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## CONCENTRATION OF POTASH ORES CONTAINING SYLVITE

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This invention relates to the concentration of potash ores containing sylvite and especially to potash ores containing mixtures of oceanic salts and clays and of which sylvite and halite are normal constituents. The invention has for a more particular and representative application the separation and concentration of the sylvite values of sylvite ores which in their naturally occurring state contain small but nevertheless objectionable amounts of insoluble clay-like minerals that interfere with the concentration of the sylvite content of such ores by flotation and other known concentrating procedures. A typical example of sylvite ores of this type is that found in the Carlsbad district of New Mexico.

It is already known that sylvite can be recovered in the form of a concentrate from suitably ground potash ores suspended in a saturated solution of the soluble constituents of such an ore by froth flotation and other methods involving wet stratification. However, the methods heretofore employed commercially have not been found entirely satisfactory when applied to potash ores containing clay-like minerals, being open to the objections, among others, that they do not insure a uniformly high commercial grade of concentrate and a uniformly high recovery. Methods involving the use of collecting agents, such for example as the froth flotation process, also require relatively large amounts of the collecting agent.

Various proposals have been made for improving the grade of the sylvite concentrate and the recovery, among them being proposals to add various reagents along with the collecting agent to the ore pulp during the conditioning treatment preparatory to flotation, tabling or other appropriate wet stratifying classification. These agents have been termed "auxiliary" collecting agents when used in this environment and include starch, dextrin and certain lignin derivatives and cellulosic materials that are water-soluble or colloiddally dispersible in water.

As a result of extended investigations of the behavior of these so-called "auxiliary" collecting agents and others that will be referred to hereinafter, we have found that these agents that have heretofore been claimed to function as collecting agents do not in fact function in such a manner. Our investigations indicate that to the extent that improvements in grade of concentrate and recovery are realized when a so-called "auxiliary" collecting agent, such for example as starch, is used in conjunction with one of the conventional collecting agents such as a continuous chain alkyl amine, such improvements may be explained as due to the action of the "auxiliary" agent in suppressing or controlling the tendency of the clay slime particles to react with the conventional collecting agent and in this way decrease the proportion of such agent that is available to perform its normal collecting function.

It is one of the principal objects of the present invention to provide a method of separating and concentrating the sylvite values from potash ores of the general class above mentioned by a wet stratifying separation which is relatively economical as respects the amount of collecting agent required.

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It is a further important object of the invention to produce concentrates of sylvite from potash ores that are of uniformly high commercial grade and with high percentages of recovery.

It is a still further object of the invention to provide a new type or group of slime control agents having various advantages as compared with the so-called "auxiliary" collecting agents heretofore used or proposed.

Other objects and advantages of the present invention will become apparent as the description proceeds.

The present invention is based in part on our observation that the insoluble slimes that are formed when clay-containing potash ores are ground and suspended in saturated brine solutions are only imperfectly separated from the pulp by the commonly employed mechanical desliming procedures unless the desliming treatment is repeated many times. Even when the ore is subjected to repeated desliming treatments in excess of those that would be regarded as commercially practical, sufficient insoluble slime will remain to interfere with and cut down the efficiency of the collecting agent. We have further observed that if due regard is had to the amount of insoluble slime present in the ore feed to the flotation or other wet stratifying circuit, it is possible to suppress the tendency of the slime to react with the collecting agent by adding to the ore pulp at a stage in the conditioning treatment in advance of that in which the collecting agent is added an amount of a suitable reagent sufficient to render the clay or other insoluble slime particles incapable of reacting with or otherwise rendering the collecting agent ineffective.

We have found further that the control of the insoluble slime to inhibit or limit its adverse action on the flotation may be very satisfactorily brought about by adding to the pulp a suitable proportion of a member of the class consisting of the polyglycols and their ethers. These compounds have the advantage that they are effective when used in relatively small proportions, depending upon the amount of insoluble slime present in the ore pulp, to render the clay slime particles inactive toward the collecting agents, such as the high molecular weight aliphatic amines, normally used in concentrating the sylvite values of potash ores containing sylvite. For example, when treating sylvite ores from the Carlsbad district that have been partially deslimed to the extent economically feasible by conventional mechanical desliming methods only a very small amount, usually 0.1 lb. per ton of ore, of one of the polyglycols or their ethers will ordinarily suffice as compared with 0.5 lb. or more of starch.

They have the further advantage that contrary to their classification as dispensants and their behavior as such in other environments, the members of this class exhibit a flocculating action upon the insoluble slime constituents of an ore pulp containing sylvite to which they are introduced in the presence of brine. Apparently the flocculating action is related to the brine nature of the suspension medium. The flocculating action appears to be of advantage in the process because of the consequent reduction in the amount of exposed surfaces of the insoluble slime particles, when brought together as flocs, which have to be coated or reacted sufficiently with the polyglycol compound to suppress the normal tendency of the slime minerals to react with or otherwise render ineffective the amines and similar collecting agents used to prepare the ore for the concentration treatment.

It is further observed that when potash ores of the class under consideration are being prepared for treatment by flotation, the polyglycol compounds appear to impart definite improvement to the floating characteristics of the pulp in that a less tough but more persistent froth is produced when one of such compounds is present in the pulp during the flotation step. This is particularly notice-

able when an amine collecting agent is being used, and has the advantage that there is a lessened tendency for halite particles to become entrapped in the froth and carried over mechanically into the concentrate. It is also observed that the polyglycol compounds of the class above defined tend to improve the frothing characteristics of the pulp and also in a measure to perform the function of froth modifying agents, thus making it possible to decrease the amount of one of the conventional frothing agents that is customarily employed in conjunction with a collecting agent in preparing potash ore pulps for a wet stratifying separation. As will be brought out further hereinafter in describing specific applications of the process, the proportion of a conventional frothing agent, such as Dupont Frother B-23, methyl amyl alcohol or pine oil, may be very materially reduced as compared with present day practices in the froth flotation treatment of potash ores containing sylvite.

The fact that an amine collector or similar collecting agent alone will satisfactorily float sylvite from its admixture with halite if clay slime is not present was clearly demonstrated by our tests with synthetic ores made from chemically pure salts of KCl and NaCl. Similar results were obtained with practically completely deslimed natural sylvinitic ore from the Carlsbad district. The following examples gives the results obtained in flotation tests conducted under identical conditions on a synthetic sylvinitic ore containing no slime, except that in the one case an amine collecting agent was used alone and in the other case starch was also added. The amine collecting agent was the commercial product of Armour & Co., sold under the trade designation "Armac TD" and understood to consist of the water soluble acetate salts of the normal hexadecyl, octadecyl and octadecenyl amines in the approximate proportions of 30, 25 and 45 parts by weight.

