CONCENTRATION OF LEAD-ZINC SULPHIDES IN ORES

SUBJECT - ORE DRESSING

TITLE OF THESIS

"The Concentration of Lead-Zinc Sulphides in Ores and their separation from one another."

Before proceeding with an account of the experimental work, some of the definitions and general principles applicable to the concentration of ores will be given.

DEFINITION.

"An ORE is a natural aggregation of minerals from which a metal or metallic compound can be recovered with profit on a large scale."

(The minerals which make up an ore deposit do not belong to any one class of rocks or minerals, but are oxides, sulphides, carbonates, chlorides or metallic salts in general.)

Ore Dressing, Dressing of Minerals (Aufbereitung German, Preparation Mechanique) are general terms used, which includes the whole series of operations that have for their object the separation of a mass of mixed minerals into its mineralogical constituents, or the cleaning of one mineral constituent from the accompanying mineral or minerals which may be looked upon from the technical point of view as the impurities of the former.

"The process of mechanically separating and saving valuable minerals from the valueless material of an ore whereby the valuable minerals are concentrated into smaller bulk and weight by discarding some of the waste, or the process of mechanically separating two or more minerals, which combined, have little value, into two or more products, each of increased value, is called Ore Dressing."

Ore Dressing makes use of the physical properties of minerals and rocks; and the difference in behaviour between the valuable and waste minerals affords methods for the separation of the former from the latter. The physical properties of interest in ore-dressing are:

Hardness,

Tenacity, brittleness or friability,

Structure and fracture,

Aggregation,

Color and lustre

Specific gravity and settling power,

Adhesion,

Greasiness.

Electro Conductivity,

Magnetic Susceptibility,

Change in condition by heat from non-magnetic to magnetic.

Change in condition by heat from dense to porous,

Decrepitation by heat,

The physical characteristics of lead and zinc sulphides which occur in nature are as follows:

Galena P b S Hardness 3.-

Lustre-Metallic

Color- lead gray, tarnishes to black

Streak - lead gray

Cleavage - Perfect cubic

Brittle

Sp.G. 7.5

Occurs massive cleavable, coarse to fine granular, rarely fibrous, and in isometric (usually cubo- octahedral) crystals; sometimes in skeleton crystals..

VARIETIES

ARGENTIFEROUS

The minerals, especially the fine-grained variety called steel galena, may contain so much silver as to make it a valuable silver ore. Gold and many other elements are also often present. Galena is the principal ore of lead and often very valuable because because of its gold and silver content.

In order that the different behaviours of the various associated minerals and gangue stones may be fully appreciated, a synopsis of their physical properties is given below:

<u>PYRITE</u> FeS_2 Hardness 6 - 65

Lustre Metallic

Color - pale to full brass yellow.

Spec. Gravity 4.95 - 5.1

Cleavage - usually more apparent; otherwise, poor to good cubic.

Brittle. Fracture Conchoidal to uneven.

QUARTZ SiO_2 Hardness 7

Spec. Grav. 2.65 - 2.66

No cleavage. Conchoidal fracture when crystallized and uneven fracture when massive.

CALCITE $CaCO_3$ Hardness 3

Spec. Grav. 2.7

DOLOMITE (Ca, Mg) Co_3 Hardness 3.5-4

Spec. Grav. 2.8 - 2.9

SIDERITE $FeCO_3$ Hardness 3.5-4

Spec. Grav. 3.83 - 3.88

RHODOCHROSITE $MnCO_3$ Hardness 3.5-4.5

Spec. Grav. 3.45 - 3.6

Garnet Hardness 6.5 - 7.5

Spec. Grav. 3.15 - 4.3

Ore dressing may be divided into two parts, severing and separating.

1. Severing or Detaching. The valuable minerals as they occur in the rock are attached to waste minerals, and to sever the one from the other, the various steps of breaking, crushing, comminuting are used.

2. Separating. After the crushing has severed the valuable minerals from the waste, the two are still mixed togther, and the true separation, which puts the good ore into the store bin, and sends the waste to the dump, must then take place.

The properties that have the most effect on crushing will be taken up first.

HARDNESS (or SIFTNESS) -

Minerals differ greatly in this respect differing from the hardness of the diamond to the softness of talc, their ability to scratch one another being considered the measure of hardness.

hardness.

Moe's scale of hardness is the one most used by most mineralogists and may be found in any work on this subject.

Hardness affects the wear of crushing machines; the harder the mineral the greater the wear. It does not necessarily affect the tendency of the minerals to produce fines or slimes in crushing.

TENACITY, BRITTLENESS, OR FRIABILITY:

Some minerals such as certain forms of horneblende and feldspar exhibit extraordinary toughness, although they are not very hard; other minerals are brittle and break with comparative ease, as, for example, some varieties of quartz. A hard, brittle mineral will, when in agitation make more fines or slimes than one which is soft and tough.

The use of a graded crushing and graded separation to diminish the amount of fines or slimes produced, is quite frequently resorted to with brittle minerals.

STRUCTURE AND FRACTURE:

The structure of a mineral tends to modify the shape of the particles resulting from crushing.

Cleavable minerals may break into cubical blocks, as galena; into elongated fragments as galena, feldspar, calcite and sphalerite; into flat scales, as galena, mica, graphite and talc.

Granular minerals will drop naturally into separate rounded grains when broken, as magnetite, garnet, and some varieties of galena. The shapes of all these grains have an important bearing upon their power to settle in water or in air.

MINERAL AGGREGATION.

The valuable minerals may occur ~~in some~~ as masses, as in the banded vein structure, and in pockets or ~~rings~~ vugs. They may also occur ~~in~~ as large crystals mixed with the waste minerals, or both of ~~which~~ these conditions are favorable for complete separation. On the other hand, they may occur, intermingled with the waste minerals either in granular structure, that is to say, rounded grains or small, compact crystals; or in the case of acicular structure, in long needle-like crystals, the valuable and waste minerals penetrating in all directions, or finally with a laminated structure in thin layers alternately of good and worthless material; all of which conditions add difficulty to the problem of ore dressing.

The physical properties that have most to do with separation will be considered next.

COLOR AND LUSTRE.

These qualities are of the greatest value in handpicking. Slight differences in color or in lustre, for instance, the color and metallic lustre of the cleavage faces of galena and the resinous lustre of sphalerite furnish valuable aids in hand-picking.

SPECIFIC GRAVITY

Specific gravity may be defined as the ratio of the weights of equal volumes of substances. For convenience, distilled water at 60oF is usually taken as the standard of comparison. The difference in specific gravity of minerals affords the surest and most valuable means of separating them from each other. This property may be employed in two different ways namely as affecting settling power, which is by far the most important, or as affecting momentum, which is of limited application.

GREASINESS:

This is a term used to express the tendency of minerals to float on the surface of water as if they were greasy. It is caused by the aversion of the surface of the particle to become wetted. All minerals exhibit the tendency but, for instance, native copper, native gold, cassiterite, sphalerite, graphite, and some of the silver minerals.

This property, which until recently has been regarded rather as a difficulty to be overcome than as an aid to mineral separation, is made use of in the various flotation processes such as the Elmore, the Potter and the Delprat.

MAGNETIC SUSCEPTIBILITY.

The attraction of the magnet is quite strong in some minerals and metals, notably magnetite, some forms of pyrrhotite, cast iron, wrought iron, steel, nickel, and cobalt. Other minerals such as franklinite, chromite, serpentine, "blackjack" or iron bearing sphalerite, garnet, etc., have a weak magnetism. Still others such as quartz, calcite, gypsum, feldspar, etc., exhibit no attraction whatever. By using properly constructed magnets this property may be utilized, not only in separating the magnetite from non-magnetite, but also those that are more from those that are less magnetic.

An ore dressing process usually consists of at least two steps, in which the second is supplementary to the first. Thus sorting in classifiers is followed by sizing on slime tables; and sizing by screens is followed by sorting in jigs. In each case the first step prepares the ore for the second, and the second which is the most important, supplements and completes the work which the first could not perform alone.

Ore Dressing is essentially a branch of Technology. In the case of a purely scientific subject its limits are capable of clear and exact definition, and its scope is easily fixed; but this is far from being the case with a technical art, the boundaries of which are merely decided by expediency or prescribed by custom. Accordingly we find that it is all but impossible to say exactly where the operations included in the term "Ore Dressing" begin, or where they leave off, and we find them encroaching on the one hand, upon the domain of the miner, and on the other, overlapping that of the metallurgist and manufacturer.

The concentration problem for a particular ore will in all probability differ in many details from that presented by any other ore. For example, three different lead-zinc sulphide ores from British Columbia were studied in this investigation.

(1) From the Van Roi Mine, Silverton

(2) From the Blue Bell Mine, Ainsworth,

(3) From the St Eugene Mine, Moyie, B.C.

(1) The Van Roi ore is Galena, and sphalerite with high grade silver minerals (freibergite, proustite, etc.) associated with siderite, calcite, quartz, and crushed slate, often affording beautiful illustrations of brecciation.

The average content of the ore as mined is 4% lead, 10% and 18 oz. of silver per ton. It yields in concentration two products: galena, selected, and concentrate (65% lead, 9% zinc, and 120 oz. of silver per ton) and zinc concentrate (4% lead, 45% zinc and 40 oz. of silver per ton.)

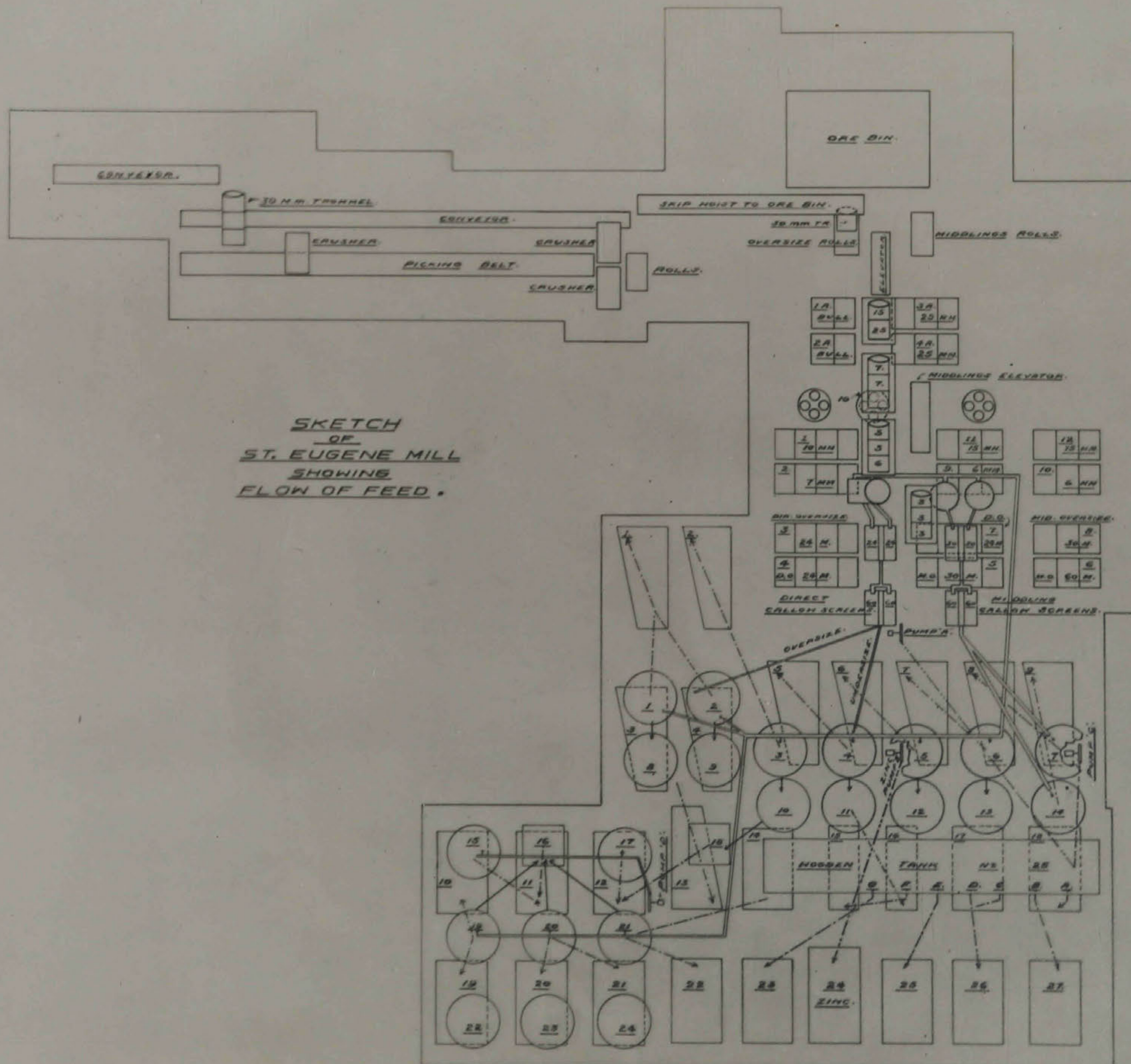
A simple lead ore concentrator designed to treat a large tonnage with a small force of men would not suit this ore because the losses of silver would be too large. The mill should be designed for a large percentage extraction, even at the expense of reduced capacity per man, and hence a higher treatment cost per ton. Hand picking should be a very prominent feature in such a mill. See pages 45-57

