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DETERMINATION OF CRITICAL POINT OF CONCENTRATING TABLES ON FLAT RIVER ORE.

by

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THESIS

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DETERMINATION OF CRITICAL POINT OF CONCENTRATING TABLES ON FLAT RIVER ORE.

In concentrating any ore on tables there is, theoretically, a critical point in sizing, beyond which it can not be expected to recover the valuable minerals; that is, valuable mineral finer than a certain size will go with the gangue and be lost. For instance, in the diagram of the Wilfley Table shown, the concentrates grade from coarse to fine as indicated, but instead of grading on down into very fine sizes farther up the table these finer sizes are found mixed with the middlings, tailings and slimes as indicated by the arrows. The problem is to determine the critical sizes where the divisions occur.

The attempt of the following experiments was to determine these critical sizes in the concentration of the lead ores of the Flat River district. For this purpose, fifteen samples were obtained from a mill of that district, these samples being heads, concentrates, middlings, and tails from three Wilfley Tables. The feed for these tables came from a three spigot classifier, the product from the first spigot went to a Wilfley Table No. 1, the product from the second spigot went to Wilfley Table No. 2, the product from

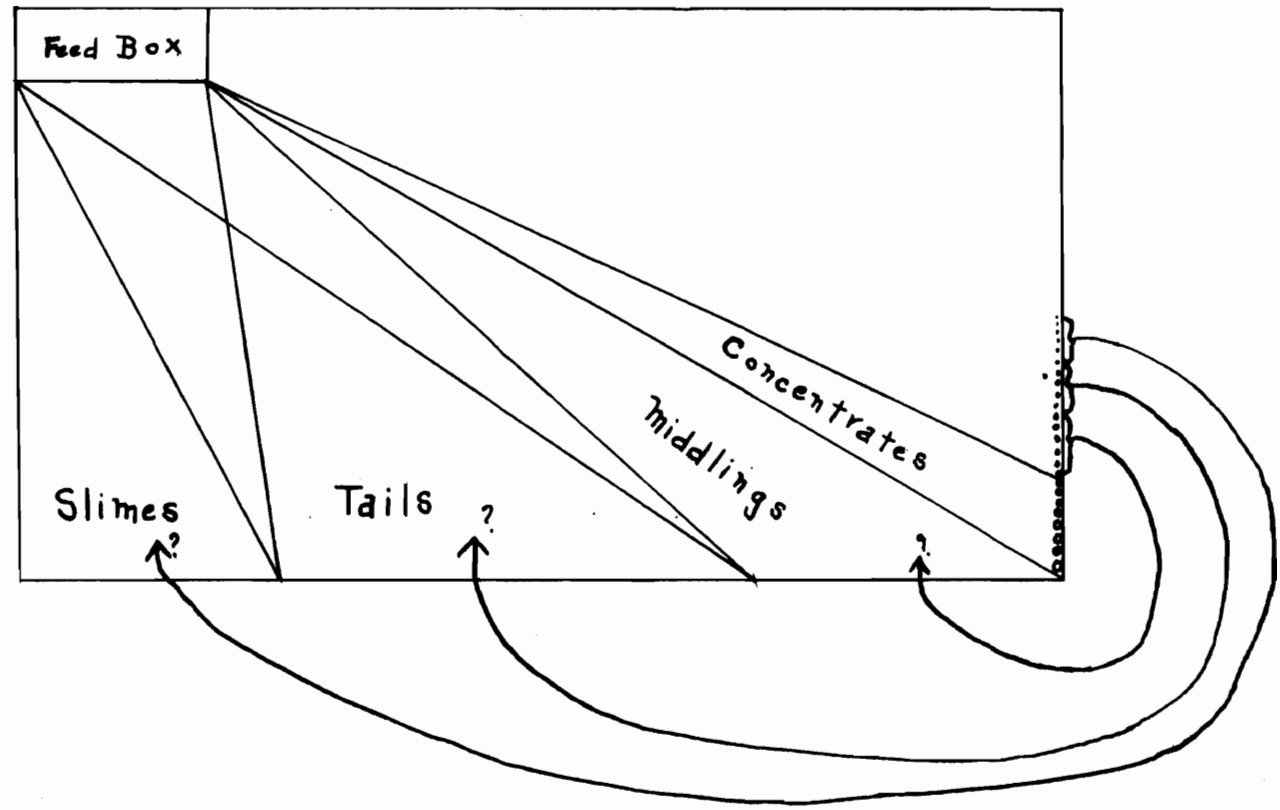

Diagram of Wilfley Table Separation.

the third spigot went to Wilfley Table No. 3, and the overflow to an Isbell Vanner. All of the material would pass a screen having 30 openings per linear inch.

