AMALGAMATION

AT THE

ONTARIO MILL

COMPARED WITH

THE RUSSELL PROCESS

AT THE

MARSAC MILL.

COMPARISON WITH SMELTING.

BY

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COMPARISON

BETWEEN THE

Amalgamation Process at the Ontario Mill

AND THE

Russell Process at the Marsac Mill.

1891–1892.

By W. G. Lamb, Superintendent of Marsac Leaching Department.

In a preceding pamphlet by Mr. W. A. Wilson has been given a comparison of Amalgamation at the Ontario, with the Russell process at the Marsac Mill (Daly Mining Co., Park City, Utah,) for the first three months of 1891.

The object of the following pages is to continue the comparison for the whole year, and to present statistics on points not covered in previous publications.

The Russell process has now been in continuous use at the Marsac for nearly four years, starting Jan. 1, 1889, running continuously during that year in competition with amalgamation, the ore treated being divided between the two processes, and finally superseding amalgamation at the end of that year.

The amalgamation statistics here given are from the Ontario Mill, located in the same camp. In that mill amalgamation has been in continuous use since its start in January, 1877.

From their long experience with it—fifteen years—the Ontario obtains as good results by this process as are possible.

As the cost of labor, fuel and supplies are the same for the two mills, a comparison of statistics is of value in determining the general efficiency and economy of the two processes. The

figures here given are taken from the books and reports of the two companies, and are published by permission of the managements.

The properties of the two companies adjoin and are on the same vein.

The equipment of the two mills and mill men employed, is as follows:

STATEMENT A.

ONTARIO.	MARSAC.
2 Rock Crushers,	1 Rock Crusher,
2 Rotary Driers,	2 Rotary Driers,
40 Ore Stamps,	30 Ore Stamps,
10 Salt Stamps,	5 Salt Stamps,
2 Stetefeldt Furnaces,	1 Stetefeldt Furnace,
24 Pans,	6 16½-ft. Ore Vats,
12 Settlers,	8 9-ft. Precipitating Tanks.
71 Mill Men.	51 Mill Men.

The Ontario Mill treats only the ore from the Ontario Mine, and the Marsac only ore from the Daly Mine.

The analyses and values of the ore treated at the Ontario and Marsac Mills for 1891, are as follows, the samples on which these analyses were made being composed of all the battery samples taken each day during the entire year:

STATEMENT B.

	ONTARIO. Per cent.	MARSAC. Per cent.
Silica	75.0	76.60
Zinc	5.73	5.30
Lead	1.80	3.50
Iron	2.80	1.65
Sulphur	2.23	0.70
Lime (Ca O.)	1.76	1.32
Magnesia (Mg O.)	0.23	trace
Copper	0.29	0.39
	Ozs.	Ozs.
Silver	39.50	39.10
Gold ($0.91)	0.044	($0.91) 0.044

These two ores are practically the same, both in composition and value.

The statistics which will be here given on the Ontario and Marsac Mills, refer, of course, only to the comparative efficiency of Amalgamation and the Russell process. But the question has been asked why these ores are not sold to the smelters instead of being milled.

To sell the ore (which is milled at the Marsac) to the smelters would result as follows:

The expenses of the Daly Mining Co. for the above year (1891) are:

STATEMENT C.

Extraction (Mining)	$6.52
Prospecting	1.65
Hauling to Mill	0.83
Milling	6.27
Sundries	0.96
Making a total of	$16.23

With the exception of "milling" and "hauling to mill," these expenses, if the ores were sold to smelters instead of milled, would still continue. Deducting these two items, the expenses are $9.13.

On the other hand, with silver at 83 cents per ounce, and lead at $4.00, the highest price offered by the Salt Lake, Kansas City, Leadville and Denver smelters, for ore of the above analysis, 39.10 ounces per ton in silver and 91 cents gold, is $14.06 f. o. b. at Park City, the seller to pay hauling to sampler, and all sampling and shipping charges, amounting to $2.68 net per ton of ore.