(2) The Blue Bell ore carries on an average 10.6% of lead, 11.7% of zinc, and 3.27 oz. silver per ton. The galena and sphalerite are so intimately mixed that a satisfactory separation cannot be made

on sizes over 3 m.m. A mill designed to concentrate this ore would not include hand picking except for waste, or jigs for treating sizes coarser than 3 m.m. The low silver content of the ore calls for a low treatment cost per ton and large capacity in the mill. (see pp 58—315 [illegible]

(3) The St Eugene Ore contains from 12% to 15% lead, 4% zn. and 5 oz. silver per ton. The galena is not intimately mixed with either the syphalerite or gangue, hence a comparatively large proportion can be picked out by hand and sent directly to the smelter.

The design of a mill for this ore should include a careful hand picking of the free lumps of galena; graded crushing and sizing to prevent undue sliming of the galena left in the ore; coarse jigs and good sand and slime treatment plants. The following notes(pages 13—44) are the result of a study of the concentrating plant at Moyie.


SKETCH
OF
ST. EUGENE MILL
SHOWING
FLOW OF FEED.
CONVEYOR.
CONVEYOR.
CRUSHER.
CRUSHER
PICKING BELT.
CRUSHER.
ROLLS.
ORE BIN.
SKIP HOIST TO ORE BIN.
OVERSIZE ROLLS.
MIDDLINGS ROLLS.
MIDDLINGS ELEVATOR.
DIRECT
CALLOW SCREENS.
MIDDLING
CALLOW SCREENS.
PUMP A.
OVERSIZE.
WOODEN TANK No 25
ZINC.

The St. Eugene Lead-Zinc Concentrating Mill.

This mill is situated on the banks of Lake Moyie, near the town of Moyie, British Columbia.

The more important operations may be conveniently and properly classified:-

(a) Coarse Crushing Section.

(b) Screening and Coarse Concentration Section.

(c) Fine Crushing and Fine Concentration Section.

(d) Slime Concentration Section.

A preliminary description of the several sections, considered in conjunction with the attached plan of the mill, may be helpful to the Reader.

Coarse Crushing Section.

The ore is transported from mine to mill in trains of cars hauled by an electric locomotive. Upon reaching the mill it is weighed and then dumped into ore bins- of which there are four. One of these receives the coarse ore and one the fine ore from the lower mine levels, and similarly the other two receive coarse and fine ore from the upper mine levels.

Automatic feeders discharge the fine ore evenly and continuously, the ore falling on an endless moving belt which delivers it to a thirty millimetre (30 mm.) revolving screen. The undersize from this screen falls on a second belt conveyor delivering it to a skip elevator, which in turn discharges into the mill storage bin. The oversize falls on a thirty-six inch conveyor or picking belt, which also receives the ore from the coarse ore bins after it has received a preliminary crushing in a 24" x 15" Farrel crusher. (Blake crusher type.)

During the travel of this belt, men, stationed at either side of it, pick out such pieces of galena, as are sufficiently clean to be shipped to the Trail smelter, without further preparation. This material will be designated "shipping ore". Similarly, other ore sorters remove pieces of gangue or waste rock which contain little ot no galena. Usually there are four men employed in sorting at the Moyie mill, two men remove the shipping ore and two sort out waste.

The material on the picking belt, after it has passed the ore sorters, requires further comminution and is discharged to two 9" x 15" Blake Crushers, which in turn discharge to a set of 12" x 36" rolls. After passing through the rolls, the ore is raised by a pair of automatic loading and dumping skips which discharge to a sampling machine. The sampler automatically cuts out 1/18th. of all the ore delivered to it, the balance or "reject" passing directly to the Mill storage bin. The portion thus cut out passes through a pair of rolls, set about one-quarter of an inch apart, thence to a Vezin automatic sampler which cuts out one-fourteenth. The reject again goes to the mill storage bin. In this way a sample of about 1.75 tons is obtained which which approximately represents the composition of the 500 tons treated per twenty four hours.

This sample is coned and quartered on a steel floor and thus reduced to a sample of about 250 pounds. It is then dried and pulverized in a grinder of the coffee mill type. and reduced by "riffle" sampling to a sample of about 500 grammes.

Screening and Coarse Concentration Section.

The ore from the mill storage bin, which has a capacity of about 275 tons, is automatically fed to a 30 mm. trommel. The oversize from this trommel passes to a set of rolls where it is crushed and delivered, together with the undersize from the trommel, to a bucket elevator which in turn discharges into the main trommel line.

The main trommel line consists of screens of- 15, 25, 7, 10, 3, and 6 millimetre openings respectively.

The oversize from the 25 mm. screen is treated on 2--2 Compartment Jigs- 1A, and 2A.

The - through 25 mm., on 15 mm.,size feeds 2--3 Compartment Jigs- 3A and 4A.

The middlings from these four jigs- 1A, 2A, 3A, 4A- are crushed in a pair of rolls about 1/4" apart and returned to the main elevator and trommel line.

The size- through 15mm, on 10mm- goes to 2- 3 Comp't. Jigs--Nos. 11 and 12.

The size-- through 10mm., on 7mm.- goes to one- 4 Compartment Jig- No.1.

The size- through 7 mm., on 6 mm.- feeds one- 4 Compartment Jig--No.2., and the size-- through 6mm., on 3 mm. to 2- 3 Compartment Jigs-- Nos. 9 and 10.

The undersize from the 3 mm. screens goes to an hydraulic classifier, the spigot product of which feeds 2-24 mesh Callow Screens. The oversize from these screens is treated on - 3- 4 compartment jigs,--Nos. 3, 4, 7.

The undersize from the 24 mesh screens passes to 2- 60 mesh Callow screens, while the overflow from the classifier goes to Callow tanks. The treatment of these products will be considered in the fine and slime concentration sections.

The middlings from all jigs treating under 15 mm. material go to three Huntington mills in which they are ground to pass through screens with 16 and 30 meshes to the linear inch. The Huntington mill product is elevated to 2 hydraulic classifiers and the spigot products, or hutches, from these classifiers feed 2- 30 mesh Callow screens. The oversize from these screens is treated on jigs- Nos. 5 and 8. The undersize passes to 2- 60 mesh Callow screens, the oversize from which is treated on jig No.6. The tailings from this jig go back to the Huntington mills.

Fine and Slime Concentration Sections.

It will be noted that there are two separate and distinct combinations of Callow screens. The first- 24 & 60 mesh- treats the fine ore coming from the main trommel line. This feed is called "direct feed". The material which stays on the 24 mesh screen is treated on jigs as stated above. The ore passing the 24 mesh and staying on the 60 mesh screen is fed to Wilfley table No. 4. This table makes a concentrate containing 75% lead, as the feed is rich, and the slime water and tailings from this table are sent to table No. 13 for re-treatment. The undersize of the 60 mesh screen goes to Callow tank No. 4 which in turn feeds Wilfley table No. 5. The concentrates from this table contain about 82% lead and the slime water is sufficiently valuable to be sent to the concentrates bin where the very finely ground up sulphide in suspension is settled and saved.

Callow tank No. 4 overflows to tank No.11 which feeds vanner No. 16. The overflow from tank No. 11 goes to the tail-race.

The second combination of Callow screens-- 30 and 60 mesh-- are fed with re-ground middlings and the "On 30" and "on 60" sizes are jigged as described. The " through 60" size goes to Callow tank No. 7 which overflows to tank No. 14. These tanks feed Wilfley tables Nos. 8 and 9 respectively.

The overflow from the direct feed classifier joins the overflows from the two middlings classifiers and the whole is carried in a launder to Callow tanks-- Nos. 6, 5, 3, 2, 1, 21, 20, and 19. At each one of these tanks there is a 12" x 12" sump or box, with an orifice in one side. The orifice is faced with a disk of 1/4" steel plate pierced with holes of varying diameter. By rotating the disk the orifices in the disk are brought, one by one, in apposition with the orifice in the sump and in this way the feed to the different tanks can be closely regulated or cut off entirely. Tanks- No. 6, 5, 3, 2, 1, 21, 20, 19, overflow to tanks- No. 13, 12, 10, 9, 8, 24, 23, 22, and the overflow from these flows to the tail-race. Tank No. 10 overflows to wooden tank No. 18 which overflows to the tail-race.

Tanks No. 1, 2, 3, 5, and 6, feed tables No. 1, 2, 6, and 7. Tanks No. 10, 12, and 13, feed vanners No. 15, 17, and 18. Tanks No. 21, 20, 19, 22, 23, and 24, feed vanners No. 10, 19, 20, 21, 14, and 22. Tanks No. 11, 12, and 18, feed vanners No. 16 and 12.

The slimes by carried off by the water at the head end of the Wilfley tables receiving direct feed, contains about 10% lead. This is raised by centrifugal pumps A and "C"- to settling tank No. 25 of V-shaped cross section-- 55' long--8' wide and 8' high, and its overflow goes to the tail-race. This tank feed vanners No. 2, 3, 25, 26, and 27.

The tailings from all the vanners receiving direct feed are pumped by centrifugal pump "D"- to Callow tanks No. 17, 15, and 16. The overflow from these goes to the tail-race. These tanks feed vanners No. 11, and 12.

The middlings from tables No. 6, 7, 8, and 9, carry about 18% zinc, and 8% lead. These are pumped by pump "B"- to table No. 24 which makes a lead concentrate and a zinc product containing 22% zinc and 4% lead. The zinc product is stored pending the discovery of an economical process for raising the zinc content to 40%--50% Zn.

Coarse, fine and slime concentrates are collected in their respective bins, the overflow from the fine and slime concentrates bins being to three settling tanks, each 100 feet long.

The mill equipment includes 16 jigs, 11 Wilfleys and 16 Frue vanners.

General Considerations.

The writer spent a month in the St. Eugene mill studying the mechanical details, the general concentration practice and was actively engaged in securing the regular mill samples during that time. For additional accuracy and information, another week was entirely devoted to sampling the products in the various sections to ascertain their characteristics and composition. The screen analyses and the assays were made in the laboratories at McGill University.

It might be said that the systematic sampling of all parts of a milling plant, is an essential in operating it, and this part of the work is only too often neglected or done in a very perfunctory manner.

At the St. Eugene mill however, general samples are taken each day, as also samples of products from individual machines which require careful attention and adjustment. As a further precaution samples of all the products are taken at least once a week and the monthly and bi-monthly reports contain statements of the tonnage milled, the average assay of the mill-feed, general tailings, shipping ore and concentrates, also the percentage of lead recovered and the ratio of concentration for the period under consideration.

The following examples will be of interest.

(See next page--Tables 1 and 2.)

Table No. 1.

Month of May---------1909.

Ore brought to mill----------------------- 12686 tons.

