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CONCENTRATING OR SEPARATING OF THE VALUES FROM SOLUBLE ORES

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This invention relates to the concentrating or separating of the values from ores. More particularly it relates to flotation processes or modifications thereof wherein a mineral collector is employed.

This application is filed as a continuation-in-part of our co-pending application, Serial No. 278,314, filed March 24, 1952, now abandoned.

In the type of flotation process to which this invention is applicable, "slimes" are usually present in the flotation step and impair the efficacy of the reagent or agent which functions as the mineral collector. In those processes where extremely slimy pulps are encountered it is the general practice to include a desliming step for removing the slimes from the ore pulp prior to the passage of the pulp to flotation; however, even in these instances some slimes escape the removal step and pass to flotation so that the problem of their adverse effect upon the mineral collector is still present. To inhibit this adverse effect of slimes upon the collector during the flotation step it has been the common practice to employ auxiliary reagents and examples of such auxiliary reagents as starch and dextrin, with starch having perhaps the widest application throughout the mineral dressing industry.

The processes and methods of the present invention are the results of the discovery that the use of a polymer consisting principally of mannose units as an auxiliary reagent gives greatly improved yields as compared to other reagents in the auxiliary class, and it is, therefore, the general object of this invention to provide an improved method of separating the values from ores by flotation wherein a polymer consisting principally of mannose units, is employed as the auxiliary reagent.

As used herein the term "polymer consisting principally of mannose units" is intended to include those naturally occurring compounds such as mannogalactan and glucomannan, or any compound in which mannose units are predominant. For the sake of clarity, the description herein will refer to mannogalactan and its function as an auxiliary reagent, but it is to be understood that the invention is not limited to this specific compound.

The invention has been found particularly applicable to froth flotation processes but is, adaptable to other concentrating operations wherein a selective mineral collector is employed, i. e., agglomeration processes.

A particular object of the invention is to provide an improved method of recovering sylvite ores wherein the usual collector is employed in the flotation step and also wherein mannogalactan is added to function as an auxiliary reagent.

Another object is to provide an improved flotation process employing a mineral collector and an auxiliary reagent which process effects maximum recovery of the valuable ore constituents with a minimum amount of said auxiliary reagent.

Mannogalactan occurs naturally in the seeds of many legumes, an example of which is the endosperm of the pod-bearing legume known as "guar." It has been found that the mannogalactan occurring in guar seeds consists of approximately 67% mannose units and 33% galactose units. However, the proportion of mannose units to galactose units may vary from that of the guar seeds, depending upon the particular source of the material. Other common sources of mannogalactan suitable for the practice of the method herein disclosed are the seeds of the following: carob bean, honey locust, flame tree, huizache, tara, palo verde, and Kentucky coffee.

Glucomannan is a reserve carbohydrate found in the corms of plants of the Araceae family and comprises a polymer of mannose and glucose units in the approximate proportion of two mannose units to one glucose unit.

It has been found that mannogalactan is efficient as an auxiliary reagent when used in conjunction with mineral collectors, such as aliphatic amines and aliphatic soaps and it is believed that it has wide application in flotation processes employing such selective collectors.

The use of mannogalactan as an auxiliary reagent will be described herein as applied to the concentration of soluble potassium ores but the invention is not to be limited to this specific field of use.

In the concentration of soluble potassium ores, mannogalactan is several times as effective as starch, which is generally recognized as an efficient auxiliary, on the basis of equivalent yields. Maximum recovery of the sylvite can thus be effected with the use of a minimum amount of the auxiliary, whereby a substantial economic advantage is realized. Not only does the reduced amount of auxiliary provide an economic advantage solely from the cost standpoint but it also makes such auxiliary particularly useful in the usual closed system of operation. As is well known, it is highly desirable, in such closed system, to hold the quantity of the added reagents or collectors to a minimum to eliminate possible building-up of the added material which might interfere with overall operation; since mannogalactan is effective as an auxiliary reagent in minimum quantities, its use in the usual closed system is advantageous. A marked improvement in yield when using mannogalactan as the auxiliary is obtained with different types of mineral collectors.

