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REPORT ON VISIT TO THE GRUM JOINT VENTURE FOR KERR ADDISON MINES LIMITED

March 4, 1976

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Objectives

The objectives of the visit were to examine the headings which were driven from the decline and to suggest methods which could be used to reduce the overbreak and to improve the stability of some of the openings.

The comments made below summarize views expressed by the writer during his brief visit to the property February 24-27, 1976.

Geology

The geology of the region is very complex and some authors have described many structural overprints, the main ones being the original bedding and its folding, the later foliation and some evidence of a later crosscutting mineralization.

The foliation known locally as F2 is the most prominent structural feature because it describes the direction of greatest weakness in the wall rocks. With the presence of water either as a flow source or merely as seepage, the rock mass strength, in many cases, approaches zero.

General Observations

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1. The F2 Foliation

The regional strike of the F2 foliation is NE-SW and it dips southerly at a low angle but it is locally warped both in strike and dip. These variations appear to be due to several factors, some prominent east northeasterly trending faults with a left hand separation, warps caused by variations in the competency of the foliated rock mass and by "gently" regional cross-folding of the bedding.

2. The Water Content in the Rocks

Little is known about the water content in the rock mass other than that much appears to be related to local perched water, which is eventually drained. The present thoughts of the people at the mine are that most water of this type is encountered in the vicinity of the more competent rock contacts such as near more massive sulphide bodies. However, it may also be related to the gentle cross-folding of the original bedding.

The presence of water adversely affects the strength of the wall rocks and also results in poor bonding between shotcrete and the wall rocks. If it can be drained, both these factors can be overcome. However, at present, there is no method available by which the perched water could be drained off before it impairs the strength of the wall rocks.

3. The More Prominent Joints

There are several patterns of fairly prominent joints (those with exposed lengths exceeding 8 feet). These frequently parallel the

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more prominent faults or strike obliquely to them. They tend to occur in areas of F2 warping and could possibly be adjustment joints. However, they should be mapped because their line of intersection, if unfavourably oriented, could cause the fall of larger volumes of ground.

4. The Insipient Jointing

The entire succession is cut by numerous hairline like "planes" of weakness which tend to strike both parallel to the strike of the F2 foliation and perpendicular to its dip. Additional planes were also noted which were oriented normal to these. The joint spacing of these somewhat discontinuous joints is between 10 and 20 centimeters.

In the areas where the F2 foliation is convex towards the hanging wall, these insipient joints would be in a relaxed state in the rock mass and thus would be prone to slough. In some cases, damp areas in the walls and back where the above mentioned conditions existed, resulted in the development of an excessively high back and/or irregular wall.

Recommendations

A. Related to Driving the Headings

1. Drilling and Blasting

It is my opinion that the powder factor is too high for the average ground conditions. Since it is difficult to remedy this without trial and because the ground conditions vary from round to round and from day to day, the following suggestions are made:

(a) Increase the number of delays between the shots fired in the round after the cut has been squared off.

(b) Try to toe in the holes of the square; i.e., those outlined in red on the attached print. See Fig. 1.

(c) Stem these holes with a spacer and wedge a 15 cm. split wooden plug in order to obtain more benefit from the gas pressure wave (heave factor) of the explosive. With average ground or harder ground, only one spacer and plug may be adequate whereas it may be found that, in the strongly foliated ground, two plugs should be used for 9 foot rounds. I think that stemming can be done at all times but, in your kind of ground which varies so rapidly , it would be wiser to stem just the holes which are longer than 6 feet. In the case of 9-13 foot holes, two plugs per hole should be experimented with. See Fig. 2.

(d) The perimeter holes above shoulder height should all be stemmed with two plugs separated by a spacer. Furthermore, it would be advantageous to double the delay between holes as marked on the sketch. See Fig. 1.

