Bulletin No. 99 *Mineral Technology Series No. 22*

University of Arizona Bulletin

BARYTES

BY

M. A. ALLEN AND G. M. BUTLER

Entered as second class matter November 23, 1915, at the postoffice at Tucson, Arizona, under the Act of August 24, 1912. Issued weekly, September to May.

PUBLISHED BY THE

University of Arizona
Bureau of Mines

G. M. BUTLER, *Director*

TUCSON, ARIZONA

1919-1920

University of Arizona Bulletin

MINERAL TECHNOLOGY SERIES No. 22 AUGUST, 1919

BARYTES

PREFACE

In spite of the improbability that a deposit of barytes in the State of Arizona could be mined profitably under existing conditions, the Arizona Bureau of Mines frequently receives samples of barytes from all parts of the State together with requests for information concerning the value, properties, uses, etc. of this mineral. The Bureau has, therefore, deemed it advisable to prepare this pamphlet which admittedly covers the barytes industry imperfectly. It is hoped, however, that the facts presented herein will prove helpful to the many prospectors and others whom the Bureau endeavors to serve; and that, although the distribution of this pamphlet may not stimulate the State's mineral production, it may still be the means of preventing what is very likely to prove a useless expenditure of time and money.

For more complete information on the subject the reader may consult the articles and publications listed in the selected bibliography that forms a part of this bulletin.

DESCRIPTION OF BARYTES

Synonyms: Barytes is the commercial name of the mineral known to scientists as barite which is also sometimes called baryta (although this term is correctly applicable only to barium oxide), and is most frequently termed "heavy spar" or "tiff" by miners.

Composition: Pure barytes is a sulphate of barium ($BaSO_4$) containing 67.7% of barium oxide (BaO), and 34.3% sulphur trioxide (SO_3). Varying, but usually small, percentages of strontium and calcium sulphates are often present, as is also, more rarely, ammonium sulphate. The common impurities are iron and manganese oxides, silica, clay, and bituminous or carbonaceous substances.

Hardness: Barytes is a relatively soft mineral even when most crystalline. It can be scratched *easily* with a knife, but not with a finger nail.

Luster: When transparent the luster is glassy, but transparency is rarely shown and is almost confined to crystals. When translucent the luster varies from glassy, through stony, to rather dull.

Color: The barytes in the great majority of commercially

important deposits is snow white. Not infrequently, however, the mineral is stained yellow, brown, or reddish by iron oxides, and less commonly gray tints result from the presence of manganese oxides or carbonaceous matter.

Glassy crystals are often blue, brown, yellow, reddish, colorless, or white. In fact, the massive translucent material is sometimes blue or reddish, but the fact remains that a very large proportion of the barytes produced is of the translucent, white, or slightly iron-stained type.

Color of the Powder: Unless heavily impregnated with iron or manganese oxides and opaque, the powdered material is white. If so impregnated, it may be yellowish, brownish, reddish, or gray.

Cleavage: One of the most distinctive peculiarities of the mineral is the very strong tendency shown by each grain or crystal to cleave or split into thin plates that are sometimes slightly warped. The resulting cleavage surfaces are relatively smooth, and reflect light brilliantly.

Not only does a grain or crystal of barytes cleave easily in one direction, but it splits somewhat less readily and smoothly in two other directions perpendicular to the one first mentioned. These subordinate cleavages intersect at angles of about 101°38′ or 78°22′; and the development of all three cleavages on a single grain or crystal will yield diamond-shaped or rhomboidal plates similar to those shown in Figure 1.

Barytes, then, cleaves or splits in three directions, one of which is more prominent than the other two which intersect the first *at right angles,* and which intersect each other in the angles already mentioned.

Specific Gravity: Barytes has a specific gravity of 4.3 to 4.6; that is, it is about four and a half times as heavy as an equal volume of

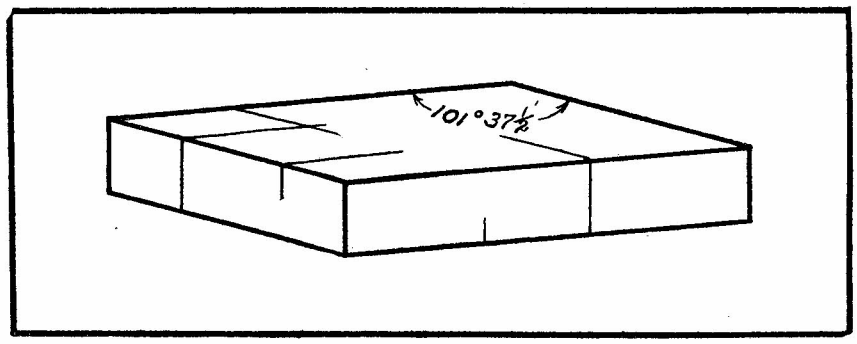

Figure I. Cleavage Fragment of Barytes.

water. Because of its high gravity, only 7.1 cubic feet of compact barytes are required to weigh a ton (2000 pounds). As most of the commoner, non-metallic lustered minerals have specific gravities between 2.6 and 3.5, it will be appreciated that this great weight is one of the most characteristic features of the mineral, and will alone serve to call the prospector's attention to barytes, and to distinguish it from several other substances with which it may be confused.

