Memorandum

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Vancouver, B. C.
1983-07-11

PROPERTY VISIT
AKIE Pb/Zn DISTRICT
CIRQUE DEPOSITS

EARL D. DODSON:

On July 8, 9 and 10 I visited the Cirque property owned by Dome Petroleum Limited. The property is up for sale. The Cirque property contains two Pb/Zn/Ag ore bodies: Cirque with 40 M̄ tonnes grading 2.2% Pb, 8.0% Zn and 47 g/tonne Ag. The South Cirque has an indicated reserve of 10 M̄ tonnes of similar grade with an additional up dip potential of 10 M̄ tonnes. A complete exploration camp and airstrip are in place at Finbow and are connected to the property by a 40 km long gravel road.

Further district potential lies to the SE of the Cirque trend, i.e. the Fluke, Elf and Gin properties.

Fluke: On this property a barium horizon with an associated Pb anomaly prompted the drilling of 5 holes. Mineralization consists of pyrite, mostly framboidal, in a brecciated siltstone over a 20 m interval. Pb values were in the ppm range only, Zn grades are up to 9.9% over .6 m and Ag values are less than 1 oz/t.

Elf: Barite/sulphide mineralization is high grade, narrow (several meters thick) and occurs on a steeply dipping overturned S limb of an anticlinal structure. Best intersection to date is 13.8% Pb and Zn with 27 g/Ag occurring 300 m down dip from the surface showing. Mineralization has been traced for 800 m along strike and 600 m down dip. An associated, 8 km long Pb/Zn geochem anomaly has been tested for 1 km about the Elf showing and by three drill holes at its northern end where mineralization was minimal (mostly pyrite).

Gin: These claims were staked to cover a barite horizon with minor traces of pyrite. Two weak lead/barium anomalies were outlined on either side of this barite zone. No detailed work or drilling has been done to date.

I spent two days in the district. The first day I looked at the stratigraphy, rock types, drill locations, etc. on the properties with Lee Pigage of Cyprus Anvil. The second day I examined pertinent drill core from each property.

My impressions are:

Cirque and South Cirque: Total outlined reserves are 50 M̄ tonnes of app. 10% Pb and Zn and 47 g/t of Ag. Additional drilling on South Cirque is needed (app. 8 holes) to test the up dip potential and before the joint development of these ore bodies can take place.

All facilities at Finbow, including roads, are in excellent shape and development could proceed immediately upon completion of, or concurrent with the drilling. Obviously, apart from the economics for Pb and Zn, with Dome looking for $1 B̄ debt financing by September, this is the time to acquire these deposits.

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<u>Fluke:</u> Here an exhalitive horizon exists which contains mostly pyrite where drilled. Additional drilling will be difficult for topographic reasons. The potential of this prospect was tested in one direction and remains open down dip and in the other strike direction.

At South Cirque the fringing facies of the base metal ore body is developed similarly with the ore deposit being located less than 1000 m down dip.

On the other hand on the Gataga J.V. claims extensive pyrite/barite horizons exist that lack significant base metal mineralization.

<u>Elf:</u> At Elf drilling to date has outlined 2 $\overline{M}$ tonnes of Pb/Zn (2% Pb, 6% Zn and 30 g/t Ag). The prospect looks good but the logistics don't. The almost vertical attitude of the ore horizon presents a problem. The ore horizon and associated sediments are overlain by a steeply dipping thrust which drilling has failed to penetrate. Subsequent evaluation was done through angled holes from below the surface showing. The ore zone remains to be evaluated between surface and 300 m (±) depth by subhorizontal holes to be located on a steep slope, but the potential has been well tested in the immediate vicinity of the showing.

High risk potential exists and the risks include:

1. The mineralization is finer grained than at Cirque and may prove more difficult to treat.

2. Evaluation by drilling will be tough and expensive.

3. Along strike to the south, even though a geochem anomaly exists, the surface showing seems to disappear under the overlying? thrust which makes along strike projection rather speculative.

4. Three drill holes on the north end of the geochem anomaly did not encounter significant mineralization.

<u>Gin:</u> The property has not been evaluated well enough for a complete assessment. However, we have had many similar occurrences of barium with geochemically anomalous Pb and Zn on our Gataga property (i.e. Bear) that turned out uneconomic. Obviously, the property is a very high risk proposition.

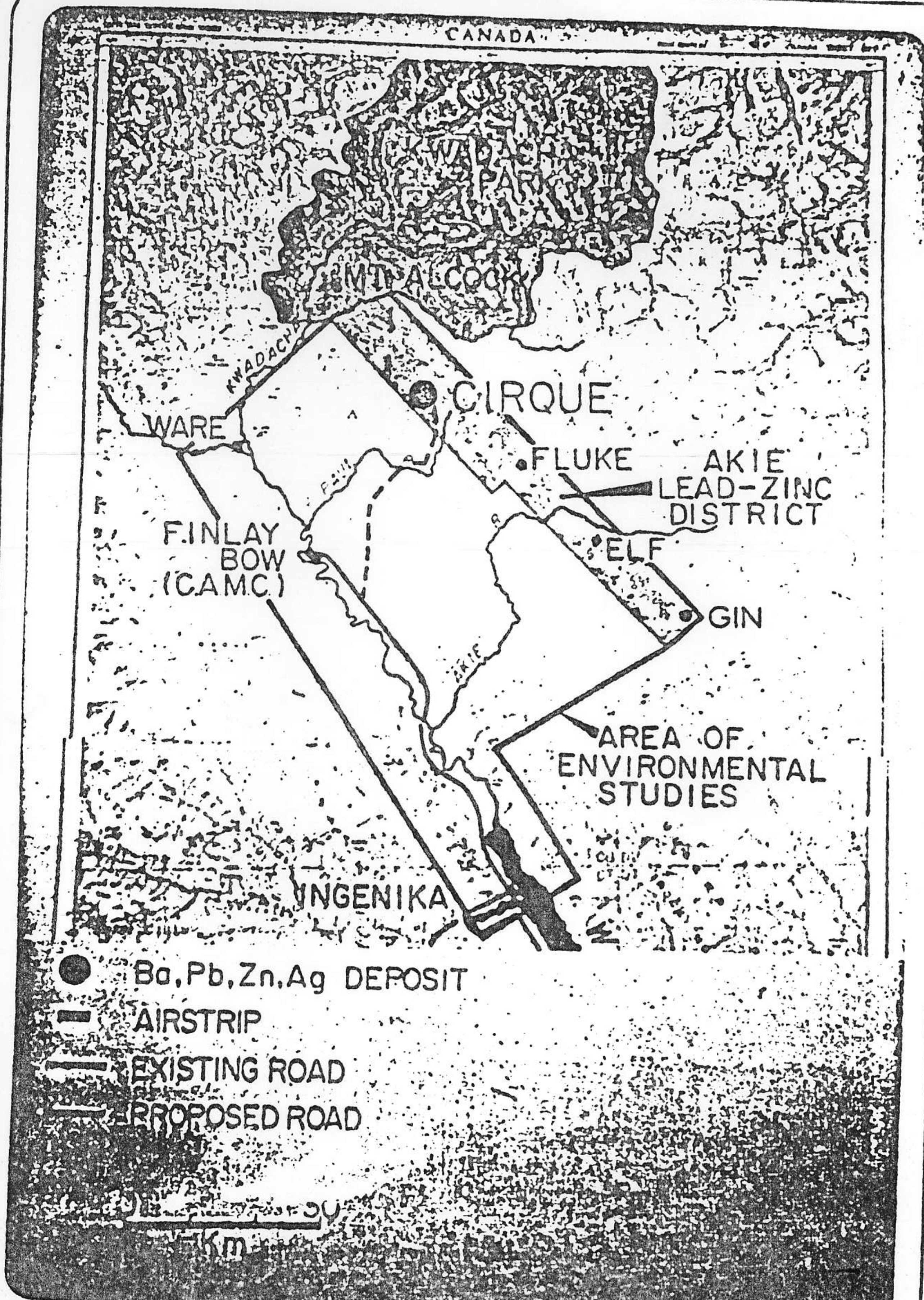
These are only my preliminary impressions. All propositions are expensive as they require drilling. I will obtain some more maps and cross sections from Dome and give you a more extensive presentation once it is all compiled. As far as the Elf property, it will take about two months to put all the exploration data together as this wasn't done by the Cyprus staff.

If we are at all interested, we should try to option or buy the complete package including the ore deposits. By just optioning the exploration properties and in the event of a discovery, we are putting us at the mercy of whoever will develop the Cirque deposits. A logical approach would be to obtain and develop the Cirque properties while carrying on simultaneous exploration on the other properties.

Larry

L. DEKKER

LD:am


CANADA
KWADACHA PARK
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ELF
GIN
AKIE
AREA OF
ENVIRONMENTAL
STUDIES
INGENIKA
Ba, Pb, Zn, Ag DEPOSIT
AIRSTRIP
EXISTING ROAD
PROPOSED ROAD
50
Km

CHAPTER 4

THE CIRQUE BARITE-ZINC-LEAD DEPOSITS, NORTHEASTERN BRITISH COLUMBIA

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INTRODUCTION

Several stratiform barite and barite-zinc-lead deposits have recently been discovered in Devonian carbonaceous shales in the Akie District of northeastern British Columbia (MacIntyre, 1980, 1981, 1982; Carne and Cathro, 1982). At present the most significant of these is the Cirque deposit (Figs.4.1, 4.3). The Cirque claims were staked in 1977 during a regional joint venture exploration program conducted by Cyprus Anvil Mining Corporation and Hudson's Bay Oil and Gas Company Ltd. Detailed geology and diamond drilling have outlined two significant Ba-Fe-Pb-Zn-Ag mineral deposits on the claim group.

The Cirque deposit (Figs.4.3, 4.4) is a lensoid, stratiform, barite-sulphide body 1000 metres long, 300 metres wide and 2 to 70 metres thick. Its northeastern margin is exposed at surface. Current drill indicated reserves are 40 million tonnes with an overall grade of 7.8% Zn, 2.2% Pb and 47 grams/tonne Ag. The southern fringe of the deposit is not yet drill defined.

The South Cirque deposit (Figs.4.3, 4.5) is a stratiform, barite-sulphide body approximately 1 kilometre southeast of the main Cirque deposit. It is not exposed at surface. Several diamond drill intersections over a length of 700 metres and a width of 250 metres, with thicknesses ranging from 2 to 30 metres, indicate a significant resource. This deposit remains open to the north, south and east.

This paper describes the geologic setting and mineral facies of both deposits with emphasis on the Cirque deposit. The discussion includes constraints and parameters bearing on any genetic model.

Regional geology in the vicinity of these deposits has been outlined by Cecile and Norford (1979), Fritz (1979), Gabrielse (1975, 1981), Gabrielse et al. (1977), and Taylor et al. (1979). Although MacIntyre (1980, 1981, 1982, this volume) has presented a descriptive overview of the Paleozoic strata, regional stratigraphic and paleontological control for the Devonian-Mississippian shales in the Akie District is limited.

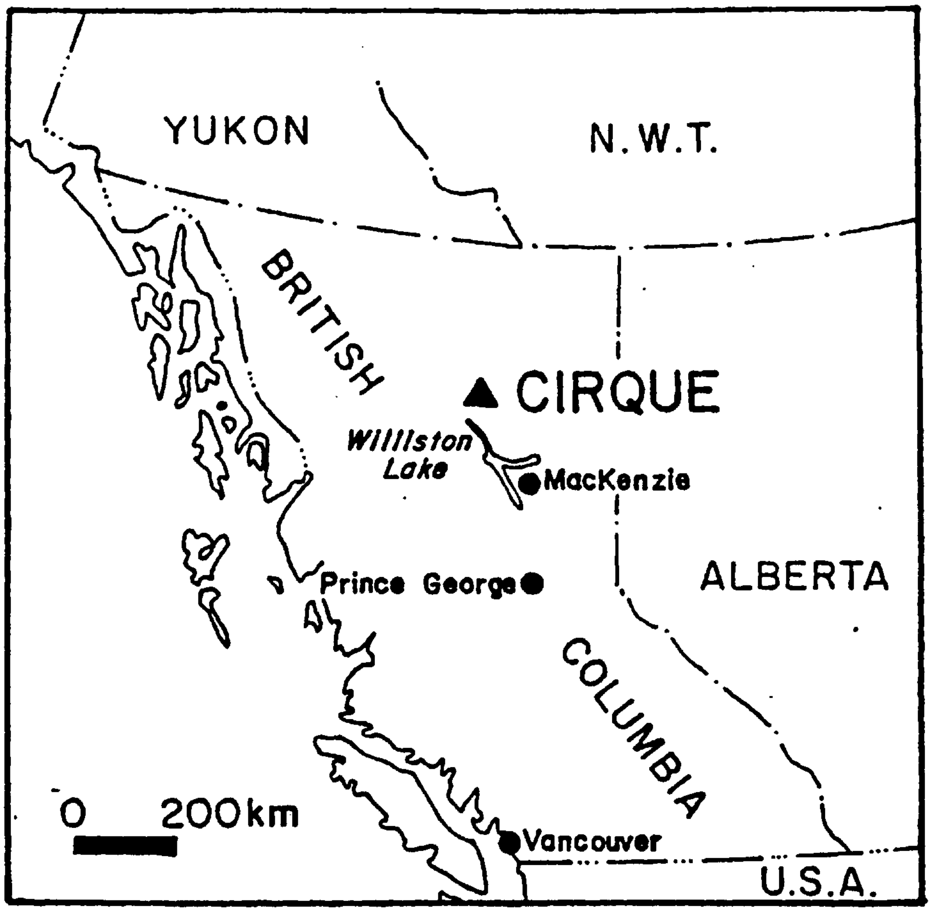

Fig. 4.1. Cirque location map.

REGIONAL GEOLOGY

Strata in the Akie District range in age from Cambrian through Triassic. Ordovician-Silurian rocks delineate a facies transition from shale basin sedimentation (southwest) to carbonate platform sedimentation (northeast) at least 25 km northeast of the Cirque claims (Cecile and Norford, 1979). Strata in the deposit area represent a laterally uniform basinal environment.

In contrast, rapid facies changes in Devonian-Mississippian strata indicate more localized, northwest-trending depositional troughs. Previously, the Devonian-Mississippian clastic rocks containing the deposits have been informally called "Black Clastics" (Taylor et al., 1979). Recently Gordey et al. (1982) described facies relationships for these strata along the eastern margin of Selwyn Basin and suggested using the term Earn Group after Campbell (1967), a convention adopted here. Although Earn Group rock types in Selwyn Basin are similar to those of the Akie District, facies relations are locally different.

Structurally the Cirque area is within the Rocky Mountain Fold and Thrust belt. The dominant structural style consists of tight, asymmetric, northeast-verging folds bounded by northeast-directed reverse faults. Devonian-Mississippian Earn Group strata are preserved in northwest-trending synclinal fold keels and thrust panels (Fig. 4.3). Deformation is considered to be broadly Laramide in age.

GEOLOGY OF CIRQUE CLAIMS

Stratigraphy

Fig. 4.2 summarizes the stratigraphy in the vicinity of the Cirque claims. The Silurian to Mississippian section is subdivided into several mappable units to which informal formational names have been applied.

The oldest rocks are a thick sequence of early Ordovician to late Silurian graptolitic, calcareous, black shales containing regionally

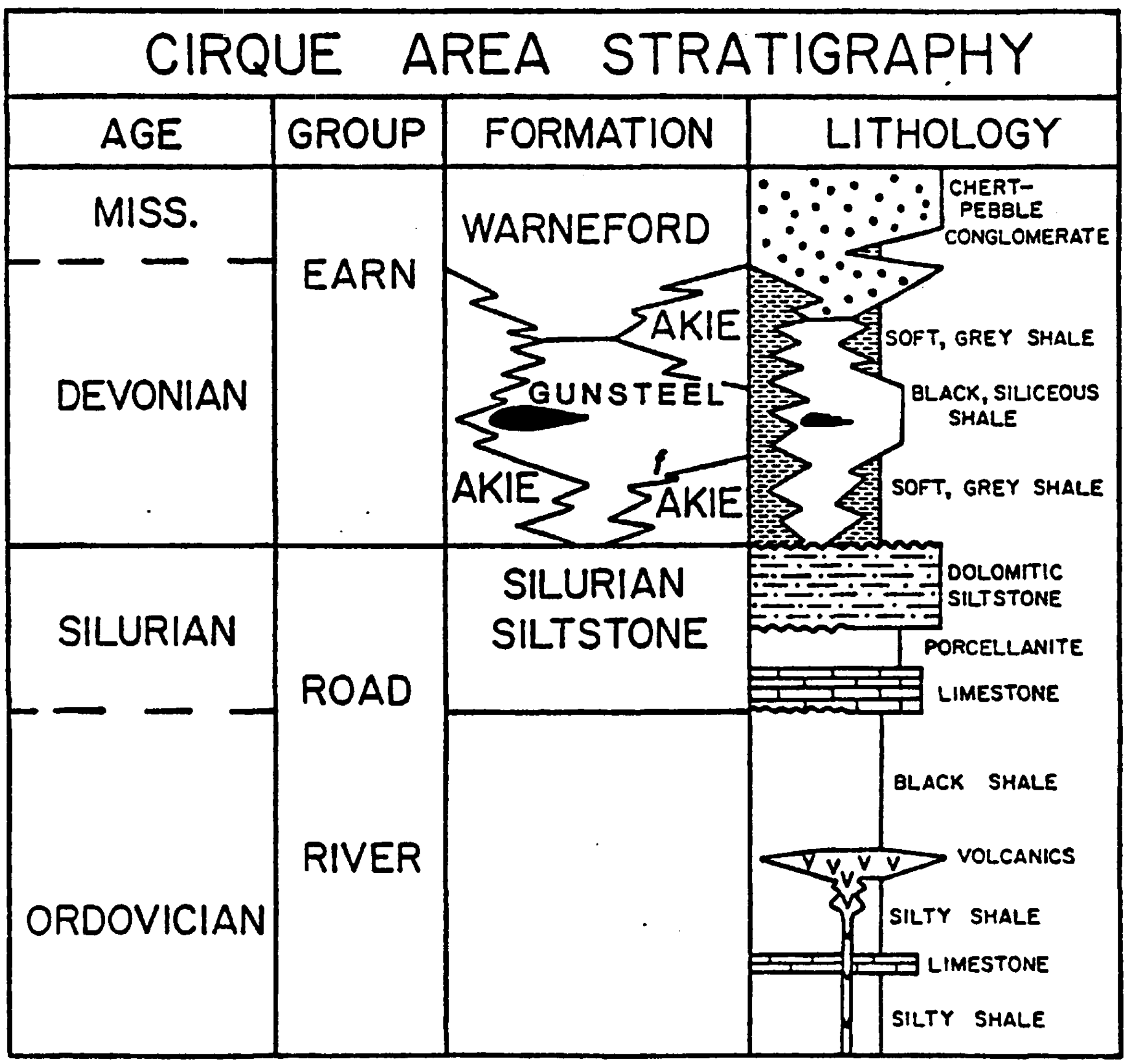

Fig. 4.2. Stratigraphy, Cirque area; mineral deposit in black. Position of dated ammonoid samples shown by symbol "f".

mappable turbiditic units of limestone, chert, quartzite and siltstone (Cecile and Norford, 1979). Correlation with the Selwyn Basin indicates that the shales and intercalated sediments are typical of the Road River Formation (Jackson and Lenz, 1962; Gabrielse, 1975, p.11). Following Gordey <u>et al</u>. (1982) the Road River Formation is here informally given group status. Because of the difficulties in distinguishing between

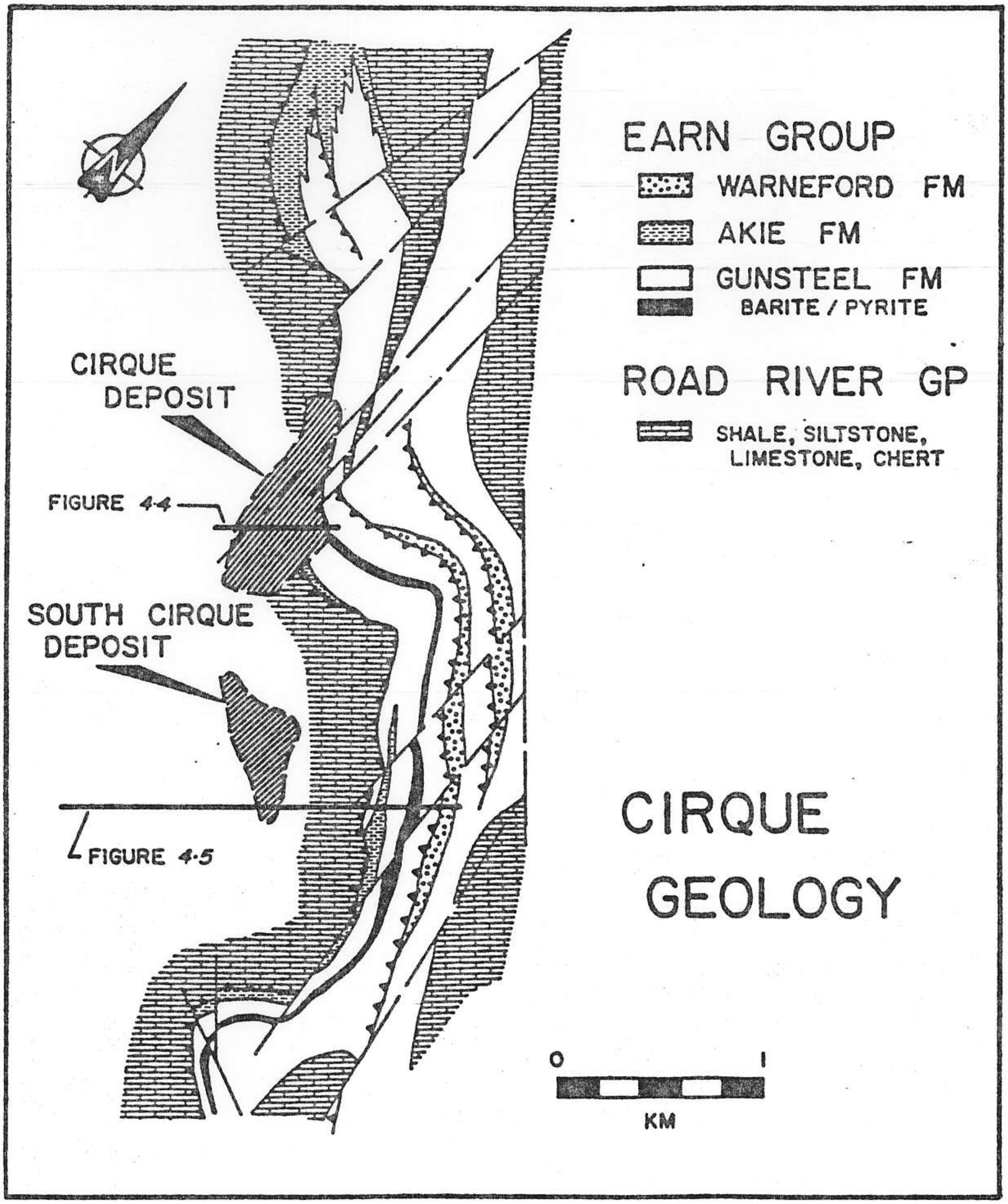

Fig. 4.3. Simplified geology map, Cirque area. Deposits are shown projected vertically to surface. Section lines for Figs. 4.4 and 4.5 are shown.

the graptolitic black shales of the upper Road River group and the sparsely fossiliferous black shales of the lower Earn Group, we have arbitrarily defined the top of the Road River group as the top of a prominant, tan-weathering, bioturbated, turbiditic, dolomitic siltstone of Silurian age (SD unit of Cecile and Norford, 1979). This corresponds to the definition of the Road River Formation proposed by Gordey et al. (1981) for the Selwyn Basin. It also roughly corresponds to a change in depositional conditions from a uniform broad-basin sedimentation pattern to localized troughs characteristic of Earn Group deposition.

The lower contact of Earn Group strata with the Silurian siltstone has been observed both in drill core and outcrop. The contact is normally sharp although locally it grades downward to a breccia containing angular to subrounded Silurian siltstone clasts in a shale to siltstone matrix. The presence of different Earn Group facies immediately overlying the Silurian siltstone suggests that the lower contact of the Earn Group is a diachronous onlap unconformity (see below).

The Earn Group has been divided (Fig. 4.2) into coarse clastic rocks (Warneford formation) and fine clastic rocks (Akie and Gunsteel formations). The Gunsteel and Akie formations are distinguished on the basis of hardness, colour, and weathering characteristics. Generally the Warneford and Akie formations everlie the Gunsteel formation, although in detail they are also interbedded with it.

The Gunsteel formation contains all carbonaceous, siliceous, fine clastic rocks within the Earn Group. It is typically planar laminated and weathers to a distinctive blue-grey or light blue-grey colour, especially on scree slopes. The Gunsteel is a regionally mappable, laterally extensive unit that forms the lower portion of the Earn Group, except near the Cirque deposits (see below). Thickness ranges from zero to more than 200 metres, and changes in thickness are locally abrupt.

The Gunsteel fermation has been divided into two main facies (Fig. 4.4). The most siliceous facies is ribbon-bedded, black porcellanite with thin carbonaceous shale partings spaced at 1-10 cm intervals. The porcellanite beds are silicified, carbonaceous, fine clastic rocks with siltstone laminae that include variably preserved, locally abundant radiolarians. These porcellanites are lithologically similar to deep-sea cherts and porcellanites which have been described from Mesozoic and Cenozoic sequences (Crerar et al., 1982; Pisciotto, 1981; Nisbet and Price, 1974; Von Rad and Rösch, 1974). Porcellanite members range from less than 1 m to more than 20 m in thickness and locally contain one or more horizons of blebby to laminated barite with pyrite. Barite horizons situated stratigraphically below the Cirque deposit contain the ammonoid Ponticeras which is an index fossil for earliest late Devonian (Frasnian) (W. Nassichuk, personal communication, 1978). The ribbon-bedded porcellanites occur mainly at the top and/or bottom of the Gunsteel formation (Figs. 4.4, 4.5).

The other major Gunsteel facies ie a noncalcareous, thick-bedded, black, siliceous shale, which has been informally called the "Pregnant Shale". Locally this shale contains nodules and/or concretions of pyrite, calcite, chert, or barite. Medium grey, slightly calcareous, graded, quartzose siltstone laminae are common and locally abundant.

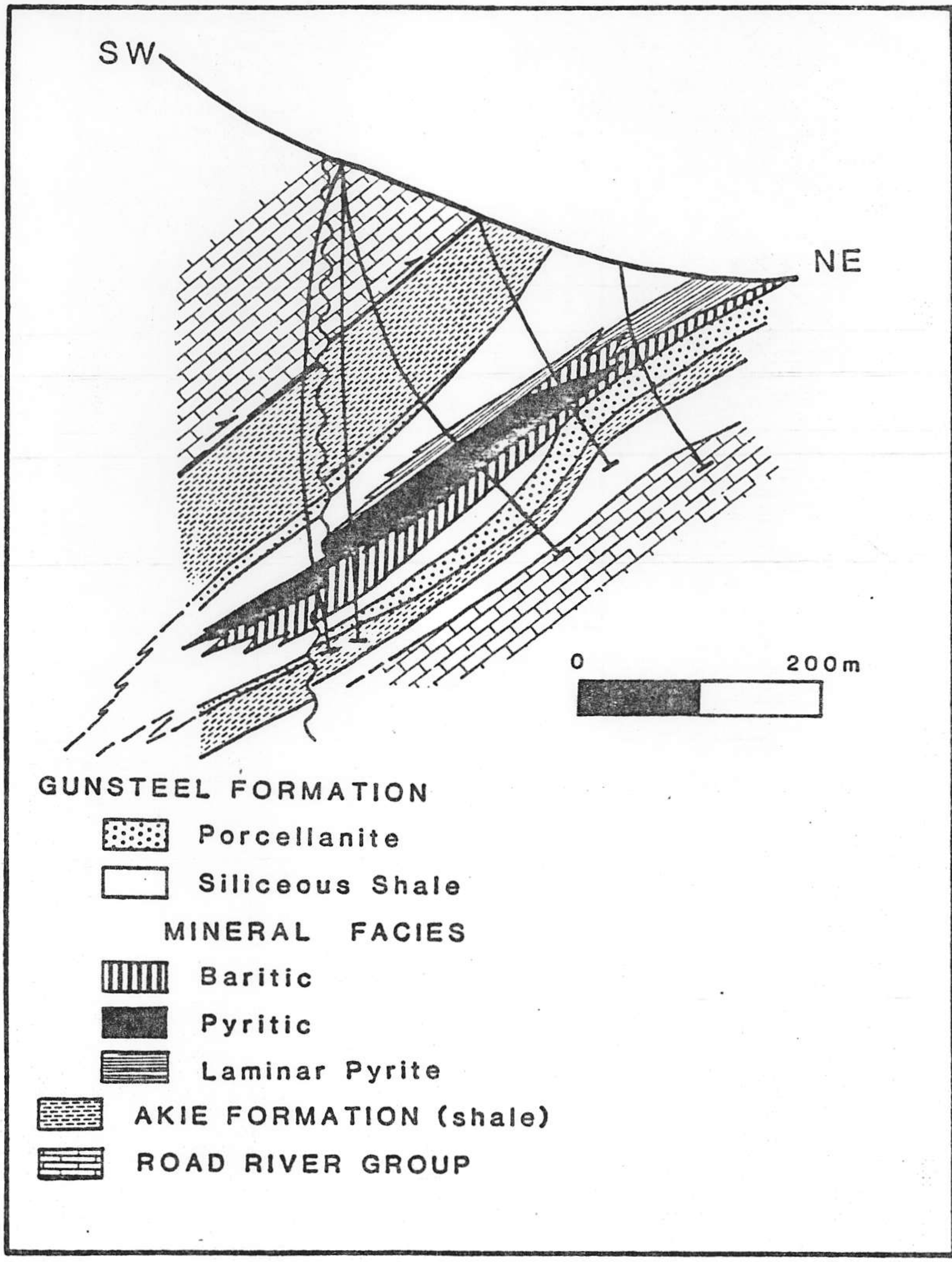

Fig. 4.4. Schematic vertical cross section through Cirque deposit. Line of section (297+50 N) shown on Fig. 4.3; view azimuth 320°. Down-dip information is projected from adjacent sections. Details of Akie and Gunsteel formations are discussed in the text.

The siliceous shale is the immediate host for the stratiform barite-sulphides on the Cirque claims. Regional mapping has shown that it is a laterally extensive unit occurring at or near the base of Earn Group. This unit is regionally unmineralized but locally is anomalous in lead and zinc adjacent to the Cirque deposits and other showings in the Akie District. This geochemical anomaly is caused by thin beds of laminated framboidal pyrite with minor sphalerite and galena. These beds are laterally equivalent to part if not all of the barite-sulphide interval (see Mineral Facies).

The Gunsteel is a locally symmetrical sequence enveloping the Cirque barite-sulphide deposits. It pinches out rapidly to the northwest (Fig. 4.3) and southwest (Fig. 4.4). To the east and northeast it maintains a thickness of 100 to 300 metres. Facies variations within the Gunsteel are locally abrupt. Within the porcellanite members, the most extensive barite horizons are east and northeast of the Cirque deposit.