Ex. 1.—A synthetic ore made up of a mixture of 40% chemically pure KCl and 60% NaCl ground to pass a 20 mesh screen was made into a pulp of about 30% solids with a saturated solution of the ore constituents. Pearl starch in the proportion of 0.40 lb. per ton of the ore was then added to the pulp in a Fagergren 3 liter laboratory flotation cell and conditioned by agitation at 1070 R. P. M. for two minutes. A solution of Armac TD in the proportion of 0.10 lb. per ton of ore was then added to the pulp which was then conditioned by further agitation for thirty seconds. Flotation was then effected. The results were as follows:

| Product       | Weight, gms. | Weight, percent | KCl, percent | KCl Recovery |         |
|---------------|--------------|-----------------|--------------|--------------|---------|
|               |              |                 |              | gms.         | Percent |
| Conc. ....    | 433.1        | 42.9            | 97.7         | 41.9         | 97.0    |
| Tailing ..... | 577.3        | 57.1            | 2.3          | 1.3          | 3.0     |
|               | 1,010.4      |                 |              | 43.2         | 100.0   |

Ex. 2.—This operation was identical with Ex. 1 except that no starch was added. The results were as follows:

| Product       | Weight, gms. | Weight, percent | KCl, percent | KCl Recovery |         |
|---------------|--------------|-----------------|--------------|--------------|---------|
|               |              |                 |              | gms.         | Percent |
| Conc. ....    | 458.2        | 45.5            | 95.5         | 43.5         | 98.2    |
| Tailing ..... | 548.1        | 54.4            | 1.5          | 0.8          | 1.8     |
|               | 1,006.3      |                 |              | 44.3         | 100.0   |

Considering the limits of analytical error and ability to reproduce test conditions, there was no significant difference in the result obtained in these two tests.

In another set of comparative tests a controlled amount of insoluble slime approximating ½ of one per cent of the weight of the synthetic ore and obtained from a typical

Carlsbad sylvinitic ore was added to the chemically pure mixture of KCl and NaCl.

Ex. 3.—In the first of these tests both starch and Armac TD were added in the same proportions and in the same order as in Ex. 1 described above. The results were as follows:

| Product       | Weight, gms. | Weight, percent | KCl, percent | KCl Recovery |         |
|---------------|--------------|-----------------|--------------|--------------|---------|
|               |              |                 |              | gms.         | Percent |
| Conc. ....    | 373.6        | 40.9            | 95.0         | 38.9         | 97.7    |
| Tailing ..... | 539.5        | 59.1            | 1.5          | 0.9          | 2.3     |
|               | 913.1        |                 |              | 39.8         | 100.0   |

Ex. 4.—In the second of these tests no starch was used and the proportion of Armac TD was the same as in Ex. 3 described above. The results were as follows:

| Product       | Weight, gms. | Weight, percent | KCl, percent | KCl Recovery |         |
|---------------|--------------|-----------------|--------------|--------------|---------|
|               |              |                 |              | gms.         | Percent |
| Conc. ....    | 44.3         | 4.8             | 73.6         | 3.5          | 8.4     |
| Tailing ..... | 872.6        | 95.2            | 40.2         | 38.3         | 91.6    |
|               | 916.9        |                 |              | 41.8         | 100.0   |

The value of starch when insoluble clay slime is present is obvious from the results of these tests.

In order to observe the effect of varying amounts of insoluble slime, a series of tests were conducted on a typical Carlsbad sylvinitic ore in which the ore was subjected to successive mechanical desliming treatments and representative samples of the ore taken at each stage of the desliming treatment were subjected to flotation.

The flotation reagent used was Armac TD in the proportion of 0.156 lb. per ton of ore. As a frothing aid, Dupont Frother B-23 in the proportion of 0.004 lb. per ton of ore was added with the collector. Dupont Frother B-23, hereinafter sometimes referred to as "B-23," is a commercial product of the Dupont Company commonly used in the flotation art as a frothing aid and froth modifier. It is understood to consist of 40-45% of primary alcohols (principally 2,4-dimethyl pentanol-1), 45-50% of secondary alcohols (principally 2,4-dimethyl hexanol-3), and 8-12% of unidentified ketones.

The results of these tests are summarized in the following table:

TABLE NO. I

| Test No. | Desliming No. of Steps | Pounds Insoluble (-270 Mesh) Material per ton Flotation Feed | Percent KCl Recovery |
|----------|------------------------|--------------------------------------------------------------|----------------------|
| 240..... | 1                      | 9.36                                                         | 2.32                 |
| 241..... | 2                      | 5.62                                                         | 5.97                 |
| 242..... | 3                      | 2.62                                                         | 29.12                |
| 243..... | 4                      | 1.28                                                         | 88.55                |
| 244..... | 5                      | 0.84                                                         | 97.16                |
| 245..... | 6                      | 0.52                                                         | 98.55                |

Our investigations have indicated that substantially all the objectionable insoluble slime is removed from the ore samples by screening the ore in the form of a saturated brine pulp at 270 mesh. Therefore, this procedure was followed in making the determinations set forth above.

The desliming operations consisted of the following standard procedures:

1. A 1200 gm. sample of dry, -14 mesh ore is weighed.

2. This sample is pulped with fully saturated brine (KCl and NaCl) in a standard Fagergren 3 liter laboratory flotation machine. The pulp is brought to a pre-

determined level mark about 2" below the top of the bowl.

3. The cell is agitated at standard operating speed for 5 minutes. (Note: In all subsequent desliming steps this time is reduced to 1 minute.)

4. The pulp is permitted to settle for one minute after the agitation period.

5. The suspended slime and brine is then siphoned to a depth of 4 1/4" from the top of the bowl.

The following procedure was used to determine the pounds of insoluble —270 mesh material per ton of ore present in the sample after any given number of desliming operations:

1. Two hundred grams of deslimed ore resulting from step 5 above is removed from the cell.

2. This 200 gm. sample is screened over a 270 mesh screen. The screen undersize is then leached to remove all water soluble constituents. The insoluble portion is then dried and weighed. From this weight the percentage of insoluble slime is calculated.

3. To obtain the percentage of KCl recovery the remaining 1000 gms. from step 1 of the previous procedure is floated with 0.16 lb. of Armac TD per ton of ore for three minutes.

The head sample used in tests 240 through 245 contained approximately 20 pounds of insoluble slime per ton.