Each of these samples was thoroughly mixed and a small sample taken for chemical analysis. A screen analysis was made on each of the original samples, using a new set of Tyler's Standard Screens, consisting of 35, 48, 65, 80, 100, 115, 150, 170 and 200 mesh screens. The use of these screens is recommended for screen analysis, because the openings increase and decrease throughout the series in a fixed ratio, and hence will divide the product in better proportion than a sieve series with no fixed relationship between the openings. Many industries have established 200 mesh screens as the minimum in screen sizing. The Bureau of Standards of the United States Government has taken as a standard the 200 mesh sieve made from 0.0021 inch wire, and having an opening the linear dimension of which is 0.0029 inch. This sieve has been adopted as the base of the Tyler Standard screen scale. The 100 mesh sieve in this screen scale also comes within the specifications adopted by the Bureau of Standards. The diameters of the openings in the scale increase in the ratio of the fourth root of 2, or 1.189, the factor recommended by

Prof. Richards in his work on ore dressing. This gives a ratio of the square root of 2, or 1.414 between the areas of the openings in successive screens. This ratio applies to the finer sizes from 65 to 200 mesh. For the two coarser screens the ratio between the diameters of the openings is the square root of 2 or 1.414 , so that each area is double the next finer.

The tails, heads, middlings and concentrates were screened in the order named, to avoid any possible salting of the poorer samples, which might result if the richer samples were screened first. The product from each screen was weighed to the nearest half gram and analyzed for lead. All chemical analyses were made in duplicate.

The determinations for lead were made by the ammonium molybdate method as follows. Made up a standard solution of ammonium molybdate containing about 4.74 gm of ammonium molybdate in two liters of water. Standardized this solution as follows: Weighed carefully several samples of C.P. lead sulphate and dissolved them in a saturated solution of ammonium acetate in distilled water. Boiled about ten minutes and titrated boiling hot with the ammonium molybdate solution, using a dilute solution of tannic acid as an outside indicator. Weight of lead sulphate divided by the number of cubic centi-

meters of ammonium molybdate required, and multiplied by the factor 207/303, gives the lead equivalent of one cubic centimeter of the ammonium molybdate solution. Ran a blank test consisting of 50 cubic centimeters of distilled water and 25 cubic centimeters of ammonium acetate solution. Found this required 0.3 cubic centimeters of ammonium molybdate solution to give an end point. Hence 0.3 cubic centimeters was subtracted from all our subsequent readings.

In running the analysis on the samples of ore, we took one gram of the heads and tailings, one half gram of the middlings and one quarter gram of the concentrates. Dissolved each sample in about 5 c.c. of nitric acid and 10 c.c. of hydrochloric acid. Cooled and added about 7 c.c. of sulphuric acid and boiled to dense white fumes. Cooled, added about 50 c.c. distilled water and boiled. Cooled to room temperature, filtered, and dissolved precipitate in about 25C.c. of saturated solution of ammonium acetate in original beaker. Added 50 c.c. of distilled water, boiled and titrated boiling hot with the ammonium molybdate as described above, using a dilute solution of tannic acid as an outside indicator.

$$\frac{\text{No. c.c. } NH_4MoO_4 \text{ minus 0.3 c.c.} \quad X \text{ standard}}{\text{Weight of sample}} = \% \text{ Lead}$$

The results of the analyses are to be found in the accompanying tables.

It was impossible to determine any critical sizes from these samples for several reasons. First, the size of the samples was much too small to give satisfactory results, several of the screen products weighing less than one gram. Each product should be much larger than this to be a fair sample and to give an accurate analysis of the lead contained in the given size. Also the results show a nearly perfect separation of the valuable mineral from the gangue. The tables apparently were recovering practically all of the valuable mineral so that no critical size could be found. This complete recovery is probably partly due to the fact that the ore treated consists principally of galena with a dolomite gangue, and due to the large difference in specific gravity of these minerals, a good separation can be obtained.

The recovery shown by these samples was unusually high, even for this class of ore, and it seems likely that the samples were obtained from laboratory experiments rather than from ordinary mill work. Hence because of

these ideal conditions, no critical sizes could be determined. In order to obtain any satisfactory results along this line, a large number of experiments should be done right at the mill, where samples of sufficient size could be readily obtained and conditions varied as desired.

Classifier Spigot No. 1, Wilfley Table Heads.

ORIGINAL SAMPLE.