All nonsiliceous shales in Earn Group have been included within the Akie formation. Akie shales are planar laminated, generally medium grey and soft to extremely soft. They become dark grey, graphitic and moderately hard southwest of the Cirque deposit. Commonly, the shales weather to pale grey and rusty-brown lenticular flakes.

On the northwest, west and southwest margins of the Cirque and South Cirque deposits, the Akie and Gunsteel formations are intercalated with siltstone which is included in the Akie formation. The siltstone also occurs as thin interbeds within the deposits. It is soft, variably calcareous, speckled, planar to irregularly laminated and burrow mottled. Clastic grains are mainly carbonate with minor quartz. The siltstone is variably brecciated and silicified adjacent to and within the mineral deposits. A thick siltstone and shale sedimentary breccia lies immediately below the South Cirque deposit and is silicified only at the top contact with barite-sulphides. Akie shales and siltstones immediately overlie the Silurian siltstone beneath and down-dip of the Cirque deposits. Along strike and up-dip of the deposits these lower members of the Akie formation pinch out; and the Gunsteel formation directly overlies the Silurian siltstone.

Coarse clastic rocks in the Earn Group are included within the Warneford formation. The Warneford is virtually absent in the immediate vicinity of the Cirque deposits but is well represented in the structural panel immediately to the east (Figs. 4.3 and 4.5). Several distinctive facies are recognized in the Warneford formation. The dominant facies consists of moderately hard to soft, grey to black shale, characterized by intraformational breccia and lenses to discontinuous laminae of pyritic, quartzose siltstone. Large composite lenses of coarse sandstone and chert pebble conglomerate are locally present within this facies. This unit commonly weathers to a medium-light blue-grey colour. Chert clasts are black, grey, white, and rarely pink or green.

The uppermost Warneford facies is a thick-bedded, soft, grey, silty shale which weathers to a distinctive dark rusty brown. This shale is characterized by the occurrence of numerous planar beds of tan weathering, cross-laminated, quartzose, pyritic siltstone to sandstone.

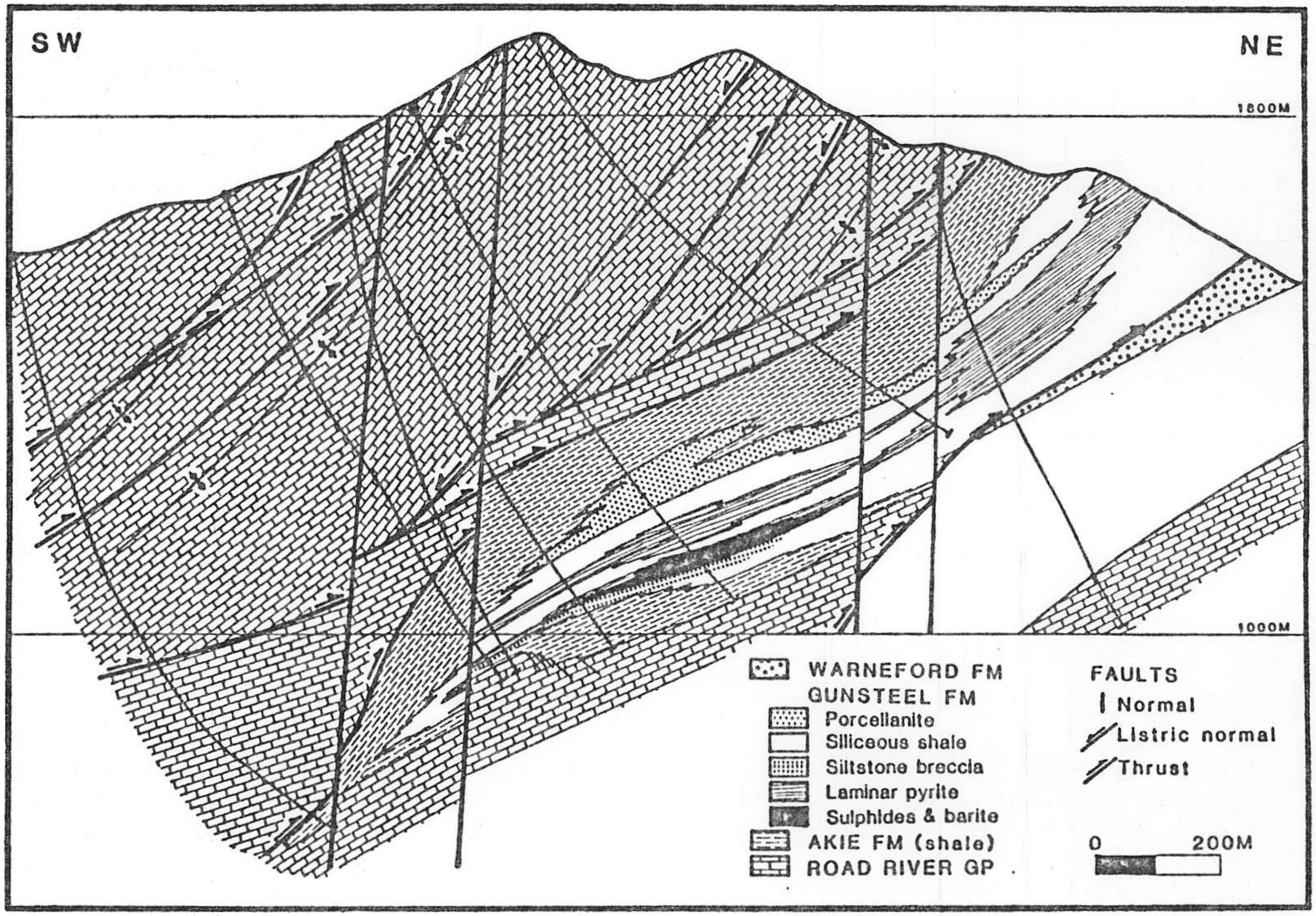

Fig. 4.5. Schematic vertical cross section through South Cirque deposit. Line of section (283+00N) shown on Fig. 3; view azimuth 320^{o}. Details in the panel containing the deposit are described in text. Note unmineralized, undifferentiated siliceous shale below eastern thrust.

Structure

Both Cirque and South Cirque mineral deposits occur within an upright southwest-dipping limb of Earn Group strata overthrust by a structurally complex panel of highly imbricated Road River group strata (Figs. 4.3, 4.5). Primary bedding (S_0) within the slightly imbricated Earn Group panel dips moderately to the southwest. Small scale minor folds with overturned southwest-dipping limbs occur only locally within this panel.

In contrast to the coherent style of the Earn Group panel, the overlying Road River panel contains numerous, isolated synclines and anticlines bounded by high angle reverse faults. These reverse faults flatten to the southwest and are rooted in the thrust fault separating the two panels. These relations are shown in Fig. 4.5.

All stratigraphic units contain a pervasive southwest-dipping cleavage (S_1) which is axial planar to macroscopic folds. Reverse faults are subparallel to this cleavage. In shales, S_1 forms a slaty cleavage, and in siltstones, limestones, and porcellanites it consistently forms a closely spaced fracture cleavage. Cleavage-bedding relations have been used to help outline macroscopic folds and structural discontinuities within the structural panels.

Two styles of late normal faults have been interpreted. Listric normal faults are subparallel to the reverse and thrust faults. These faults are restricted to the overlying Road River structural panel and appear to be rooted in the high angle reverse faults (Fig. 4.5). They do not extend into the Earn Group structural panel and therefore do not disrupt the mineral deposits. Numerous arrays of steeply dipping to vertical, planar, normal faults cut across all stratigraphic units. They provide conduits for springs which cause many of the gossans in the Akie District.

GEOLOGY OF THE CIRQUE DEPOSIT

Stratigraphy and Mineralogy

Cirque is a bedded barite deposit with a continuum of facies from nearly 100% barite to nearly 100% sulphides. The deposit contains several interbeds of siliceous, carbonaceous shale and siliceous siltstone that can be locally correlated among the drill intersections. Overall these interbeds constitute less than 10% of the deposit. The siltstones ane mainly restricted to the deposit, but on the northwest and west boundary they form thick units in the adjacent shales and extend into the deposit as interbeds. Most of the siltstone interbeds are intraformational breccias with a shale-siltstone matrix.

Contacts between clastic rocks and the mineral deposit are depositional and visually abrupt. Gradational contacts occur where siltstone intraformational breccias within the deposit consist of siltstone clasts in a sulphide-rich matrix. These breccias generally grade into bedded sulphides. Sulphide clasts are absent from these breccias. Locally the contact between the mineral deposit and the enclosing siliceous shale

Table 4.1. Grades of mineral facies, Cirque deposit, from assay of three composite samples, from 29 drill intersections. Specific gravities (S.G.) were determined for selected typical samples.

FACIES	Pb(%)	Zn(%)	Ba(%)	Fe(%)	Ag(g/t)	S.G.
Baritic	1.3	6.2	40.7	6.2	33	4.2-4.4
Pyritic	3.3	11.1	19.4	17.9	73	4.4-4.7
Laminar Banded Pyrite	0.6	4.0	2.0	--	24	2.7-3.1

is a gouge or shear zone. Stockworks, disturbed bedding zones, or alteration halos are not visible within the surrounding Gunsteel formation, although minor barite and sulphide veins have been intersected in the footwall in two places.

Major minerals in decreasing order of abundance are barite, pyrite, sphalerite and galena. Microprobe and polished section studies of core samples and concentrates have failed to locate a silver mineral. Presumably the silver is present through substitutional solid solution within pyrite, sphalerite, and galena. Copper minerals have not been observed. Very little carbonate is present within the deposit.

Mineral Facies

Three major facies are recognized within the deposit (Table 4.1). The baritic and pyritic facies constitute most of the deposit; laminar banded pyrite occurs dominantly as a fringe facies within the siliceous shale.

The baritic facies consists of pale grey to white, diffusely laminated, fine to medium grained barite with less than 40 percent sulphides. Sulphides occur as discontinuous 1-5 mm thick, wavy, lenticular laminations of pyrite, sphalerite and minor galena. Sulphide laminae are concentrations of framboidal pyrite in a matrix of interlocking barite and sphalerite grains. Framboids range from single grains to 25 micron clusters. Galena is remobilized and commonly occurs at grain boundaries and as fracture fillings in barite. The spatial associations of sphalerite with pyrite, and galena with barite are consistent throughout the baritic facies. A small proportion of the baritic facies is intraformational breccia of barite with a shale and sulphide matrix.

The pyritic facies is distinguished from the baritic facies by its greater sulphide content (>40%) and higher lead-zinc-silver grades (Table 4.1). The pyritic facies ranges from diffusely interbedded sulphides and barite to nearly 100% sulphides. Mineralogy consists of pyrite, barite, sphalerite and galena. Pyrite occurs as framboidal clusters with subhedral pyrite overgrowths. Fractures in the large pyrite grains are filled by sphalerite and galena (K. McClay, personal communication, 1982). Irregular colloform aggregates of pyrite (20-50 microns in diameter) with galena and sphalerite interlayers and sub-

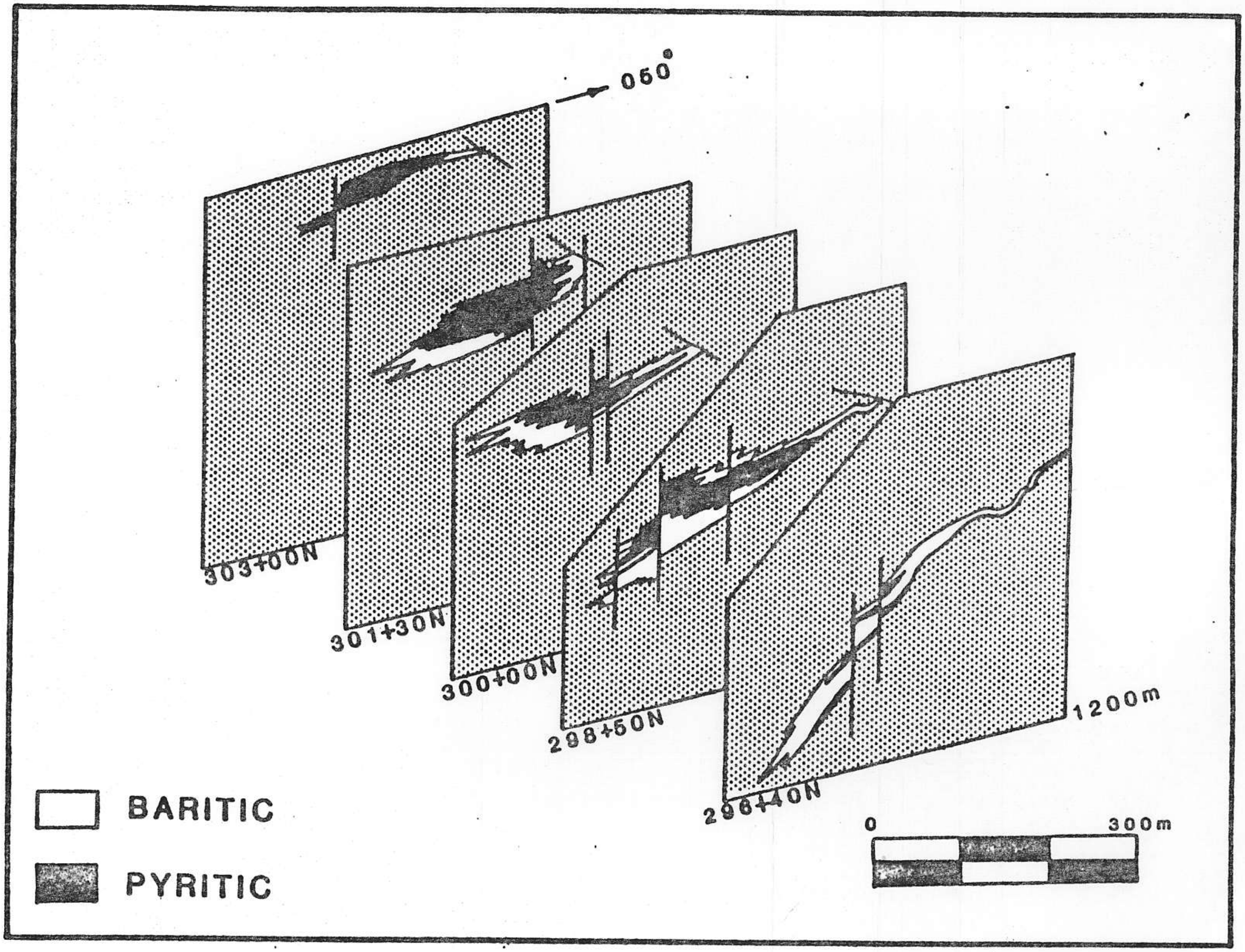

Fig. 4.6. Mineral facies distribution on selected 050° sections, Cirque deposit.

spherical atoll structures with pyrite-rimmed cores of galena or sphalerite are also seen. Sphalerite occurs as interlocking grains with pyrite and as fine-grained laminations within the pyrite beds. Cross-cutting sharp-edged veins te diffuse pods of coarsely crystalline barite with patches of coarsely crystalline galena are restricted to the pyritic facies.

The laminar banded pyrite facies consists of 0.1 to 1.5 centimetre interlaminae of pyrite and black siliceous shale. Individual pyrite laminae are densely disseminated, 20 micron, spheroidal, granular framboids of pyrite in a matrix of siliceous shale with sparse granular sphalerite and galena.

Mineral Facies Distribution

Fig. 4.6 illustrates the overall facies distribution within the Cirque deposit. In plan, the pyritic facies predominates in the north end of the deposit, and baritic facies predominates in the south. In cross section, the position of the pyritic facies trends from the top of the deposit in the west to the bottom in the east. This facies change appears to be diachronous relative to siltstone interbeds that cut the facies boundaries. Within the overall facies distribution, thin units of the pyritic facies commonly occur immediately adjacent to the siltstone interbeds.

The laminar banded pyrite occurs as a fringe facies and minor constituent of the Cirque deposit (Fig. 4.4). This facies is located primarily to the east and immediately above the deposit. Individual pyrite beds appear to thicken from east to west, towards the upper eastern edge of the deposit and are interpreted as lateral equivalents of most if not all of the barite-sulphide mass.

Trend Maps

Contour maps of isopachs, overall lead+zinc grades, zinc/lead ratios and overall silver grades were plotted using 42 diamond drill intersections. In each case, the borehole and the individual intersection were plotted in plan and the appropriate value was assigned to the center of the intersection. True thicknesses were calculated from apparent thicknesses in drill cere and checked on cross-sections. Weighted averages were calculated for tha entire intersection.

The axis of thickest barite and sulphides (Fig. 4.7A) trends northerly and is near the western margin of the deposit. Thickness decreases more rapidly to the west than to the east. A contour map of the average combined lead+zinc grades (Fig. 4.7B) shows that the axis of highest grade material lies just east of the thickest portion of the deposit and is skewed to the northwest. The axes of best grade and greatest thickness coincide in the northern end of the deposit where grades are uniformly high. The zinc/lead ratio map (Fig. 4.8A) shows a zinc-rich western margin with increasing lead content to the east. The highest grades and thickest portions of the deposit heve a

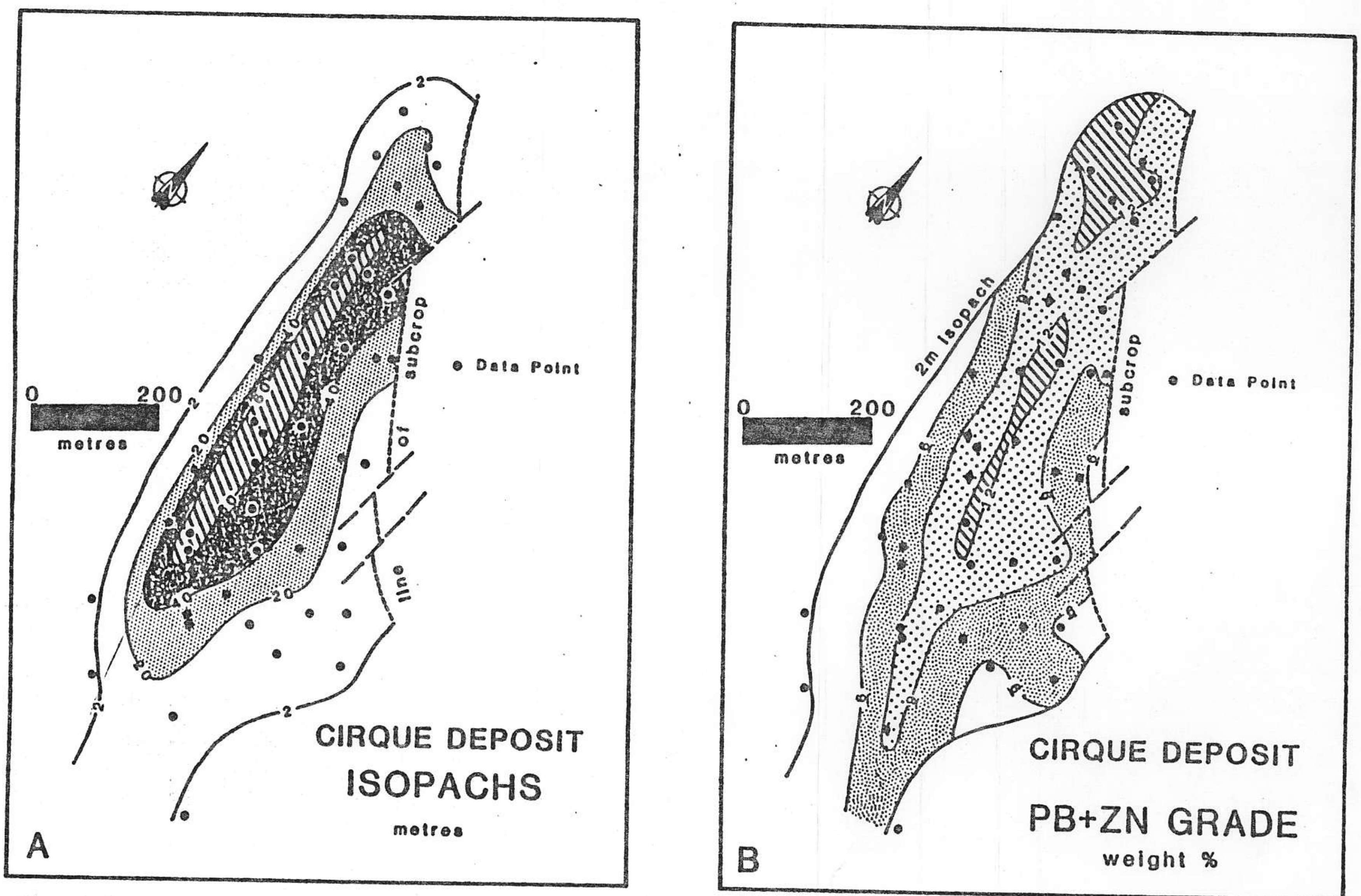

Fig. 4.7. Cirque trend maps: A) Isopach with contours at 2, 20, 40 and 60 metres.
B) Pb and Zn grades contoured at 6.0, 9.0, 12.0 combined wt % Pb+Zn.

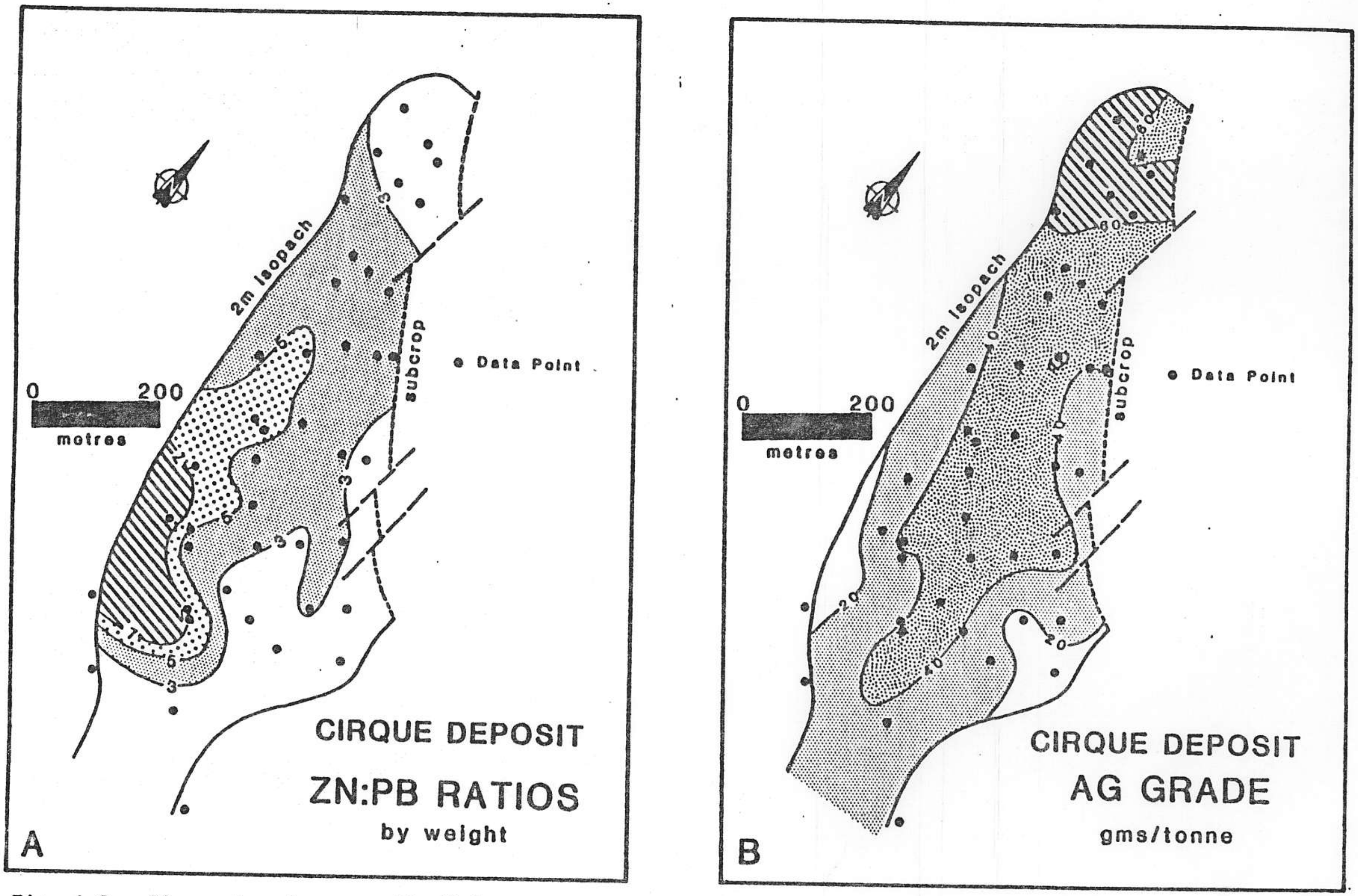

Fig. 4.8. Cirque trend maps: A) Zn/Pb ratios contoured at 3, 5, 7 by weight.
B) Ag grades contoured at 20, 40 and 60 grams/tonne.

zinc/lead ratio of between 3 and 4. Silver content (Fig. 4.8B) correlates directly with the highest lead+zinc grades. The highest silver grades occur in the northern end of the deposit where the pyritic facies predominates.

GEOLOGY OF SOUTH CIRQUE DEPOSIT

The South Cirque deposit is similar in many respects to the Cirque deposit. They belong to the same barite-sulphides continuum with the same facies subdivisions. Barite and sulphides in both deposits have a conformable interbedded relationship with the host Gunsteel siliceous shales. Both are lenticular and have a fringe laminar banded pyrite facies. The two deposits also have 1 to 3 m interbeds of siltstone and siltstone breccia, with thick siltstone units to the west, northwest and southwest.

Differences between the two deposits consist of facies variations within and adjacent to them. In South Cirque the pyritic facies is commonly calcareous. In addition to the fringe laminar banded pyrite facies present in both deposits, South Cirque also contains thick laminar banded pyrite units above the barite and sulphides (Fig. 4.5). Thick laminar banded pyrite east of the South Cirque deposit (Fig. 4.5) cannot be compared to Cirque, because facies immediately east of the Cirque deposit have been eroded (Fig. 4.4). The South Cirque deposit is immediately underlain by an extensive siltstone breccia unit; this breccia is thin and discontinuous beneath the Cirque deposit. Down-dip from the South Cirque, this siltstone breccia contains bedded sphalerite and pyrite. This feature cannot be compared to siltstones down-dip of the Cirque deposit due to insufficient drilling. Porcellanite, which occurs below and above the Cirque deposit, is present only above the South Cirque deposit.

DISCUSSION

Several constraints can be placed on a genetic model for the Cirque deposits. Important parameters that must be considered are summarized in Table 4.2 and discussed in more detail in the following section. Underlying this discussion is the implicit (but very essential) assumption that the deposits have a syngenetic-diagenetic origin. This assumption is based on the stratiform-stratabound nature of the deposits, the interlayering of barite and sulphides with fine clastic rocks on all scales, and the occurrence of delicately laminated, framboidal pyrite containing minor galena and sphalerite in the shales adjacent to the deposits.

The overall sedimentation rate for shales in the vicinity of the deposits was probably quite low. Shales between the top of the Silurian siltstone (approximately 400 Ma, Cecile and Norford, 1979) and the Gunsteel porcellanite containing Ponticeras (358 Ma) range from 20 tb 150 metres thick. This corresponds to an average sedimentation rate of 0.5 to 4 metres per million years. Although lacking detailed paleontologic control, this is similar to the overall sedimentation rate for Late Devonian tn Mississippian starved basin facies in Utah (Sandberg and

Table 4.2. Constraints on genesis of Cirque deposits.

1. Background sedimentation rate corresponds to that of a starved basin.
2. Paleotopographic relief on the basin floor was high in the vicinity of the deposits.
3. Main Cirque deposit is an extremely thick, asymmetric stratiform lens interdigitated with siliceous shales at its margins, but lacking shale interlaminae within the deposit.
4. Both deposits are spatially associated with silicified, brecciated and laminated siltstones.
5. Main Cirque deposit occurs in southwest part of an asymmetric envelope of siliceous shale and porcellanite that contain radiolarians.
6. Both deposits are fringed by zinc-lead-bearing laminar banded pyrite.
7. Blebby to laminated barite occurs in porcellanites above, below and east of the main deposit. This barite is separate from the deposit.
8. Vents or alteration halos have not been recognized.
9. Deposits are crudely segregated mixtures of barite and sulphides.
10. The Cirque deposit is asymmetrically zoned in distribution of the overall mineral facies continuum and metals.

Gutschick, 1979).

Pinch-out of the lower members of the Akie formation to the immediate north, east and south of the Cirque claims suggests a depositional basin that was somewhat isolated from others in the Akie District. Local variations in thickness of Earn Group strata within the Cirque claims indicate that the Devonian erosional surface, as represented by the uppermost contact of the Silurian siltstone, had significant local topographic relief (e.g. Fig. 4.5). These abrupt topographic variations suggest the presence of sub-basins although they cannot be directly correlated with the geometry of the mineral deposits.

Depositional sub-basins related to each deposit can be inferred from the geometric and lithologic character of the deposits. High specific gravities and the virtual absence of shale interlaminae in the baritic and pyritic facies indicate that deposition of barite and sulphides was an order of magnitude faster than that of the enclosing siliceous shale. Unless the baritio and pyritic facies were lithified immediately, a topographic depression would have been required to contain them. Any such basin could not have been deep enough at one time to accommodate the entire Cirque deposit because improbable depositional slopes of 20° to 60° would have been required to contain the asymmetric barite-sulphide lens. A reasonable depositional model for the deposits would therefore include the development of shallow sub-basins with continued subsidence being roughly equivalent to the rate of infilling by barite and sulphides.

The tbick siltstones and siltstone breccias within and adjacent to the deposits suggest further refinements to this model. Siltstone units thicken rapidly west of the Cirque deposit and their overall shape resembles that of a clastic wedge. Such a wedge may have formed the west margin of the sub-basin containing each deposit. The siltstone breccias occur only in the immediate vicinity of the mineral deposits. It is likely that they represent Akie siltstones that were proximally brecciated and silicified during deposition of the barite and sulphides. The presence of clastic breccias and mesoscopic clastic wedges suggests proximal growth fault(s) to the west of the mineral deposits. Individual movements of the growth faults could have generated the siltstone interbeds.

Empirically the ribbon-bedded porcellanites and siliceous shales of the Gunsteel formation are spatially associated with the mineral deposits. The Gunsteel formation locally contains abundant, well preserved radiolarians. Lithologically similar thin-bedded cherts and siliceous muds from Mesozoic and Cenozoic marine environments have been recovered from the deep-sea drilling program (Von Rad and Rösch, 1974; Pisciotto, 1981). In these cases the siliceous sediments resulted from diagenetic alteration of accumulations of tests of siliceous organisms. Conversely the distinctive lithologic characteristics of inorganic hydrothermal cherts described in the Franciscan Formation (Crerar <u>et. al</u>., 1982) are not present in the Gunsteel formation or the deep-sea cherts. The siliceous nature of the Gunsteel formation, therefore, is biogenic in origin and by itself does not appesr to represent excessively abnormal depositional conditions.

