #2 F.W. crosscut - Faint vertical striations on the smooth F.W. slip.
4. In #5 F.W. crosscut - Faint striations on the H.W. pitching  $55^{\circ}$  down to the southeast.
5. In #5C F.W. crosscut - Faint striations on the H.W. pitching  $60^{\circ}$  down to the southeast. All of the above are too vague and weak to be dependable except #1.
6. The usual movement in the District on similarly striking faults is reported to be the H.W. moves down and east with respect to the F.W.

Data indicating Westward Movement of Hanging Wall.

1. The strongest argument for this is the well authenticated fact that bedding attitudes in #1 and #2 H.W. crosscuts are respectively approximately  $N 20^{\circ} W$  (except where bent by faults) and  $N$  and  $S$ , both with East dips. At and near the lode hanging wall the bedding strikes are more or less parallel to the shear and in all cases dip southerly. In order to check, it must necessarily follow that the  $N-S$  beds have been dragged around to the eastward by a westward movement of the hanging wall as in "B" of (12) M38 -51. These attitudes show quite definitely in the central and western parts of the tunnel where bedding a short distance from the lode-shear makes an obtuse angle with the shear, much less definitely in the eastern section where the bedding approaches parallelism with the shear.
2. In #4 crosscut two fairly good "grain" bedding planes show a swing to the east near the shear; no bedding could be found on the opposite side of the crosscut.

3. In the drift between Stas. 28 and 29 there are several bedding planes that show a sharp swing to the eastward in strike from north and south to nearly east and west.
4. At Sta. M32 fractures (?) which resemble bedding planes swing eastward from a nearly N. and S. strike.

To sum up, it seems very probable that some part of the movement along the shear has been of the hanging wall westward.

The lode-shear east of #5 crosscut, where the sharpest change in strike occurs, is comparatively narrow, has a strong gouge and little or no quartz or calcite and no metallic mineralization. West of #5 crosscut the lode shear is wider, more brecciated, has a less concentrated gouge, considerable quartz and calcite with appreciable amounts of lead, zinc and silver, which, in some parts below the level, increases to the point of being good ore. This, in conjunction with the bent bedding-strike, could conceivably be taken to indicate first a westerly movement of the hanging wall which bent the bedding planes eastward, followed by an easterly movement of the H.W. along the shear, thereby opening a breccia zone for mineralization.

#### Notes on Hecla 5000 level.

This level, 315 feet lower than the Monarch Tunnel, starts from the end of Mammoth #7 West drift. Just east of Sta. 736, it encountered a shear which is apparently a continuation across the vein of a shear in the footwall of the old drift which shows in several diamond drill holes. It was presumed that this would join the main vein-shear but it evidently cuts through it. Since it is very similar in appearance to the main vein it was followed for some 300 feet through a faulted area of Argillite and porphyry. From Sta. 739 to 742-X the diagonal crosscut passes through moderately thin bedded Argillites with occasional intercalated thin beds of limestone. The bedding attitudes are in general approximately the same as those in the portal crosscut of the Monarch tunnel.

The main vein was cut at Sta. 742-X and exposed a kidney of fair ore. Bedding close to the vein appears to be bent to the right but the data are somewhat vague.

Several beds of impure limestone lie midway between #1 and #2 crosscuts.



A small anticline occurs at #2 crosscut followed by a syncline, and a second anticline, a little east of #3 crosscut. A second syncline is at 130 feet west of #3 crosscut.

Bedding strikes from #1 F.W. crosscut to Sta. 758 are at obtuse angles to the vein, with very few strictly local exceptions.

There is a little definite evidence, anywhere in the Hecla level, of bedding bent and dragged to the eastward near the H.W. of the vein, such as there is on the Monarch level. What little evidence there is consists of two not entirely certain planes at #1 F.W. crosscut and bedding which is somewhat bent eastward, but only at one to two feet from the H.W. of the vein. (See #2 crosscut, and near Stations 750 and 752 and at #4 crosscut.)

On this level bedding attitudes are mostly far plainer and clear cut than on the Monarch level; the beds are generally thinner and "grain" is more plentiful. However, west of the porphyry near Sta. 757 in soft, black, "dead" Argillite, bedding planes are obscure and no "grain" was found. So far as I can recall, I have never found rock like this elsewhere on the property.

East of midway between Stas. 744 and 745 the formation is mostly hard Argillite or Argillaceous-quartzite with occasional beds of limestone. West of that point the rocks are predominantly rather soft Argillite with almost no quartzite such as is common on the Monarch level.

There is more difference than similarity between the two levels.

At and east of Sta. 750 the vein on the two levels is nearly parallel and dips 60° to 65°. At a few feet west of Sta. 750 the sharpest curve in the vein occurs and thence to the face at Sta. 758 (May 1st face) the vein is much flatter as shown in the following table:

<u>Sta.</u>	<u>Distance</u>	<u>Dip</u>	<u>Sta.</u>	<u>Distance</u>	<u>Dip</u>
748		63°	750+30 ft.		58°
	160			220	
750		59½°	752		48°
	40			100	
750+30 ft.		58°	755		45½°
				200	
			758		43°

The bend in the vein therefore, plunges 41° S 45° to 50° east from the Monarch level to the Hecla level.

To date there is little to indicate whether <sup>or not</sup> the ore body found below the Monarch level in drill holes is the same body as that opened at the present end of the Hecla drift. If they are parts of the same orebody it would have a rather flat rake to the south-south-west.

The question of the relative movement along the shear of the hanging wall relative to the footwall has not been determined. Contradictory data which are plain to be seen could apparently only be reconciled by assuming that movement along the shear had, at some stage, reversed the direction of its horizontal components of movement.

There are strong indications that there have been at least two stages of fracturing and mineralization. The first and strongest brecciation was healed by calcite, with little quartz and rare traces of zinc. Later, the healed breccia was again broken and minor quartz and calcite with lead and zinc were deposited, often in open cavities in banded forms or in kidneys wherever the mineralization could penetrate.

It seems entirely possible that one of these movements might have reversed the movement of the other.

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May 1, 1955