Weight— 154.5 g.m. Wet Assay= 14.4 Pb Pb Content= 22.36 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb content Grams
Thru	On				
		Ratio = 1.414			
	35	0.0164	26.5	15.6	4.1
35	48	0.0116	28.0	14.0	3.9
48	65	0.0082	30.5	12.0	3.6
		Ratio = 1.189			
65	80	0.0069	12.5	12.9	1.6
80	100	0.0058	19.5	15.9	3.1
100	115	0.0049	8.5	15.7	1.3
115	150	0.0041	9.5	17.4	1.6
150	170	0.0035	5.0	17.3	0.86
170	200	0.0029	4.0	16.7	0.67
200			9.0	27.0	2.70

Classifier Spigot No. 1, Wilfley Table Tails.

ORIGINAL SAMPLE.

Weight= 115. g.m. Wet Assay= 0.1 % Pb Pb Content= 0.1 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb content Grams
Thru	On				
		RATIO=1.414			
	35	0.0164	27.0	Trace	
35	48	0.0116	27.5	"	
48	65	0.0082	24.0	"	
		RATIO=1.189			
65	80	0.0069	9.5	"	
80	100	0.0058	13.5	"	
100	115	0.0049	5.5	"	
115	150	0.0041	4.0	"	
150	170	0.0035	1.5	"	
170	200	0.0029	1.0	"	
200			1.0	"	

Classifier Spigot No. 1, Wilfley Table Middlings.

ORIGINAL SAMPLE.

Weight= 80.0 g.m. Wet Assay= 7.6% Pb Pb Content= 6.0 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb content grams
Thru	On				
		RATIO = 1.414			
	35	0.0164	10.5	48.5	5.1
35	48	0.0116	2.5	9.2	0.2
48	65	0.0082	4.0	1.0	0.04
		RATIO = 1.189			
65	80	0.0069	3.0	Trace	
80	100	0.0058	7.5	"	
100	115	0.0049	8.0	"	
115	150	0.0041	12.5	"	
150	170	0.0035	8.5	"	
170	200	0.0029	9.0	"	
200			14.0	3.6	0.5

Classifier Spigot No. 1, Wilfley Table Concentrates.

ORIGINAL SAMPLE.

Weight= 69.0 g.m. Wet Assay= 76.0%Pb Pb Content= 52.44 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh Thru	Mesh On	Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb Content Grams
		RATIO=1.414			
	35	0.0164			
35	48	0.0116	7.0	81.6	5.712
48	65	0.0082	9.0	77.4	6.966
		RATIO=1.189			
65	80	0.0069	5.0	74.8	3.74
80	100	0.0058	8.0	74.6	5.968
100	115	0.0049	5.5	75.2	4.13
115	150	0.0041	8.0	72.2	5.776
150	170	0.0035	6.0	77.6	4.656
170	200	0.0029	7.0	77.4	5.418
200			13.0	76.7	9.975

Classifier Spigot No. 2, Wilfley Table Heads.

ORIGINAL SAMPLE.

Weight= 17.5 g.m. Wet Assay= 10.0% Pb Pb Content= 1.75 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb content Grams
Thru	On				
		Ratio=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082			
		Ratio=1.189			
65	80	0.0069			
80	100	0.0058	3.0	1.0	0.03
100	115	0.0049	1.0	3.3	0.033
115	150	0.0041	2.0	3.9	0.078
150	170	0.0035	1.5	4.9	0.029
170	200	0.0029	2.0	5.3	0.106
200			7.5	21.0	1.575

Classifier Spigot No. 2, Wilfley Table Tails.

ORIGINAL SAMPLE.

Weight= 132 g.m. Wet Assay= 0.1% Pb Pb Content= 0.13 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh Thru	Mesh On	Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb Content Grams
		RATIO=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082	3.0	0.1	0.003
		RATIO=1.189			
65	80	0.0069	7.0	0.1	0.007
80	100	0.0058	25.5	Trace	
100	115	0.0049	15.5	"	
115	150	0.0041	25.0	0.2	0.05
150	170	0.0035	12.0	Trace	
170	200	0.0029	15.0	0.3	0.04
200			29.0	Trace	

Classifier Spigot No. 2, Wilfley Table Middlings.

ORIGINAL SAMPLE.

Weight= 75.5 g.m. Wet Assay= 1.5% Pb Pb Content= 1.1 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in inches	Weight grams	Wet assay per cent Pb	Pb content grams
Thru	On				
		Ratio=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082			
		Ratio=1.189			
65	80	0.0069			
80	100	0.0058			
100	115	0.0049	3.5	0.2	0.01
115	150	0.0041	7.0	0.2	0.02
150	170	0.0035	7.5	0.2	0.02
170	200	0.0029	14.0	0.2	0.3
200			43.0	2.0	0.86

Classifier Spigot No. 2, Wilfley Table Concentrates.

ORIGINAL SAMPLE.

