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Baak

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[54] **BENEFICIATION OF NEW YORK STATE TALC**

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[58] **Field of Search** 241/4, 15, 16, 20, 21, 241/24; 209/9

[56] **References Cited**

UNITED STATES PATENTS

3,307,790	3/1967	Cohn et al.	241/20 X
3,346,111	10/1967	Thompson et al.	209/9
3,356,211	12/1967	Mathews	209/9
3,599,879	8/1971	Clark	241/4

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[57] **ABSTRACT**

Process of beneficiating Gouverneur, New York talc ore to produce a high purity, platy talc substantially free of tremolite. The process involves crushing the ore and irradiating the crushed ore with short wavelength ultraviolet radiation to cause the talc in the crushed ore to fluoresce predominantly white and the tremolite in the crushed ore to fluoresce a predominantly non-white color. The irradiated crushed ore is then separated into a first portion in which the fluorescent areas of the constituent rocks fluoresce predominantly white, and a second portion in which the fluorescent areas of the constituent rocks fluoresce a predominantly non-white color. The rocks in the first portion are crushed further preferably to a particle size of minus 100 Tyler mesh, and are subjected to at least one froth flotation step. The talc recovered from the froth formed during the last froth flotation step is characterized by a G.E. brightness about 90 and a tremolite content of less than 1.0 percent by weight.

12 Claims, No Drawings

BENEFICIATION OF NEW YORK STATE TALC

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the production of a high purity talc, suitable for cosmetic applications, from talc ore including a high proportion of undesirable impurities, such as asbestos in the form of tremolite.

2. Description of the Prior Art

Since talc has many uses requiring different grades of purity, it has been the practice to separate the talc to varying degrees from the impurities with which it is associated in its natural state. The customary milling practice consists of grinding and sizing, beneficiation generally being obtained by hand sorting and cobbing. The natural floatability of talc has been advantageously employed to separate the talc from gangue materials which are associated with the talc in its ore form.

High grade talc in the form of powder has found wide acceptance in the cosmetic industry for application to human skin. For such uses, it is desirable to have the talc as free as possible of any irritating particles. Accordingly, in the past the highest quality talcum powders have been made from talc ore which, as mined, contain no more than 4 to 5 percent of impurities, the remainder being substantially pure talc. See, e.g., U.S. Pat. No. 3,102,856 — Chase.

Certain talc ores, such for example as those found in the region of Gouverneur, New York, contain a substantial proportion of undesirable impurities, notably asbestos in the form of tremolite, and such ores have not in the past been economically feasible sources for the production of cosmetic grade talc. Such ores consist of three types: tremolite talc ore, limey talc ore, and green talc ore. The tremolite talc ore contains talc with tremolite and serpentine as principal impurities; the limey talc ore contains talc, both fibrous and foliated, limestone and tremolite; the green talc ore contains foliated talc, quartz, feldspar and tremolite. Froth flotation of the above-mentioned ores had been reported as early as 1939 [J.E. Norman et al., "Froth Flotation of Talc Ores from Gouverneur, New York," Bulletin American Ceramic Society 18, No. 8, p. 292 (1939)]. Although some enrichment of the talc was obtained by flotation, the tremolite residues in the cleaner concentrates, as reported by the authors, ran in the range of between 13 to 35 percent. Such cleaner concentrates were therefore entirely unsuitable as cosmetic grade talc which should be essentially free, i.e., contain less than 1 percent by weight, of fibrous silicates, such as tremolite and serpentine.

It is known that many minerals will fluoresce upon exposure to ultraviolet radiation, and both shortwave and longwave ultraviolet light have been used for the detection of various minerals. The characteristics of certain minerals has also been employed as the basis for sorting techniques. For example, U.S. Pat. No. 2,717,293 — Holmes describes tungsten ore sorting apparatus which takes advantage of the characteristic fluorescence of that mineral when exposed to ultraviolet radiation.