This series of tests shows conclusively that the insoluble slime content of the flotation feed bears a significant relationship to the recovery of KCl.

Our investigations clearly indicate the necessity for establishing unusually stable conditions on the surfaces of the insoluble slime particles if a satisfactory froth flotation concentration is to be effected. It is further apparent that a satisfactory slime control agent must establish a stronger bond with the slime than the slime is capable of establishing with the amine. If this condition does not exist, then the amine may displace the slime control agent. The test results set forth in the following table offer proof of this point:

TABLE NO. II

| Test No. | Slime Treatment                                                          | Percent KCl Assay |              |              | Percent KCl Distribution |              |              |
|----------|--------------------------------------------------------------------------|-------------------|--------------|--------------|--------------------------|--------------|--------------|
|          |                                                                          | Conc.             | Cleaner Tail | Rougher Tail | Conc.                    | Cleaner Tail | Rougher Tail |
| 375..... | Pilot-slime not added.....                                               | 99.90             | 24.04        | 5.01         | 88.00                    | 1.30         | 10.70        |
| 374..... | Untreated slime added.....                                               | 95.40             | 94.20        | 4.39         | 85.0                     | 8.4          | 8.4          |
| 376..... | Slime treated with 1 lb. methoxy polyethylene glycol 750 per ton of ore. | 97.8              | 44.5         | 5.02         | 88.2                     | 3.4          | 8.4          |

In the three tests tabulated above a 1000 gram sample of a typical Carlsbad district sylvinitic ore was deslimed seven times following the procedure which was outlined under the description of the tests referred to in the preceding Table No. I.

A standard flotation test was run on each sample using 0.159 pound of Armac TD and 0.001 pound of B-23 per ton of ore.

The insoluble slimes which were removed before flotation were leached, dried and pulverized. Ten grams of the pulverized slime thus prepared were added to the rougher concentrate of test 374 and a cleaning flotation test was run without the addition of other reagents. It will be noted that in test 375 where the slimes were not added to the rougher concentrate, the KCl recovery in the concentrate was 88%. When the untreated slimes were added the recovery dropped to 6.6%. A comparison of these two tests indicates that a very considerable portion of the amine which in test 374 coated the KCl particles in the rougher test was removed and consumed by the slimes in the cleaner test. The amazing capacity of the slimes to consume amine by adsorption, absorption or a combination of these methods is

also indicated in this test. This capacity can hardly be attributed to surface area alone. A base exchange reaction is suggested.

In test 376 the ten gram sample of slime was agitated in brine with 1 pound of Methoxy Polyethylene Glycol 750 per ton of ore before it was added to the rougher concentrate. In this test there was little or no consumption of the amine by the slime. The tendency of the slime to react with or destroy the collecting power of the amine appeared to be completely inhibited by the polyglycol compound.

As indicated above, the extraordinary ability of the insoluble clay slime to consume amine cannot be attributed solely to adsorption, and the evidence points to absorption through a base exchange rather than mere adsorption. This theory is supported by consideration of the composition of the insoluble slime content of the Carlsbad ores. The insoluble clay minerals found in these ores contain as a major constituent nontronite, which is a form of montmorillonite. Montmorillonite is known to almost always display a high base exchange capacity.

Although we do not consider that the practice of our invention is dependent upon the correctness of any precise theory as to the way the chemical slime control agents act in suppressing the tendency of the clay slimes to consume amine and similar collecting agents added to a potash ore, the evidence points to the formation of nontronite complexes with those organic compounds that exhibit a tendency to suppress the reaction of amines with nontronite. More specifically, in the case of the polyethylene glycols and their ethers it appears that nontronite-polyethylene glycol compound complexes are formed and that these complexes are sufficiently stable to resist displacement of the glycol component of the complex by the amine. This view is further substantiated by the fact that our investigations show that much more satisfactory results are obtained when the polyglycol compound is added to the ore pulp in advance of the addition of the amine so as to insure that the surfaces of

the clay slime particles shall have been coated or reacted with the polyglycol compound before the amine is introduced into the ore pulp.

The following examples and groups of examples give the results obtained with the use of various polyglycols and their ethers in comparison with several examples of tests with the use of a representative amine collecting agent alone. Several tests are also set forth to illustrate the comparative results obtained when starch, one of the agents previously known to the art, is used as a slime control agent under similar conditions as regards insoluble slime content of the ore pulp and the stage of introduction of the agent into the pulp as are employed in using the polyglycols and their ethers in our method.

The collecting agent used in the following examples was the previously mentioned commercial product of Armour & Co., sold under the designation Armac TD. Armac TD is typical of those collectors known to be suitable for concentrating sylvite from sylvinitic and other potash ores containing sylvite and which are classified as water soluble salts of normal aliphatic amines containing a continuous carbon chain of at least 8 carbon atoms.

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These amine collectors are available commercially in the form of the normal amines and their corresponding salts within a range of continuous carbon chain lengths varying from 8 to 18 carbon atoms.

*Tests in which Tergitol TMN-650 was used as the slime control agent (also comparison test using no Tergitol TMN-650)*

*Exs. 5-8.*—In this series of tests a batch of sylvinitic ore from the Carlsbad district was crushed to  $-\frac{1}{4}$ " and divided into samples of 1000 gms. each and then screened over a 20 mesh screen. In each case the  $+20$  mesh fraction approximating 720 gms. was suspended in 1740 cc. of a saturated brine from the same kind of ore to produce a pulp containing about 25% solids. The resulting pulp was then ground  $2\frac{3}{4}$  minutes at 64 R. P. M. in an 8" I. D. rod mill. The resulting product was then combined with the  $-20$  mesh fraction from the previous screening operation and the whole introduced into a Fagergren 3 liter glass bowl laboratory flotation cell and agitated for five minutes at 1070 R. P. M. The pulp was then deslimed twice by agitating one minute, settling one minute, and siphoning to the depth of  $4\frac{1}{2}$ " from the top of the bowl. The deslimed product was then screened over a 35 mesh screen.

The plus and minus fractions were then separately conditioned in two stages. In Ex. 5, 5 cc. of a 2% aqueous solution of a polyethylene glycol ether designated by the manufacturer as Tergitol TMN-650 was added to the  $+35$  mesh fraction followed by conditioning by agitation for two minutes. Thereupon 3 cc. of a 2% aqueous solution of Armac TD was added and the pulp was then further conditioned for 30 seconds.

