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DIVISION OF MINES AND GEOLOGY
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# MARKETING OF METALLIC AND NONMETALLIC MINERALS

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## FOREWORD

A prospector, after finding a deposit of mineral that appears to have possible value, commonly asks — can this mineral be sold; at what price; and to whom? The exact answers to these questions change over relatively short periods of time, but we believe the questions are important enought to justify answering them in the form of an Information Circular of the Washington Division of Mines and Geology.

To answer these questions the Division was fortunate in obtaining the services of Donald L. Anderson, professor of mining in the School of Mineral Engineering at the University of Washington. The author knows prospecting and mining through firsthand experience as well as through academic training and teaching.

This report on marketing of metallic and nonmetallic minerals should serve as a useful companion to an earlier report on prospecting in Washington by the same author and also published by the Division of Mines and Geology.

MARSHALL T. HUNTTING, Supervisor
Division of Mines and Geology

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# MARKETING OF METALLIC AND NONMETALLIC MINERALS

by Donald L. Anderson

## INTRODUCTION

A company or individual contemplating the development of a mineral deposit should consider the following questions: Can it be sold? In what form? At what price? And where? This is particularly true of the nonmetallic minerals, for which competition is keen and freight rates important; it is true to a lesser extent for metallic minerals.

Problems in the sale of common base metals such as copper, lead, and zinc are relatively simple. The disposal of nonmetallics is more difficult, and regardless of the type of mineral that is to be marketed, it should be noted by newcomers to the industry that the price of the fabricated metal or processed mineral on open markets does not represent the value of the ore as it comes from the mine. For a metallic mineral, two high-cost items are freight rates and smelter charges. Except in rare cases of high-grade ore, both of these factors combine to make it economically impossible to ship a raw ore directly to a custom smelter.

In general, there is a ready market for the common metallic minerals at custom smelters throughout the western United States, and the shipper can calculate or estimate returns by referring to current metal prices.

The sale of nonmetallics is entirely different. The seller must find or possibly create a market, and, in addition to freight and process charges, he may face keen competition from other producers and may also have to face the hazards of substitutes for his product.

It is hardly necessary to say that mineral raw materials play a vital part in the economy of the community, state, and nation. Mining, logging, and agriculture are the three basic industries of our nation, and it is difficult to conceive of manufactured articles that did not originate from the earth's surface or subsurface. Traditionally, the availability of minerals has

resulted in the growth of industry, as evidenced by the great steel industry of the Lake Ports that feeds on the iron ores of the Lake Superior ranges, the copper smelters of the Salt Lake City area that use ore from disseminated copper deposits, and, locally, cement plants using limestone from deposits in Washington.

National emergencies during the 20th century have spotlighted the need for an adequate supply of strategic minerals, a supply that unfortunately cannot be turned on and off as the need dictates. Mineral producers must accept the fact that the demand for their products generally follows the business cycle. However, it should be remembered that mineral raw materials are the first to be affected by a business recession, and, because of manufacturers' inventories, they are the last to be affected by a business recovery.

Industry breeds industry; copper smelters produce waste sulfide gases that can be converted into sulfuric acid, and this in turn can give rise to new chemical plants—all depending on the minerals in the ground and whether they can be mined and useful products extracted at a profit.

The history of the discoveries and production of metallic minerals in the western United States is closely associated with pioneering and colonizing. The story of the discovery of gold in California followed by the surging gold rush to that area is common knowledge. Gold historically has been the forerunner of population influx. Australia, British Columbia, and Alaska are examples following California. It is interesting to note, however, that a large part of the present gold production from the continental United States comes as secondary metal from the mining of base metals.

Silver production in Nevada had a spectacular growth, followed by a sharp decline after the rich ores near the surface were extracted and the price of the metal fell. Nevertheless, silver stimulated growth of the State, and the search for silver resulted in discoveries of other metals and minerals. Copper and gold in Montana, lead-zinc and silver in Idaho, and copper in the Southwest all gave life to industries that were established before the turn of the century. During the present century, copper production in Alaska rose and declined in the 1920's and 1930's, iron production in California and Utah became established, and the subsequent industrial growth resulted in a demand for nonmetallic minerals.

