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"Crystal Peak Garnet, A Massive Skarn-Hosted Andradite Deposit Near Penticton, British Columbia"

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ABSTRACT

Crystal Peak Garnet Corporation is in the permitting stage of developing the largest known, highest grade garnet deposit in the world. The deposit is located near Penticton, British Columbia, and consists of mainly andradite garnet in a skarn environment. Drill indicated reserves total 40 million tonnes of about 80% garnet in three zones, with additional geological reserves of 60 million tonnes. Detailed drilling in the proposed pit area defined 3.35 million tonnes of 81.3% garnet. At the proposed operating rate of 60,000 tonnes per year, it is expected that Crystal Peak will soon be the world's largest garnet producer.

Garnet is an important industrial mineral. Its high density, angularity, hardness and non-toxicity make it an excellent product for many abrasive applications and other uses. However, currently available garnet products are relatively expensive: Idaho garnet sells for about US$160-260/ton FOB minesite. Because of the size and purity of the Crystal Peak deposit, it is expected that production costs will be low enough to capture a significant share of existing markets as well as allow development of markets previously inaccessible because of garnet's historically high cost.

INTRODUCTION

Crystal Peak Garnet Corporation, a wholly-owned subsidiary of Vancouver-based Polestar Exploration Inc., is in the permitting stage of developing a large, high grade deposit of skarn-hosted andradite garnet near Penticton, British Columbia. Drilling conducted in 1989 and 1990 indicated 40 million tonnes of about 80% garnet in three zones, with additional geological reserves of 60 million tonnes. Detailed drilling in the proposed pit area has defined 3.35 million tonnes of 81.3% garnet.

The deposit has excellent potential for development. Elevations are moderate, ranging from 1900 to 2100 m.a.s.l. Road access and power lines are already in place because of nearby mining and recreational developments. All supplies, facilities and manpower requirements are available in the nearby communities of Penticton and Keremeos.

Capital pre-production costs are estimated at approximately $3,000,000. The construction phase of the project, scheduled for June 1991 (depending on permitting), is estimated to require six months to complete.

The Crystal Peak deposit is larger and of higher grade than any garnet deposit currently mined anywhere in the world. At the proposed operating rate of 60,000 tonnes per year, it is expected the Crystal Peak deposit will be the world's largest producer.

GEOLOGICAL SETTING

The Crystal Peak deposit comprises much of Mt. Riordan, within the Intermontane Belt of the Canadian Cordillera. The major rock units in the area are members of the Late Triassic Nicola Group. Early Jurassic intrusions are fairly common, and are represented in the area by the Bromley Batholith and Cahill Creek Pluton.

The Crystal Peak skarn deposit is the most easterly of a series of skarns which includes the presently operating Nickel Plate Mine and the old French and Goodhope mines. The composition of the skarns varies from high arsenic and gold with low garnet in the western part of the series to high garnet with low gold and no arsenic in the eastern part at Crystal Peak (Ray and Dawson 1988; Ray et al. 1988).

The Crystal Peak garnet deposit is unusual in that it is very large and of very high grade. The surface extent of the garnet body is 300x800 m, including three major zones of particularly high grade (North, South, and West Zones). Cliff exposure and drilling indicate high grade garnet at considerable depths: one drill hole intersected high grade garnet at a depth of 200 m. Replacement of limestone by garnet is almost complete: only one small limestone lens was observed in a drill hole (Grond and Wolfe 1991).

Diopside (clinopyroxene) is the most common accessory mineral. In most cases, the diopside has been partially altered to actinolite, sericite and epidote. Quartz, epidote and occasionally sphene occur in relatively low quantities. Calcite content is also relatively low, occurring in small veins near the top of Mt. Riordan and as interstitial blebs up to 3 cm across. Magnetite, hematite and various sulphides including pyrite, pyrrhotite and rarely chalcopyrite occur in very minor amounts throughout the deposit. Average values for accessory minerals in the North Zone deposit are as follows:

Diopside - 10.94%
Quartz - 2.46%
Calcite - 1.83%
Actinolite, epidote, sericite - 4.67%
Feldspar - .03%
Sphene - .064%
Apatite - .06%
Opaque - .44% (magnetite and minor sulphides)

Garnet occurs as massive garnetite or coarsely crystalline aggregates, locally showing growth zonation. Red-brown, green, and pink-orange are the most common colours although buff and black varieties have been noted.

