SUMMARY OF "NOTES ON FLOTATION."

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Few modern advances in metallurgy and oredressing are of equal interest to the sudden development of methods of separating minerals by flotation.

Nearly all older methods of separating metallic from earthy minerals depended on differences in specific gravity, flotation makes use of differences in surface properties such as affinities for oils or gases, and therefore may effect separations previously impossible owing to similarity in specific gravity.

Such has been the case at Broken Hill, the scene of the first great success of flotation, where fine Zinc Blende and Galena are separated from Rhodonite.

That some minerals have "greasy" surfaces has been known for years, and also that under certain conditions they float, for many devices have been used to catch float gold and tin. It was also known that acids sometimes made sulphides float, for Dr. Watson in his Chemical Essays, published many years ago, mentions the flotation of Galena when acted upon by nitric acid, and the sulphur set free during the solution of a sulphide copper ore in nitric acid was early known to carry copper and suitable precautions taken. Many methods for ore treatment by flotation have been patented, the earliest being about 1860. The majority of these are unworkable, but that of Carrie J. Everson in 1885 makes a splendid separation of certain classes of ores and it is hard to understand why it was never worked on a commercial scale.

Separation by flotation may roughly be divided into the following classes:—

1. Absorption of the metallic minerals in large volumes of thick oil, the chief example of which is the old Elmore Process. A mixture of ore and water was gently agitated with a large quantity of oil, the oil absorbed the metallic minerals and such quantities were used that the specific gravity of the loaded oil was less than that of water. Separation of the

oil and mineral from the gangue was effected by means of a spitz; the bulk of the oil was removed by a centrifugal and used again.

2. Flotation by gas generated in a mixture of ore and water. A good example of this method is the Potter Process. The crushed ore was treated with hot dilute sulphuric acid which acted on the carboncites present and generated carbon deoxide. The bubbles of gas attached themselves to the mineral particles and carried them to the surface where they remained as a thick froth and were floated off.

3. Surface Float: De Bavay. The ore, after suitable treatment, such as washing with acid and chlorine, is made into a thin pulp with water and a small quantity of light oil, and allowed to flow gently on to the surface of water. The mineral particles remain on the surface and are run off while the gangue sinks.

4. Air Emulsion Float. Minerals Separation Process. A thin pulp of finely-crushed ore is violently agitated with hot dilute sulphuric acid. The acid is too weak to give a Potter float. A small quantity of some organic contaminating agent is added and the agitation continued. A thick froth of mixed metallic minerals and gas is obtained which is allowed to flow or is scraped off a spitz. This last process is one of the most interesting and seems destined to supersede all the others. It has recently been modified, giving the so-called differential process by which not only are sulphides separated from silicates, but one sulphide from another.

That sulphides should differ in their readiness to float was perhaps to be expected, but that gases should vary in their affinities for mineral surfaces seemed almost impossible. Yet there is evidence that carbon dioxide is a better float forming gas than others, and analysis of the gas entangled in float scums have shown it to be the last to be removed from the mineral particles by the air pump.

Statements have been made that when oleic acid is used as the contaminating agent in the Minerals Separation Process it is impossible to determine its distribution after flotation, as the amount found on the concentrates added to that on the tailings always gives a result greater than the amount originally used.

During the hearing of a lawsuit on the flotation patents figures were given tending to show that all the oleic acid used in the Minerals Separation Process attached itself to the sulphide particles. It was stated that the bulk was found in the concentrates and that the small amount in the tailings was exactly accounted for by the unfloated sulphides. The sum of these two was about the amount of oleic acid added.

These results were so contrary to previous experience that the whole question was re-opened and remarkable results obtained.

The oleic acid present in concentrates and tailings was determined by making ether extracts. The first results showed about 0.04 per cent. ether extract from both concentrates and tailings, a result much in excess of the oleic acid added. Yellow crystals were noticed in the extract, which proved it was not all oleic acid. These yellow crystals were examined, and found to be sulphur.

Many more extractions were made on different samples, and the sulphur separated from the oleic acid.

Different samples gave very dissimilar results; the following are fairly typical:—

TOTAL ETHER EXTRACT.

	No. 1.	No. 2
Concentrates	0.121%	0.147%
Tailings	0.062%	0.029%

After Separation of Sulphur.

	No. 1.	No. 2
Concentrates: Sulphur ..	0.090%	0.048%
Oleic Acid	0.025%	0.096%

	No. 1.	No. 2
Tailings: Sulphur	0.028%	0.013%
Oleic Acid	0.033%	0.015%

The amount of oleic acid found after separating the sulphur is still more than that added, so the mill tailings being fed to the flotation plant were treated with ether.

The following result was obtained:—

Sulphur	0.0006%
Oil	0.0052%

It was calculated that to supply this amount of oil, two tons would be required per week, while the whole plant was using less than one ton.

Finally a piece of ore was taken from the centre of a big uncracked block, carefully kept from contact with anything greasy, and an ether extract made. The surprising result was obtained of 0.0037% oily matter in clean Broken Hill sulphide ore.

Samples of ore were also taken from Cobar and Cloncurry, and both found to give an oily residue after extracting with ether.

Mention should be made of the fact that all the ether used had been distilled three times and found to give nc residue.

It was hoped to obtain enough extract from perfectly clean ore to invesigate its nature, but so far this has been impossible.

During the lawsuit already referrred to, attempts were made to show that small pieces of platinum foil were not raised to the surface of liquids by carbon dioxide bubbles if they were perfectly clean.

Slightly greased particles of platinum were readily buoyed to the surface of soda water on warming, while pieces that had been cleaned by treatment with strong nitric acid did not attach themselves to bubbles, but following the nitric acid treatment by heating to redness, made the platinum almost as ready to float as the oiled pieces.

A final outcome of the investigation of flotation is the possible use of the principles involved for deoiling boiler water. This has not yet been tested on a large scale, but small experiments show that water which is opalescent owing to oil contamination, becomes perfectly clear after filtration through finely crushed galena.

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