In fact, the major "abnormality" of the siliceous Gunsteel formation is that it pinches out down-dip and along strike from the Cirque deposits. This spatial association might be related to mass kills (Kanmera, 1974) or organic blooms resulting from exhalative activity. Another possibility is that the radiolarian-rich sediments might have been preferentially deposited within the catchment srea of the postulated mineral deposits sub-basins (e.g. Nisbet and Price, 1974). Preferential preservation of biogenic silica due to silica-rich bottom waters is yet another possibility that must be considered (Garrison, 1974, p.375). Whatever model is used for the formation of the siliceous sediments must account for the fact that the Gunsteel formation, though highly variable in thickness, is regionally widespread and also occurs where no mineral occurrences have been discovered.

Conclusive evidence of a vent or feeder zone for the mineral deposits has not been found. The extension of the siliceous facies, the laminar banded pyrite and barite horizons east of the Cirque deposit suggests that gentle currents or ocean floor topographic gradients transported the metalliferous brines in that direction. The overall thickness of the deposit and the fringe laminar banded pyrite facies also tail off to the east. These features suggest that the vent for the Cirque deposit was located beneath the axis of greatest thickness in the western portion of the deposit (Fig. 4.7A).

Intermixing of barite and sulphide minerals in the Cirque deposit is contrasted with the separation of sulphide minerals and barite in other deposits of this type, such as Meggen (Krebs, 1981) and Tom (Carne, 1979). Models developed for these deposits cannot be directly applied to Cirque.

The Cirque deposit also contains internal zonation in distribution of mineral facies and metal ratios (Fig. 4.7). The zonation suggests that the deposit is related to a unique hydrothermal(?) vent. By analogy with the Sullivan deposit (Freeze, 1966; Hamilton et al., this volume), the Zn/Pb ratios for Cirque indicate that the vent is located near the Pb-rich east side of the deposit. This contrasts with the vent position inferred from overall stratigraphic and topographic arguments. Theoretical and experimenal work with transport of galena and sphalerite in chloride brines shows that metal zoning is highly dependent on the ultimate source of the metals (Anderson, 1973). At Cirque, therefore, metal zoning by itself cannot be used to locate a vent because the source and composition of the mineralized brines is not known.

The absence of copper minerals, the preservation of pyrite framboids, and the absence of a hydrothermal alteration halo all suggest a low temperature for mineralization. These criteria must be viewed with caution, however, as the lack of chalcopyrite may be related to chemical factors in the source area for the brines. Similarly the lack of an alteration facies may alternatively be explained by inferring a distal vent or structural removal of the appropriate rock types.

In summary, the Cirque deposits appear to be related to isolated basins or sub-basins within a larger northwest-trending depositional trough. Sedimentation rates correspond to those of starved basins. Indirect evidence suggests that at least part of the basin development was related to growth faults with contemporaneous clastic submarine fan development. The siliceous Gunsteel formation is spatially, and may be genetically, related to the barite-zinc-lead deposits. A discrete hydrothermal vent is inferred for each deposit. Gentle currents and bottom topography influenced the distribution of materials produced from, or in association with these vents. Further drill testing, geochemical analyses, paleontologic control and a better understanding of the above mentioned zonations are needed before a genetic model for these deposits can be finalized.

ACKNOWLEDGEMENTS

The authors are listed in alphabetic order and have contributed equally to this paper. Discussions with H. Gabrielse, G. Taylor, S. Gordey, M. Cecile, R. Thompson and B. Norford have improved our understanding of the stratigraphy. G. Gorzynski, B. Youngman and V. Sterenberg have contributed to our knowledge of the Cirque area. M. Watkins typed the manuscript. Reviews by G. Simpson, D. Jennings and D. Sangster improved the manuscript. The Mineralogical Association of Canada is acknowledged for making possible our participation in this short course. Cyprus Anvil Mining Corporation is thanked for permission to present these ideas which nevertheless remain the full responsibility of the authors.

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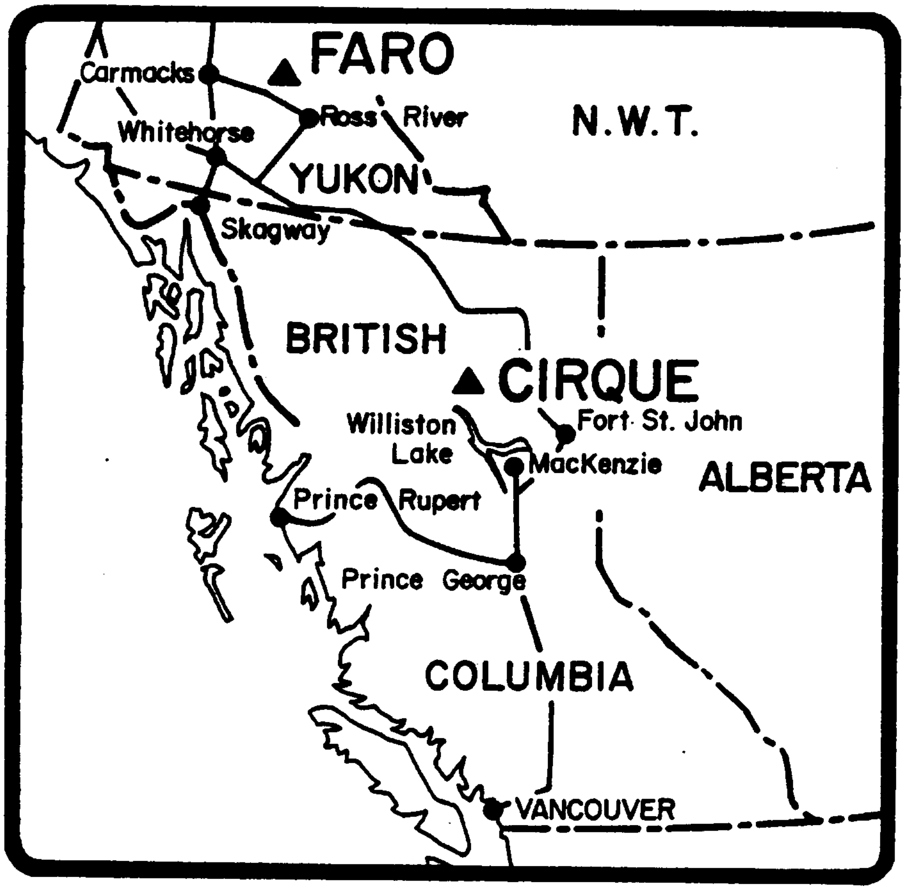
MAJOR "SHALE HOSTED" MASSIVE SULPHIDE DEPOSITS
SELWYN BASIN - YUKON + B. C.

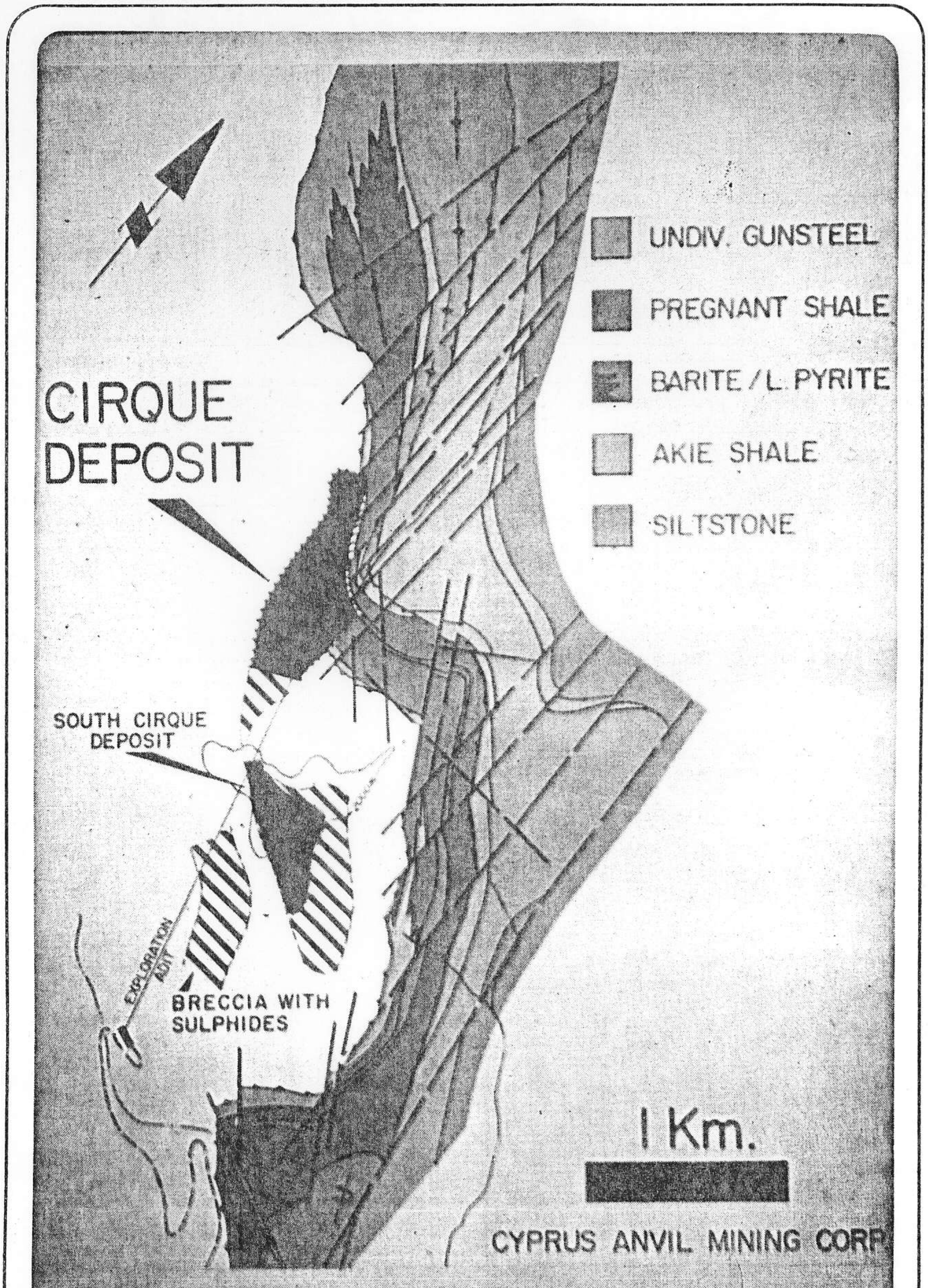
DISTRICT	AGE	DEPOSIT	MINEABLE RESERVES PROVEN (M̄ TONS)	GRADE % Zn	% Pb	oz Ag	% Cu	LENGTH x WIDTH (m)	THICKNESS AVERAGE	MAX	DIAMOND DRILLING (m)	POTENTIAL RESERVES TOTAL (M̄ TONS)	SOURCE/DATE DAY/MONTH/YEAR	COMMENTS
ANVIL	LOWER CAMBRIAN	FARO	65.7	5.7	3.4	1.2	.16	1350 x 700	45		13,000		Dome 1/1/82	Three lenses Open Pit Production Started 1969
		GRUM	34.3	4.9	3	1.5		1200 x 300	60		62,300 +1,036 Decline +1,880 Drifting		1/1/82	Two Lenses
		VANGORDA	6.0	4.3	3.3	1.5	.3	760 x 150	8 to	70	13,400		1/1/82	
		DY	21	6.9	5.6	2.7		1680 x 670	6 to	60	41,470	50 to 100	AC 1982	Two Lenses From 650 to 900 m
		SWIM	5	9.5 comb.		1.5	Tr	450 x 150	20	85	7,400		AC 1981	
MAC(MILLAN) PASS	UPPER DEVONIAN (FRASNIAN)	TOM WEST EAST	7.8 3	7.2 8.5	4.5 11.5	1.3 4.5	Tr	1200 x 400+ 170 x 200	3 to 3 to	60 6	12,543 +Decline	Open Down Dip	HBMS 6/82	Dips 70° W Vertical
		JASON SOUTH MAIN	7.7 2.6	5.2 13.4	9.4 1.2	3.5 Low		 1000+	 2 to	19 20	±7,800+	400	AC 1980 +Pers.Comm.	At depth of 400 m+
HOWARDS PASS	LOWER SILURIAN (LLANDOVERIAN)	HOWARD PASS (XY Highest Grade Portion	125 9	5.4 10.6	2.1 5.5	<0.5 -)		7600 x 2450	16.8	Av.	22,160 +1,294 Adit		Placer + Cygnus 1982	Applies to XY and ANNIV deposits only
GATAGA (CIRQUE)	UPPER DEVONIAN (FRASNIAN?)	CIRQUE (of which SOUTH CIRQUE	40 13.7 10	8.0 11.0 Similar to Cirque	2.2 3.2	1.5 2.3)		1000 x 300 700 x 250	2 to 2 to	70 30	36 DDH 50,000± 7 DDH 6,000±	Open to S 70 20	Dome 3/1982	
OTHER	UPPER DEVONIAN	CLEAR LAKE (of which	58 3.5	3.4 comb. 14.5 comb.		.3 1.5		900 x 350+		90	5,100+	Open at Depth	Pers.Comm. Getty 15/3/83	Mostly pyrite ore body

Compiled by L. Dekker 15/3/83

CYPRUS ANVIL

CIRQUE




CIRQUE DEPOSIT
UNDIV. GUNSTEEL
PREGNANT SHALE
BARITE / L. PYRITE
AKIE SHALE
SILTSTONE
SOUTH CIRQUE DEPOSIT
EXPLORATION ADIT
BRECCIA WITH SULPHIDES
1 Km.
CYPRUS ANVIL MINING CORP.

SUMMARY

A major lead-zinc-silver district has been identified in the Akie district, some 230 kilometers north of Mackenzie in northeastern British Columbia.

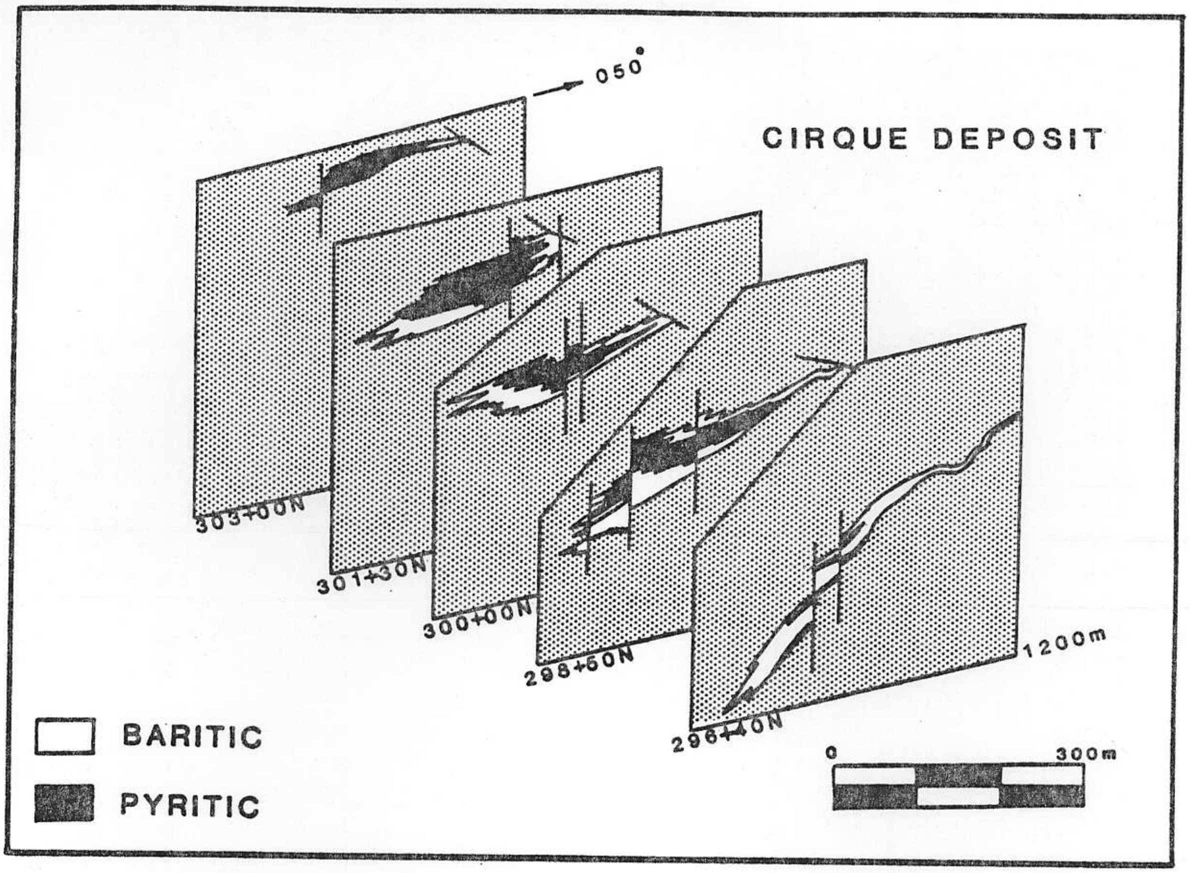
The Cirque Deposit, which contains a current reserve of 40 million tonnes of 10% combined lead-zinc with 47 grams per tonne silver, still remains open to the south.

Additional reserves have been outlined on the Cirque property. The South Cirque Deposit, discovered in 1982, has been intersected by seven drill holes with an estimated resource and target zone potential of 20 million tonnes. A drill hole collared to intersect mineralization 200 meters down-dip from surface barite-sulphide mineralization on the Fluke claims outlined several narrow sulphide horizons over a 20 meter thickness of siltstone breccia identical to the formation hosting the South Cirque Deposit.

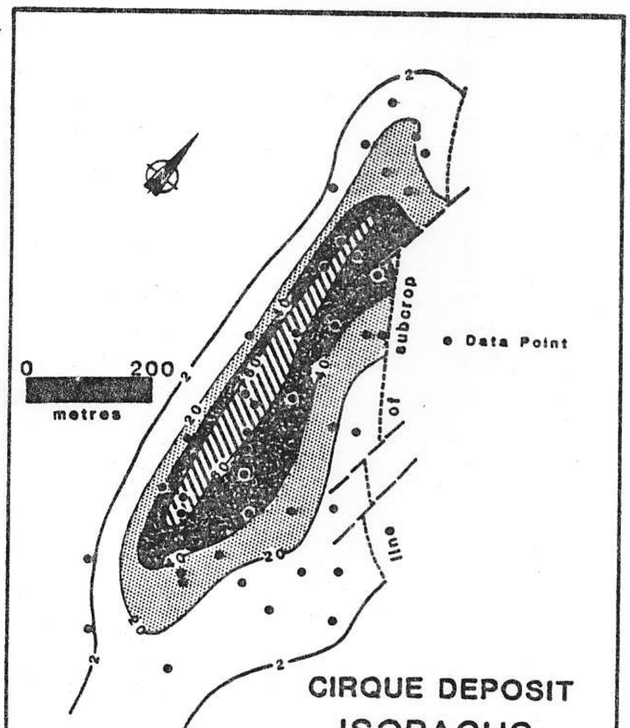
Total expenditures in the Akie District are approximately $21 million, of which $17 million has been capitalized on the Cirque property. Work includes 62,000 meters of diamond drilling, completion of a 1,600-meter airstrip, construction of 87 kilometers of all-weather road and purchase of capital equipment to support an underground exploration program.

The early identification of the South Cirque Deposit enhances the viability of a future mining scheme by not only outlining additional reserves, but by delineating zones of higher grade material that lie along the contemplated route of the Cirque production adit. Another year of surface diamond drilling is required to define the reserve potential and distribution of grade within the South Cirque Deposit, from which an optimum schedule for underground development of the property can be determined.

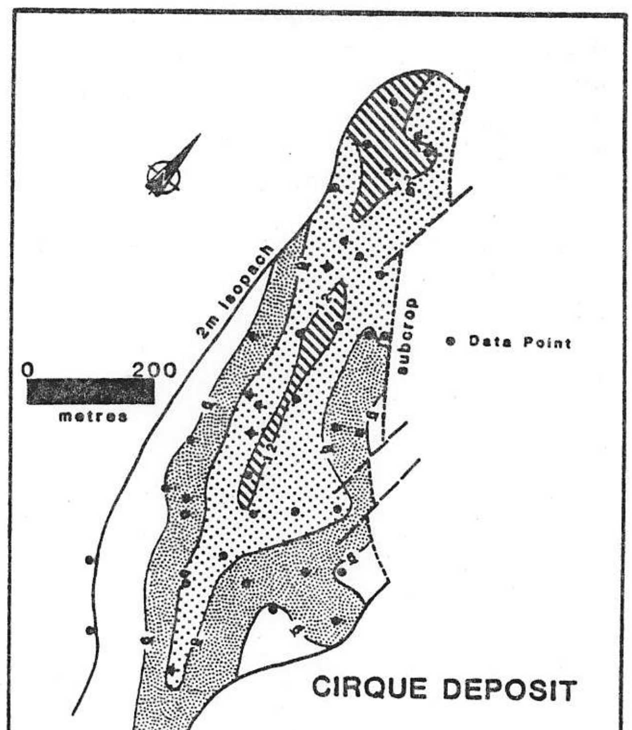
The magnitude of the ultimate project can be compared to the Anvil mining operations. Additional tonnage outlined on the Cirque and potential reserves on the Elf and Fluke claims can only enhance the long term viability of the Cirque development.



050°
CIRQUE DEPOSIT
303+00N
301+30N
300+00N
298+50N
296+40N
1200m
BARITIC
PYRITIC
0
300m



0
200
metres
Data Point
subcrop
of
line
CIRQUE DEPOSIT
ISOPACHS
metres
A



0
200
metres
2m isopach
subcrop
Data Point
CIRQUE DEPOSIT
PB+ZN GRADE
weight %
B

CIRQUE POTENTIAL

Cirque Deposit

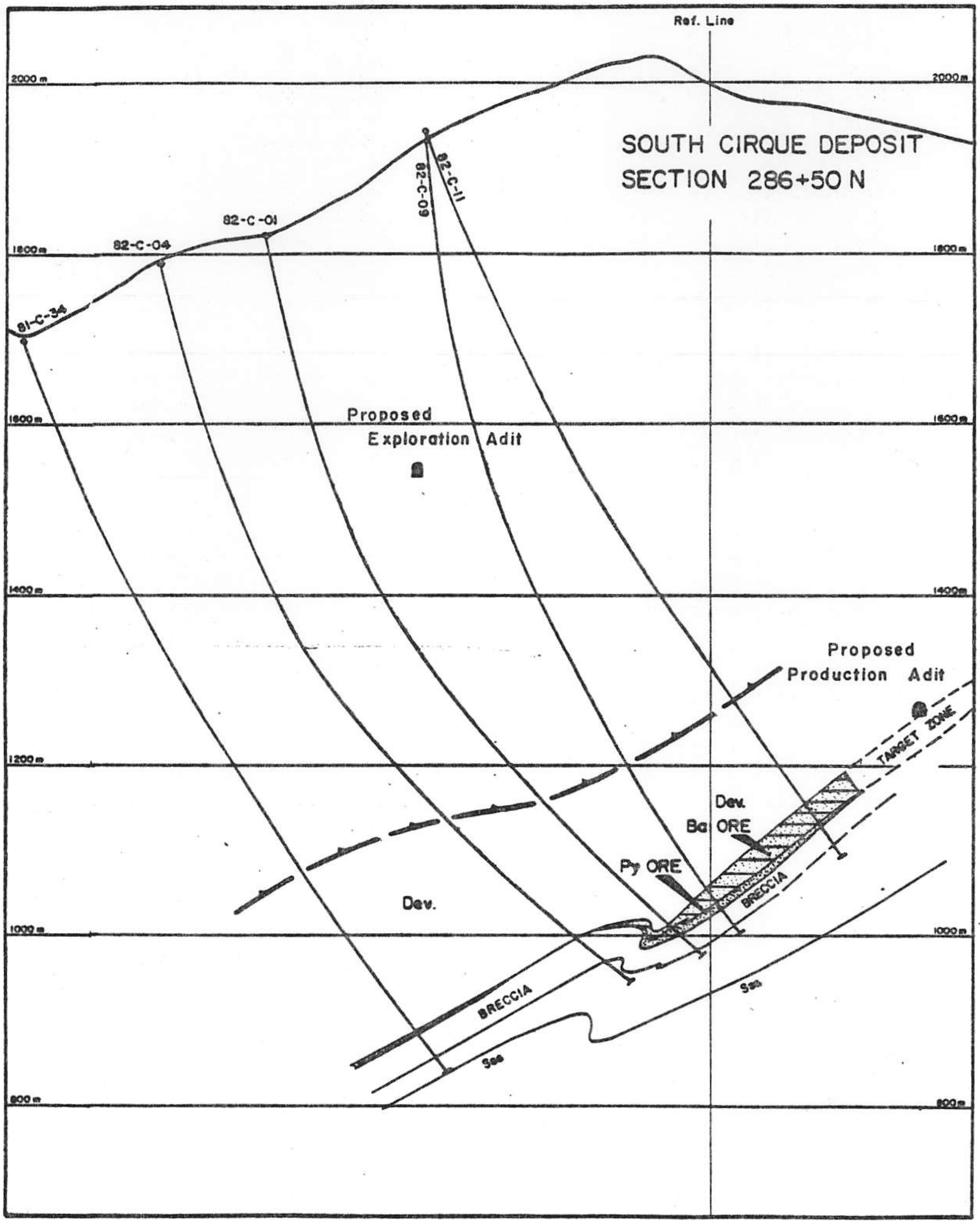
The massive stratiform Cirque Deposit, as delineated by 36 diamond drill holes, is 1,000 meters long, 300 meters wide and varies from 2 to 70 meters thick. This tabular barite-sulphide body, occurring within a black siliceous shale envelope, lies along the southwest dipping limb of a northwest trending anticline. The current reserve of 40 million tonnes of 2.2% lead, 7.8% zinc and 47 grams per tonne silver, contains a north-central block of 14 million tonnes grading 3.2% lead, 11.0% zinc and 70 grams par tonne silver. A crudely calculated mining reserve, based on a conceptual bulk mining method requiring a minimum thickness of 10 meters and anticipated cut-off of 8%, was calculated at 20.5 million tonnes grading 3.0% lead, 9.4% zinc and 60 grams per tonne silver. Although the deposit remains open to the south, a geological estimate of this strike extension is not included in the reserve calculations.

The situation of the deposit plunging to the south, associated with an extreme rise in topography, negates further delineation from surface. Close-spaced surface drilling to further define a mining reserve within the known boundaries is considered unproductive due to the high cost and unpredictable hole deviation encountered in hanging-wall formations.

Sufficient data was available by January, 1982 to conduct a preliminary economic evaluation using the above drill-indicated reserves. A conceptual underground bulk mining scheme using two adits was proposed. Metallurgical projections and the concentrator flowsheet were based on laboratory testwork. The conceptual mill design had an annual throughput of 2,000,000 tonnes that would approximately produce 45,000 and 250,000 tonnes of lead and zinc concentrate respectively. Detailed studies of concentrate transportation, power supply and operating costs were also included in this evaluation. Total pre-production capital costs were estimated at $416 million in 1982 dollars.

Results of this economic study resulted in a plan for a two year program of underground exploration, test stoping and metallurgical testing that would provide a basis for a feasibility study. Initiation of a three kilometer, 4 x 3.5 meter exploration adit to provide direct access to the deposit was proposed in 1983. This adit, collared at 1,500 meters, would also be used as an integral part of the ultimate mine development, providing alternate access, air return, as well as equipment and safety routes that would be linked to the main production adit collared at 1,200 meters.

The logistical base to support the undarground program, which included purchase of a 50-man camp, road maintenance equipment, steel bridges and a sawmill; construction of 87 kilometers of all-weather gravel road to within 300 meters of the proposed exploration portal site and completion of the Finbow airstrip to accommodate hercules aircraft, is now in place. Construction of the initial exploration adit is now contingent on the potential reserve to be defined in the South Cirque Deposit.


Ref. Line
SOUTH CIRQUE DEPOSIT
SECTION 286+50 N
2000 m
1800 m
1600 m
1400 m
1200 m
1000 m
800 m
81-C-34
82-C-04
82-C-01
82-C-09
82-C-11
Proposed
Exploration Adit
Proposed
Production Adit
TARGET ZONE
Dev.
Ba ORE
Py ORE
BRECCIA
Dev.
Sss

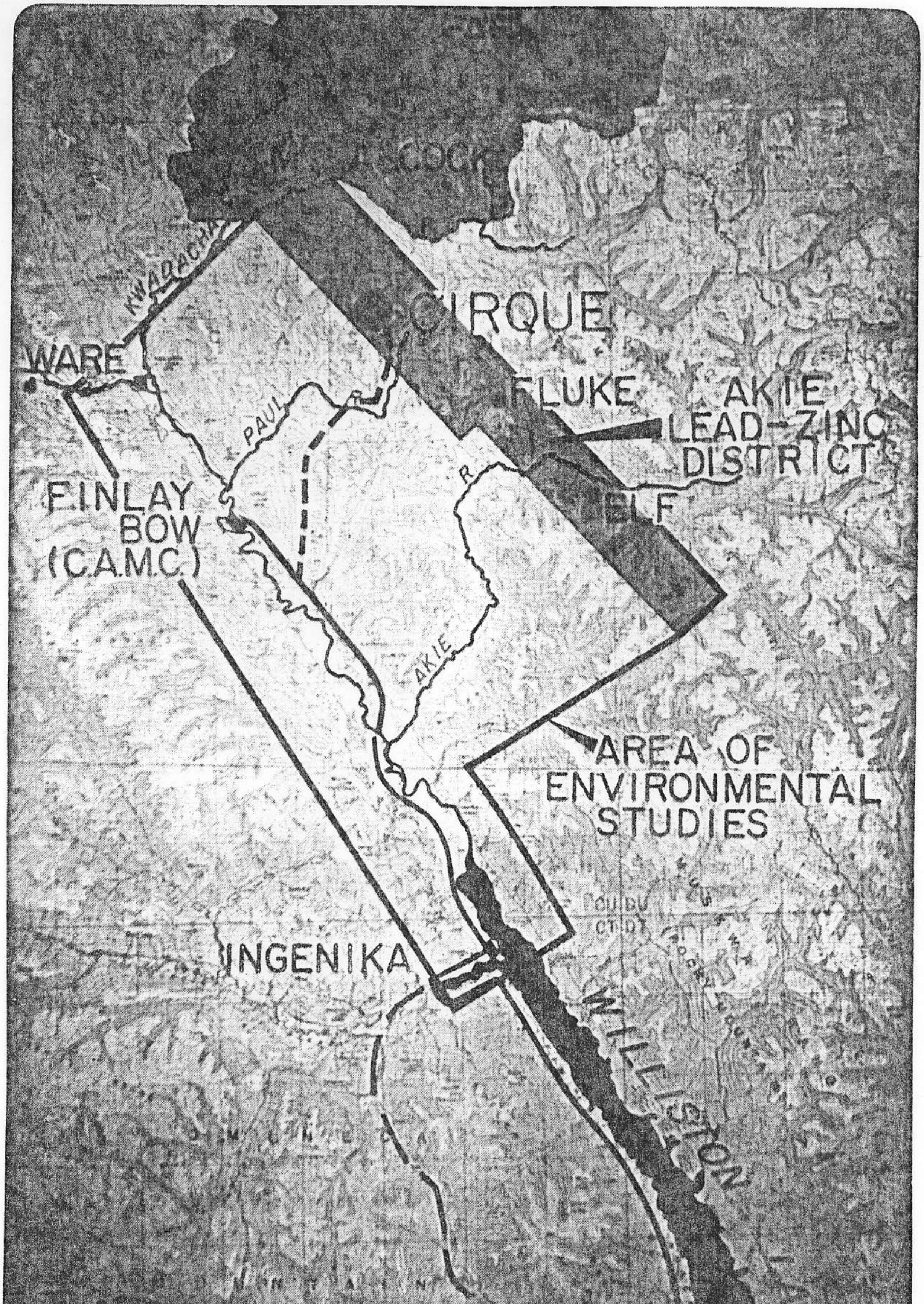
South Cirque Deposit

The 1982 deep drilling program, based on geological interpretation, was successful in discovery of an additional barite-sulphide body termed the South Cirque Deposit. This deposit, intersected by seven drill holes along three constructed cross sections, has been outlined over a length of 700 meters, a width up to 250 meters and a thickness of 2 to 30 meters. Mineralization encountered to date is similar to pyritic and baritic facies found in the Cirque Deposit. The pyritic facies, averaging 11 to 17% combined lead-zinc with 50 - 60 grams per tonne silver, consistantly occurs at the base of the deposit. The baritic facies averages 6 to 9% combined lead-zinc with 20 to 34 grams per tonne silver.