The separation of ore particles which have been preferentially coated with liquid fluorescent material is described in U.S. Pat. No. 3,356,211 — Mathews. The coating liquid used in the process disclosed, in addition to being specific to particles of one of the minerals in the ore, is also capable of fluoresceing at a characteristic wavelength after exposure to ultraviolet, X-ray, or other type of radiation.

A method of rendering asbestos in asbestos-containing rock differentially fluorescent in relation to host rock is described in U.S. Pat. No. 3,346,111 — Thompson et al. The patentees there state that when an asbestos-containing rock is dipped into a fluorescent dye solution and is washed and inspected under suitable radiation, such as ultraviolet light, the exposed seams of asbestos can be identified by the relative brilliance of their fluorescence. They add, however, that for practical purposes the ratio of light emitted by host rock is not sufficiently great to enable easy identification of asbestoscontaining rocks by that method. Accordingly, they describe a process of rendering asbestos in asbestos-containing rocks differentially fluorescent in relation to host rock by contacting the rocks with a liquid dispersion of a precipitated fluorescent dye and removing the non-sorbed material from the rocks, as by washing, sufficiently to render exposed asbestos differentially fluorescent in relation to host rock. The method described by Thompson et al. is said to be applicable to sorting of rocks containing various types of asbestos, including crocidolite, chrysotile, amosite, tremolite and actinolite.

SUMMARY OF THE INVENTION

It is a primary object of the present invention to provide an economical process for the production of a high purity talc from talc ore containing a high proportion of tremolite as an impurity.

The present invention is particularly suited for the production of high quality talc from talc ores such, for example, as are found in the region of Gouverneur, New York. Such ores in the past have not been suitable for the production of cosmetic grade talc because of their high proportion of impurities, notably tremolite, which could not economically be separated from the desired talc product. By virtue of the present invention, a high quality talc product may be economically produced from ores whose tremolite content may in some instances exceed the talc content of the ore.

Generally stated, this invention provides a process for preparing a high quality talc from talc ore containing a high proportion of tremolite as an impurity by crushing the talc ore, irradiating the crushed ore with short wavelength ultraviolet radiation to cause the talc in the crushed ore to fluoresce predominantly white and the tremolite in the crushed ore to fluoresce a predominantly non-white color, separating the crushed ore into a first portion in which the fluorescent areas of the constituent rocks fluoresce predominantly white and a second portion in which the fluorescent areas of the constituent rocks fluoresce predominantly non-white, crushing the first portion to a particle size of minus 20 mesh, forming a dilute aqueous slurry of the crushed first portion, the slurry having a solids content preferably not exceeding about 15 percent by weight of the slurry, subjecting the slurry to at least one froth flotation step, removing the froth formed during the final froth flotation step, and recovering a high purity talc from the floated froth.

The present invention takes advantage of the fact that the talc and tremolite constituents in Gouverneur, New York talc ore are differentially fluorescent when exposed to short wavelength ultraviolet or other radia-

tion. The talc constituent of the ore, when irradiated with short wavelength ultraviolet light will fluoresce predominantly white, in a greenish-white or cream white color, whereas the tremolite constituent will fluoresce a distinctly non-white color, i.e. apricot-pink to orange or red. See, e.g., Warren, Minerals That Fluoresce With Mineralite Lamps, Bulletin No. 315 of Ultra-Violet Products, Inc. (1969).

The invention further takes advantage of the discovery that tremolite and foliated talc are not homogeneously distributed one with another in talc ore mined in the region of Gouverneur, New York, but instead appear to be distributed in concentrated masses throughout the ore. Accordingly, when the ore is crushed into rocks of a manageable size, certain rocks will contain more foliated talc than tremolite. By exposing the rocks to short wavelength ultraviolet radiation in accordance with the invention, the high talc-low tremolite content rocks which are predominantly suitable for subsequent crushing and flotation steps can be isolated from the remainder of the crushed ore.