Waste removed by sorting----------------- 686 "

Ore milled----------------------- ----------- 12000 "

Products.	Tons.	% Weight.	% Pb.	Oz. Ag.
Fine Concentrates	607.5	32.4	60.0	25
Coarse "	401.9	21.4	56.0	23
(High Grade Slimes)	462.8	24.7	77.0	32
(Direct Feed) Slimes	372.8	19.9	59.0	24
Shipping ore	30.0	1.6	51.0	21
Totals-----------	1875.0	100.0		% Zn.
Zinc Concentrates	170.0	----------------	6.9	20.63

	% Pb.	% Zn.	Oz. Ag.
Feed.	11.8	2.7	4.6
Tailings	1.9	0.9	0.5

		% of Total Pb.
Recovery ---	Concentrates and Tails Assays-----	83.1
"	Feed and Tails Assays. -----------	86.4

Ratio of Concentration:- 6.4 : 1 :: Tons Feed : Tons Concent.

or more simply, 6.4 tons of feed produced 1 ton of Concentrates.

Table No. 2.

June 1---12, 1909.

Ore brought to mill---------------------------- 3548 tons.

			% Pb.	Oz. Ag.
			17.1	6.5
Concentrates produced.	654	tons.		
Shipping ore sorted at mill	49	"		
" " " " mine	11	"		
	714	"	62.0	25.0

Recovery------------------- 66.8% of the lead.

Ratio of concentration---- 5 : 1.

Note:- The feed assay was high during this period, on account of alterations in the sampling department which were not completed until June 16th.-09. The actual extraction was probably much higher than the apparent extraction.

Mill Stoppages.

If for any cause the mill is closed down for over six minutes, an explanation is entered in a book kept for the purpose, and a copy of these entries appears in the reports. This is a point of great economic importance because it indicates the many changes and improvements which should be made in the mechanical equipment. A conservative estimate of the monetary loss per hour for each hour the mill was closed down, would approximate $ 175.00

Many machines such as steel belt conveyors, bucket elevators, etc,, when partly worn out, cause much loss of time for repairs. It is necessary therefore, to keep careful account of all stoppages with a view to striking an economical mean between losses from stoppages on the debit side and the value of the longer service on the credit side.

The following list of mill stoppages is illustrative of difficulties ordinarily encountered.

Table No. 3.

Stoppages during the month of May-09.

Hours.	Cause.
4	Babbitting elevator bearings.
6	Break in the flume.
2.5	Trouble in the water supply.
3	Repairs-top pulley-fine elevator.
12	Trommel and elevator repairs.
1	Changing jig sumps.
24	Repairs back plate-middlings rolls, new coarse elevator and general repairs st same time.
2	New drive pulley for pump.
2.5	Trommel repairs.
0.5	Skips.
1.5	Rolls choked.
2	Sampler belt.
2.5	Cleaning water pipes.
7.5	Tail-race choked.
3.5	New fine elevator belt.
3	Middlings rolls.
12.5	General mill repairs.

90.0 hours---Total.

June 1--12-09.

6	Coarse elevator gear and pinion replaced.
1	Trouble with water supply.
2.5	Trommel and elevator repairs- & changing jig.
1.5	Tail-race choking.
0.5	Sampler belt.
0.5	Rolls choked.
4	Repairs middlings rolls.
3	Elevator and trommel repairs.
0.75	Lacing skip drive belt.

19.25 hours---Total.

General Mill Samples.

The following are a series of samples covering five weeks operation. They are given for each week instead of an average for the five weeks so that the variation from week to week may be noted.

Table No. 4.

Test No.1-------- Week ending May 13, 1909.

Feed. from.		Feed assay. % Pb.	% Zn.	Table No.	Tailings % Pb.	assay. % Zn.
Oversize 60 mesh,	direct.	19.9	2.9	4	1.4	0.2
Undersize " "	Tank 4	23.1	2.5	5	1.3	1.0
	Tank 6	12.2	3.0	7	1.6	1.1
	" 5	12.4	2.4	6	1.5	2.1
	" 3	12.7	2.5	2	1.8	--
	" 1-2	12.9	3.3	1	2.2	--
	" 7	8.3	3.9	8	1.2	--
	" 14	12.3	4.2	9	1.5	1.5
	" 21	13.4		22	4.8	
	"			14	4.0	
	" 20	12.2		20	3.5	
				21	4.5	
	" 19	12.4		19	3.9	
				10	5.0	
	" 11	15.9		16	5.3	
	" 24					
	" 15	5.8		11	3.8	
	" 16					
	" 24					
	" 17	4.8		12	4.3	
	" 18					
	" 25	A 7.1		18	3.4	
		B 7.6		27	3.1	
		C 7.3		17	3.0	
		D.8.4		26	2.8	
		E 8.3		25	3.3	
		F 9.4		15	5.1	
		G.9.7		23	4.1	

Table No. 5.

Test No. 2------- Week ending May 20th.-1909.

Feed from:-		Feed Assay. % Pb.	%Zn,	Table No.	Tailings Assay. % Pb.	%Zn
Oversize 60 M. D.		33.4	2.2	4	1.0	0.5
Undersize- Tank	4	36.9		5	1.8	2.0
"	6	17.9		7	1.3	1.7
"	5	17.1		6	1.5	
"	3	16.6		2	2.1	1.9
"	1-2	15.4		1	2.4	
"	7	15.0		8	2.0	3.0
"	14	14.2		9	2.3	
"	21	14.8		22	6.5	
				14	5.1	
"	20	19.1		20	4.1	
				21	4.8	
"	19	16.3		19	3.0	
				10	2.9	
"	11	16.8		16	4.6	
"	24	12.3				
"	16			11	7.5	
"	24					
"	17	5.6		12	4.5	
"	18					
"	25	A11.3		18	3.6	
	B	9.5		27	4.1	
	C	10.3		17	5.0	
	D	14.2		26	3.5	
	E	12.0		25	2.8	
	F	12.0		15	6.4	
	G	11.8		23	4.3	

Table No. 6.

Test No. 3------- Week ending May 27th.-1909.

Oversize 60 M.D.		40.4	4.1	4	1.7	2.3
Undersize-Tank	4	41.0	4.0	5	2.5	4.0
"	6	21.1	5.5	7	1.5	2.4
"	5	21.6	4.8	6	1.3	
"	3	20.7	4.7	2	2.3	4.0
"	1-2	21.0	5.4	1	1.8	
"	7	13.0	9.1	8	1.6	5.1
"	14	17.0	10.2	9	2.1	
"	21	18.9		22	6.9	
"				14	7.4	
"	20	20.0		20	7.3	
"				21	5.8	
"	19	20.6		19	5.1	
				10	4.1	
"	11	19.5		16	7.1	
"	24	16.2		11	8.3	
"	16					
"	24					
"	17	6.5		12	5.0	

Table No. 6- continued.

Feed from-	Feed Assay % Pb.	% Zn.	Table No.	Tailings Assay. % Pb.	% Zn.
Tank 18					
" 25A	11.4		18	4.4	
"B	13.4		27	4.9	
"C	13.6		17	4.4	
"D	17.0		26	4.5	
"E	16.3		25	4.6	
"F	14.3		15	7.7	
"G	15.1		23	7.9	

<u>Table No.7.</u>

Feed from:-	Feed Assay. % Pb.	% Zn.	Table No.	Tailings Assay. % Pb.	% Zn.
Oversize 60M.D.	23.8	3.3	4	1.5	0.6
Undersize " Tank 4	26.6	3.7	5	1.9	2.0
Tank 6	16.8	3.1	7	1.2	0.9
" 5	14.4	2.7	6	1.6	
" 3	14.3	3.6	2	1.7	2.2
" 1-2	16.2	3.2	1	1.3	
" 7	10.7	5.2	8	1.6	2.4
" 14	9.8	4.8	9	2.0	2.4
" 21	12.8		22	4.2	
			14	5.1	
" 20	12.8		20	3.7	
			21	4.0	
" 19	13.1		19	3.9	
			10	6.2	
" 11	14.6		16	5.0	
" 24					
" 16	10.6		11	8.0	
" 24					
" 17	4.8		12	3.2	
" 18					
" 25 A	9.0		18	5.1	
" B	8.9		27	4.4	
C	9.2		17	3.8	
D	10.0		26	3.6	
E.	10.3		25	4.5	
F	9.6		15	5.7	
G	10.9		23	6.4	

Table No.8.

Test No.6------------------------Week ending June 17-09.

Feed from:-	Feed Assay % Pb.	Feed Assay % Zn.	Table No.	Tailings Assay % Pb.	Tailings Assay %Zn.
Oversize 60 M.D.	45.5	4.5	4	1.0	0.5
Undersize " Tank 4	48.5	4.8	6	1.6	1.4
Tank 6	20.1	4.9	7	3.2	2.7
" 3	20.0	4.4	2	2.2	2.4
" 1-2	20.6	4.6	3	1.5	
" 7	16.4	8.0	8	2.1	6.2
" 14	15.9	7.4	9	2.2	
" 21	21.1		22	6.8	
			14	7.0	
" 20	17.9		20	6.0	
"			21	7.1	
" 19	18.8		19	6.6	
			10	6.1	
" 11	18.5		16	11.3	
" 24					
" 16	15.8		11	9.2	
" 24					
" 17	9.8		12	5.9	
" 18					
" 25 A	11.5		18	5.4	
B	12.4		27	5.2	
C	10.6		17	5.7	
D	12.5		26	4.6	
E	10.1		25	4.9	
F.	14.2		15	8.1	
G	14.3		23	8.2	

Table No. 9.

Test No. 5 ------- Week ending June 17-09.

Jig Tailings.

	Assay. % Pb.	Assay. % Zn.
Bull jigs--- 1 A.	1.2	
2 A.	1.1	
3 A.	2.8	0.5
4 A.	3.1	
Lower Jigs--No. 1	1.5	0.3
" 2	1.6	
" 3	1.3	0.4
" 4	1.3	
" 5	3.2	3.1
" 7	2.6	0.4
" 8	2.9	3.1
" 9	1.0	
" 10	1.1	0.3
" 11	1.7	0.5
" 12	1.5	0.5

The amount of variation in the mill feed is often an important factor in the concentrating problem. An ideal case would be, where the feed to the mill and to each individual machine was maintained constant in both quantity and quality.

It will be noted that the various feeds in the St. Eugene mill are subject to considerable fluctuations in value. The galena often occurs in massive form, hence it is more difficult to control the grade of the feed than it would be in a mill treating the galena limestone of Springhill, Missouri, where the galena is evenly disseminated through the limestone. Nevertheless, with skilled labour in the mill, the variation is not large enough to be a matter of any considerable difficulty.

Screen Analyses and Assays- Fine Concentrates Section.

It will be recalled that the direct feed from product, from the 60 mesh Callow screens, goes to Table No. 4. It contains about 30% lead. The tailings and slime water from table No. 4 go to table No. 13 for re-treatment.

The products from table No. 4 are sampled daily and the assays for thirteen consecutive days were as follows:-

(See next page--Table No. 10.)

Table No. 10.

Date.	Concentrates.		Tailings.	
May.	% Pb.	% Zn.	% Pb.	% Zn.
12	71.3	5.4	1.9	1.8
13	73.9	2.8	1.3	0.6
14	72.1	3.8	1.0	0.4
15	74.8	4.4	1.7	1.3
16	70.0	5.2	1.4	0.7
17	75.7	3.4	1.8	1.1
18	76.3	4.4	2.5	1.9
19	74.1	4.6	1.7	0.5
20	71.3	5.0	1.5	0.6
21	72.7	4.5	1.6	1.1
22	75.8	3.0	1.5	1.2
23	72.7	4.1	1.9	1.4
24	73.9	3.1	1.3	0.4

The undersize from the 60 mesh Callow screens goes to Callow tank No. 4, its spigot feeds table No. 5 and its overflow goes to tank No. 11 which feeds vanner No. 16. This feed will be called " direct feed to vanner room."

Table No. 11 contains the assays of the products from table No. 5 for thirteen days.

Table No. 11.

Date	Concentrates.		Zinc Middlings.		Tailings.	
May	% Pb.	% Zn.	% Pb.	% Zn.	% Pb.	%Zn.
12	81.8	2.6	14.1	21.4	1.8	6.1
13	83.9	0.9	15.5	17.4	1.6	1.7
14	80.7	1.6	12.6	20.7	1.9	1.7
15	82.5	1.0	9.2	25.6	1.0	2.2
16	82.6	1.0	13.8	20.9	1.1	2.2
17	82.7	0.7	17.3	20.4	1.8	3.1
18	81.8	1.6	11.2	19.8	3.2	4.9
19	82.7	0.7	16.3	17.2	1.5	2.6
20	80.2	1.3	16.2	22.0	2.0	4.4
21	79.9	2.0	13.9	23.9	2.0	7.3
22	82.7	1.3	31.4	16.2	2.8	5.8
23	82.0	1.1	23.8	19.8	2.8	6.4
24	83.7	0.2	9.4	17.5	1.4	1.0

Table No. 12.