The  $-35$  mesh fraction was similarly conditioned in stages. In the first stage  $7\frac{1}{2}$  cc. of a 2% solution of Tergitol TMN-650 was added followed by conditioning for two minutes. Thereupon 1 cc. of a 2% solution of Armac TD was added and the whole conditioned for 30 seconds.

The thus conditioned plus and minus fractions were then combined in the Fagergren cell and floated for three minutes at 1070 R. P. M. The room and brine temperature was maintained at 80° F.

In Exs. 6, 7 and 8 the conditioning of the plus and minus 35 mesh fractions was conducted in the same way in stages, with the length of the conditioning steps the same as in Ex. 5 but with the proportions of the additions of Tergitol TMN-650 and Armac TD changed proportionately in the separate stages in each case to correspond with the changes in the total proportions of these agents. In each case the room and brine temperatures were maintained at 80° F.

The respective proportions of Tergitol TMN-650 and Armac TD are indicated in the tabulation below along with the grades of concentrates and the recoveries in each instance:

| Ex.    | Tergitol TMN-650, lbs./ton of ore | Armac TD, lbs./ton of ore | Conc., Percent KCl | KCl Recovery, Percent |
|--------|-----------------------------------|---------------------------|--------------------|-----------------------|
| 5..... | 0.50                              | .16                       | 96.5               | 93.3                  |
| 6..... | 0.10                              | .16                       | 96.0               | 86.8                  |
| 7..... | 0.10                              | .20                       | 95.0               | 90.9                  |
| 8..... | 0.20                              | .16                       | 96.2               | 87.9                  |

*Exs. 9-13.*—This series of tests was conducted with the same proportions of reagents throughout and the same procedures as regards conditioning in stages were followed in each test, except that the number of desliming treatments was varied as indicated in the tabulation below. The ore samples were all taken from the  $-14$  mesh fraction screened from a typical Carlsbad sylvinitic ore as received from the mine. In running each test 1200 gms. of the  $-14$  mesh ore was introduced into a Fagergren cell with sufficient saturated brine to fill the cell to about 2" from the top of the bowl, agitated at 1070 R. P. M.

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for five minutes and then deslimed by settling for one minute and siphoning to a depth of  $4\frac{1}{4}$ " from the top of the bowl. The cell was then refilled with brine and agitated for one minute. In the instances where more than one desliming step was performed, the pulp was allowed to settle for one minute following each successive agitating step of one minute and then siphoned to the same depth as specified above.

On conclusion of the desliming treatment in each instance and after the cell had been refilled with brine and reagitated, a sample of approximately 200 gms. of the ore was removed to permit of a determination of the proportion of the remaining slime. The remainder of the pulp was then placed in a 6" diameter bottle, settled for 20 minutes and adjusted to 60% solids. 5 cc. of a 2% solution of Tergitol TMN-650 was then added. After rotating the bottle for two minutes at 94 R. P. M., 4 cc. of a mixture of 40 cc. 2% Armac TD and 0.10 cc. of B-23 frother was added and the pulp was then further conditioned by rotating the bottle for 30 seconds. The conditioned pulp was then transferred to the Fagergren cell and subjected to flotation for 3 minutes while agitating at 1070 R. P. M. The temperature was maintained at 70° F. throughout the several tests. In all of the tests designated as Examples 9-13 the proportion of Tergitol TMN-650 amounted to 0.20 lb. per ton of ore, the proportion of Armac TD amounted to 0.156 lb. per ton of ore and the proportion of B-23 frother amounted to 0.004 lb. per ton of ore.

The number of desliming steps, the proportions of residual slime and the concentrate grade and recovery obtained in each test are set forth in the following tabulation:

| Ex.     | Desliming, No. of Steps | Lbs. Insoluble $-270$ Mesh Material Per Ton Flotation Feed | Conc., Percent KCl | KCl Recovery, Percent |
|---------|-------------------------|------------------------------------------------------------|--------------------|-----------------------|
| 9.....  | 1                       | 23.20                                                      | 56.0               | 4.4                   |
| 10..... | 3                       | 6.40                                                       | 90.7               | 44.1                  |
| 11..... | 4                       | 5.12                                                       | 93.0               | 94.3                  |
| 12..... | 5                       | 2.46                                                       | 96.6               | 90.9                  |
| 13..... | 6                       | 2.20                                                       | 95.4               | 97.6                  |

*Ex. 14.*—The results of this test are presented for comparison with the results obtained in the tests identified as Exs. 12 and 13 above. In this test the same quantities of ore and proportions of Armac TD and B-23 were used as in Examples 9-13, inclusive. No slime control agent was added. The same procedures were also followed throughout with the desliming treatment repeated three times. The ore sample was derived from  $-\frac{1}{2}$  inch x 14 mesh Carlsbad sylvinitic ore that had been subsequently crushed to  $-14$  mesh in a coffee mill and rolls. The proportion of insoluble  $-270$  mesh material present in the ore pulp after three desliming treatments was determined as 2.62 lbs. per ton of ore. The results of the flotation and the insoluble slime determination are set forth below:

| Product | Weight, gms. | Percent Weight | Percent KCl | KCl Recovery |         |
|---------|--------------|----------------|-------------|--------------|---------|
|         |              |                |             | gms.         | Percent |
| Conc    | 124.77       | 13.39          | 88.2        | 11.81        | 29.12   |
| Tail    | 807.21       | 86.61          | 33.2        | 23.75        | 70.88   |
| Total   | 931.98       |                |             | 40.56        |         |

  

| Product    | Weight, gms. | Percent Weight | Percent Insol. | Insol. Cont., gms. | Insol. Cont. |
|------------|--------------|----------------|----------------|--------------------|--------------|
| Slime      | 52.23        | 5.31           | 14.44          | 0.765              | 86.0         |
| Flot. Feed | 931.08       | 94.69          | 0.131          | 0.124              | 14.0         |
|            | 984.21       |                |                | 0.889              |              |

**Tests using Methoxy Polyethylene Glycol 750**  
(also comparison test on deslimed ore)

Exs. 15-20.—This series of tests was conducted by using the same proportions of reagents throughout and the same procedures as regards conditioning in stages were followed in each test, except that the number of desliming treatments was varied as indicated in the tabulation hereinafter set forth. The ore samples were crushed and ground material obtained by crushing 5" Carlsbad sylvinitic ore in a jaw crusher and then reducing in a coffee mill and rolls to -14 mesh.