An essential feature of the present invention, which is critical to the successful separation of the tremolite from the foliated talc and the consequent production of a cosmetic grade talc product, is the combination of ultraviolet sorting and froth flotation operations. In this connection, it has been found that froth flotation alone — absent the ultraviolet sorting step — will not afford an economical separation of the impurities from the talc.

An additional advantage of the invention is based upon the discovery that the fibrous talc constituent of ore from the region of Gouverneur, New York appears to be more associated with tremolite than with the desired platy or foliated talc constituent of the ore. Accordingly, the high quality talc produced in accordance with the invention is characterized by a low fibrous talc content as well as being substantially free (i.e. contains less than 1 percent and preferably less than 0.5 percent) of impurities such as tremolite and serpentine. As a result, the slip or feel of the talc beneficiated in accordance with the process of the invention is excellent, thus rendering talc especially suitable for cosmetic applications.

The present invention further contemplates the additional option step of wetting the crushed talc ore with water, prior to irradiation and sorting, to facilitate the sorting operation. In this connection, it has been discovered that the wetting of the crushed ore with water enhances the contrast in color between the talc and tremolite constituents of the ore, so that upon exposure to ultraviolet radiation the discrimination between those rocks which are predominantly suitable for further treatment, i.e. the rocks whose fluorescent areas fluoresce predominantly white, is facilitated.

In accordance with the invention, the crude talc ore may be prepared for sorting by crushing the mined ore to a manageable particle size such, for example, as rocks in the general size range of under 2 inches. The sorting of the ore rocks can then be accomplished optically by hand cobbing or with the aid of any of the presently available automatic sorting machines on the market, such as, for example, the Sortex 621 M Optical Separator, manufactured by Sortex Company of North America, Lowell, Mich., which include a shortwave ultraviolet light source. To some extent, the size of rocks to which the original ore is crushed will depend upon the type of sorting technique that is to be used. Where automatic sorting machines are employed, the ore may be crushed to a particle size of less than one-half inch, preferably from one-eighth to one-quarter inch in size.

Generally speaking, sorting of the crushed rock is achieved in accordance with the invention by first irradiating the crushed rock with short wavelength radiation such for example as ultraviolet light characterized by a wavelength of from about 250nm (nanometer) to about 340nm. The color patterns in the rocks exposed to the ultraviolet light source are quite discernible. For example, under short wavelength mercury light of 254nm., the talc constituent of the ore will fluoresce a greenish-white or cream white. The tremolite constituent on the other hand will fluoresce an apricot-pink to orange or red. As above noted, a definite improvement may be reached optically for the dsicrimination between acceptable and rejectable rocks for sorting purposes with consequent improved yields in the final product by wetting the ore rocks with water prior to exposing them to the ultraviolet light source. When the moistened rocks are inspected under shortwavelength ultraviolet light, a substantial increase in darkness of the impurities is observed, while the talc shows undiminished whitish fluorescence. As will be appreciated by those skilled in the art, numerous other light sources, such as UV lasers active in the preferred short wavelength region (i.e. from 250 to about 340nm) may be used in the practice of the invention.

As the sorting is conducted, whether by machine or by hand, crushed ore in the form of rocks is separated into a first portion in which the fluorescent areas of the constituent rocks fluoresce predominantly white and a second portion in which the fluorescent areas of the rocks fluoresce predominantly non-white. Once this sorting step is completed, the first portion of rocks, i.e. those containing a substantial quantity of talc as opposed to tremolite, are further crushed prior to flotation for the purpose of freeing the mineral particles from each other. In this connection, it has been found that the rocks should be crushed to a particle size of minus 20 Tyler mesh, and preferably below minus 100 mesh, or finer, to achieve the desired high grade talc product. For cosmetic purposes, the ore should be ground to a particle size of 100 percent minus 100 mesh and 98 percent minus 200 mesh.