Microprobe analyses show the garnet to be about 90% andradite ($Ca_3Fe_2Si_3O_{12}$) and 10% grossularite ($Ca_3Al_2Si_3O_{12}$). Andradite and grossularite form a solid solution series with Fe and Al being interchangeable. To a lesser extent Mg or Mn can substitute for Ca.

A granodiorite contact at the eastern edge of the skarn is well exposed. In addition, small diorite remnants are scattered in a broad zone through the centre of the skarn. The diorite remnants are believed to have had some influence on skarn formation: samples of adjacent massive garnetite rock have distinct relict intrusive textures.

GRADE DETERMINATION

Since garnet content cannot be determined by conventional assay techniques, a variety of different methods was employed. Both visual estimates and thin section analyses were used to estimate garnet content in the drill core. Representative samples (532 in total) were selected for thin section analyses during core logging. In general, thin section analyses corresponded remarkably well with visual estimates.

Two additional methods of grade determination were employed to check results - thin section analyses of crushed mixed core and heavy liquid separation. All methods correlated well and final results were judged to be accurate within a percent or two.

RESERVE CALCULATIONS

Simple reserve calculations for the entire deposit have been generated based on average garnet content in drill holes. Surface dimensions were derived by results of detailed surface sampling and mapping to outline exposed areas of high grade garnet-bearing rock. An average specific gravity of 3.5 was used to determine tonnage.

A total of approximately 40,000,000 tonnes of about 80% garnet was calculated based on modest depths (less than 100 m). An additional 60,000,000 tonnes of possible geological reserves are indicated. This is based principally on extended depth, as drill hole data and cliff exposures indicate that the deposit is much deeper than cut-off depths used in calculations.

Detailed reserve calculations have been made for the proposed quarry in the North Zone (Giroux 1991). Semi-variogram analysis indicates an isotropic structure for garnet, with a horizontal range of 120 m. The nugget effect is less than 10% of the sill value so estimation errors are relatively low.

Blocks 20 x 20 x 5 m were estimated by ordinary kriging and show reserves in the North Zone of 3.35 million tonnes averaging 81.3% garnet at a 64% garnet cutoff between levels 2025-2085 m. The current pit outline in this zone contains 1.93 million tonnes of 80%

garnet or 25 years production at 75,000 tonnes per year (60,000 tonnes finished product).

MINING, METALLURGY AND PROCESSING

Surface mining operations will employ standard quarrying methods: drilling, blasting, loading and hauling operations to break and move approximately 75,000 tonnes of rock each year. This production rate will be sufficient to supply 300 tonnes of mill feed per day to the processing plant, which will be operating 250 days per year. No waste rock is anticipated. Quarrying will take place for four to six weeks per year with material being stockpiled at the processing plant.

Metallurgical testing has shown that only physical processes are necessary to produce garnet abrasives at Crystal Peak. No chemical reagents are required.

The ore is composed of 75-85% andradite garnet, 15-20% diopside, with minor calcite and quartz, accessory actinolite and epidote and trace amounts of magnetite, pyrite and chalcopyrite. The final product will contain about 90% garnet, 10% diopside and trace amounts of the minor and accessory minerals. Tailings will consist of water and fine mineral sands composed of lesser amounts of garnet and greater amounts of the other minerals.