Odor: Some specimens of barytes have a fetid odor; that is, they smell like bad eggs; but this is not a common characteristic.

Mode of Occurrence: Commercially important barytes usually occurs in masses composed of large or small, flat or slightly warped plates. Less frequently the material is granular, and rarely rather earthen. Crystals (sometimes found projecting into vugs) are commonly of types similar to those illustrated in Figure II.

Blowpipe and Chemical Tests: When heated before the blowpipe barytes flies to pieces. If powdered, moistened, and heated slowly, it will fuse and color the flame a light greenish yellow. This same color is shown if the powdered mineral is sprinkled upon a hot wood or alcohol flame.

If the powdered mineral is fused with about twice its volume of sodium carbonate (soda), and the cold fused mass is placed upon a clean, moistened silver coin, a dark brown to black, permanent stain will be imparted to the coin. If small fragments are thrown upon live coals, a crackling sound will be heard.

The mineral is insoluble in acids.

Distinction from Similar Minerals: Barytes is most commonly confused with calcite (calcium carbonate), fluorite (calcium fluoride), and scheelite (calcium tungstate).

Calcite when placed in hydrochloric (muriatic) acid, or strong vinegar, will effervesce or appear to make the liquid boil. It is a relatively light mineral (the specific gravity is 2.71), and, although individual grains or crystals cleave very easily and smoothly in three directions, never do such cleavage surfaces intersect at right angles.

Fluorite (fluor-spar) is slightly harder than barytes, is a relatively light material (the specific gravity is 3.2), is usually green or purple, and single grains or crystals cleave or split easily and smoothly in four directions, none of which intersect at right angles.

Scheelite is harder to distinguish from barytes than are the other minerals mentioned. This is unfortunate since scheelite is a very valuable ore of tungsten, and prospectors frequently confuse the two minerals. In order to distinguish them, it should be remembered that scheelite is considerably harder than barytes although it can be scratched with a knife, is considerably heavier (it has a specific gravity

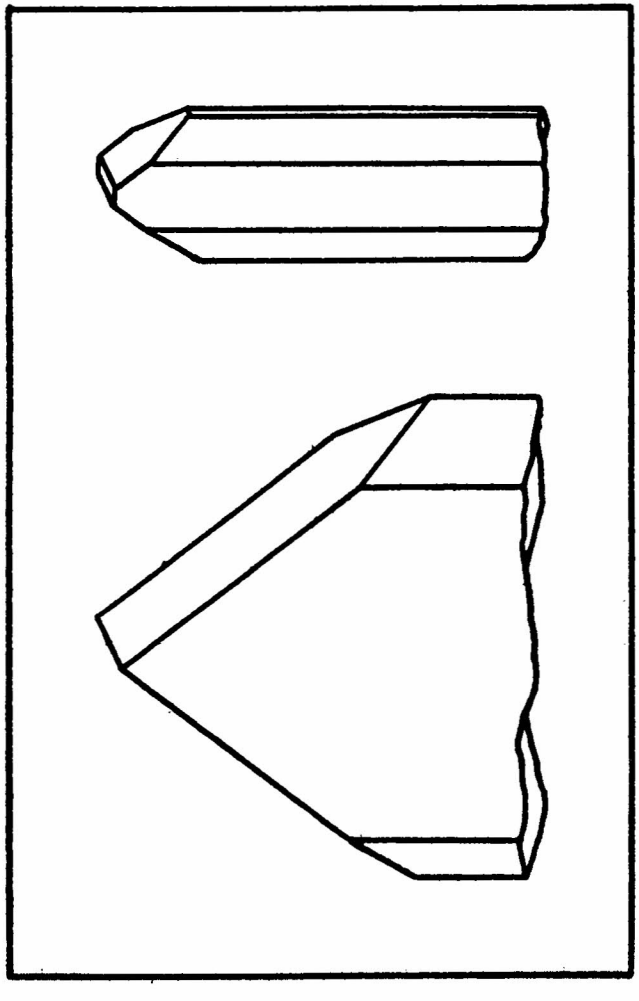

Figure II. Common Types of Barite Crystals.

of about 6.0), shows little or almost no tendency to cleave or split smoothly as does barytes (and cleavage surfaces in the rare cases where they are developed never intersect at right angles), does not occur in tabular masses, and is frequently found in crystals which often have the form of pyramids with square bases. Scheelite is also most frequently associated with quartz, feldspar, mica, and tourmaline. The common associates of barytes are mentioned elsewhere in this bulletin.

