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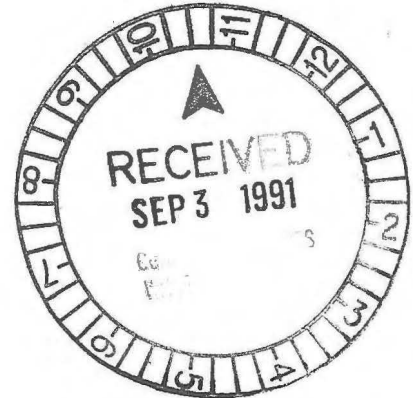
cc CHF
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August 9, 1991

Mr. John Hogg
General Manager
Curragh Resources, Inc.
P.O. Box 1000
Faro, Yukon Y0B 1K0



Dear Sir:

Re: Evaluation of East Pit Wall Stability

Further to the request of Mr. Colin Benner, Vice President, the stability of the east pit wall has been inspected and evaluated.

A site inspection of the pit wall was made Wednesday, August 7, 1991. Typical site photographs are appended.

Information was provided to me by Mr. A. Stewart of Piteau Associates and Curragh Mining staff on movement monitoring and history, geology and structural geology, groundwater and surface water, blasting and the mining plan.

A summary of my comments and recommendations made to senior mining staff at the mine Thursday, August 8th is as follows:

Geology

The east wall is comprised extensively of moderately weak to weak phyllites with a high mica content and lower than normal friction angle, compared to other local rock.

A harder nose exists about midway along the east pit wall which is described as calc silicate rock. This rock is much more competent and is tending to act as a retaining wall to the slope.

The phyllites both north and south of the calc silicate is moving and ravelling. These zones are referred to as the north slump and south slump.

The major Big Indian Fault intersects the east wall at a small angle to the face and dips about 75 - 80° toward the pit. Prior to extensive movement, this fault was likely a low permeability barrier to water seeping toward the pit. This fault is about 100 feet wide.

Secondary shears have recently been observed which dip into the slope at about 65 - 70°. Recent toppling movement has occurred along these shears.

Curragh staff suggest a shear may exist at the contact of the calc silicate and underlying phyllite which is dipping about 40° toward the pit. This contact appears to have been encountered near the toe of the calc silicate slope. The location and orientation of this shear zone is very important to future stability and should be located accurately.

It is recommended that geology develop a cross-section perpendicular to the face along the center of the calc silicate block showing as much structural geologic detail as is known. This section should be forwarded to Mr. A. Stewart.

In order to develop an accurate model of the failure and failure mechanism, an accurate geologic model is required.

Failure Mechanism

Extensive slope monitoring has been performed. Figures 1 and 2 show movement results for hubs 15 and 16 about mid-height on the slope. Horizontal movement sectors are generally much larger than vertical sectors. This indicates toppling type failure. Observation from the south end of the east slope clearly indicates toppling failure with material moving in behind as a graben, which continues to apply lateral pressure.

The mechanism is described as a multiple toppling failure with the Big Indian Fault as the apparent back feature. As a result of this movement, follower slumping is occurring above and beyond the fault. The movements commenced during spring melt, accompanied with many rainy periods. On June 27th, active mining was halted due to the increased rate of ravelling.

The rate of movement between July 20 - 27 became very severe, reaching up to 3 metres per day. Extensive fracturing occurred in the central portion of the slope and major slope ravelling developed.

Material between the two shears near the top of the calc silicate zone and the Big Indian Fault is moving downward as a graben pressuring the lower toppling zone.

The Faro Creek diversion ditch has existed for many years above the crest of the east wall. Past recommendations have been to line this ditch. However, this was never effectively done. Water from this ditch has continued to seep into the east wall, creating high water pressures. On July 21, Faro Creek was diverted by pumping

water from a sump into a pipeline so the diversion seepage ceased. Within one to seven days, movements began to slow dramatically and many are now in the order of only 10 percent of the maximum movement.