Crushing Circuit

Run-of-mine ore from the stockpile will be transported to and passed through a scalping grizzly of 1" mesh, with the -1" material passing directly to a surge bin feeding a 48" gyradisc crusher. The +1" material will be conveyed to an 18" x 24" jaw crusher to reduce the oversize from the grizzly to -1", which will then be conveyed to the surge bin feeding the gyradisc crusher.

The product from the gyradisc crusher will be passed through a 6' x 20' double deck screen (8 mesh) with the oversize being recirculated and the -8 mesh reporting to the Sizing Circuit.

Sizing Circuit

The sizing circuit consists of a series of hydrosizers for size separation and cleaning. The four stage elutriation will produce four product sizes, -8/+20 mesh, -40/+60 mesh, -60/+100 mesh and a -100 mesh tailings (current studies indicate that much of the tailings product may also be marketable). The sized material is dewatered prior to hot-air drying to less than 5% moisture. Recovered water is recycled.

The four sizes of specification sands designated above are those which will fulfil the current market demands. If market conditions change, other size fractions can be produced easily with minor adjustments to the hydrosizers.

The dried sands are conveyed to and passed through low intensity magnetic separators. This serves to remove not only metal particles from the crushing operations, but also magnetite and pyrrhotite traces present in the original ore. The cleaned and dried sands are then directed to the magnetic circuit for final cleaning and upgrading.

Magnetic Circuit

The primary circuit consists of high intensity magnetic separators. Test results show that this operation will upgrade the garnet sands to about 90% garnet. The tailings from the primary circuit are passed through a scavenger circuit also consisting of high intensity magnetic separators. The concentrate from this circuit adds about 6% (of original feed) to the primary circuit concentrate.

The tailings from the scavenger circuit will consist of 45% garnet with 50% diopside and the remainder being quartz, calcite, actinolite etc.

The concentrates from the magnetic circuit are directed to storage bins prior to packaging and shipping. Packaging will include 36 kg (80 lb) triple paper bags, 2 tonne bulk bags and possibly direct bulk.

MARKETING

Current world production of garnet is estimated at 100,000 tonnes annually, with North American production being about 50,000 tonnes produced from two mines - one in New York and the other in Idaho. Other important producers are Australia and India, and recent reports indicate that pilot plant testing is being conducted in Montana and California. North American consumption is estimated at about 46,000 tonnes annually.

Garnet's main applications are:

- Abrasive blast cleaning
- Abrasive waterjet cutting
- Water filtration
- Bonded and coated abrasive products
- High density aggregate
- Wear resistant surfaces

The first four uses listed above probably account for about 90% of North American garnet consumption.

The most promising future market for garnet is in abrasive blast cleaning. In North America alone, 5,000,000 tonnes of blasting abrasives are used each year, with west coast consumption estimated to be at least 500,000 tonnes. The market is currently dominated by silica sand and smelter and coal slags, with garnet consumption being on the order of only 20,000 to 30,000 tonnes. Garnet has a good chance of increasing its market share, however, because of serious health concerns about silica (which is linked to silicosis) and some slags (which commonly contain toxic heavy metals which can endanger workers and contaminate landfills after disposal).

Garnet's success in winning a market share in the abrasive blast cleaning industry to date has been limited by two factors: relatively high price (averaging about US$230/ton compared to sands and slags costing US$50-US$100/ton) and limited availability. Despite this, from 1983 to 1988 garnet consumption in all markets increased by 50% in the United States and in the last five years has tripled in the rest of the world.

Strong future markets are developing in Japan and Europe for garnet in the blast cleaning industry. This is as a result of health and environmental risks associated with silica sand and slags. The use of silica is banned in most European countries and current demand is filled primarily with slags. Extremely high disposal costs are causing consumers to look for alternatives. Garnet is receiving considerable attention for several reasons including its ability to be reused several times in blast cleaning thus reducing disposal costs by reducing the amount of waste produced.

An increasingly important market for garnet is in abrasive waterjet cutting. The market for garnet in this sector is increasing at a rate of 30% per year and annual consumption is estimated at 20,000 tonnes. Customers are currently paying between US$300 and US$600/ton for garnet product. This market is very price sensitive as garnet represents 70% of the hourly operating cost of the process.