(e) In the event that the F2 foliation dips adversely to the wall of the heading, cross-breaking or splitting across the foliation will be facilitated by drilling blank holes 6-9 inches on either side of the perimeter holes which penetrate the foliation. This will have the effect of initiating the propagation of a pre-split parallel to the wall of the opening and thereby will decrease the blast weakening of the foliated rock face.

2. <u>Bolting</u>

In the phylitic ground when the normal rock bolt is tightened, the stress applied to the phylitic walls at the toe anchor may cause rock mass flow or slippage resulting in the loss of cohesion between toe and collar. It is therefore recommended that this form of bolting be discontinued and that grouted rebar bolts be used instead.

In placing the bolts, care should be taken that each bolt increases the coefficient of friction along all visible planes of weakness. Thus all bolts should be driven at angles greater than 25° to such planes or lines of weakness. In the Grum area, the objective should be to tie at least 6-8 steeply dipping joints together with each rock lock bolt. When the bolt has set, the strap could be bolted on and would hold the surface area together providing greater stability. This results in a tightening of the ground during relaxation because the creep movement or expansion of the wall will generally not be linear but will be dictated by the geometry of the planes of weakness. In many cases, the wall bolts have been placed parallel or nearly parallel to the F2 foliation and care should be taken to ensure that the bolts cut across the foliation at at least 25°. The bolting jumbo is ideally suited for early bolting of the back especially if the holes need not be normal to the face.

I have spoken to the people of Asbestos Corporation and they claim that, in their peridotite ground, they had best success with rebar bolts grouted with a mixture of Fondu cement and No 4T fibre. They used a mixture of 2 parts cement to 1 part fibre, mixed up enough into a soupy consistency to fill the holes to be rebarred. They then inserted the rebar bolts into the holes together with a bleeder tube, plugged the collar and pumped the cement mixture into the hole with a homemade type of plunger pump until they had filled each hole. The cement was allowed to set for 24 hours before the bolt was tensioned.

The Asbestos people feel that, for your purposes, the No. 4T fibre at $20 per 100 lbs. would be too expensive and suggest No. 5D or 5K fibre or any other off grade material which could be obtained locally. They base their comments on the results of a test using 1000 bolts of all types in which they found that the cement-fibre mixture was the best for their purposes. Unfortunately, this material was never written up, so I can only pass on to you their verbal comments.

Shotcreting

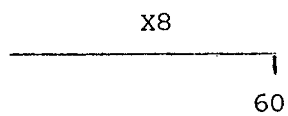
In damp or wet areas, where poor ground conditions are encountered, shotcreting is the only way to preserve the opening. In such cases, it is necessary to apply several layers of shotcrete to form a lining capable of containing the wall rocks. Although it is very expensive, this method cannot be avoided at this stage. However, I feel that diligent observation and mapping of variations in the trend of the F2 foliation as well as a better understanding of the variation in the wall rocks will lead to the possibility of drying out these damp areas and thus of reducing the number of shotcrete applications.

Mapping

The mapping program being carried out is commendable and, in broad terms, indicates all the salient features of the geology.

I have suggested to the Senior Geologist that he amplify his program somewhat to include the following aspects which I am sure will prove well worth the additional trouble.

(1) Map the insipient joint patterns by noting their strike, dip and frequency in the following way -



where X8 means 8/meter.