To illustrate the advantages and improved results produced by the use of a polymer consisting principally of mannose units, such as mannogalactan, as the auxiliary, a series of comparative tests were conducted; such tests compare the recovery obtained when mannogalactan is used as the auxiliary to the recovery realized when potato starch is employed as the auxiliary. Potato starch was selected for the comparison because it is generally recognized as having highly efficient qualities as an auxiliary reagent.

The tests which were made and the results of which are hereinafter fully set forth were confined to froth flotation of potassium chloride and sodium chloride from a sylvite ore of the Carlsbad, New Mexico, area. However, it is obvious that the invention is applicable to agglomeration processes.

It is well known that sylvite (potassium chloride) can be recovered from a pulp of the ore in a saturated solution of the soluble constituents of sylvite ore in accordance with concentration operations by using as a collector an aliphatic amine containing a straight chain hydrocarbon group, either saturated or unsaturated, or the salts of such amine resulting from their combination with water-soluble acids. The amines useful as collectors for sylvite include, but are not limited to, the following aliphatic primary amines: n-decylamine, n-undecylamine, n-dodecylamine, n-tetradecylamine, n-hexadecylamine, n-heptadecylamine, n-octadecylamine, n-octadecenylamine. The foregoing primary amines contain a straight chain hydrocarbon group having from 10 to 18 carbon atoms but other amines containing a straight chain hydrocarbon group up to 22 carbon atoms would probably be suitable for the practice of this method.

The aliphatic amines may be added to the ore pulp in the form of the free base, or as the salts formed by their combination with acids. The amine collectors may be used individually or as mixtures, and the mixtures need not necessarily consist only of aliphatic primary amines or their salts but may also contain varying proportions of aliphatic secondary and tertiary amines or their salts, such as are commonly found in commercial products. For example, the collector may be an amine acetate manufactured by Armour & Company under the trade name "Armac TD" and consisting of approximately 30% hexadecylamine acetate, 25% octadecylamine acetate, and 45% octadecenylamine acetate. Other commercial products which would be satisfactory as collectors include the distilled grade of hydrogenated tal-

low amine acetate sold under the trade name of "Armac HTD" by Armour & Company.

It is also well known that halite (sodium chloride) can be floated in this type of process by employing as a collector an aliphatic soap.

Certain tests were conducted wherein the salts of aliphatic amines were used as the collector while additional tests were carried out using aliphatic soap as the collector.

In the tests using the salts of aliphatic amines for the recovery of sylvite (potassium chloride), the collectors selected were Armac TD and Armac HTD. These collectors were used in the form of an aqueous solution. The auxiliary reagents with the exception of ilesmannan were used in the form of a brine sol; illesmannan was prepared as a water sol. The dispersion in the sol is greatly enhanced by the addition of heat during its preparation, which in turn markedly improves its auxiliary action. The test procedure was as follows:

Thoroughly-mixed batches of sylvinite ore from the Carlsbad area were split into several 600-gram samples for use as feed. These samples were wet-ground to minus 14 mesh using a saturated KCl-NaCl brine as a carrier. The ground samples were partially deslimed by decantation to a 60% pulp density. The auxiliary reagent was added to the above slurry and conditioned for 45 seconds. The collector was then added and similarly conditioned for 45 seconds. The reagentized pulp was then added to a Fagergren test cell where it was diluted to approximately 20% solids. It was agitated for two minutes without air and then floated to the absence of mineral in the froth.

In the following test data, which is self-explanatory, Armac TD was employed as the collector:

Test I.—No Auxiliary, using Armac TD

	Type	Quantity
Auxiliary	0	0.
Collector	Armac TD	0.40 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	26.5	
Concentrate		
Tails	26.5	100.00

Test II.—Mannogalactan consumption vs. recovery using Armac TD

	Type	Quantity
Auxiliary	Mannogalactan (Guar)	0.05 lb./ton ore.
Collector	Armac TD	0.40 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	26.5	
Concentrate	56.7	33.0
Tails	21.0	67.0

Test III.—Mannogalactan consumption vs. recovery using Armac TD

	Type	Quantity
Auxiliary	Mannogalactan (Guar)	0.10 lb./ton ore.
Collector	Armac TD	0.40 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	26.5	
Concentrate	58.4	97.9
Tails	1.0	2.1