Direct Feed to Vanner Room.

Date	% Pb.	% Zn.
May 16.	16.4	4.6
" 17	14.4	4.6
" 18	13.9	3.3
" 19	13.6	4.0
" 20	16.8	3.6
" 21	24.2	5.7
" 22	18.8	3.9
" 23	17.3	4.0
" 24	19.5	3.8
"		

The following are screen analyses of the various direct feed products which have passed through the 24 mesh Callow screens. :-

Table No. 13.

Product- Through 24 mesh Callow Screens.

General Assay:- Pb.--- 45.9%)
Zn.--- 4.3%)

Size.	% Weight.	Assays. % Pb.	% Zn.	% of Total Pb.	% of Total Zn.
On 30	7.1	37.0	3.6	5.7	5.9
" 40	15.2	38.1	4.0	12.6	14.1
" 60	17.4	43.3	5.2	16.6	21.1
" 80	14.4	42.5	4.4	13.4	14.8
" 100	10.6	43.1	4.0	10.0	9.8
" 150	2.6	43.8	4.6	2.5	2.8
" 200	10.5	44.0	3.2	10.0	7.8
- 200	22.2	60.2	4.6	29.2	23.8
				100.0	100.0

Table No. 14.

(Product.
(Direct Feed- On 60 mesh Callow screens- To Table No. 4.

General Assay:- Pb.--- 31.6%)
Zn.--- 4.4%)

Size.	% Weight.	Assays. %Pb.	%Zn.	% of Total Pb.	% of Total Zn.
On 30	12.3	27.3	3.0	10.6	8.5
" 40	27.7	27.3	4.6	23.9	29.3
60	36.8	33.3	3.6	38.9	30.5
80	10.7	31.9	5.6	10.8	13.8
100	4.1	38.4	4.4	5.0	4.1
150	1.8)	39.4	4.4	5.7	5.1
200	2.8)				
- 200	3.8	42.0	10.0	5.1	8.7
	100.0			100.0	100.0

Table No. 15.

Product:- -60 Mesh Callow Screens- To Tank 4.

General Assay:- Pb.---24.7%)
Zn.--- 4.2%)

Size.	% Weight.	Assays. % Pb.	% Zn.	% of Total Pb.	% of Total Zn.
On 80	13.4	12.6	6.8	6.9	22.2
" 100	13.4	14.4	6.0	7.9	19.6
" 150	6.2)	27.6	4.8	29.6	31.0
" 200	20.5)				
- 200	46.5	29.4	2.4	55.6	27.2
	100.0			100.0	100.0

Table No. 16.

Product:- Spigot of Tank No. 4.-- Feed to Wilfley No. 5.

General Assay:- Pb.---39.1%)
Zn,--- 4.2%)

Size.	% Weight.	Assays % Pb.	% Zn.	% of Total Pb.	% of Total Zn.
On 80	21.6	37.8	5.0	20.9	26.0
" 100	15.8	35.0	3.4	14.2	12.9
" 150	7.9	44.2	4.0	8.9	7.6
" 200	18.4	39.4	4.6	18.5	20.3
- 200	36.3	41.4	3.8	37.5	33.2
	100.0			100.0	100.0

Table No. 17.

Product:- Overflow from tank 4- Feed to tank No. 11.

General Assay:- Pb.--- 11.1 %.
Zn.--- 2.4 %.

Size.	% Weight.	Assays. % Pb.	% Zn.	% of Total Pb.	% of Total. Zn.
On 200	4.4	1.1	0.9	0.4	1.6
- 200	95.6	11.6	2.5	99.6	98.4

Table No. 18.

Product:- Spigot, Tank No. 11-- Feed to Vanner No. 16.

Size.	% Weight.	Assays. % Pb.	% Zn.	% of Total Pb.	% of Total. Zn.
On 200	2.7	20.3	4.4	2.9	3.7
- 200	97.3	18.7	3.2	97.1	96.3

General Assay:- Pb.---18.8%
Zn.--- 3.2%

Table No. 19.

Product:- No. 5 Wilfley-Zinc Concentrates.

General Assay:- Pb.---4.4 %
Zn.--21.4 %.

Size.	% Weight.	Assays % Pb.	% Zn.	% of Total Pb.	% of Total Zn.
On 60) " 80)	24.6	6.6	19.8	37.4	22.7
" 100	20.0	4.0	20.0	18.4	18.6
" 150	15.4	3.7	23.6	13.1	16.8
" 200	23.1	1.3	20.2	6.9	21.9
- 200	16.9	6.2	25.4	24.2	20.0
	100.0			100.0	100.0

Table No. 20.

Product:- Wilfley Tailings- No. 5 Table.

General Assay:- Pb.---1.0 %.
Zn.---1.5 %.

Size.	Weight-%.	Assays. % Pb.	% Zn.	% of Total Pb.	% of Total Zn.
On 150	73.0	0.9	1.4	67.0	67.8
" 200) - 200)	27.0	1.2	1.8	33.0	32.2
	100.0			100.0	100.0

Table No. 21.

Product:- Wilfley Table No. 4 Tailings.

General Assay:- Pb.---1.6 %.
Zn.---0.7 %.

Size.	Weight-%	Assays. % Pb.	% Zn.	% of Total Pb.	% of Total. Zn.
On 40) " 60)	16.3) 20.9)	0.6	0.6	14.2	30.2
" 100	16.3	0.6	0.7	5.3	15.4
" 200	16.3	1.5	0.8	15.6	17.6
- 200	30.2	3.3	0.9	63.9	36.8
	100.0			100.0	100.0

REGROUND MIDDLINGS

The through 60 mesh Callow screen product of the re-ground middles goes to Callow Tank No.7. which overflows or sloughs to No.14. These tanks feed tables 8 & 9 and tank 14 sometimes feeds vanner 18.

TABLE 22

No. 8 WILFLEY TAILS Pb 2.2 Zn 8.7

SIZE	%WT	PB	ZN	% TOTAL LEAD	% TOTAL ZINC
On 150	70.5	2.4	9.7	76.3	79.0
200	21.3	1.1	5.0	10.5	12.2
Th. 200	8.2	3.4	9.2	13.1	8.8
	100.0			100.0	100.0

(40)

No.9. WILFLEY TAILS Pb 3.0 Zn 3.9 TABLE 23.

SIZE	%WT	PB	ZN	TOTAL LEAD	TOTAL ZINC
On 150	63.3	1.4	3.8	2.93	62.5
200	14.3	1.0	2.4	4.7	8.9
Thru 200	22.4	8.9	4.9	66.0	28.6
	100.0			100.0	100.0

(41)

SLIMES CONCENTRATION SCREEN ANALYSES

Slime water from the main trommel line is carried in a launder to Callow tanks Nos.6,5,3,2,1, 21,20,19.

FEED TO CALLOW TANK

Pb 17.0

TABLE No.24 No.1. Zn 4.6

80 - 150 2

100 -150 2.5

SIZE.	% WT	PB	ZN	% TOTAL PB	% TOTAL ZN
On 150	7.1	2.7	3.5	1.1	5.4
On 200	10.2	6.5	5.2	3.9	11.6
Th.200	82.7	19.5	4.6	95.0	83.0
	100.0			100.0	100.0

FEED TO CALLOW TANK

Pb 19.1

Zn 5.0

TABLE No.25

No.2.

On 80 1.5
On 100 2.5
On 150 .5

On 150	7.0	3.1	3.7	1.1	5.1
200	8.3	7.8	5.5	3.4	9.0
Th.200	84.7	21.5	5.1	95.5	85.9
	100.0			100.0	100.0

TABLE 26

FEED CALLOW TANK 3. Pb. 16.8
Zn 4.8

SIZE	%wt	Pb	Zn	Pb%	Zn%
150	10.6	2.6	4.8	1.6	10.5
200	10.6	10.5	5.1	6.6	11.2
Th. 200	78.8	19.5	4.8	91.8	78.3
	100.0			100.0	100.0

TABLE 27

FEED CALLOW TANK 5. Pb. 17.6
Zn 5.0

On 150	10.9	4.1	4.1	2.5	9.0
200	7.6	10.6	5.8	4.6	8.9
Th.200	81.5	20.0	5.0	92.9	82.1
	100.0			100.0	100.0

FEED CALLOW TANK 6 — Pb 12.4

TABLE 28 — Zn 6.0

SIZE	WT	%wt	Pb	Zn	%pb	%zn
80-100	~~15x4~~	15.4 ~~6x6~~	6.6	6.7	8.2	17.1
100-150		6.9	10.1	6.5	5.6	7.4
150-200		25.0	10.8	6.8	21.8	28.2
Th. 200		52.7	15.1	5.4	64.4	47.3
		100.0			100.0	100.0

FEED CALLOW TANK 19. — TABLE 29

SIZE	% WT	assays Pb	assays Zn	% total Pb	% total Zn
On 200	13.0	1.5	2.8	1.5	6.4
Th. 200	87.0	15.0	6.1	98.5	93.6

Tanks 6,5,3,2,1, 21,20,19 slough off into tanks Nos. 13, 12, 10, 9, 8, 24, 23, and 22. These in turn slough to tail race. Tank No.10 sloughs to wooden tank No.18 and No.18 to tail race. Tables Nos. 12, 6 & 8 are fed from tanks Nos. 1, 2, 3, 5, & 6.

TABLE 30

No.1. WILFLEY TAILS Pb 2.1 Zn.1.8

SIZE	% WT	ASSAY %Pb	%Zn	TOTAL Pb	Total Zn
	50	1.4	1.1	33.3	29.7
On 200		2.8	2.6	66.7	70.3
Thro.200	50				
				100.0	100.0

TABLE 31

No.2 Wilfley Tails Pb. 2.2 Zn. 3.8

On 200	35.4	1.0	2.6	16.0	23.6
Th.200	64.6	2.9	4.6	84.0	76.4
	100.0				100.0

TABLE 32

WILFLEY TAILS No.7.

	%wt	ASSAY Pb	Zn	%total lead	% total zinc
On 150					
On 150	41.5	.8	1.5	11.7	25.5
200	17.1	.2	1.2	12.0	8.4
Th.200	41.4	5.2	3.9	76.3	66.1

Vanners Nos. 15, 17 amd ;8 from Tanks Nos. 10,12 and 13; vanners Nos 10, 19, 20, 21, 14 and 22 from tanks Nos. 21, 20, 19, 22, 23, and 24, Vanners Nos. 16, and 12 from tanks Nos. 11, 12 & 18.

The slime in the water from the head end of the Wilfley tables on direct feed contains about 10% lead and is pumped by centrifugal pumps A and C to settling tank No.25 which is 55' x 8' x 8' V. shape. This tank has 7 spigots. It feeds vanners Nos. 23, 25, 26, and 27.

TABLE 33 — 25 A. — Pb - 10.3, Zn - 3.2

SIZE	%WT	PB	ZN	TOTAL PB	TOTAL ZN
On 200	13.4	3.3	2.5	4.3	10.5
Th.200	86.6	11.4	3.3	95.7	89.5

TABLE 34 — 25 B. — Pb 10.6, Zn 3.4

On 200	12.3	.4	2.1	.5	7.6
Th.200	87.7	12.	3.6	99.5	92.4

TABLE 35 — 25 C. — Pb. 7.6, Zn 2.8

On 200	11.8	.3	1.2	.5	5.0
Th.200	88.2	8.6	3.	99.5	95.

25 D.

TABLE 36

~~On 200~~	%wt	Assay Pb	Zn
On 200	10.7	8.9	3.3
Th.200	89.3		

25E

TABLE 37

On 200	2.8	9.1	3.0
Th.200	97.2		

25 F.

TABLE 38

On 200	.4	10.5	3.0
Th.200	99.6		

25G.