The total expense incurred, therefore, by the Daly Company before the ore can be sold to the Smelters is $11.81 per ton; the price offered being $14.06, there would be a net profit on each ton sold to the smelters of $2.25. But by milling, after deducting all mining, prospecting, hauling, milling, sundry and product expenses, the net profit per ton on the same ore is $12.88, making the net difference between smelting and milling $10.63 per ton, or, on 24,214 tons per year, a difference in favor of the latter of $257,394.82.

To return to the comparison of Ontario and Marsac. The following table gives the crushing statistics for 1891 :

TABLE I.

AMOUNT OF ORE, TIME ON BATTERY, MESH OF SCREEN, RATE OF CRUSHING.

1891.

MILL.	Ore	Time Battery Run	Mesh of Screen	Rate of Crushing per day	Rate of Crushing per stamp per day
	Tons	Days.	Mesh.	Tons.	Tons.
Ontario, 40 Stamps	25,650	341.8	26	75.0	1.87
Marsac, 30 Stamps	24,214	347.0	20	70.0	2.33

The above difference in rate of crushing per stamp is probably not due entirely to difference in mesh of screen, as Ontario ore may not crush as fast as Daly, even in the same battery and with same mesh of screen, owing to less dryness, or temperature, of the ore as it goes to the battery from the dryers.

Table II—This gives the comparative fineness and baseness of the product for 1891, as shipped from the Ontario and Marsac Mills, the product of the Ontario being bars of bullion, and that of the Marsac dried sulphides, the form in which all Marsac products were shipped during 1891.

TABLE II.

FINENESS AND BASENESS OF PRODUCT.

1891.

SILVER.		GOLD.		COPPER.	
Fineness of Product.		Fineness of Product.		Baseness of Product.	
Ontario.	Marsac.	Ontario.	Marsac.	Ontario.	Marsac.
Fine.		Fine.		Fine.	
.425	.313	.00025	.00026	.575	.153

The figures given for the Marsac represent the average dried precipitates from the wash water and leaching solutions, excepting the lead carbonate product.

The distribution of the silver in the products for 1891 was as follows:

STATEMENT D.

Base Sulphides—from Wash Water	11.63 per cent.
Regular " —Ordinary and Extra Solution	85.55 per cent.
Lead Carbonate " " "	1.71 per cent,
Mill Cleanings—under filters and in launders	1.11 per cent.

The large amount, 11.63 per cent. of silver product as wash water precipitate, is caused by precipitating the weak hyposulphite solution in same tanks with the wash water.

The wash water product assays per ton 3957.0 ozs. silver and $58.44 gold. The regular sulphides from leaching solutions assay from 7150.0 ozs. to 11420.0 ozs.—averaging 9815.0 ozs. silver per ton for year 1891, and $187.00 gold.

During the present year, 1892, all the lead has been precipitated by soda ash, making the average value of regular sulphides in silver 11527.0 ozs., and $246.00 in gold, or a gain of 17½ per cent. in fineness of sulphides, due to the precipitation of the lead by itself by soda ash. For reasons connected with the chemical reactions in the refining of the product, also, it is essential that lead should be kept out of the sulphides, thus necessitating the use of soda ash as a precipitant for the lead.

An analysis, by Stallman, of an average lot of dried sulphides, is as follows:

Copper	21.60 per cent.
Sulphur	24.83 "
Iron	0.75 "
Alumina	0.25 "
Arsenic	trace
Antimony	0.18 per cent.
Silica	0.25 "
Lead	0.50 "
Silver	34.78 "
Gold	0.03 "
Soluble in water	12.76 "

The lead carbonate assays 30 per cent. Lead, so far for 1892.

Table III gives the comparison of fineness of product in silver for 1891-1892.

TABLE III.

COMPARISON OF FINENESS OF PRODUCT IN SILVER, ETC.
1891-1892.

Year.	Ontario Bullion.	Marsac "Regular" dried Sulphides.	Marsac Total dried Sulphides.	Marsac Bullion.	Cost of marketing product per oz. of silver produced.		Price obtained per ounce for silver.	
					Cts.		$	
	Fine.	Fine.	Fine.	Fine.	Ontario	Marsac	Ontario	Marsac
1891	.425	.337	.313	No Sulphides refined at Mill.	3.47	3.45	0.9755	0.9700
1892	.380	.395	.351	.923				

The figures given for 1892 are up to Sept. 1st. During 1891 all the product of the Marsac Mill was shipped in the dried state. The "regular" sulphides referred to are the precipitates from the "ordinary" and "extra solutions."