Extensive testing of the Crystal Peak garnet products has been done under both laboratory and field conditions. The quality of the product is excellent and it performs very well in both sandblasting and waterjet cutting applications. Continued testing will be carried out for numerous other industrial applications.

Both demand and price outlook for garnet products are very positive. Given recent growth rates in garnet consumption, it is reasonable to predict the world market could require another 200,000 tonnes annually within five years at the present high price structures. If garnet could be sold in the US$100/ton range (Crystal Peak Garnet's projected price for sandblasting grit), it is estimated the blast cleaning industry in the western United States alone could consume more than 200,000 tonnes annually.

CONCLUSIONS

Crystal Peak Garnet Corporation is in the permitting stage of developing the largest known, highest grade garnet deposit in the world. The deposit is located near Penticton, British Columbia, and consists of mainly andradite garnet in a skarn environment. Drill indicated reserves total 40 million tonnes of about 80% garnet in three zones, with additional geological reserves of 60 million tonnes. Detailed drilling in the proposed pit area defined 3.35 million tonnes of 81.3% garnet. At the proposed operating rate of 60,000 tonnes per year, it is expected that Crystal Peak will soon be the world's largest garnet producer.

Garnet is an important industrial mineral with rapidly expanding markets in spite of its currently high price relative to available alternatives. Because of the size and purity of the Crystal Peak deposit, it is expected that production costs will be low enough to capture a significant share of existing markets as well as allow development of markets previously inaccessible because of garnet's historically high cost.

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Figure 1.

The deposit is located 300 kilometres east of Vancouver, B.C.

Figure 2.

A large zone of approximately 80% garnet will include a quarry in the North Zone.\

Figure 3.

The proposed North Zone quarry is outlined on the western flank of Mt. Riordan.

Figure 4.

A sample of drill core shows well developed garnet growth rings which occur throughout the deposit.

Figure 5.

The metallurgical flow sheet demonstrates the simple mechanical process required to produce a garnet product.

Figure 6.

The largest potential market for garnet is in the sandblasting industry where approximately five million tonnes of abrasive are consumed in North America each year.

Figure 7.

Abrasive water-jet cutting represents a fast growing industry that relies almost exclusively on garnet as an abrasive.