Pb. 96
Zn 4.1

TABLE 39

				% Tot.Pb	% Tot.Zn	
On 200	1.8	4.6	1.7	.9	.8	
Th. 200	98.2	9.7	4.1	99.1	99.2	(37)

The tailings from all the Vanners on direct feed are pumped by centrifugal pump D to tanks Nos. 17,15,16, The overflow of these tahks goes into tailrace. These tanks feed vanners 11 & 12.

VANNERNo.12 June 21.

Feed.

On 80	1.5	~~FEED~~	Pb	6.2	TABLE 40 a
100	.5		Zn	2.7	
120	.25				
200	4.75				

		ASSAYS			
SIZE	%WT	PB	ZN	PB%	ZN%
On 200	14.	3.0	1.7	6.8	8.7
Th.200	86.	6.7	2.9	93.2	91.3
	100.0			100.0	100.0

TAILS Pb 4.9 Zn 2.5 Table 40 b

	%wt	Pb	Zn	%total Pb	%total Zn
On 200	10	1.9	1.1	3.9. ~~4x5~~	4.5
Th. 200	90	5.2	2.6	96.1	95.5
	100.0			100.0	100.0

HEADS Pb 29.3
Zn 4.5 40 c.

~~Pb 4.2~~ (xxxx)

~~Zn 2.5~~

On 80	1.0				
100	2.0				
120	3.5				

	%wt	Pb	Zn	Tptal Pb	Total Zn
On 200	17.7	2.4	1.0	1.5	3.98
Th.200	82.3	35.1	5.2	98.5	96.02

~~CONCENTRATE~~

~~Pb. 29.3~~ ~~(38)~~

~~Zn 4.5~~

The overflow from all the fine concentrates bins is carried to three settling tanks each 100' long.

OVERFLOW FINE CONCENTRATE BINS (41) ~~(39)~~

Table 41

SIZE	%WT	PB	ZN	% TOTAL PN	% TOTAL ZN
On 200	20.0	.5	1.8	.6	10.8
Th.200	80.0	2 .9	3.9	99.4	89.2

THE WAKEFIELD MILL, SILVERTON, B.C.

This mill is operated under a limited lease by the Van Roi Mining Company to treat the ore from the Van Roi Mine. The mill is well built and could easily be converted into a first class concentrating plant for the treatment of lead-zinc ores. It is operated by water power and has a capacity of 7 tons per hour.

The machinery consists of one 9" x 15" rock breaker, (Blake type) 3 sets of rolls, one Huntingdon Mill, one trommel line with 16 m.m. 12 m.m. 6 m.m. and 4 m.m. screens, four 2 compartment jigs and two four compartment jigs, also 7 Wilfley tables. The jigs, operating on 16 m.m. 12 m.m and 6 m.m. material, produce a lead concentrate only, the middlings being re-crushed. Jigs operating on 4 m.m. material produce a lead and zinc concentrate, the middlings going to a Huntingdon mill.

All smaller sizes are classified and go to the Wilfley tables to produce both lead and zinc concentrates. The first Wilfley also makes middlings which are recrushed.

Before discussing the details of the concentration practise, it may be interesting to state that this mill is an example of the better class of mills in the Slocan District. All of these mills were designed and built by experienced men, that is, experienced mill wrights and carpenters.

Is it any wonder that we do not have good concentration practice in mills designed and built by men who place first importance on the framework and foundations of the building and the placing of the machinery; and think that the first and only factor in the ~~transfe~~ construction of a classifier is that it should be water tight.

These factors are, of course, essential. A properly designed mill will fail to do good work if not well constructed, just the same as a well designed bridge or machine will fail if the artizans' work is poorly done.

The Wakefield mill is operated by the Van Roi Mining Company temporarily, pending the completion of their own mill, which will, no doubt, make a much better saving with less than half the milling cost.

When this mill was leased by the Van Roi Mining Company, it had a capacity of three tons per hour, and was not known to have run steadily for a longer period than three successive hours.

By the application of technical knowledge and practical experience, the capacity was increased to over seven tons per hour, the extraction raised about twenty per cent and shut-downs reduced to one shift per month (for repairs), all this being accomplished without any additional installation of machinery.

No changes involving any considerable outlay have been thought advisable because of the terms of the lease; therefore the classifiers have been left as they were. This would seem to be rather a false economy.

The critical study of a concentration plant necessitates careful sampling of the products of the different departments. These samples should be accurately assayed, sized on a series of screens with known apertures, , each screen product assayed, and the results tabulated or plotted in the form of a curve.

Such a study was made of the Table Department in the Wakefield Mill.

The screen analyses and assays of the feed, tails and slime from Wilfley Table No.1. are shown in Tables Nos 42.43,44 respectively.

TABLE No. 42 Feed to Wilfley Table No.1. .... Wakefield Mill.

ASSAYS

SIZE	% WT	% Pb	% Zn	% Total Lead	% Total zinc
12-20	.4	1.6	3.0	.6	.4
30	1.2				
40	4.7	1.1	2.9	1.1	1.0
60	15.1	1.1	6.3	3.9	6.8
80	19.3	.7	15.2	3.2	20.9
100	14.1	.6	20.9	2.0	20.9
120	6.3	2.8	20.8	4.1	9.3
150	.8	4.8	19.5	0.9	1.1
200	13.3	6.5	17.6	20.7	16.7
Thro 200	24.8	10.6	13.0	63.5	22.9
	100.0			100.0	100.0

Wakefield Feed Pb - 4.2
Zn -14.1

TABLE No. 43 TAILS FROM WILFLEY

TABLE No.1. WAKEFIELD MILL

ASSAYS

SIZE	% WT	% Pb	% Zn	% Total Lead	% Total Zn
20.30	.4	.3	1.6	.2	.3
40	2.6	.5	2.3	2.5	2.3
50	6.7	.5	2.0	6.6	5.0
60	9.7	.5	2.4	11.4	8.7
80	26.8	.3	2.4	15.7	24.3
100	22.8	.3	3.3	13.4	28.4
120	8.8	.8	3.3	13.7	11.0
150	1.3	.8	2.1	2.4	1.0
200	14.1	.8	2.5	22.1	13.3
Thro 200	6.8	.9	2.2	12.0	5.7
	100			100.0	100.0

Wakefield Tails Pb - .5
Zn - 2.6

Table No. 44 Slime carried off by water at head end of Wilfley Table No.1. Wakefield Mill.

SIZE	%WT	ASSAY % Pb	% Zn
On 200	1.25%	3.9	7.9
Thro. 200	98.75		

A glance at Table No. 42 will show that the feed of Table No.1. has been subjected to no classifying action altho it is one of the products of the so called classifiers. This feed cannot be mistaken for anything but a natural product such as would be produced by direct crushing and screening. Indeed it does not even compare favorably with the Deslimed sands in Table No. 54

yet this product is fed to the Wilfley Tables.

Now, much experimenting has been done in all parts of the world with a view to determining the best feed for a Wilfley Table, the result of which proves conclusively that a Wilfley Table does far better work with sized feed than with natural feed.

The term "sized feed" includes both screen sized products and classifier sized products. Some question still exists as to which of these give the better results.

The series of Wilfley Table runs on Blue Bell ore (See Tables 56-80 inclusive) would point to screen sized feeds giving better results.

Aside from any experimental proofs that natural feed for a Wilfley Table is completely outclassed by sized feed, it seems only logical when the different factors are taken into account:

1st. Coarse feed requires a large quantity of wash water but this will carry off a lot of the values in slimes.

2nd. Coarse feed requires long strokes; fine feed requires short quick strokes; both these adjustments cannot be had at one and the same time.

3rd. The slope, if adjusted for coarse feed will not suit fine feed and vice versa.

From (2) and (3) it will be seen that the adjustments for coarse feed will not suit fine feed and vice versa. In treating a natural feed, where fine and coarse are mixed together, the intermediate adjustments that would in all probability be adopted, would result in a poor saving on the total feed as a whole.

Not having the various weights of the different products on Wilfley Table No.1. it would not be safe to hazard any statements as to extractions.

It might be pointed out that although the assay of feed through 200 mash table No.---42 is 10.6% lead and 13% zinc and the assay of tails through 200 mesh Table No.--43 is 0.9% lead and 2.2% zinc, no such large saving is made on this size as would be represented by these figures. A great proportion of this size is probably carried off in the slimes at the head end of the table which contain 3.9% lead and 7.9% zinc.

The following are the general results obtained at this mill during April, May and June, 1909.

TABLE No. 46

WAKEFIELD MILL. REPORT FOR MONTH OF APRIL.

PRODUCT	WT. TONS	%Pb	%Zn	Oz Ag
Feed	1337	40	10.0	18.6
Lead Concentrates	77	67.2	8.2	132.4
Zinc Concentrates	110	4.0	41.9	56.5

Mill ran only 180 hours owing to interruption to flume caused by mud slide.

TABLE No. 47

(WAKEFIELD MILL)

Report for month of May

PRODUCT	WT TONS	Pb%	%Zn	Ag Oz
Feed	2415	-	-	-
Lead Conc.	210	61.7	11.3	133.2
Zinc "	129	4.0	43.7	60.0

Total approximate value of lead and zinc concentrates $19,990.

Mill run 327 hours.

TABLE No. 48

WAKEFIELD MILL - REPORT FOR MONTH OF JUNE.

Products	Wt Tons	Pb%	Zn%	Ag.Oz.	% Tot. Lead in feed	% Tot. Zinc in feed	% Tot. Silver in feed
Feed	1553	4.8	8.9	17.7	100.0	100.0	100.0
Lead Concs.	120	58.7	14.5	134.4	94.5	12.6	58.6
Zinc "	91	3.1	44.3	54.4	.4	29.2	18.0

Approximate value of lead and zinc concentrates $11,750. Total duration of run 231 hours.

Owing to high water carrying out the Wakefield intake Dam and a portion of the flume they were unable to start milling until June 11th.

Referring to Table No. 48, the recovery of 94.5% of all lead, in lead concentrates is in reality high, because the lead assays are done by the fire method.

NOTE: A discussion of this method will be taken up under the heading: " Methods of Assaying" (see Appendix.)

In the concentration of ores a mill may have both good technical practice and good commercial practice, but these two are very often incompatible.

Needless to say, the policy of any mill is to make the practice as commercially good as possible whether the technical practice is good or bad.

Take, for instance, the report for June, Table #48. The lead concentrates contained 14.5% zinc when by suitable adjustment this could easily be cut down to 6% zinc. The lead smelters pay for 95% of the silver content and penalize zinc 50¢ for every unit % over 8%. The zinc smelters pay for only half the silver in the zinc concentrates.

A discussion of the profits that accrued from the sale of this grade of concentrates would involve tariffs, freight rates, and comparisons of the German smelter vs. American smelter valuations of zinc ores, all of which are matters purely of the moment.

BLUE BELL MILL, AINSWORTH, B.C.

The ore consists of massive pyrrhotite, galena, Sphalenite and pyrite mixed with a limestone gangue.

No detailed study was made of products at this mill but a representative sample of the mine product was shipped to Montreal and a test made on it at the ore-dressing laboratories at the College.

The following is an account of the various steps taken in the study.

A lot of 1422 lbs. of ore (mine size) was first broken by a gyratory crusher set at 1½". Then screened on a 30 m.m. screen and the over-size re-crushed so that all the ore passed 30 m.m. This product was coned and quartered, one quarter (343 lbs) being reserved for the sample, and the other three quarters screened on a series of screens with decreasing aperture sizes. Tables 49 & 49a give the results of this screening:

TABLE 49.

Wt of sample screened 1079.0

No	sizes	Wts	%	
1	30mm-23 m.m.	198.65	18.6	
2	23 mm - 15.89 mm	234.75	22.0	
3	15.89 mm/ -98.89 mm	202.9	18.9	
4	9.889 -65.9	100.0	9.3	
5	6.59 -3.15	95.4	9.0	
6	thro 3.15	237.7	22.2	
		1067.37		1067.37
			loss	11.63

Table 49 a Pb -9.3

Screen analysis of original ore 2n - 11.1

Size m.m.	wt.	%wt	Assays Pb	2n	%	%
30-23		18.6	7.17	9.8	14.5	16.7
23-15.89		22.0	7.58	10.4	18.2	20.9
15.89-9.9		18.9	7.37	10.0	15.2	17.3
9.9-6.59		9.3	8.81	10.8	8.9	9.1
6.59-3.15		9.0	9.42	11.2	9.2	9.2
3.15-0		22.2	14.13	13.2	34.0	26.8
		100.0			100.0	100.0
3.15-.2		176.0	13.93	13.3		
.24-0		119.25				

The thro 3.15 m.m. product was sampled and a complete screen analysis made with standard screens.