The "total" sulphides include the "wash water precipitate" also.

During 1893 all the gold and silver in Marsac sulphides will be parted and refined at the mill by a new wet process. According to the terms of the contract which has been made, the full corrected assay value of the sulphides produced at the mill, is to be returned as silver bullion 998, and gold bullion 995 fine, which can be shipped directly to the mint, requiring no further treatment. The total cost, according to the contract, is to be 1¼ cents per ounce of silver treated.

By the term "full corrected assay value," or "exact assay," is meant the assay value of the sulphides, as determined by the best method of fire assaying, plus the silver (and gold) found by assaying the slag and cupel, which may be called the by products of the assay, and which contain, on an average, 1.3 per cent. of the full value of the sulphides.

The following table gives the fineness of products in gold for 1891 and 1892.

TABLE IV.

FINENESS OF PRODUCTS IN GOLD.
1891-1892.

Year.	Ontario Bullion.	Marsac "Regular" Sulphides.	Marsac Total Sulphides.	Marsac Bullion.	Net price obtained per ounce for gold.	
					$	
	Fine.	Fine.	Fine.	Fine.	Ontario	Marsac
1891	.00025	.00034	.00026	No Sulphides refined at Mill.	0.00	20.00
1892	.00023	.00041	.00032	.00097	20.67	20.67

The table for 1892 goes up to Sept. first only. Both of the above products of the Marsac are finer in gold than the bullion of the Ontario.

Table V covers only the year of 1891, as no comparisons are made on these points, except at the end of the year, and, therefore, can not now be given for 1892.

TABLE V.

WATER, CHEMICALS, IRON AND POWER.
1891.

Water used per ton.		Total Chemicals and quicksilver per ton.		Wrought and cast iron consumed per ton.		Power for driving pans, stirring & handling solution, pressing and grinding product.		Machinery Expense.	
Ontario.	Marsac	Ontario.	Marsac.	Ontario.	Marsac.	Ontario.	Marsac.	Ontario.	Marsac,
Cubic feet.		$		lbs.		H. P.		$	
400	56	1.315	0.900	5.5	0.05	108	8	0.31	0.07

The figures given on consumption of iron represent the amount actually consumed, *i. e.*, the amount purchased, less the amount sold as "scrap" to foundries and smelters.

The amount of water given for Marsac includes that used for sluicing out tailings, which is about 16 cubic feet per ton of ore.

The cost of chemicals per ton of ore for 1890 was $0.658, and for 1891 $0.825, an increase per ton of $0.167.

This increase is due to use of warm solutions and baser ore. A comparison of results is of interest.

STATEMENT E.

1890	Value of ore	37.31 ozs.
1891	" "	39.10 ozs.
1890	Mill Extraction, cold solution, 50° F	88.77 per cent.
1891	" " warm solution, 100° F	91.57 per cent.
1890	Cost of chemicals, per ton of ore	$0.658
1891	" " " "	$0.825

TABLE VI.

COMPARISON OF CHEMICALS CONSUMED AT MARSAC MILL WITH COLD (50°) AND WARM (100°) SOLUTION.
1890—1891.

Year.	Solution how used.	Chemicals consumed per ton of ore.	Cost of chemicals per ton of ore.	Chemicals per oz. of silver produced	Cost of chemicals per oz. of silver produced.	Silver value of ore treated.	Actual extraction based on raw ore value
	O. Fah.	lbs.	$	lbs.	$	oz.	per cent.
1890	Cold (50 F)	13.51	0.658	.424	0.0175	37.31	88.77
1891	Warm (100 F)	18.75	0.825	.521	0.0229	39.10	91.57

NOTE.—The cost of Marsac chemicals in Table V is for total mill chemicals, of which only $0.825 belongs to the leaching department.

The above figures show a gain of 2.8-10 per cent. in extraction for 1891, with warm solutions, over 1890, when cold solutions were used, amounting to 1.095 oz. per ton of ore.

