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MINING LAND USE
WHITEHORSE, Y.T.

KETZA RIVER MINE

REPORT
ON
1999 SITE INSPECTION

Prepared for:
NORTHERN AFFAIRS PROGRAM
Calgary, Alberta

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G1000

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1.0 INTRODUCTION

The Water Resources Division of the Northern Affairs Program commissioned Mr. M Stepanek of Geo-Engineering (M.S.T.) Ltd. to inspect the geotechnical aspects of the Ketza River Mine. The site was visited on September 12, 1999 in the company of Mr. H.F. McAlpine. This was the writer's thirteenth site visit since 1987.

Mine operations were suspended in November 1990. A caretaker was monitoring the site during the warm season and visited the location several times during the winter until last year. At the time of the site visit, there was no mining company personnel present and the entry gate was opened.

The property was acquired in December 1993 by YGC Resources Ltd. This company did some exploration studies, the last one in 1998. However, significant mill equipment was removed and transferred to the Mt. Nansen mine in 1998. During the equipment removal, some segments of the mill building and associated facilities were damaged. The mill building and the camp are not secured. There are also unsecured chemicals, some of them apparently toxic, such as sulfuric acid and a large container of Cyanobrik. Mine area roads and trails that were cut into steep mountain slopes continue to degrade (because of uncontrolled erosion) while others are impassable due to rock falls.

During this year's site visit, specific attention was paid to waste dumps, tailings pond dams and water diversion structures. A comprehensive review of geotechnical conditions of mine facilities and existing closure plans was undertaken last year and presented in a report dated December 1998.

2.0 MINES AND WASTE DUMPS

Walls of all open pits continue to ravel. Relatively little rock debris exists along the toe of the Ridge Pit. Rock falls occur in the Breakzone Pit. The wall at the underground mine entrance in the Breakzone Pit is quite unstable and rock debris completely block the mine entrance. Another underground mine entrance, located downslope from the Ridge Pit, is partially blocked by slide debris. Other existing adits are gated.

Similarly, most of the waste dump faces creep or slump at a very slow rate. Most prominent bulging, forming a two-step outer face configuration (Photo 1) occurs on the waste dump on the Peel Creek valley slope. A significant vertical displacement occurred over the period of the last decade and continuing movement is indicated by fresh cracks.

As noted above, less activity was observed on other waste dumps. Ravelling is evident on the Breakzone Pit dump on the Cache Creek valley slope. Minor cracks were observed along the outer edge of the Ridge Pit dump.

3.0 TAILINGS POND DAMS

Inspection of tailings pond dams included a review of their crests and slopes, observation of seepage flows along dam toes and examination of the emergency spillway. The water level in the pond was, at the time of inspection, at or slightly below its historical high. An erosion step in the upstream face of the dams was about 300 mm above the pond water level at the time of the inspection. However, this step could also be a product of wave action.

Almost all the tailings, previously forming beaches in front of both dams and along the Cache Creek diversion dyke, were submerged (Photo 2) at this time.

No benchmarks or staff gauge exist at the pond. It was estimated that the water level in the pond was about 2 m and 1 m below the dam crest and emergency spillway crest respectively. It appears that the design elevation of the emergency spillway invert (referenced to be 1,312.5 m above sea level (a.s.l.) in the 1998 SRK report) has been inadvertently modified, by the cross-traffic or imperfect construction control. Construction drawings indicate that the crests of both dams are supposed to be at elevation 1,314.0 m a.s.l. Since the water level in the pond was estimated to be at about elevation 1,312.0 m a.s.l. (2 m below the dam crests) and overflow did not occur, it is likely that the spillway invert is approximately at elevation 1,313 m a.s.l. If these estimates are correct, the tailings pond does not have sufficient freeboard.

Our record indicates that the water level of the pond fluctuated between 1,309.6 m and 1,311.1 m in the past seven seasons. The estimated water level rise between 1998 and 199 is almost one meter, which is unprecedented. Examination of the upstream pond perimeter indicated that the Subsidiary creek diversion ditch was overtopped during the freshet period, likely because the ditch was plugged with ice and water flowed across the road into the pond. A series of erosion rills cut into the road between the diversion ditch and the pond (Photo 3) supports this interpretation.