All this mineral development caused the construction of base-metal smelters located at strategic places throughout the West; most of them were in the vicinity of the mines, but some were built at industrial centers or along waterfronts. The smelters so constructed were mostly custom smelters, many of which are still in operation today, and it is these units that provide markets in the West for many metallic ores and concentrates.

## COMMON METALS

### ALUMINUM

Bauxite, the principal ore of aluminum, for the most part is mined outside the United States; main source countries are the West Indies and the north coast of South America. Some bauxite is mined in the south-central United States, but none on the west coast. Aluminum reduction plants have been built in the Pacific Northwest to take advantage of favorable rates for electrical energy; such plants feed on alumina ($Al_2O_3$) brought in from out-of-State.

Along the west coast there are extensive deposits of high-alumina clays that have been investigated and that may be considered a future source of aluminum. Ferruginous bauxite in southwestern Washington also has been investigated and has a potential for future development.

At the present time (1963), aluminum on world markets is in more than ample supply. Future demand will depend on general domestic business activity, the further development of foreign markets, and the development of new uses for the metal. A ready market exists for domestic bauxite ore through the raw materials divisions of the major aluminum companies, provided the deposit has quality, quantity, and favorable location.

The producers of aluminum in the West are:

Aluminum Company of America, Vancouver, Wash., and Wenatchee, Wash.

Anaconda Aluminum Co., Columbia Falls, Mont.

Harvey Aluminum, Inc., The Dalles, Oreg.

Kaiser Aluminum & Chemical Corp., Mead, Wash.

Reynolds Metals Co., Longview, Wash., and Troutdale, Oreg.

Table 1.—Common metals

| Metal | Source mineral | | | | Price* | |
|---|---|---|---|---|---|---|
| | Name | Chemical composition | Marketable form | Common impurities | Concentrate | Finished metal |
| Aluminum | Bauxite | Mixture of aluminum oxides | 50% $Al_2O_3$ plus impurities | Silica, iron | -------- | $0.28 per lb. |
| Antimony | Stibnite | $Sb_2S_3$ | Concentrate of $Sb_2S_3$ | Silica, iron | 50%-$3.40<br>65%-$4.25<br>per short ton | $0.32 per lb. |
| Chromium | Chromite | $FeCr_2O_4$ | 44% $Cr_2O_3$ content | Excess of iron, also phosphorus, sulfur | $20-$30 per long ton | $1.15 per lb. |
| Copper | Chalcopyrite and chalcocite | $CuFeS_2$<br>$Cu_2S$ | Concentrate of copper sulfides | Zinc, arsenic, antimony, bismuth | -------- | $0.30 per lb. |
| Iron | Hematite, magnetite | $Fe_2O_3$<br>$Fe_3O_4$ | 50% iron content | Phosphorus, sulfur | $9-$10 per long ton, Pacific ports | -------- |
| Lead | Galena | PbS | Lead sulfide concentrate | ---------- | -------- | $0.103 per lb. |
| Magnesium | Sea water | -------- | Magnesium metal | ---------- | -------- | $0.35 per lb. |
| Manganese | Pyrolusite and other oxides | $MnO_2$ | 48% Mn content | Phosphorus, sulfur | $0.85 per long ton unit of contained Mn | $0.34 per lb. |
| Mercury | Cinnabar | HgS | Quicksilver | Arsenic minerals | -------- | $185.00 per flask of 76 lb. |
| Molybdenum | Molybdenite | $MoS_2$ | 90% $MoS_2$ concentrate | Varied | $1.40 per lb. of Mo | $3.35 per lb. |
| Nickel | Pentlandite and garnierite | $(Fe,Ni)S$<br>$(Ni,Mg)SiO_3$ | Nickel sulfide concentrate<br>Raw ore | Varied<br>Varied | -------- | $0.79 per lb. |
| Tin | Cassiterite | $SnO_2$ | Tin concentrate | Varied | -------- | $1.09 per lb. |
| Titanium | Rutile, ilmenite | $TiO_2$<br>$FeTiO_3$ | 94% $TiO_2$ concentrate<br>60% $TiO_2$ concentrate | Varied<br>Varied | $102 per ton<br>$23-$26 per ton | $1.32 per lb. |
| Tungsten | Wolframite, scheelite | $(Fe,Mn)WO_4$<br>$CaWO_4$ | Tungsten concentrate<br>Tungsten concentrate | Varied<br>Varied | $16-$18 per unit of $WO_3$ | $2.75 per lb. |
| Zinc | Sphalerite | ZnS | Zinc sulfide concentrate | Varied | -------- | $0.11 per lb. |

*The prices are for March 1963.