TABLE 50. Pb 14.13

Product thro. 3.15 m.m. Zn-13.2

Size	%wt	Assays Pb	Zn	%	%
on 8	18.9	13.4	11.6	16.6	17.0
On 12	16.5	12.1	14.0	13.1	17.9
16	8.3	13.7	13.2	7.5	8.5
20	7.1	14.6	14.0	6.8	7.7
30	10.2	16.6	12.4	11.1	9.8
40	7.2	16.8	12.8	7.9	7.1
60	8.4	16.8	14.0	9.2	9.1
80	5.8	16.8	14.2	6.4	6.3
100	3.6	20.7	14.0	4.9	3.9
150	2.1	15.8	13.0	2.2	2.1
200	3.5	16.3	14.0	3.7	3.8
thro 200	8.4	19.1	10.4	10.6	6.8
	100.0	B.B. thro. 3 m.m.			100.0

The thro 3.15 m.m. product was screened on a .24 m.m. screen = 16 mesh

EABLE 51

Resizing of thro. 3 m.m. size

7.	3.15 - 16 mesh	116.0
8.	thro.16 mesh	119.25
		235.25

A jig test was made on the thro. 3.15 m.m. on 2.4 m.m. product to determine whether crushing to this size detached the Galena and Sphalerite from one another and from the gangue sufficiently well to justify the use of jigs. The jig used had a plate glass front which enabled the operator to determine by inspection that it was not practicable to attempt concentration on this ore without finer crushing. Therefore, it was all crushed in rolls to pass thro. a .24 m.m. (or 16 mesh) screen.

A screen analyses of which is as follows:-

TABLE 53. Pb.- 9.2
Zn.10-2

Product thro 16 mesh Zn.- 10.2

Size	%wt	Assays Pb	Zn	%	%
40	36.0	7.5	10.0	29.3	35.2
60	16.0	8.2	10.2	14.2	15.9
80	10.8	8.4	11.2	9.8	11.8
100	6.5	10.2	11.4	7.2	7,3
120	2.3	12.3	11.4	3.1	2.6
thro 120	28.4	11.8	9.8	36.4	27.2
	100.0				100.0

Tro. 16 mesh.

The thro. 16 mesh product was thoroughly wetted and pumped with 140 lbs. of water per minute to a two foot cone, the spigot product of which is called Deslimed sands, the overflow contained the slimes.

The ore feed weighed 835.76 lbs. The spigot product or deslimed sands weighed 640.76 lbs. and the slimes 195 lbs.

TABLE 54.

Screen analysis of Deslimed Sands Pb 10.6
Zn-10.4

Assays

Size	Wt	%wt	Pb	Zn	10%	10%
40		45.5	7.9	9.5	33.7	41.5
60		20.9	9.3	11.2	18.2	22.5
80		11.9	9.8	9.8	11.0	11.3
100		6.0	15.4	11.8	8.7	6.8
120		2.5	19.0	12.5	4.5	3.2
thro 120		13.2	19.3	11.6	23.9	14.7
						100.0

~~Deslimed~~ Sands.

TABLE 55

Screen analysis of overflow slimes

Size	%wt
On 30	.2
60	1.4
80	5.0
100	3.0
150	13.3
200	14.7
Thro 200	62.4

assay

P.b.	Zn
7.0%	8.8

The deslimed sands were divided into two portions, one of which was classified, giving a spigot product and an overflow product, and the other screened on a 60 mesh screen producting two sizes on 60 and thru. 60.

Screen analyses of these products are given in tables Nos. 56, 62, 68 and 74.

Wilfley table tests were made on each of these four products.

TEST No.1. Wilfley Table run on Spigot product.

ADJUSTMENTS:

R.P.M. - 275 Slope 5°20'

Length of stroke 7/8" Middlings cut off 15 3/8"

Feed water	31.00	lbs.	per	min.
Wash "	72.48	"	"	"
Total	103.48	"	"	"

Weight of ore fed -		173.19#
Weights recovered		
Heads	30.07	
Middles	79.63	
Tails	60.20	
Slime	1.13	170.83
Loss.......		2.36#

Duration of run - 14 min.

The screen analyses and assays of the various products are as follows:-

TABLE No.56. SPIGOT FEED Pb 14.0 Zn 10.7

Size	$ wt	Assay Pb	Assay Zn	% Total Load	% Total Zinc
On 20	2.0	8.7	9.0	1.2	1.7
30	30.7	9.9	8.4	21.7	24.1
40	26.2	12.2	13.4	22.8	32.8
60	22.1	12.6	11.0	19.9	22.8
80	9.4	21.8	11.2	14.7	9.9
100	3.7	27.5	10.2	7.3	3.5
120	1.2	27.8	9.2	2.4	1.0
Thro 120	4.7	2.98	9.4	10.0	4.2
	100.0			100.0	100.0

TABLE No.57

SPIGOT HEADS

Pb 59.4
Zn 5.8

Size	Wt%	Pb	Zn	% total lead	% total zinc
40	27.1	69.1	7.5	31.5	21.0
60	26.6	50.3	6.0	22.6	27.4
80	20.7	51.0	8.0	17.9	28.6
100	9.6	58.4	6.2	9.4	10.2
120	5.2	68.0	4.6	5.9	4.1
Thro 120	10.8	69.4	4.7	12.8	8.7
				100.0	100.0

TABLE No.58

Spigot Middles Pb 4/5

Zn 14.7

Size	% wt	Assays Pb	Zn	% total lead	% total zinc
40	64.5	4.5	14.0	64/5	61.6
60	20.7	3.2	16.4	14.7	23.2
80	8.8	6.1	13.8	11.9	8.3
100	2.7	5.4	16.0	3.8	2.9
120	.6	6.1	16.6	.8	.7
Thru.120	2.7	7.3	17.8	4.3	3.3
	100.0			100.0	100.0

TABLE No.59

Spigot Tails Pb 3.1 or 3.15

Zn. 8.7

SIZE	%wt	Assays Pb	Assays Zn	% total Pb	% total Zn
40	81.2	2.9	8.5	73.7	79.2
60	11.9	2.9	9.6	10.8	13.0
80	3.7	3.3	9.0	3.8	3.8
100	1.0	3.7	8.6	1.2	.9
120 Thro 120	2.2	15.3	12.4	10.5	3.1
				100.0	100.0

Slime 10. lead 12.0 zinc

The following Tables Nos. 60 and 61 derived from the above Tables Nos. 56, 57, 58, and 59 show the distribution of values and saving on each size in the various products.

TABLE No.60

Pb. SPIGOT

Size	Pounds Pb on basis of 2000# feed				% Pb saved		
	Feed	H	M	T	H	M	T
On 20	3.5						
30	60.8						
40	63.9	66.2	27.3	16.7	60.	24.8	15.2
60	55.7	47.4	6.2	2.4	84.6	11.1	4.3
80	39.2	37.4	5.5	.9	85.2	12.5	2.3
100	20.6	19.9	1.6	.3	91.3	7.3	1.4
120	6.7	12.5	.3	2.4	82.2	2.0	15.8
Thro 120	28.0	26.6	1.9		93.3	6.7	

TABLE No.61.

Zn SPIGOT

Size	Pounds Zn in 2000 lbs feed				% Zn saved in		
~~On 20~~	Feed	H	M	T	H	M	T
On 20	3.6	)					
30	51.6	)					
40	70.2	) 4.3	84.8	48.8	3.1	61.6	53.3

Table 61, Continued.

Size	Pounds Zn in 2000# feed					% zn. saved in	
60	48.6	5.7	31.9	8.1	12.5	69.7	17.8
80	20.2	5.9	11.4	2.4	30.2	57.7	12.1
100	7.5	2.1	4.6	.6	28.8	63.0	8,2
120	2.2	.8	.9	1.9	22.2	25.0	52.8
T.120	.8.8	1.8	4.5		28.5	71.5	

TEST No.2. Wilfley Table

Run on the Classifier Overflow

Adjustments

R P M 268 Slope = 2850'

Length of stroke 7/8" Midlings cut-off 13½"

Feed water	34.0#	per min
Wash Water	62,76#	" "
	98.76#	" "

Weight of ore fed 155.06#

Weights recovered:

Heads	7.88#
Middles	40.00#
Tails	102.50#
Slimes	1.2#
Total	151.58#

Loss .... 3.48#

TEST No.2. WILFLEY TABLE

(Continued)

Duration of run 17 min.

The screen analyses and assays of the various products are as follows:

Table No.62. Overflow Feed P.B. 6.8
Zn 8.9

Size	Total st.	Assays Pb	Zn	% of total lead	% of total zinc
20	.4	2.8	3.8	3.5	3.6
30	8.1				
40	13.8	.7	3.8	1.4	5.9
60	20.5	.8	9.8	2.4	22.6
80	19.1	.8	9.5	2.3	20.4
100	10.4	5.3	9.5	8.1	11.1
120	5.3	9.8	10.6	7.6	6.3
thro 120	22.4	22.7	11.9	75.0	30.1
	100.0			100.0	100.0

TABLE No.63

OVERFLOW HEADS Pb 60.9
Zn 5.1

Size	%wt	ASSAYS Pb	Zn	%total lead	%total zinc
60	2.8	27.3	6.4	1.2	3.5
80	6.1	53.7	4.4	5.3	5.2
100	10.2	65.9	3.8	10.7	7.5
120	9.9	62.4	3.4	9.9	6.5
thro 120	71.0	63.5	5.6	72.9	77.3
	100.0			100.0	100.0

TABLE No.64

OVERFLOW MIDDLES Pb 1.8
Zn 17.4

Size	%wt	Assay Pb	Assay Zn	% total Pb	% total Zn
40	6.2	.8	23.2	2.7	8.2
60	14.4	2.9	15.8	23.2	1.3
80	20.0	.6	19.4	6.7	22.3
100	16.2	.9	20.5	8.1	19.0
120	8.3	1.1	20.8	5.0	9.9
Thro 120	34.9	2.8	19.6	54.3	39.3
	100.0			100.0	100.0

TABLE No.65

OVERFLOW TAILS Pb .9
Zn 5.5

Size	%wt	Pb	Zn	% total lead	% total zinc
40	42.3	1.1	3.8	53.4	29.4
60	25.8	.6	5.8	17.8	27.4
80	16.7	.8	7.0	15.4	21.4
100	6.3	.8	7.4	5.7	8.6
120	2.0	.6	7.2	1.4	2.6
Thro 120	6.9	.8	8.4	6.3	10.6
	100.0			100.0	100.0

Slime 10.1% Pb 12% Zn

The following tables Nos/ 66 & 67 derived from the above numbers 61, 62, 63, and 64 show the distribution and saving in each size of the various products.

TABLE 66

OVERFLOW RUN ON BASIS OF 2000# FEED

	Pounds lead in 2000 # Feed				% lead saved in		
SIZE	HEADS	MIDDLES	TAILS	FEED	HEADS	MIDDLES	TAILS
60	7.75	2.13	9.3	9.75	40.4	11.1	48.5
80	3.33	.62	1.76	3.05	58.4	10.8	30.8
100	7.85	.755	.664	11.00	84.9	88.1	7.0
120	6.36	.472	.58	10.40	91.1	6.6	2.3
Thru. 120	45.7	5.05	.726	101.97	88.9	9.8	1.3
Total	70.99	9.127 82.725	12.608	136.17			

TABLE 67

OVERFLOW RUN ON BASIS OF 2000# Feed

	Pounds zinc in 2000# feed				% zinc saved		
SIZE	Feed	Heads	Middles	Tails	Hds.	Midd's	Tails
60	57.23	1.81	19.19	40.9	2.8	31	66.1
80	36.3	.27	6.9	15.4	1.3	30.5	68.2
100	19.7	.39	17.3	6.1	1.7	72.7	25.6

Table 67 (Continued)

Size	Feed	Hds	Mdls	Tails	Hds	Mdls	Tails
120	11.2	.34	8.9	1.9	2.7	80.2	17.1
Thru. 120	53.4	4.04	35.2	7.6	8.6	75.3	16.1
	177.83	6.85	87.49	71.9			
			166.24				

TEST NO.3. WILFLEY TABLE

Run on an 60 Mesh Product

Adjustments

RP M 270 Slope 5° 35'

Length of stroke 7/8" Middlings cut off 12 5/8"

Feed water 6.4# per min.