In running each test 1200 gms. of the -14 mesh ore was introduced into a Fagergren cell with sufficient saturated brine to fill the cell. The pulp was agitated at 1070 R. P. M. for five minutes and then deslimed by settling for one minute and then siphoning to a depth of 4 1/4" from the top of the bowl. In the instances where more than one desliming step was performed, the pulp was allowed to settle for one minute following each successive agitating step of one minute and then siphoning to the depth specified above. On conclusion of the desliming treatment in each instance and after the cell had been refilled with brine and reagitated for one minute, a sample of approximately 200 gms. of ore was removed to determine the proportion of remaining slime. The remainder of the pulp was then conditioned in stages and adjusted to 60% solids in the same manner as was done in running the tests represented by Exs. 9-13 above, whereupon the conditioned pulp was transferred back to the Fagergren cell and floated for the three minutes at 1070 R. P. M. and 70° F. The reagent proportions were as follows:

|                                      |                 |
|--------------------------------------|-----------------|
|                                      | Lbs./ton of ore |
| Methoxy Polyethylene Glycol 750----- | 0.20            |
| Armac TD-----                        | 0.159           |
| B-23-----                            | 0.001           |

The number of desliming steps and the concentrate grade and recovery obtained in each test are set forth in the following tabulation:

| Ex.     | Desliming,<br>No. of<br>Steps | Lbs. Insoluble<br>-270<br>Mesh Material Per Ton<br>Flotation<br>Feed | Conc.,<br>Percent<br>KCl | KCl Recovery,<br>Percent |
|---------|-------------------------------|----------------------------------------------------------------------|--------------------------|--------------------------|
| 15----- | 1                             | 10.52                                                                | 83.60                    | 33.05                    |
| 16----- | 2                             | 7.72                                                                 | 93.60                    | 64.70                    |
| 17----- | 3                             | 5.04                                                                 | 94.2                     | 81.00                    |
| 18----- | 4                             | 2.56                                                                 | 93.4                     | 93.62                    |
| 19----- | 5                             | 1.04                                                                 | 93.2                     | 97.60                    |
| 20----- | 6                             | .24                                                                  | 91.8                     | 97.83                    |

Ex. 21.—The results of this test illustrate that a highly satisfactory grade of concentrate and a good recovery are obtainable if the ore pulp has been substantially completely freed of insoluble clay slimes. A 1000 gm. ore sample derived from the same sources and reduced to -14 mesh in the manner previously described was introduced into a Fagergren cell and agitated with saturated brine at 1070 R. P. M. for five minutes. The pulp was then deslimed seven times by successively agitating one minute, settling one minute and siphoning to a depth of 4 1/2" from the top of the bowl as previously described.

On concluding the desliming treatments, the cell was refilled with brine and Armac TD and B-23 frother were added in the same proportions as specified in Exs. 15-20 above. After agitating for 30 seconds, the mixture was floated for three minutes at 1070 R. P. M. and 70° F. The rougher tails were then filtered and removed and the rougher concentrate was replaced with the brine in the Fagergren cell. Similar proportions of Armac TD and B-23 frother were then added and the mixture agitated for 30 seconds, whereupon it was refloated for three minutes at 70° F. as before. The results are tabulated below:

| Product            | Weight,<br>Gms. | Weight,<br>Percent | KCl,<br>Percent | KCl Recovery |         |
|--------------------|-----------------|--------------------|-----------------|--------------|---------|
|                    |                 |                    |                 | Gms.         | Percent |
| Cleaner Conc.----- | 263.558         | 30.70              | 99.90           | 30.67        | 88.00   |
| Cleaner Tails----- | 16.541          | 1.90               | 24.04           | 0.46         | 01.30   |
| Rougher Tails----- | 589.837         | 67.40              | 5.01            | 3.74         | 10.70   |
| Total-----         | 874.936         | 100.00             |                 | 34.87        | 100.00  |

Ex. 22.—This test was conducted with an identical sample of ore and under the same conditions as described for Ex. 21 through the rougher flotation stage. After the rougher tails had been filtered and removed and the rougher concentrate replaced with the brine in the Fagergren cell and before making the second addition of flotation reagents, a previously prepared mixture of treated slime was added to the pulp and the pulp was then conditioned for five minutes with agitation before adding the flotation reagents for the cleaner run. The treated slime addition consisted of a damp filter cake obtained by agitating 10 gm. of fine and dried insoluble slime in a beaker with 25 cc. of 2% Methoxy Polyethylene Glycol 750 in brine for five minutes and then filtering. The above proportions of slime and Methoxy Polyethylene Glycol 750 were equivalent, respectively, to 20 lbs. of insoluble slime and one lb. of Methoxy Polyethylene Glycol 750 per ton of ore. It will be observed that despite the high proportion of insoluble slime, its tendency to consume the flotation reagent was entirely suppressed by the methoxy polyethylene glycol.

The results are set forth below:

| Product            | Weight,<br>gms. | Weight,<br>percent | KCl,<br>percent | KCl Recovery |         |
|--------------------|-----------------|--------------------|-----------------|--------------|---------|
|                    |                 |                    |                 | Gms.         | Percent |
| Cleaner Conc.----- | 317.607         | 34.20              | 97.8            | 33.4         | 88.20   |
| Cleaner Tails----- | 26.787          | 2.90               | 44.5            | 1.29         | 3.40    |
| Rougher Tails----- | 584.722         | 62.90              | 5.02            | 3.16         | 8.40    |
| Total-----         | 929.116         | 100.00             |                 | 37.85        | 100.00  |

**Tests using various other polyglycol ethers**

Ex. 23.—This test was conducted with an identical sample of ore and under the same conditions as concerns proportions of reagents and the procedures as regards desliming and conditioning in stages as were employed in Ex. 18 except that, instead of using .20 lb. of Methoxy Polyethylene Glycol 750 per ton of ore, .10 lb. of Methoxy Polyethylene Glycol 350 were used. The results are set forth below:

| Product    | Weight,<br>gms. | Weight,<br>percent | KCl,<br>percent | KCl Recovery |         |
|------------|-----------------|--------------------|-----------------|--------------|---------|
|            |                 |                    |                 | Gms.         | Percent |
| Cone-----  | 176.27          | 19.86              | 95.6            | 19.00        | 49.15   |
| Tails----- | 711.62          | 80.14              | 24.55           | 19.68        | 50.85   |
| Total----- | 887.89          |                    |                 | 38.68        |         |

  

| Product         | Weight,<br>gms. | Weight,<br>percent | Insoluble,<br>percent | Insol. Distribution |         |
|-----------------|-----------------|--------------------|-----------------------|---------------------|---------|
|                 |                 |                    |                       | Gms.                | Percent |
| Slime-----      | 61.20           | 6.45               | 16.30                 | 1.077               | 76.55   |
| Flot. Feed----- | 887.89          | 93.55              | 0.353                 | 0.330               | 23.45   |
| Total-----      | 949.09          |                    |                       | 1.407               |         |

This example is cited to illustrate the influence of variation in the proportion of the methoxy polyethylene glycol compound and also to bring out the differences in the effectiveness of the particular polyethylene glycol compounds. The lower recovery as compared with Ex. 18 suggests that less than the optimum amount of the polyethylene glycol compound was used. The fact that a

lower molecular weight compound was employed is also believed to partly explain the lower KCl recovery.

