O T T A W A December 5th, 1941.

IR 1124

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1124.

Sink-and-Float Tests on a Sample of Galena-Gold Ore from Sop's Arm, White Bay, Newfoundland.

13P

(Copy No. 32.)

1942

BUREAU OF MINES
DIVISION OF METALLIC MINERALS
ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

O T T A W A December 5th, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1124.

Sink-and-Float Tests on a Sample of Galena-Gold Ore from Sop's Arm, White Bay, Newfoundland.

Shipment:

A shipment of 3 sacks of ore, net weight 240 pounds, was received on August 20th, 1941. The shipment was submitted by W. F. Hutchings, Sop's Arm, White Bay, Newfoundland.

Location of Property:

The property from which this ore was taken is located at Sop's Arm, White Bay, in the northwestern quarter of Newfoundland.

Character of the Ore:

Six polished sections were prepared and examined microscopically for the purpose of determining the character of the ore.

Gangue -

The gangue is composed of two component parts: (a) milky-white quartz, and (b) siliceous, greenish-grey rock material which carries a small amount of finely disseminated carbonate. The quartz is somewhat fractured and transected by narrow, hair-like cracks. Both constituents bear local, brown stains of iron oxides.

Metallic Minerals -

The sulphides are largely massive and form the greater portion of the six polished sections. A very small percentage is disseminated as irregular grains and subhedral crystals coarse to fine in size. In their approximate order of decreasing abundance the metallic minerals are: galena, pyrite, chalcopyrite, sphalerite, covellite, tetrahedrite-tennantite(?), and native gold.

Galena:

Largely in fine-textured masses but, as already noted, a small percentage occurs as disseminated grains in gangue, especially along fractures. It contains occasional grains of the other metallic minerals and narrow veinlets of gangue material.

Pyrite and Chalcopyrite:

These minerals have the same modes of occurrence as galena. In the polished sections examined

(Pyrite and Chalcopyrite, cont'd) -

both minerals are abundant and are present in approximately equal amounts. The pyrite is somewhat fractured and veined with gangue and contains small inclusions of chalcopyrite and galena. The chalcopyrite encloses grains of pyrite, galena, sphalerite, and gangue.

Sphalerite:

A small quantity of light-coloured sphalerite occurs as small masses and irregular grains associated with the other sulphides, particularly with chalcopyrite.

Covellite:

Tiny flakes in chalcopyrite, sphalerite, and galena are common, but total quantity is small.

Tetrahedrite-Tennantite(?):

Several small inclusions are visible in galena. They are too tiny to identify with certainty but resemble tetrahedrite-tennantite.

Gold:

Seven irregular grains of native gold, ranging from 108 microns (-100 +150 Tyler mesh) down to 14 microns (-800 +1100 Tyler mesh) in size, were observed in the sections. All occur in galena, except one which is in a small patch of gangue between masses of chalcopyrite and galena.

Sampling and Assaying:

Owing to the nature of the test conducted, which requires coarse crushing, no assay sample was cut from the shipment but head sample assays calculated from the products of the tests are as follows:

(Continued on next page)

(Sampling and Assaying, cont'd) -

Gold	-	0.153 oz./ton.
Silver	-	1.37 "
Lead	-	1.80 per cent.

Experimental Tests:

Small-scale sink-and-float tests were conducted on this sample of ore to determine its suitability or otherwise for treatment by this process.

The object of the process is to reject a low-grade fraction of the ore at a coarse size by making a density separation in a bath of substantially stable galena-water suspension. Material finer than 8 mesh can never be treated by this process under any circumstances and for any given ore the lower size limit may be even coarser than 8 mesh. For preliminary testing the size range of ore treated by this process is usually -1"+8 mesh.

The object of the process is to reject a considerable fraction of the ore at a coarsely crushed size that will be too low grade to repay milling costs and at the same time retain the richest fraction of the ore for further treatment by standard methods along with the untreatable fines.

This is done by making a density separation of the fraction to be treated in a bath of substantially stable galena-water suspension in which the heavier and richer portions settle to the bottom while the lighter portion floats to the surface and is skimmed off.

The medium used in these tests is the same as would be used in a large-scale plant test and its density can be controlled to an accuracy of 0.01 by altering the proportions of galena and water.

The tests are described in detail as follows:

(Continued on next page)

(Experimental Tests, cont'd) -

Size-Density Analysis.

The sample submitted was crushed and screened to a size range of -1"+8 mesh. The minus 8 mesh material was weighed and assayed and then set apart till needed at a later time. The -1"+8 mesh fraction was divided into 4 approximately equal parts by coning and quartering. On one of these quarters a size-density analysis was made as follows:

The sample of ore was fractionated on a series of screens at 1/8 inch intervals starting with 7/8 inch and going down to 3/8 inch sized openings. The finest fraction was -3/8"+8 mesh.