Wash Water 60.14# "

Total 66.54# "

Weight of ore fed 178.69#

Weights recovered

Heads	19.0#
Middles	61.94#
Tails	94.50#
Slime	2.1
	177.54

177.54

Loss 1.15

Duration of run 16 min.

The sreen analyses and assays of the various products are as follows:-

TABLE No.68 - on 60 Feed Pb 5.8 Zn 9.0

SIZE	%Wt	Pb	Zn	% total Pb	% total Zn
40	80.5	5.8	8.9	80.5	79.1
60	18.7	5.9	9.7	18.9	20.0
Thru. 60	.8	4.9	10.6	.6	.9
	100.0			100.0	100.0

TABLE No.69

ON 60 HEADS Pb 50.1 Zn 7.5

SIZE	Wt	ASSAYS Pb	Zn	% total lead	% total zinc
40	50.8	62.6	3.8	63.5	77.5
60	36.7	36.3	11.4	26.6	16.8
80	6.9	38.6	12.8	5.3	3.3
100	2.0	28.0	11.0	1.1	.9
120	.6				
Thru. 120	3.0	4.92	10.4	3.5	1.5
	100.0			100.0	100.0

TABLE No.70

On 60 MIDDLES Pb. 1.1
Zn 16.6

Size	% wt	Assay Pb	Assay Zn	Total lead	Total zinc
40	66.9	1.1	16.7	67.4	67.4
60	25.2	0.6	16.1	13.9	24.3
80	4.9	1.2	16.5	5.5	4.9
100	1.4				
120	-	4.8	18.6	13.2	3.4
Thru. 120	1.6				
	100.0			100.0	100.0

TABLE No. 71

ON 60 TAILS Pb .8
Zn 5.2

SIZE	%wt	Pb	Zn	%total lead	% total zinc
40	82.2	.8	5.6	84.5	88.3
60	15.4	.6	3.0	11.8	8.9
80	1.2	.8	4.0	1.1	.9
Thru. 80	1.2	1.7	8.2	2.6	1.9
				100.0	100.0

The following Tables Nos/ 72 & 73 derived from Tables Nos. 68. 69, 70, and 71, show the distribution of values and saving on each size in the various products.

TABLE No. 72

ON 60 FEED

Pb.

	Pounds Pb in 2000 Feed				% Pb saved in		
SIZE	FEED	H.	M.	T	H	M	T
On 40	93.3	69.	5.2	7.1	84.8	6.4	8.8
On 60	22.2	28.8	1.1	1.0	93.2	3.6	3.2
Thru 60	.8	10.3	1.4	.3	85.8	11.7	2.5
Total	116.3	108.1	7.7	8.4	87.2	7.1	
From		124.2					
Gen.Assay	116.	108.4	7.8	8.6			

TABLE No.73.

Zn

	On 60 Feed Pounds Zn in 2000				% Zn on		
Size	Feed	H	M	T	H	M	T
On 40	143.2	4.2	79.0	49.5	3.2	59.5	37.3
On 60	36.3	9.1	28.7	5.0	21.2	67.0	11.8
Thru 60	1.7	2.9	9.4	1.6	20.8	67 6	11.6
Total	181.2	16.2	118.1	56.1	8.5	62.2	29.3
from			190.4				
Gen. Assay	180.	16.2	117.5	55.9			

TEST No.4. EILFLEY TABLE

Run on Thro. 60 Mesh Product

Adjustments.

R.P.M. 290 Slope 3° 00

Length of stroke 5/8" Middlings cut off 16 7/8"

Feed Water	10.05# per min.
Wash "	53.7 "
Total "	63.75 "

Weight of ore fed 133.32#

Weights recovered

Heads	15.38	
Middles	38.38	
Tails	74.00	
Slime	2.4	
	130.16	130.16
Loss		3.16

Duration of run 22 min. 30 sec.

The screen analyses and assays of the various products are as follows:-

TABLE No.74

Thro. 60-Feed   Pb.12.6
Zn 11.6

SIZE	%wr	Pb	Zn	%total lead	% total zinc
60	22.9	8.4	10.0	15.3	19.7
80	27.8	8.4	12.1	18.5	28.8
100	16.4	13.7	11.7	17.9	16.6
120	5.9	11.8	13.4	5.5	6.8
Thru. 120.	2.70	19.9	12.1	42.8	28.1
	100Q0			100.0	100.0

Table No.75   Thru. 60 Heads   Pb 74.8
Zn-2.5

Size	%wt	Pb	Zn	%total lead	%total zinc
60	13.2	79.4	2.2	14.0	11.8
80	20.9	80.0	4.9	22.4	42.5
100	14.4	78.4	1.4	15.0	8.2
120	5.5	76.2	1.6	5.6	3.7
Thru. 120	46.0	69.6	1.8	43.0	33.8
	100.0			& 100.0	100.0

TABLE No.76

Thru. 60 Middles Pb 8.9
Zn -15.9

SIZE	%wt	Pb	Zn	% total lead	%total zinc
60	12.7	13.7	9.8	19.6	7.8
80	20.6	11.5	13.6	26.7	17.6
100	20.0	9.0	17.4	20.2	21.9
120	7.6	7.0	19.8	6.0	9.4
Thru. 120	39.1	6.2	17.6	27.5	43.3
	100.0			100.0	100.0

TABLE No.77

Thru. 60 Tails Pb 1.4
Zn 11.7

Size	%wt	Pb	Zn	% total lead	% total zinc
On 60	36.2	1.6	12.2	41.7	37.7
80	30.3	1.2	13.4	26.5	34.7
100	13.7	1.2	10.2	11.8	11.9
120	3.9	.6	11.4	1.7	3.8
Thru. 120	15.9	1.2	8.8	18.3	11.9
	100.0			100.0	100.0

The following tables Nos. 78 & 79 derived from tables Nos. 74, 75. 76, and 77 show the distribution of values and saving on each size in the various products:-

Table No.78

Through 60 Worked out on basis of 2000# of feed

Size	Pounds lead in 2000#				% Pb saved		
	Feed	H	M	T	H	M	T
60	38.5	25.5	10.5	6.7	60	24.6	15.4
80	46.7	40.3	14.2	4.2	68.6	24.2	7.2
100	44.9	26.4	10.8	1.9	67.5	27.6	4.9
120	13.9	10.1	3.5	.27	73.0	25.2	1.8
T.120	107.3	77.3	14.5	2.2	82.3	15.4	2.3
	251.3	179.6	53.5	15.27	72.3	21.5	6.2

247.37

Table No. 79

Through 60 Worked out on basis of 2000# Feed

SIZE	Pounds Zinc in 2000"				% Zn. saved		
	Feed	H	M	T	H	M	T
No.60	45.8	0.7	7.5	51.1	1.2	12.6	86.2
80	67.4	2.47	16.8	47.2	3.7	25.4	70.9
100	38.4	.48	20.8	16.2	1.3	55.5	43.2
120	15.8	.21	9.2	5.1	1.4	63.3	35.3
T 120	65.4	2.00	41.3	16.2	3.3	69.5	27.2
	232.8	5.86	95.6	135.8	2.4	40.4	57.2

237.26

TABLE No.80

Percentage saving of lead in the Heaes

Test	No.1.	75.3
"	No.2.	46.4
"	No.3.	92.5
"	No.4.	70.4

From Table No. 80 by taking a weighted average for tests 1 & 2, the extraction of lead is 65% for the classified products combined. Similarly from tests 3 & 4 the combined extraction from screened products is 80.5%. This would seem to indicate that in the case of the Blue Bell ore, screen sizing would be preferable to classifying to prepare material for the Wilfley Tables.

LABORATORY TESTS ON MOYIE ORE

This lot of ore was different from the usual run of feed to the St Eugene Mill, in that the lead and zinc sulphides were rather finely disseminated in the ~~gangues~~ gangue stones. It is probably a sample from one of the dumps and represents the reject from hand picking and cobbing in the earlier life of the mine.

The ore was crushed in the five stamp mill, through a 16 mesh screen, followed by a rough classification, dividing it into two products, sands, and slimes.

Wilfley Table tests were run on the sands and Vanner and Wilfley tests on the slimes.

Of the four Wilfley tests on the sands no great variation was found in the results. Therefore, one only of the tests will be detailed in this paper.

These details are as follows:-

WILFLEY TABLE TEST No.5.

CLASSIFIER SANDS, MOYIE ORE.

Net weight dry ore		354 lbs.
Feed rate samples 2 min.	27.41	
" sample	3.00	30.4 "
Net weight of ore treated on Table		323.6 "
Time official test. Begun 3.06 p.m.		
" " Ended 3.30 "		
Duration of test		24 min.
Rate of dry ore fed to table per min.	$\frac{323.6}{24}$	13.5 lbs.
" from Feed rate samples		13.7 "
% Dry Sand in Feeder discharge		68.3 "
" water do		31.7

Pounds water per min, in Feed	6.3
" added to "	23.0
Total feed water pounds per min.	29.3
Wash water do	15.8
R P M	288
Length of stroke in inches	7.8" = .87
Slope of Table	3°50'
Position of middles cut off	9.5 inches

SCREEN TEST AND ANALYSES

TABLE No.81

Feed 323.6 lbs　　Pb. 5.7%　　Zn 3.3%

SIZE	WT%	% Pb	% Zn
On 20	10.8	0.50	3.4
30	15.8	1.15	2.2
40	6.2	1.80	2.7
60	11.9	2.70	3.3
80	14.0	3.70	3.5
100	5.0	4.10	3.0
150	14.9	8.10	3.2
200	15.4	10.60	3.6
Th. 200	6.0	23.60	3.7

TABLE No.82

Concentrates 18.5 lbs　　Pb 67.6%　　Zn 5.6%

SIZE	WT %	%Pb	%Zn
On 20	0.9	40.4	8.6
30	2.3	43.4	8.4
40	1.8	53.8	7.8
60	4.6	61.2	6.8
80	11.4	63.0	5.9
100	3.6	67.2	5.4
150	22.7	67.0	5.1
200	34.0	60.8	4.8
Th. 200	18.7	75.4	4.4

TABLE No.83

Middlings 28.2 lbs. Pb 3.6% Zn 6.7%

SIZE	Wt%	%Pb	%Zn
On 20	8.4	1.3	5.5
30	12.8	1.9	5.9
40	6.2	2.1	6.4
60	11.1	2.9	8.0
80	13.2	3.8	8.4
100	4.3	3.5	6.8
150	15.1	3.1	6.8
200	16.4	2.0	5.4
Th 200	12.5	8.9	4.9

TABLE No.84

Tailings 262 lbs Pb% Zn 2.6%

SIZE	WT %	% Pb	%Zn
On 20	12.1	0.3	2.1
30	15.4	0.5	2.1
40	7.5	0.7	2.4
60	11.0	0.7	3.0
80	15.0	0.9	3.1
100	4.0	1.0	2.8
150	16.8	1.2	2.4
200	14.1	1.5	3.2
Th. 200	4.1	4.1	3.6

Slimes recovered 10.2 lbs. Pb. 14.1% Zn 3.6%

The following Nos. 85, & 86 derived from Tables 81, 82, 83, & 84 show the distribution and saving in each size of the various products.

TABLE 85 LEAD on basis of 2000# of Feed.

LBS.

SIZE	FEED	HEADS	MIDDLES	TAILS	% IN HEADS	% IN MIDDLES	% IN TAILS
20	0.17	0.07	0.03	0.10	35	15	50
30	0.58	0.13	0.07	0.20	32	18	50
40	0.35	0.16	0.04	0.14	47	12	41
60	0.53	0.55	0.09	0.20	65	11	24
80	1.65	1.32	0.14	0.35	73	7.7	19.3
100	0.66	0.47	0.03	0.10	78	5.0	17.0
150	3.83	2.81	0.13	0.53	81	3.7	15.3
200	5.19	3.83	0.09	0.55	86	1.7	12.3
Th. 200	4.53	2.64	0.31	0.44	78	9.1	12.9
Total	17.49	11.98	0.93	2.61			

ZINC on basis of 2000# Feed

TABLE 86.

