RECOVERY OF GOLD USING GRAVITY CONCENTRATION THE HEMLO EXPERIENCE

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ABSTRACT

The installation of gravity concentration circuit at the Golden Giant Mine has resulted in some surprising results. The rationale for installing a gravity circuit in a mill treating a finely disseminated ore and experiencing recoveries in the order of 96.5% are discussed. The impact of mercury on the test program is discussed as well as cost savings resulting from a 50% reduction in stripping frequency.

KEYWORDS

Gold gravity concentration; Knelson Concentrator; Gemini shaking table; mercury; cost reduction; in-situ head grades, forecasted head grades; mill heads.

INTRODUCTION

The Golden Giant Mine is located 45 km east of Marathon on the North Shore of Lake Superior. The mill started production in 1985 and has since processed some 8.4 million tonnes of ore grading 12.4 gms per tonne. The mill and concentrator has been described in previous publications. [1,2]

Three mining operations are presently mining the main Hemlo deposit, which is a tabular structure that varies in width from 3 to 45 metres, and extends 2.5 kilometres along strike and 1.2 kilometres down dip. Hemlo Gold owns the central, lower portion of the deposit.

The mineralized zone is characterized by a fine-grained aggregate of microcline feldspar (feldspar containing potassium, KA1si308) with variable amounts of barite, muscovite, and vanadian muscovite(green mica). The ore zone is also strongly enriched in molybdenum, arsenic, antimony, and mercury. Gold occurs mainly as l-50 micron grains located along recrystallized silicate grain boundaries. Coarse gold is less common but is observed in narrow discontinuous veinlets and as clots in quartz pods within the ore zone.

Repeated grind/recovery tests over the years have confirmed that a fine grind is required to liberate the gold. The current target in the mill is 89-90% minus 200 mesh.

This paper will outline the rationale for investigating gravity concentration with an ore that was finely disseminated, in a mill with recoveries that were in the order of 96.5% utilizing cyanidation and CIP technology.

BACKGROUND

The first hint that something was amiss came when a crusher mechanic started to find “brass” on the distributor plate of the short head crusher. Concerns about a disintegrating crusher vanished when the “brass” assayed 89% gold and 10% silver. In total 1.6 kilo of gold nuggets the largest being 184 gms were found (fig. 1) Each had very obviously passed through the short head several times before being trapped on the crusher distribution plate.

This started a re-evaluation of the process as well as a new look at metallurgical results from the point of view that we may be misinterpreting the results.

A detailed look at leach tailings assays over a three month period (Fig. 2) indicated that a spike was observed every 24-28 samples. The regularity with which these occurred suggested that contamination was not necessarily the problem.

Head grade determination has always been difficult at the Golden Giant. One would think that grinding to 90% - 200 mesh would ensure a fairly homogeneous sample yet daily samples have consistently underestimated the gold leaving the refinery. Periodic head adjustments had to be made to balance the gold distribution in the mill, a process totally understandable to a metallurgist but forever perplexing to the geological staff.

Both the above inferred that possibly, even at a grind of 90%-200 mesh, there was a nugget effect at the Golden Giant Mine.

Historically projected grades and ounce production from a geological perspective while conservative was very accurate. On an historic basis cut factors and to some extent dilution factors were developed to ensure this accuracy.

A study was started to look at mineralogy throughout the Golden Giant's milling process. This study includes sections of tailings samples. Native free gold was found in most tailings samples, although, all were relatively small (less than 10u).

The CIP tails sample was treated in a 12" Knelson concentrator. From a tailings sample grading 0.4-0.5 gms/tonne, a concentrate grading 60-90 gms/tonne was routinely produced. Examination of photographs of this concentrator (Fig. 3) seemed to confirm one of our fears. A 50 u particle of free gold in a tailings sample.

A test program to recover coarse gold in the grinding circuit utilizing a fully automated Knelson concentrator was initiated.