No deformations or cracks were observed on the crests of either dam and the dam slopes were in good condition. Visual examination of seepages at the toes of both south and north dams, indicate a significant increase of discharged water since 1998. At the north dam, heavy seeps occur along the toe at several locations (Photo 4) and also from the dam abutment (natural slope) to the south. Algae covers the bottom of the concentrated flow path. The ground and dam material in seepage zones is soft and quicks when exposed to vibration.

It is difficult to examine the toe of the south dam because this area is covered with a drainage blanket (Photo 6) and discharged flow downstream from the pumphouses indicates that significant seepage exists at this dam as well.

The existing emergency spillway (of an unknown capacity) may have to convey flows exceeding the remaining pond storage capacity. Should an uncontrolled discharge from Subsidiary creek occur, similar to this year's event, the overflow may happen during the year 2000 break-up. The impact of this flow would largely depend upon the actual volume of flow. The spillway is shallow and its armour is small-sized (Photo 7). It was not constructed for large flows. Larger flows may erode the rip-rap and may cut a new channel over the hillside in the spillway bend area.

4.0 STABILITY OF DAM EMBANKMENTS

Golder reports, in a letter dated February 27, 1987, that factors of safety against sloughing for the downstream slope of an unspecified dam (probably the north one) were analyzed to be 2.0 and 1.4 for static and dynamic conditions, respectively. No input parameters, except earthquake acceleration of 0.08 g were provided at that time.

SRK's stability analyses, undertaken in 1990 and 1994, dealt with the downstream slope of the south dam only. It was assumed (by SRK) that the wider core of the south dam would be more susceptible to a deep-seated failure. These analyses also assumed that the north dam is founded on outwash sand and gravel (Ø' = 39°, c' = 0) and the south dam on glacial till (Ø' = 37°, c' = 0), This assumption ignores the existence of

> "a thinly layered deposit of silty sand to silty and gravel with occasional clean sand and clean gravel layers.... encountered between depths of about 4.6 m and 8.4 m in Borehole 3, drilled ... near the western end of the tailings pond.
>
> The results of a grain size analysis carried out on a sample of the deltaic deposit ... indicate that the material is about 2 per cent gravel, 38 per cent sand and 60 per cent silt." (Golder, 1986).

Similar deposits were encountered in Borehole SRK 1 (from 9.6 m to 12.4 m), drilled from the crest of the south dam and in Borehole SRK 2 (from 21.0 m to 24.7 m), drilled from the crest of the north dam. These materials reportedly sloughed and heaved into the hollow stem.

Because of these differences, the stability of both dams was reviewed in 1998. Models of both dams and their foundations were developed and soil properties estimated on the basis of available characteristics and grain size analyses.

We have selected slightly different shear strength parameters (from those used by SRK) for the following reasons:

- Sand and gravel shells are comprised of relatively course material; apparently a well-graded mixture of sand and gravel and Ø'= 39° was selected.

- The upstream and downstream segments of the north dam and toe of the south dam below the shells appears to be of a gravelly silty sand. It is believed that Ø'= 33° is more appropriate than the previously chosen Ø'= 39°.

- The dam cores are comprised of sandy with up to 50% fines passing No. 200 sieve. Because of the high fine content, shear strength Ø'= 30°, lower than that chosen by SRK (Ø'= 35°) was selected for our analyses.

Piezometric levels, reported in 1990, were used for the stability analysis. The horizontal acceleration used in the pseudo-static analyses was 0.078 g, based on the design acceleration of 0.062 g (established by Golder), multiplied by the amplification factor of 1.25. The analyses were carried out using the GSLOPE computer program (developed by MITRE Software Corporation).

Our computer analyses indicate sufficient factors of safety against failure for the south dam for both static (min. Fs = 2.1) and pseudo-static (min. Fs = 1.7) conditions. Detailed documentation of these analyses is shown in Appendix C in our 1998 report.