SIZE	Feed	Heads	Middles	Tails	%in Hds.	%in Mdls	%in Tails
20	1.17	0.02	0.13	0.66	2.5	16	81.5
30	1.11	0.02	0.21	0.85	1.8	19.5	78.7
40	0.53	0.02	0.11	0.47	3.7	18.3	78.0
60	0.65	0.07	0.25	0.86	6.0	21.2	72.8
80	1.56	0.12	0.31	1.22	78.2	18.8	74.0
100	0.48	0.04	0.08	0.29	9.8	19.5	70.7
150	1.51	0.21	0.29	1.05	13.5	18.7	67.8
200	1.76	0.30	0.25	1.18	17.3	14.5	68.2
Th. 200	1.71	0.15	0.17	0.38	22.0	21.0	54.0
Total	9.48	0.95	1.80	6.96			

% of total Lead which is saved in Heads - 68.0%

SLIME CONCENTRATION is perhaps the most difficult problem on ore dressing and the farthest from a satisfactory solution.

The Vanner tests on the Moyie Slimes mentioned above all give low percentage extractions, due in a large degree, no doubt, to the low grade of the feed which contained only 4.6% lead. Only one of these runs will be detailed here.

PLATE No.

VANNER TEST No.1.

ON BASIS OF 2000# FEED.

ASSAYS VANNER RUN ON 1 TON BASIS

Feed Pb 4.6
Zn 2.06

SIZE	WT	%PB	ZN FEED	LBS LEAD	LBS ZINC
150	9.0	1.1	2.8	.99	1.62
200	202.0	3.6	4.4	7.27	8.88
Th. 200	1708.0	4.9	1.8	83.69	30.74
	2000.0			91.95	41.24

~~%TotalxPb~~

	% total Pb	% recovery lead	% total Zn	
150	1.1		6.0	
200	7.9		21.0	
	91.0	100.0	73.0	100.0

HEADS 35.6 lbs. Pb.69.8
Zn. 2.0

~~150~~

SIZE	WT	%PB	ZN	LBS LEAD	LBS ZN	% Total Pb	% rec. Lead	% tot. Zn	% rec Zn
150	.5	23.2	18.	.12	.09	.12	10.9	.2	
200	.5	52.6	16.4	.26	.08	.29	36.8	.2	
Th. 200	34.6	70.8	[illegible]	24.497	.71	26.91	29.6	1.8	
	35.6			24.87	.88	27.32			

TAILS 64.4 lbs. Pb 3.3
Zn 2.08

150	75.0	.5	1.1	.38	.82	.42		2.0 ✓	
200	180.0	2.4	1.2	4.32	2.16	4.75		5.3	
Th. 200	1709.4	3.6	2.2	61.52	37.59	67.71		90.5	
	1964.4			66.22	40.57	72.88			

Appendices

METHODS OF ASSAYING.

SILVER ASSAY. The pot fusion (or crucible assay) was used for silver. 2 assay tons of ore mixed with 3 assay tons of the flux specified below was fused at a moderate heat (in a muffle furnace) and poured very hot, the operation occupying in all about 35 minutes.

Flux	Litharge	9 parts
	Soda Bi-Carb	3 parts
	Borax Glass	1
	Salt cover	

Enough nitre or flour being added to abtain a button of about 22 grammes.

ZINC ASSAY - Some of the first samples of each ore were checked by means of a method involving the elimination of manganese through the agency of bromine and the use of sodium sulphate. As the results obtained by this method checked those obtained by the shorter Colorado method when carefully handled, the samples were determined by that method as follows:

Treat ½ to 1 gram of the sample in a casserole with 8 c.c. strng nitric acid. Heat until Nitrous fumes cease, add a little potassium chlorate, evaporate to dryness, and dehydrate. (If much lead is present the addition of 5 grams of Nh4Cl before evaporation is of advantage in preventing caking and if the evaporation is carried on carefully, there need be no fear of loss of zinc by volatilization as chloride.

To the solid mass add 5 grams of NH_4Cl, 15 c c. NH_4 OH and 25 c.c. water. Boil for a few minutes. Filter off insoluble oxides, etc. (which should include all the manganese) wash with hot water. Dilute to 250 c.c. Neutralize with H Cl and add 5 c c in excess. Add a small quantity of test lead to precipitate any copper that may be present. Titrate hot with a standard solution of potassium ferrocyanide, using uranium acetate or nitrate as an indicator.

It is found necessary for close work to standardize under exactly the same conditions as exist in the actual assay, even in the quantity of zinc, as far as possible.

LEAD ASSAY

Treat ½ to 1 gram of the sample with concentrated nitric and heat until action ceases. Add 8 c.c. of sulphuric acid and boil until heavy SO_3 fumes are evolved and continue heating until drop under cover glass is of an oily consistency. Cool. add 50 c.c. of water and boil. Cool, add 70 c.c. of cold water and allow to settle for at least 30 minutes. Filter. Wash residue once with cold distilled water. Place the original breaker under funnel and pour a boiling concentrated solution of ammonium acetate on the filter. Wash contents of filter into original breaker, being careful to keep bulk of solution as low as possible. If any lead sulphate remains boil until it is all dissolved. Dilute to 250 c.c. with boiling water and titrate hot with ammonium molybdate using as an indicator a freshly prepared solution of tannin.

In tables 45, 46, and 47 the lead was determined by the Fire Assay.

The determination of lead in all the other samples was made by the above volumetric method the fire assay being rejected because of its well recognized inaccuracy..

The Fire Assay (Dry Assay) for lead, owes its continuance in practice to the fact that many smelters buy lead products on the basis of the Fire assay.

In a discussion of the Fire or Dry Assay Method vs. the Wet Method (chemical analyses) some smelter managers argue thus: The losses in the fire assay for lead represent the losses in smelting, therefore, this is the most equable basis on which to buy lead ores. While others argue, "we know what the losses are in our smelter, and prefer to settle on the basis of the Wet assay minus a certain percentage to balance the loss in smelting."

In a smalter treating ores from one district this latter arrangement is undoubtedly the better, because the losses can be accurately determined. for ores from that district, and the deduction applied to the wet assays.

For a smelter treating lead ores of great variation in character, the Dry method is better from the smelter manager's point of view, because the smelter losses will vary considerably with the different ores.

In the Slocan District lead ore can be sold to the Trail Smelter on the basis of the Fire Assay, or on the basis of the Wet assay minus 1.7%.

The Fire assay is entirely used in that district, for two reasons principally,-

1. The assayers there had long experience with the Fire Assay, before the Wet method was used as a basis for settlement, and therefore have become expert at it. The results are not subject to the great uncertainty of lead fire assay results, obtained by less experienced men.

2, Mill Superintendents do not like to have their mill extractions look low in comparison with those of the neighboring mill which still uses the Fire assay.

There is no valid reason for continuing the use of the Fire assay for lead in a concentrating plant; it is too unreliable, especially for such products as Feed and Tails. A manager using it cannot tell from the assay results what the extraction of lead is in his mill. Several cases coming under the observation of the writer can be cited, that have shown results of over 100% extraction, which is of course absolutely ridiculous.

The intelligent operation of any concentration mill necessitates accurate and systematic sampling, and the accurate assaying of these samples. This would seem to make necessary the adoption of the wet assay for lead, for all the products of the mine and mill.

SCREEN TESTS.

All the screen analyses or sizing tests were made with a set of Institute of Mining & Metallurgy, Standard Laboratory Screens. The 150 & 200 mesh Screens have not yet been made for this series, therefore the 150 & 200 mesh screens used do not conform with the specifications of the I.M.M. Standard Series.

The following are details of the screens used in these experiments:-

I M M Standard Labr. Screens

Mesh or apert.per lineal inch	Diam. of wire in	Diam. of wire m m	Aperture in	Aperture mm	Screening arre %
5	0.1	2.54	o.1	2.540	2.500
8	0.063	1.600	0.062	1.574	24.60
10	0.05	1.270	0.05	1.270	25.00
12	0.0417	1.059	0.0416	1.056	24.92
16	0.0313	.795	0.0312	0.792	24.92
20	0.025	.635	0.025	0.635	25.00
30	0.0167	.424	0.0166	0.421	24.80
40	0.0125	.317	0.0125	0.317	25.00
50	0.01	.254	0.01	0.254	25.00
60	0.0083	.211	0.0083	0.211	24.80
70	0.0071	.180	0.0071	0.180	24.70
80	0.0063	.160	0.0062	0.157	24.60
90	0.0055	.139	0.0055	0.139	24,50
100	0.005	.127	0.005	0.127	25.00
120	0.0041	.104	0.0042	0.107	25.40
150				.09	
200				.077	

Great difficulty has been experienced in obtaining expressions for the size of openings of each of the series of screens, which is at once convenient, and at the same time designates definitely the diameter of the aperture. The most common practice is to give the number of openings per linear inch, or mesh. This method does not give satisfaction because each manufacturer uses a different sized wire, therefore the diameter of apertures in a certain mesh screen of one make does not necessarily correspond with the diameter of the apertures in the same mesh screens of other makes.

The Standardization Committee of the I.M.M. to overcome this difficulty have drawn up specifications for a series of standard laboratory screens, the chief factor in which is the constancy of the percentage area of apertures (25%). Some considerable difficulty has been encountered in manufacturing sizes finer than 100 mesh for this series. For practical use it is found that in all sizes coarser than 60 mesh, the screens blind or clog very easily. This is caused by the large sizes of wire used which makes the entrance to each aperture more or less funnel shaped. It would suggest that the use of a flat wire band might overcome this difficulty in sizes where it is most pronounced, namely, in all screen sizes coarser than 20 mesh.

ORE DRESSING MACHINERY

Mechanical and constructional details of the various machines used have been omitted as not coming within the scope of this paper. Such details may be obtained from trade catalogues and text books on Ore Dressing.

A short statement of some of the most important principles involved in the various machines mentioned in this paper will be given.

The operations in a concentrating mill may be described in a general way as follows:

1. Breaking
2. Hand Picking
3. Crushing
4. Screening and Classifying
5. Coarse concentration
6. Sand "
7. Slime "

The breaking is usually done by jaw crushers.

Type 1. Overhung, or has the movable jaw pivotted at the top thus giving the maximum movement at the bottom. (Blake Type)

Type 2. Underhung, or has the movable jaw pivotted at the bottom, thus giving maximum movement at the top.

(Dodge type)

Crushing is usually done with rolls which are two iron or steel cylinders having hard steel shells set at the desired distance apart, and made to revolve so that the upper surfaces move towards one another.

SCREENING. Coarse screening is usually done with trommels (or revolving screens) which are drums consisting of a cylindrical mantle of sheet iron punched with holes of the required diameter.

Fine screening has been recently made commercially practicable by the introduction of the Callow screen, which consists of an endless belt of woven wire screening 2' wide, travelling over a pair of drums 18" in diameter, set at about 4'6" centres, over which the screening belt runs continually at a speed of 25 to 125 ft. per min.

The work of Classifiers and Jigs depends ~~entirely upon~~ primarily upon the different settling powers of minerals having a difference in specific gravity.

Sand concentration is most commonly done with riffle tables of which the Wilfley Table is one type. The riffle table is a development from the plane percussion table. The riffles reduce the erratic influence of cross currents, and keep the pulp from being too swiftly carried down to the tailings discharge. These machines also utilize the principle of momentum. The heavier minerals and large gangue particles settle upon the table, and remain there by reason of the friction during the forward impulse of the table. At the end of the stroke the particles of greater mass are projected further than the lighter particles, thus effecting a separation.

Vanners are used for slime concentration. Many of them afford a fair approximation to the Vanning motion of a shovel point in the hands of a Cornish miner.

The degree of economic concentration attained by any form of slime concentrator, however, is relatively low. The percentage recovery usually increases with a higher specific gravity of the mineral, for obvious reasons.