In accordance with the invention, the preferential flotation of the platy talc from the ore impurities contained in the crushed portion of ore rock is acheived by utilizing a relatively dilute slurry having a solids content of less than about 15 percent by weight. Preferably, the solids content will be 10 or less percent by weight of the slurry. It has also been discovered that particularly good results may be achieved by dispersing the ground first portion of crushed ore in deionized water. If desired, a small amount of a water-soluble frother may be added to improve the separation of the tremolite during the froth flotation. Preferably, the amount of frother added to the slurry is less than about 0.2 pound of frother per ton of solids in the slurry. While any of the well known, commercially available frothers may be used, it has been found that particularly outstanding results can be achieved by the use of methyl isobutyl carbinol or isopropanol. Other suitable frothers useful in the practice of the invention will readily occur to those skilled in the art.

In accordance with a preferred form of the invention, a fairly dilute pulp, containing less than 10 percent by weight of solids, is used, and is conditioned with a small amount of frother which may be either methyl isobutyl carbinol or isopropanol. Where isopropanol is used, it has been found desirable to additionally add sodium silicate to the slurry to depress the tremolite and further improve separation. The slurry is then aerated and a first concentrate withdrawn. It has been found desirable to refloat this concentrate, without addition of any reagents, to produce good quality talc concentrate. To assure virtually complete removal of the tremolite a third flotation step may be employed, although two flotation steps are generally sufficient to provide a talc product in which the tremolite and serpentine contents are less than 1 percent.

The froths may be processed in a conventional manner by thickening, filtration, washing and drying.

It has been found that upon the completion of the process combining the sorting technique involving the separation of the crushed ore under ultraviolet light and subsequent grinding and flotation steps as outlined above, no traces of tremolite could be observed in the talc samples produced. The samples were inspected using microscopic techniques, X-ray diffraction and X-ray spectrometry.

As noted above, an additional advantage of the process of the invention is that the fibrous talc constituent of the ore is also for the most part removed with the tremolite during the process of the invention.

If the talc product is to be used for cosmetic purposes, it may if desired be subjected to a chlorine treatment to remove all micro-organisms. This is generally achieved prior to the final drying step. The subsequent drying of the chlorinated talc product will remove the volatile chlorine from the talc.

In order that those skilled in the art may better understand how the present invention may be practiced, the following examples are given by way of illustration and without limitation. The talc used in the examples which follow was ore obtained from the Gouverneur, New York region. Typical chemical analyses of talcs there mined are set forth below.

	(1)	(2)
SiO_2	59.80	66.23
MgO	27.45	25.71
Fe_2O_3	0.05	0.13
Al_2O_3	0.57	1.05
CaO	6.80	2.26
GeO	0.15	0.22
MnO	0.39	0.16
Ignition Loss	4.75	3.86
water (105°C)	0.45	0.25
CO_2	1.18	0.56

(1) Average sample of mined talc zone, Talcville, Gouverneur district, New York; Analysis by Glen Edgington, U.S. Dept. of Agriculture. See U.S. Geological Survey Bulletin 1167.

(2) Average sample of footwall talc zone, Fowler, Gouverneur district, New York; Analysis by Glen Edgington, U.S.D.A. See U.S. Geological Survey Bulletin 1167.

EXAMPLE I

Talc ore was ground to a particle size wherein the constituent rocks were less than about 2 inches in size. The rocks were then exposed to ultraviolet radiation, and specifically to ultraviolet light having a wavelength of 254nm. Upon irradiation of the crushed ore it was observed that certain rocks included fluorescent areas which were predominantly white whereas other rocks included fluorescent areas which were predominantly non-white in color and varied from a pink to orange. The irradiated rocks were then manually separated into two portions, the first portion comprising rocks in which the fluorescent areas were predominantly white, and the second portion comprising rocks in which the fluorescent areas fluoresced predominantly non-white. A 150 pound sample of rocks from the first portion was then collected, micro-pulverized, and then screened through a 200 mesh screen. The oversized materials were re-micro-pulverized and re-screened repeatedly to secure 100 percent minus 200 mesh materials as flotation feed.