TEST CIRCUIT

The Knelson Concentrator has been adequately described elsewhere as well as its performance being the subject of much study. 3,4,5,6,7 Further elaboration is hardly necessary except to say 96% - 98% operating time is expected to be the norm.

The circuit layout is shown in Fig. 4. One of four primary cyclone underflows feeds the 30" Knelson. A trash screen removes any material plus 10 mesh. Flow to the unit is in the order of 60 tonnes per hour. While this is in excess of recommended feed rates, we find no detrimental effects.

Cycle time for the machine has been set at two hours (Fig. 5) to maximize recovery. Water flow for fluidization is 35-40 m3/hr. Operating problems occur under 25 m3/hr as the fluidizing holes plug with solids. Increasing water flow has minimal impact.

The concentrate from the Knelson, approximately 50 kilograms per batch, assaying 3-8% Au, is stored in a small tank. The concentrate is further treated on a Gemini shaking table to produce a final concentrate assaying 75-80% gold. Recovery of gold on the table exceeds 90%. The table is operated between 20-30 hours per week on day shift. The final concentrate is shipped directly to Johnson Matthey for refining.

COSTS

Total costs for the project was $160,000. The ability to reduce stripping frequency by 50% will result in a savings of $240,000 annually (Table 1) giving the project a reasonable return without metallurgical improvements. This is a result of recovering 35-40% of the gold in grinding and utilizing excess capacity in CIP stripping and electrowinning.

MERCURY

The initial plan was to smelt the table concentrate on site. This procedure worked well until large amounts of liquid mercury was found in the ducting from the induction furnace.

A sample of table concentrate was sent out for analysis. Mercury content of the individuals grains varied from 1 ppm to 19%. Average for the total sample was over 6% (Fig. 7) Attempts to refine the concentrate on site were stopped.

The table concentrate is now shipped to Johnson Matthey for refining. Cost to Hemlo amounts $1.20 per ounce gold treated.

METALLURGICAL IMPACT

As can be expected , the search for a 0.1% recovery improvement is difficult. Feed grades can vary from 8 gm/tonne to 20 gm/tonne. The head sample appears biased on a daily basis. A fairly long test will be required to confirm any recovery improvements. Reirculating load of gold in the grinding circuit is reduced from 6000 percent to 500 percent.

Correlation of mill heads with those forecast by the geological department (Fig. 6) gave some very surprising anomalies. The bar chart compares diamond drill grades, forecast grades (cut and diluted) and mill heads over a 16 month period. The agreement between mill heads and forecasted grades is normally excellent. When the Knelson was operating, mill head grades compared favourably to uncut diamond drill grades measurably higher than expected. While this, in part, may be due to reduction in inventory in the grinding circuit, two months seems a long time to reduce this inventory. Long term testing in 1994 will be required to evaluate this trend.

CONCLUSIONS

The installation of a gravity concentration circuit at the Golden Giant Mine has proved to be very beneficial. Operating cost reductions in the order of $244,000 annually are attractive against capital cost of $160,000. Cash flow is improved as 35% of total gold production reaches the market approximately 10 days sooner. The potential to eliminate apparent losses of coarse gold remains to be evaluated in 1994.