OCCURRENCE OF BARYTES

Commercial deposits of barytes are found in (1) veins, (2) replacements or disseminations, and (3) residual deposits in clay, etc.

The veins may consist entirely of barytes or of barytes with or without other gangue minerals and with varying proportions of metallic ores. Many types of such vein deposits have been found, and they occur in all classes of rocks.

In the replacement or disseminated deposits the barytes occurs in lumps varying widely in size. Such masses are usually in calcareous or dolomitic limestone.

The residual deposits are usually found in beds of soil or clay, and have resulted from the chemical and mechanical disintegration of vein or disseminated deposits. Concentration is accomplished by the dissolving out or washing away of lighter, associated rocks or minerals.

ASSOCIATED ROCKS AND MINERALS

It has already been stated that barytes is associated with a very wide variety of rocks. Probably the larger deposits occur in calcareous or dolomitic limestone, sandstone, or the residual clay resulting from the disintegration of these rocks. Watson and Grasty* mention deposits in Virginia which are associated with red shales and impure limestone. So far as is known, all the Arizona deposits occur as veins in igneous or sedimentary rocks.

The ore minerals most frequently associated with barytes are, in order of decreasing frequency of occurrence, galena (lead sulphide) and several silver minerals, sphalerite or zinc blende (zinc sulphide), pyrite (iron sulphide), chalcopyrite (copper-iron sulphide), marcasite (iron sulphide), etc.; while the frequently associated gangue minerals are fluorite (calcium fluoride) quartz, (often chert), limonite (hydrous iron oxide), and calcite (calcium carbonate).

---

*T. L. Watson and J. S. Grasty, Barite of the Appalachian States, Trans. A. I. M. E., Vol. LI.

ARIZONA OCCURRENCES

Most of the deposits of barytes in Arizona that have come to the attention of the Arizona Bureau of Mines are mineral veins in which the barytes occurs as a gangue mineral, and is usually present in relatively small proportions. The sample is usually submitted to the Bureau in the hope that the barytes is a valuable ore mineral, its unusual weight having attracted the attention of the miner. Even though such deposits were close to a market, it is doubtful whether the barytes in them would have any value except, perhaps, in a few instances when the mineral might be profitably mined as a by-product.

Mr. E. L. Jones of the United States Geological Survey reports* the occurrence of barytes-bearing veins in sandstone in the northern part of the Whipple Mountains on the Colorado Indian Reservation, about ten miles from Parker, Yuma County. The veins are said to be small, but in places attain a width of three feet, and can be traced for 100 feet. Calcite is found with the barytes in some of the veins. The better material seems to occur in the smaller veins.

Dr. C. J. Sarle, Professor of Geology in the University of Arizona, states† that there is a vein of barytes of considerable size in the northern part of the Cababi Mining District in Pima County. Judging from the dump and workings, it seems probable that the vein reaches a maximum width of three feet. The barytes carries galena, and is stained very slightly with iron.

The Bureau has recently learned of the presence of barytes in Tombstone Canyon, four miles north of Bisbee, but this occurrence has not been investigated, and nothing is known concerning the extent of the deposit.

H. C. Gardner, of Bisbee, states in a letter dated March 25, 1919, that he has knowledge of two deposits of barytes in Middle Pass, Dragoon Mountains, about nine miles from Pearce station. He says that the mineral occurs in veins from three to five feet wide, which can be traced on the surface about 100 feet. One vein contains pure white material, while that in the other is yellowish brown, doubtless due to iron stain.

The Bureau has received information that deposits of barytes varying in size from narrow veinlets up to veins eighteen inches wide, occur in Hunter, Ash, and Ramsey Canyons in the Huachuca Mountains, about sixteen miles by road from Hereford station on the E. P. & S. W. railroad. It is claimed that these veins can be traced on the surface for a considerable distance.

---

*Barium and Strontium, J. M. Hill, Mineral Resources of the United States, U. S. G. S., 1917.

†Oral communication.

Barytes is also reported to occur in the Mule Mountains, northeast of Bisbee, and between the Whetstone and Mestana Mountains in the low lying hills.

Mr. Butler, about a year ago, examined two small barytes veins on the property of the Ash Spring Mining Company located about twelve miles by road in an easterly direction from Douglas, Arizona. They are not over a foot wide, are entirely composed of platy, slightly iron-stained mineral and occur in limestone and porphyry.