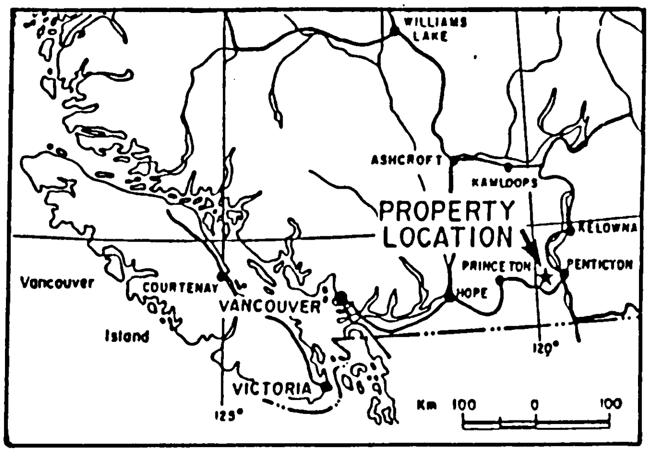
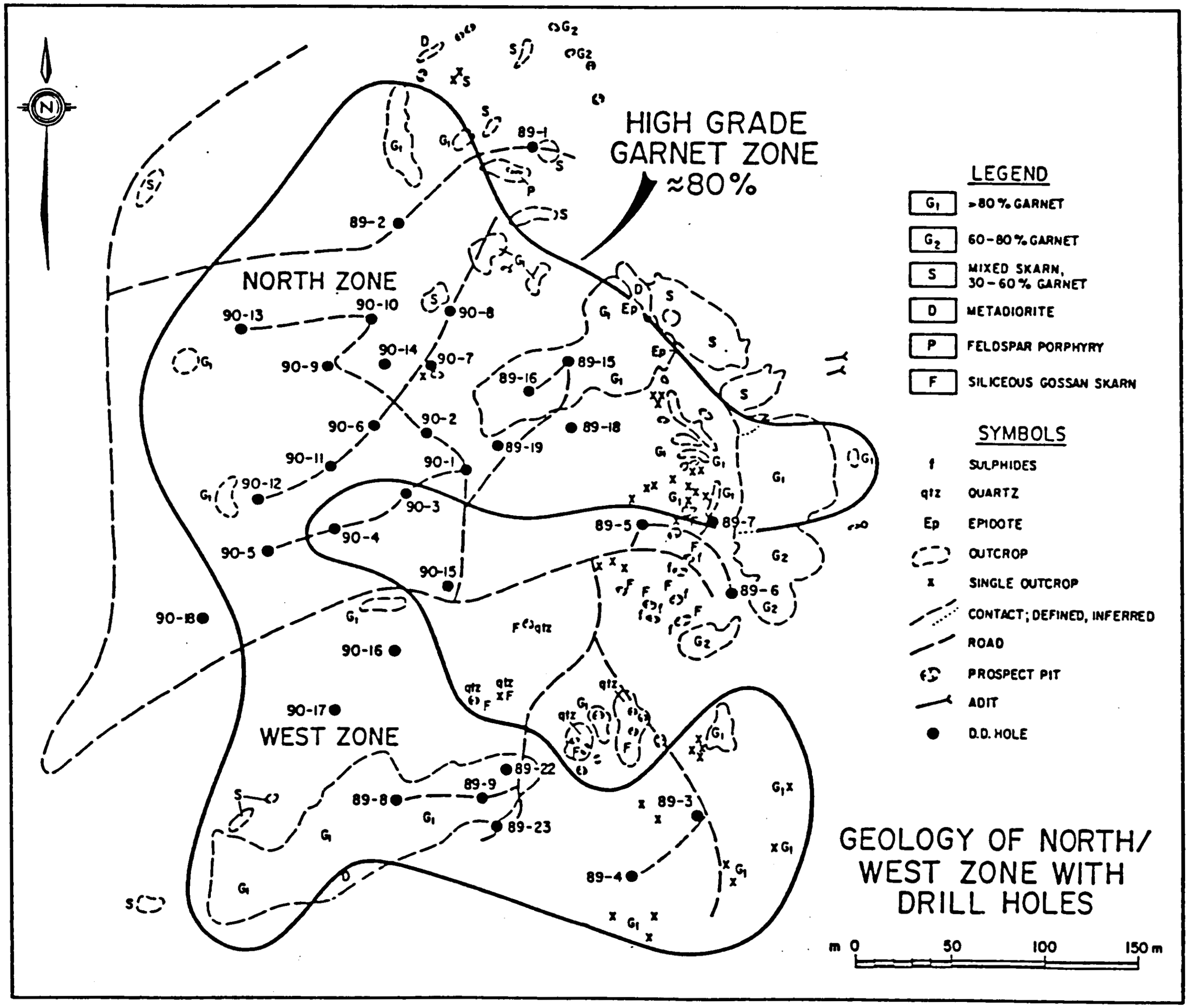

WILLIAMS LAKE
ASHCROFT
KAMLOOPS
PROPERTY LOCATION
KELOWNA
PRINCETON
PENTICTON
HOPE
Vancouver
Island
COURTENAY
VANCOUVER
VICTORIA
125°
120°
Km 100 0 100

Fig. 1.

