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RECOVERY OF GOLD FROM A MAGNETIC BLACK SAND.

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Introduction:

Six tests were made by the Alaska Station of the Bureau of Mines on a sample of black sand delivered to the station by Messrs. James, Eagan & Griffen from Fairbanks Creek, Fairbanks mining district, Territory of Alaska, to devise a method of recovering the gold content.

More than 90 per cent of this black sand consisted of magnetite and garnet which can be separated magnetically. The Station has no equipment for magnetic separation other than an electromagnet similar to the one used by Day and Richards, (Day, D.T., and Richards, R.H., Investigations of Black Sands from Placer Mines, U. S. Geol. Survey, Bull. 285, 1906, pp. 160-163), which can only be used satisfactorily on small samples. To treat the entire lot of black sand with this machine would have been impracticable. Therefore only a small part of the sand was so treated, the rest being divided into five lots in order to obtain comparative results from other methods of treatment.

Preliminary Treatment:

The sand was dried. The oversize from a 10-mesh screen, which was found to be free from gold, was discarded.

Mercury had been added to the sand before delivery to the Station, with the result that some of the gold was amalgamated but no free mercury was present.

After sampling, there remained for testing purposes 112 pounds. This was accurately divided into 4 portions weighing 14 pounds each and 2 portions weighing 28 pounds each.

Methods of Treatment:

The following methods were used and the results reported are for gold only:

Test 1 - Magnetic Separation. 14 pounds were separated by the electro-mag into three products; magnetite, garnet and nonmagnetic material. The ma and the garnet were assayed; the nonmagnetic material was panned, and th ing was assayed:

The results obtained were as follows:

	Weight Pounds	Assay Ozs Per Ton	Contents Troy Ozs	Contents Per Cent
Bullion recovered.....	0.1	---	0.0951	94.16
Magnetite.....	2.7	0.10	0.0001	0.10
Garnet.....	10.6	0.81	0.0043	4.26
Nonmagnetic tailing.....	0.6	4.96	0.0015	1.48
	14.0	14.428	0.1010	100.00

Test 2 - Amalgamation. 14 pounds were amalgamated for 4 hours in an Abbe pebble mill. Water in the proportion of 1 of water to 2 of sand was added, with caustic soda equal to 2 pounds per ton of sand.

The results obtained were as follows:

	Weight Pounds	Assay Ozs Per Ton	Contents Troy Ozs	Contents Per Cent
Bullion.....	0.1	---	0.1098	97.00
Tailing.....	13.9	0.49	0.0034	3.00
	14.0	16.171	0.1132	100.00

Test 3 - Amalgamation. 14 pounds were amalgamated for 4 hours in an Abbe pebble mill. Water in the proportion of 1 of water to 2 of sand was added, with cyanide in the proportion of 1 of cyanide to 800 of sand, in order to brighten the gold and render it more amenable to amalgamation.

The results obtained were as follows:

	Weight Pounds	Assay Ozs Per Ton	Contents Troy Ozs	Contents Per Cent
Bullion.....	0.1	---	0.0976	88.89
Solution.....	---	---	0.0047	4.28
Tailing.....	13.9	1.08	0.0075	6.83
	14.0	15.686	0.1098	100.00

Test 4 - Amalgamation. This test differed from Test 3 only in that the sand was allowed to soak in the cyanide solution for 42 hours before amalgamation was started.

The results obtained were as follows:

	Weight Pounds	Assay Ozs Per Ton	Contents Troy Ozs	Contents Per Cent
Bullion.....	0.1	---	0.1000	89.77
Solution.....	---	---	0.0104	9.33
Tailing.....	13.9	0.14	0.0010	0.90
	14.0	15.914	0.1114	100.00

Test 5 - Table Concentration. 28 pounds were treated on a Card table without previous classification. A concentrate and a tailing were obtained. Some thin flakes of gold passed into the tailing.

The concentrate was amalgamated in an Abbe pebble mill for 4 hours.