STATEMENT F.

24,214 tons treated at 1.095 oz. additional extraction		26,514.33 ozs.
Less extra cost of chemicals per ton of ore	$0.167	
" " " " steam for heating solution	0.02	
Total extra cost per ton	$0.187	
Making total extra cost for year		$ 4528.01
26,514.33 ozs. silver at average value 97c		$ 25,718.90
Total extra cost for year		4,528.01
Net gain for year		$ 21,190.89

The total cost of all steam to leaching department is $0.1297 per ton of ore. This includes steam for—

Air compressor, which supplies air for stirring wash-water and solutions.
Elevating solution to storage tanks, and pressure tank for pressing all products.
Heating all solutions and wash water.
Dissolving caustic soda in making sodium sulphide.
Ejectors for leaching vats.
Ejectors for filtered solution.
Engine for precipitate grinder.

The cost of heating solutions is not over $0.02 per ton of ore.

Tables VII and VIII.—These give comparative figures, by months, between amalgamation at the Ontario, and the Russell process at the Marsac, for 1891, using warm solutions. Coarser crushing could probably be adopted at the Marsac without decreasing the extraction percentage. Little, however, would be gained by the change, as the capacity of the Mill would still be limited by the capacity of the Ore Driers, which are already being run to their limit. The Stetefeldt Furnace, with a slightly increased draft, could probably treat 125 tons per day. In former years, while working decomposed ore from the upper levels of the Daly Mine, which crushed very easily, as high as 95 tons per day have been roasted.

The comparison of fuel is between wood at the Ontario and coal at the Marsac. While wood was used at the Marsac the amount consumed was about .114 cords as against .153 cords at the Ontario.

The temperatures represent that in the amalgamation pans and that of the solution running out of the ore vats. Of course the amount of water to be heated for amalgamation is much less than that of the solutions for leaching. It is not always necessary, however, to heat the leaching solutions, but as warm solutions filter more rapidly than cold, where the leaching rate is slow, or vat capacity insufficient, the using of warm solution permits of increased volume. The rates of leaching cold and warm solutions, at Marsac, is as two and one-half to three.

TABLE VII.

PREPARATION OF THE ORE.

1891.	Weight of ore treated per month.		Fineness of crushing.		Fuel used per ton in roasting.		Rate of roasting per furnace per day.		Per cent. of salt used in roasting.	
	Ontario.	Marsac.	Ontario.	Marsac.	Ontario.	Marsac.	Ontario.	Marsac.	Ontario.	Marsac.
Month.	Tons.		Mesh of screen.		Cords wood.	Tons Coal.	Tons.		Per cent.	
January	2311	2112					38.5	68.1	14.4	8.27
February	2057	1915					36.7	69.5	13.2	8.32
March	2287	2169					36.9	70.0	12.8	8.45
April	2129	2126					35.5	70.9	13.0	8.20
May	1937	2079					31.3	67.1	13.1	8.06
June	2263	1301	26	20	.153	.087	37.7	68.5	14.0	8.23
July	2122	2128					34.2	68.5	14.6	8.18
August	2164	2085					35.0	69.5	13.8	8.23
September	2075	2029					34.6	67.6	14.6	8.14
October	2084	2073					33.6	67.0	14.7	8.39
November	2057	1975					34.3	65.9	14.1	8.25
December	2164	2222					35.5	73.5	14.4	8.40
Totals and Averages,	25650	24214	26	20	.153	.087	35.1	70.0	13.9	8.26

The actual running time of battery at Marsac was 5.2 days more than Ontario.

TABLE VIII.

WEIGHT OF CHARGES, TEMPERATURES, LABOR, CHEMICALS AND MILL EXTRACTION.