Potential for additional reserves in the South Cirque area lies updip to the east as supported by lead-zinc ratios and trends of the ore-host rock facies. An order of magnitude calculation indicates a potential resource of 10 million tonnes. Continuity and thickness of mineralization outlined so far would suggest the South Cirque Deposit has a potential reserve of approximately 20 million tonnes.

Continued surface drilling is required to outline the potential size and distribution of ore facies prior to initiation of an underground exploration phase. The optimum development scheme and timing of either the 1,500 or 1,200 meter adit is contingent on the potential impact of a South Cirque high grade zone added to the existing reserves of the Cirque Deposit. The South Cirque Deposit occurs at an elevation between 900 and 1,200 meters, directly below the proposed route of the 1,200 level production adit. The position of this adit is ideal for further reserve definition upon completion of the surface program.

Narrow, high-grade sulphide mineralization associated with the footwall siltstone breccia, grading from 10 to 42% combined lead-zinc, has been intersected west of the South Cirque Deposit. Although tonnage potential appears limited, the grade encountered makes it attractive for continued exploration.



CIRQUE
FLUKE
AKIE
LEAD-ZINC
DISTRICT
WARE
KWADACHA
PAUL
FINLAY
BOW
(C.A.M.C.)
AKIE
AREA OF
ENVIRONMENTAL
STUDIES
INGENIKA
WILLISTON

DISTRICT POTENTIAL

Discovery of the South Cirque Deposit has increased the resource of potentially economic mineralization in the Akie District to 60 million tonnes, averaging 10% combined lead-zinc. This new zone supports past predictive geological modelling indicating the presence of several sub-basins with associated barite-sulphides on the Cirque property. Further reserve potential exists both to the south and west of the Cirque - South Cirque trend.

An intersection of sulphide mineralization with sporadic lead-zinc values, roughly 200 meters down-dip from surface barite mineralization, indicates the presence of an additional deposit on the Fluke claims. This mineralization, consisting of narrow sulphide intervals throughout a 20-meter section of siltstone breccia, is identical to the geological setting of the South Cirque Deposit. The presence of mineralization in lithologies indicating sub-basin development on the Fluke supports the existence of another deposit that may add a significant reserve to the district.

Narrow, high-grade, steeply dipping barite-sulphide mineralization on the Elf has been traced for 800 meters along strike and 600 meters down-dip. Although only a limited tonnage has been outlined to date, there is potential for thickening to the south along the overturned limb of a northwest trending anticline. Potential for additional deposits is excellent, as only one kilometer of an eight kilometer horizon of favourable host rock, with associated lead-zinc anomalies, has been tested. Surface exposures are similar to the host units on the Cirque property subcropping up-dip from the South Cirque Deposit.

An additional barite-sulphide deposit on Mt. Alcock remains within Kwadacha Wilderness Park, to which boundary change would be subject to a legislative decision.

The discovery of the South Cirque Deposit and spatial association of similar geologic environments with known mineralization supports the reality of a major zinc-lead-silver district, with excellent potential for additional reserves.

PROPOSED 1983 PROGRAM AND FUTURE DEVELOPMENT

Definition of the South Cirque Deposit is essential prior to completion of an economic evaluation of the property and initiation of an underground exploration and development program. The position of the initial adit is contingent upon the tonnage and grade of this new deposit.

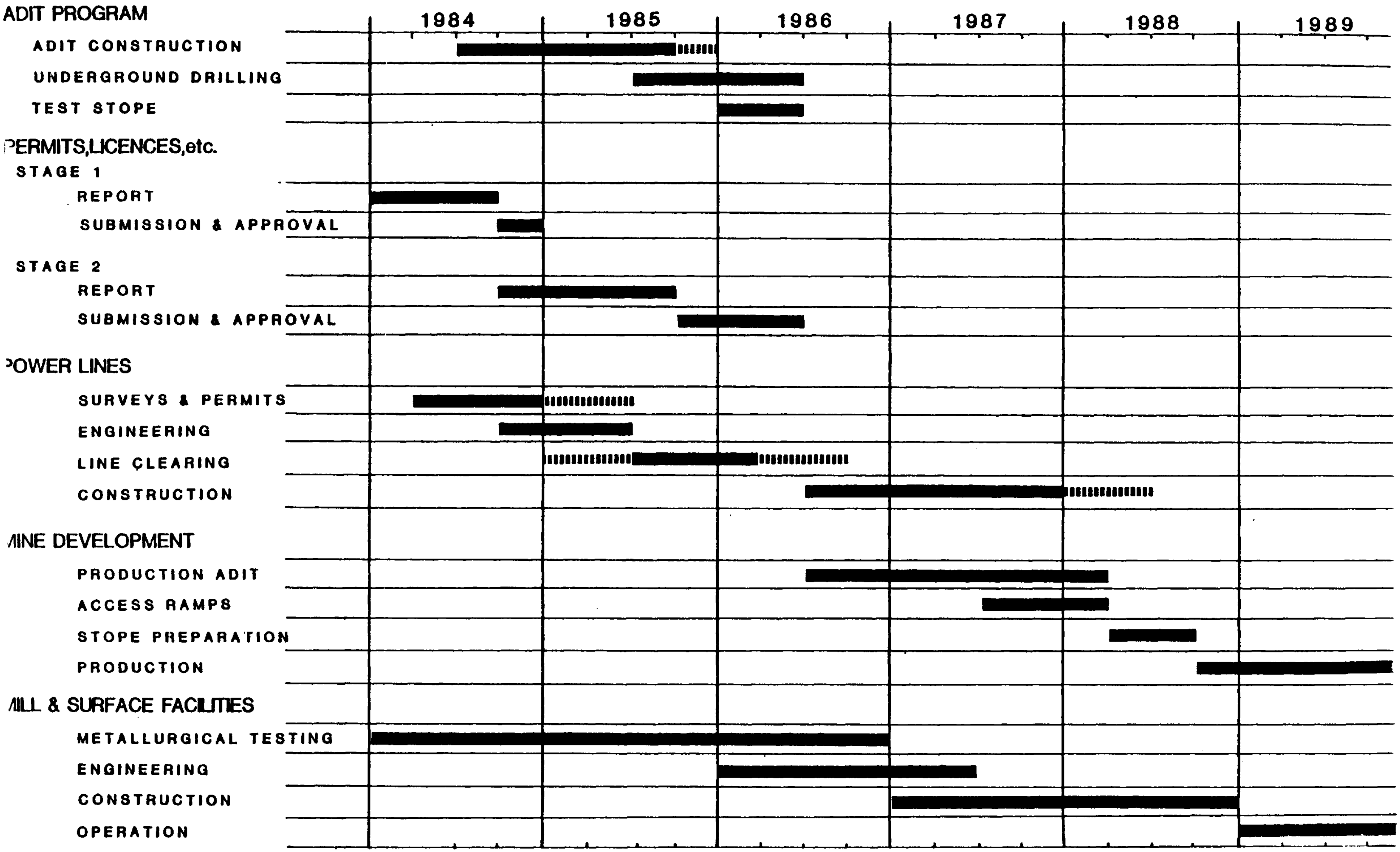
A minimum of ten holes, at an anticipated cost of $2 million, is required in 1983 to crudely define the reserve potential of this deposit.

The above drilling program should enhance the viability by identifying and developing higher grade reserves. The ongoing Cirque development schedule includes a two year underground program to provide direct access to the deposit for rapid delineation by underground drilling and test stoping to determine mining methods. The configuration of adits will also form an integral part of the ultimate mine development.

The optimum schedule for the development of the Cirque property includes overlapping schedules for adit, power line, government permits and mine-mill development. While not entirely interdependent, the individual schedule for the exploration adit obviously affects all others. At the conclusion of the proposed two year underground program in 1984/85, all available data would be in hand to carry out a final feasibility on the project.

The total cost of the proposed work to achieve final feasibility is $25 million over three to four years.

CIRQUE DEPOSIT DEVELOPMENT SCHEDULE



CYPRUS ANVIL
ANVIL DISTRICT

DOME PETROLEUM LIMITED

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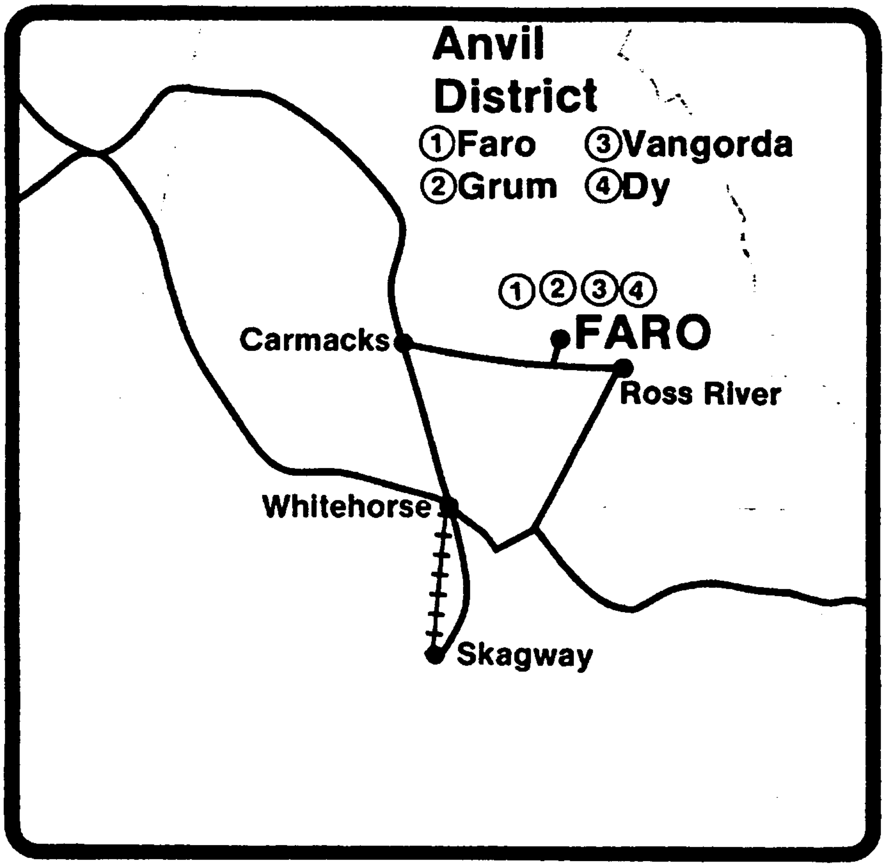

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A B S T R A C T

This report describes the Cyprus Anvil lead/zinc/silver mine-mill complex located at Faro, Yukon Territory.

The Faro mine is one of the world's largest producing lead/zinc/silver mines. In 1981 Cyprus Anvil Mining Corporation produced concentrates containing metal valued at $167 million, which is equivalent to 40 percent of the Yukon's direct revenue. The bulk of the concentrate is exported to Japan under long-term contracts with Toho Zinc and Mitsui Mining and Smelting. In 1981 Cyprus Anvil supplied about 40% of lead and 20% of zinc imported by Japan.

As of January, 1982 geologic reserves were estimated to be 95 million tonnes, and mineable ore reserves were estimated to be 78 million tonnes. Drilling programs planned in 1982 and 1983 are expected to increase both categories of reserves at the Faro, Vangorda and Grum deposits. There is a high probability that several additional deposits will be discovered between the Faro and the Sea deposits. A twenty-five year development plan has been established to exploit these reserves.

TABLE I

ANVIL DISTRICT GEOLOGICAL RESERVES AND GRADE
(82/01/01)

DEPOSIT	GEOLOGIC RESERVES (000 Tonnes)	GRADE Lead %	Zinc %	Silver g/mt
FARO	34,000	3.0	4.6	35
GRUM	31,000	3.1	4.9	49
VANGORDA	5,000	3.3	4.3	48
DY	20,000	5.7	7.0	82
SWIM	5,000	3.8	4.7	42
TOTAL	95,000			

INTRODUCTION

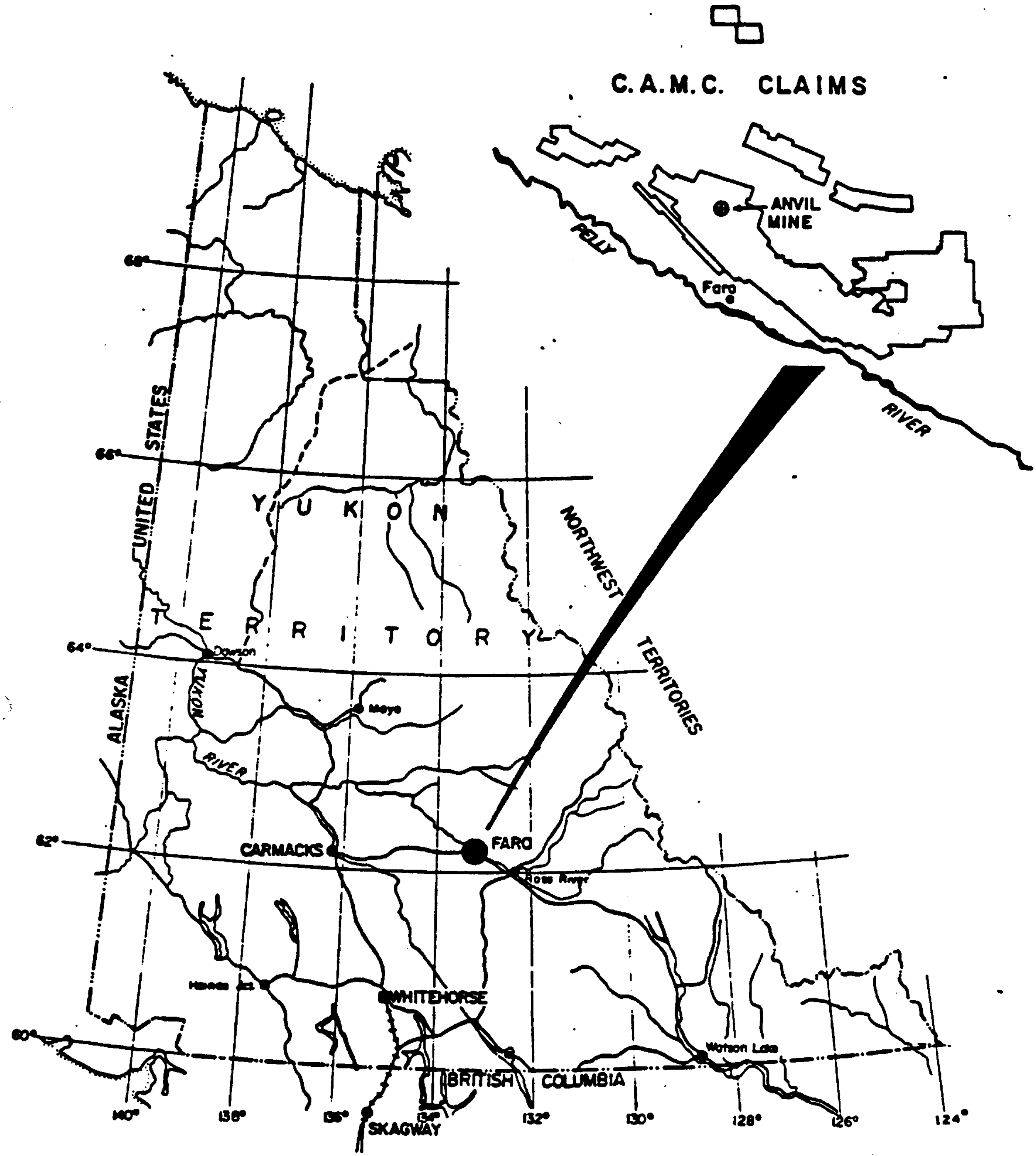
The mining and milling facilities of Cyprus Anvil are located near Faro, in the south central portion of the Yukon Territory, Canada. Faro, the second largest town in the Yukon, has a population of 2,000 and was built by the company to accommodate mine employees and their families. The town is served daily by a scheduled airline and is connected by an all-weather highway to Whitehorse, the capital of the Yukon.

On April 1, 1982, the company employed 650 people at Faro and 32 at its head office in Vancouver.

The mill had an original design capacity of 4,500 tonnes per day. The operation has been expanded three times to its current daily planned capacity of 9,300 tonnes. It is expected that this level of operation can be maintained for a period in excess of 25 years.

The Whitepass and Yukon Railway Corporation transports the metal concentrates from Faro to Whitehorse by truck and then by rail to the ocean port of Skagway, Alaska.

Most of the concentrates are sold under long-term sales contracts to Mitsui Mining and Smelting Company Limited and Toho Zinc Company Limited of Japan. The remaining portion of the concentrates is sold on the spot market.



CYPRUS ANVIL MINING CORPORATION

CLAIM HOLDINGS

ANVIL DISTRICT

YUKON

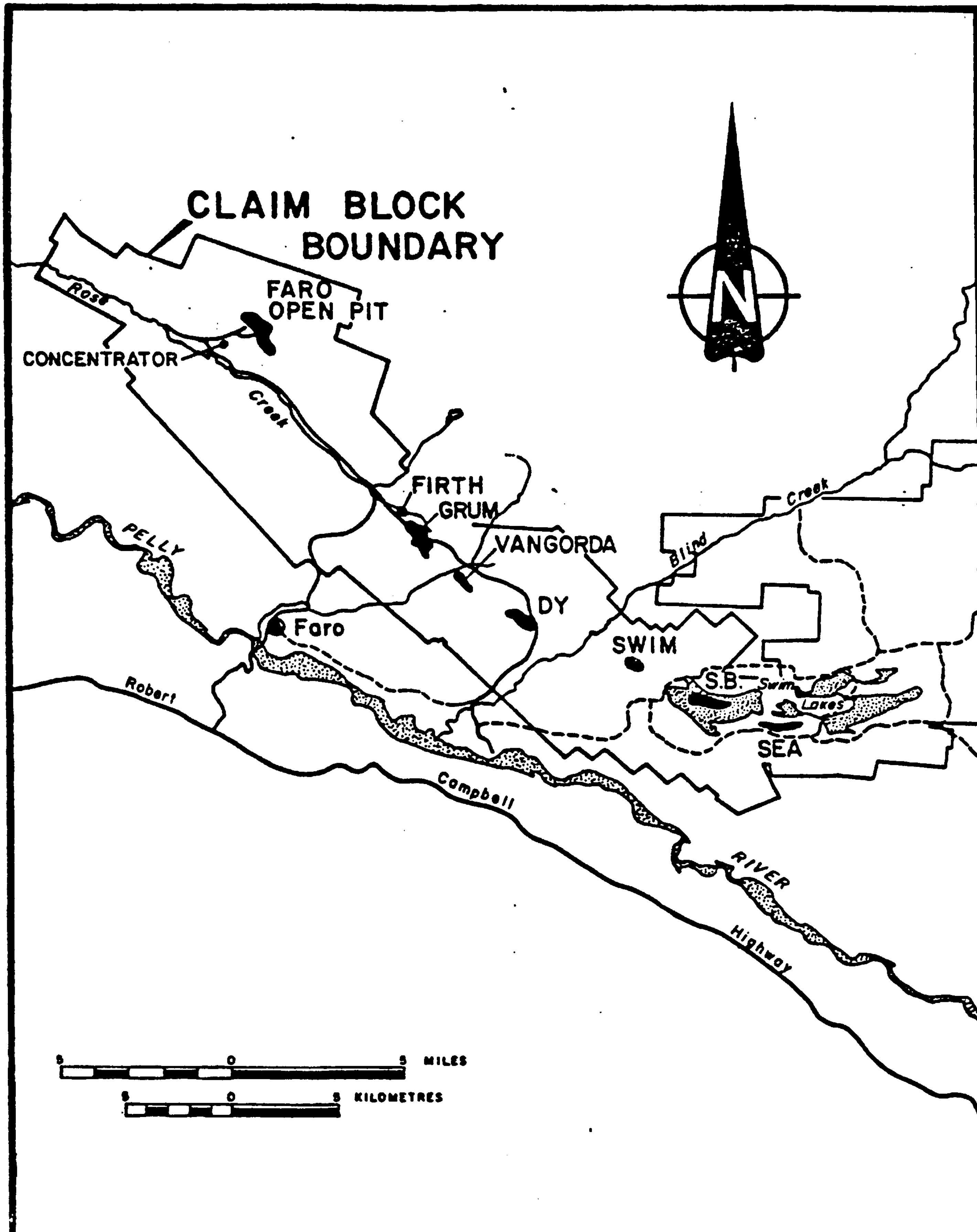
SCALE · 1" = 100 MILES

H I S T O R Y

Cyprus Anvil Mining Corporation, a Canadian mining company, was recently acquired by Hudson's Bay Oil & Gas and is now part of Dome Petroleum Limited. The Company was incorporated in 1965 as a British Columbia company, Anvil Mining Corporation Limited, owned 60% by Cyprus Mines Corporation of Los Angeles and 40% by Dynasty Explorations Limited of Vancouver. The mine and mill located near Faro, Yukon commenced production in late 1969.

In 1975 the mining operational experience of Anvil and the Yukon exploration expertise of Dynasty were combined to form Cyprus Anvil Mining Corporation. This new corporation was formed to explore, acquire and develop mineral resources and thereby extend operations beyond the remaining life of the Faro orebodies.

Cyprus Mines merged in 1979 with Standard Oil of Indiana. Through this merger Standard Oil acquired 63% ownership of Cyprus Anvil Mining Corporation. In early 1981 Standard Oil placed their interest in Cyprus Anvil up for sale. Hudson's Bay Oil & Gas paid $345 million for Standard Oil's and the remaining minority shareholders' interest. The entire ownership of Cyprus Anvil Mining Corporation has since been acquired by Dome Petroleum Limited through the purchase of Hudson's Bay Oil & Gas.



CYPRUS ANVIL MINING CORPORATION
ANVIL MINING DISTRICT

F A R O   D E P O S I T

The Faro Deposit is a strataform, stratabound massive sulphide ore body approximately 1,350 metres by 700 metres with a gentle dip to the southeast. Additional mineralization has been indicated by widely spaced holes down dip from current pit limits. Drilling to prove up this additional mineralization is planned for 1982 and 1983. This reserve may be mineable by open pit methods.

ORE RESERVES
(82/01/01)

Nature of Reserves	Tonnes (Million)	% Pb	% Zn	Ag (gms/DMT)
Mineable-open pit*	27.8	2.9	4.3	36
Stockpile	2.4	2.9	4.7	38
Mineable-underground	--	--	--	--
Total Mineable Reserves*	30.2			
Additional Reserves	4.1			
Estimated Mineable Reserves	34.3			

* 5% dilution included

GRUM DEPOSIT

The Grum Deposit, located approximately 14 kilometres from the Faro minesite, consists of two sulfide horizons which are structurally complicated by successive fold deformation and faulting.

Grum was discovered in 1973, by A.E.X. Syndicate. Prior to the acquisition of the property in 1979 by Cyprus Anvil, more than 41,000 metres of surface diamond drilling, a 2,900 metre exploration decline, 15,000 metres of underground diamond drilling, bulk sampling and metallurgical pilot plant testing of the ore had been done. Cyprus Anvil has diamond drilled an additional 6,300 metres to define the structure of the deposit.

The 1982, 1983 exploration program includes drilling to the east of the Grum pit to test for geologically inferred reserves. Cyprus Anvil geologists expect 5 million tonnes of high grade ore to be found. South of the Grum pit in the Champ zone there is 1.5 million tonnes of drill-indicated reserves.

ORE RESERVES
(82/01/01)

Nature of Reserves	Tonnes (Million)	% Pb	% Zn	Ag (gms/DMT)
Mineable-open pit*	16.8	3.0	4.9	47
Mineable-underground	11.0	3.0	4.9	47
Total mineable reserves	27.8			
Additional Reserves	6.5			
Estimated Mineable Reserves	34.3			

* 6% dilution included

V A N G O R D A   D E P O S I T

The Vangorda Deposit, the first mineral deposit found in the Anvil district, was discovered in 1953. It is adjacent to the Grum and is situated approximately 16 kilometres from the minesite. Definition diamond drilling was done in 1954 and 1955 by a subsidiary of Kerr Addison Mines Ltd.

Drilling was continued in 1979 by Cyprus Anvil and provided the basis for a new geological model. The 1979 drilling program consisted of 63 holes, representing 10,500 metres of drill core. An additional 2,900 metres were drilled in 1980 and 1981.

The additional reserves of 1.5 million tonnes are drill indicated but have been excluded from mineable reserves due to poor core recovery and difficulties in data interpretation. During 1982, the data on this tonnage will be recompiled and further recommendations made.

ORE RESERVES
(82/01/01)

Nature of Reserves	Tonnes (Million)	% Pb	% Zn	Ag (gms/DMT)
Mineable-open pit*	4.5	3.3	4.3	47
Mineable-underground	--	--	--	--
Total Mineable Reserves	4.5			
Additional Reserves	1.5			
Estimated Mineable Reserves	6.0			

* 5% dilution

DY DEPOSIT

The Dy deposit is located 19 kilometres east of the Faro minesite and adjacent to the Vangorda deposit. Cyprus Anvil geologists discovered the deposit in 1976 as a result of detailed structural and lithologic mapping. The deposit has been defined during the past three years by 36,000 metres of diamond drilling. The mineralization occurs in two horizons, is folded and varies in depths, from 650 to 900 metres.

Due to the high cost of drilling this deep deposit, it is proposed that follow-up exploration be from underground by sinking an exploration shaft.

ORE RESERVES
(82/01/01)

Nature of Reserves	Tonnes (Million)	% Pb	% Zn	Ag (gms/DMT)
Mineable-open pit	--	--	--	--
Mineable-underground	15.0	5.7	7.0	82
Total mineable reserves	15.0			

GEOLOGICAL POTENTIAL

The complex deformational history and widespread favourable stratigraphy suggests a high probability that several additional deposits will be discovered within the 40 kilometres zone between the current Faro open pit and the Sea deposit.

The area has strong geological promise beyond the reserve potential described in previous sections. Drill-inferred reserves exist between the Grum deposit and Firth showing. The most promising locations for finding deposits similiar to the Dy is in the region between the Faro and Grum deposits, in the Blind Creek area, and immediately east of the Swim deposit. Additional drilling is also required to evaluate a sulphide sheet deposit underlying Swim Lake.

Consequently, it is reasonable to expect between 30 and 70 million tonnes of ore grade lead zinc mineralization with recoverable values in gold, and silver will be discovered.

D E V E L O P M E N T

Development Plan

The Anvil district development plan is predicated upon the sequential mining of the various ore bodies.

The mill will treat ore at the current 3.4 million D.M.T./year until 1985 when throughput will be increased 20%. Modifications to the primary crushing circuit will provide for this increase in milling rate. Production of ore from the Faro pit will increase as the pit matures and the stripping ratio drops.

Present Faro ore reserves are scheduled to be depleted during 1991 and are to be replaced with ore from the Vangorda and Grum deposits. In order to assure continuity of ore supply to the concentrator, preproduction development of the Grum and Vangorda deposits is scheduled to commence in 1986 with engineering and design costs for the construction of the overland conveyor.

The Dy deposit preproduction development is scheduled to begin in 1989 with the sinking of a shaft. This shaft will provide access to the Dy orebody allowing underground exploration diamond drilling, test stoping and development. During the latter half of 1991 a decline will be driven from the bottom of the Vangorda pit to provide production accese to the Dy orebody.

Concentrator

The Anvil concentrator is designed along conventional crushing, grinding, differential flotation and dewatering methods.

The design of the primary and secondary crushing plants has remained unchanged since the commencement of operations in 1969, though the mill feed rate and concentrator capacity has been increased 3 times during this period. Crushing capacity can be increased above the present 10,300 dry metric tonnes per day with modifications.

The grinding circuit was modified substantially during 1980 and 1981 to allow milling of ores containing finely disseminated mineralization. The grinding circuits now have the capacity to mill all known ores at a daily throughput of 11,200 D.M.T./day.

The capacity of the flotation circuit was also increased during the recent modifications to provide increased retention time in the circuit as is required with the finer grinds of sulfides. Instrumentation systems, including an on-stream process pulp analyser were installed.

The thickening capabilities were increased to reflect the slower settling rates of the finer concentrates. The four original disc filters were replaced with larger diameter machines and an additional filter installed. Materials handling systems were improved and concentrate stock tanks installed, to improve the efficiency of the five rotary kiln dryers.

The tailings impoundment facility was expanded significantly in 1980 and 1981 to provide the additional retention time as required by the finer grind. The new facilities will require periodic increases in dam elevations, and will assure compliance with all current legislation.

Electrical

The Northern Canada Power Commission (N.C.P.C.) supplies electrical power to Faro through a 370 kilometre, 138 KV transmission line. The installation of a new hydro-electric turbine is scheduled to be complete by year end 1983 at which time N.C.P.C. will have a total generating capability of approximately 100 M.W. Further hydro-electric development in the Yukon is a distinct possibility and studies are underway to define this potential. Transmission line capacities inhibit N.C.P.C.'s ability to satisfy all of the Cyprus Anvil's power requirements. However, N.C.P.C. will install sufficient onsite generating capacity to provide for all future requirements.

Ore Haulage

Various ore haulage systems have been examined to determine the most dependable and cost-efficient means of transporting ore from the Vangorda Plateau to the existing mill site, a distance of approximately 15 kilometres. The alternative systems considered included

a) off-highway trucks

b) highway trucks

c) a railroad

d) an overland conveyor

The overland conveyor system was selected to be best suited for the application. Capital and operating costs will include a conveyor, a crusher at the Vangorda Plateau and appropriate stockpiling facilities at each end of the conveyor.