## ANTIMONY

The market for antimony is closely linked to that of lead. These metals have similar properties, and a principal use of each is in the manufacture of storage batteries. Like lead, antimony is recovered from scrap, which serves as a secondary source of the metal.

Most of the primary antimony used in the United States is obtained from stibnite ores and concentrates imported from Latin America. Numerous deposits of antimony are reported in Alaska, but this area suffers from high costs of transportation to markets. The price of antimony is quoted at New York or Laredo, Texas—a major processing point.

Possible buyers for antimony ores and concentrates include the following:

American Smelting and Refining Co., 120 Broadway, New York 5, N.Y.

C. Tennant, Sons & Co., 100 Park Avenue, New York 17, N.Y.

Morris P. Kirk and Son, Inc., 5909 N.W. 61st Ave., Portland, Oreg.

National Lead Company, Laredo, Tex.

## CHROMIUM

The mineral chromite is the chief source of chrome, the important metal whose principal use is in the production of alloy steel. Chromite is found in nature associated with peridotite-serpentine rocks, and despite some domestic production in wartime, the chrome ores of the United States are relatively unprofitable to mine; hence our domestic needs are largely filled by imported ores.

In addition to the demand for use in steels, chromite is used in the manufacture of refractories for lining metallurgical furnaces. Other uses for chrome are in the chemical industry and for chrome plating.

Possible buyers for chromite include:

American Metals and Minerals Corp., 75 West St., New York 17, N.Y.

C. Tennant, Sons & Co., 100 Park Avenue, New York 17, N.Y.

Kaiser Aluminum & Chemical Corp., 1924 Broadway, Oakland 12, Calif.

Union Carbide Metals Co., 30 E. 42nd St., New York 17, N.Y.

W. R. Grace & Co., Inc., 60 E. 42nd St., New York 17, N.Y.

## COPPER

A ready market exists for copper ores and concentrates at the custom copper smelters located throughout the western United States. Reserves of copper minerals are generally high, both in the free world areas and on domestic levels. The demand for copper is good, and the price has remained at a relatively high level despite the ample supply. Most of the copper produced in the United States today comes from large low-grade open pit mines, although some

production comes from higher grade vein deposits. The average grade of the open pit copper ores is about 0.8 percent copper content per ton (or 16 pounds of copper per ton) of ore mined. By contrast, the copper content of the South American ores is considerably higher, and the African ores have about four or five times the value of our local copper deposits. Despite this, the high productivity as a result of mechanization of United States mines has fostered growth and a high rate of exploration for future domestic production.

Markets for copper ores and concentrates include the following:

American Smelting and Refining Co., Tacoma, Wash., Hayden, Ariz., and El Paso, Tex.

The Anaconda Company, Anaconda, Mont.

Inspiration Consolidated Copper Co., Inspiration, Ariz.

Magma Copper Company, Superior, Ariz.

Phelps Dodge Corporation, Douglas, Ariz.

## IRON

Before World War II the market for iron ore along the west coast, and particularly in the Pacific Northwest, was limited or nonexistent. Because of high freight rates, the producing steel centers of the industrial Midwest were too remote to be considered; the nearest steel plant was in Utah. This condition remained until the early 1940's, when a new steel plant was built in southern California. This plant, however, has a supply of ore for its current requirements, and hence a domestic market for iron ore along the west coast is still limited.

Since 1950, the picture for iron ore has undergone a complete change because of the development of markets in Japan. The expanding Japanese industrial economy has created a demand for iron (and copper) along the entire Pacific Coast.