Test IV.—Mannogalactan consumption vs. recovery using Armas TD

	Type	Quantity
Auxiliary	Mannogalactan (Guar)	0.20 lb./ton ore.
Collector	Armac TD	0.40 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	26.5	
Concentrate	59.5	99.2
Tails	0.4	.8

Test V.—Starch consumption vs. recovery using Armac TD

	Type	Quantity
Auxiliary	Potato starch	0.20 lb./ton ore.
Collector	Armac TD	0.40 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	26.5	
Concentrate	60.1	34.4
Tails	20.5	65.6

Test VI.—Starch consumption vs. recovery using Armac TD

	Type	Quantity
Auxiliary	Potato Starch	0.40 lb./ton ore.
Collector	Armac TD	0.40 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	26.5	
Concentrate	58.9	97.8
Tails	1.0	2.2

Test I illustrates that no recovery was obtained when no auxiliary reagent was employed.

In Test II, whereon 0.5 pound of mannogalactan per ton of ore was employed, recovery was 33%. In Test III, wherein .10 pound of mannogalactan per ton of ore was used, recovery increased to 97.9%, while in Test IV wherein .20 pound mannogalactan per ton of ore was employed, recovery increased to 99.2%.

Employing the same collector reagent, Test V illustrates that when .20 pound potato starch per ton of ore was employed, recovery was only 34.4%; comparing this to the use of .20 pound mannogalactan per ton of ore (Test IV), it is evident that the mannogalactan is several times as effective. Test VI increased the starch per ton of ore to .40 pound, and although this is double the amount of mannogalactan employed in Test IV, recovery is still less, being 97.8% as compared to 99.2% in Test IV.

The data shown in Tests I–VI, illustrate that mannogalactan is several times as effective as starch and obviously a considerably less amount of mannogalactan need be employed for the same recovery which is particularly advantageous in closed systems. Mannogalactan has also been found superior to starch in that the froth characteristics are decidedly better, thereby reducing troublesome problems in the handling and pumping of concentrates. Since the froth characteristics are improved, mannogalactan is of decided advantage in flotation processes regardless of the type of selective mineral collector employed.

In the following tests, Armac HTD was used as the collector:

Test VII.—No auxiliary using Armac HTD

	Type	Quantity
Auxiliary		
Collector	Armac HTD	0.50 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	26.0	
Concentrate	0.0	
Tails	26.0	100.0

Test VIII.—Mannogalactan using Armac HTD

	Type	Quantity
Auxiliary	Mannogalactan (Guar)	0.20 lb./ton ore.
Collector	Armac HTD	0.50 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	26.0	
Concentrate	58.7	73.0
Tails	10.4	27.0

Test IX.—Starch using Armac HDT

	Type	Quantity
Auxiliary	Potato Starch	0.20 lb./ton ore.
Collector	Armac HTD	0.50 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	26.0	
Concentrate	57.7	42.8
Tails	18.4	57.2

Test VIII reflects that where .20 pound of mannogalactan per ton of ore was employed, recovery was 73%. A similar quantity of potato starch which was used in making Test IX shows recovery to be only 42.8%. These comparative tests clearly illustrate the higher efficiency of mannogalactan as the auxiliary reagent.

All of the foregoing tests with the different amine collectors illustrate that the superiority of mannogalactan is not confined to a particular class of aliphatic amines but is useful with the saturated as well as the unsaturated members.

Other tests employing mannogalactan produced from honey locust, and tara as well as tests employing the glucomannan identified as ilesmannan, were conducted and the following test data illustrates the improved results obtained.

Test X.—Mannogalactan from honey locust using Armac TD

	Type	Quantity
Auxiliary	Locust Bean Gum	0.15 lb./ton ore.
Collector	Armac TD	0.40 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	26.5	
Concentrate	61.1	95.0
Tails	2.1	5.0

Test XI—Mannogalactan from tara using Armac TD[1]

	Type	Quantity
Auxiliary	Tara	0.25 lb./ton ore.
Collector	Armac TD	0.40 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	27.3	
Concentrate	59.8	89.4
Tails	4.9	10.6

[1] This test conducted on feed containing more clay than Tests I to X.

