OPEN PIT

DRILLING AND BLASTING

AT

CRAIGMONT MINES LIMITED

by

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INTRODUCTION

The Craigmont Mine is located near the Village of Merritt, 240 miles north-east of Vancouver. The concentrator has been in production since September 1961.

Craigmont is a combined open pit and underground operation. To date, slightly more than 90 percent of the mill feed has been mined from the open pit. As underground development proceeds the ore requirements from the open pit will decrease. The average milling rate from September 1961 to April 1964 is approximately 4,900 tons per day. Since the start of open pit operations, a period of approximately three years, a total of 37,000,000 tons of ore and waste have been mined. The current production rate from the open pit is 50,500 tons of ore and waste per day.

GEOLOGY

The Craigmont orebody is a copper-iron deposit lying in the Nicola Series consisting of volcanic and sedimentary type rocks, along the southern boundary of the diorite and quartz-diorite Guichon batholith.

The ore, chalcopyrite associated with hematite and magnetite, occurs in a steeply dipping limey rock, bounded by walls of greywacke. The limey zone has been deformed by drag folding and brecciation to form the ore zone.

SUPERVISION AND CONTROL

The open pit operation is on a three shift per day, seven day per week basis with supervision as follows:

1	General Foreman	- Day Shift
4	Shift Foremen	- One on Each Shift
4	Shift Bosses	- One on Each Shift
1	Blasting Supervisor	- Day Shift.

Blasting is carried out on day shift under the direction of the Blasting Supervisor.

The duties of the Blasting Supervisor are:-

1. Compiling comprehensive records for each blast in order to improve the drilling and blasting efficiency in subsequent blasts.
2. Determining from these records, in conjunction with the General Foreman, the correct drilling, loading and delay patterns for each blast.
3. Supervising the seven man blasting crew.
4. Conducting tests with new products, techniques and handling procedures.
5. Compiling comprehensive records of all rotary bits used in order to evaluate the various makes and types of bits.

The drilling and blasting operations account for approximately 30 percent of the total open pit operating cost. Close supervision and careful analysis of extensive records provides safe, economical drilling and blasting procedures.

DRILLING

The Bucyrus-Erie 40-R Rotary Drill, the Reich CT 750 Rotary Drill and the Ingersoll-Rand Drillmaster "Down-the-Hole Drill" have been used at Craigmont. It was known, from drillability tests and from pre-production drilling that the waste rock was suitable for rotary drilling but only limited information was available on the drilling characteristics of the ore zone. Initially, one 40-R was purchased and a Drillmaster obtained on a rental purchase basis. In February 1962, additional drill capacity was required. The Reich drill was purchased, with the decision based primarily on an initial cost. Cost experience with the three drills indicated it would be economical to do all drilling with Bucyrus-Erie 40-R drills. Consequently a second 40-R was purchased and the other drills used strictly on a standby basis.

The present production requirements, 50,500 tons per day of ore and waste, are easily drilled with six 40-R drill shifts per day.

The use of several drills at Craigmont has provided considerable information on large hole drilling. It is felt that a comparison of the performance and costs of these drills would be of interest.

Ingersoll-Rand Drillmaster

The electric powered Ingersoll-Rand Drillmaster, capable of drilling 6 inch diameter holes, was in use from March 1961 to January 1963. Because of hole caving conditions frequently encountered in waste and a shortage of bailing air, performance in waste drilling was poor. Consequently the Drillmaster was used for drilling the hard ore zone. Difficulty was encountered in collaring holes due to ravelling ground in the top 2 - 3 feet of the hole. This was partially alleviated by casing the top of the hole with 2 foot lengths of 8 inch pipe, and increasing the annular velocity by increasing the drill rod diameter from 4 inch to 5 inch.

Drilling costs per ton broken were almost double those attained with the 40-R. Production, in tons drilled per shift, averaged less than half that attained with the 40-R.

Reich CT 750 Rotary Drill

The diesel powered Reich CT 750 Rotary Drill, in use from February 1962 to March 1964, was initially used to drill 9 inch diameter holes but was later modified to drill 7 7/8 inch diameter holes. Drilling was confined entirely to waste rock and due to its manoeuverability was particularly useful for blast hole drilling for open pit extensions.

Drilling costs per ton broken were almost double those attained with the 40-R. Production, in tons drilled per shift, averaged 60 percent of that attained by the 40-R.

Bucyrus-Erie 40-R Rotary Drills

The electric powered Bucyrus-Erie 40-R Rotary Drills, used to drill 9 inch diameter holes, have proven to be superior to the other types of drills used at Craigmont. Each is equipped with a water injection system, in addition to a No. 8 Rotoclone, for dust suppression. Water consumption is 45 gallons per shift. A detergent is added to the drill water to increase dust suppression qualitities and decrease the amount of water used. Alcohol is added to drill water in the winter to prevent freezing.

Each drill is equipped with an extended mast to allow a 40 foot hole to be drilled in one pass. Two $7\frac{3}{4}$ inch diameter rods, 27 feet, 9 inch and 12 feet, 6 inch in length, are used. A spare

rod, 27 feet, 9 inch is carried on each drill.

Drill rod connectors, cast by a manufacturer, are threaded in the Craigmont machine shop and welded to cold drawn seamless mechanical tubing to produce drill rods. Stabilizers are also cast by a manufacturer and threaded in the machine shop. These are built up with strips of T-1 steel and hard surfacing, as required.

Drill bits account for 50 percent of the drill operating costs. Several types and makes of bits have been evaluated. The majority of the drilling is with steel tri-cone bits, designated as "H-type" by the manufacturers. Less than 5 percent of the drilling is with tungsten carbide bits.