1891.	Weight of each charge to pans and vats.		Temperature in pans and vats.		Labor on pans, vats and product shipm't.		Chemicals and quicksilver in use.		Silver extraction in mill by daily samples.	
	Ontario.	Marsac.	Ontario.	Marsac.	Ontario.	Marsac.	Ontario.	Marsac.	Ontario.	Marsac.
Month.	Tons.		F°		$		$		Per cent.	
January	1.3	72.0	160	100	0.46	0.32	9360	385	91.1	92.0
February					0.43	0.31			92.4	92.7
March					0.48	0.31			91.9	92.5
April					0.46	0.30			92.9	91.4
May					0.49	0.32			88.1	90.5
June					0.45	0.32			88 6	91.2
July					0.46	0.32			90.7	92.7
August					0.45	0.31			92.5	92.8
September					0.43	0.32			91.1	90.9
October					0.45	0.32			90.4	90.4
November					0.48	0.33			91.4	92.7
December					0.43	0.29			88.9	91.9
Averages	1.3	72.0	160	100	0.46	0.31	9360	385	90.8	91.8

The chemicals and quicksilver represent the cost of what is actually in use at any given time, but does not include the supply in store. For the Ontario the amount, $9560, is the actual value of the quicksilver in *circulation;* and for the Marsac, $385 is the actual value of the hyposulphite, bluestone, caustic soda, sulphur and soda ash in the leaching and precipitating solutions.

The following table gives the per cent. of salt used, and the extraction of silver at the Ontario and Marsac Mills, by months, for 1892, up to December first, the fineness of crushing being the same, and other statistics approximately the same, as given in Tables 7 and 8.

The word "extraction," as employed in connection with the Russell Process means "apparent extraction" from the material charged to the leaching vats, unless it is stated to be "actual." In calculating "apparent extraction" only the values *per ton* of ore and tailings, and the per cent. of soluble salts in the ore, need be obtained; while for determining "actual extraction" the total value of material treated, and the "clean up," must be known. With the term "actual extraction," are used also the expressions "from raw ore," or "from roasted ore," and to be accurate it must also be stated whether the extractions are based on the "apparent values" or on the "exact values," the latter value including the 5 to 15 per cent. of silver and gold which may enter the slag and cupel in assaying ores and tailings. Unless otherwise stated "apparent values" are understood.

TABLE IX.

PER CENT. OF SALT USED AND MILL RESULTS.

1892.

Month.	Per Cent. of Salt Used.		Extraction of Silver.	
	Ontario. Per Cent.	Marsac. Per Cent.	Ontario. Per cent.	Marsac. Per Cent.
January	13.9	10.0	89.9	91.5
February	13.2	9.5	92.0	92.7
March	13.8	9.5	92.4	91.6
April	13.9	9.5	92.5	92.8
May	13.7	10.1	89.5	92.3
June	15.2	9.4	90.2	88.1
July	14.6	8.9	88.5	92.2
August	14.0	9.3	90.4	92.5
September	13.8	8.9	91.2	92.5
October	15.0	9.6	90.4	92.8
November	15.0	9.4	91.5	92.4
Average	14.2	9.5	90.8	91.9

When red hot ore is "wet down" the steam produced causes a reduction of some of the silver compounds to a state in which they are not readily soluble in the leaching solutions.

This injurious effect is greater on some ores than on others, and on ore from the same mine is greater in proportion to its baseness.

The mill extraction at the Marsac would be about 2 per cent. higher, or 94 per cent. if the ore were charged dry and cool to the ore vats, instead of "wetting it down" on the cooling floor while red hot, as is now done. This would require an enlargement of the present cooling floor, and an additional expense of about thirteen cents per ton in handling the ore. For instance, at the Aspen Mill, which has a large cooling floor and where the roasted ore is always charged dry and cool to the ore vats, the total cooling floor expenses, from the time the red hot ore is dumped on the floor up to and including the charging of the ore to the leaching vats, are 49 cents. The corresponding expenses at the Marsac are 36 cents per ton.

The results given in the following table illustrate the injurious effect of wetting down base ore, the ore treated being composed of milling and shipping ore in the proportion produced at the mine.

TABLE X.

EFFECTS OF "WETTING DOWN," WHILE RED HOT, BASE ONTARIO ORE.