Test XII.—Glucomannan using Armac TD

	Type	Quantity
Auxiliary	Ilesmannan	0.25 lb./ton ore.
Collector	Armac TD	0.40 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	27.3	
Concentrate	60.0	96.7
Tails	1.6	3.3

The higher efficiency of mannogalactan as an auxiliary reagent is not restricted to a particular type of collector reagent or to a particular flotation process. One method of concentrating the valuable constituents of soluble salt mixtures is to remove the sodium chloride impurity by froth flotation, using as a collector an aliphatic soap. The tests hereinafter outlined evidence the fact that improved results are obtained in processes of this type where mannogalactan is employed as the auxiliary reagent.

In the tests made using an aliphatic soap as the collector, the test procedure was as follows: Identical feed samples, consisting of 1000 grams of mixed sodium and potassium salts, were prepared. Said samples were dry ground to pass a 28 mesh sieve and to contain approximately 20% minus 200 mesh. The samples were pulped to 50% density in a brine saturated with the major constituents of the feed and containing a soluble lead salt equivalent to two grams of lead per liter of brine. The auxiliary was added and the pulp conditioned for thirty seconds. Following this step, the pulp was transferred to a standard test cell where it was diluted with brine to approximately 35% solids. The soap collector was then added and flotation of the halite (sodium chloride) was commenced. Flotation continued to the absence of mineralized froth. Attention is directed to the fact that starvation reagent quantities were used in an effort to contrast auxiliary power rather than to produce a commercial result.

Test XIII.—No auxiliary using soap (principally pelargonic acid)

	Type	Quantity
Auxiliary	0	0.
Collector	5% aliphatic acid soap.	0.294 lb. dry soap/ton ore.
	Percent NaCl	Percent NaCl Recovery
Feed	58.0	
Float	81.9	17.6
Residue	54.6	82.4

Test XIV.—Starch auxiliary using soap (principally pelargonic acid)

	Type	Quantity
Auxiliary	Potato Starch	0.25 lb./ton ore.
Collector	5% aliphatic acid soap.	0.294 lb./dry soap/ton ore.
	Percent NaCl	Percent NaCl Recovery
Feed	58.0	
Float	77.2	20.0
Residue	54.6	80.0

Test XV.—Mannogalactan auxiliary using soap (principally pelargonic acid)

	Type	Quantity
Auxiliary	Mannogalactan	0.25 lb./ton ore.
Collector	5% aliphatic acid soap.	0.294 lb./dry soap/ton ore.
	Percent NaCl	Percent NaCl Recovery
Feed	58.0	
Float	77.2	44.7
Residue	48.3	55.3

Test XVI.—No auxiliary using oleic acid soap

	Type	Quantity
Auxiliary	0	0.
Collector	Oleic Acid Soap	0.50 lb./ton ore.
	Percent NaCl	Percent NaCl Recovery
Feed	56.8	
Float	83.1	40.2
Residue	46.8	59.8

Test XVII.—Starch auxiliary using oleic acid soap

	Type	Quantity
Auxiliary	Corn Starch	0.50 lb./ton ore.
Collector	Oleic Acid Soap	0.50 lb./ton ore.
	Percent NaCl	Percent NaCl Recovery
Feed	56.8	
Float	82.7	71.0
Residue	32.2	29.0

Test XVIII.—Mannogalactan auxiliary using oleic acid soap

	Type	Quantity
Auxiliary	Mannogalactan	0.50 lb./ton ore.
Collector	Oleic Acid Soap	0.50 lb./ton ore.
	Percent NaCl	Percent NaCl Recovery
Feed	56.8	
Float	85.3	81.5
Residue	22.9	18.5

In the foregoing Test XIII where no auxiliary was used, a recovery of 17.6% was obtained. In Test XIV .25 pound of potato starch per ton of ore was employed and the result was only slightly improved since recovery was increased to 20%. When .25 pound of mannogalactan per ton of ore was used, as set forth in Test XV, recovery was increased to 44.7%, thereby demonstrating that the use of mannogalactan provides a marked improvement in yield. Tests XVI to XVIII demonstrate that mannogalactan increased recovery when used as an auxiliary with oleic acid soap.

To further illustrate the higher efficiencies obtained when using a polymer consisting of principally mannose units as the auxiliary reagent, the following tests are cited to indicate auxiliary action with the sulphate-type collectors in the flotation of both sylvite and halite.