Toppling failures that the writer has encountered before are at the Annaconda Twin Buttes pit south of Tuscon, Arizona (25 million cu. yds.), Cassiar and Lornex (20 million cu. yds.).

Concern regarding the calc silicate and lower phyllite shear location and possible future movement along this shear must be addressed with better geological information. Continued field mapping of newly exposed benches is required.

Factors Which Contributed to the Movements

Rock Structure

The existence of the weak phyllites, the steep dipping Big Indian Fault and the secondary shears dipping into the slope contributed to the toppling failure.

The geology and existence of weak rock is a given which cannot be changed and must be taken into account in the design.

Groundwater

The presence of groundwater in the slope has a major impact on rock stability:

- shear strength is reduced due to buoyancy forces,
- cohesion of weak rock is reduced,
- seepage forces are created by drainage flow toward the face,

- water pressure in tension cracks is developed,
- hydrodynamic shock is created by blasting below the water table.

Since the mine was developed, seepage has existed in the east wall from the Faro Creek diversion. As the pit has been deepened, the influence of groundwater on stability has generally worsened. In July, movement increased substantially. On July 21, Faro Creek was diverted into a pipeline. Except for short term heavy rains since then, seepage infiltration has been reduced. The result has been a dramatic reduction in the rates of movement in the slide area. It is concluded that seepage has been the major factor impacting on the movement.

Considerable wet areas still exist in the lower slope area. Further effort to reduce water pressures in the slope is recommended.

Blasting

Seismic acceleration forces near this face have been large. A review of blasting plans for June 27th indicated that 1,800 kg to 4,600 kg per delay were detonated below the south slump using 234 holes. Back line spacing was 12 feet with 70 kg per hole.

Prior to the strike on March 19th, 50,800 kg were blasted in front of the calc silicate block using 9 production rows, up to 2,800 kg per delay and 308 holes.

These blasts in saturated ground would be expected to generate 20 - 40 in/sec particle velocity in the final wall. This is a severe shake which would cause dynamic stress in the rock.

To maintain future stability with an existing low safety factor, future blasting energy must be reduced.

Pit Face Curvature

The east wall has a curved alignment with the calc silicate projected somewhat into the pit. For the same slope angle, concave wall slopes result in increased stress on the slope.

Stress Relief

As an excavation is developed, the rock rebounds slightly due to stress relief. This increases porosity and may open discontinuities to allow additional water to infiltrate the rock structure.

It is important to note that two of the major factors which have influenced slope stability, groundwater and blasting, can be modified to improve stability or limit the impact on stability.

Present Danger

Movements commenced during spring melt gradually increasing until major acceleration July 20 - 27. Considerable ravelling developed. Due to the ravelling danger, the mining was discontinued June 27.

On July 21, Faro Creek was diverted into a pipe. Within 1 - 2 days movements decreased rapidly. At the same time, ravelling has greatly reduced.

I have no knowledge of any large toppling failure that collapsed rapidly anywhere in the world. Al Stewart of Piteau Associates concurs with this.

We are of the opinion that the slope condition is sufficiently safe for mining to commence with precautions and procedures described in the next section.

It is our opinion that the calc silicate is acting as a retaining wall and that a smooth planar failure feature has not developed. Curragh is cautioned that the existence, location and orientation of a potential shear zone along the calc silicate contact must be determined.

A critical movement rate cannot be given. Rather, it is recommended that a program be developed to improve general stability, reduce destabilization forces, incorporate a procedure to catch occasional ravel and to reduce further movement and ravelling.

Recommended Program

1. Install six vacuum assist horizontal drains. There is still considerable seepage issuing from the wall so water pressures are still influencing the movement. In addition, mining is proposed to go considerably deeper. This will increase stresses in the slope. Maximum drainage effort is therefore strongly recommended.