Ex. 24.—This test was conducted under identical conditions and with the same ore as used in Exs. 18 and 23 except that .10 lb. of Methoxy Polyethylene Glycol 550 per ton of ore was used as the slime control agent. The grade of concentrate and recovery were closely similar to those realized in Ex. 23, as shown below:

| Product    | Weight, gms. | Weight, percent | KCl, percent | KCl Recovery |         |
|------------|--------------|-----------------|--------------|--------------|---------|
|            |              |                 |              | Gms.         | Percent |
| Cone.....  | 158.40       | 18.04           | 94.8         | 17.10        | 43.80   |
| Tails..... | 720.50       | 81.96           | 26.8         | 21.95        | 56.20   |
|            | 878.90       |                 |              | 39.05        |         |

  

| Product         | Weight, gms. | Weight, percent | Insoluble, percent | Insol. Distribution |         |
|-----------------|--------------|-----------------|--------------------|---------------------|---------|
|                 |              |                 |                    | Gms.                | Percent |
| Slime.....      | 58.90        | 6.28            | 15.4               | 0.981               | 73.2    |
| Flot. Feed..... | 878.90       | 93.72           | 0.385              | 0.361               | 26.8    |
| Total.....      | 937.80       |                 |                    | 1.342               |         |

Ex. 25.—This test was conducted on a 1200 gm. sample of the same —14 mesh material as was used in Exs. 21 and 22. The sample was pulped and deslimed four times in the same manner as described for Exs. 9–13 inclusive. After removing a 200 gm. sample for determining the proportion of residual slime, the remaining pulp was placed in a 6" diameter bottle and allowed to settle for twenty minutes. The density was then adjusted to a solids content of 60%. The pulp was then conditioned for flotation by first adding 2½ cc. of a 2% aqueous solution of a polyethylene glycol ether designated by the manufacturer as Tergitol Dispersent NPG 101, followed by rotation of the bottle at 94 R. P. M. for two minutes, whereupon sufficient collecting agent (Armac TD) and B–23 were added to bring their respective proportions to 0.159 lb. and 0.001 lb. per ton of ore. After further conditioning by agitation for 30 seconds, the pulp was introduced into the Fagergren cell and floated for three minutes at 1070 R. P. M. while maintaining the temperature at 70 degrees F. The results of this test are set forth below:

| Product    | Weight, gms. | Weight, percent | KCl, percent | KCl Recovery |         |
|------------|--------------|-----------------|--------------|--------------|---------|
|            |              |                 |              | Gms.         | Percent |
| Cone.....  | 140.19       | 16.1            | 87.5         | 14.08        | 36.6    |
| Tails..... | 730.80       | 83.9            | 29.0         | 24.35        | 63.4    |
| Total..... | 870.99       |                 |              | 38.43        |         |

  

| Product         | Weight, gms. | Weight, percent | Insoluble, percent | Insol. Distribution |         |
|-----------------|--------------|-----------------|--------------------|---------------------|---------|
|                 |              |                 |                    | Gms.                | Percent |
| Slime.....      | 61.50        | 6.6             | 17.4               | 1.142               | 83.6    |
| Flot. Feed..... | 870.99       | 93.4            | 0.24               | 0.224               | 16.4    |
|                 | 932.49       |                 |                    | 1.366               |         |

Ex. 26.—This test was conducted on a —14 mesh product obtained by crushing a run of mine lot of Carlsbad sylvinitic ore to —½", followed by screening to obtain the —14 mesh material for the sample. A 1000 gm. sample of the —14 mesh material was formed into a pulp in the Fagergren flotation machine and agitated for five minutes by rotation at 1070 R. P. M. This was followed by desliming by successively settling one minute, siphoning to a depth of 4½" from the top of the bowl, refilling the bowl with brine as before and agitating for one minute, and repeating this sequence four times. The pulp was then screened over a 35 mesh screen. The +35 mesh

fraction was then repulped with brine whereupon 5 cc. of a 2% aqueous solution of the polyethylene glycol ether used in Ex. 25 was added. The pulp was then conditioned by agitating for two minutes whereupon 3 cc. of a 2% Armac TD solution was added and the pulp then further conditioned by agitating for thirty seconds. The —35 mesh fraction was likewise conditioned by adding 7½ cc. of a 2% aqueous solution of the above mentioned polyethylene glycol compound and agitating for two minutes. Thereafter 1 cc. of a 2% solution of Armac TD was added and the pulp was then further conditioned by agitating for thirty seconds. The two conditioned products were then combined and introduced into the Fagergren cell along with two drops of methyl isobutyl carbinol and then floated for three minutes. In proportions by weight per ton of ore the reagent summary was as follows:

|                                | Pounds |
|--------------------------------|--------|
| Tergitol NPG 101 .....         | 0.50   |
| Armac TD.....                  | 0.16   |
| Methyl isobutyl carbinol ..... | 0.05   |

The results are set forth below:

| Product      | Weight, gms. | Weight, percent | KCl, percent | KCl Recovery |         |
|--------------|--------------|-----------------|--------------|--------------|---------|
|              |              |                 |              | Gms.         | Percent |
| Cone.....    | 368.5        | 40.2            | 95.7         | 38.5         | 96.0    |
| Tailing..... | 548.8        | 59.8            | 2.6          | 1.6          | 4.0     |
|              | 917.3        |                 |              | 40.1         |         |