Density separations were made on each of these fractions as follows: The first separation was made using a medium density of 2.65 giving a "float" and a "sink" product. The float was weighed and assayed while the first sink was retreated at a higher density, in this case 2.70 to give an intermediate "float" and a second "sink". The intermediate float was weighed and assayed while the second sink was again retreated at 2.825 giving a second intermediate product and a final sink product.

The products from the finest fraction separated, -3/8" +8 mesh, were screened on 3, 4 and 6 mesh screens after which all the separation products were weighed and assayed for lead and gold.

According to their values as determined by assaying the intermediate products may be directed either into the sink or into the float by altering the density of the separating medium.

The results of the size-density analysis are laid down in the following table:

SIZE-DENSITY ANALYSIS.

(S.F. Test No. 30 - W. F. Hutchings)

Size Fractions	-6+8 Mesh		-4+6 Mesh		-3+4 Mesh		-3/8+3 Mesh		-½+3/8"	
	- Weight Proportions -									
DENSITY FRACTIONS	% Size fraction	% S.F. feed	% Size fraction	% S.F. feed	% Size fraction	% S.F. feed	% Size fraction	% S.F. feed	% Size fraction	% S.F. feed
Float @ 2.65	88.4	4.61	87.8	5.62	86.1	6.89	81.7	7.94	84.7	12.58
Float @ 2.70; sink @ 2.65	5.3	0.27	6.8	0.44	8.0	0.64	10.8	1.05	7.8	1.15
Float 2.825; sink @ 2.70	0.9	0.05	1.4	0.09	2.9	0.23	4.2	0.41	5.0	0.74
Sink @ 2.825	5.4	0.28	4.0	0.25	3.0	0.24	3.3	0.32	2.5	0.38
TOTAL -	100.0	5.21	100.0	6.40	100.0	8.00	100.0	9.72	100.0	14.85
	Assays, per cent		Assays, per cent		Assays, per cent		Assays, per cent		Assays, per cent	
	Pb	Au	Pb	Au	Pb	Au	Pb	Au	Pb	Au
Float @ 2.65	Trace	0.03	Trace	0.01	Trace	0.005	Trace	0.01	0.01	0.01
Float @ 2.70; sink @ 2.65	0.20	0.04	0.30	0.04	0.05	0.04	0.10	0.03	0.10	0.04
Float 2.825; sink @ 2.70	5.87	0.83	1.76	0.44	1.10	0.28	0.30	0.12	0.70	0.13
Sink @ 2.825	49.20	3.24	52.90	3.62	55.20	3.99	62.92	4.06	54.90	3.76

SIZE-DENSITY ANALYSIS.

(S.F. Test No. 30 - W. F. Hutchings, cont'd)

Size Fractions	-5/8"+½"		-¾"+5/8"		-7/8"+¾"		-1"+7/8"		Total	
	- W e i g h t P r o p o r t i o n s									
DENSITY FRACTIONS	% Size fraction	% S.F. feed	% Size fraction	% S.F. feed	% Size fraction	% S.F. feed	% Size fraction	% S.F. feed	% Size fraction	% S.F. feed
Float @ 2.65	77.7	20.35	73.6	3.95	72.1	11.13	72.2	6.37	79.44	79.44
Float @ 2.70; sink @ 2.65	12.1	3.16	14.3	0.77	15.9	2.46	14.5	1.28	11.22	11.22
Float @ 2.825; sink @ 2.70	5.6	1.47	9.9	0.53	10.1	1.56	12.2	1.07	6.15	6.15
Sink @ 2.825	4.6	1.20	2.2	0.12	1.9	0.30	1.1	0.10	3.19	3.19
TOTAL	100.0	26.18	100.0	5.37	100.0	15.45	100.0	8.82	100.00	100.00
	Assays, per cent		Assays, per cent		Assays, per cent		Assays, per cent			
	Pb	Au	Pb	Au	Pb	Au	Pb	Au		
Float @ 2.65	0.05	0.02	Trace	Nil	0.25	Nil	0.05	0.015		
Float @ 2.70; sink @ 2.65	0.10	0.015	0.15	0.01	0.25	0.045	0.15	0.01		
Float @ 2.825; sink 2.70	0.20	0.02	0.65	0.06	0.05	0.03	0.20	0.01		
Sink @ 2.825	68.80	4.48	79.80	6.665	47.20	4.47	4.22	1.50		

(Experimental Tests, cont'd) -

The product floated at 2.65 is practically all quartz and is low enough in grade to be discarded throughout the entire size range with the possible exception of the -6+8 mesh fraction which assays 0.03 ounce gold per ton. However, under operating conditions the separations would be made in bulk, the complete size range of ore being fed in together, and this would increase the chances of a lower-grade reject being produced in this size. If under operating conditions this size reject should continue high in gold the feed to sink-and-float could be screened on 6 mesh thus sending all -6+8 mesh ore to further treatment as fines.