DISTRIBUTION OF BARYTES

The mineral barytes is the source of practically all commercial barium compounds. Witherite, a carbonate of barium, occurs in commercially valuable deposits in only rare instances, one such deposit is in California and is worked by the Barbour Chemical Company of San Francisco; another is located in England.

Since most of the markets for barium compounds are east of the Mississippi River, it is not surprising that the demand is largely met by deposits occurring in the Appalachian Mountains, Kentucky, and Missouri. Although barytes is found in most of the Appalachian states, about 65% of the domestic production is mined in the state of Missouri, the market for this material being situated at St. Louis. Material from this state is considered especially desirable because it is relatively soft. So far as known, the only operations in the west are being carried on by two companies, one in Colorado and one in California.

The deposits of barytes in Missouri and in the east occur in rocks of pre-Cambrian to Triassic age, the more important producing areas being in late Cambrian and Ordovician sedimentary rocks. The age of residual deposits resulting from disintegration and erosion of veins and disseminations is not always determinable.

USES OF BARYTES

The chemical inertness of barytes makes it especially useful as a paint base. It is stable (undergoes no chemical change) in the presence of acids, alkalies, and gases; and for this reason paints with a barytes base can be used under conditions which would cause other paints to deteriorate rapidly.

Some paint bases in common use also react slightly with linseed oil when ground with the oil. Barytes does not do this, and less oil is required with this mineral than with such other paint bases. Aniline dyes and other colors can be precipitated upon barytes to form a base for colored paint.

Barytes is used as a paint base in three forms, namely: "lithopone," ground barytes, and "blanc fixe."

Lithopone is a mixture of chemically precipitated zinc sulphide and barium sulphate in the proportion of 30% of the former and 70% of the latter. Statistics issued by the United States Geological Survey for the three years ending in 1917, prove* that the use of this preparation has increased until more barytes is now utilized in the manufacture of lithopone than for any other purpose. This is shown by the following table which gives in short tons the total consumption of barytes in the United States for the three years mentioned:

Year	For barium chemicals	For ground barytes	For lithopone	Total
1915	10,216	53,903	44,503	108,622
1916	38,283	75,507	71,898	185,688
1917	49,842	60,132	86,065	196,039

Gardner and Heckel state† that lithopone "is used in the manufacture of interior flat paints of the oil type, such paints having almost entirely supplanted the use of the corroded white lead which was at one time used in interior painting. The more dense nature, lower price, and sanitary value of lithopone are responsible for this change. Lithopone is, moreover, used to a large extent in the manufacture of oilcloth, shade cloth, and linoleum. Its whiteness makes it of particular value for this purpose." It is also employed in making rubber tires.

Ground barytes is manufactured in three grades: Prime white (ground and washed, but not floated or bleached), pure white floated (ground, washed, floated, and bleached), and off color (ground and washed, with or without floating, but unbleached). It is either used alone as a paint base or is mixed with other substances.

Blanc fixe is chemically precipitated barium sulphate. It may be used for the same purpose as ground barytes, but is a purer and more expensive product.

Barytes, chiefly in the ground form, is used for many purposes other than the manufacture of paint, such as a filler for rubber to which it imparts resiliency and durability, as a constituent of the white coating on cotton cloth used to cover packed meats, as in the manufacture of wallpaper, as in making glazed paper, as an adulterant

*Barytes and Barium Products,, J. M. Hill, Mineral Resources of the United States, U. S. G. S., 1917.

†Barytes as a Paint Pigment, H. A. Gardner and G. B. Heckel, Trans. A. I. M. E., Vol. L.

for paper to which it gives weight without imparting strength or other valuable properties, as a constituent of putty, artificial ivory, and asbestos cement and as in the manufacture of various barium compounds used as chemical reagents, and in a number of industries. Those barium compounds most used industrially are barium oxide, chloride, carbonate, sulphide, and hydrate.

Barium oxide is used in sugar refining and in the manufacture of glass, especially rolled glass, hollow ware, crystal, and table glass. The Jena phosphate crown glass is reported to contain 28% of barium oxide. This compound is also in demand in the ceramic arts as a substitute for lead compounds since it imparts a high luster and added weight to glazes. For this purpose it must be of the highest quality since impurities dull the glaze.

Barium chloride or carbonate will prevent the efflorescence or crystallization of salts on the exterior of bricks or other clay products; and in the leather industry hides are sometimes soaked in the chloride to give them fraudulent weight.

Barium sulphide is utilized to remove the hair from and to soften and "plump" hides, and as a constituent of luminous paint.

Barium hydrate unites readily with lime, so is used to soften water and prevent deposition of scab in boilers. It also has been occasionally employed in beet sugar manufacture, but its poisonous properties have mitigated against its extensive use. Most of the barium compounds are poisonous, the more soluble ones being especially dangerous. Other barium compounds of commercial value are the acetate, chlorate, cyanide, fluoride, hydroxide, peroxide, chromate, and nitrate.