Weight= 50.5 g.m. Wet Assay= 78.2% Pb Pb Content= 39.5 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb Content Grams
Thru	On				
		RATIO=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082			
		RATIO=1.189			
65	80	0.0069			
80	100	0.0058			
100	115	0.0049			
115	150	0.0041	0.5	51.8	0.25
150	170	0.0035			
170	200	0.0029	0.5	73.2	0.36
200			49.0	81.0	39.7

Slassifier Spigot No. 3, Wilfley Table Heads.

ORIGINAL SAMPLE.

Weight= 18.5 g.m. Wet Assay= 9.38% Pb Pb Content= 1.735 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh Thru	Mesh On	Opening in Inches	Weight Grams	Wet Assay Per Cent Pb	Pb Content Grams
		RATIO=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082			
		RATIO=1.189			
65	80	0.0069			
80	100	0.0058			
100	115	0.0049	1.0	2.9	0.029
115	150	0.0041	1.0	0.6	0.006
150	170	0.0035	1.0	0.4	0.004
170	200	0.0029	2.0	0.3	0.006
200			13.5	13.5	1.82

Classifier Spigot No. 3, Wilfley Table Tails.

ORIGINAL SAMPLE.

Weight= 80. g.m. Wet Assay= 0.26% Pb Pb Content= 0.2 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb Content Grams
Thru	On				
		Ratio=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082			
		Ratio=1189			
65	80	0.0069			
80	100	0.0058			
100	115	0.0049	0.5	0.4	0.002
115	150	0.0041	2.0	0.1	0.002
150	170	0.0035	3.5	0.13	0.004
170	200	0.0029	7.5	0.13	0.01
200			66.5	0.13	0.086

Classifier Spigot No. 3, Wilfley Table Middlings.

ORIGINAL SAMPLE.

Weight= 136 g.m. Wet Assay= 8.1% Pb Pb Content= 11.0 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in Inches	Weight Grams	Wet Assay Per Cent Pb	Pb Content Grams
Thru	On				
		RATIO=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082			
		RATIO=1.189			
65	80	0.0069	5.0	Trace	
80	100	0.0058	1.0	Trace	
100	115	0.0049	1.0	Trace	
115	150	0.0041	3.5	Trace	
150	170	0.0035	6.0	0.2	0.01
170	200	0.0029	12.0	0.2	0.02
200			106.0	10.3	10.9

Classifier Spigot No. 3, Wilfley Table Concentrates.

ORIGINAL SAMPLE.

Weight= 48.5 g.m. Wet Assay= 81.3% Pb Pb Content= 39.4 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in Inches	Weight Grams	Wet Assay Per Cent Pb	Pb Content Grams
Thru	On				
		RATIO=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082			
		RATIO=1.189			
65	80	0.0069			
80	100	0.0058			
100	115	0.0049			
115	150	0.0041			
150	170	0.0035			
170	200	0.0029	0.5	76.8	0.38
200			47.5	83.0	39.4

Isbell Vanner Heads.

ORIGINAL SAMPLE.

Weight= 119 g.m. Wet Assay= 3.8% Pb Pb Content= 4.5 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb content Grams
Thru	On				
		Ratio=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082			
		Ratio=1.189			
65	80	0.0069			
80	100	0.0058	3.5	0.3	0.001
100	115	0.0049	1.5	0.3	0.0005
115	150	0.0041	2.0	0.35	0.0007
150	170	0.0035	1.5	3.1	0.04
170	200	0.0029	3.0	2.6	0.07
200			106.0	4.5	4.7

Isbell Vanner Tails.

ORIGINAL SAMPLE.

Weight= 103.5 g.m. Wet Assay= 0.26% Pb Pb Content= 0.268 g.m.

Screen Analysis.				Chemical Analysis.	
Mesh Thru	Mesh On	Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb content Grams
		Ratio=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082			
		Ratio=1.189			
65	80	0.0069			
80	100	0.0058	2.5	Trace	
100	115	0.0049	1.5	"	
115	150	0.0041	2.0	"	
150	170	0.0035	1.0	"	
170	200	0.0029	1.5	0.1	0.001
200			93.0	0.2	0.18

Isbell Vanner Concentrates.

ORIGINAL SAMPLE.

Weight= **27.0** g.m. Wet Assay= **78.6% Pb** **Pb** Content= **21.2** g.m.

Screen Analysis.				Chemical Analysis.	
Mesh		Opening in Inches	Weight Grams	Wet Assay per cent Pb	Pb Content Grams
Thru	On				
		Ratio=1.414			
	35	0.0164			
35	48	0.0116			
48	65	0.0082			
		Ratio=1.189			
65	80	0.0069			
80	100	0.0058			
100	115	0.0049			
115	150	0.0041			
150	170	0.0035			
170	200	0.0029			
200			**27.0**	**78.6**	**21.2**