The results obtained were as follows:

	Weight Pounds	Assay Ozs Per Ton	Contents Troy Ozs	Contents Per Cent
Bullion	0.2	---	0.1871	86.10
Table Tailing	22.3	2.39	0.0266	12.24
Concentrate after amalgamation	5.5	1.30	0.0036	1.66
	28.0	15.521	0.2173	100.00

Test 6 - Classifier Concentration. 28 pounds were treated in a one-spigot Richards vortex classifier, the velocity of the upward stream in the sorting column being 35 feet per minute. From this classification a concentrate and a tailing were obtained.

The concentrate was amalgamated in the same manner as the table concentrate.

The tailing was screened wet on a 40-mesh screen, the undersize being amalgamated in the Abbe pebble mill.

The results obtained were as follows:

	Weight Pounds	Assay Ozs Per Ton	Contents Troy Ozs	Contents Per Cent
Bullion from concentrate	0.2	---	0.2017	91.94
Bullion from fine tailing	---	---	0.0079	3.60
Classifier coarse tailing	16.2	0.97	0.0079	3.60
Classifier fine tailing after amalgamation	2.9	0.16	0.0002	0.09
Concentrate after amalgamation	8.7	0.38	0.0017	0.77
	28.0	15.671	0.2194	100.00

COMPARATIVE RESULTS

The following results from the different tests are given for gold only:

	Pounds Treated	Total Recovery	Per Pound Recovery Loss Cents		Per Cent Recovery
Test 1 -					
Magnetic Separation.....	14	$1.966	14.04	0.87	94.16
Test 2 -					
Amalgamation, no cyanide..	14	2.270	16.21	0.50	97.00
Test 3 -					
Amalgamation, cyanide....	14	2.017	14.41	1.80	88.89
Test 4 -					
Amalgamation, cyanide....	14	2.067	14.76	1.69	89.77
Test 5 -					
Table Concentration.....	28	3.867	13.81	2.23	86.10
Test 6 -					
Classifier Concentration.	28	4.332	15.47	0.72	95.54

From the results obtained it is evident that Test 2, which involved amalgamation in a barrel using a small amount of caustic soda, gave the best recovery.

Classifier concentration and amalgamation of the concentrate, which necessitated amalgamating only 32 per cent of the original sand, gave a gold recovery of 91.94 per cent, and by amalgamating that portion of the tailing finer than 40 mesh the recovery was increased to 95.54 per cent.

The recovery obtained by magnetic separation was fairly satisfactory and could probably have been improved by amalgamating the non-magnetic product instead of panning it. However, this method of treatment can not be profitably used in the placer mines of Alaska.

The use of cyanide, as in Tests 3 and 4, resulted in a gold loss of 4.28 per cent where the cyanide was added at the time of amalgamation, and 9.33 per cent where the cyanide was added 42 hours before amalgamation. These losses represent a loss of 2/3 cents and 1½ cents per pound respectively. The loss per pound would increase with the value of the sand and where much fine gold is present the loss would be relatively much greater.

The recovery of the gold by table concentration proved to be disappointingly low. This recovery would possibly have been greater had classification been resorted to prior to table treatment, but it had been decided that the value of the sand would not warrant classification before table concentration.

Recommendations:

Black sand, such as that treated, can be satisfactorily treated by amalgamation in a revolving barrel. Caustic soda should be used as an aid in this amalgamation. The use of cyanide during amalgamation or before amalgamation will result in a loss of 5 to 10 per cent of the gold through its dissolving action.

If the quantity of sand is too great to amalgamate the entire amount, it may be concentrated by employing a classifier, whereby the bulk is reduced to approximately 40 per cent of its original weight with very little gold loss. The coarser portion of the sand, which is free from gold, should be removed from the classifier feed. The water supply should be constant so that the upward stream in the sorting column of the classifier does not vary from 35 feet per minute.

If much of the gold is very fine the classifier overflow or tailing should be passed over a screen to separate the finer portion which may then be amalgamated in the revolving barrel. -- U. S. Bureau of Mines, Reports of Investigations.