The flotation pulp was prepared by slurrying the talc ore in deionized water to make up a slurry of 10 percent solids. To ensure complete wetting of the tremolite and serpentine constituents of the ore during the flotation, the pulp was mixed at a high speed for at least 30 minutes. The flotation consisted of a two stage operation, i.e. rougher flotation, and a first cleaner flotation. Methyl isobutyl carbinol was added into the pulp just prior to the pumping of the pulp into the first flotation cell at 0.15 pounds of methyl isobutyl carbinol per ton of solids in the slurry. The feed rate of the pulp to the rougher cell was about 45 pounds per hour. The feed rate of the first cleaner flotation was about 20 gallons per hour.

The rougher concentrate was collected, re-slurried with deionized water to make dilute pulp of about 10 percent solids to be floated in the cleaner cell. The rougher tails were collected, filtered on a vacuum filter and dried. The middlings from the cleaner flotation step were collected, filtered and dried. The cleaner concentrate was screened through a 200 mesh screen, dried, micro-pulverized and screened again. All of the minus 200 mesh concentrates were pulped in water again for sterilization with sodium hypochlorite which was introduced at 0.2 milliters of concentrated (15 percent available chlorine by weight) sodium hypochlorite per liter of pulp. The sterilization was carried out over night, and the pulp was subsequently filtered and dried.

To ensure proper flotation against entrapment of unwanted tremolite, the tremolite content in the talc was checked frequently with X-ray diffraction during an interval of one to two hours during the flotation period.

The recovery data are as follows:

Concentrate	64 lbs.	47.2%
Middlings	33.5	24.7
Tails	38	28
Total	135.5 lbs.	99.9%

The X-ray spectrometry analysis and physical data for the foregoing example are as follows:

	Concentrate	Middlings	Tails
% SiO_2	66.13	63.08	59.95
% MgO	35.30	33.75	38.24
% Fe_2O_3	0.06	0.12	0.21
% Al_2O_3	0.25	0.25	0.25
% CaO	0.05	0.64	3.05
G.E.B.	95.0	90.6	83.6

EXAMPLE II

Talc ore from the region of Gouverneur, New York was ground into rocks from 2 to 6 inches in size. These rocks were exposed to ultraviolet radiation of a wavelength as described above, whereupon certain of the rocks included fluorescent areas which were predominantly white, whereas other rocks fluoresced predominantly non-white, i.e. from pink to orange. The irradiated rocks were manually separated into two portions as in the preceding example. The portion in which the rocks flouresced predominantly white were micropulverized to minus 200 mesh in size, and flotation was accomplished as in the previous example. The recovery data are as follows:

	Weight lb.	Talc %	(1) Weight	Serpentine %	Weight	Tremolite %	Weight
Crude Ore	300	30	90	37	111	33	99
U-V Sorted Concentrate	100	69	69	17.3	17.3	13.7	13.7
Flotation Concentrate	48	99	47.5	0.24	0.5	0.24	0.5
Flotation Waste	26	50.6	12.4	27.6	7.2	21.6	5.6
Flotation Middlings	26	32.9	9.1	37.3	9.7	29.6	7.7

(1) The talc composition is noted as total talc, both platy (foliated) and fibrous. In the flotation concentrate, it is estimated that about 98% of the talc is foliated but in the crude ore only ⅔ or less may be of the foliated type.

The present invention thus affords an improved process for economically producing high grade talc, such for example as may be used in cosmetic applications, from talc ore of the type mined in the Gouverneur, New York region which is characterized by relatively high contents of tremolite and serpentine and which heretofore could not be economically beneficiated to a purity level required for cosmetic applications. The high quality talc product produced by the process of the invention is also characterized by an improved lubricity as a result of its high platy talc content and a low content of fibrous and granular talc. In addition to being substantially free of tremolite, i.e. having less than 1 percent by weight of tremolite impurity, the final talc product produced in accordance with the process of the invention is characterized by a G.E. brightness of at least 90, excellent fragrance retention and excellent slipperiness and shine characteristics. The normal cosmetic grind of talc produced in accordance with the invention can also be used as a dry lubricant of white color in place of graphite or molybdenum disulfide, both of which have adverse colors. In addition, talc produced by the process of the invention may also be used in the preparation of paint, paper, textiles, ceramic compositions, rubber, plastics, and various other applications well known to those skilled in the art.