The two intermediate products are largely the siliceous greenish-grey rock material referred to in the microscopic examination but also contain some quartz with galena or other sulphides attached. These two products carry worth while quantities of gold but might be rejected as far as the lead content is concerned.

The final "sink" product is rich in both lead and gold and amounts to 2.61 per cent of the weight of original ore treated, including minus 8 mesh fines.

The minus 8 mesh fines amount to 18.20 per cent of the weight of original ore and assay: lead 2.32 per cent; gold 0.265 ounce per ton. They contain 20.80 per cent of the total lead and 28.41 per cent of the total gold.

The following table has been prepared by reducing the size-density table to simpler form and including minus 8 mesh fines in the proper proportion. The various density fractions listed in this table are the average of all the size-fractions listed in size-density table for the corresponding densities. The table shows the net result of each successive separation at a higher density.

(Table follows on next page)

(Experimental Tests, cont'd) -

Summary of Size-Density Analysis.

Product	Weight, per cent	Assay Pb, per cent	Assay Au, oz./ton	Distribution, per cent Pb	Distribution, per cent Au
Float @ 2.65	64.98	0.057	0.012	1.83	4.59
Float @ 2.70; Sink @ 2.65	9.18	0.15	0.028	0.68	1.51
Float @ 2.825; Sink @ 2.70	5.03	0.37	0.067	0.92	1.99
Sink @ 2.825	2.61	58.92	4.13	75.77	63.50
-8 mesh fines	18.20	2.32	0.265	20.80	28.41
Feed sample (cal.)	100.00	2.03	0.17	100.00	100.00

This table indicates two possibilities in both of which the sink-and-float process could be used to good advantage:

(1) A density separation at 2.825 or thereabouts would produce a high-grade shipping product containing 75.77 per cent of the lead and 63.50 per cent of the gold. In addition the minus 8 mesh fines could be fed to a jig with a 20 mesh screen to produce a -8+20 mesh concentrate as well as a hutch product which could be cleaned on a table if necessary. In this way no further crushing or grinding would be needed. Although there was an insufficient quantity of minus 8 mesh material with which to conduct a satisfactory jig test on a reasonable scale, preliminary small-scale tests indicate that recoveries of gold, silver and lead will be increased by about 12 per cent by treating the fines in this way. It is also probable that in a well designed plant adjusted to optimum conditions these figures could be increased. A sample of jig concentrate obtained from such a small-scale test assayed as follows:

Gold - 3.16 ounces per ton
Silver - 30.88 " "
Lead - 41.88 per cent.

(2) If facilities are available for further treatment of pre-concentrated products the ore could be separated at 2.65 or possibly 2.70 density, the float being rejected as waste and the "sink" along with the fines would be ground and floated to produce a concentrate for shipping. In this case higher recoveries can be expected than those obtained in the first option.

The possibilities of the second option have been examined as follows:

(Continued on next page)

(Experimental Tests, cont'd) -

A sample of the ore with a size range of -1"+8 mesh was separated in bulk at 2.65 density. 2.65 was chosen as the separating density in preference to 2.70 owing to the marginal gold assay shown for the product "Float at 2.70; sink at 2.65" in the summary of size-density analysis.

The results of this test are summarized in the following tables:

Table I. - Distribution of Products from Crushing.

Product	Weight, per cent	Assays Pb, per cent	Assays oz./ton Au	Assays oz./ton Ag	Distribution, per cent Pb	Distribution, per cent Au	Distribution, per cent Ag
S.F. feed	81.58	1.40	0.107	1.07	72.71	64.03	63.89
Fines -8 mesh	18.42	2.32	0.265	2.69	27.29	35.97	36.11
Feed sample (cal.)	100.00	1.57	0.136	1.37	100.00	100.00	100.00

Table II. - Distribution of Products from S.F. Separation.

S.F. conc.	22.45	6.15	0.44	4.65	98.89	92.72	97.12
S.F. tailing	77.55	0.02	0.01	0.04	1.11	7.28	2.88
S.F. Feed (cal.)	100.00	1.40	0.107	1.07	100.00	100.00	100.00

Table III. - Summary of Products from Pre-Concentration.

