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METHOD OF FLOTATION OF OXIDIZED ORES

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This discovery relates to a process of recovering values from oxide ores as distinguished from those of the sulfide type.

Throughout this specification the term "oxidized ore", "oxide ore", or "non-sulfide ore" are intended to designate an ore in which the metal values are present substantially as non-sulfide compounds. In such ores the metal values may occur as carbonate, sulfate, oxide, or as some other oxygenated compound of the metal. Such ores have usually been formed in nature by oxidation of the original sulfides, and consequently, they may contain small amounts of unaltered sulfides. As far as the present discovery is concerned, however, such sulfides are present incidentally.

The recovery of sulfide minerals by the flotation process is now highly developed and reagents adapted thereto are well known in the art. Heretofore, however, the flotation concentration of oxide ores has been very unsatisfactory. Practically all of the proposed methods have involved a preliminary sulfidization of the oxide component in an attempt to produce upon the surface of the mineral a coating of sulfide which would render it susceptible to ordinary sulfide flotation reagents. This sulfidization operation has proven very troublesome in practice, partly because some of the oxide minerals sulfidize with difficulty, if at all, and partly because the sulfidizing reagent frequently introduces complications and difficulties in the operation of the flotation cell.

The essence of my invention is that I recover such oxide minerals without preliminary sulfidization by employing a reagent or combination of reagents adapted specifically to the flotation of such oxide minerals.

Certain of the reagents specified in this application are well known in the recovery of sulfides. It does not follow, however, that sulfide reagents are applicable to oxide flotation, and, as a matter of fact, there is no theory of reasoning by which one could conclude that a sulfide flotation reagent would operate efficiently on oxides. The entire history of the flotation art has shown that the reverse is true. According to prior practice, values present in non-sulfide form were either recovered by sulfidization or were lost with the tailings. In the present invention, however, by suitable selection of reagents, I am enabled to recover the non-sulfide minerals by froth flotation by the use of a reagent combination adapted to the recovery of such specific minerals.

The reagents employed in flotation serve a number of specific purposes and may in general be divided into three classes: First, collectors or promoters whose function is to collect into aggregates the mineral to be floated, and probably to attach such aggregates to the bubble; second, frothing agents whose purpose is to supply the bubble which is essential for the raising of the heavy mineral particles from the ore pulp; and third, reagents known as conditioning reagents whose exact function is obscure but which probably serve a variety of purposes, such as freeing the solution from soluble heavy metal salts which, if not so removed, would themselves consume the more expensive collectors, and possibly also to establish a proper hydrogen-ion concentration.

The use of such collectors as potassium ethyl xanthate, thiocarbanilid and the dithiophosphates is old in the flotation of sulfide minerals.

I have discovered that the glycines in alcoholic solution and derivatives thereof, the xanthates and their salts when used in combination with a frother such as pine oil, the organic cyanamides and the disubstituted dithiophosphoric acids and their salts are effective in floating maximum concentrates of oxide ores.

The following tables show these reagents as used with pulps containing the red copper oxide cuprite, the blue copper carbonate azurite and the lead carbonate cerussite.

In all tests the operation was substantially as follows:

A 50 gram specimen of the ore was passed through rolls and ground on a bucking board to pass through a 200 mesh screen. This sample was then stirred for five minutes with 135 cc. of distilled water in a small mechanically agitated flotation machine, the reagents added and stirred for two minutes. The water level was then brought up to the level of the "spitzkasten", being run in from a constant level water bottle and a float was conducted for eight minutes. In this time the constant level water bottle delivered 80 to 85 cc. of water.

In all of the pulps noted the pH of the con-

centrate filtrate was determined by taking 10 cc. thereof, plus the amount and concentration of indicator specified in Clark on "The Determination of Hydrogen Ions", and comparing the color of the solution with the color chart, all of which is well known. The minimum and maximum pH value ran from 6.8 to 9.4.

The results secured are tabled below:

Test	Ore	Reagents lbs/ton				Conc. gr.	Tails gr.	Percent Floated
		AF25	APG	PX	PCy			
1	Cuprite	5.76				45.5	4.7	91.0
2	do	1.44	1.28			42.2	6.8	84.4
3	do	1.44			3.20	38.6	10.3	77.2
4	Azurite	2.88				47.7	2.0	95.4
5	do	1.44	0.32			49.0	0.9	98.0
6	Cerussite	1.44				48.7	0.6	97.4
7	do			5.0		47.5	1.8	95.0
8		0.48	0.32			47.7	2.0	95.4
9		0.48			1.60	49.0	0.8	98.0

AF 25—Cresylic acid (25%) and diaryldithiophosphoric acid.

APG—Alcoholic solution of phenylglycine.

PX 0.54 lbs/ton pine oil and indicated amounts of K xanthate.

PCy—Phenyl cyanamide.

From the above it will be seen that maximum values were recoverable with these reagents operating upon the typical ores above specified.

While only certain derivatives and substitution products of the various reagents are set out in the tables, and only certain ores are represented by the experiments described, yet obviously I do not wish to be limited thereto, as my discovery is to be construed broadly to cover equivalent reagents and ores of which the above examples are mentioned merely for the sake of illustration.

In the claims where I have specified oxidized ore I intend the same to cover ores which are substantially non-sulfide, in character and include many so-called oxide ores which frequently contain 5% or perhaps more sulfide.

I claim:

1. A process of flotation which includes the step of subjecting oxidized ore to a froth flotation operation in the presence of a glycine.

2. A process of flotation which includes the step of subjecting oxidized ore to a froth flotation operation in the presence of an alcoholic solution of a glycine.

3. A process of flotation which includes the step of subjecting oxidized ore to a froth flotation operation in the presence of phenyl glycine.

4. A process of flotation which includes the step of subjecting oxidized ore to a froth flotation operation in the presence of a glycine and a di-substituted dithiophosphate.

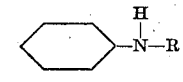
5. A process of flotation which includes the step of subjecting oxidized ore to a froth flotation operation in the presence of phenyl glycine, cresylic acid and di-aryl dithiophosphoric acid.

6. A flotation reagent including phenyl glycine, cresylic acid and di-aryl dithiophosphoric acid.

7. A process of flotation which includes the step of subjecting oxidized ore to a froth flotation operation in the presence of phenyl cyanamide.

8. A process of flotation which includes the step of subjecting an oxidized ore to a flotation operation in the presence of a flotation reagent taken from a group of organic amino acids consisting of glycines and phenyl cyanamid.

9. A process of recovering ore values from crude ores, which comprises the step of subjecting the crude material to a froth flotation operation in the presence of a promoter having the probable formula—



where R is a group selected from a class consisting of CN and carboxylic acids.

10. A process of flotation which includes the step of subjecting an oxidized ore to a froth flotation operation in the presence of a flotation promoting reagent consisting of an amino substituted phenyl compound containing an acid residue selected from a group consisting of CN and COOH.

11. A process of flotation which includes the step of subjecting an oxidized ore to a froth flotation operation in the presence of a flotation reagent selected from a group consisting of phenyl glycine and phenyl cyanamide.

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