Test procedures for this group of experiments were the same as those previously outlined for fatty acid soap flotation with the exception that where sylvite is the floated mineral the brine contained no lead.

The first of this series demonstrates the improvement obtained when using either mannogalactan or glucomannan with a sulphated fatty ester in the flotation of halite from a potassium ore. The sulphated ester selected was Emery Industries' Twitchell 7250.

Test XIX.—No auxiliary using Twitchell 7250

	Type	Quantity
Auxiliary	0	0.
Collector	Twitchell 7250	6.0 lb./ton ore.
	Percent NaCl	Percent NaCl Recovery
Feed	56.8	
Float	86.4	38.7
Residue	46.7	61.3

Test XX.—Starch auxiliary using Twitchell 7250

	Type	Quantity
Auxiliary	Corn Starch	0.5 lb./ton ore.
Collector	Twitchell 7250	6.0 lb./ton ore.
	Percent NaCl	Percent NaCl Recovery
Feed	56.8	
Float	88.7	89.7
Residue	13.9	10.3

Test XXI.—Mannogalactan auxiliary using Twitchell 7250

	Type	Quantity
Auxiliary	Mannogalactan	0.5 lb./ton ore.
Collector	Twitchell 7250	6.0 lb./ton ore.
	Percent NaCl	Percent NaCl Recovery
Feed	56.8	
Float	84.1	97.8
Residue	3.8	2.2

Test XXII.—Glucomannan auxiliary using Twitchell 7250

	Type	Quantity
Auxiliary	Ilesmannan	0.5 lb./ton ore.
Collector	Twitchell 7250	6.0 lb./ton ore.
	Percent NaCl	Percent NaCl Recovery
Feed	56.8	
Float	82.4	98.4
Residue	3.0	1.6

In the foregoing tests, recovery was improved from 38.7% using no auxiliary, through 89.7% using starch, to 97.8% and 98.4% using mannogalactan and glucomannan respectively.

Additionally, this series of tests showed a marked improvement in froth characteristics when using the polymers consisting principally of mannose units.

The second series of experiments with sulphate-type collectors employs the commercial product Drene, which

consists principally of sodium lauryl sulphate, to float the mineral sylvite from potassium ores.

Test XXIII.—No auxiliary using Drene

	Type	Quantity
Auxiliary	0.	0.
Collector	Drene	6.0 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	27.3	
Float	0	0
Residue	27.3	100.0

Test XXIV.—Starch auxiliary using Drene

	Type	Quantity
Auxiliary	Corn Starch	0.5 lb./ton ore.
Collector	Drene	6.0 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	27.3	
Float	47.9	66.8
Residue	14.6	33.2

Test XXV.—Mannogalactan using Drene

	Type	Quantity
Auxiliary	Mannogalactan	0.5 lb./ton ore.
Collector	Drene	6.0 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	27.3	
Float	43.3	94.0
Residue	4.1	6.0

Test XXVI.—Glucomannan using Drene

	Type	Quantity
Auxiliary	Ilesmannan	0.5 lb./ton ore.
Collector	Drene	6.0 lb./ton ore.
	Percent K_2O	Percent K_2O Recovery
Feed	27.3	
Float	44.1	82.4
Residue	9.8	17.6

In Test XXIII, with no auxiliary reagent, there was no mineral collection. Test XXIV, using starch, effected flotation. However, Tests XXV and XXVI again demonstate the superiority of mannose polymers.

It is understood that the mannogalactan is used in the process in the usual well known manner of use of auxiliary reagents and it is, therefore, deemed unnecessary to outline in detail the introduction of the mannogalactan into the system since such introduction may be accomplished in various ways in accordance with procedures well known in the art. Any system of operation can be employed in utilizing the disclosures herein in commercial practice.

The invention has a wide field of application and the discovery of this new flotation auxiliary reagent has marked economical significance, not only in the concentration or treatment of soluble salts but also in other flotation processes where the use of an auxiliary reagent has been found beneficial.

Having described the invention, we claim:

1. The improvement in the method of separating valuable constituents from potassium ores which comprises subjecting the ore to a concentrating process employing a mineral collector, said improvement residing in, distributing in said ore during the concentrating process a useful amount of an auxiliary reagent which is a polymer consisting principally of mannose units.