Failure of the north dam toe may occur under current seepage/ground conditions or during the design seismic event. While a Factor of Safety slightly bigger than unity is indicated for static loading of the toe of the dam, a Factor of Safety lower than unity is indicated for the same area under dynamic loading. This analyses confirm that the long-term stability of the north dam requires design and construction of a toe berm. However, the overall stability of the dam against a deep-seated failure appears to be satisfactory for operational conditions.

5.0 CACHE CREEK DIVERSION

Both the upstream and middle segments of the creek diversion continue to perform well. There are only minor erosional features such as sub-channels, localized steps and locally undercut channel slopes.

The downstream segment and the drop section (destroyed during the 1992 spring break-up and reconstructed the same year) continue to deteriorate. The slide on the south side of the channel retrogresses further uphill and its headscarp is bigger. The centre portion of the slump encroaches into the creek channel, narrowing the channel width (Photo 8). Both channel banks are also eroded further downstream (Photo 9). Cracks are evident, caused by oversteepening of channel slopes. Rip-rap ravels into the channel and during bigger flow stages is transported further downstream. It appears that both downcutting of the channel and retrogressive erosion are taking place.

The channel outlet to Oxo Creek represents another weak segment of this diversion. The channel is narrow and the dyke is small.

While these are structural deficiencies which may cause erosion and deposition of materials, they should not have a significant adverse impact on the stability of the tailings pond since the uppermost and middle segments of the diversion perform satisfactorily.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The inspection confirms that seepage (and apparently the phreatic line within the dams) reflects changes in the pond water level. Previously undertaken stability analyses (see the 1998 report) indicate that the north dam requires design and construction of a toe berm to ensure its integrity. This issue is more important now since the pond water level is only about 2 m below the dam crests and approximately 1 m below the spillway invert.

The possibility that the emergency spillway would have to handle a major flow represents a potential hazard to the integrity of the tailings pond. Since there is no caretaker and maintenance of the site, such event may occur during the forthcoming spring break-up.

The third concern relates to the lack of access control. No closure plan was formally accepted and there appears to be no action contemplated in this regard. At the same time, the facility is exposed to vandalism and the visiting public to chemicals, some of which may be toxic.

It is, therefore, recommended to clarify the current ownership of this facility, obtain and review a closure plan and have the necessary closure measures undertaken by the Owner.

Respectfully submitted:

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G1000/Ketza/1999 Insp

APPENDIX A

PHOTOGRAPHS

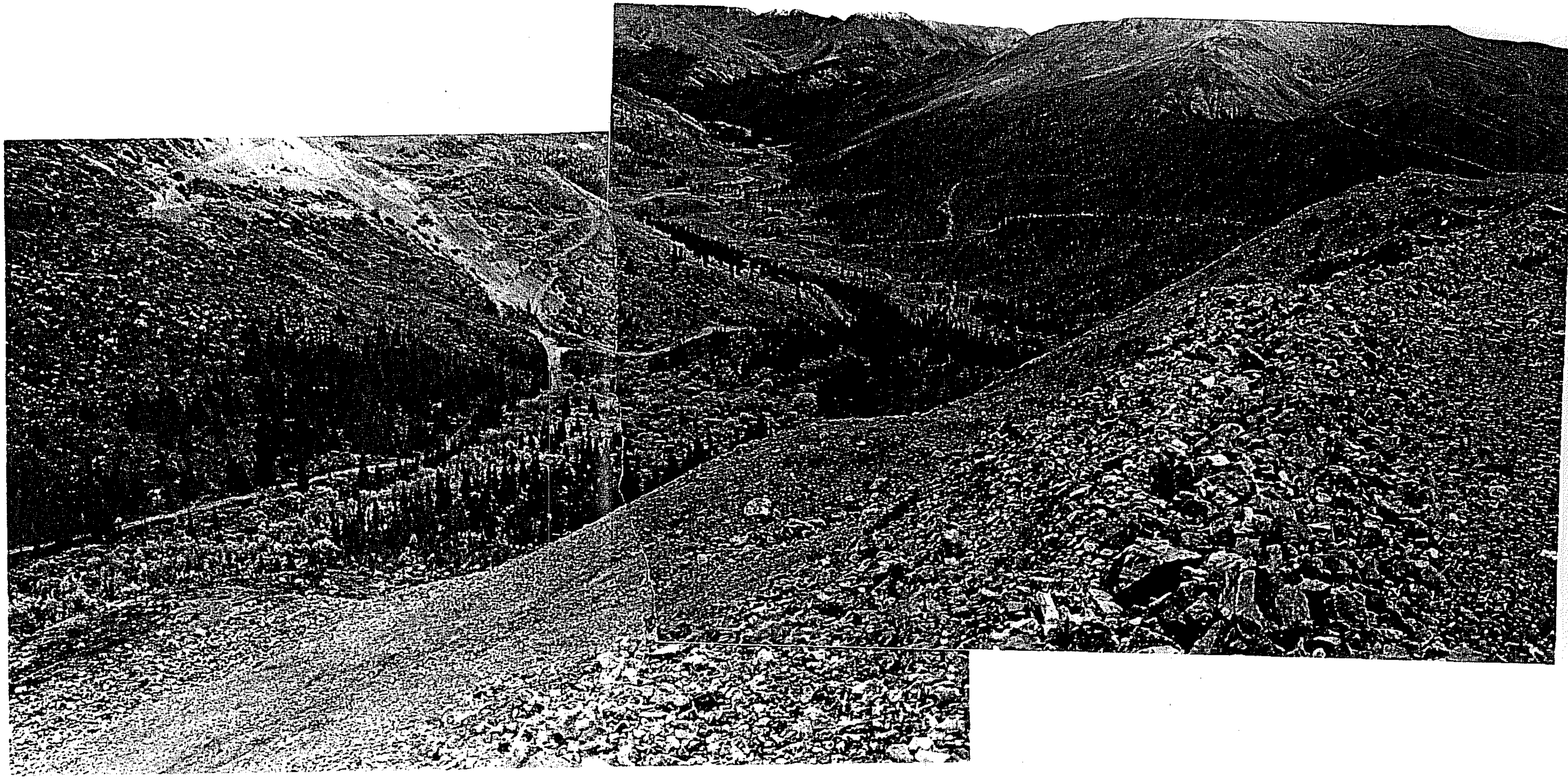

Photo 1: View of Peel Creek valley waste dump. Note two bulges; the surface of the upper bulge used to be at road level, shown on the right.