Fig 2



N
HIGH GRADE
GARNET ZONE
≈80%
NORTH ZONE
WEST ZONE
LEGEND
G1 >80% GARNET
G2 60-80% GARNET
S MIXED SKARN, 30-60% GARNET
D METADIORITE
P FELDSPAR PORPHYRY
F SILICEOUS GOSSAN SKARN
SYMBOLS
f SULPHIDES
qtz QUARTZ
Ep EPIDOTE
OUTCROP
x SINGLE OUTCROP
CONTACT; DEFINED, INFERRED
ROAD
PROSPECT PIT
ADIT
D.D. HOLE
89-1
89-2
89-3
89-4
89-5
89-6
89-7
89-8
89-9
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90-18
GEOLOGY OF NORTH/
WEST ZONE WITH
DRILL HOLES
m 0 50 100 150 m

Fig 6.

Fig 3

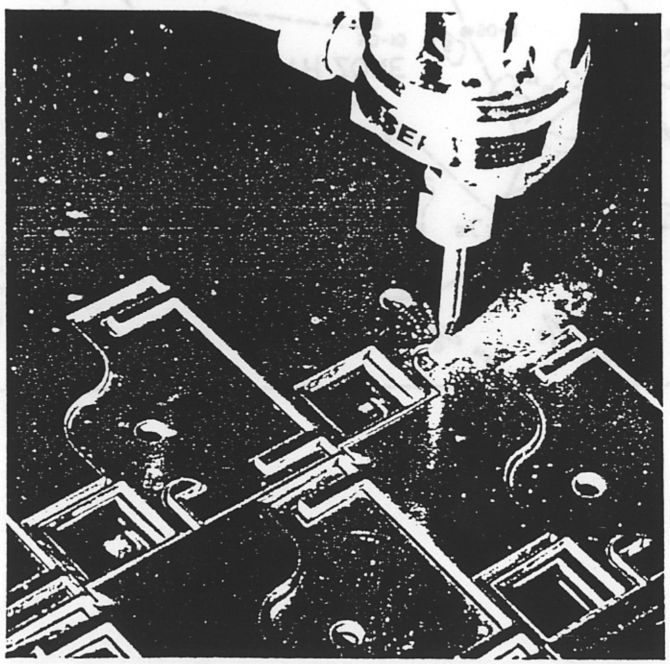

Fig 7.