The drains should be installed from the safest location available at the toe into the calc silicate. Some form of shield or wire mesh frame to protect from ravel may be required for the drill. Drains are to be fanned from one location with the first two drains to be perpendicular to this slope $+7\ 1/2^\circ$ and $-7\ 1/2^\circ$. Other drains should be fanned 15° apart.

The drains are to be 200 feet long, at a 3%+ gradient. Standard P.V.C. 1 1/2 inch diameter drain pipe is to be inserted in each hole. The inner 170 feet to be perforated with 0.02 inch slots, the outer 30 feet unperforated.

The drains are to be set up for vacuum drainage with a single vacuum manifold. Vacuum is to be applied for two weeks. Water flows are to be monitored twice daily.

Geology is to be mapped by evaluating the drill cuttings. Shear zones are to be noted. After the vacuum is discontinued, the drains are to be allowed to flow by gravity. Take off the vacuum manifold. The drains must be kept from freezing during the winter and glacial buildup must be controlled.

2. Extend the lower water interception pipe another 200 feet south to limit seepage above the south end of the south slump.
3. Clean up the talus below the north slump and construct on 6 foot high catch berm with 1 1/2:1 side slopes at the toe of the slope to catch any ravel from above.
4. Develop an 8 foot high catch berm with 1 1/2:1 side slopes below the south slump toe to catch ravelling rock. Clean out if and when required with a long boom backhoe.
5. Modify the blasting program to limit seismic acceleration forces. Typical recommendations are:
 - Reduce line hole spacing to 8 feet. Use sonotubes to better disperse explosives. Detonate this line last. Do not dig beyond this line.
 - Use three buffer lines spaced 12 feet apart with lower powder amounts.
 - Delay every production hole using 50 m/sec delays.

- Detonate rows perpendicular to the wall - maximum 50 holes per blast. This may mean multi blasts per day. If movement stops or cold, below freezing weather develops, the total number of holes per blast to be reviewed.
- 6. Continue to monitor movement. Add monitors at lower levels as the mine deepens. Continue to provide movement data to Al Stewart of Piteau Associates for evaluation. Use the same surveyor and instrument if possible. Watch for any unusual sign of bulging, crushing or spalling in the toe.
- 7. Take advantage of cold winter weather and the likely increased stability and reduced ravelling, due to reduced winter seepage. Plan for all mining to be completed by about April 1, 1992 to not extend into the spring melt period.

Experience in the past is that movements reduce or stop during winter periods.

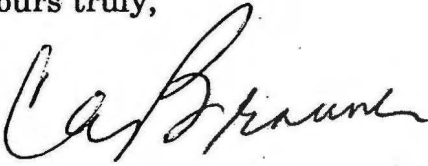
Garret Vos advised a conservative mine plan has developed which would remove 58 percent of the original ore removal program. This would use a 100 foot wide berm. It is considered that this can be reduced, particularly in the north half. The mine plan should be reviewed as each bench is developed.

It is recommended that the stability data be documented to maintain program continuity.

My involvement on the project has been as a Review Consultant. I wish to state that the work of A. Stewart is reasonable and I recommend you continue with his services.

If you have any questions please contact me.

Yours truly,

A handwritten signature in black ink, appearing to read "C.O. Brawner". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

C.O. Brawner, P.Eng.