TABLE II

ANVIL AREA - LONG TERM DEVELOPMENT PLAN
(THOUSANDS OF TONNES)

	FARO		VANGORDA		GRUM		DY		NEW DEPOSIT		TOTAL	
YEAR	ORE	CONC	ORE	CONC	ORE	CONC	ORE	CONC	ORE	CONC	ORE	CONC
1982	3,392	369									3,392	369
1983	3,395	352									3,395	352
1984	3,495	358									3,496	358
1985	4,073	419									4,073	419
1986	4,073	476									4,073	476
1987	4,073	505									4,073	505
1988	4,085	516									4,085	516
1989	4,073	474									4,073	474
1990	4,073	434									4,073	434
1991	69	8	4,004	473							4,073	481
1992			2,018	176	2,055	261					4,073	437
1993					4,073	518					4,073	518
1994					4,073	518					4,073	518
1995					4,073	470					4,073	470
1996					4,073	470					4,073	470
1997					3,268	362	700	127			3,968	490
1998					1,760	185	1,550	282			3,310	467
1999							1,500	272	1,250	227	2,750	499
2000							1,500	272	1,250	227	2,750	499
2001							1,500	272	1,250	227	2,750	499
2002							1,500	272	1,250	227	2,750	499
2003							1,500	272	1,250	227	2,750	499
2004							1,500	272	1,250	227	2,750	499
2005							1,250	227	1,500	272	2,750	499
2006							1,250	227	1,500	272	2,750	499
2007							1,250	227	1,500	272	2,750	499
TOTAL	34,802	3,908	6,022	649	23,375	2,784	15,000	2,721	12,000	2,178	91,199	12,241

A P P E N D I X

APPENDIX

INDEX

CYPRUS ANVIL
OPERATING STATISTICS

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Ore Milled (ooo DMT)	1779	2425	2636	2630	2654	2926	1520	3116	3280	2823	2825	2757
Metal Produced												
Lead (MM lbs.)	120	204	212	223	206	209	68	148	181	160	142	128
Zinc (MM lbs.)	139	211	219	236	208	231	121	225	247	221	181	184
	259	415	431	459	414	440	189	373	428	380	323	313
Average Price												
Lead U.S. $/lb.	.13	.12	.14	.20	.26	.19	.20	.30	.34	.62	.48	.40
Zinc U.S. $/lb.	.13	.16	.18	.24	.35	.38	.36	.35	.32	.42	.42	.50

CYPRUS ANVIL MINING CORPORATION
CASH COST & CONVERSION STATISTICS ASSUMING PRODUCTION SOLD AS PRODUCED
Canadian $000

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Production Department Costs												
Wages and Payroll Benefits	3,923	4,471	4,406	4,812	6,133	8,787	5,394	10,965	12,811	13,536	17,634	25,369
Power	931	985	1,147	1,265	1,861	2,291	1,515	3,339	3,837	3,625	4,270	6,535
Supplies - Mine/Mechanical	2,578	3,602	3,530	3,652	5,661	7,249	5,485	9,125	12,644	12,978	18,557	23,765
- Milling	3,705	3,937	4,980	5,071	6,877	9,531	5,898	10,671	11,146	11,132	12,788	12,240
Total	11,137	12,995	14,063	14,798	20,532	27,858	18,352	34,100	40,438	41,271	53,249	67,909
General & Administrative												
Labour - Faro	689	705	701	753	963	1,224	961	1,667	2,026	2,558	3,533	5,048
- H.O.	129	188	174	251	177	344	440	707	704	1,036	2,982	2,757
Supplies & Services - Townsite	996	821	631	974	1,428	1,767	2,433	3,081	2,848	3,883	5,075	6,517
- Minesite	600	668	749	1,050	1,473	2,356	2,281	2,586	2,260	3,230	5,288	6,476
- H.O.	204	396	301	439	414	725	816	1,014	1,048	2,387	1,325	1,990
Total	2,618	2,678	2,556	3,467	4,455	6,416	6,931	9,055	8,886	13,364	18,203	22,788
Inland Freight and Terminal	6,197	9,753	9,986	11,125	10,805	14,231	7,268	14,432	16,364	17,831	17,648	20,983
Conversion												
Ocean Freight and Superintendence	-	2,596	1,962	3,389	4,212	4,555	2,916	3,420	5,791	8,478	9,364	9,845
Treatment Charge	-	17,813	23,237	37,095	51,105	50,165	24,332	52,325	68,462	71,936	59,281	53,085
Total	13,970	20,409	25,199	40,484	55,317	54,720	26,348	55,745	74,253	80,414	68,645	62,930
TOTAL OPERATING COSTS	33,922	45,835	51,804	69,874	91,109	103,225	58,899	133,332	139,941	152,880	157,745	174,610
Revenue												
Pb. and Zn.	36,405	57,894	66,826	100,519	125,427	126,309	56,790	122,736	142,185	192,211	145,315	143,883
Ag. and Au	2,738	3,630	3,908	6,529	11,443	11,303	2,773	5,931	11,546	17,288	55,531	23,772
Total	39,143	61,524	70,734	107,048	136,870	137,612	59,563	128,667	153,731	209,499	200,846	167,655

SALES CONTRACTS SUMMARY

Two major sales agreements are in effect with two Japanese customers: Toho Zinc Co. Ltd., and Mitsui Mining & Smelting Co. Ltd. The main points of the sales contracts are summarized below:

1. Parties

The terms of the agreements are identical in almost all respects; there are differences in lead treatment charges and delivery port nominations.

2. Product and Specifications

The agreements provide for the sale and delivery of lead and zinc concentrates with chemical and moisture specifications.

3. Term

The agreements cover a six year period commencing January 1, 1978 and ending December 31, 1983.

4. Quantities

The contractual quantities for 1982 - 83 are presented as follows, expressed in dry metric tons:

Company	Lead Conc.	Zinc Conc.
Toho Zinc	67,000	134,000
Mitsui Mining & Smelting	38,000	76,000
Total	105,000	210,000

In 1981 actual deliveries to Japan represented approximately 85 percent of total concentrate production.

5. Shipment and Delivery

Concentrates are delivered to Skagway, Alaska C and F Japan. Cyprus Anvil is responsible for the arranging and bears the cost of ocean freight.

6. Price

Cyprus Anvil is paid for the contained metal in the concentrates less certain deductions or treatment charges as levied by the smelting company.

The terms and conditions of sales concentrate generally reflect prevailing market conditions and historical relationships.

7. Weighing, Sampling & Moisture Determination

Final wet weights and sampling on concentrate shipments is performed at the smelters. All costs associated with such services are for the Buyers' account with the Seller entitled to representation at its expense.

8. Title, Risk of Loss, Insurance

Legal title to cargo and risk of loss passes to Buyer only after the ship has left United States Territorial waters, as defined by United States law. Buyer arranges insurance at his own expense.

9. Payment

All payments are made in United States dollars.

10. Governing Law

The law of the Yukon Territory govern and control the agreement.

The above constitute the major contractual terms and conditions of the Japanese contracts. Contracts arising from spot market sales of concentrate follow basically the same general format.

TECHNICAL PAPER

The attached technical paper was presented before the Canadian Institute of Mining and Metallurgy in 1978. During 1980 and 1981, the concentrator was extensively modified to accommodate the milling of newly acquired ores exhibiting finely disseminated mineralization. Thus the installed grinding capabilities were more than doubled to achieve the required physical liberation of lead and zinc from galena and sphalerite.

Notwithstanding recent modification to process the finer grained ores, the basic design and concentrator flowsheets remain virtually unchanged as published in the appended paper.

Current Operating Practice At the Cyprus Anvil Concentrator

W. N. Wallinger, General Mill Superintendent,
Cyprus Anvil Mining Corporation,
Faro, Yukon Territory

Abstract

The mine and concentrator of Cyprus Anvil Mining Corporation are situated in south-central Yukon, some 120 miles north of Whitehorse.

The large lead-zinc concentrator employs conventional crushing and grinding, followed by differential flotation, to produce selective lead and zinc concentrates, as well as a mixed lead-zinc (bulk) concentrate.

Since the commencement of operations in 1969, the concentrator has undergone expansions and modifications which have increased the capacity to 10,000 tons per day, and afforded some metallurgical improvements.

History

THE HUGE Faro Number One orebody was discovered in mid 1965. The decision to put the mine into production was made in August, 1967.

The Faro Number One orebody originally contained about 60 million tons of massive sulphide ore at an average grade of 3.4% lead, 5.7% zinc, 30% iron and 1.2 oz/ton silver. The average specific gravity is 4.16.

Initial operation of the concentrator, at 5,500 tons per day, began in September, 1969. An expansion of the concentrator to increase capacity to 6,600 tons per day and to allow the production of mixed lead-zinc (bulk) concentrates was completed in 1970.

A second expansion of the concentrator, to increase capacity to 10,000 tons per day, was undertaken in 1973. The new tertiary grinding and rougher-scavenger flotation sections went on-stream in December, 1973. Final modifications to the cleaner flotation sections were completed by mid 1974.

William N. Wallinger was born and educated in British Columbia, and began his career in mining with Cominco Limited as an assayer. During the nearly twenty years spent with the Cominco organization, he served in technical and supervisory capacities at the Sullivan and Bluebell concentrators in British Columbia, Pine Point in the Northwest Territories and Cominco Potash in Saskatchewan.

Joining Cyprus Anvil Mining Corporation in 1970 as assistant mill superintendent, Mr. Wallinger progressed to his present position of general mill superintendent with over-all responsibility for the production, metallurgy and maintenance of the Cyprus Anvil concentrator.

Keywords: Cyprus Anvil mine, Milling, Crushing, Grinding, Concentrators, Classifying, Scavenging, Roughing, Thickening.

Equipment and Operation

PRIMARY CRUSHING

Ore is hauled from the open pit to the crusher in 120-ton trucks during two shifts per day, seven days a week. The 54- by 74-ft Allis-Chalmers gyratory crusher reduces the ore to –6 in. Truck dumping and circuit operation are remotely controlled (since early 1976) from the Secondary Crusher Control Room.

The crusher discharge drops on to a variable-speed, 60-in. Stephens-Adamson apron feeder and then to a 42-in. belt conveyor which feeds two 6- by 16-ft Tyler screens with 6- by 4-ft Trelleborg rubber panels. Minus-½-in. material is conveyed directly to the fine ore bins by a series of belt conveyors.

The primary screen oversize is conveyed to a coarse ore storage building with a live capacity of 16,000 tons. Ore is distributed in the storage building by a shuttle conveyor. Dust collection is accomplished with three Ducon wet scrubbers. (See crusher flowsheet, Figure 1.)

FINE CRUSHING

Ore is withdrawn from the bottom of the coarse ore storage by activating an appropriate number of the ten vibrating Carman feeders. Through a system of belts, the ore is fed to the 7-ft Symons standard secondary crusher, set at 1-¼ in.

The crusher discharges onto the 6- by 16-ft Tyler secondary screen (Tyrod deck), with the minus-½-in. material being conveyed to the fine ore bins. The oversize ore forms the feed to the two 7-ft Symons shorthead tertiary crushers, with nominal settings of ⅜ in. The tertiary crushers discharge onto their respective 6- by 16-ft Tyler screens with Trelleborg slotted rubber decks. Undersize goes to the fine ore bins and the oversize is recycled.

A tripper car, on the fine ore bins' feed belt, distributes the ore to the three circular silos. Dust collection equipment includes four Ducon wet scrubbers.

Operation of both the primary and secondary section is carried out from the secondary control room by one operator, who communicates by radio with pit and mill supervisors.

The crushing operation is facilitated by the use of eleven closed-circuit television cameras mounted at strategic points in the circuits. Six television monitors are mounted in the control room.

Per-cent-of-load meters on major motors and belt scale readouts supply additional operating information.

PRIMARY-SECONDARY GRINDING

Throughput averages 10,000 short dry tons per day. The primary-secondary grinding section consists of three parallel circuits, each composed of one 9- by 12-ft Hardinge rod mill, one 9- by 12-ft Hardinge ball

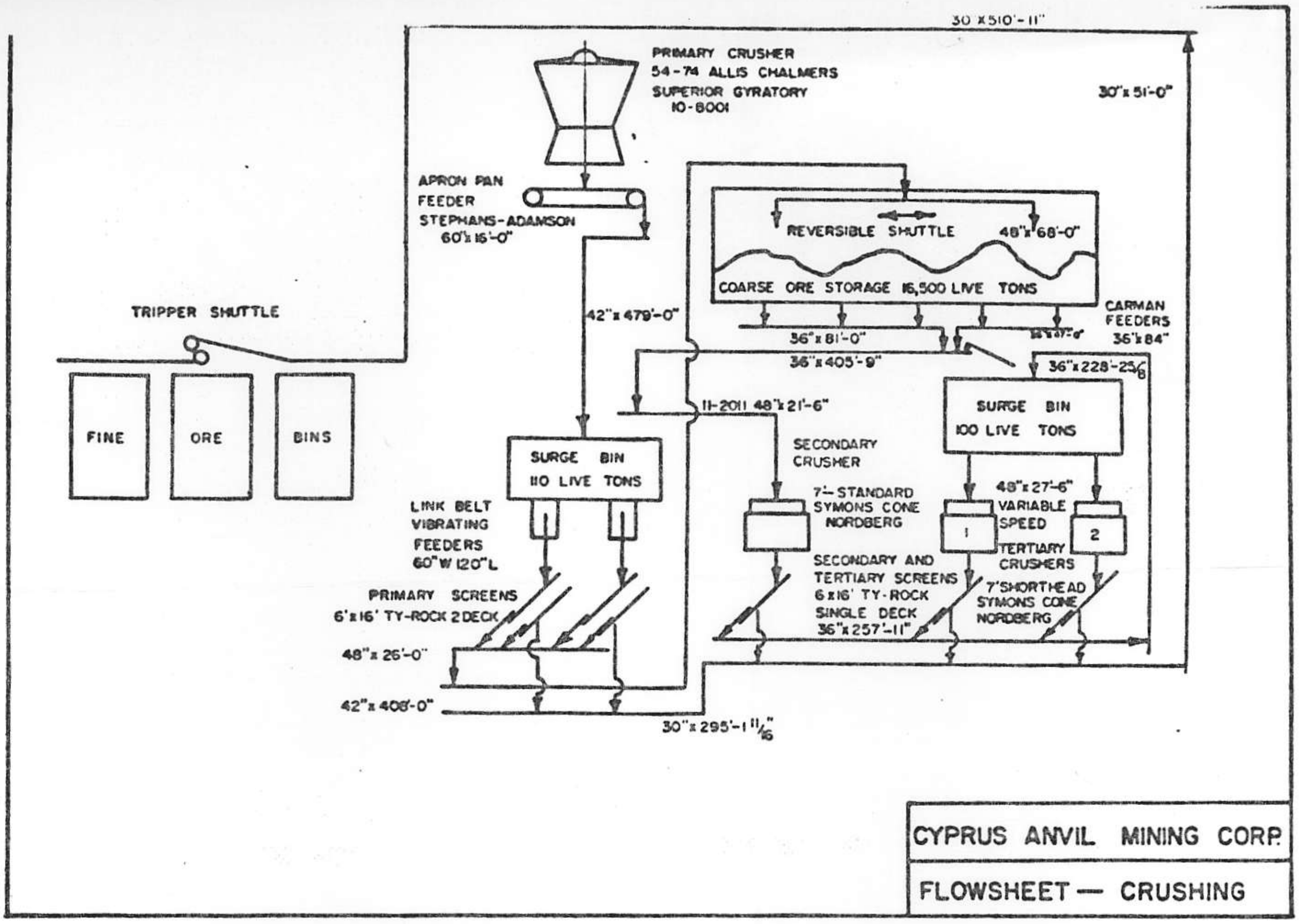


FIGURE 1 — Cyprus Anvil Mining Corporation flowsheet — crushing.

mill, two 20-in. Krebs cyclones and two 10- by 8-in. SRL pumps.

All rod and ball mills are driven by 450-hp synchronous motors through Fawick clutches. The rod mills rotate at 18.4 rpm or 72% critical speed, are lined with manganese-steel wave-type liners and are charged with 3½-in.-diameter rods.

Feed for each grinding circuit is stored in 40-ft-diameter cylindrical steel bins, each with a live capacity of some 1,700 tons. Ore is withdrawn from each bin by means of three slot feeders. The speed of one feeder under each bin is variable and is controlled on the basis of the rod mill feed belt weigh scale indication.

To maximize tonnage through the primary and secondary grinding circuits, it was found necessary to carry abnormally high slurry densities. Cyclone feeds are frequently in excess of 75% solids; ball mill discharge densities average 87% solids. The ball mill circulating loads are generally in the 200% range.

Make-up water to the rod mills is adjusted remotely to give an average discharge density of 85% solids.

Ball mill discharge densities average 87% solids; circulating loads are generally in the 200% range. Bond work indices for primary-secondary grinding range from 8.5 to 9.5.

TERTIARY GRINDING

Equipment consists of one 13½- by 22-ft Allis-Chalmers overflow ball mill in closed circuit with a cluster of six 20-in. Krebs cyclones. The two cyclone feed pumps are 14 by 12 SRL's.

The mill is driven by a 2500-hp motor through a Fawick air clutch at 15.08 rpm or 72% of critical speed. Liners are Skega rubber and media are 1½-in.-diameter steel balls. Ball consumption averages approximately 1.2 pounds per ton.

The combined cyclone overflow from the primary-secondary grinding circuits is laundered to the tertiary circuit, where it is joined by the lead scavenger concentrate. Circulating load is in the 300% range and the mill discharge density averages 82% solids.

The Cyclopac overflow, at a normal density of 55% solids, flows by gravity to the lead flotation feed distributor

The flotation feed grind averages about 70% -200 mesh, but varies quite widely with changes in ore composition.

Frequently, ore containing a large percentage of coarse-grained pyrite (up to 40% iron) will necessitate reducing the grinding circuit throughput in

TABLE 1 — Grinding Media Consumption

3-½-in. grinding rod consumption................	0.80 lb/ton of feed
2-in grinding ball consumption..................	0.70 lb/ton of feed

order to avoid 'sanding' in pipes, pumpboxes and flotation cells.

Bond work indices for tertiary grinding range from 10.0 to 14.0.

A particle-size monitor, purchased and installed in 1973, has functioned only intermittently due to problems with excessive wear and 'sanding' of the unit. Modification of the unit to reduce these problems is planned for the future.

Regrinding

The regrind section consists of three 9- by 12-ft Hardinge overflow ball mills driven by 450-hp motors through Fawick air clutches at 20.4 rpm or 80% of critical speed. Each mill is in closed circuit with a cluster of six 10-in. Krebs cyclones.

As described under the flotation section, one re-

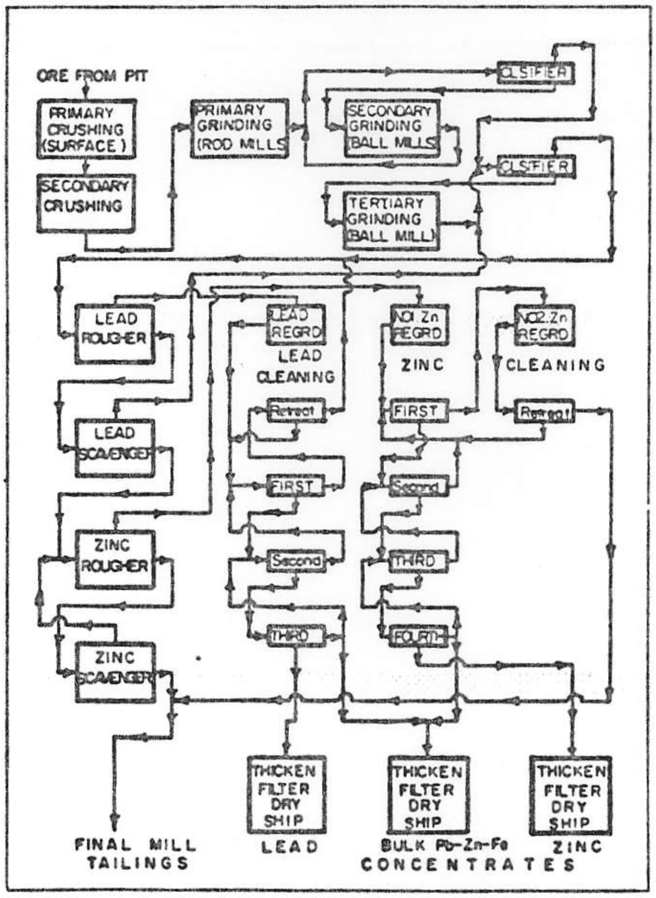


FIGURE 2 — The 10,000-tpd Anvil Mill flowsheet.

TABLE 2 — Comparison of Metallurgical Results by Year

Year	Lead Conc. (% Lead)	Zinc Conc. (% Zinc)	Total Lead *Recovery (%)	Total Zinc *Recovery (%)
1970...	66.2	49.3	76.0	66.3
1971...	67.1	49.8	82.7	70.3
1972...	68.5	50.7	84.5	73.5
1973...	66.5	51.1	84.3	77.3
1974...	65.0	51.5	83.4	77.1
1975...	66.9	50.8	85.8	80.1
1976...	67.3	51.4	81.7	79.6

*Recovery figures do not include lead in zinc concentrate or zinc in lead concentrate.

grind mill treats the lead first-cleaner feed, a second mill treats zinc first-cleaner feed and the third mill handles the zinc retreatment feed (first-cleaner tailing).

The regrind mills are lined with Skega rubber and are charged with 1½-in. steel balls. Media consumption in the regrind section is in the order of 0.4 lb/ton of mill feed.

FLOTATION

It is a maxim that "the ores of the Yukon are hard won", and the Faro deposit is no exception.

A grind of 70% -200 mesh is required for reasonable results on flotation feed, followed by substantial regrinding in order to attain concentrate grades.

Although the ore treated to date has been from a single pit, the composition varies widely on a day-to-day basis. The pyrrhotite content, in particular, has a decided influence on metallurgical results, with the higher-pyrrhotite ores being more refractory.

Consequently, the pyrite/pyrrhotite ratio of the ore is analyzed on a daily basis and serves as an indicator of its amenability to flotation.

The zinc mineral has a high iron content, with a theoretical composition in the order of 6 $ZnS \cdot FeS$; hence concentrate grades of 52% zinc are the maximum normally attainable.

Silver is of great economic importance, with approximately 60% reporting to the lead concentrate, which assays in the order of 15 oz/ton.

Initial plant operation yielded metallurgical results that were considerably inferior to those predicted by the feasibility study. This led to considerable effort being expended in circuit modifications and reagent testing, with little change in results. The commencement of bulk production, in the fall of 1970, did not yield the hoped-for improvement in metallurgy. The largest single advance in metallurgical performance came in 1971 when soda ash replaced lime as the pH modifier on the lead circuit feed, giving significant gains in grade and recovery of both lead and zinc. The commissioning of the fourth-stage zinc cleaning section in 1972 permitted the attainment of a 51% zinc concentrate on a consistent basis.

The increased grinding and flotation capacity provided by the expansion, completed in 1974, resulted in further metallurgical improvements.

Some of the ore treated exhibits varying degrees of oxidation, with, as expected, deleterious effects on the metallurgy. The addition of 1.0 lb/ton of sodium sulphite, in conjuction with above-normal soda ash, improves these results and has become standard operating practice for any particularly refractory ore.

During 1975, a relatively new facet of ore dressing, oxygen demand measurement of pulp streams, was tested in the mill. Monitoring the oxygen demand of grinding mill discharges led to the redistribution of cyanide to all stages of grinding, rather than just rod mills. The unwanted iron and zinc sulphides (greater consumers of oxygen than galena) would be complexed by the cyanide ion as new surfaces were freshly created, rendering them immune to oxidation. Less surface oxidation, that is, lowering the oxygen demand, results in less xanthate attachment and more efficient depression. With effective complexing, oxidation is directed toward the lead mineral and activation is enhanced, galena being unaffected by cyanide.[1]

Lead rougher/scavenger flotation is carried out in two 15-cell banks of 200-cu.-ft Denver machines. The scavenger tails are routed to the zinc circuit; the scavenger concentrate is pumped back to the tertiary grinding circuit. The rougher concentrate, averaging about 25% lead, is reground prior to cleaner flotation.

Three conventional cleaning stages, utilizing a total of 48 Wemco 100-cu.-ft cells, upgrade the concentrate to 67% lead. Tailings from the first cleaning stage are scavenged in a 13-cell retreatment bank; the retreatment tailings are pumped back to the lead rougher feed. A portion of the tailing from the third-stage cleaning is used as the source of lead in the production of bulk concentrate.

Three 14- by 12-ft tanks with Denver agitator mechanisms were installed to condition the zinc circuit feed; in practice, these units are normally bypassed because they yielded no evident metallurgical benefit and in addition they tended to 'sand out'.

The zinc rougher/scavenger flotation circuit is comprised of three 15-cell banks of 200-cu.-ft Denver machines. As in the lead section, a system of double launders and removable trays permits the middle 5-cell section of each bank to be used for either roughing or scavenging. The scavenger tailing forms the greater part of the plant tailing; the scavenger concentrate is returned to the rougher feed.

The rougher concentrate, containing some 30% zinc, is reground along with the second cleaner tailing and the retreatment concentrate. The strategy is to regrind the entire feed to the first stage of cleaning.

Four conventional cleaning stages employ a total of 60 Wemco 100-cu.-ft cells as well as 8 Denver 100-cu.-ft cells (fourth stage) to produce a concentrate of 51% zinc.

Tailings from the first-stage cleaning are reground, conditioned and then scavenged in a 13-cell retreatment bank. The retreatment tailings combine with the scavenger tailing to form the flotation circuit tailing.

A portion of the tailings from the fourth cleaners is used as the zinc constituent in the production of bulk concentrate.

A bank of six 100-cu.-ft Galigher cells, installed in the flotation basement, has been used periodically to reject barium in that portion of the fourth cleaner tailing destined for bulk concentrate production.

TABLE 3 — Metallurgical Balance, 1975

Product	S.D. Tons	Assays (%) Lead	Zinc	Iron	Distribution (%) Lead	Zinc	Iron
Mill Feed	3,225,223	4.03	5.41	32.87	100	100	100
Lead Conc.	145,453	66.89	5.07	6.37	74.90	4.23	0.87
Zinc Conc.	230,494	2.04	50.80	10.78	3.62	67.13	2.34
Bulk Conc.	77,113	18.37	29.34	15.53	10.91	12.97	1.13
Final Tailing	2,772,163	0.50	0.99	36.58	10.57	15.67	95.66

Air for lead and zinc rougher/scavenger flotation cells is supplied at 3 psig by one of three 10,00-cfm Spencer blowers.

With the exception of soda ash and sodium sulphite, flotation reagents are fed as liquids or slurries through solenoid valves controlled by adjustable timers in the control room. The pH measurement has been a problem area, requiring the full-time services of one instrument technician for calibrations and probe cleaning. Recent trials of a differential-electrode system indicate that this system requires only a fraction of the maintenance required by a conventional electrode system.

Hourly flotation circuit samples are analyzed in dry powder form by an Inax X-ray analyzer (radioisotope source) interfaced with a Hewlett Packard computer.

Dewatering

THICKENING

Thickening equipment consists of four Eimco thickeners. Lead concentrate is thickened in a 75-ft-diameter tank, zinc in a 65-ft-diameter tank and bulk in a 90-ft-diameter unit. The fourth thickener is 40 ft in diameter and can be used for any of the three concentrates during repair to the primary thickener.

Underflows are pumped to the filters by 5- and 6-in. Allis-Chalmers SRL centrifugals, which are currently being equipped with remotely controlled, variable-speed hydraulic drives. Percol 351 is used as a settling aid and is fed to the thickener feed.

TABLE 4 — Typical Reagent Addition Rates (lb/ton)

Addition Point	NaCN	Na_2CO_3	$Ca(OH)_2$	$CuSO_4$	Z-11	MIBC	1012	Na_2SO_3	pH
Primary Grinding	0.04	2.2			0.07				
Secondary Grinding	0.06								
Tertiary Grinding	0.11				0.01			0.60	
Lead Roughers						0.012			10.0
Lead Scavengers					0.05	0.008			10.0
Lead First Cleaner	0.02		0.04						10.5
Lead Second Cleaner					0.01				10.9
Lead Third Cleaner			0.11						11.5
Lead Retreat					0.02				10.5
Zinc Roughers			0.64	0.42	0.12		0.004		11.0
Zinc Scavengers					0.11		0.003		11.0
Zinc First Cleaner			0.07						11.3
Zinc Second Cleaner			0.10	0.04	0.01				11.6
Zinc Third Cleaner			0.18						11.9
Zinc Fourth Cleaner			0.36						12.2
Zinc Retreat				0.17	0.04				11.3
TOTAL	0.23	2.2	1.50	0.63	0.44	0.02	0.007	0.60	

FILTERING

Filtering of the thickened pulps (65 to 75% solids) is carried out using six 8-ft 6-in. Peterson disc filters. Vacuum, at a normal 22-in. mercury, is supplied by three CL 6003 Nash pumps. Plant air is used to discharge the filter cake, with low-pressure air partially expanding the bag and then two bursts of high-pressure air completing the discharge. No scrapers are required.

A solution of Alcopol "O", at 0.3 lb/ton of concentrate, is mixed with the filter feeds and assists in producing concentrate moistures in the range of 8 to 12%.

Filter bags are Neotex, and the changeover to a model with a zipper and Velcro closure is now in progress. Originally, disc sectors were wooden, but due to poor service life the wooden sectors are gradually being replaced by stainless steel and polyethylene sectors.

DRYING

Concentrate drying equipment consists of four concurrent, stainless steel, 5- by 40-ft rotary kilns, with heat supplied by coal-fired 10×10^6-Btu/hr furnaces. A fifth concurrent, stainless steel, 6- by 40-ft rotary kiln has heat supplied by an oil-fired furnace of 10×10^6-Btu/hr capacity.

Each dryer is equipped with a Ducon wet scrubber, with the discharges and filtrates pumped to the appropriate thickener. Target moistures for the dried concentrate are: lead 4.5%, zinc 5.5% and bulk 5.0%. The speed of the stoker on the coal-fired furnaces is controlled by the temperature of the dryer discharge; as response is rather sluggish, variation in dryer feed rates can result in wide fluctuations in dryer product moistures.

As filter drying capacity is marginal at times, the operating strategy is to employ two filters on lead concentrate to feed the larger 6-ft-diameter dryers, two filters on zinc to feed two dryers, and one filter and dryor on bulk. The remaining filter and dryer is equipped to handle any one of the three concentrates that the varying concentrate volumes dictate.

The dryers were originally equipped with knockers, but these were removed several years ago. Cleaning by hand is carried out as required, normally at one- to two-month intervals.

Load-Out

The three partially dried concentrates are conveyed to the 10,000-ton-capacity storage building, where they are discharged into their respective piles. A Caterpillar 988 front-end loader is used to load each truck-mounted container with 30 tons of concentrate. Weighing is done with a 60-ton-capacity truck scale.