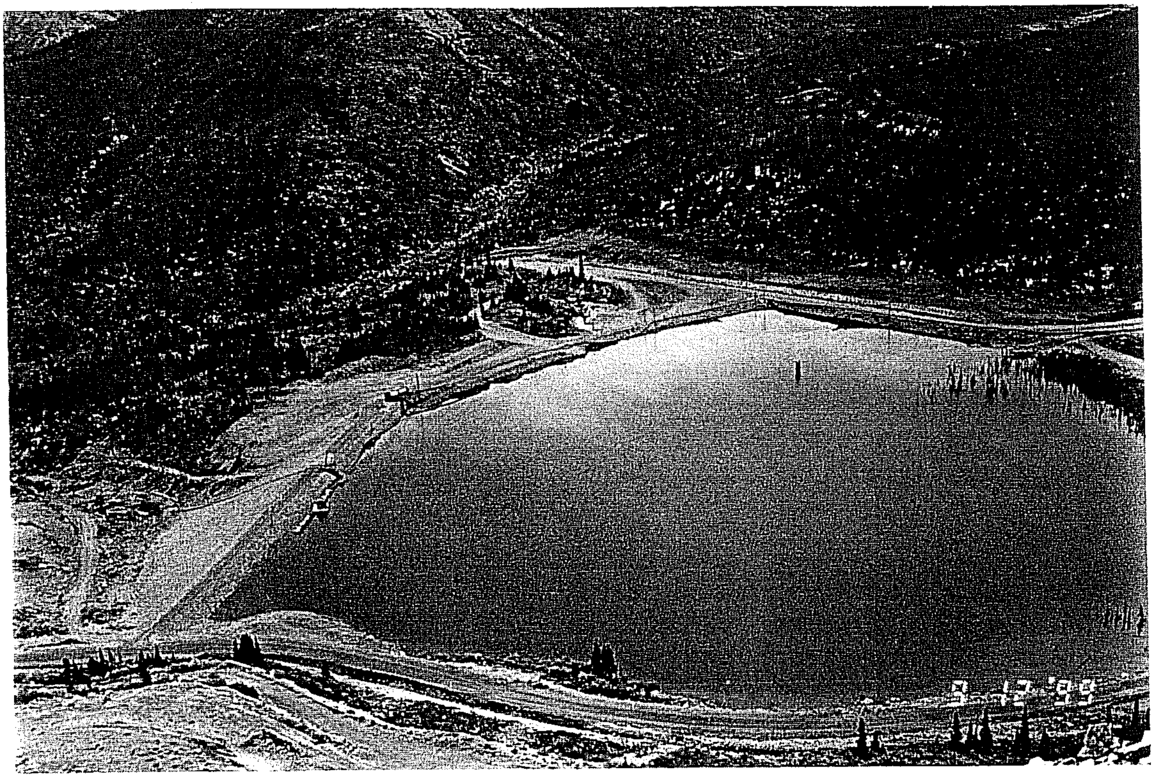

Photo 2: View of the tailings pond. Note that most of the previously exposed tailings are submerged.

Photo 3: Erosion rills cut into the road indicate overflow from the Subsidiary Creek, likely during the spring break-up time.

Photo 4: View of the north dam toe. The broken line indicates approximate extent of seeps.

Photo 5: View of the seepage flow below the north dam toe. Note algae growing in the flow channel.

Photo 6: Ponded water below the toe of the south dam.