Among the miscellaneous uses of barytes and barium compounds are the following: In the manufacture of insecticides and rat poison, enameled iron, poker chips, hydrogen peroxide, oxygen, signal lights and fireworks, and lake colors. Massive barytes takes a good polish and is sometimes used as a substitute for marble under conditions where its relatively high weight is not a drawback.

MINING METHODS

Many of the more important deposits of barytes are so "patchy" and disconnected that the mining methods followed are very simple. Much of the product comes from open pits and shallow shafts. Such workings rarely reach a depth of 200 feet, and the majority are probably not deeper than forty feet.

The barytes in the residual deposits is associated with clay, and sorting is usually done in the workings. The product is then spread on floors where the action of the elements disintegrates a portion of the adhering clay which falls from the lumps leaving them purer

than when mined. At some mines shaking screens, cradles, and boxes are used to break up the clay and to separate it from the barytes.

PREPARATION FOR MARKET

The crude barytes is usually sold to mills for preparation for the market, but some milling companies operate their own mines.

The treatment in the mills varies according to the nature of the particular material treated and the market demand it is intended to meet. Generally the process used is somewhat as follows: The crude barytes is first crushed, the size to which it is reduced depending upon the nature, amount, and fineness of the impurity. Both wet and dry crushing are practiced. After crushing, the limestone, chert, clay, sandstone, coarse iron oxides, and fluorite are extracted by log washing and jigging. Iron oxide is removed by "bleaching" which is accomplished by treating the crude crushed barytes with a weak solution of sulphuric acid. This dissolves out the iron oxide and limestone. Large amounts of iron and limestone may make the acid cost prohibitive. The bleached ore is then log washed, dried in a rotary drier, and pulverized in rolls and buhr mills. Sometimes the barytes is ground in slip mills, and is water separated or classified before being bleached. Drying is an important step since imperfect drying may cause the barytes to become stained during grinding. Buhr mill grinding is the most satisfactory method of pulverizing the barytes if it is to be used for paints and rubber.

Manganese oxide cannot be removed by sulphuric acid treatment alone. "Furnace bleaching" must then be applied, and both manganese and iron oxides may be removed in this way. In this operation the barytes is roasted with nitre, salt, and sulphuric acid; and the roasted product is washed and dried.

The crushing and treatment of some barytes yields large quantities of slime, which, if there is a sufficient quantity present in the washings, is recovered on tables, dried, and marketed as off-color barytes, or it may be bleached.

Pure white floated barytes is a very uniform product both as regards size and purity and is obtained by water classification.

Blanc fixe is made by roasting the bleached barytes with carbon, thus forming barium sulphide which is dissolved in water. The solution is then treated either with sulphuric acid or salt-cake which precipitates fine, pure barium sulphate.

Lithopone is made by roasting barytes with coal, forming barium sulphide and some barium carbonate, then dissolving the barium sulphides in water, filtering, and adding a solution of sulphate of zinc

which precipitates barium sulphate and zinc sulphide. The precipitate is calcined, ground, washed, dried, and pulverized. Sometimes ground clay or gypsum is then added as an adulterant.

VALUE OF BARYTES

The following table shows the average price received for various grades of barytes before, during, and just following the close of the war. Unless otherwise noted, the quotations are those announced by the United States Geological Survey:

Barytes	1913	1917	1918	3 months of 1919
Crude as mined, per ton	$ 3.45	$ 5.66		
Ground barytes, F. O. B. mills, per ton	$14.18	$ 18.05	$22-$25*	$20-$22*
Pure white floated, per ton		$25-$36	$32-$36*	$30-$34*
Ground barytes off-color, per ton		$22-$24	$22-$28*	$21-$26*

The price received for crude barytes is dependent upon its quality and proximity to grinding mill or market. The figures given by the United States Geological Survey for the price paid for crude barytes in 1917 varied from an average of $4.66 per ton for Tennessee to $6.63 per ton for Missouri. The price ruling for Tennessee for 1918 was about $10 per long ton at the mine.

During the latter part of 1918 ground barytes F. O. B. mills remained stationary at $25 per ton throughout September to the first part of December, but during the last two weeks of December the price fell to $22 per ton, at which figure it remained until the middle of March, 1919, when it again dropped to from $20 to $21.50.

Pure white floated barytes ranged between $35 per ton as a minimum and $36 per ton as a maximum, from September, 1918, until the latter part of December, when the price fell to between $32 and $34 where it remained until the middle of March, 1919, after which it fell to about $30.

Ground off-color barytes brought $23 to $26 per ton during most of 1918, but fell to between $22 and $24 during the latter part of December, and January and February, 1919. It advanced to from $23 to $26 the first part of March, 1919, but later dropped to from $21 to $24, a new low level.