Mesh of Screen on Battery.	Per cent. of Salt used in Roasting.	Silver, Value of Raw Ore per ton.	Per cent. Extraction by Leaching in Mill.
Mesh.	Per cent.	Ozs.	Per cent.
30	—15 to 17—	104.0	82.6
30		85.2	81.3
30		80.8	78.8
30		87.3	84.0
30		108.0	87.0
30		101.0	87.2
30		107.0	88.4
30	15-17	96.3	84.2

The mill extractions on charges of the same kind of ore *not* wet down, but charged dry and cool to the ore vats were from 92 to 93 per cent.

At Aspen the average assay office extractions from roasted ore *not* wet down while hot on cooling floor are 81.4 per cent. by the old leaching process, and 92.5 per cent. by the Russell Process. If the same ore is wet down on the cooling floor while hot the above results become about 66.0 per cent. and 87.0 per cent. respectively, or in other words, they are lowered 15 and 5 per cent.

The results given in the following table are an illustration of what can be done on Ontario ore (or on Marsac) by the Russell Process, if the ore is *not wet down* while red hot, but charged dry and cool to the ore vats, as is done at Aspen. These mill runs, on which statistics are given in Table XI, were made at the Ontario Mill, the ore being roasted in the Stetefeldt Furnace and leached in the experimental plant at that mill. The ore treated in the first three runs (26, 20 and 16 mesh screens), was composed of a mixture of shipping and milling ore, or an average of all the ore produced by the Ontario Mine.

The analysis of this ore was approximately as follows:

STATEMENT G.

Silica	55.21 Per Cent.
Alumina	13.14 "
Zinc	9.60 "
Lead	6.07 "
Sulphur	7.68 "
Iron	2.77 "
Copper	1.41 "
Antimony	1.20 "
Manganese	0.45 "
Arsenic	0.20 "

TABLE XI.

MILL RUNS BY RUSSELL PROCESS ON ONTARIO ORE.

Charged Dry and Cool to Leaching Vats.

Mesh of Screen and size of Wire used on Battery.	Tons Crush'd in 24 hours per Stamp	Tons Roast'd per day by one furn'ce	Cords of Wood used in furn'ce per ton	Horse Power req'rd for furn'ce	Labor per ton including the Roasting and Piling on the Cooling Floor.	Per cent. of Salt.	Per cent. Mill Extraction by Amalgamation.	Per cent. Mill Extraction by Russell Process.
26 Mesh 32 Wire	2	40	1/8	1/2	56 cts.	16	89.2	93.6
20 Mesh 28 Wire	2 3/4	55	1–10	1/2	48 "	12 1/2	Too	97.0
16 Mesh 26 Wire	3 1/2	70	1–12	3–5	41 "	12	coarse	97.1
10 Mesh 23 Wire	4 1/2	94	1–16	1	34 "	14	for	93,4
6 Mesh 20 Wire	6 1/3	126	1–20	1 1/2	26 "	8	Amalgamation.	91.9

NOTE.—Average results by Amalgamation at Ontario, with 26 mesh screen, are 91.0 per cent.

The Ontario now mills, on an average (for 365 days per year), 70.3 tons, of the analysis given at the beginning of this article, and, for lack of milling capacity, ships to the smelters 31.1 tons, averaging, so far, for 1892, 14.94 per cent. Lead and 6.53 per cent. Zinc. But the average of the two, or the total product of the mine, contains 5.93 per cent. Zinc and 5.83 per cent. Lead, or 3.67 per cent. less Zinc and 1/4 of 1 per cent. less Lead than previously to 1884, when all the ore was milled.

The mill results at that time by the Russell Process were as given in Table XI, with 26, 20 and 16 mesh screens, and 16, 12½ and 12 per cent. salt, the roasted ore being charged dry and cool to the ore vats. To mill the 100 tons, present total product of the Ontario, instead of milling 70 and shipping 30, would result in largely increased profits to the Company.

The value of gold in the ore is so small that the amount treated and extracted is not figured up until the end of the year, and so cannot yet be given for 1892.

The following table gives the results for 1891:

TABLE XII.

ACTUAL EXTRACTION OF GOLD. (RAW ORE.)
1891.
(1 oz. gold=$20.67.)