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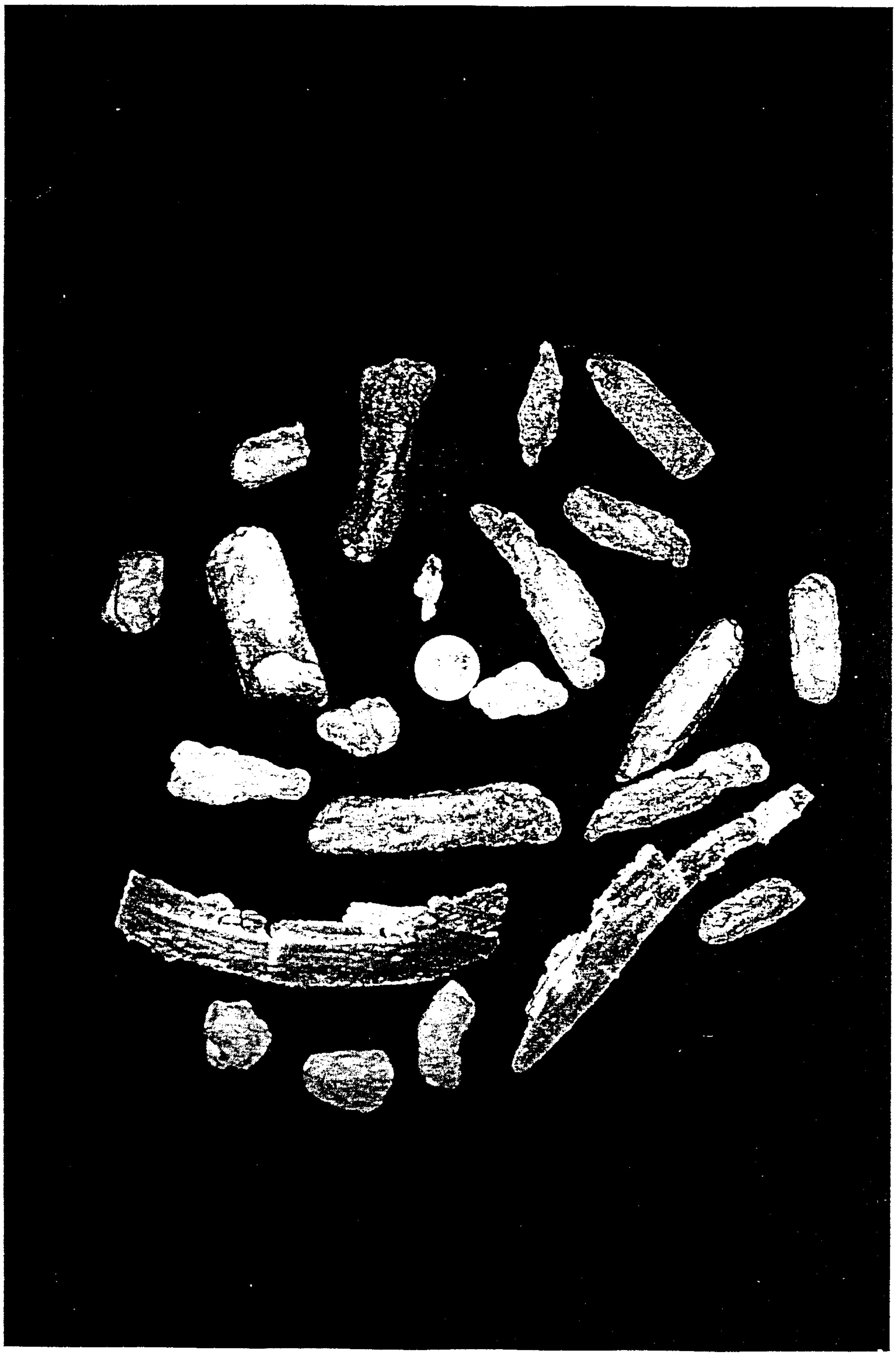