COB:cg

Enclosures

cc: Mr. A. Stewart,
Piteau Associates

c:curragh.rpt

FIG. 1 - RELATIVE MOVEMENT VS TIME - PRISM

Prism # 15

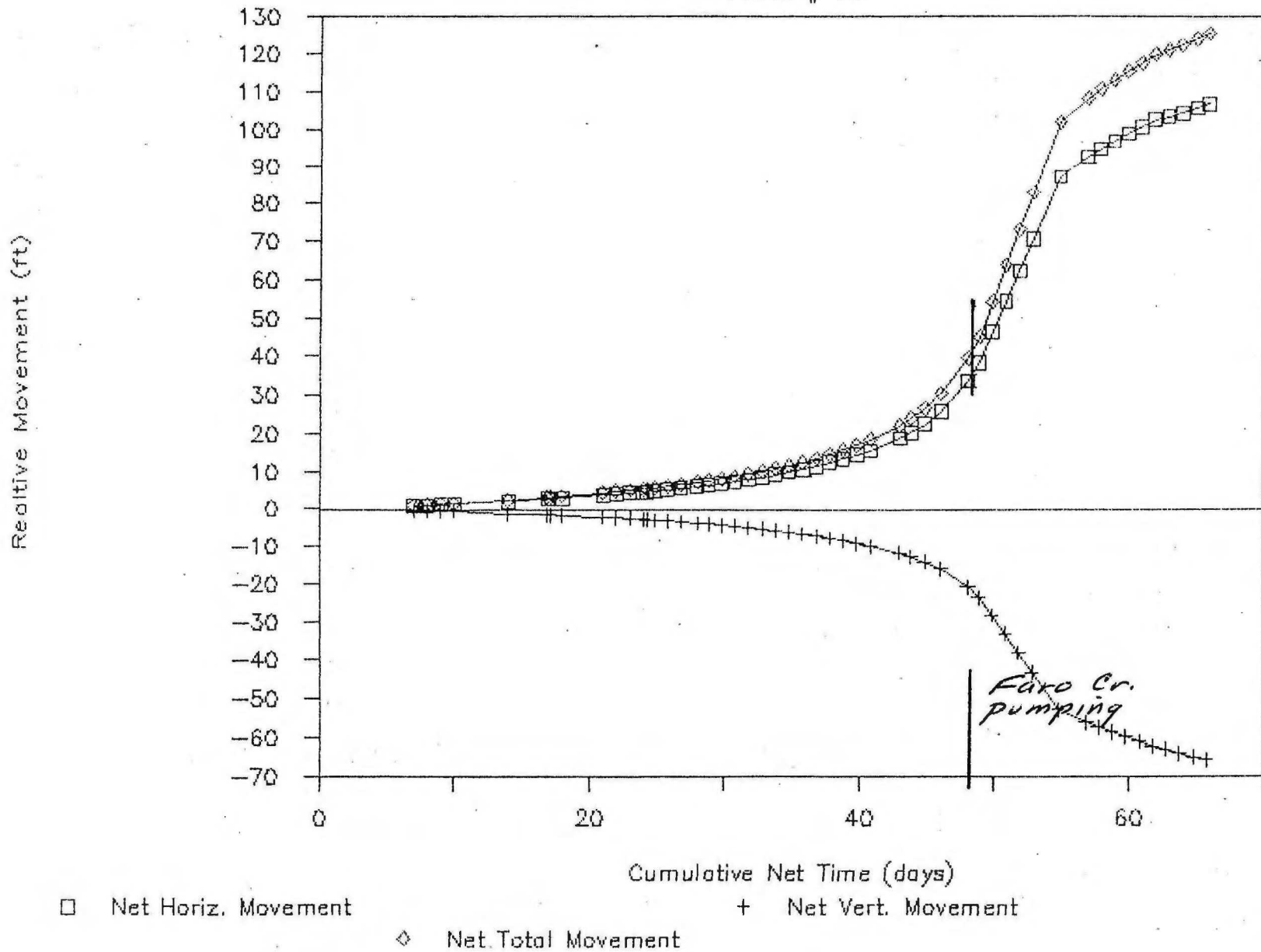
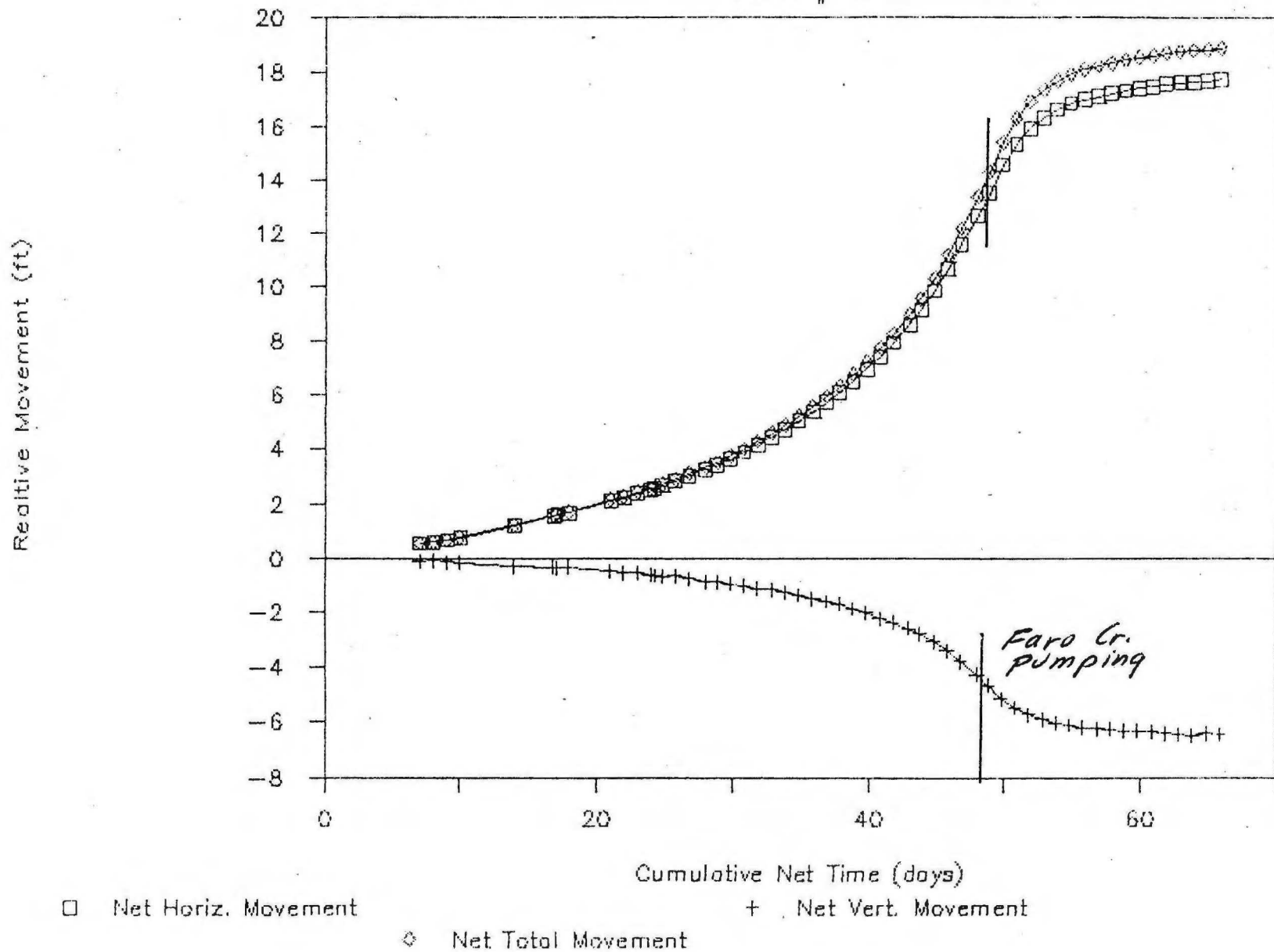