2. The improvement in the method of separating valuable constituents from potassium ores which comprises subjecting the ore to a concentrating process employing a mineral collector, said improvement residing in, distributing in said ore during the concentrating process a useful amount of an auxiliary reagent which is a polymer containing mannose and galactose units.

3. The improvement in the method of separating valuable constituents from potassium ores which comprises subjecting the ore to a concentrating process employing a mineral collector, said improvement residing in, distributing in said ore during the concentrating process a useful amount of mannogalactan to function as an auxiliary reagent.

4. The improvement in the method of separating valuable constituents from potassium ores by a flotation process employing a mineral collector, said improvement residing in distributing in the ore a useful amount of mannogalactan which functions as an auxiliary reagent.

5. The improvement in the method of concentrating sylvite from a sylvite ore in a pulp formed by suspending the sylvite ore in a saturated aqueous solution of the soluble ore constituents and conditioned with a selective mineral collector, said improvement residing in distributing in said pulp a useful amount of mannogalactan as an auxiliary reagent.

6. The improvement in the method of separating sylvite from a pulp containing it which comprises subjecting said pulp to a concentrating process employing a collector selected from the group consisting of aliphatic amines and their salts formed by their combination with water soluble acids, which acids are relatively devoid of surface active properties, said improvement residing in distributing in said pulp a useful amount of mannogalactan to function as an auxiliary reagent.

7. The improvement in the method of concentrating sylvite from a sylvite ore in a pulp formed by suspending the sylvite ore in a saturated aqueous solution of the soluble ore constituents and conditioned with a collector selected from the group consisting of aliphatic amines containing a straight chain hydrocarbon group having from 10 to 22 carbon atoms, and their salts formed by their combination with water soluble acids, said improvement residing in distributing in said pulp a useful amount of an auxiliary reagent which is a polymer consisting principally of mannose units.

8. The improvement in the method of concentrating sylvite from a sylvite ore in a pulp formed by suspending the sylvite ore in a saturated aqueous solution of the soluble ore constituents and conditioned with a collector selected from the group consisting of the aliphatic amines containing a straight chain hydrocarbon group having from 10 to 22 carbon atoms, and their salts formed by their combination with water soluble acids, said improvement residing in distributing in said pulp a useful amount of mannogalactan as an auxiliary reagent.

9. The improvement in the method of separating potassium chloride from sylvite ore by froth flotation wherein the mixture of salts being slurried in brine is subjected to a flotation step in which an aliphatic soap is employed as the sodium chloride collector, said improvement residing in distributing in the brine slurry an auxiliary reagent which is a polymer consisting principally of mannose units.

10. The improvement in the method of separating valuable constituents from potassium ores by a flotation process wherein the ore is subjected to a flotation step in which an aliphatic soap is used as the collector, said improvement residing in distributing in the ore mannogalactan which functions as an auxiliary reagent.

11. The improvement in the method of separating sodium chloride from salt mixtures by froth flotation wherein the mixture of salts being slurried in brine is subjected to a flotation step in which an aliphatic soap is employed as the sodium chloride collector, said improvement residing in distributing in the brine slurry mannogalactan as an auxiliary reagent.

12. The improvement in the method of separating valuable constituents from potasium ores which comprises subjecting the ore to a concentrating process employing a mineral collector, said improvement residing in, distributing in said ore during the concentrating process a

useful amount of mannogalactan which is produced from the endosperm of guar.

13. The improvement in the method of separating valuable constituents from potassium ores which comprises subjecting the ore to a concentrating process employing a mineral collector, said improvement residing in, distributing in said ore during the concentrating process a useful amount of mannogalactan which is produced from honey locust.

14. The improvement in the method of separating valuable constituents from potassium ores which comprises subjecting the ore to a concentrating process employing a mineral collector, said improvement residing in, distributing in said ore during the concentrating process a useful amount of mannogalactan which is produced from tara.

15. The improvement in the method of separating valuable constitutents from potassium ores which comprises subjecting the ore to a concentrating process employing a mineral collector, said improvement residing in, distributing in said ore during the concentrating process a useful amount of glucomannan.

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