FIGURE 1

Figure 2
LEACH RESIDUE

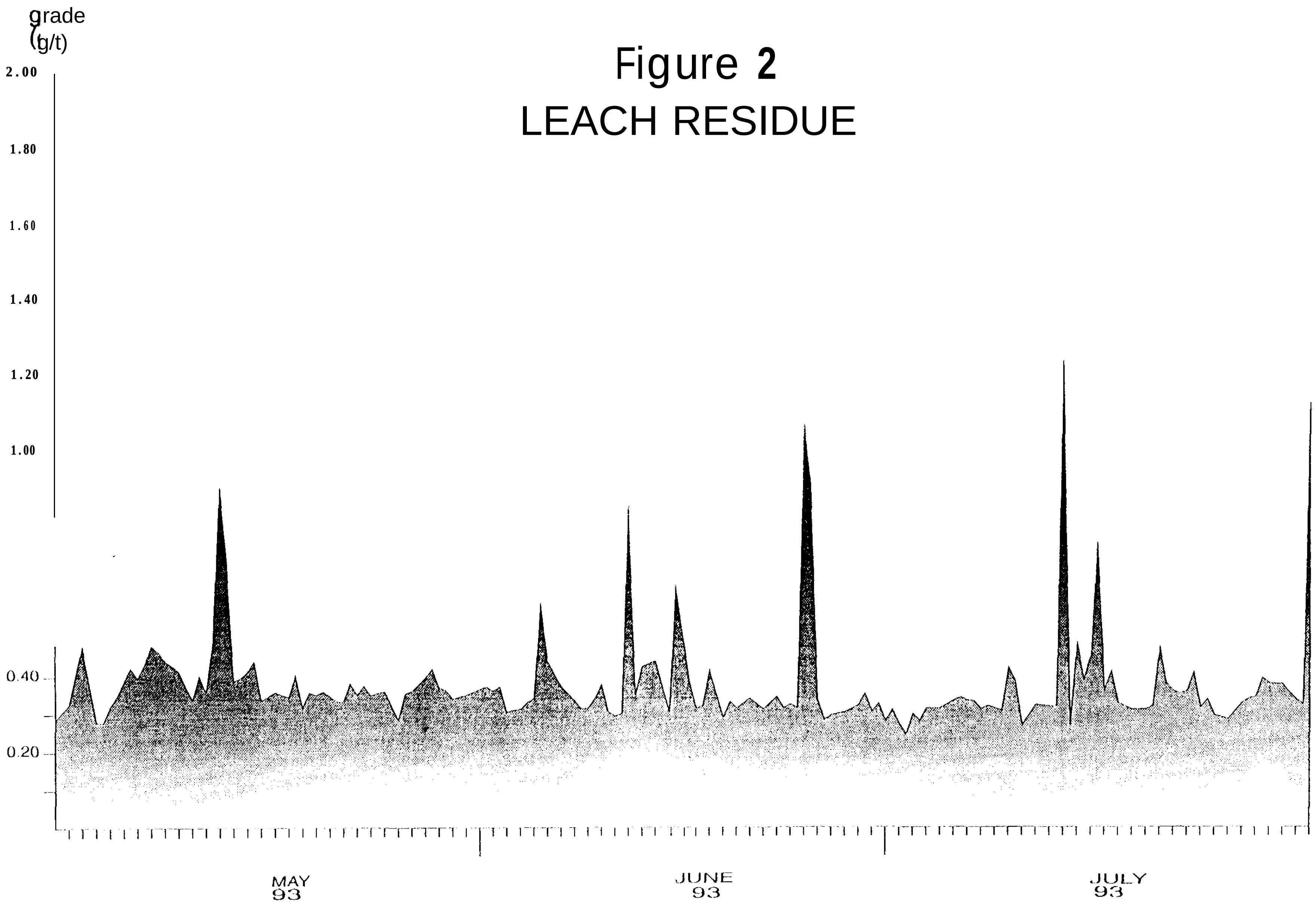


FIGURE 3

FIGURE 4

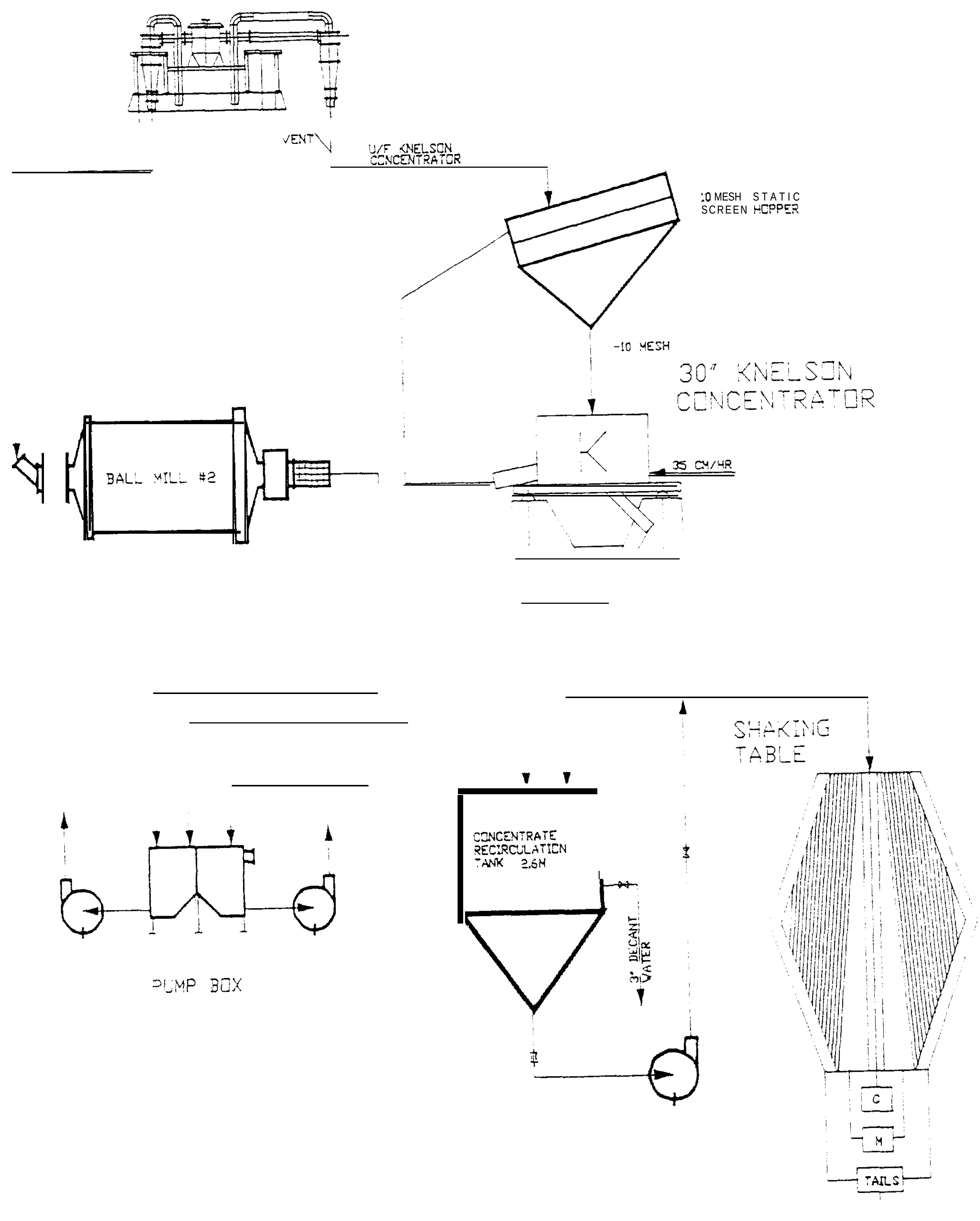

VENT
U/F KNELSON
CONCENTRATOR
10 MESH STATIC
SCREEN HOPPER
-10 MESH
30" KNELSON
CONCENTRATOR
35 CM/HR
BALL MILL #2
SHAKING
TABLE
CONCENTRATE
RECIRCULATION
TANK 2.6M
3" DECANT
WATER
PUMP BOX
C
M
TAILS