Ex. 27.—In this test 1200 gms. of a —14 mesh fraction of a Carlsbad sylvinitic ore was added to the Fagergren cell with sufficient brine to fill the bowl to ½" from the overflow lip. The resulting pulp was agitated for five minutes and then deslimed four times by settling one minute and siphoning to ¾" from the top of the cell, then refilling with brine, reagitating for one minute and then allowing to settle for one minute, whereupon a similar portion was siphoned off as before. On conclusion of the fourth desliming step, the cell was refilled with brine, agitated, and a 200 gm. sample of this ore was then removed. The remaining pulp was placed in a 6" diameter glass bottle, settled for twenty minutes and adjusted to a density of 60% solids. Five cc. of a 2% solution of a composition manufactured by Charles Chemical Co. and known commercially as Nonic 218 was added. The composition is understood to consist principally of a polyethylene glycol tert. dodecylthioether. The bottle was then rolled for two minutes at 94 R. P. M., whereupon the flotation reagents were added in the proportions of 0.156 lb. of Armac TD and 0.004 lb. B–23 frother per ton of ore. After further conditioning by rolling for thirty seconds as before, the ore pulp was then transferred to the Fagergren cell and floated for three minutes at 1070 R. P. M. Temperature was maintained at 70° F. as in the preceding example. The results of this test were as follows:

| Product    | Weight, gms. | Weight, percent | KCl, percent | KCl Recovery |         |
|------------|--------------|-----------------|--------------|--------------|---------|
|            |              |                 |              | Gms.         | Percent |
| Cone.....  | 328.28       | 37.8            | 95.5         | 36.1         | 97.6    |
| Tail.....  | 539.28       | 62.1            | 1.4          | 0.9          | 2.4     |
| Total..... | 867.56       |                 |              | 37.0         |         |

  

| Product         | Weight, gms. | Weight, percent | Insoluble, percent | Insol. Distribution |         |
|-----------------|--------------|-----------------|--------------------|---------------------|---------|
|                 |              |                 |                    | Gms.                | Percent |
| Slime.....      | 89.6         | 9.4             | 24.2               | 2.271               | 92.6    |
| Flot. Feed..... | 867.56       | 90.6            | 0.201              | 0.182               | 7.4     |
|                 | 957.16       |                 |                    | 2.453               |         |

The methoxy polyglycol compounds used in various of the above described tests and referred to by the numerical designations 350, 550 and 750, as well as the polyglycol compounds designated as Tergitol TMN-650 and Tergitol Dispersent NPG 101, are manufactured by Carbide & Carbon Chemicals Co. It is understood that the numerical designations refer to the approximate molecular weights of the respective members of the above group of compounds with the exception of Tergitol Dispersent NPG 101 which has an approximate molecular weight of 600.

Ex. 27.—In this test 1200 gms. of a —14 mesh fraction of a Carlsbad sylvinitic ore was subjected to three successive desliming treatments conducted in the manner hereinbefore described. A 200 gm. sample of the thus partially deslimed ore was then screened over a 270 mesh screen to separate and determine the amount of the remaining insoluble slime material. As thus determined the proportion of residual slime present corresponded to 1.86 lbs. per ton of flotation feed.

The remainder of the pulp sample, containing approximately 100 gms. of ore, was then placed in a 6" diameter bottle and adjusted to a pulp density of 60% solids, followed by conditioning in stages by first adding dibutoxy tetraglycol in a proportion corresponding to 0.20 lb. per ton of ore, then rotating the bottle for two minutes at 94 R. P. M., followed by the addition of Armac TD and B-23 in the respective proportions of 0.159 lb. and 0.002 lb. per ton of ore. The bottle was then further rotated for thirty seconds at 94 R. P. M. The conditioned pulp was then transferred to the Fagergren cell and subjected to flotation for three minutes while agitating at 1070 R. P. M.

The concentrate grade and recovery and the proportion of KCl remaining with the tailings obtained in this test were as follows:

| Concentrate        |                       | Tailings             |                      |
|--------------------|-----------------------|----------------------|----------------------|
| Grade, Percent KCl | KCl Recovery, Percent | Content KCl, Percent | Percent of Total KCl |
| 90.3               | 62.6                  | 20.6                 | 37.4                 |

#### Tests using polyglycols

In addition to the tests previously described wherein various polyglycol ethers were used as slime control agents, the following tests were conducted with the use of several representative polyglycols. The ore used in these tests was a typical Carlsbad sylvinitic ore which had been subjected to three successive desliming treatments conducted in the manner hereinbefore described, starting in each case with a 1200 gm. sample of —14 mesh ore, and in each case separating a 200 gm. sample of the partially deslimed ore and screening this sample over a 270 mesh screen to separate and determine the amount of the remaining insoluble slime material.

After removing the portion of each sample required for the residual slime determination, the remainder of the pulp of each sample, containing approximately 1000 gms. of ore, was then placed in a 6" diameter bottle and adjusted to a pulp density of 60% solids, followed by conditioning in stages in the manner as previously described; that is to say, the specified amount of polyglycol was first added to the pulp in each instance except in the case of the pilot or control sample, test 490, whereupon the bottle was rotated for two minutes at 94 R. P. M. A mixture of Armac TD and B-23 was then added and the pulp was further conditioned by rotating the bottle for thirty seconds. The conditioned pulp was then transferred to the Fagergren cell and subjected to flotation for three minutes while agitating at 1070 R. P. M. In each of tests 491 and

492, the proportion of the polyglycol compound amounted to 0.20 lb. per ton of ore. In these tests and also in the pilot test 490, the proportion of Armac TD amounted to 0.159 lb. per ton of ore and the proportion of B-23 amounted to 0.002 lb. per ton of ore.

The proportion of residual slime present, the concentrate grade and recovery and the proportion of KCl remaining with the tailings obtained in each test are set forth in the following tabulation:

| Test No. | Slime Control Addition | Insol. —270 Mesh Material (lbs. ton Flotation Feed) | Concentrate        |                       | Tailings             |                      |
|----------|------------------------|-----------------------------------------------------|--------------------|-----------------------|----------------------|----------------------|
|          |                        |                                                     | Grade, Percent KCl | KCl Recovery, Percent | Content KCl, Percent | Percent of Total KCl |
| 490      |                        | 3.18                                                | 67.6               | 18.6                  | 37.4                 | 81.4                 |
| 491      | P. G. 300              | 2.0                                                 | 94.9               | 50.0                  | 24.9                 | 50.0                 |
| 492      | P. G. 600              | 2.3                                                 | 94.3               | 62.1                  | 19.1                 | 37.9                 |

The compounds designated in the table above as "P. G. 300" and "P. G. 600" are polyethylene glycols manufactured by Carbide & Carbon Chemicals Co. The numerical designations are understood to refer to the approximate molecular weights of the compounds.

