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WILLIAM TROTTER, OF NEW YORK, AND ELTOFT WRAY WILKINSON, OF QUEENS VILLAGE, NEW YORK, ASSIGNORS TO MINERALS SEPARATION NORTH AMERICAN CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF MARYLAND

CONCENTRATION OF PHOSPHATE-BEARING MATERIAL

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This invention relates to the concentration of phosphate-bearing material and is herein illustrated as applied to the concentration of phosphate-bearing rock Florida phosphate pebble, by the aid of organic soaps such as the oleates of the amines.

It is found that certain organic soaps produced by the combination of a fatty acid and an amine, especially those which are made from amines in which the nitrogen is connected to a carbon atom carrying also at least two hydrogen atoms, are very effective flotation agents. It has been found that such soaps made with oleic acid are highly effective.

In the following tests the material used was the reject from a sieving process of concentration of phosphate from No. 11 mine of International Agricultural Corporation at Mulberry, Florida, containing about 23 per cent of the phosphate known as bone phosphate of lime. This material was mostly 20-mesh or finer and was deprived of most of its slimes, as this facilitated obtaining a rich concentrate and diminished the consumption of reagents.

In one test this material was made into a pulp with water and agitated in a minerals separation subaeration machine of the box type, and agitated with 2.5 pounds per ton of a soap made by mixing equimolecular proportions of the alkyl amine known as diethylamine, $(C_2H_5)2NH$, and oleic acid. This product was soapy and was soluble in water. It was added to the pulp in a five per cent solution. There was also added four pounds per ton of a liquid substantially immiscible in water such as fuel oil. The resulting float was collected and was found to contain 68.8% of bone phosphate of lime which was 85.7% of the bone phosphate of lime in the crude material treated.

An equally rich concentrate was obtained when triethylamine was substituted for the diethylamine, but the total recovery was a few percent smaller.

In another test the soap was replaced by a soap made from oleic acid and commercial triethanolamine, soluble under the conditions used and containing about 3 parts of the hydroxy amine known as triethanolamine, 1 part diethanolamine and a trace of monoethanolamine. The other conditions of this test were identical. The resulting float was collected and found to contain 67.2% of bone phosphate of lime and which was 66.4% of the bone phosphate of lime in the crude material treated.

A somewhat inferior result was obtained when the fuel oil was omitted, both the grade and percentage of recovery being in the neighborhood of 1% lower.

In another test, using the four pounds per ton of fuel oil, the soap above described was replaced by the soap isoamylamine oleate. In this test another similar sample of the same ore was used with the same amount of fuel oil, the soap in this case being dissolved in the fuel oil. The results are shown in the following table, the concentrates being retreated twice without addition of reagents. B. P. L. represents bone phosphate of lime.

	Weight	B. P. L.	B. P. L. recovery
	Per cent	*Per cent*	*Per cent*
Heads	100.	25.0	
Concentrates	28.0	65.0	72.8
1st middlings	33.4	9.0	12.2
2nd middlings	12.2	15.6	7.6
Tails	26.4	7.4	7.6

Other tests indicated that there was no material advantage in dissolving the soap in the oil, but that sometimes the best results were obtained when the base was first added to the aqueous pulp and the requisite fatty acid was added later in the theoretical proportions, so that the soap was made in situ. In some cases better results were obtained when, instead of adding equimolecular pro-

portions of amine base and fatty acid, an excess of amine was added.

Another sample of the same phosphate-bearing material was concentrated by agitation in an aqueous pulp with 2.5 pounds of benzylamine oleate and 4 pounds of Oklahoma fuel oil, both per ton of solids. The results are shown in the following table:

	Weight	B. P. L.	B. P. L. recovery
	Per cent	*Per cent*	*Per cent*
Heads	100.	24.59	
Concentrates	34.9	57.6	81.7
Tails	65.1	6.9	18.3

Another sample of the same phosphate-bearing material was concentrated by agitation in an aqueous pulp with 2.5 pounds of the soap obtained when diethylamine reacted with equimolecular proportions of stearic acid. It was found that excellent results were obtained without the addition of fuel oil or other liquid immiscible with water. The crude ore added to the pulp contained about 23% of bone phosphate of lime. The concentrate carried 69.8% of bone phosphate of lime which was 53.8% of the bone phosphate of lime in the crude material treated.

If it is desired to obtain a very rich concentrate the soap may be made with an amine and with the distilled fatty acids of cocoanut oil instead of with oleic acid. The resulting flotation agent was found to yield a rich concentrate although the recovery was found to be less than with a corresponding oleic acid soap.

It has been found that in some instances carbon tetrachloride may be substituted for the fuel oil.

Very good results were obtained when Tennessee phosphate rock was used as the phosphate-bearing material to be concentrated. Cassiterite and coal have been found to be amenable to concentration by this process.

Table tailings of the Anaconda Copper Mining Co. treated by this procedure yielded a high recovery and a low grade concentrate capable of being recleaned.

48-mesh Calumet and Hecla table middlings from the regrinding plant, assaying about 6% native copper, treated with 3 pounds per ton of diethylamine oleic acid soap with the further addition of one-half pound of potassium xanthate per ton, yielded a concentrate assaying 40.6% copper, with a recovery of 75.8% of the copper present.

Having thus described certain embodiments of the invention what is claimed is:

1. The process of concentrating phosphate-bearing material which consists in agitating a pulp of the fine material with a soap produced by the combination of fatty acid and an amine, and separating the float.

2. The process of concentrating phosphate-bearing material which consists in agitating a pulp of the fine material with a soap produced by the combination of fatty acid and an amine in which the nitrogen is connected to a carbon atom which carbon atom is connected to at least two hydrogen atoms, and separating the float.

3. The process of concentrating phosphate-bearing material which consists in agitating a pulp of the fine material with a small quantity of a soap produced by the combination of oleic acid with an alkyl amine, and separating the float.

4. The process of concentrating phosphate-bearing material which consists in agitating a pulp of the fine material with a small quantity of a soap produced by the combination of oleic acid with an alkylamine, with the further addition of a liquid substantially immiscible in water, and separating the float.

In testimony whereof, we have affixed our signatures to this specification.

WILLIAM TROTTER.
ELTOFT WRAY WILKINSON.