TABLE 5 — Typical Screen Analyses — Tyler Mesh Per Cent Retained

	+80	+100	+150	+200	+325	−325
Flotation Feed	8.0	5.0	8.0	10.5	15.5	53.0
Lead Conc.				0.5	1.5	98.0
Zinc Conc.				4.0	10.0	86.0
Bulk Conc.				9.0	16.0	75.0
Final Tailing	8.5	5.5	8.5	11.0	16.0	50.5

The White Pass & Yukon Route own and operate the truck/rail container system for transporting the concentrates to tidewater at Skagway, Alaska. The concentrate containers were designed for this application, and have a metal lid to prevent wind losse and moisture pick-up.

The normal concentrate shipping rate is 45 truck units per day, with loading being carried out around the clock, seven days a week.

During the winter months, the interior of each container is sprayed with 1 gallon of ethylene glycol, prior to loading, in order to prevent the adhesion of frozen concentrates to the metal container.

When the concentrate production rate has exceeded the capacity of the truck haulage system, the extra inventory of concentrate has been stockpiled outside until heulage capacity was available. Experience has shown that outside stockpiling has resulted in very significant concentrate losses, as well as considerable contamination of the reclaimed concentrate with gravel.

Heating Plant

Heating for the mill, shops and warehouse is supplied from a heating plant located in the concentrator building.

The heating plant consists of three 25×10^6-Btu/hr, coal-fired, high-temperature-water (htw) generators, a primary htw distribution loop and three secondary htw distribution systems. The generators are designed to produce high-temperature water at a constant discharge temperature of 400°F. The water is circulated through the primary and secondary systems and returns to the htw generators at a minimum of 268°F. The entire htw system is pressurized to a minimum operating pressure of 300 psig by a nitrogen system.

The heating equipment connected to the secondary distribution system is controlled to satisfy the heating demand for its particular service. The coal for both space heating and concentrate drying ie received in concentrate containers, which are dumped on the open storage pile.

The coal is reclaimed from the pile with a front-end loader and fed to the coal crusher. The crushed coal is conveyed by a bucket elevator belt and drag chain to the coal storage bin located above the generators.

Tailings Impoundment

Mill tailings are impounded in Rose Creek Valley directly below the mill. A diversion channel, approximately one mile long, was constructed along the south side of the valley floor to provide a storage area of 165 acres for tailings.

The centerline method of tailing dam construction is employed, with the downstream half of the dam being composed of naturally classified tailing sand. Nonclassified tailings, containing 85% solids, are transported by gravity to the perimeter of the dam by a 16-in.-diameter Schedule 80 Sclair pipe. The tailings are deposited at 100-ft intervals along the rest of the dike and cone on a 5% slope. These tailings are levelled and compacted upstream of the centerline of the dam. The pond level is maintained by a surface decant ditch constructed along the side hill at the northwest abuttment of the dam. This ditch is raised at 5-ft intervals as required.

All dam construction is designed by geotechnical consulting engineers and approved by the Territorial Water Board. Water quality decant and seepage is monitored by weekly samples which are analyzed for deleterious elements and by quarterly bio-assay samples which are tested for toxicity.

Water

The plant-site water requirements of some 4,000 (U.S.) gpm are pumped from a station on nearby Rose Creek by vertical-turbine, electrically driven pumps. A diesel-driven emergency pump can supply a limited amount of water in the event of a power outage.

The water supply line is 24-in. steel pipe with polyurethane insulation, equipped with drain valves for use in the unlikely event of a power outage and diesel pump failure occurring in cold weather.

Most of the process make-up water is low pressure, obtained by gravity from the storage tank. Three booster pumps supply high-pressure water for pump glands, sprays and washdown hoses.

Two water pumps, along with a chlorinator and filters, provide potable water for the complex. Fire protection is provided by an electrically driven pump with a diesel-driven back-up pump. There is no water reclamation whatsoever at this time.

Maintenance

A preventive maintenance program is in the process of being implemented, with only the crushing and grinding areas being complete at this date. The following are some maintenance features.

1. The primary crusher is stripped down each summer to try to insure against having to make repairs in severe winter weather.
2. Rebuilding a worn primary mantle using an automatic welding system was found to be more costly than purchasing and installing a new liner. The primary mantle liner pattern was modified to reduce the amount of "throw away".
3. Rod mill barrel liners are zinced; this procedure was adopted after shifting of liners had produced elongation of the barrel bolt holes.
4. Rubber liners in the secondary ball mills have a service life of two to three times that of Ni-hard liners. All rubber linings in pipes, launders, pumpboxes, etc., are applied by hot vulcanizing in a rubber shop in Vancouver. This procedure was adopted after repeated failure of cold-bonded rubber exposed to slurries. Rubber wear parts from pumps, conditioners and flotation cells are all rebuilt in Vancouver.
5. Flotation cell launders are constructed of polyethylene and have given very satisfactory service; however, pulp transfer launders of the same type of construction were unsatisfactory due to deformation of the plastic and have been largely replaced by pipes.
6. Many of the gravity slurry lines are of polyethylene and ABS piping and have exhibited excellent resistance to abrasion.
7. Original vacuum pumps were rotary lobe units and were replaced by Nash pumps because of a history of low availability and high maintenance. The original reciprocating compressors were replaced with screw-type units for the same reasons.

Personnel

The mill supervisory staff consists of the following 21 employees:

General Mill Superintendent
Chief Metallurgist
Mill Production Superintendent
Mill Maintenance Superintendent
General Foreman (Production)
General Foreman (Maintenance)
Surface Foreman
Labour Foreman
Training Foreman
Heating Plant Engineer
Plant Metallurgist
Chief Assayer
Shift Foremen (4)
Maintenance Foremen (4)
Preventive Maintenance Supervisor

The non-supervisory work force consists of the following 143 employees:

Operations	75
Maintenance	52
Heating Plant	6
Assay and Metallurgy	10

The employees union is the United Steelworker's of America, with one local representing the operating employees and another representing the office and technical employees.

All operations personnel are hired in the labourer category are promoted almost exclusively on the basis of seniority. This has necessitated setting up a fairly extensive operator training program.

Women have been successfully employed in operating positions since early 1975.

References

(1) Carlson, C., and Muir, W., The Role of Oxygen Demand in the Flotation of a Complex Sulphide Ore, Proceedings of the Canadian Mineral Processors, p. 261, January 1976.
(2) Cyprus Anvil Hammers Out Big Expansion in the Yukon, C.M.J., Vol. 96, No. 8, August 1975.
(3) Proceedings of the Eighth Annual Meeting of the Canadian Mineral Processors, January 1976.

FINANCIAL ANALYSIS

Cyprus Anvil

1. Facilities	-	Mine Equipment Mill Equipment Townsite
2. Anvil District	-	Faro Vangorda Grum Dy Others Potential for Lead/Zinc Barite Property
3. Akie Dsitrict (50%)	-	Cirque Fluke Elf Gin Other Showing
4. Exploration Properties		
5. Coal Properties	-	Torrens Tulameen
6. Debt (83-01-01)	-	$170 million

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Exhibit 1 Anvil District

A. Valuation to January 1, 1983

B. Prices for 1983 + (1982 - US$)

   Zinc - $.54/lb
   Lead - $.44/lb
   Silver - $12/oz
   Gold - $500/oz

C. Exchange Rate - .82 ($US/$Cdn)

D. Inflation - 9%

E. Royalty - maximum 50% incremental rate.

F. Operating cost reduction approximately 7% from historical trend.

Area	$MM	Comments
1. Labour	4.0	Total employees reduced from 800 to 690 (March 15, 1982). Review on manpower plans is in progress.
2. Power	7.0	Current power costs are 10.4¢ per kwh. This will be reduced as the ratio of diesel to hydro power is reduced.
3. Freight	4.0	Trucks are cheaper than rail by $10/tonne concentrate. This is being investigated.
4. Head Office	1.0	Synergy upon amalgamation with a corporate body.

Exhibit 2 Cash Flow Anvil District

Stand - Alone Taxes

CYPRUS ANVIL

ANVIL DISTRICT EVALUATION
CASH FLOW PAGE
THOUSANDS OF DOLLARS

YEAR	REVENUE	OPERATING COSTS	ROYALTIES PRIVATE	ROYALTIES GOVERNMENT	INTEREST	TAXES	CAPITAL	DEBT	WORKING CAPITAL	CASH FLOW
1983	287 971	252 789					28 489			6 692
1984	315 975	276 319		1 545			29 174			8 937
1985	417 834	323 310		1 956			10 193			82 375
1986	506 729	352 421		10 294		13 401	14 172			116 440
1987	576 384	383 253		22 776		30 016	11 270			129 069
1988	658 120	410 353		31 625		77 724	15 004			123 414
1989	664 566	428 075		35 401		55 471	56 390			89 229
1990	649 059	444 090		39 709		11 150	137 452			16 657
1991	791 982	516 770		27 221		31 701	98 245			118 045
1992	848 575	647 914		45 407		27 758	57 222			70 274
1993	1 119 973	765 731		18 604		63 861	84 918			186 859
1994	1 189 505	826 583		55 188		71 503	87 116			149 116
1995	1 183 562	856 468		56 909		53 820	101 372			114 992
1996	1 290 083	931 339		44 883		86 196	63 990			163 675
1997	1 480 830	1 063 338		62 946		115 767	53 741			185 038
1998	1 554 819	1 111 467		94 143		78 304	158 284			112 621
1999	1 839 565	1 287 375		117 581		168 781	25 359			240 469
2000	2 005 126	1 403 238		148 408		197 876	37 513			218 090
2001	2 185 587	1 529 530		161 955		214 218	40 889			238 995
2002	2 382 290	1 667 188		182 924		232 470	44 569			255 139
2003	2 596 696	1 817 235		205 411		252 673	48 580			272 797
2004	2 830 398	1 980 786		229 639		270 637	59 920			289 417
2005	3 085 134	2 159 056		254 485		299 300	57 718			314 575
2006	3 362 296	2 353 371		284 214		330 387	33 940			360 884
2007	3 665 448	2 565 175		312 822		363 568	27 971			395 913
2008				346 773						(346 773)
PV 0	37,489,005	26,353,170		2,792,821		3,046,583	1,383,491			3,912,941
PV15	5,320,355	3,796,871		248,904		309,534	306,909			658,137

NO ALLOWANCE HAS BEEN MADE FOR OUTSTANDING NPI ON PARTS OF THE GRUM AND DY DEPOSITS

Exhibit 3

Cash Flow

Anvil District

Flow - through Taxes

CFPAGE

CYPRUS ANVIL

ANVIL DISTRICT EVALUATION
CASH FLOW PAGE
THOUSANDS OF DOLLARS

YEAR	REVENUE	OPERATING COSTS	ROYALTIES PRIVATE	ROYALTIES GOVERNMENT	INTEREST	TAXES	CAPITAL	DEBT	WORKING CAPITAL	CASH FLOW
1983	287 971	252 789				(69 273)	28 489			75 965
1984	315 975	276 319		1 545		(5 736)	29 174			14 674
1985	417 834	323 310		1 956		19 019	10 193			63 356
1986	506 729	352 421		10 294		40 852	14 172			88 990
1987	576 384	383 253		22 776		56 792	11 270			102 292
1988	658 120	410 353		31 625		75 796	15 004			125 341
1989	664 566	428 075		35 401		59 102	56 390			85 598
1990	649 059	444 090		39 709		6 776	137 452			21 032
1991	791 982	516 770		27 221		39 744	98 245			110 001
1992	848 575	647 914		45 407		24 548	57 222			73 484
1993	1 119 973	765 731		18 604		64 792	84 918			185 928
1994	1 189 505	826 583		55 188		68 299	87 116			152 320
1995	1 183 562	856 468		56 909		49 125	101 372			119 688
1996	1 290 083	931 339		44 883		82 789	63 990			167 082
1997	1 480 830	1 063 338		62 946		115 590	53 741			185 216
1998	1 554 819	1 111 467		94 143		88 434	158 284			102 491
1999	1 839 565	1 287 375		117 581		172 406	25 359			236 844
2000	2 005 126	1 403 238		148 408		189 616	37 513			226 350
2001	2 185 587	1 529 530		161 955		208 048	40 889			245 165
2002	2 382 290	1 667 188		182 924		227 728	44 569			259 881
2003	2 596 696	1 817 235		205 411		248 892	48 580			276 578
2004	2 830 398	1 980 786		229 639		267 488	59 920			292 566
2005	3 085 134	2 159 056		254 485		296 548	57 718			317 328
2006	3 362 796	2 353 371		284 214		327 863	33 940			363 408
2007	3 665 448	2 565 175		312 822		361 449	27 971			398 031
2008				346 773		(11 707)				(335 066)
PV 0	37,489,005	26,353,170		2,792,821		3,004,980	1,383,491			3,954,543
PV15	5,320,355	3,796,871		248,904		282,701	306,909			684,971

NO ALLOWANCE HAS BEEN MADE FOR OUTSTANDING NPI ON PARTS OF THE GRUM AND DY DEPOSITS

Exhibit 4 **Revenue Assumptions** Anvil District

(1982 Dollars)

CYPRUS ANVIL

ANVIL DISTRICT EVALUATION
REVENUE STATISTCS
THOUSANDS OF DOLLARS

YEAR	$US/LB ZN	$US/LB PB	$US/OZ AG	$US/OZ AU	EXCHANGE CDN/US	MM LBS ZN	MM LBS PB	M OZ AG	M OZ AU	REVENUE--$MM(CDN) ZN	REVENUE--$MM(CDN) PB	REVENUE--$MM(CDN) AG	REVENUE--$MM(CDN) AU	TOTAL	PRODUCT M TONNES	VALUE $/TONNE
1983	0.54	0.44	12.00	500	0.82	229	153	1972	0	151	82	29	0	262	351	745
1984	0.54	0.44	12.00	500	0.82	228	158	1941	0	150	85	28	0	264	358	736
1985	0.54	0.44	12.00	500	0.82	269	198	2494	0	177	106	37	0	320	418	764
1986	0.54	0.44	12.00	500	0.82	286	229	3051	0	188	123	45	0	356	475	748
1987	0.54	0.44	12.00	500	0.82	312	232	2814	0	206	125	41	0	371	505	735
1988	0.54	0.44	12.00	500	0.82	320	240	3387	0	211	129	50	0	389	516	754
1989	0.54	0.44	12.00	500	0.82	279	239	3293	0	184	128	48	0	360	473	761
1990	0.54	0.44	12.00	500	0.82	279	189	2594	0	184	101	38	0	323	434	744
1991	0.54	0.44	12.00	500	0.82	264	224	3049	37	174	120	45	23	361	481	752
1992	0.54	0.44	12.00	500	0.82	263	205	3998	22	173	110	59	13	355	436	814
1993	0.54	0.44	12.00	500	0.82	348	225	4892	13	229	121	72	8	430	517	831
1994	0.54	0.44	12.00	500	0.82	348	225	4140	13	229	121	61	8	419	517	810
1995	0.54	0.44	12.00	500	0.82	310	212	3889	13	204	114	57	8	383	470	815
1996	0.54	0.44	12.00	500	0.82	310	212	3889	13	204	114	57	8	383	470	815
1997	0.54	0.44	12.00	500	0.82	315	231	4166	17	208	124	61	10	403	490	823
1998	0.54	0.44	12.00	500	0.82	292	281	4056	21	192	124	59	13	388	467	831
1999	0.54	0.44	12.00	500	0.82	299	263	4504	28	197	141	66	17	421	499	843
2000	0.54	0.44	12.00	500	0.82	299	263	4504	28	197	141	66	17	421	499	843
2001	0.54	0.44	12.00	500	0.82	299	263	4504	28	197	141	66	17	421	499	843
2002	0.54	0.44	12.00	500	0.82	299	263	4504	28	197	141	66	17	421	499	843
2003	0.54	0.44	12.00	500	0.82	299	263	4504	28	197	141	66	17	421	499	843
2004	0.54	0.44	12.00	500	0.82	299	263	4504	28	197	141	66	17	421	499	843
2005	0.54	0.44	12.00	500	0.82	299	263	4504	28	197	141	66	17	421	499	843
2006	0.54	0.44	12.00	500	0.82	299	263	4504	28	197	141	66	17	421	499	843
2007	0.54	0.44	12.00	500	0.82	299	263	4504	28	197	141	66	17	421	499	843
2008	0.54	0.44	12.00	500	0.82	0	0	0	0	0	0	0	0	0	0	0

Exhibit 5 **Capital Cost Assumptions** Anvil District

(1982 Dollars)

CYPRUS ANVIL

ANVIL DISTRICT EVALUATION
CAPITAL EXPENDITURES
THOUSANDS OF DOLLARS

	CAPITAL EXPENDITURES							TAX ALLOCATION						
	OLD MINE			NEW MINE		EXPLORATION		CCA POOLS			CAP WRITEOFFS			
YEAR	MINING	MILLING	OTHER	EQUIP	STRIP	PROV	CDN	10	12	28	100	30	DEPL	ITC
0	0	0	0	0	0	0	0	112000	15000	0	16600	0	23800	19180
1983	11987	8500	1100	0	0	3850	0	21587	0	0	3850	0	4117	2159
1984	6017	12500	1100	0	0	3850	0	19617	0	0	3850	0	5450	1962
1985	1722	500	1100	0	0	4200	0	3322	0	0	4200	0	1567	332
1986	3295	500	1100	0	0	4700	0	4895	0	0	4700	0	1733	490
1987	2000	500	1100	0	0	3400	0	3600	0	0	3400	0	1300	360
1988	2000	500	1100	2000	200	2750	0	3600	0	2000	2950	0	1817	560
1989	2000	500	1100	22000	1130	2750	0	3600	0	22000	3880	0	8793	2560
1990	0	500	2100	39000	20500	3825	0	2600	0	39000	24325	0	21275	4160
1991	2000	500	1100	20000	17130	2500	0	3600	0	20000	19630	0	13377	2360
1992	2000	500	1100	0	17000	2500	0	3600	0	0	19500	0	6667	360
19'	2000	500	1600	0	26000	1350	0	4100	0	0	27350	0	9283	410
1994	2000	500	1100	0	26000	0	0	3600	0	0	26000	0	8833	360
1995	2000	500	1100	0	26000	2000	0	3600	0	0	28000	0	9500	360
1996	1000	500	1100	0	15700	0	0	2600	0	0	15700	0	5400	260
1997	0	500	1600	5000	5000	2000	0	2100	0	5000	7000	0	4167	710
1998	3000	500	2600	21000	7000	4000	0	6100	0	21000	11000	0	10833	2710
1999	3000	500	2100	0	0	0	0	5600	0	0	0	0	167	560
2008	6000	500	1100	0	0	0	0	7600	0	0	0	0	167	760
2001	6000	500	1100	0	0	0	0	7600	0	0	0	0	167	760
2002	6000	500	1100	0	0	0	0	7600	0	0	0	0	167	760
2003	6000	500	1100	0	0	0	0	7600	0	0	0	0	167	760
2004	6000	500	1100	0	0	1000	0	7600	0	0	1000	0	500	760
2005	6000	500	1100	0	0	0	0	7600	0	0	0	0	167	760
2006	2000	500	1600	0	0	0	0	4100	0	0	0	0	167	410
2007	1000	500	1600	0	0	0	0	3100	0	0	0	0	167	310
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0
****	85021	32500	33000	109000	161660	44675	0	262521	15000	109000	222935	0	139745	45132

OTHER POOLS AT THE START OF THE FIRST YEAR
LOSS CARRY FORWARDS 36600 $M

Exhibit 6 Operating Cost Assumptions Anvil District

(1982 Dollars)

CYPRUS ANVIL

ANVIL DISTRICT EVALUATION

BREAKDOWN OF COSTS--$ THOUSANDS

	DIRECT OPERATING COSTS				------OVERHEADS------			TRANSPORTATION		-----SMELTER-----		
YEAR	MINING	MILLING	OTHER	ELECTRIC	OFFICE	MINESITE	TOWNSITE	LAND	OCEAN	LEAD/ZINC	ADMIN	TOTAL
1983	53988	41939	2814	4306	3000	9000	6000	21323	11352	72941	557	227220
1984	52527	42403	2897	2434	3000	9000	6000	20691	11569	74247	568	225335
1985	50871	45986	3375	0	3000	9000	6000	23089	13518	86673	663	242175
1986	34867	45986	3375	0	3000	9000	6000	26152	15366	98161	754	242662
1987	25654	45986	3375	0	3000	9000	6000	27771	16318	104467	800	242371
1988	18122	46122	3385	0	3000	9000	6000	28374	16672	106759	818	238253
1989	20650	46105	3375	0	3000	9000	6000	26042	15302	97608	751	227834
1990	20650	46105	3375	0	3000	9000	6000	23857	14018	90025	688	216720
1991	18893	50009	3375	0	3000	9000	6000	26429	15529	98472	762	231470
1992	60430	48073	10126	0	3000	9000	6000	24005	14105	89845	692	265276
1993	63936	46105	10126	-3397	3000	9000	6000	28450	16717	107273	820	288031
1994	61196	46105	10126	-3397	3000	9000	6000	28450	16717	107273	820	285291
1995	61196	46105	10126	-3397	3000	9000	6000	25824	15174	97229	744	271003
1996	61196	46105	10126	-4029	3000	9000	6000	25824	15174	97229	744	270370
1997	69576	45046	9865	-4029	3000	9000	6000	26931	15824	101185	776	283176
1998	70820	41080	8229	-4352	3000	9000	6000	25672	15084	96248	740	271522
1999	80438	37538	6837	-4352	3500	10500	7000	27472	16142	102679	792	288546
2000	80438	37538	6837	-4352	3500	10500	7000	27472	16142	102679	792	288546
2001	80438	37538	6837	-4352	3500	10500	7000	27472	16142	102679	792	288546
2002	80438	37538	6837	-4352	3500	10600	7000	27472	16142	102679	792	288546
2003	80438	37538	6837	-4352	3500	10500	7000	27472	16142	102679	792	288546
2004	80438	37538	6837	-4352	3500	10500	7000	27472	16142	102679	792	288546
2005	80438	37538	6837	-4352	3500	10500	7000	27472	16142	102679	792	288546
2006	80438	37538	4837	-4352	3500	10500	7000	27472	16142	102679	792	288546
2007	80438	37538	6837	-4352	3500	10500	7000	27472	16142	102679	792	288546
2008	0	0	0	0	0	0	0	0	0	0	0	0

OTHER INCLUDES COAL AND CONVEYOR COSTS

ELECTRIC--CONSUMPTIONx(COST/KWH-$.067/KWH)

Exhibit 7 — Operating Costs per Tonne Milled — Anvil District

(1982 Dollars)

CYPRUS ANVIL

ANVIL DISTRICT EVALUATION
BREAKDOWN OF COSTS—$ THOUSANDS

YEAR	DIRECT OPERATING COSTS MINING	MILLING	OTHER	ELECTRIC	—OVERHEADS— OFFICE	MINESITE	TOWNSITE	TRANSPORTATION LAND	OCEAN	—SMELTER— LEAD/ZINC	ADMIN	TOTAL
1983	15.90	12.35	0.83	1.27	0.88	2.65	1.77	6.28	3.34	21.48	0.16	66.93
1984	15.02	12.13	0.83	0.70	0.86	2.57	1.72	5.92	3.31	21.24	0.16	64.46
1985	12.49	11.29	0.83	0.00	0.74	2.21	1.47	5.67	3.32	21.28	0.16	59.46
1986	8.56	11.29	0.83	0.00	0.74	2.21	1.47	6.42	3.77	24.10	0.19	59.58
1987	6.30	11.29	0.83	0.00	0.74	2.21	1.47	6.82	4.01	25.65	0.20	59.51
1988	4.44	11.29	0.83	0.00	0.73	2.20	1.47	6.95	4.08	26.13	0.20	58.32
1989	5.07	11.32	0.83	0.00	0.74	2.21	1.47	6.39	3.76	23.96	0.18	55.94
1990	5.07	11.32	0.83	0.00	0.74	2.21	1.47	5.86	3.44	22.10	0.17	53.21
1991	4.64	12.28	0.83	0.00	0.74	2.21	1.47	6.49	3.81	24.18	0.19	56.83
1992	14.84	11.80	2.49	0.00	0.74	2.21	1.47	5.89	3.46	22.06	0.17	65.13
1993	15.70	11.32	2.49	-0.88	0.74	2.21	1.47	6.98	4.10	26.34	0.20	70.72
1994	15.02	11.32	2.49	-0.83	0.74	2.21	1.47	6.98	4.10	26.34	0.20	70.04
1995	15.02	11.32	2.49	-0.83	0.74	2.21	1.47	6.34	3.73	23.87	0.18	66.54
1996	15.02	11.32	2.49	-0.99	0.74	2.21	1.47	6.34	3.73	23.87	0.18	66.38
1997	17.53	11.35	2.49	-1.02	0.76	2.27	1.51	6.79	3.99	25.50	0.20	71.36
1998	21.40	12.41	2.49	-1.31	0.91	2.72	1.81	7.76	4.56	29.08	0.22	82.03
1999	29.25	13.65	2.49	-1.58	1.27	3.82	2.55	9.99	5.87	37.34	0.29	104.93
2000	29.25	13.65	2.49	-1.58	1.27	3.82	2.55	9.99	5.87	37.34	0.29	104.93
2001	29.25	13.65	2.49	-1.58	1.27	3.82	2.55	9.99	5.87	37.34	0.29	104.93
2002	29.25	13.65	2.49	-1.58	1.27	3.82	2.55	9.99	5.87	37.34	0.29	104.93
2003	29.25	13.65	2.49	-1.58	1.27	3.82	2.55	9.99	5.87	37.34	0.29	104.93
2004	29.25	13.65	2.49	-1.58	1.27	3.82	2.55	9.99	5.87	37.34	0.29	104.93
2005	29.25	13.65	2.49	-1.58	1.27	3.82	2.55	9.99	5.87	37.34	0.29	104.93
2006	29.25	13.65	2.49	-1.58	1.27	3.82	2.55	9.99	5.87	37.34	0.29	104.93
2007	29.25	13.65	2.49	-1.58	1.27	3.82	2.55	9.99	5.87	37.34	0.29	104.93
2008	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	11.00

OTHER INCLUDES COAL AND CONVEYOR COSTS

ELECTRIC—CONSUMPTION*(COST/KWH-$.067/KWH)

Exhibit 8 — Operating Costs per Tonne Concentrate (1982 Dollars) — Anvil District

CYPRUS ANVIL

ANVIL DISTRICT EVALUATION

BREAKDOWN OF COSTS--$ THOUSANDS

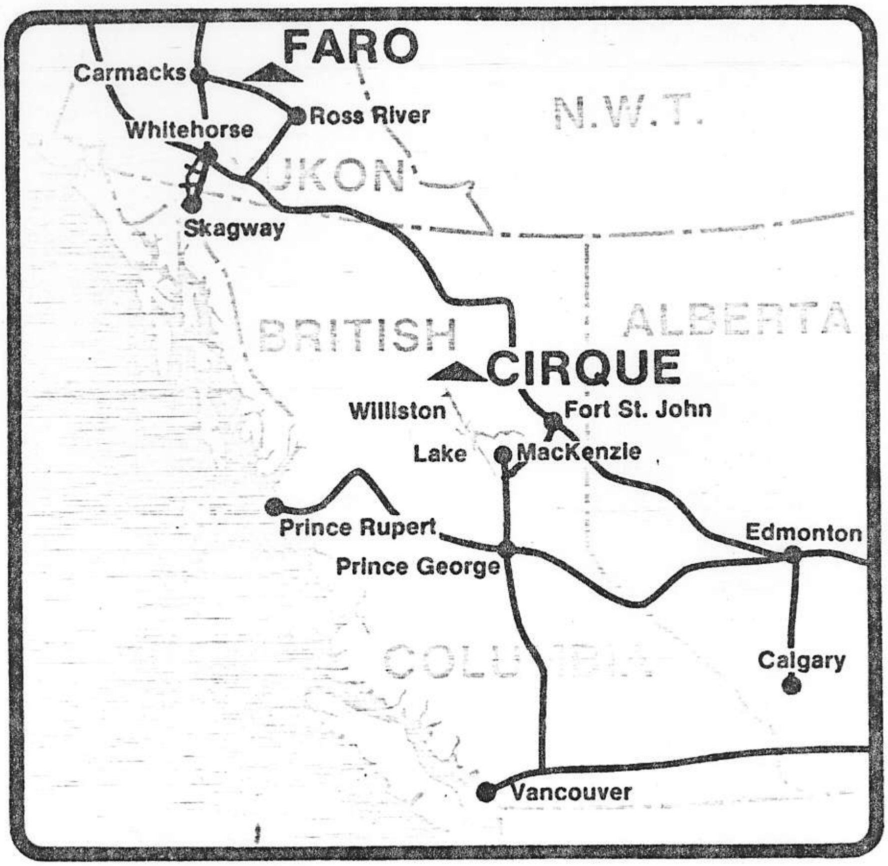
	DIRECT OPERATING COSTS				OVERHEADS			TRANSPORTATION		SMELTER		
YEAR	MINING	MILLING	OTHER	ELECTRIC	OFFICE	MINESITE	TOWNSITE	LAND	OCEAN	LEAD/ZINC	ADMIN	TOTAL
1983	153.69	119.39	8.01	12.26	8.54	25.62	17.08	60.70	32.32	207.64	1.59	646.8[illegible]
1984	146.73	118.45	8.09	6.80	8.38	25.14	16.76	57.80	32.32	207.41	1.59	629.4[illegible]
1985	121.62	109.94	8.07	0.00	7.17	21.52	14.34	55.20	32.32	207.21	1.59	578.9[illegible]
1986	73.33	96.71	7.10	0.00	6.31	18.93	12.62	55.00	32.32	206.44	1.59	510.3[illegible]
1987	50.81	91.08	6.69	0.00	5.94	17.82	11.88	55.00	32.32	206.90	1.59	480.0[illegible]
1988	35.13	89.40	6.56	0.00	5.82	17.45	11.63	55.00	32.32	206.94	1.59	461.8[illegible]
1989	43.61	97.37	7.13	0.00	6.34	19.01	12.67	55.00	32.32	206.14	1.59	481.1[illegible]
1990	47.61	106.29	7.78	0.00	6.92	20.75	13.83	55.00	32.32	207.54	1.59	499.62
1991	39.32	104.07	7.02	0.00	6.24	18.73	12.49	55.00	32.32	204.93	1.59	481.70
1992	138.46	110.15	23.20	0.00	6.87	20.62	13.75	55.00	32.32	205.85	1.59	607.80
1993	123.60	89.13	19.58	-6.57	5.80	17.40	11.60	55.00	32.32	207.38	1.59	556.83
1994	118.31	89.13	19.58	-6.57	5.80	17.40	11.60	55.00	32.32	207.38	1.59	551.53
1995	130.33	98.19	21.57	-7.23	6.39	19.17	12.78	55.00	32.32	207.08	1.59	577.1[illegible]
1996	130.33	98.19	21.57	-8.58	6.39	19.17	12.78	55.00	32.32	207.08	1.59	575.83
1997	142.09	92.00	20.15	-8.23	6.13	18.38	12.25	55.00	32.32	206.65	1.59	578.32
1998	151.73	88.01	17.63	-9.32	6.43	19.28	12.05	55.00	32.32	206.20	1.59	581.71
1999	161.04	75.15	13.69	-8.71	7.01	21.02	14.01	55.00	32.32	205.56	1.59	577.67
2000	161.04	75.15	13.69	-8.71	7.01	21.02	14.01	55.00	32.32	205.56	1.59	577.67
2001	161.04	75.15	13.69	-8.71	7.01	21.02	14.01	55.00	32.32	205.56	1.59	577.67
2002	161.04	75.15	13.69	-8.71	7.01	21.02	14.01	55.00	32.32	205.56	1.59	577.67
2003	161.04	75.15	13.69	-8.71	7.01	21.02	14.01	55.00	32.32	205.56	1.59	577.67
2004	161.04	75.15	13.69	-8.71	7.01	21.02	14.01	55.00	32.32	205.56	1.59	577.67
2005	161.04	75.15	13.69	-8.71	7.01	21.02	14.01	55.00	32.32	205.56	1.59	577.67
2006	161.04	75.15	13.69	-8.71	7.01	21.02	14.01	55.00	32.32	205.56	1.59	577.67
2007	161.04	75.15	13.69	-8.71	7.01	21.02	14.01	55.00	32.32	205.56	1.59	577.67
2008	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	11.00