FIG. 2 - RELATIVE MOVEMENT VS TIME -- PRISM

Prism # 16



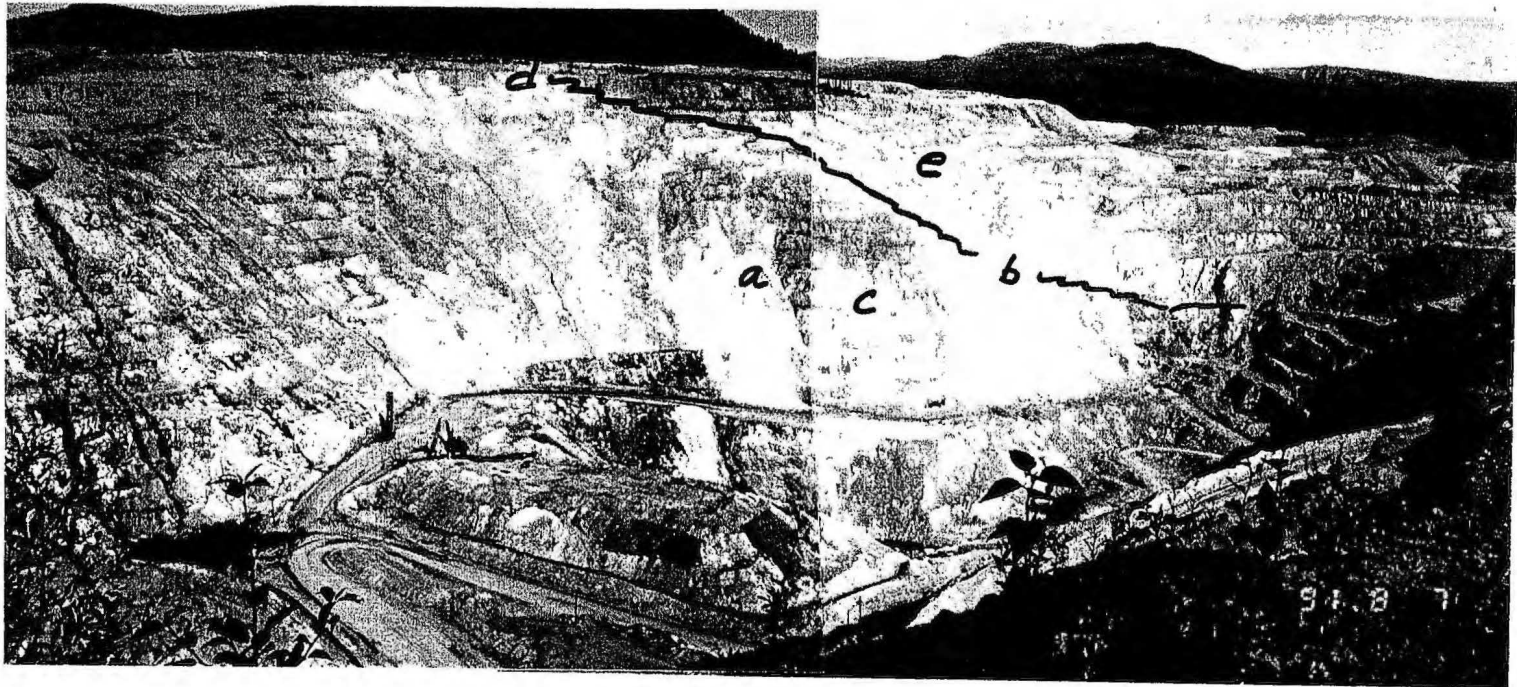


PHOTO 1: East wall of pit. The north slump and talus area (a), south slump and talus area (b) and calc silicate rock zone (c). Note negligible talus below zone c. The Big Indian Fault is behind the major talus zone (d). Upper broken moving zone behind the fault (e).