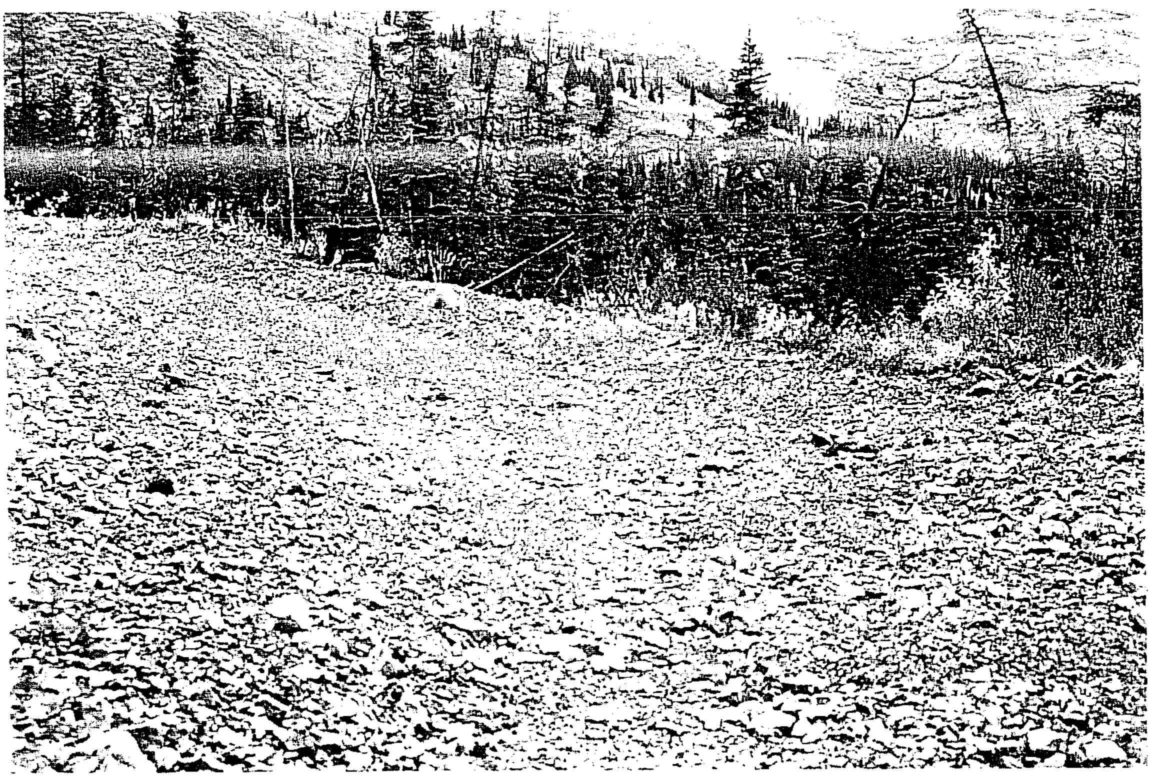

Photo 7: View of the spillway, looking north. Note shallow depth of the channel and small size rip-rap at this location.

Photo 8: Thawing of permafrost on the south side of the Cache Creek diversion continues, causing extensive sloughing. The centre segment of the slump encroaches into the channel.

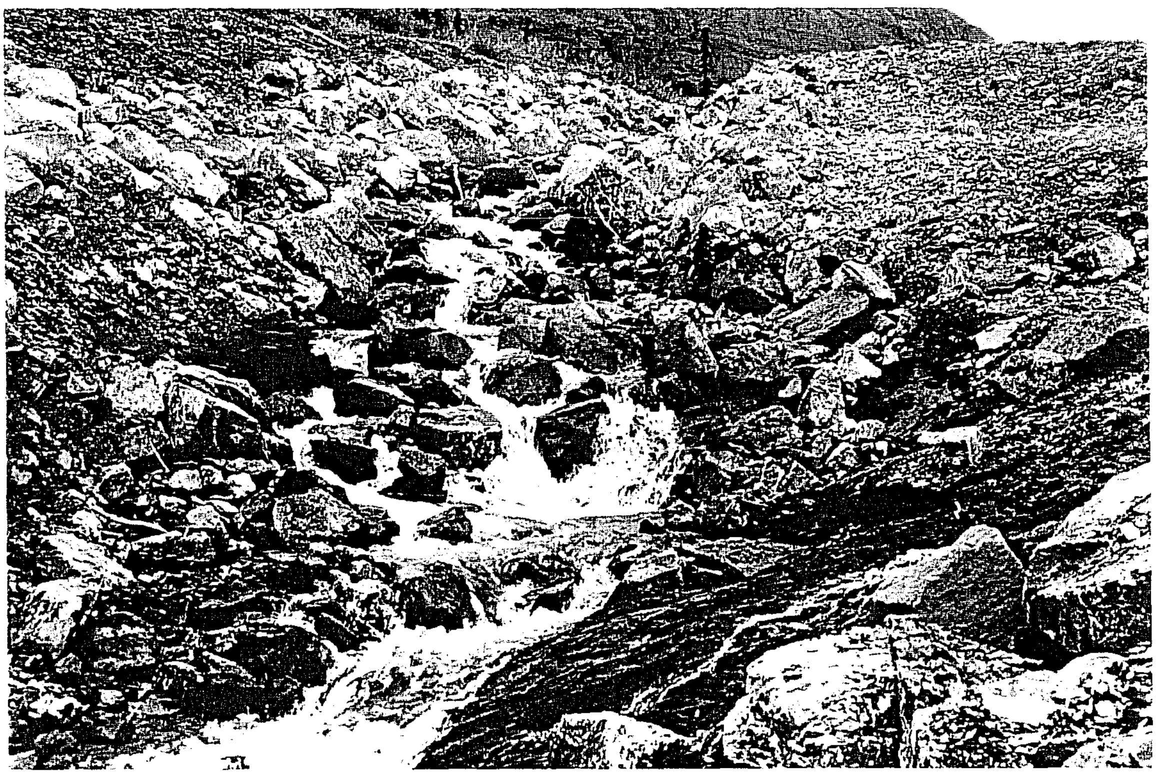

Photo 9: View of the so-called drop section. Both channel banks are undercut by erosion.