Mill.	Gold Value per Ton of Ore.	Total Gold in Ore for Year.	Actual Gold in Product.	Per Cent. Extraction of Gold.	Amount Realized on Gold.
	$	$	$	Per Cent.	$
Ontario	0.91	23,341.50	10,991.90	47.09	0.0
Marsac	0.91	22,034.74	15,727.59	71.37	15,182.20

The amount and cost of chemicals per ton of ore at the Marsac for 1891 is as follows, the prices given being the average cost laid down at the mill:

STATEMENT H.

LIXIVIATION DEPARTMENT.

Bluestone	3.24 lbs.	@	.0641 =	$0.2076
Hyposulphite of Soda	6.32 lbs.	@	.0362 =	0.2287
Caustic Soda	4.95 lbs.	@	.0555 =	0.2747
Sulphur	3.32 lbs.	@	.0257 =	0.0853
Soda Ash	0.92 lbs.	@	.0317 =	0.0292
	18.75 lbs.	@	.0440	$0.8255

BATTERY.

Sulphur, to raw ore	2.89 lbs.	@	.0257 =	$0.0743
Total Chemicals per Ton	21.64 lbs.	@	.0416 =	$0.8998

The sulphur to battery is amount added to raw ore to assist in roasting. It will be noticed that the Daly ore carries only one-third the amount of sulphur contained in Ontario ore.

The following figures give the expenses at Marsac Mill, (classified under five heads) from time the ore is piled on the cooling floor after roasting, until the sulphide product is dried and ready for shipment, or treatment in the Marsac Refinery.

These figures include the transferring of the ore from the cooling floor to the ore vats.

STATEMENT I.

COST OF LIXIVIATING DEPARTMENT.

RUSSELL PROCESS.

MARSAC MILL.

Labor.

1 Foreman,	@ $5.00	$ 5.00
3 Leachers,	@ 4.00	12.00
8 Shovelers,	@ 3.00	24.00
1 Pressman,	@ 3.50	3.50
1 Roustabout	½ @ 3.00	1.50
		$46.00

365 days @ $46.00 = $16,790.00 ÷ 24,214 tons = $ 0.6934

Chemicals.

Hyposulphite	152,808 lbs.	@ .0362 =	$5,531.64	
Bluestone	78,569 lbs.	@ .0641 =	5,036.27	
Caustic	119,741 lbs.	@ .0555 =	6,645.62	
Sulphur	80,486 lbs.	@ .0257 =	2,068.49	
Soda Ash	22,309 lbs.	@ .0317 =	707.19	
	453,913 lbs.	@ .0440	$19,989.21	

$19,989.21 ÷ 24,214 tons = $ 0.8255

Repairs.

1 Machinist	@ $4.00
Material and Supplies	@ 2.50
	$6.50

$6.50 X 365 days = $2,372.50 ÷ 24,214 tons = $ 0.0979

Power, Steam, Etc,

Total cost for mill, labor, fuel, supplies and all repairs $12,559.55

Proportions by Actual Test.

Drying, Crushing and Roasting.....$\frac{3}{4}$
Leaching Department.....$\frac{1}{4}$

$12,559.55 ÷ 4 = $3,139.89 ÷ 24,214 tons = $ 0.1297

Assay Office.

Labor, fuel and supplies, actual.....$3,013.23
Leaching Department, proportion $\frac{2}{3}$..... 2,008.82

$2,008.82 ÷ 24,214 tons = $ 0.0830

Total cost per ton of Ore, - - - $ 1.8295

SUMMARY.

The following table gives a summary of the comparisons between the Ontario and Marsac Mill expenses and extractions, for 1891.

NOTE—The "Product Expense" given below, while apparently in favor of Ontario, is, in reality, slightly in favor of Marsac, as the product of the latter mill happened to be sold at times when silver averaged lower in price than when Ontario product was disposed of.

STATEMENT J.

COMPARISON OF ONTARIO AND MARSAC

From Companies' Annual Report.

MILL EXPENSES.