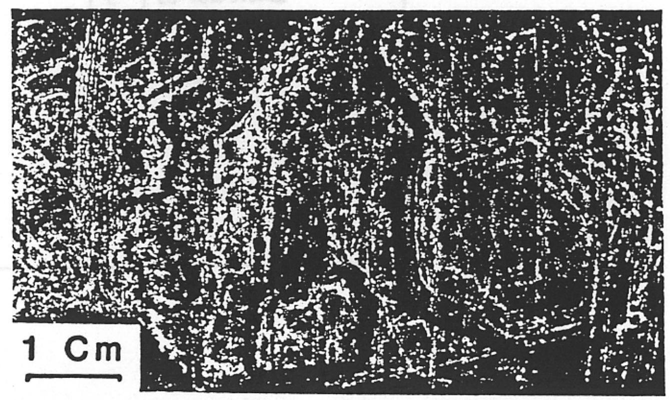

Fig 4

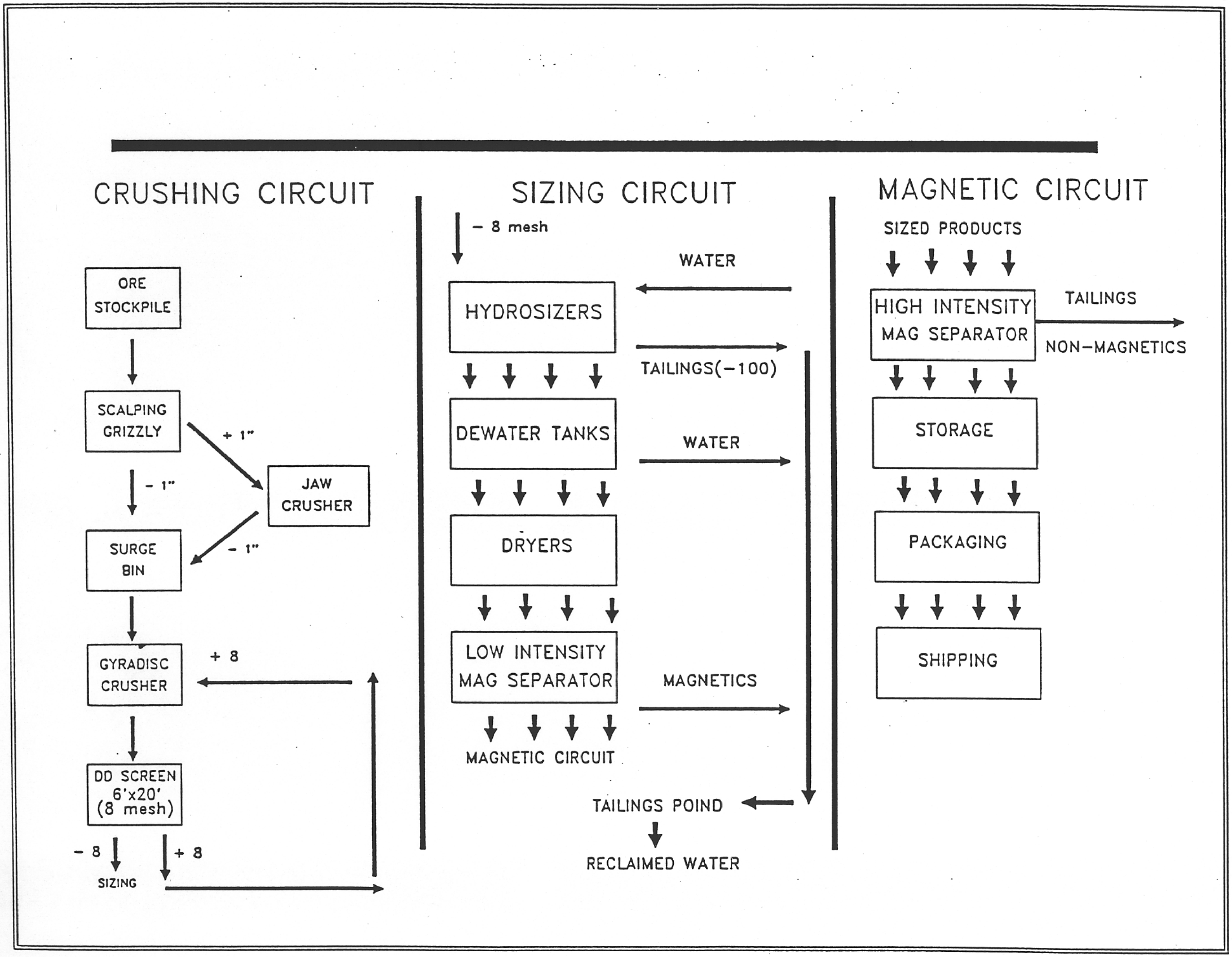
CRUSHING CIRCUIT
SIZING CIRCUIT
MAGNETIC CIRCUIT
ORE STOCKPILE
SCALPING GRIZZLY
+ 1"
- 1"
JAW CRUSHER
- 1"
SURGE BIN
GYRADISC CRUSHER
+ 8
DD SCREEN 6'x20' (8 mesh)
- 8
+ 8
SIZING
- 8 mesh
WATER
HYDROSIZERS
TAILINGS(-100)
DEWATER TANKS
WATER
DRYERS
LOW INTENSITY MAG SEPARATOR
MAGNETICS
MAGNETIC CIRCUIT
TAILINGS POIND
RECLAIMED WATER
SIZED PRODUCTS
HIGH INTENSITY MAG SEPARATOR
TAILINGS
NON-MAGNETICS
STORAGE
PACKAGING
SHIPPING

Fig 5