FIGURE 5
CYCLE TIME

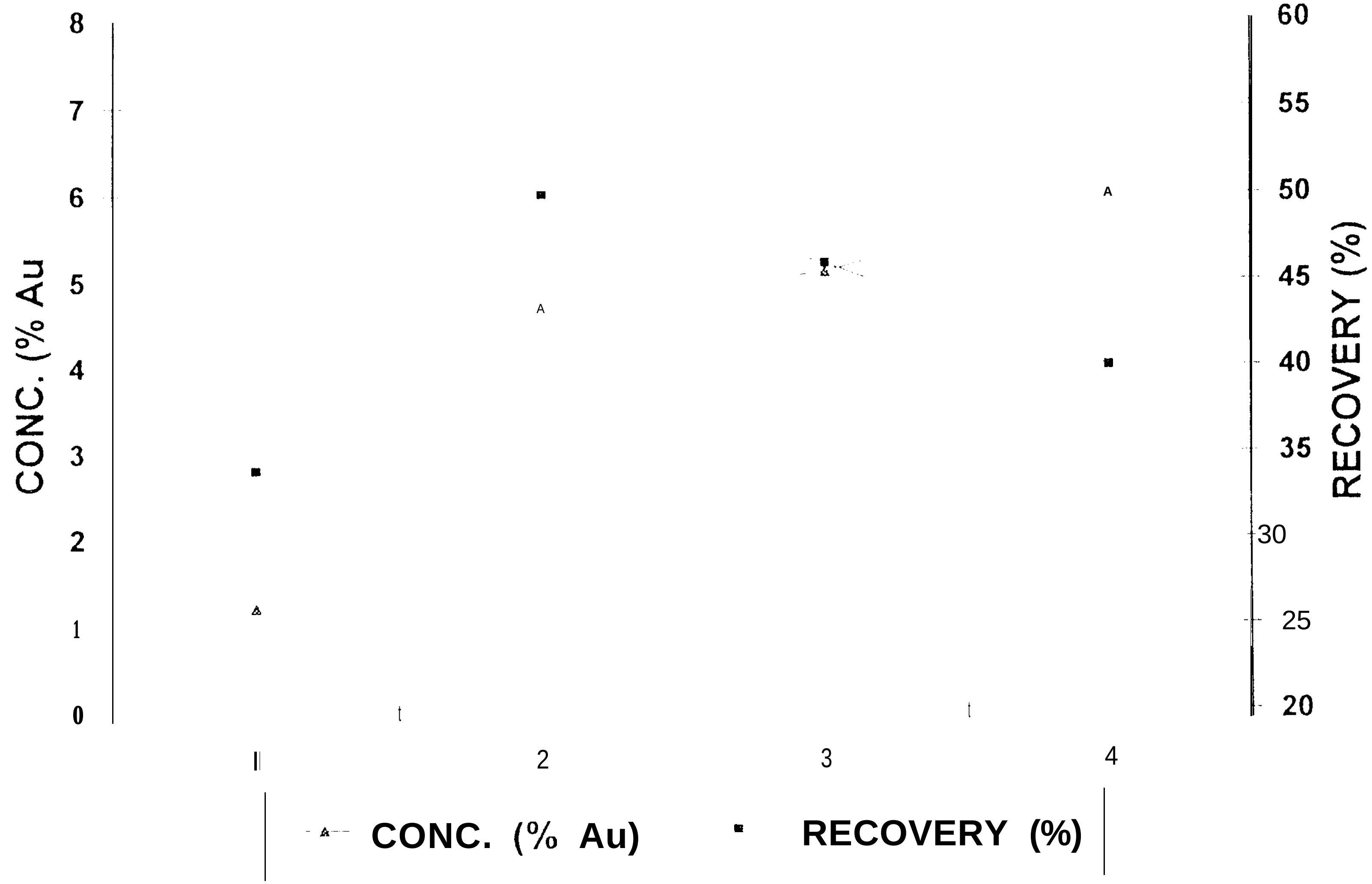


TABLE 1
Cost Savings

ITEM	$YEAR
CAUSTIC	51 700
BUNKER 'C' OIL	15 600
ANTISCALANT	3 200
ELECTROWINNING POWER	1 900
CARBON REACTIVATION POWER	93 200
CARBON DESTRUCTION	64 600
OVERTIME	14 600
TOTAL	244 800