S.F. conc.	18.31	6.15	0.44	4.65	71.90	59.37	62.05
Fines -8 mesh	18.42	2.32	0.265	2.69	27.29	35.97	36.11
Product for further treatment	36.73	4.23	0.352	3.67	99.19	95.34	98.16
S.F. tailing	63.27	0.02	0.01	0.04	0.81	4.66	1.84
Feed sample (cal.)	100.00	1.57	0.136	1.37	100.00	100.00	100.00

A flotation test was conducted on a sample of the product for further treatment which represents 36.73 per cent of the original ore and contains 99.19 per cent of the lead, 95.34 per cent of the gold, and 98.16 per cent of the silver.

(Continued on next page)

(Experimental Tests, cont'd) -

The sample was dry crushed to pass 14 mesh and then ground in a ball mill with soda ash added at the rate of 1.0 pound per ton of product. A screen test on the flotation tailing showed it to be all minus 65 mesh and 78 per cent minus 200 mesh.

A lead concentrate was floated and cleaned once after which a pyrite concentrate was floated.

Reagents to Cell:			Lb./ton
Pb float	-	Butyl xanthate	- 0.10
		Cresylic acid	- 0.15
Pb cleaner cell	-	Cresylic acid	- 0.06
Pyrite float	-	Amyl xanthate	- 0.10
	-	Pine oil	- 0.05
	-	®Copper sulphate	- 1.0

® Added at end of operation without result.

Summary of Flotation Results:

Product	Weight, per cent	Assays Pb, per cent	Assays oz./ton Au	Assays oz./ton Ag	Distribution, per cent Pb	Distribution, per cent Au	Distribution, per cent Ag
Pb conc.	5.95	66.49	4.26	49.28	88.24	74.82	74.99
Pb middling	1.23	7.64	1.84	11.48	2.10	6.68	3.61
Fe conc.	3.30	7.18	1.18	12.18	6.09	13.24	11.84
Tailing	89.02	0.18	0.02	0.42	3.57	5.26	9.56
Flotation feed (cal.)	100.00	4.48	0.34	3.91	100.00	100.00	100.00

The following table gives the distribution of the products of both concentrating operations on the basis of the original ore:

(Continued on next page)

(Experimental Tests, cont'd) -

Product	Weight, per cent	Assays Pb, per cent	Assays oz./ton Au	Assays oz./ton Ag	Distribution, per cent Pb	Distribution, per cent Au	Distribution, per cent Ag
S.F. tailing	63.27	0.02	0.01	0.04	0.81	4.66	1.84
Flotation tailing	32.70	0.18	0.02	0.42	3.54	5.02	9.39
Pb conc.	2.18	66.49	4.26	49.28	87.53	71.33	73.61
Pb middling	0.45	7.64	1.84	11.48	2.08	6.37	3.54
Fe conc.	1.40	7.18	1.18	12.18	6.04	12.62	11.62
® Average conc. (cal.)	4.03	39.37	2.92	32.21	95.65	90.32	88.77
Feed sample (cal.)	100.00	1.57	0.136	1.37	100.00	100.00	100.00

® Includes Pb conc., Pb middling and Fe conc.

Summary of Results.

Proportion of ore to be crushed to minus 1 inch - 51.56 per cent.

Proportion of ore available for sink-and-float feed - 81.58 per cent.

Proportion of ore to further treatment - 36.73 per cent.

Assays:		Lead, per cent	Gold, oz./ton	Silver, oz./ton
Ore treated	-	1.57	0.136	1.37
S. F. feed	-	1.40	0.107	1.07
S. F. tailing	-	0.02	0.01	0.04
S. F. conc.	-	6.15	0.44	4.65
Ore to further treatment	-	4.23	0.352	3.67

Elimination by weight of sink-and-float feed - 77.55 per cent.

Elimination by weight of whole ore - 63.27 per cent.

(Continued on next page)

(Summary of Results, cont'd) -

Metal recovery:

	- (Per cent) - Lead	Gold	Silver
From S. F. feed -	98.89	92.72	97.12
From whole ore -	99.19	95.34	98.16

Conclusions:

The results of this test appear to be satisfactory and indicate that the sink-and-float process could be used to good advantage in either of two schemes:

1. For final treatment of ore of a size range within suitable limits, the fines to be treated by some other form of gravity concentration.
2. As a pre-concentration treatment to reject a low-grade fraction, the "sink" plus fines to be further treated by some other form of concentration such as flotation, if any facilities are available.

The choice between the two methods would be governed largely by local conditions.

Under the first option coarse crushing only would be needed while in the second additional grinding equipment would be needed.

oooooooooooo
oooooo
oo

JDJ:GHE.