OTHER INCLUDES COAL AND CONVEYOR COSTS

ELECTRIC--CONSUMPTIONx(COST/KWH-$.067/KWH)

CYPRUS

CIRQUE



DOME

DOME PETROLEUM LIMITED

VOLUME 2

MARCH, 1982

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CYPRUS ANVIL
CIRQUE

DOME PETROLEUM LIMITED

VOLUME 2

MARCH, 1982

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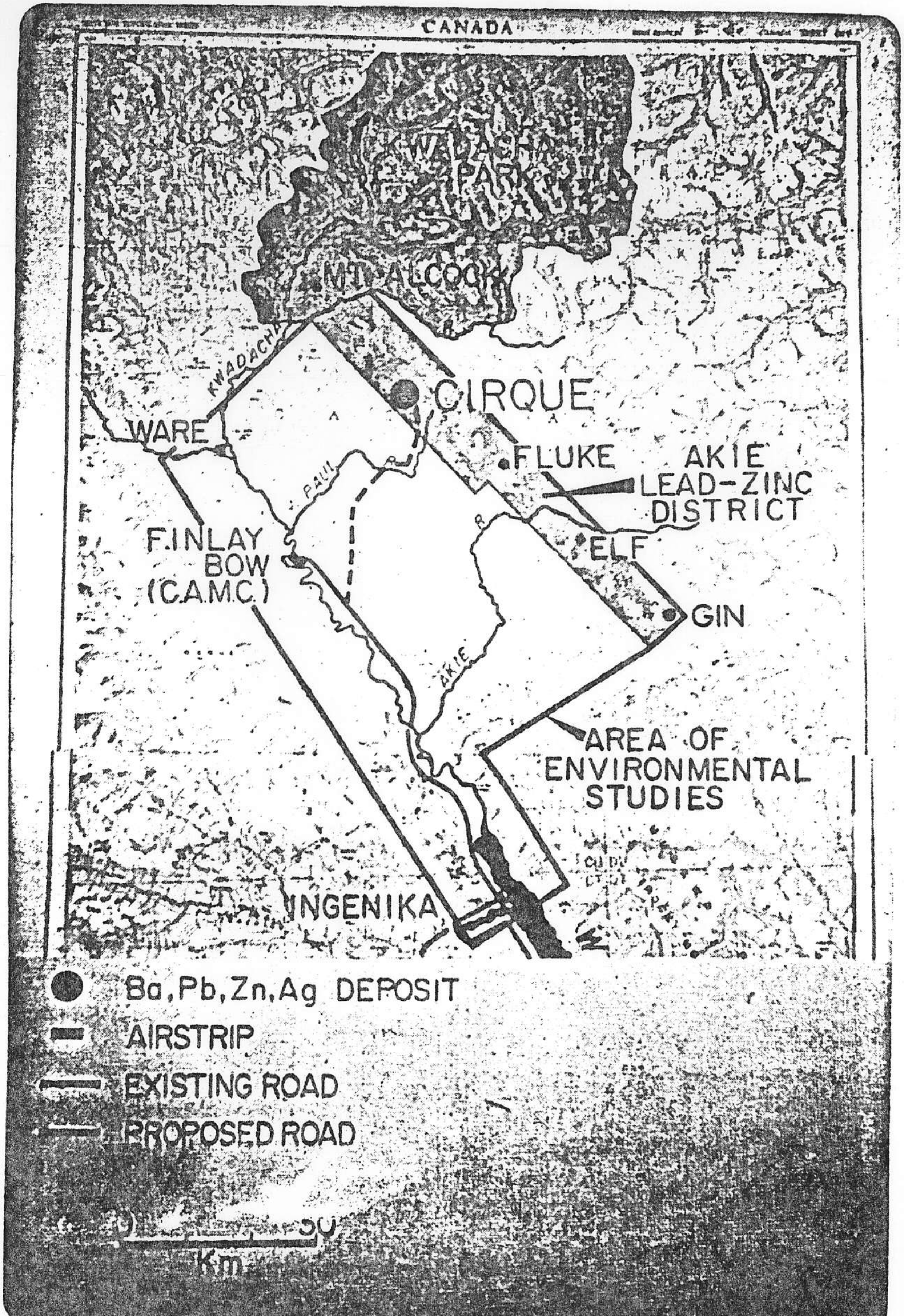
SUMMARY

A major lead-zinc-silver district has been identified in the Akie district, some 230 kilometres north of Mackenzie in northeastern British Columbia.

One major massive sulphide accumulation, the Cirque deposit, containing over 40 million tonnes grading 2.2% lead, 8.0% zinc, and 47 grams per tonne silver has been identified along with at least three other mineralized areas of high potential in a 60 kilometre belt (Fluke, Elf, Gin claims).

A high probability exists that this area will develop into a major lead-zinc mining district. Of the individual lead-zinc ore bodies in western Canada, the Cirque deposit is second only to Sullivan and Faro in size and metal content based on current indicated reserves.

A development schedule is proposed to bring the mine into production in 1988 at the rate ef two million tonnes per year. Undiscounted cash flows indicate a net profit of between one and four billion dollars - depending on reserve definition. Detailed cash flows are included in the Appendix.



CANADA
KWADACHA PARK
MT. ALCOCK
KWADACHA
CIRQUE
WARE
FLUKE
AKIE
LEAD-ZINC
DISTRICT
PAUL
FINLAY
BOW
(C.A.M.C.)
ELF
GIN
AKIE
AREA OF
ENVIRONMENTAL
STUDIES
INGENIKA
Ba, Pb, Zn, Ag DEPOSIT
AIRSTRIP
EXISTING ROAD
PROPOSED ROAD
0
30
Km

HISTORY

The Akie lead-zinc district, located 230 kilometres north-northwest of Mackenzie in northeastern British Columbia, was discovered in 1977, as a result of reconnaissance stratigraphic mapping and chemical silt sampling. The project was an extension of similar programs carried out in the Yukon Selwyn Basin and was funded by Cyprus Anvil Mining Corporation and Hudson's Bay Oil and Gas Company Ltd., which are now owned by Dome Petroleum.

The Cirque group in the Akie District was staked in 1977, and in 1978 preliminary drilling was carried out. Also in 1978, based on geological mapping and geochemical sampling, two additional claim groups, Elf and Fluke, were staked. In 1979, follow-up drilling on Cirque indicated potential lead-zinc-silver in a massive sulphide-barite deposit. A similar mineralized horizon with ore-grade intercepts has been traced for 1,200 metres on the Elf claims, and a sulphide-barite horizon has been cut in preliminary drilling on the Fluke claims. Both of these claim groups remain open to futher exploration. In 1979, anomalous stream geochemistry and a subcropping sulphide bearing barite horizon led to the staking of the Gin claims. These claims remain to be explored.

To the end of 1981, $17 million has been expended in the Akie district on 49,000 metres of diamond drilling, road and airstrip construction. Drilling on the Cirque deposit, has outlined 40 million tonnes of high grade lead-zinc-silver mineralization and has indicated additional mineral potential. In 1981, a 1,600 metre all-weather gravel airstrip was completed and approved for Hercules aircraft transport operations. An 87 kilometre road was constructed from the Finlay River to the future exploration adit portal.

CIRQUE DEPOSIT

Evaluation

By December, 1981, sufficient drill data was available on the Cirque deposit to carry out a preliminary economic evaluation.

The Cirque's drill-indicated reserves are used as a base for this study. A mining plan using adit access and vertical crater blasthole-stopping methods is proposed.

A concentrator designed for milling 6,250 tonnes per day (2 million tonnes per year) is planned. Conventional crushing and grinding facilities are incorporated into the design, along with selective flotation of lead, zinc, and silver-rich pyrite. A leaching and refining section is included for silver recovery from the pyrite. This mineralization is identical in metallurgy to the lead zinc deposits at Meggen and Rammelsberg in Germany.

Concentrates will be transported by truck and barge to the town of Mackenzie during the ice-free season, then by rail to the port. Otherwise, stock-piling of concentrate will occur when barge transportation is not possible.

No townsite is envisaged; instead, a single persons complex with a fly-in, fly-out scheme is planned.

Total preproduction capital costs are estimated at $416 million in constant 1982 dollars. Operating costs are estimated to be $35 per tonne milled.

Ore Reserves

The massive stratiform Cirque deposit, as delineated by 36 diamond drill holes, is 1,000 metres long, 300 metres wide and 2 to 70 metres thick. This massive barite-sulphide body is hosted in black elastic shale trending northwest and dipping at 20 to 30 degrees southwest.

A drill indicated reserve of 40 million tonnes grading 2.2 % lead, 8.0 % zinc, and 47 grams per tonne silver, containing a higher grade portion of 13.7 million tonnes grading 3.2 % lead, 11.0 % zinc and 70.3 grams per tonne silver, was calculated.

Narrow high grade intersections in several wide spaced drill holes south of the deposit indicates its southerly continuatien. A geological reserve of 10 million tonnes of similar grade can be anticipated with additional drilling.

Mining

Due to mountainous terrain, access will be by two adits. One, 2.5 km long and measuring 4.5 m by 4.0 m, will serve as a main haulage level; the other, alightly shorter and of smaller dimension, will facilitate ventilation and provide an alternate escape way.

The massive character of the ore body, and its indicated grade, preclude selective mining methods and dictate low cost bulk mining applications. A modified blasthole or vertical crater retreat method is proposed. Stoping blocks are laid out transverse to the dip and consist of primary, secondary, and tertiary stopes (Figures II - III). Primary stopes will be 20 m wide by 100 m long and will vary from 20 to 70 m in height. Secondary stopes consist of 20 m wide panels on either side of the primary stope. A rib pillar of 10 m width will be left between the secondary and tertiary stopes, each of which has a width of 40 m.

Principal pre-production mine development (Fig. IV) consists of:

1) Two adits to provide access and ventilation;

2) A foot wall ramp system connecting the main haulage level with the various production and drill adit levels;

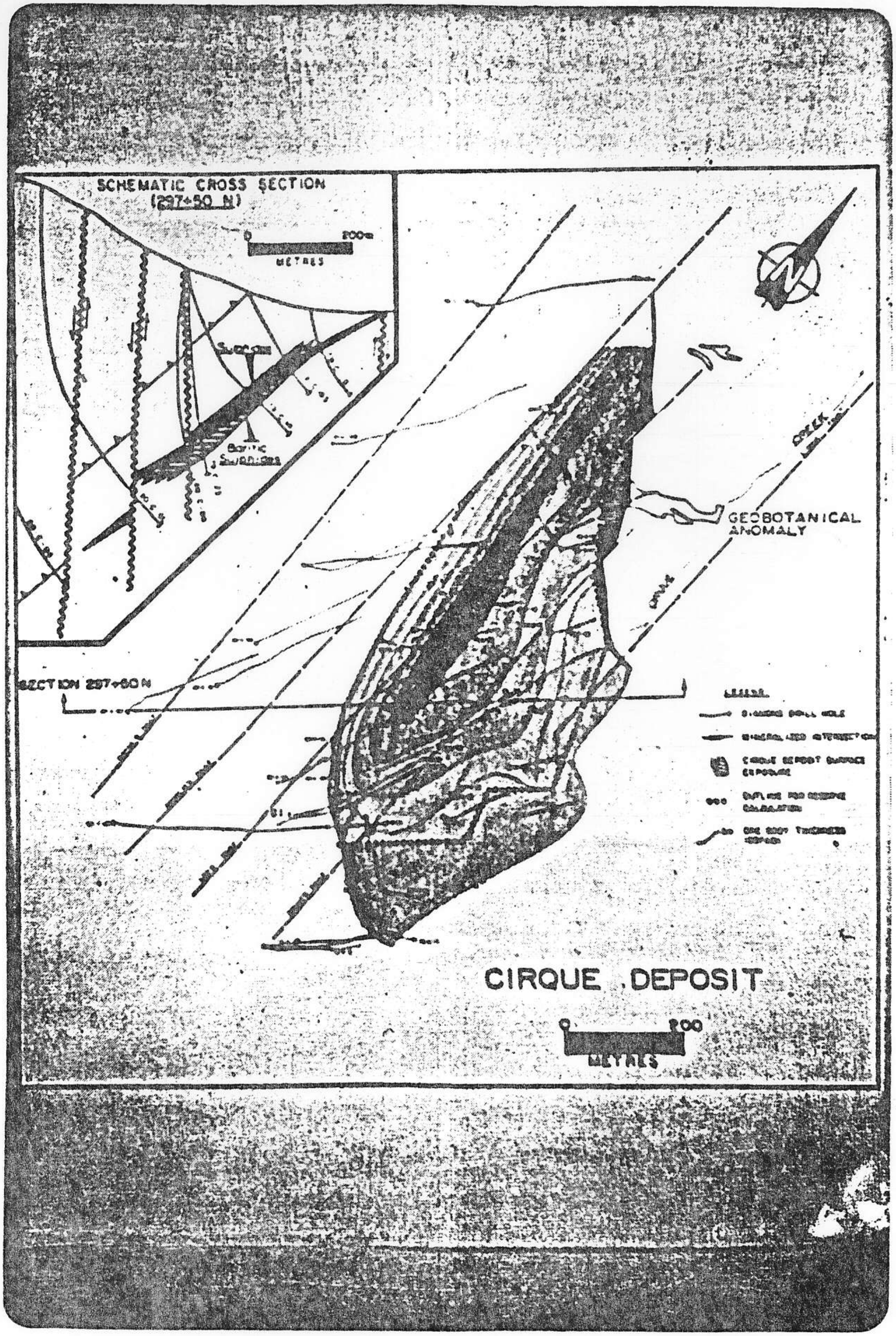
3) A hanging wall ventilation raise to provide ventilation of the production horizons;

4) An ore and waste pass system, haulage drifts and a muck transfer level;

5) Stope development for three stoping blocks, consisting of drilling drifts, production drifts and twelve drawpoints per stope.

A pre-production development schedule is illustrated on page 9.

At a production rate of 2 million tonnes per year, mine life is expected to be 15 years. Approximately 8 million tonnes of ore will be left behind as pillars, constituting an extraction rate of 78 percent.


SCHEMATIC CROSS SECTION
(297+50 N)
200m
METRES
GEOBOTANICAL
ANOMALY
CREEK
SECTION 297+50N
CIRQUE DEPOSIT
0
200
METRES

Milling and Metallurgy

Metallurgical projections and the concentrator flowsheet are based on bench scale laboratory testwork. Preliminary testwork on composited diamond drill cores indicated that a concentrate can be produced from the Cirque ore. The zinc concentrate produced is of excellent quality and essentially free from deleterious elements. The lead concentrate is of average quality. About half the silver reports to the lead and zinc concentrates. The rest of the silver reports to a silver-rich pyrite concentrate from which the silver will be extracted by cyanide leaching.

The conceptual mill design has an annual throughput of 2,000,000 tonnes. The single grinding circuit consists of a rod mill, a secondary ball mill and a tertiary ball mill, with cyclone classification. Separate lead, zinc, and pyrite flotation sections along with regrind mills are provided. A cyanidation plant for silver recovery from pyrite concentrate is included, and is designed to produce refined dore metal for shipment. All other ancillary facilities, including fine crushing, tailings disposal, fresh water supply, and warehouse and administration facilities were included in the capital cost estimate for the mill and related facilities. This estimate was prepared by Kilborn Engineering Ltd., and totals $235 million (1982 Can. $).

CIRQUE DEPOSIT DEVELOPMENT SCHEDULE

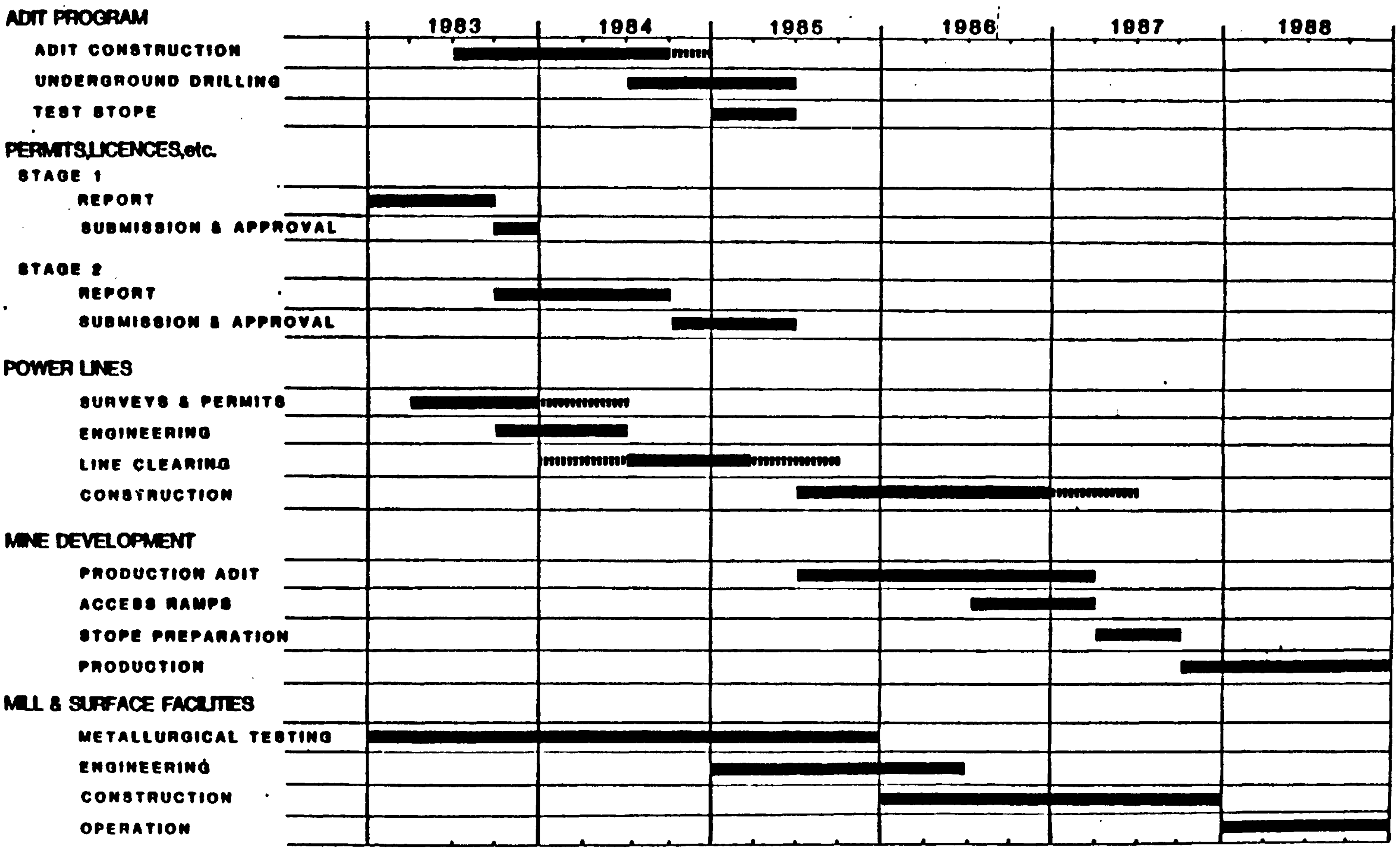


TABLE 1

The average plant metallurgical performance (Table II) is based on test work performed to the end of 1981 on a composite of the principal ore types within the deposit and the respective metallurgical characteristics assigned to each mineral type.

TABLE II

PLANT METALLURGICAL BALANCE

	Grade			Recovery %		
	% Lead	% Zinc	Gms/Tonne Silver	Lead	Zinc	Silver
Lead Concentrate	52		127	70		8
Zinc Concentrate		58	137		87	35

Silver: Assume 54% in the feed reports to the pyrite concentrate. Leaching process recovers 85% of this.

Concentrate Transportation

During ice-free conditions on Williston Lake, concentrates will be trucked from the mill site to Ingenika, then tug and barge transported to Mackenzie where the concentrates will be loaded on rail for transport to Prince Rupert, or alternatively, North Vancouver. Stock-piling will take place when water transportation is not possible. The total cost to the shipping port, including terminal costs and ship loading, is $73 per DMT. In addition, there is a fixed annual cost of $1,900,000 per year for mine road maintenance.

Power Supply

Arrangements have been made with B.C. Hydro to carry out route studies for power supply from Bennett Dam to the Cirque site. A "most favourable" route has been selected (see Map II) for a 235 Kv line. An estimated capital cost for construction of the line and transformers to deliver power (140 million KWH/yr., instantaneous rate of 25 megawatts) on site is appreximately $69 million in 1982 dollars.

Coal located northeast of Williston Lake is being evaluated as an alternative energy source. The primary objective is to define low cost steam coal reserves to supply energy for plant and accommodation heating, concentrate drying and alternative electrical power generation.

The possibility of constructing a natural gas pipeline from the vicinity of Truch, B.C., to provide on-site power generation, concentrate drying, and plant heating is also being investigated. This alternative appears to offer savings in initial capital costs, as well as favourable operating costs.

Capital and Operating Costs

Development costs for the Cirque deposit are estimated at $414 million (1982 $) and are detailed in Table III. Ongoing capital expenditures are outlined in Table IV. In addition to the main capital costs for mine and mill development, the pre-production expenditures include a power line from the Bennett Dam to the minesite.

The cost of a single persons complex (SPQ) is $14 million, versus a townsite cost of over $60 million. The cost of fly-in, fly-out and operation of the SPQ are included in the G & A costs and these costs are approximately the same as the cost of operating a townsite.

A General and Administration cost (G & A) of $15,873,000 per annum was included to cover all administration and staff department costs, flying costs, single persons complex operating costs and head office. A summary of production costs in 1982 dollars is:

1982 PRODUCTION COSTS

		$/Tonne Milled	
Mine			
	Development	3.89	
	Production	4.44	
	Maintenance	5.00	
	General	3.88	
	Total Mining		17.21
Mill			
	Production	8.03	
	Maintenance	2.06	
	Total Milling		10.09
General & Admin			
	Total G & A	7.94	
			7.94
Total 1982 Production Cost			35.24

Financial Analysis

The monetary impact of the project is summarized in undiscounted dollars by the following cases. Case 1 evaluates the current drill-indicated reserves. Case 2 evaluates the potential of the deposit which includes the expected reserves.

		Millions of Canadian Dollars	
		Case 1	Case 2
	Revenue	12128	33140
less:	Operating Costs	8520	23795
	Government Royalties	388	1190
	Taxes	1041	3322
	Capital	783	1151
equals:	Net Cash Flow:	1396	3682

The above table was constructed using the assumption that tax credits are taken when available. Other key assumptions and cash flows for both cases are in the Appendix.

DISTRICT POTENTIAL

At the Cirque deposit, drilling has tested forty percent of the lead-zinc geochemical anomaly. To date, 40 million tonnes of mineralization have been found. The deposit extends southward, and there is the potential to double the drill indicated reserves.

Narrow, high grade, steeply dipping mineralization on the Elf property has been traced for 800 metres and drill tested to 600 metres depth. Tonnage indicates potential for a southern extension. Only one kilometre of an eight kilometre horizon of favourable host rock associated with lead-zinc geochemical anomalies has been drilled.

A new discovery of stratiform "Cirque type" mineralization at the Fluke suggests the presence of an additional deposit. Drill testing is planned in the 1982-83 field seasons.

Another barite-lead-zinc-silver deposit was discovered in a continuation of this northwest-trending belt of rocks into Kwadacha Park. Cyprus Anvil has applied for the mineral rights and consequently the province is studying the proposal.

The spatial association of these deposits with similar geologic strata, the concentration of surface showings over a 60 kilometre belt, and the presence of the Cirque deposit establishes the reality of a major lead-zinc-silver district with excellent potential for several deposits.

1982 PROGRAMS AND FUTURE DEVELOPMENT

The discovery of the Cirque deposit and other mineralized bodies indicate the presence of an important lead-zinc district in British Columbia. In 1982, Cyprus Anvil plans a continuation of its active exploration program, including further reserve definition on the Cirque deposit, exploratory diamond drilling both for portal-adit development and exploration for additional deposits in the southern portion of the Cirque claims, and follow-up drilling on the known mineralized horizons on both Fluke and Elf showinga. Continued mapping of the latter properties and exploration testing of geochemical anomalies remote from known showings is also scheduled.

<u>APPENDIX</u>

TABLE III

Summary of Pre-Production Expenditures

(1982 $ Cdn. 000's)

	1983	1984	1985	1986	1987	Total
Mine Development	5,724	12,000	16,204	38,800	22,700	95,428
Power Supply*	2,000	5,800	11,960	27,508	21,632	68,900
Plant, Equipment & Facilities	-	-	31,136	88,592	115,808	235,536
Single Persons Complex	-	-	-	-	14,560	14,560
Totals	7,724	17,800	59,300	154,900	174,700	414,424

* Estimates provided by B.C. Hydro.

TABLE IV

Continuing Capital Expenditures

(1982 $Can. 000's)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Single Persons Complex		200	200	200	200	200	200	200	200	200	200	200	100	100	100
Mill					10700*	1000	1000	1000	1000	1000	1000	1000	500	500	500
Mine		800	800	1800	1800	1800	2800	2800	2800	2800	2800	2800	1400	-	-
TOTAL		1000	1000	2000	12700	3000	4000	4000	4000	4000	4000	4000	2000	600	600

* Tailings Dam
$Can. 9,700,000

TABLE V

CIRQUE DISTRICT

TONNAGE AND GRADE COMPILATION

	RESERVES	GRADE		
	(000 Tonnes)	Pb%	Zn%	Ag gmt
CIRQUE				
Drill Indicated Reserves	40,000	2.2	8.0	47
Geological Reserves	10,000	n/a	n/a	n/a
Reserves to be Discovered	20,000	n/a	n/a	n/a
TOTAL	70,000			
ELF				
Drill Indicated Reserves	2,000	2.0	6.0	30
Reserves to be Discovered	30,000	n/a	n/a	n/a
TOTAL	32,000			
FLUKE				
Reserves to be Discovered	10,000	n/a	n/a	n/a
TOTAL	112,000			

TABLE VI

KEY ASSUMPTIONS

1. Pricing (1982 U.S. $)

Zinc	$ 0.54/lb
Lead	$ 0.44/lb
Silver	$ 12.00/oz
Gold	$500.00/oz

2. Inflation and Exchange Rates

	Inflation (%)			
	Price	Capital Cost	Operating Cost	Exchange $Cdn./$ U.S.
1983	9	11	11	0.82
1984	9	11	11	0.82
1985+	9	9	9	0.82

TABLE VII

ILLUSTRATIVE - SAMPLE CALCULATIONS

CYPRUS ANVIL --BC PROPERTIES

CIRQUE DEPOSIT--15 YEARS LIFE
CASH FLOW PAGE
THOUSANDS OF DOLLARS

YEAR	REVENUE	OPERATING COSTS	ROYALTIES PRIVATE	ROYALTIES GOVERNMENT	INTEREST	TAXES	CAPITAL	DEBT	WORKING CAPITAL	CASH FLOW
1982						(1 446)	2 000			(554)
1983						(7 029)	10 891			(3 861)
1984						(16 430)	27 102			(10 672)
1985						(39 540)	85 777			(46 237)
1986						(106 414)	231 749			(125 334)
1987						(133 333)	284 483			(151 151)
1988	537 351	344 847				39 664	1 755			151 084
1989	527 680	348 712				46 636	1 913			130 418
1990	508 039	351 298				45 658	4 170			106 913
1991	571 613	391 595				57 532	29 544			92 941
1992	644 865	436 435		5 967		74 809	7 431			120 222
1993	654 294	454 266		22 050		74 061	10 800			93 117
1994	693 787	486 925		21 138		78 861	11 772			95 091
1995	783 267	542 717		21 846		94 478	12 832			111 394
1996	867 805	597 915		25 877		107 701	13 987			122 325
1997	860 792	614 664		38 292		97 705	15 246			94 885
1998	913 399	658 682		34 623		101 335	16 618			102 142
1999	986 182	713 916		35 748		110 078	9 057			117 384
2000	1 037 947	762 866		38 392		113 077	2 962			120 651
2001	1 271 048	893 092		39 142		158 484	3 228			177 103
2002	1 269 649	922 370		54 807		146 635				145 836
2003				50 566		(1 778)				(48 789)
PV 0	12,127,716	8,520,299		388,447		1,040,745	783,316			1,394,909
PV10	3,233,324	2,243,426		78,151		148,846	455,794			307,106
PV12	2,567,503	1,776,997		58,335		90,705	414,889			226,577
PV15	1,850,750	1,276,227		38,222		32,431	362,672			141,199