Figure 7

Gold Grain Composition

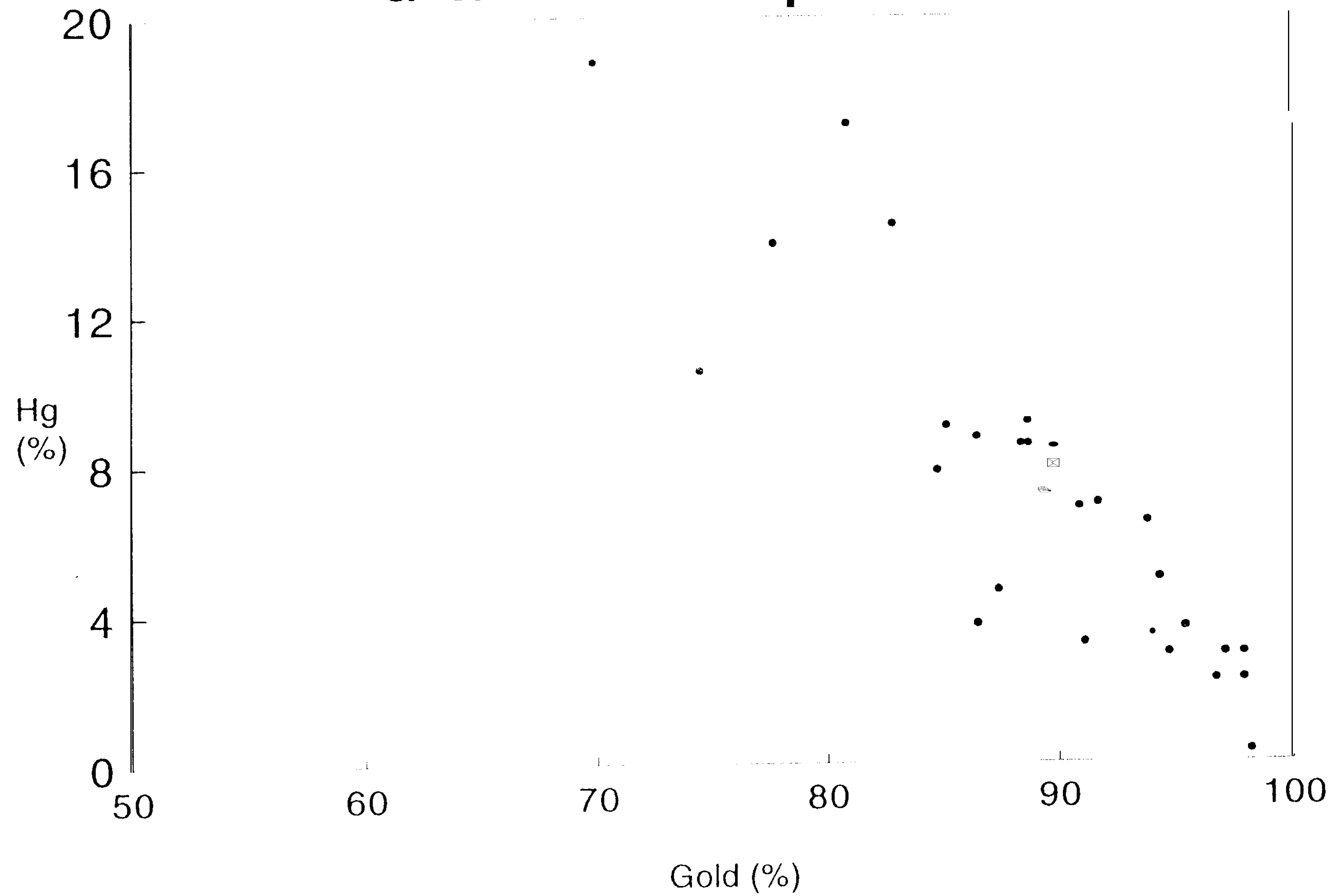
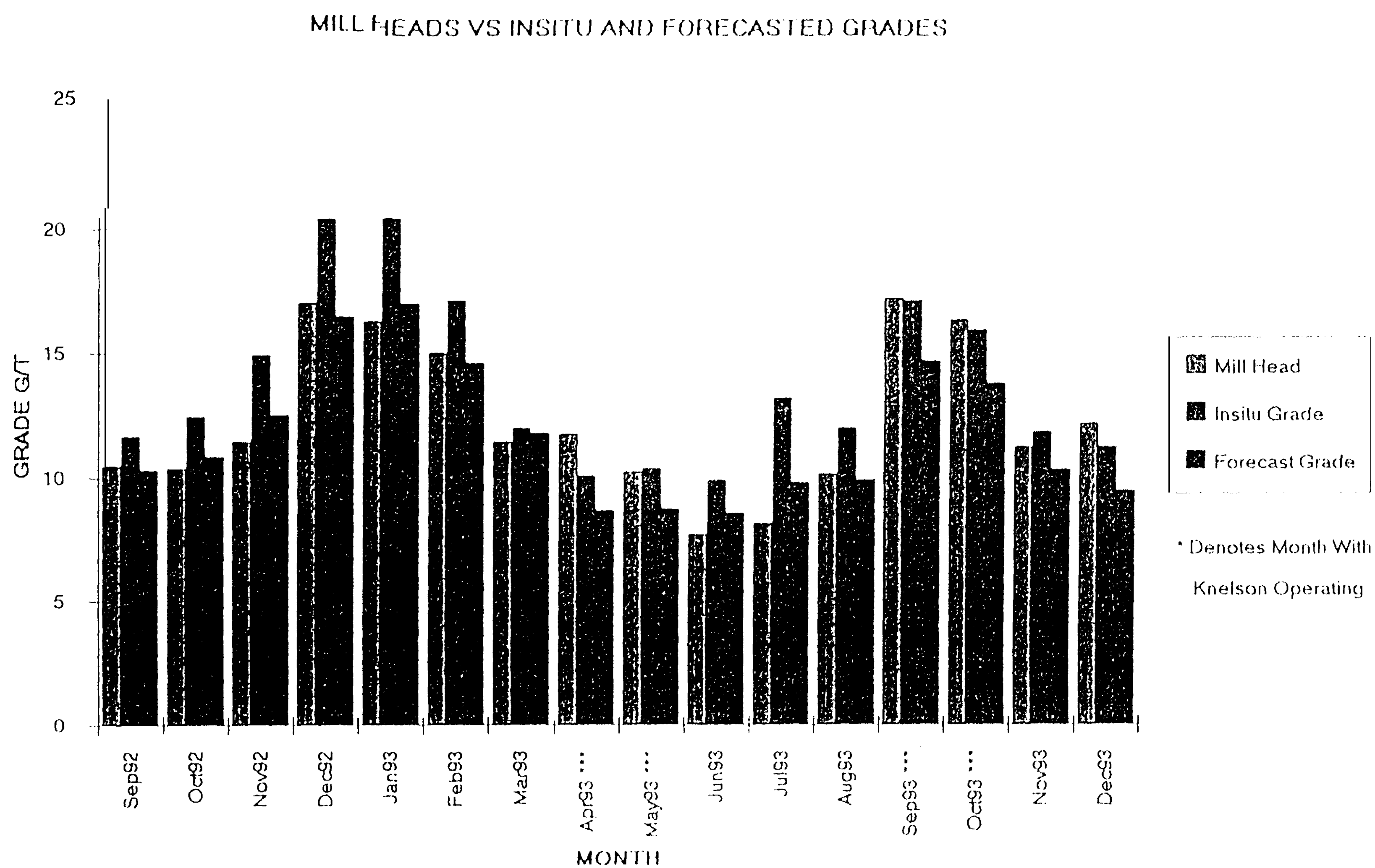


Figure 6


MILL HEADS VS INSITU AND FORECASTED GRADES
GRADE G/T
0
5
10
15
20
25
Sep92
Oct92
Nov92
Dec92
Jan93
Feb93
Mar93
Apr93 ***
May93 ***
Jun93
Jul93
Aug93
Sep93 ***
Oct93 ***
Nov93
Dec93
MONTH
Mill Head
Insitu Grade
Forecast Grade
* Denotes Month With
Knelson Operating