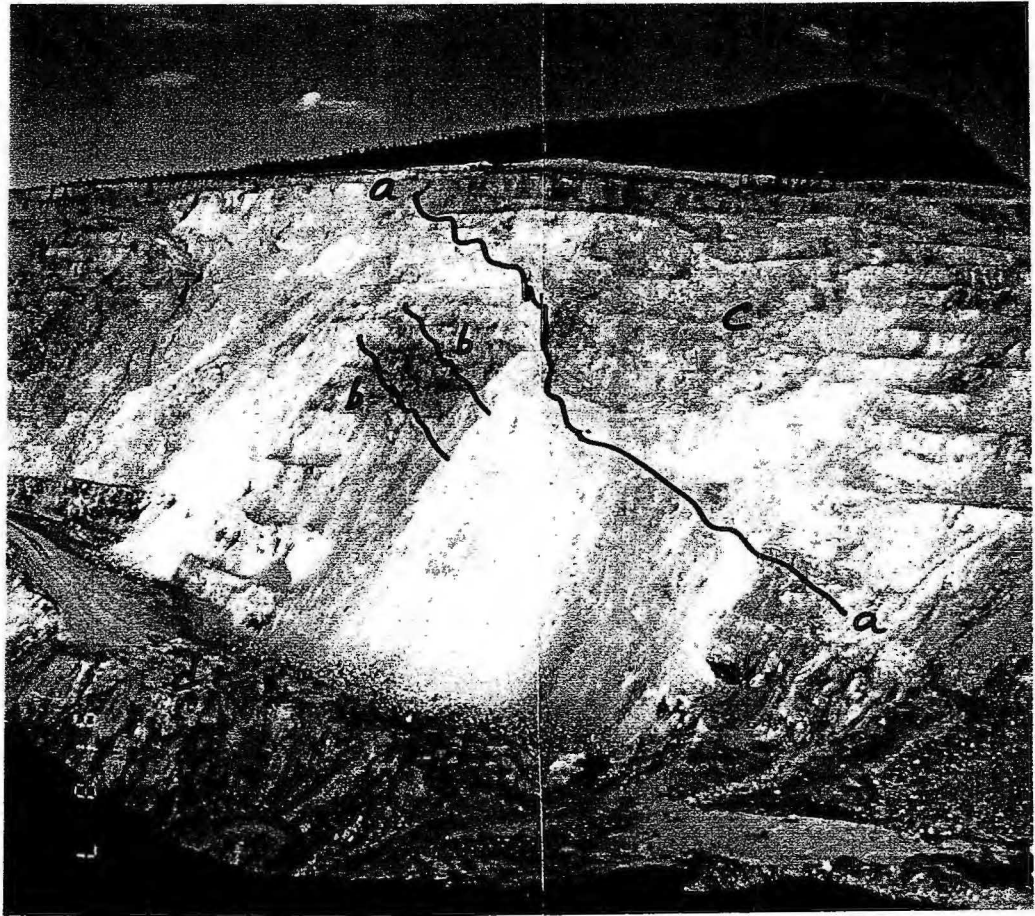


PHOTO 2: Angled view of the east slope from the south end of the pit. Note the Big Indian Fault (a) and secondary shears which dip about 70° into the pit (b) and the upper slump area (c). Note the previously blasted area on the bench (d). Greater movement has taken place in the south slump area.



PHOTO 4: Note the numerous wet areas indicating extensive seepage (a).