*Drug, Paint and Oil Reporter.

The value of crude barytes imported into the United States ranged around $2.00 per ton, and the amount brought into the country dropped from 35,840 tons in 1913 to six tons in 1917.

The soft variety with a dull, milky-white color on fresh fractures which can be easily crushed, at least on the edges of thin fragments, with the fingers is most sought since it can be more cheaply crushed and ground than the "hard crystalline" variety. The latter ordinarily has a glassy, semi-transparent look, and cannot be broken in the hands.

There is no demand for barytes carrying less than 93% barium sulphate by analysis, and for some uses it is necessary that the mineral carry at least 95% of barium sulphate. For certain purposes the 5% or less of impurities should be made up of some other material than quartz.

MARKETS

The chief markets for barytes are in the east, south of the Great Lakes, and in St. Louis, Missouri, where the manufacturers of paints, lithopone, ground barytes, and barium chemicals are situated. The output from the mines is usually sold to brokers instead of directly to consumers. This is probably due to the spasmodic manner in which most of the mining is conducted, and to the fact that few of the mines own or control milling or washing plants.

BUYERS AND SELLERS OF BARIUM PRODUCTS

Barium Acetate

Bayard Products Company, Inc., 41 Park Row, New York, N. Y.

Charles T. Stork & Company, Inc., 154 Nassau St., New York, N. Y.

Barium Binoxide

Charles F. Garrigues Company, 80 Maiden Lane, New York, N. Y.

Rollin Chemical Company, Inc., Charleston, West Virginia.

Barium Carbonate

Chicago Copper and Chemical Company, 111 W. Jackson Boulevard, Chicago, Ill.

Clenchfield Products Corporation, 120 Broadway, New York, N. Y.

Dill-Crosett, Inc., 45 John St., New York, N. Y.

Doggett Stanley, 11 Cliff St., New York, N. Y.

Durex Chemical Corporation, 320 Fifth Ave., New York, N. Y.

Gabriel & Scholl, 205 Pearl St., New York, N. Y.

Innes, Spieden and Company, Inc., 46 Cliff St., New York, N. Y.
Harshaw, Fuller and Goodwin Company, New York, N. Y.
Katzenbach and Bullock Company, Trenton, N. J.
Klipstein and Company, 644 Greenwich, New York, N. Y.
National Aniline and Chemical Company, 21 Burling Slip, New York, N. Y.
Port Morris Chemical Works, 141st and Locust Ave., New York, N. Y.
Rollin Chemical Company, Inc., Charleston, West Virginia.
E. R. Smead Company, Cleveland, Ohio.
Charles T. Stork and Company, Inc., 154 Nassau St. New York, N. Y.
John C. Wiarda and Company, Brooklyn, N. Y.

Barium Chlorate

Charles T. Stork and Company, Inc., 154 Nassau St. New York, N. Y.

Barium Chloride

Block Chemical Works, Berkeley Heights, N. J.
Chicago Copper and Chemical Company, 111 W. Jackson Boulevard, Chicago, Ill.
Clenchfield Products Corporation, 120 Broadway, New York, N. Y.
Coff-Garrod Company, Inc., Woolworth Bldg., New York, N. Y.
Dill-Crosett, Inc., of New York, 45 John St., New York, N. Y.
Durex Chemical Corporation, 320 Fifth Ave., New York, N. Y.
Gabriel & Scholl, Inc., 295 Broadway, New York, N. Y.
Grasselli Chemical Co., 347 Madison Ave., New York, N. Y.
Harrison Works, 35th and Grays Ferry Road, Philadelphia, Pa.
Innes, Spieden and Company, Inc., 46 Cliff St., New York, N. Y.
Katzenbach and Bullock Company, 100 William St., New York, N. Y.
A. Klipstein and Company, 644 Greenwich, New York, N. Y.
National Aniline and Chemical Company, 21 Burling Slip, New York, N. Y.
Port Morris Chemical Works, 141st and Locust Ave., New York, N. Y.
Roessler and Hasslacher Chemical Company, 100 William St., New York, N. Y.
Rollin Chemical Company, Inc., Charleston, West Virginia.
E. R. Smead Company, Cleveland, Ohio.
Charles T. Stork and Company, Inc., 154 Nassau St. New York, N. Y.
John C. Wiarda and Company, Brooklyn, N. Y.

Barium Cyanide

Hachmeister-Lind Chemical Company, "Sustanal," Pittsburgh, Pa.

Union Iron Works Company, 20th and Michigan, San Francisco, Calif.

Barium Fluoride

Harshaw, Fuller and Goodwin Company, New York, N. Y.