		Cost per ton of Ore.
ONTARIO—Amalgamation.		
Milling	$8.93	
Product Expense	1.23	
		$10.16
MARSAC—Russell Process.		
Milling	$6.27	
Product Expense	1.23½	
		$7.50½
Total difference in Mill expenses		$2.65½

ACTUAL EXTRACTION OF SILVER. (RAW ORE)

ONTARIO.	Actual Mill Extraction	91.0
MARSAC.	Actual Mill Extraction	91.57
Difference in Mill Extraction		0.57%
Difference in Mill Extraction for 39.10 ozs. ore,		$0.21½

ACTUAL EXTRACTION OF GOLD. (RAW ORE.)

(See Table XII.)

ONTARIO.	Mill Extraction, Gold Realized $0.0	
MARSAC.	Mill Extraction, Gold Realized per ton 0.63½	
	Difference per ton in favor of Marsac.....	$0.63½
	Total net difference per ton in favor of Marsac	$3.50½

RECAPITULATION. (Ontario Tonnage.)

25,650 tons of ore milled in 1891, at difference of $3.50½ per ton (or saving by Marsac over Ontario, per year).....	$91,057.09

In the case of most ores, a comparison as to extraction, etc., between amalgamation and the Russell Process would probably be much more in favor of the latter, as there are but few mills in which as good work is done as at the Ontario. Against the twenty-two points of comparison given below, amalgamation exceeds the Russell Process in one point only, viz: Fineness of product in silver (Table III). Although for this year (1892) even this one point will be in favor of Lixiviation, the product now being refined at the mill, while in 1893 the product will be both refined and "parted."

The Russell Process has the advantage over amalgamation in the following twenty-two points, the difference (omitting cost of plant) amounting to over $3.00 per ton of ore.

1.—Coarseness of crushing.	(Tables 1, 7 and 11.)
2.—Percentage of salt used.	(" 7, 9 and 11.)
3.—Fuel consumed.	(" 7 and 11.)
4.—Capacity of roasting furnace.	(" 7 and 11.)
5.—Weight of charges.	(Table 8.)
6.—Water used.	(" 5.)
7.—Labor.	(Statement A.)
8.—Power.	(Table 5.)
9.—Machinery expense.	(" 5.)
10.—Temperatures.	(" 8.)
11.—Iron.	(" 5.)
12.—Chemicals per ton.	(" 5.)

13.—Chemicals in use.	(Table 8.)
14.—Extraction of silver.	(Tables 8, 9 and 11.)
15.—Extraction of gold.	(Table 12.)
16.—Less copper—baseness of product.	(" 2.)
17.—Cost of marketing silver.	(" 3.)
18.—Cost of marketing gold.	(Tables 4 and 12.)
19.—Fineness of product in gold.	(Table 4.)
20.—Total cost of treatment.	(Statement J.)
21.—Net profits per ton.	(Statement J.)
22.—Less cost of plant.	(Statement A.)

Or the comparison may be stated as follows, using Marsac figures as a basis:

To treat about the same number of tons of ore per day, of approximately the same composition as at the Marsac, the Ontario (amalgamation) requires 45 per cent. more power, 39 per cent. more labor, 30 per cent. more stamps, twice the number of furnaces, 48 per cent. more salt, and 40 per cent. greater cost of chemicals, and yet yields a less per cent. both of gold and silver than the Marsac (Russell Process).

NOTE.—The Ontario Company are now erecting a Russell Process Leaching Plant, of 200 tons daily capacity, for the treatment of *old tailings* which have been produced from their mill by amalgamation in former years.

These tailings will be transferred directly from the "pits" to the leaching vats and leached without any drying, crushing, roasting or other preliminary treatment. The actual extraction from these tailings by the Russell Process averages 36 per cent. of the Silver and 64 per cent. of the Gold, at a total expense of $1.16, including hauling, loading and treatment.

The Ontario Company are also proposing to erect a Russell Process Leaching department to replace their present amalgamating plant, which will be discarded.

All crushing and roasting will be done in the present mill, the roasted ore being thence transferred to the leaching vats, instead of to the amalgamating pans as formerly.

The entire product of the Ontario Mine, averaging 70 tons milling and 31 tons smelting ore, per day, will then be treated by the Russell Process, in the new plant which will have a capacity of 100 to 110 tons of *ore* per day.

The total cost of the whole 300-ton plant is estimated at $75,000, exclusive of grading.