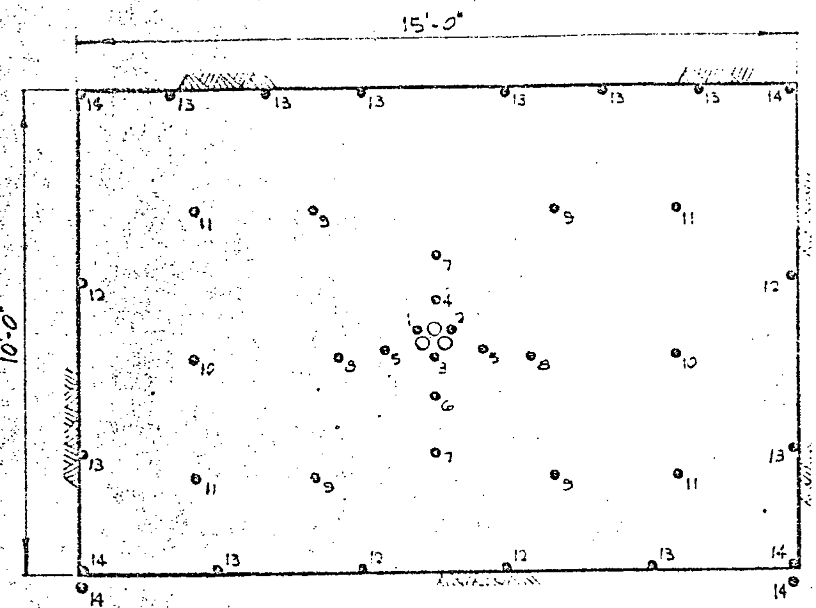
(2) Note changes in joint frequencies with some care.

(3) Note all changes in strike and dip which are greater than 10^{o} by a new symbol.

(4) Trace the strike and plunge of the F2 foliation along the wall of the drift by a trend line. In this way, it may be possible to distinguish between regional and local changes in F2 foliation.

(5) Mark distinctly all prominent joints (joints traceable for 8-10 feet).

(6) Distinguish clearly between faults and strong joints.



10' x 15 DRIFT - TYP. SECTION
SCALE B

CAP NO	AMT.
1	1
2	1
3	1
4	1
5	2
6	1
7	2
8	2
9	4
10	2
11	4
12	4
13	10
14	6
	41

HOLE DIA. 1⅞"
DRILL = 44 - 11' HOLES
BLAST = 41 - 11' HOLES

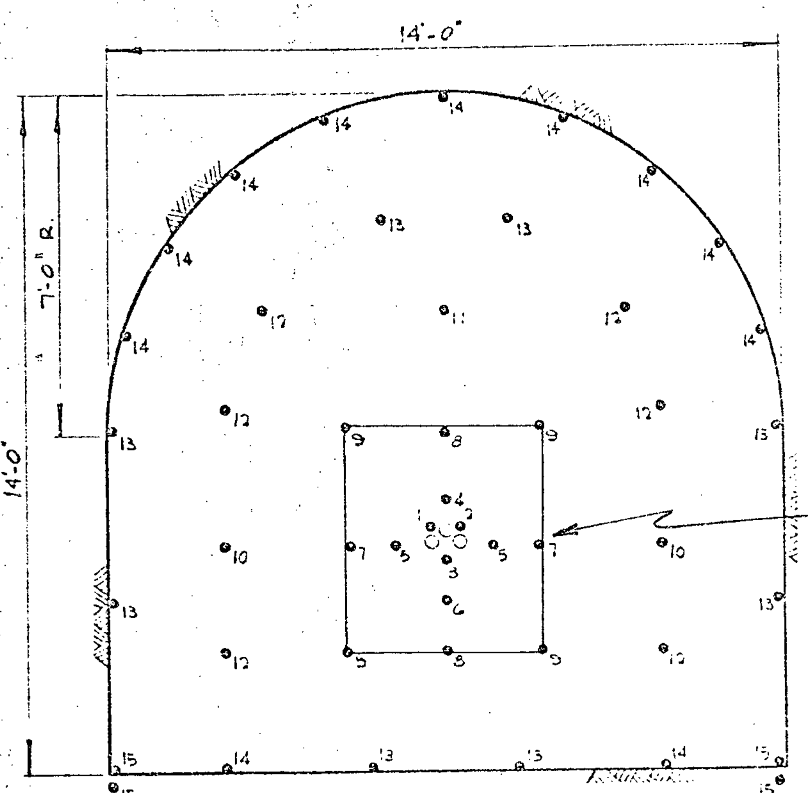
BLAST WITH:
XACTEX - 8 HOL
CILGEL 'B' - 33 HOL