Barium Hydrate

Block Chemical Works, Berkeley Heights, N. J.

Chicago Copper and Chemical Company, 111 W. Jackson Boulevard, Chicago, Ill.

Durex Chemical Corporation, 320 Fifth Ave., New York, N. Y.

Innes, Spieden and Company, 46 Cliff St., New York, N. Y.

A. Klipstein and Company, 644 Greenwich, New York, N. Y.

Roessler and Hosslacher Chemical Company, 100 William St., New York, N. Y.

E. R. Smead Company, Cleveland, Ohio.

Charles T. Stork and Company, Inc., 154 Nassau St., New York, N. Y.

John C. Wiarda and Company, Brooklyn, N. Y.

Barium Hydroxide

Charles T. Stork and Company, Inc., 154 Nassau St., New York, N. Y.

Barium Nitrate

C. Bischoff and Company, 451 Washington, New York, N. Y.

Block Chemical Works, Berkeley Heights, N. J.

Chicago Copper and Chemical Company, 111 W. Jackson Boulevard, Chicago, Ill.

Durex Chemical Corporation, 320 Fifth Ave., New York, N. Y.

Farmingdale Chemical Works, Inc., Farmingdale. L. I., New York, N. Y.

Harshaw, Fuller and Goodwin Company, Cleveland and New York City.

Marden, Orth, and Hastings Company, 61 Broadway, New York, N. Y.

National Aniline and Chemical Company, 21 Burling Slip, New York, N. Y.

Port Morris Chemical Works, 141st and Locust Ave., New York, N. Y.

Roessler and Hosslacher Chemical Company, 100 William St., New York, N. Y.

Rollin Chemical Company, Inc., Charleston, West Virginia.

E. R. Smead Company, Cleveland, Ohio.

Charles T. Stork and Company, Inc., 154 Nassau St., New York, N. Y.
Williamson and Company, 28 Burling Slip, New York, N. Y.

Barium Peroxide

C. Bischoff and Company, 451 Washington St., New York, N. Y.
Copper and Copper, 309 Broadway, New York, N. Y.
C. P. N. Chemical Company, 80 Reade St., New York, N. Y.
Edgertyn Aniline Corporation, 118 William St., New York, N. Y.
Grasselli Chemical Company, Inc., 40 Cliff St., New York, N. Y.
Katzenbach and Bullock Company, 100 William St., New York, N. Y.
A. Klipstein and Company, 644 Greeenwich, New York, N. Y.
National Aniline and Chemical Company, 21 Burling Slip, New York, N. Y.
E. R. Smead and Company, Cleveland, Ohio.
Charles T. Stork and Company, 154 Nassau St., New York, N. Y.

Barium Sulphate

The Chemical Pigments Corporation, 617 Stock Exchange Bldg., Philadelphia, Pa.
Dill-Crosett, Inc., of New York, 45 John St., New York, N. Y.
Durex Chemical Corporation, 320 Fifth Ave., New York, N. Y.
Innes, Spieden and Company, 40 Cliff St., New York, N. Y.
Nulsen, Klein and Krause Manufacturing Company, St. Louis, Mo.
Paint, Milling and Manufacturing Company, Mineral Point, Mo.
Charles T. Stork and Company, 154 Nassau St., New York.
E. M. and F. Waldo, 11 Broadway, New York, N. Y.
Warren Products Company, 296 Broadway, New York, N. Y.
John C. Wiarda and Company, Brooklyn, N. Y.

Barium Sulphide

Block Chemical Works, Berkeley Heights, N. J.
Clinchfield Products Corporation, 120 Broadway, New York, N. Y.
Durex Chemical Corporation, 320 Fifth Ave., New York, N. Y.
Mallenckrodt Chemical Works, St. Louis, Mo.

Barytes

The Chemical Pigment Corporation, 617 Stock Exchange Bldg., Philadelphia, Pa.
Charles B. Chrystal, 11 Cliff St., New York, N. Y.
J. W. Coulston and Company, 80 Maiden Lane, New York, N. Y.
Durex Chemical Corporation, 320 Fifth Ave., New York, N. Y.
Ed. B. Fulper, 713 American Mechanics Bldg., Trenton, N. J.
Gabriel and Scholl, 205 Broadway, New York, N. Y.

Katzenbach and Bullock Company, 100 William St., New York, N. Y.
Liberty Company, 120 Liberty St., New York, N. W.
Nulsen, Klein and Krause Manufacturing Company, St. Louis, Mo.
Point Milling and Manufacturing Company, Mineral Point, Mo.
William H. Scheel, 159 Maiden Lane, New York, N. Y.
E. R. Smead Company, Cleveland, Ohio.
Charles T. Stork and Company, Inc., 154 Nassau St., New York, N. Y.
Whittaker, Clark and Daniels, Inc., 250 Front St., New York, N. Y.
J. Early Wood, Inc., 21 Platt St., New York, N. Y.