As stated previously in this application, the polyglycol compounds all exhibit a flocculating action on the clay slimes in a brine suspension medium. However, there does not appear to be a direct correlation between the degree of flocculating action and the ability of the polyglycol compounds to suppress the tendency of the slimes to react with the collecting agent and reduce the concentrate grade and the recovery. Other factors being equal there does, however, appear to be a degree of correlation between the molecular size of the polyglycol compound and its ability to inhibit the reaction of the collecting agent with the insoluble slime constituents, and, therefore, when using a higher molecular weight polyglycol compound as the slime control agent the proportion may be reduced somewhat as compared with the amount of the slime control agent when using a lower molecular weight member of the group.

Although the above aspects are important and should be borne in mind in determining the optimum amount of slime control agent to be used with a given ore, it is more important to determine as accurately as possible the insoluble slime content of the ore pulp that is to be conditioned and floated, and to vary the proportion of the slime control agent in accordance with the proportion of slime present. From the practical point of view, it will be generally more economical to subject the ore to a partial desliming preliminary to the treatment with the slime control agent. From the standpoint of cost of equipment, cost of power, maintenance, supervision and loss of KCl in the slimes fraction, there are practical limitations to the amount of desliming that may be effected in a commercial operation by means of mechanical and other previously known desliming methods. On the other hand, resort to the use of slime control agents to the exclusion of desliming is usually impractical because of the cost of the additional slime control agent required to insure a satisfactory concentrate and recovery. A combination of a preliminary desliming treatment followed by conditioning with a slime control agent, all preliminary to the addition of the collecting agent, is most satisfactory in commercial practice, and the extent to which the preliminary desliming is employed will vary depending upon the plant layout or flow sheet, or the particular type of mechanical desliming equipment available. According to our investigations it appears that a highly satisfactory overall operation may be realized by first desliming the ore sufficiently to reduce the slimes to around and preferably below 4 lbs. per ton of ore. This insures that the pro-

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portion of the slime control agent may be kept within satisfactory limits from the cost standpoint.

Where herein reference has been made to the use of polyglycols and their ethers as "slime control agents," it is to be understood that this expression is intended to characterize the special function of these agents of forming complexes with or otherwise inhibiting the normal tendency of insoluble clay slimes and similar base exchange mineral particles to react with or absorb amines and other cationic collecting agents when associated therewith in an ore pulp. The term "slime control agent" as used herein in referring to the polyglycol compounds is not intended to indicate that these compounds act to disperse slimes or to induce their flocculation so that they may be more readily separated from an ore pulp by decantation or other wet methods. As brought out previously herein, although the polyglycol compounds are sometimes referred to as dispersants and do function as such in water and various other liquids, they behave entirely differently in a brine solution. Moreover, their function as control agents in the sense that this term is used herein does not manifest itself except when they are introduced into a brine pulp containing clay slime minerals having the ability to form complexes with the polyglycol compound that are sufficiently stable to suppress any tendency of the clay slime minerals to react with or render ineffective the collecting agents that are added to prepare the ore for flotation or other suitable wet stratifying separation.

The invention is applicable to the conditioning or reagentizing of potash ores containing sylvite for separation of the desired sylvite from such ores by any of the wet stratifying methods that involve the use of an appropriate collecting agent for facilitating the separation of the sylvite from the other ore constituents, such as froth flotation, skin flotation and agglomeration tabling.

It is to be understood that the beneficial effects of the use of the polyglycol compounds of the class hereinbefore described in the separation and recovery of sylvite from potash ores containing sylvite is not restricted to their use with the particular type of amine collecting agents used in the specific samples. The advantages of the invention may be realized when using any of the amine collecting agents known to be effective as collectors of sylvite present in pulps of potash ores containing sylvite. In fact, any of the agents that are classed as cationic collectors and are likewise effective in collecting sylvite may be used. It will be understood, of course, that in selecting a particular collecting agent due regard will be had to the solubility characteristics of the collector and the temperature of the brine pulp.

It is to be understood that the examples set forth herein are merely illustrative of the invention and that, within the scope of the appended claims, the invention may be practised in various other ways that will readily suggest themselves to the person versed in the art.

We claim:

1. The improvement in the concentration of sylvite from potash ores containing sylvite in association with minor but objectionable amounts of clay and similar slime-forming constituents, which comprises forming the ore in the state of a feed of suitable fineness for a wet stratifying separation treatment into a pulp with a saturated aqueous solution of the soluble ore constituents, mixing a slime control agent with said pulp in a proportion sufficient to suppress the tendency of the slime constituents present

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to react with a collecting agent suitable for collecting sylvite, said slime control agent being selected from the group consisting of the polyglycols and their ethers having a molecular weight of about 300, and thereafter distributing such a collecting agent in said pulp and then subjecting the mixture to a separation treatment to remove the sylvite.

2. A method as set forth in claim 1, wherein the potash ore is subjected to a mechanical desliming treatment to remove a substantial part of the slimes before the slime control agent is added.

3. A method as set forth in claim 1, wherein the separation is effected by a froth flotation treatment.

4. A method as set forth in claim 1, wherein the separation is effected by an agglomeration tabling treatment.

5. A method as set forth in claim 1, wherein the slime control agent consists at least principally of a methoxy polyethylene glycol ether.

6. A method as set forth in claim 1, wherein the slime control agent consists at least principally of a polyethylene glycol tert. dodecylthioether.

7. A method as set forth in claim 1, wherein the slime control agent consists at least principally of a mono-ether of a polyethylene glycol.

8. A method as set forth in claim 1, wherein a cationic collector is used as the collecting agent.

9. A method as set forth in claim 1, wherein the collecting agent consists at least principally of an aliphatic amine containing a continuous carbon chain of at least 8 carbon atoms.

10. A method as set forth in claim 1, wherein the collecting agent consists at least principally of a water soluble salt of an aliphatic amine containing a continuous carbon chain of at least 8 carbon atoms.

11. A method of concentrating sylvite from sylvinitic ore containing minor but objectionable amounts of clay and similar slime-forming constituents, which comprises forming the ore in the state of a feed of suitable fineness for froth flotation into a pulp with a saturated solution of the soluble ore constituents, mixing a slime control agent with said pulp in a proportion sufficient to suppress the tendency of the slime constituents present to render a cationic collecting agent ineffective, said slime control agent being selected from the group consisting of the polyglycols and their ethers having a molecular weight of at least about 300, thereafter distributing a cationic collecting agent in said pulp and then subjecting the mixture to a froth flotation separation treatment to remove the sylvite.

12. A method as set forth in claim 11, wherein the collecting agent consists principally of water soluble salts of aliphatic amines having continuous carbon chain lengths of at least 8 carbon atoms.

13. A method as set forth in claim 11, wherein the slime control agent consists at least principally of a methoxy polyethylene glycol ether.

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