It should be understood that while the present invention has been described in considerable detail with respect to certain specific embodiments thereof, it is not to be considered limited to those embodiments, but may be used in other ways without departure from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. A process for the preparation of a high purity talc from talc ore containing tremolite as an impurity, which comprises

crushing the talc ore,

irradiating said crushed ore with short wavelength radiation to cause the talc in said crushed ore to fluoresce predominantly white and the tremolite in said crushed ore to fluoresce a predominantly non-white color,

separating said crushed ore into a first portion in which the fluorescent areas of the constituent rocks fluoresce predominantly white and a second portion in which the fluorescent areas of the constituent rocks fluoresce predominantly non-white,

crushing said first portion to a particle size of minus 20 mesh,

forming a dilute aqueous slurry of said crushed first portion, said slurry having a solids content not exceeding about 15 percent by weight of said slurry,

subjecting said slurry to at least one froth flotation,

removing the froth formed during the final froth flotation step, and

recovering a high purity talc from said floated froth.

2. The process of claim **1** in which the aqueous slurry is formed by dispersing said first portion of crushed ore in deionized water.

3. The process of claim **1** including the step of adding a frother to the slurry to improve the separation of the tremolite from the talc during the froth flotation.

4. The process of claim **3** in which said frother is selected from the class consisting of methyl isobutyl carbinol and isopropanol.

5. The process of claim **3** in which the amount of frother added to said slurry is less than 0.2 pound of frother per ton of solids.

6. The process of claim **1** including the step of wetting said crushed ore with water to enhance the contrast in color between the talc and the tremolite constituents of said ore upon exposure to ultraviolet radiation thereby to facilitate the discrimination between rocks to be separated into said first portion and rocks to be separated into said second portion.

7. The process of claim **1** in which the radiation directed at said crushed ore is characterized by a wavelength of from about 250nm to about 340nm.

8. The process of claim **1** in which the talc ore is crushed into rocks under 2 inches in size prior to said irradiation.

9. The process of claim **1** in which said first portion is crushed into a particle size of minus 100 mesh.

10. The process for the preparation of a high purity platy talc from Gouverneur, New York talc ore includ-

ing platy talc, fibrous talc, and tremolite as an impurity, which comprises

crushing the talc ore,

irradiating said crushed ore with ultraviolet radiation characterized by a wavelength of from between 250 and 340nm to cause the talc in said crushed ore to fluoresce predominantly white and the tremolite in said ore to fluoresce predominantly non-white,

separating said irradiated crushed ore into a first portion in which the fluorescent areas of the constituent rocks fluoresce predominantly white and a second portion in which the fluorescent areas of the constituent rocks fluoresce predominantly non-white,

crushing said first portion into a particle size of minus 100 mesh,

forming a dilute aqueous slurry of said crushed first portion in deionized water, said slurry having a solids content not exceeding about 15 percent by weight of said slurry and including a frother to improve the separation of tremolite from the talc in an amount of less than 0.2 pound of frother per ton of ore,

subjecting said slurry to at least two consecutive froth flotation steps,

removing froth formed during the final froth flotation step, and

recovering from said floated froth a high purity platy talc characterized by a G.E. brightness of at least 90 and a tremolite content of less than 1.0 percent by weight.

11. The process of claim **10** in which the frother is selected from the class consisting of methyl isobutyl carbinol and isopropanol.

12. The process of claim **10** including the step of wetting said crushed ore with water prior to said irradiation to enhance the contrast in color between the talc and the tremolite constituents of said ore upon irradiation thereby to facilitate the discrimination between rocks to be separated into said first portion and rocks to be separated into said second portion.

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