Lithopone

F. Behrend, Inc., 45 Front St., New York, N. Y.
Chemical Pigments Corporation, 617 Stock Exchange Bldg., Philadelphia, Pa.
Coff-Garrod Company, Inc., Woolworth Bldg., New York, N. Y.
J. W. Coulston and Company, 80 Maiden Lane, New York, N. Y.
C. P. N. Chemical Company, Inc., 80 Reade St., New York, N. Y.
Dill-Crosett, Inc., of New York, 45 John St., New York, N. Y.
P. W. Drockett and Sons Company, Cincinnati, Ohio.
Edward B. Fulper, 713 American Mechanic Bldg., Trenton, N. J.
Gabriel and Scholl, Inc., 295 Broadway, New York, N. Y.
Grasselli Chemical Company, 347 Madison Ave., New York, N. Y.
Harrison Works, 35th and Grays Ferry Road, Philadelphia, Pa.
Innes, Spieden and Company, Inc., 46 Cliff St., New York, N. Y.
Katzenbach and Bullock Company, 100 William St., New York, N. Y.
Mineral Refining and Chemical Corporation, 44 Whitehall St., New York, N. Y.
The New Jersey Zinc Company, 55 Wall St., New York, N. Y.
William H. Scheel, 159 Maiden Lane, New York, N. Y.
Siemon and Elting, 93 Nassau St., New York, N. Y.
Stresen, Reuter and Hancock, Inc., 122 S. Michigan Ave., Chicago, Ill.
J. Early Wood, Inc., 21 Platt St., New York, N. Y.

SELECTED BIBLIOGRAPHY

The Barite Deposits of Missouri, by W. A. Tarr, Economic Geology, Vol. XIV.

Geology and Mineral Deposits of the Ozark Region, by H. A. Buehler, Trans. A. I. M. E., Vol. LVIII.

Barite of the Appalachian States, by T. L. Watson and J. S. Grasty, Trans. A. I. M. E., Vol. LI.

Barytes as a Paint Pigment, by H. A. Gardner and G. B. Heckel, Trans. A. I. M. E., Vol. L.

Barytes, by James M. Hill, U. S. G. S. Mineral Resources 1912, 13, 14, 15, 16, 17.

Barytes Industry of Cole County, Missouri, by F. C. Bryant, Engineering and Mining Journal, Vol. 95.

Barytes in Tennessee, by A. H. Fay, Engineering and Mining Journal, Vol. 87.

Barytes, Occurrence and Methods of Preparation, by Schuyler Frazier, Chemical Engineering, February, 1911.

A Commercial Occurrence of Barite near Cartersville, Georgia, by C. W. Hayes and W. C. Phalen, U. S. G. S. Bul. No. 340.

Barytes and Its Preparation for the Market, by Edwin Higgins, Engineering News, Vol. 53.

Barytes Industry in the South, by E. K. Judd, Engineering and Mining Journal, Vol. 83.

A Barytes Grinding Plant, by E. K. Judd, Engineering and Mining Journal, Vol. 83.

The Geology and Preparation of Barite in Washington County, Missouri, by A. A. Steel, Trans. A. I. M. E., Vol. XL.

Geology of the Virginia Barite Deposits, by T. L. Watson, Trans. A. I. M. E., Vol. XXXVIII.

Lake Bases, Their Composition and Uses, by F. H. Jennison, Oil Paint and Drug Reporter, Vol. 81.

The Lead and Zinc Rocks of Central Kentucky, with notes on the mineral veins, by A. M. Miller, Kentucky Geological Survey Bulletin No. 2.

The Barytes Deposits of Lake Ainslie and North Cheticamp, N. S., with notes on the production, manufacture, and uses of barytes in Canada. Geological Survey of Canada, Bulletin No. 953.

A Barite Deposit near Wrangell, Alaska, by E. F. Burchard, U. S. G. S. Bulletin No. 592.

Barytes Deposits of Kentucky, by F. J. Fohs, Kentucky Geological Survey, 4 vols.

Barite Deposits in the Sweetwater districts, Tennessee, by H. B. Henegan, Tennessee State Geological Survey, Vol. 11, No. 11.
Barytes, by E. F. Burchard, U. S. G. S. Mineral Resources 1907.
The Mineral Industry, by Edwin Higgins, Vol. XIII, 1904.

ACKNOWLEDGMENTS

The published literature mentioned in the bibliography has been freely consulted and much of the information embodied in this pamphlet is from these sources. The writers wish to take this opportunity to thank the many producers of barytes and manufacturers of barium compounds for their ready cooperation in supplying data requested.