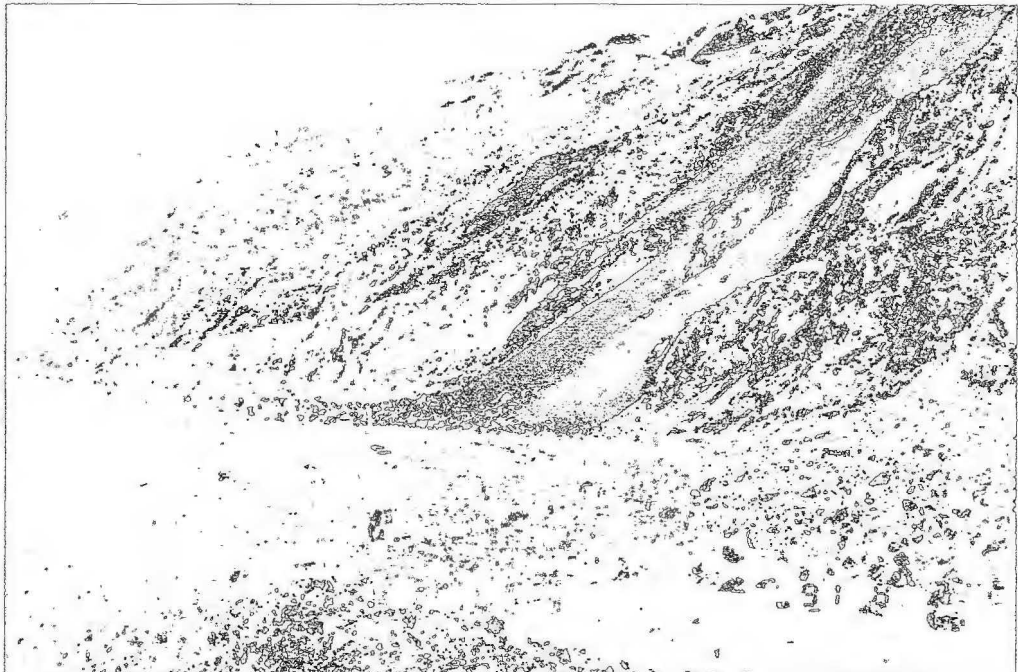


PHOTO 5: Note the zone below the calc silicate with no ravelled boulders.
Six fanned horizontal drains to be installed into the slope on plus 3% grade.

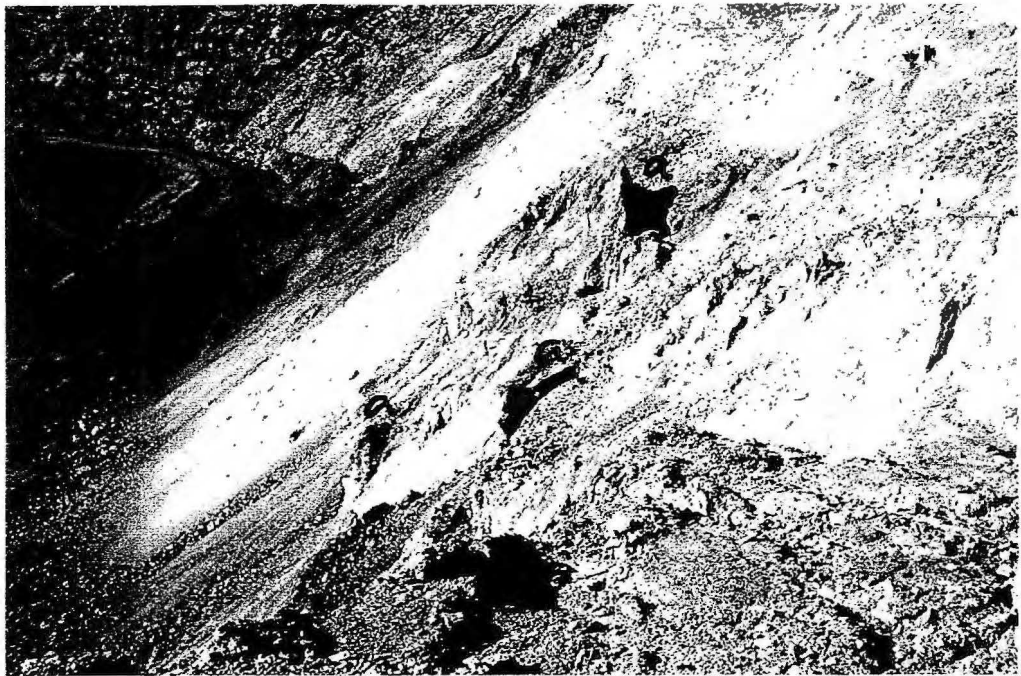


PHOTO 6: Side view of the lower east slope. Note the protruding blocks which have obviously moved in a toppling mode (a).



PHOTO 7: Side view of the upper slope. Note the protruding blocks which are evidence of toppling (a).

FARO MINE - RAINFALL

cumulative rainfall at minesite