CILGEL B 1¼" x 16" =
10' x 33 x 12" / 16" = 247
8 x 2 = 16
263
263
55

XACTEX ⅝" x 24" =
8 HOLES x 4 STICKS / 100 STICKS =

COSTING
CILGEL B = 4.53 x
XACTEX = 0.32 x
CAPS = 41 x
MISC. = SAY
TOTAL COST PER R

COST / FT. $183.69 / 10' RND



all holes along the perimeter of this line Should be toed in slightly

14' x 14' DRIFT - TYP. SECTION
SCALE B

CAP NO	AMT.
1	1
2	1
3	1
4	1
5	2
6	1
7	2
8	2
9	4
10	2
11	1
12	6
13	6
14	11
15	4
	45

HOLE DIA. ¾ - 1⅞
DRILL = 48 - 11' HOLES
BLAST = 45 - 11' HOLES

BLAST WITH:
XACTEX - 9 HO
CILGEL B - 36 HO

CILGEL B 1¼" x 16" =
10' x 36 x 12" / 16" = 270
8 x 2 = 16
286
288
58

XACTEX ⅝" x 24" =
9 HOLES x 4 STICKS / 100 STICKS

COSTING
CILGEL B = 4.97 x
XACTEX = 0.36 x
CAPS = 45 x
MISC. =
TOTAL COST PER R

COST / FT. $201.57 / 10' RND

OLES
175 STICKS/CSE.

263 STICKS

50 CASE

x 30.50 = 45.75
x 0.87 = 13.00
SAY = 6.00
RND = $64.75

ND = $8.93/FT.

/CSE.

27 CSE
/CSE
20 CSE

COSTING
CILGEL 'B' = 3.27 x $30.50 = $99.74
XACTEX = 0.20 x 43.40 = 8.68
CAPS = 29 x 0.63 = 18.27
MISC. = SAY = 6.00
TOTAL COST PER RND. $132.69

COST / FT. = 132.69 / 10' RND = $13.26/FT.