Bit life exceeds 1,700 feet for steel bits. In the volcanic tuff bits have drilled as much as 9,500 feet. Penetration rate averages 1.1 feet per minute in waste and 0.8 feet per minute in ore.

Operating costs for the 40-R drills are lower and production per shift is higher than for the other drills. The following table indicates the performance and cost of all drills in use at Craigmont.

Drill	40-R	Reich	Reich	Drillmaster
Hole Diameter	9"	9"	7 7/8"	6"
Availability	89%	70%	67%	88%
Tons Drilled / Operating Shift	10,350	6,570	3,020	4,360
Operating Cost / Ton Broken	$0.0085	$0.0154	$0.0210	$0.0126
Labour Cost / Ton Broken	$0.0034	$0.0053	$0.0113	$0.0078
Cost / Ton Broken	$0.0119	$0.0207	$0.0323	$0.0204

Secondary Drilling

A Gardner-Denver air trac drill with a portable 600 cfm. Atlas Copco compressor is used for secondary drilling. This is required for oversize boulders, hard toes in the pit floor and pioneering pioneering pit extensions.

Drilling Practices

The bench height at Craigmont is 33 feet and holes are drilled with 4 feet of subgrade. The final row of holes on each bench are drilled only to grade. Due to caving ground the average hole depth is slightly over 40 feet.

Drill patterns vary throughout the pit. The average pattern, with 9 inch holes, is 16 feet x 18 feet in ore and 20 feet x 22 feet in waste.

Hole locations are staked out by the Pit Surveyor following the pattern determined by the General Foreman and Blasting Supervisor. As each hole is completed the driller marks a hole number on the stake and also a notation whether the drilling was soft, medium or hard. With this drilling information the explosive load can be varied if required. Each hole is surveyed before being blasted.

The Pit Geologist establishes the ore zone on each bench. All holes in this area are sampled, by the drill helper, assayed and the location and ore grade plotted on a plan. This plan is used for digging control in the ore zone.

BLASTING

A crew of two blasters and five helpers load and blast 150,000 tons of ore and 1,350,000 tons of waste each month. Blasting is done on day shift, five days a week, with the blasts varying in size from 30,000 to 150,000 tons.

Loading Procedure

All holes are measured for depth before loading begins. Due to caving holes or excessive water flow it is sometimes necessary to redrill holes, which must be done before any loading begins.

The required ammonium nitrate, usually six 80 pound bags, is placed at each hole. Each bag is pierced with a hollow needle and 5/8 gallons of diesel fuel is injected by an air pump with air pressure supplied by a portable compressor. The AN-FO is loaded shortly after the mixing is completed.

Loading Technique

The use of Hydromex, a commercially prepared slurry, has been decreased by several methods.

1. In holes containing 1 - 3 feet of water, the AN-FO is placed in a plastic bag, protected by burlap, and lowered into the

hole. These bags are 2 feet in length and 2 or 3 are required in each hole.

2. In holes containing more than 3 feet of water, and in competent ground, the water can be blasted out with a 1 - 2 pound charge of high explosives blasted in the bottom of the hole. A bottom-sealed plastic liner, 45 feet long and protected by burlap, is lowered into the hole. The AN-FO is poured into the plastic liner.

3. In holes containing more than 3 feet of water, the water is usually pumped out. Two electric submersible pumps, 5 3/8 inch diameter, with a capacity of 60 G.P.M. when connected in tandem are used to pump the holes dry. Power is supplied by a 115 volt portable generator. This method is faster and easier than blasting. AN-FO is loaded in a plastic liner.

One hundred pounds of Hydromex are loaded in the toe of ore holes to increase the load density. Hydromex is sometimes used as a bottom load in holes with excessive burden. At present, less than 5 percent of explosive used is Hydromex.

All holes are bottom primed with a 160 gram PETN primer, threaded on the Primacord down line. Holes are also top primed with a 50 gram PETN primer. The explosive column is brought up to within 18 feet of the top of the hole and stemmed with drill cuttings. A deck load, 40 pounds of AN-FO, 12 feet from the top, is usually used in the ore zone.

Delay Patterns

Special Reinforced Primacord is used for all trunklines. Detonating relays, 5 milliseconds in ore and 15 milliseconds in waste, are used. The delay pattern is usually V-shaped. Each blast is completely dug out before the adjoining blast is fired.

Line Hole Blasting

The holes drilled adjacent to the final pit walls are termed line holes. These holes are drilled on 10 foot centres, 3 feet off the designed toe and only to bench elevation. The line holes, with 15 feet of burden, are blasted separately from the main bench blasts. Each line hole is loaded with 160 pounds of AN-FO, which leaves a 30 foot collar. The blast is relayed so that only two holes are fired on the same delay period. This procedure has improved the stability of the pit walls.

Load Factors

Waste blasting results are good. The load factor varies from 0.75 to 1.00 pounds per cubic yard drilled. Shovel production, with 4½ cubic yard P & H electric shovels, is 800 tons per hour.

Considerable difficulty is encountered in blasting the hard, blocky ore zones. The load factor in ore varies from 1.3 to 1.7 pounds per cubic yard drilled. There is very little consistency in results from ore blasts drilled and loaded identically. Hard, high toes are frequent and slightly less than 5 percent of the broken material is oversize. Variations in drill patterns, load factors, explosive distribution within the hole and delay patterns are constantly being tried.

Blasting Costs

Since the start of open pit operations the blasting costs have decreased from 3.97¢ per ton in 1961 to 2.69¢ per ton in 1964.

The cost for the period November 1962 - October 1963 is distributed as follows:-

Labour	9.5%
General Supplies	3.2%
AN-FO	41.6%
Hydromex	26.9%
High Explosives	2.7%
Primers and Primacord	14.8%
Equipment	1.3%
Total	100.0%