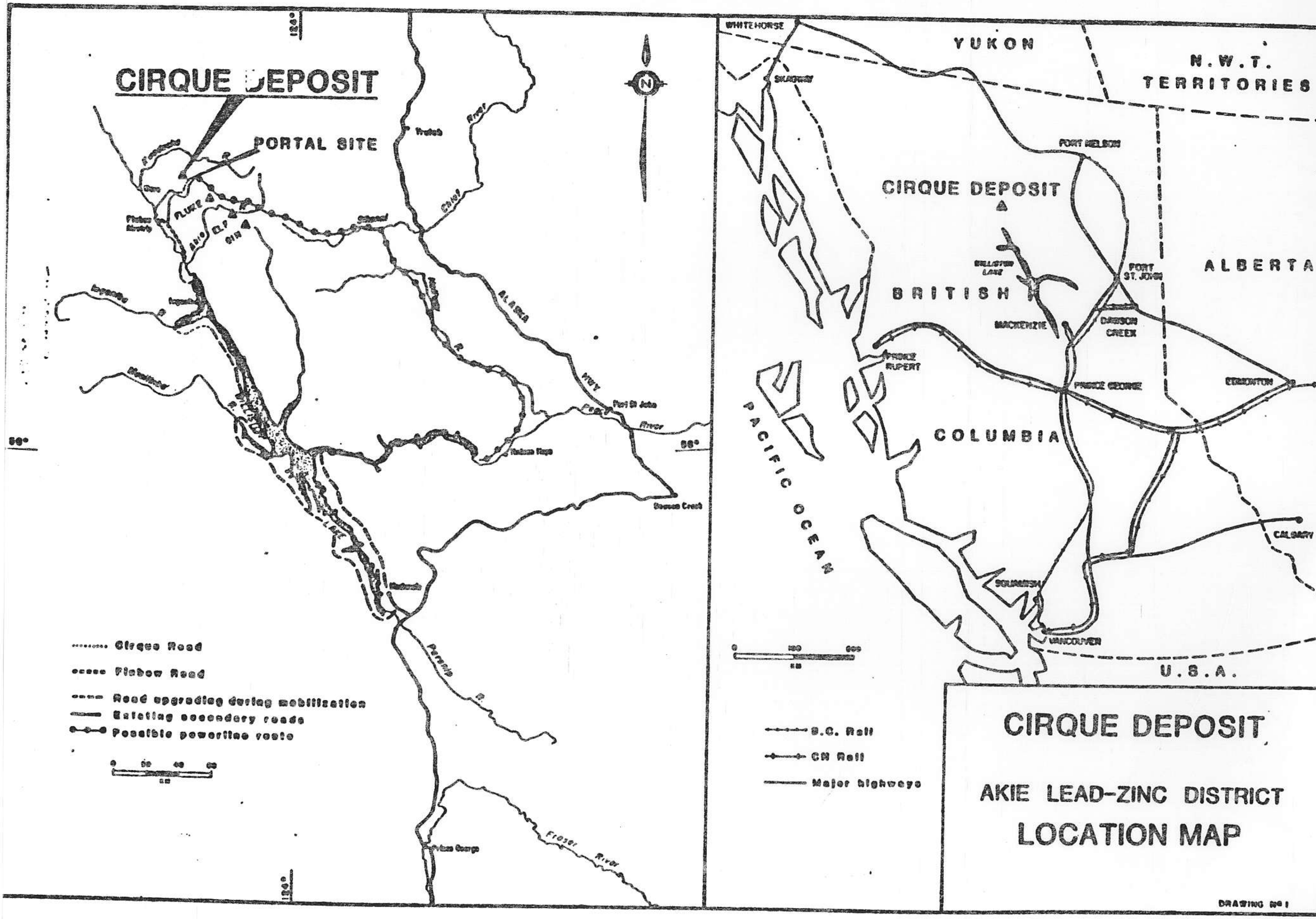
TABLE VIII

ILLUSTRATIVE - SAMPLE CALCULATIONS

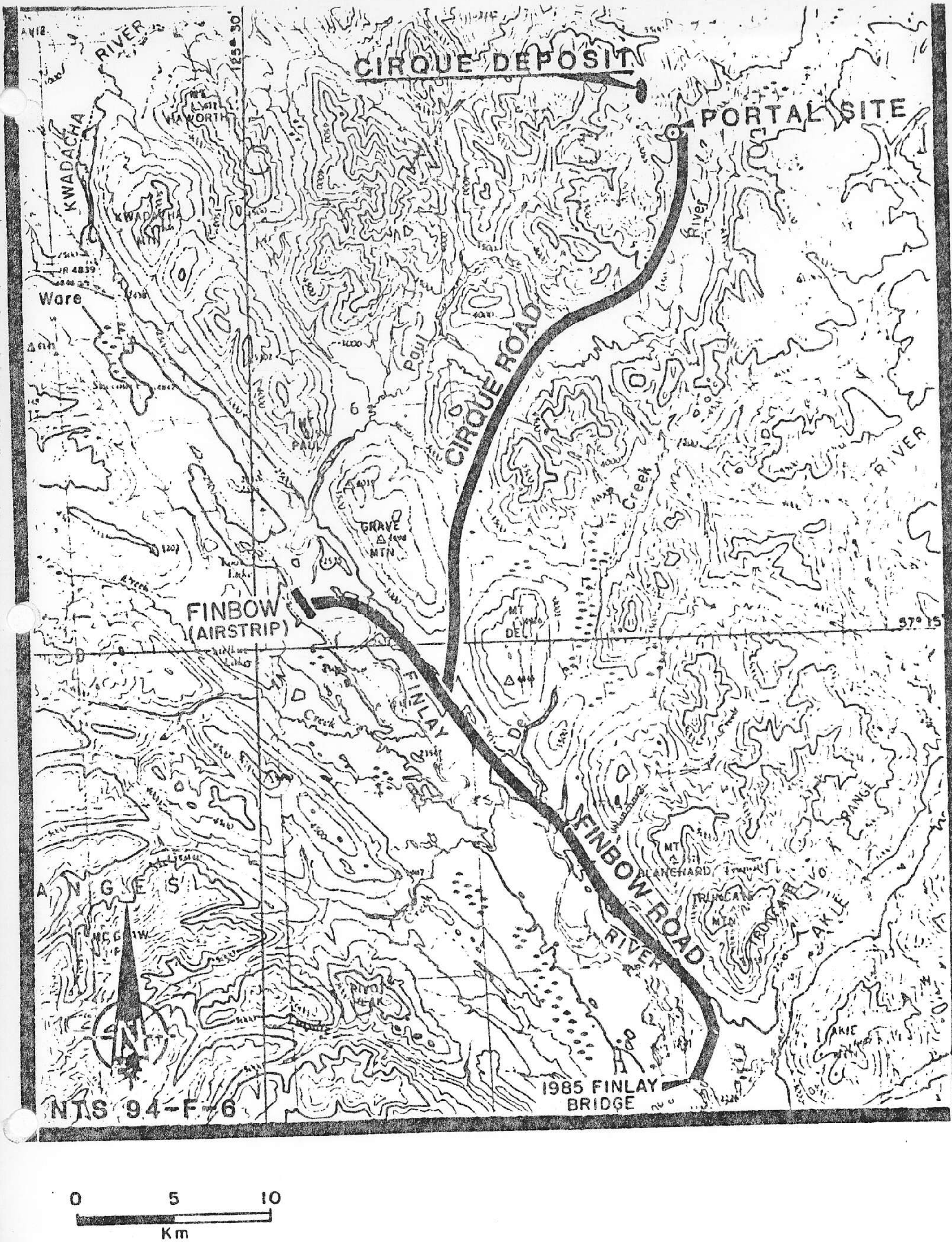
CYPRUS ANVIL —BC PROPERTIES

CIRQUE DEPOSIT—25 YEARS LIFE
CASH FLOW PAGE
THOUSANDS OF DOLLARS

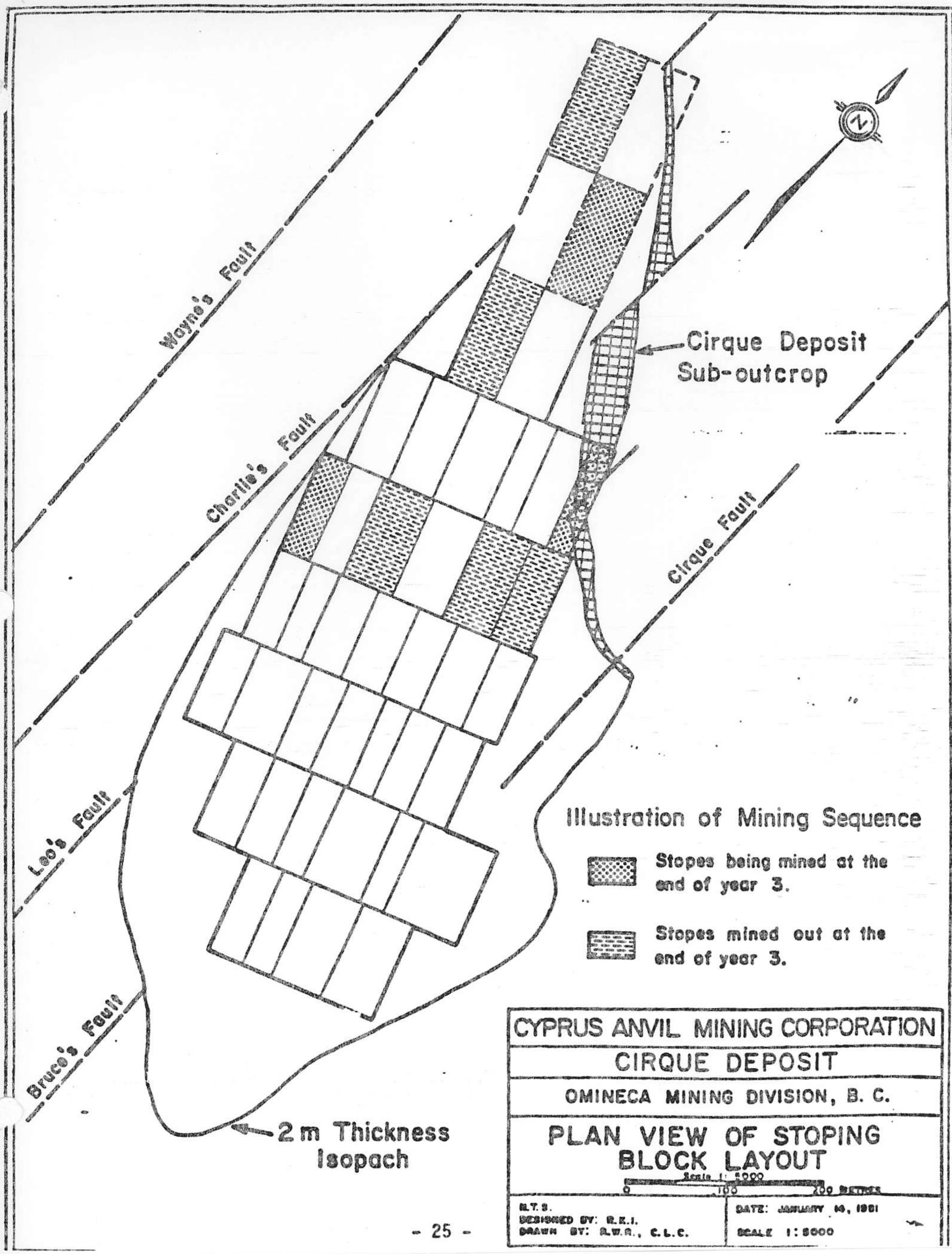
		OPERATING	ROYALTIES						WORKING	
YEAR	REVENUE	COSTS	PRIVATE	GOVERNMENT	INTEREST	TAXES	CAPITAL	DEBT	CAPITAL	CASH FLOW
1982						(1 446)	2 000			(554)
1983						(7 029)	10 891			(3 861)
1984						(16 430)	27 102			(10 672)
1985						(39 540)	85 777			(46 237)
1986						(106 414)	231 749			(125 334)
1987						(133 333)	284 483			(151 151)
1988	537 351	344 847				38 449	3 510			150 544
1989	527 680	348 712				45 314	3 826			129 828
1990	508 039	351 298				44 218	6 255			106 268
1991	571 613	391 595				55 965	31 817			92 236
1992	644 865	436 435		5 068		73 102	9 909			120 351
1993	654 294	454 266		21 771		72 202	13 500			92 554
1994	693 787	486 925		20 834		76 836	14 716			94 477
1995	783 267	542 717		21 514		92 272	16 040			110 723
1996	867 805	597 915		25 171		105 298	17 484			121 938
1997	840 792	614 664		36 254		95 087	19 057			95 730
1998	913 399	658 682		33 861		98 482	20 772			101 602
1999	986 182	713 916		34 917		105 490	22 642			109 218
2000	1 037 947	762 866		37 281		105 964	24 679			107 157
2001	1 271 048	893 092		37 428		149 294	26 901			164 333
2002	1 269 649	922 370		52 433		135 043	29 322			130 481
2003	1 383 733	1 005 384		47 542		147 199	31 961			151 648
2004	1 508 086	1 095 868		51 807		162 826	31 353			166 232
2005	1 643 629	1 194 496		57 145		179 903	18 986			193 099
2006	1 791 372	1 302 001		62 616		197 668	20 695			208 393
2007	1 952 411	1 419 181		68 814		216 523	22 557			225 336
2008	2 127 945	1 546 907		75 398		236 718	24 588			244 334
2009	2 319 276	1 686 129		82 451		262 193	21 440			267 061
2010	2 527 826	1 837 881		91 119		286 072	23 370			289 385
2011	2 755 147	2 003 290		99 444		311 979	25 473			314 961
2012	3 002 926	2 183 586		108 476		340 133	27 766			342 965
2013				118 291		(8 236)				(110 055)
PV 0	33,140,067	23,795,021		1,189,634		3,321,801	1,150,619			3,682,991
PV10	4,944,211	3,487,054		135,505		326,304	501,777			493,570
PV12	3,641,341	2,557,550		93,317		200,303	446,974			343,197
PV15	2,395,608	1,672,266		55,169		86,298	382,008			199,866

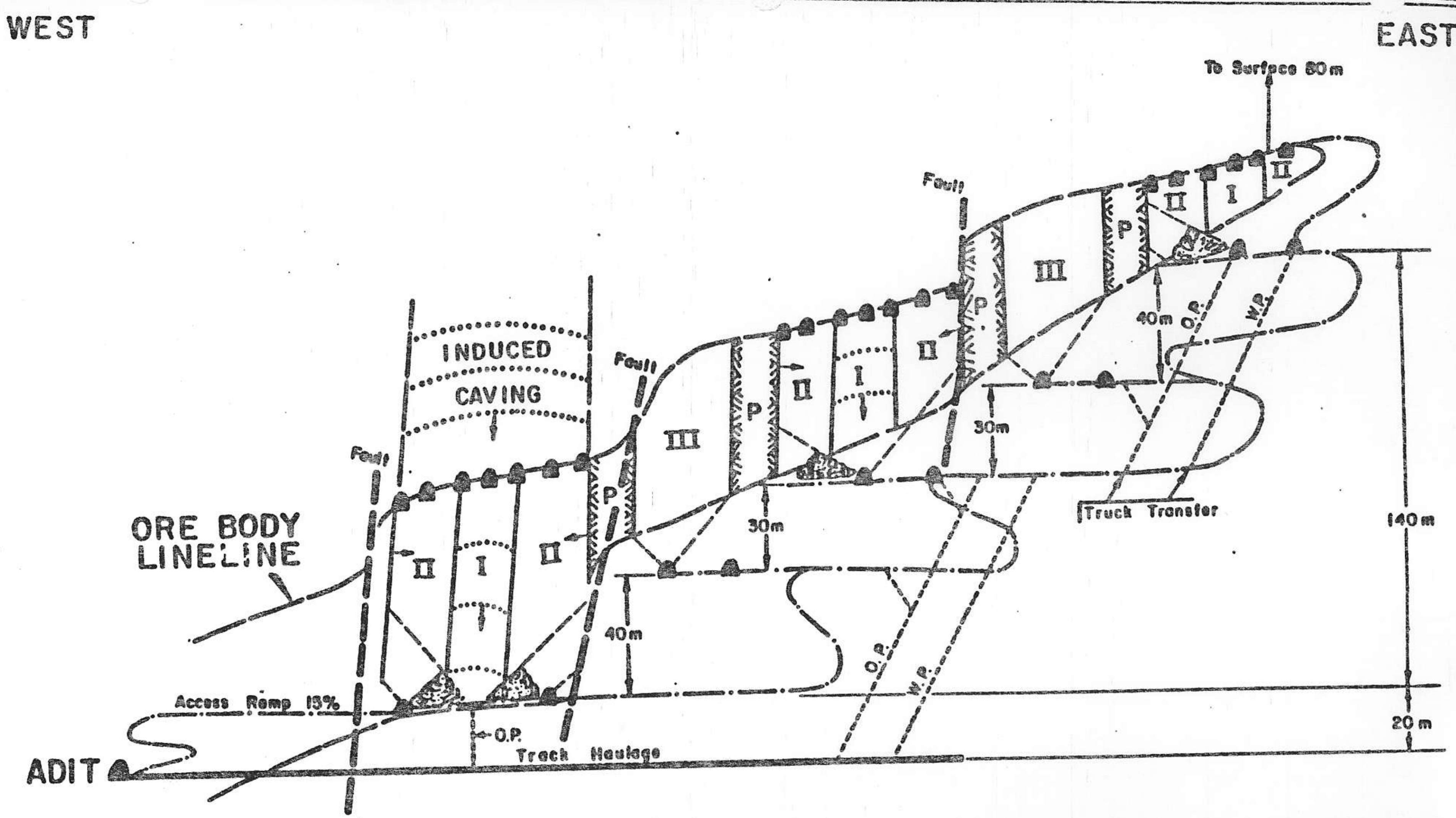


CIRQUE DEPOSIT
PORTAL SITE
Cirque Road
Finbow Road
Road upgrading during mobilization
Existing secondary roads
Possible powerline route
ALASKA HWY
Fort St John
Peace River
Fraser River
Parsnip R.
Prince George
YUKON
N.W.T. TERRITORIES
WHITEHORSE
FORT NELSON
CIRQUE DEPOSIT
BRITISH COLUMBIA
ALBERTA
FORT ST. JOHN
DAWSON CREEK
MACKENZIE
PRINCE RUPERT
PRINCE GEORGE
EDMONTON
CALGARY
SQUAMISH
VANCOUVER
PACIFIC OCEAN
U.S.A.
B.C. Rail
CN Rail
Major highways
CIRQUE DEPOSIT
AKIE LEAD-ZINC DISTRICT
LOCATION MAP
DRAWING Nº 1



CIRQUE DEPOSIT
PORTAL SITE
KWADACHA
RIVER
HAWORTH
KWADACHA MTN
Ware
MT PAUL
Paul
CIRQUE ROAD
GRAVE MTN
Creek
RIVER
FINBOW (AIRSTRIP)
MT DEL
Del
57° 15'
FINLAY
FINBOW ROAD
RIVER
MT BLANCHARD
TRUNCATE MTN
AKIE
RANGE
A N G E S
PIVOT PEAK
N
NTS 94-F-6
1985 FINLAY BRIDGE
0
5
10
Km


Wayne's Fault
Charlie's Fault
Cirque Fault
Leo's Fault
Bruce's Fault
Cirque Deposit Sub-outcrop
2 m Thickness Isopach
N
Illustration of Mining Sequence
Stopes being mined at the end of year 3.
Stopes mined out at the end of year 3.
CYPRUS ANVIL MINING CORPORATION
CIRQUE DEPOSIT
OMINECA MINING DIVISION, B. C.
PLAN VIEW OF STOPING BLOCK LAYOUT
0
100
200 METRES
DESIGNED BY: R.K.I.
DRAWN BY: R.W.R., C.L.C.
SCALE 1:5000



LEGEND:

- I Primary Stope
- II Secondary Stope
- III Tertiary Stope
- P Pillar
- O.P. Ore Passage
- W.P. Waste Passage

CYPRUS ANVIL MINING CORPORATION

CIRQUE DEPOSIT

OMINECA MINING DIVISION, B. C.

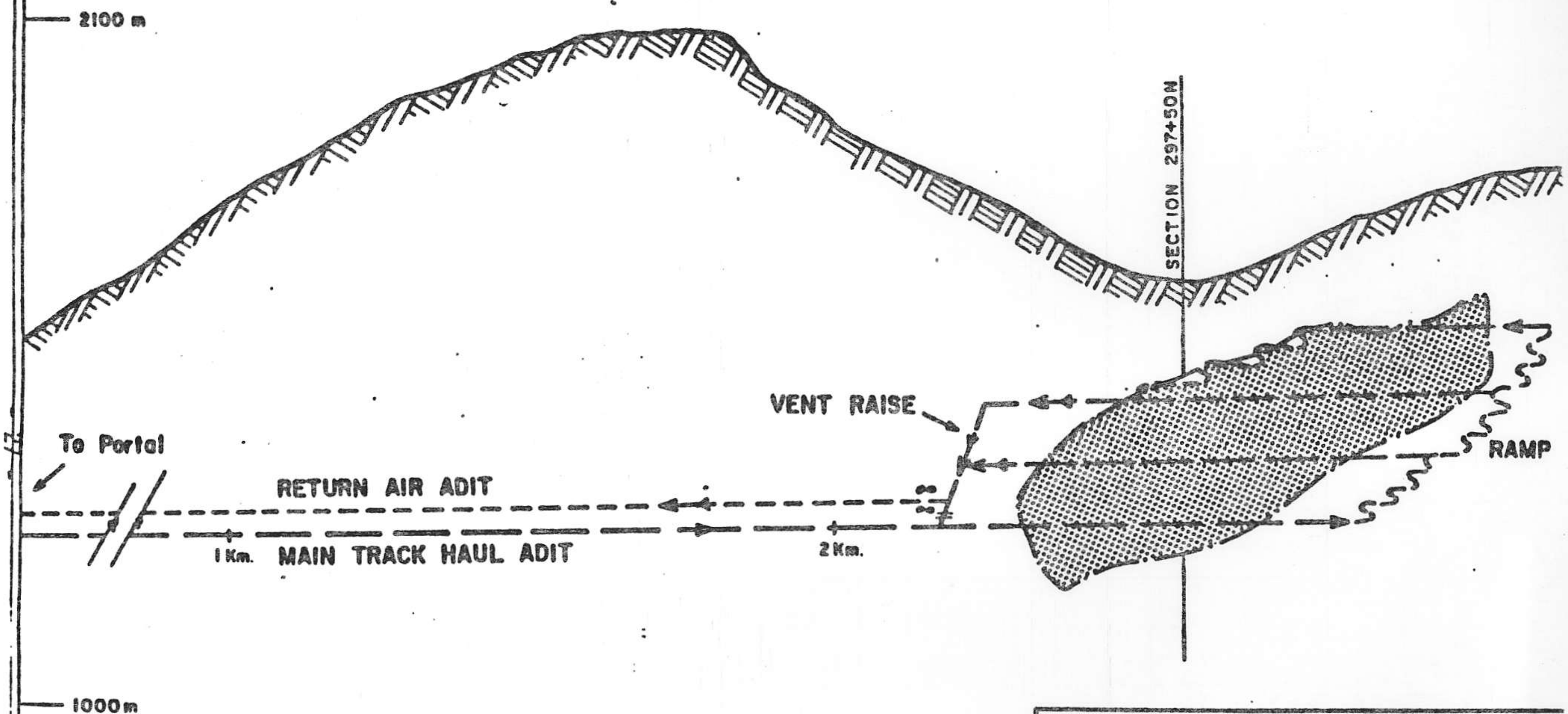
CROSS SECTION 297 + 50 N

Scale: 1: 2000

0 25 50 100 METRES

NTS: 94-F-6
DESIGNED BY: R. K. I.
DRAWN BY: E.W.F.

DATE: JAN. 14, 81
SCALE 1: 2000
FIG. III



→ FRESH AIR
←← EXHAUST AIR
∞ EXHAUST FANS

CYPRUS ANVIL MINING CORPORATION

CIRQUE DEPOSIT

OMINECA MINING DIVISION, B. C.

LONGITUDINAL VIEW

Scale: 1: 10,000

0 100 200 400 METRES

NTS:
DESIGNED BY: R.K.L
DRAWN BY: C.L.CORY

DATE: JANUARY 1981
SCALE 1: 10,000

FIG. IX

SUMMARY

A major lead-zinc-silver district has been identified in the Akie district, some 230 kilometers north of Mackenzie in northeastern British Columbia.

The Cirque Deposit, which contains a current reserve of 40 million tonnes of 10% combined lead-zinc with 47 grams per tonne silver, still remains open to the south.

Additional reserves have been outlined on the Cirque property. The South Cirque Deposit, discovered in 1982, has been intersected by seven drill holes with an estimated resource and target zone potential of 20 million tonnes. A drill hole collared to intersect mineralization 200 meters down-dip from surface barite-sulphide mineralization on the Fluke claims outlined several narrow sulphide horizons over a 20 meter thickness of siltstone breccia identical to the formation hosting the South Cirque Deposit.

Total expenditures in the Akie District are approximately $21 million, of which $17 million has been capitalized on the Cirque property. Work includes 62,000 meters of diamond drilling, completion of a 1,600-meter airstrip, construction of 87 kilometers of all-weather road and purchase of capital equipment to support an underground exploration program.

The early identification of the South Cirque Deposit enhances the viability of a future mining scheme by not only outlining additional reserves, but by delineating zones of higher grade material that lie along the contemplated route of the Cirque production adit. Another year of surface diamond drilling is required to define the reserve potential and distribution of grade within the South Cirque Deposit, from which an optimum schedule for underground development of the property can be determined.

The magnitude of the ultimate project can be compared to the Anvil mining operations. Additional tonnage outlined on the Cirque and potential reserves on the Elf and Fluke claims can only enhance the long term viability of the Cirque development.

CIRQUE POTENTIAL

Cirque Deposit

The massive stratiform Cirque Deposit, as delineated by 36 diamond drill holes, is 1,000 meters long, 300 meters wide and varies from 2 to 70 meters thick. This tabular barite-sulphide body, occurring within a black siliceous shale envelope, lies along the southwest dipping limb of a northwest trending anticline. The current reserve of 40 million tonnes of 2.2% lead, 7.8% zinc and 47 grams per tonne silver, contains a north-central block of 14 million tonnes grading 3.2% lead, 11.0% zinc and 70 grams per tonne silver. A crudely calculated mining reserve, based on a conceptual bulk mining method requiring a minimum thickness of 10 meters and anticipated cut-off of 8%, was calculated at 20.5 million tonnes grading 3.0% lead, 9.4% zinc and 60 grams per tonne silver. Although the deposit remains open to the south, a geological estimate of this strike extension is not included in the reserve calculations.

The situation of the deposit plunging to the south, associated with an extreme rise in topography, negates further delineation from surface. Close-spaced surface drilling to further define a mining reserve within the known boundaries is considered unproductive due to the high cost and unpredictable hole deviation encountered in hanging-wall formations.

Sufficient data was available by January, 1982 to conduct a preliminary economic evaluation using the above drill-indicated reserves. A conceptual underground bulk mining scheme using two adits was proposed. Metallurgical projections and the concentrator flowsheet were based on laboratory testwork. The conceptual mill design had an annual throughput of 2,000,000 tonnes that would approximately produce 45,000 and 250,000 tonnes of lead and zinc concentrate respectively. Detailed studies of concentrate transportation, power supply and operating costs were also included in this evaluation. Total pre-production capital costs were estimated at $416 million in 1982 dollars.

Results of this economic study resulted in a plan for a two year program of underground exploration, test stoping and metallurgical testing that would provide a basis for a feasibility study. Initiation of a three kilometer, 4 x 3.5 meter exploration adit to provide direct access to the deposit was proposed in 1983. This adit, collared at 1,500 meters, would also be used as an integral part of the ultimate mine development, providing alternate access, air return, as well as equipment and safety routes that would be linked to the main production adit collared at 1,200 meters.

The logistical base to support the underground program, which included purchase of a 50-man camp, road maintenance equipment, steel bridges and a sawmill; construction of 87 kilometers of all-weather gravel road to within 300 meters of the proposed exploration portal site and completion of the Finbow airstrip to accommodate hercules aircraft, is now in place. Construction of the initial exploration adit is now contingent on the potential reserve to be defined in the South Cirque Deposit.

South Cirque Deposit

The 1982 deep drilling program, based on geological interpretation, was successful in discovery of an additional barite-sulphide body termed the South Cirque Deposit. This deposit, intersected by seven drill holes along three constructed cross sections, has been outlined over a length of 700 meters, a width up to 250 meters and a thickness of 2 to 30 meters. Mineralization encountered to date is similar to pyritic and baritic facies found in the Cirque Deposit. The pyritic facies, averaging 11 to 17% combined lead-zinc with 50 - 60 grams per tonne silver, consistantly occurs at the base of the deposit. The baritic facies averages 6 to 9% combined lead-zinc with 20 to 34 grams per tonne silver.

Potential for additional reserves in the South Cirque area lies updip to the east as supported by lead-zinc ratios and trends of the ore-host rock facies. An order of magnitude calculation indicates a potential resource of 10 million tonnes. Continuity and thickness of mineralization outlined so far would suggest the South Cirque Deposit has a potential reserve of approximately 20 million tonnes.

Continued surface drilling is required to outline the potential size and distribution of ore facies prior to initiation of an underground exploration phase. The optimum development scheme and timing of either the 1,500 or 1,200 meter adit is contingent on the potential impact of a South Cirque high grade zone added to the existing reserves of the Cirque Deposit. The South Cirque Deposit occurs at an elevation between 900 and 1,200 meters, directly below the proposed route of the 1,200 level production adit. The position of this adit is ideal for further reserve definition upon completion of the surface program.

Narrow, high-grade sulphide mineralization associated with the footwall siltstone breccia, grading from 10 to 42% combined lead-zinc, has been intersected west of the South Cirque Deposit. Although tonnage potential appears limited, the grade encountered makes it attractive for continued exploration.

DISTRICT POTENTIAL

Discovery of the South Cirque Deposit has increased the resource of potentially economic mineralization in the Akie District to 60 million tonnes, averaging 10% combined lead-zinc. This new zone supports past predictive geological modelling indicating the presence of several sub-basins with associated barite-sulphides on the Cirque property. Further reserve potential exists both to the south and west of the Cirque - South Cirque trend.

An intersection of sulphide mineralization with sporadic lead-zinc values, roughly 200 meters down-dip from surface barite mineralization, indicates the presence of an additional deposit on the Fluke claims. This mineralization, consisting of narrow sulphide intervals throughout a 20-meter section of siltstone breccia, is identical to the geological setting of the South Cirque Deposit. The presence of mineralization in lithologies indicating sub-basin development on the Fluke supports the existence of another deposit that may add a significant reserve to the district.

Narrow, high-grade, steeply dipping barite-sulphide mineralization on the Elf has been traced for 800 meters along strike and 600 meters down-dip. Although only a limited tonnage has been outlined to date, there is potential for thickening to the south along the overturned limb of a northwest trending anticline. Potential for additional deposits is excellent, as only one kilometer of an eight kilometer horizon of favourable host rock, with associated lead-zinc anomalies, has been tested. Surface exposures are similar to the host units on the Cirque property subcropping up-dip from the South Cirque Deposit.

An additional barite-sulphide deposit on Mt. Alcock remains within Kwadacha Wilderness Park, to which boundary change would be subject to a legislative decision.

The discovery of the South Cirque Deposit and spatial association of similar geologic environments with known mineralization supports the reality of a major zinc-lead-silver district, with excellent potential for additional reserves.

PROPOSED 1983 PROGRAM AND FUTURE DEVELOPMENT

Definition of the South Cirque Deposit is essential prior to completion of an economic evaluation of the property and initiation of an underground exploration and development program. The position of the initial adit is contingent upon the tonnage and grade of this new deposit.

A minimum of ten holes, at an anticipated cost of $2 million, is required in 1983 to crudely define the reserve potential of this deposit.

The above drilling program should enhance the viability by identifying and developing higher grade reserves. The ongoing Cirque development schedule includes a two year underground program to provide direct access to the deposit for rapid delineation by underground drilling and test stoping to determine mining methods. The configuration of adits will also form an integral part of the ultimate mine development.

The optimum schedule for the development of the Cirque property includes overlapping schedules for adit, power line, government permits and mine-mill development. While not entirely interdependent, the individual schedule for the exploration adit obviously affects all others. At the conclusion of the proposed two year underground program in 1984/85, all available data would be in hand to carry out a final feasibility on the project.

The total cost of the proposed work to achieve final feasibility is $25 million over three to four years.