FIG 1

SCALE A 1 ½ 0 1 2 3 FEET

SCALE B 2 1 0 2 4 6 FEET

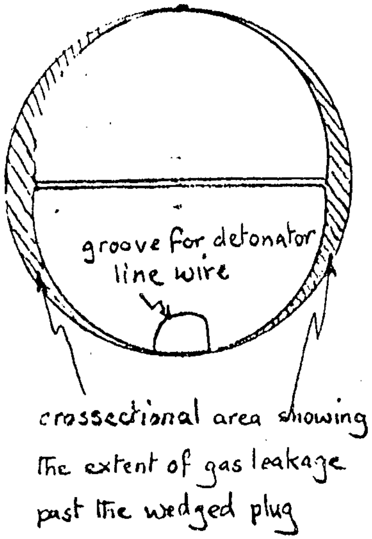
DWG NO	REFERENCE DRAWINGS

MECHANICAL LIMITS, UNLESS OTHERWISE NOTED:
FRACTIONAL ± 1/64" DECIMAL ± .010" ANGULAR ± 1/2°

NO.	DATE	REVISION

CANADIAN MINE SERV
VANCOUVER, B.C.
KERR-ADDISON MIN
GRUM DEPOSIT
DRILL + BLAST PATTERN

DESIGNED	BILL OF MAT'L
DRAWN E.N.M.	JOB NO.
TRACED	CLIENT
CHECKED	APPROVED



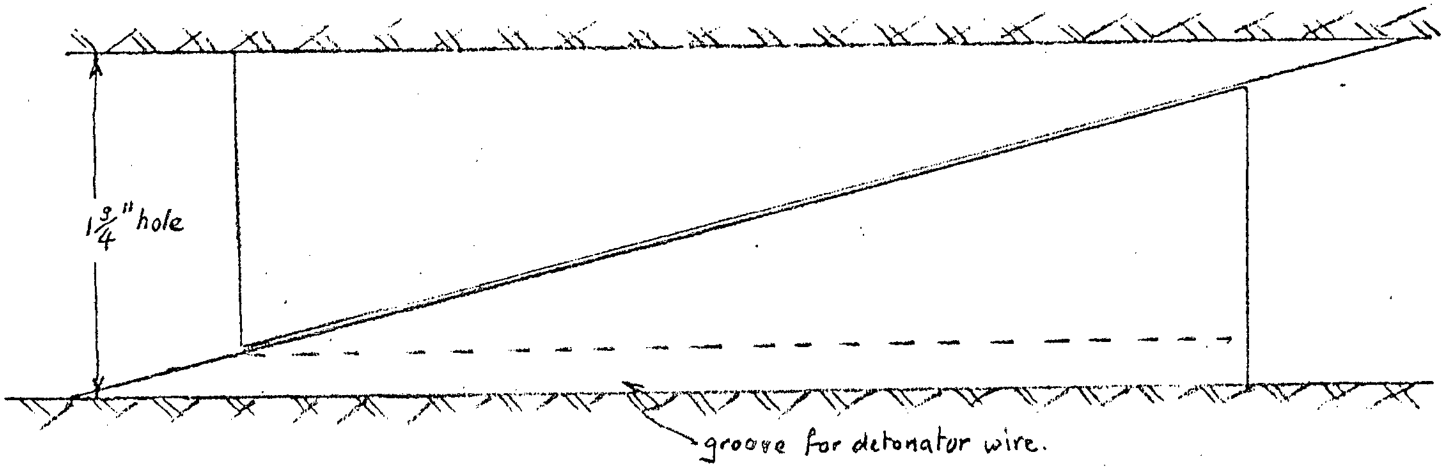
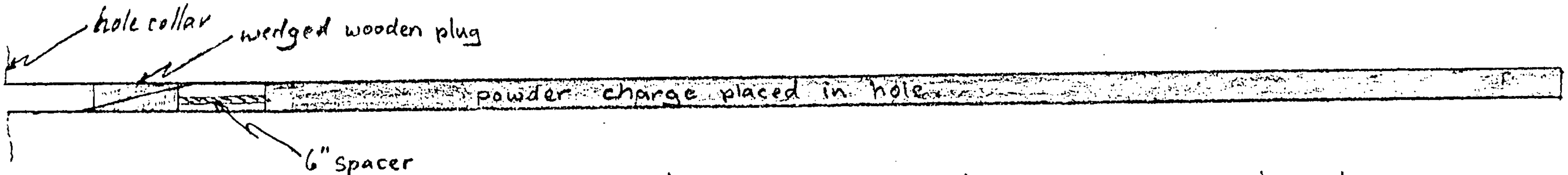
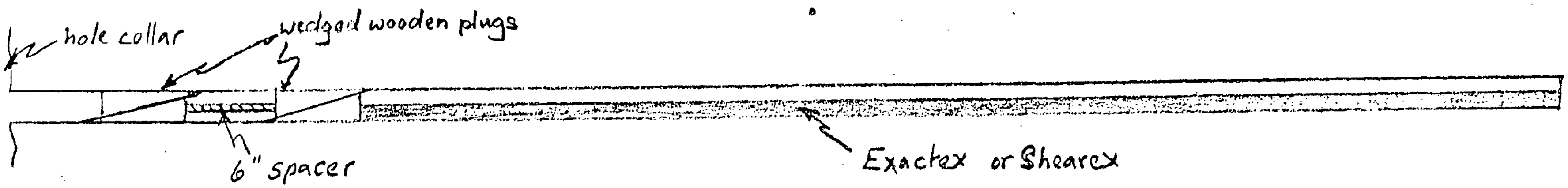


Diagram showing detail of wedged wooden plug, 6" long.



Recommended stemming for 9' holes No. 7 to 13 inclusive.



Recommended stemming of all perimeter holes above shoulder height No. 13 & 14.

FIG 2