Deposits of iron ore favorable for development and shipment to the Far East should contain at least 50 percent metallic iron in the form of iron oxides and should be low in phosphorus, sulfur, and other impurities. In addition, the mine should be located as close as possible to a shipping port and, as iron ore is of relatively low dollar value, the deposits should be sufficiently large to warrant the capital investment necessary for mass production.

There is a trend today to beneficiate or upgrade the lower grade iron ores both for domestic consumption and export. To do this economically, the deposit should preferably be in the form of magnetite, which lends itself readily to magnetic concentration. The concentrate, unless coarse from a simple upgrading process, is pelletized to make it a suitable blast furnace feed.

Not uncommonly, iron ore deposits contain other metals, such as titanium, manganese, and nickel. Although these associated elements are frequently used to make alloy steels, they must be added during the steelmaking under strict metallurgical control. They are thus not desirable constituents in iron deposits and usually are considered as impurities. In some deposits the mineralogical association is such that titanium or other minerals may be separated from the iron. In other deposits, however, the association is such that separation is not economically feasible, and hence the deposit is of doubtful value.

Buyers of iron ores and concentrates include:

C. Itoh & Co. (America) Inc., 425 Park Ave., New York 22, N.Y.

Columbia Iron Mining Co., United States Steel Co., P. O. Box 510, Geneva, Utah

Kaiser Steel Corp., Fontana, Calif.

McWhite of Canada Limited, 2645 West 4th Ave., Vancouver 8, B. C., Canada

Mitsui Busson Kaisha, Ltd., 525 Exchange Bldg., 821 Second Ave., Seattle, Wash.

## LEAD

Galena, the principal ore of lead, is an abundant mineral of widespread occurrence. As mined in the western United States, galena is usually found associated with zinc ore, and usually contains silver. The proportion of silver to lead varies greatly, but it is not uncommon to find one-half ounce of silver for each one percent of lead in an ore.

The fact that galena is associated with sphalerite and other base sulfides, including arsenopyrite, in most cases makes it imperative that a lead concentrate be made before shipment to the smelter. A few operators still mine lead on a small scale for direct shipment to nearby smelters.

In 1961, supplies of lead from domestic and foreign sources were equal to or greater than the demand. The demand for lead is closely tied to the demand by automobile battery manufacturers, the chief consumers. Lead itself is relatively indestructible and hence reappears as secondary metal in the form of scrap.

Markets for lead ores and concentrates include the following:

American Smelting and Refining Co., East Helena, Mont., El Paso, Tex., and Selby, Calif.

The Bunker Hill Company, Kellogg, Idaho

International Smelting and Refining Co., Salt Lake City, Utah

## MAGNESIUM

The metal magnesium is produced from salts extracted from sea water, and hence its production is in a somewhat different category from that of most metals. The mineral magnesite has, in the past, been a source of the metal but is mined today only as a refractory. Dolomite also has been used as a source of magnesium. Magnesium, because of its light weight and other characteristics, has uses similar to aluminum.

## MANGANESE

With the exception of rhodochrosite and rhodonite, manganese ores consist of a mixed group of oxides, of which pyrolusite is the most common; the oxides are found usually as sedimentary ores. Manganese is a widespread constituent of many rocks, but its concentration as an ore deposit is limited in occurrence. Manganese ore, like chromite, is imported for domestic use, although low-grade deposits are being investigated in this country for benefication and production.

Manganese serves its chief use in steelmaking and special alloys. Secondary uses are in the manufacture of batteries and in the chemical industry.

Possible buyers of manganese ore include:

Bethlehem Steel Co., Bethlehem, Pa.

Colorado Fuel and Iron Corp., Pueblo, Colo.

Union Carbide Metals Co., 270 Park Ave., New York 17, N.Y.

United States Steel Co., 525 William Penn Place, Pittsburgh 30, Pa.

## MERCURY

The only important ore of mercury is cinnabar, the sulfide of mercury with its characteristic red color. Cinnabar is commonly found closely associated with acidic volcanic rocks. Mercury is relatively easy to extract from cinnabar by direct retorting, hence lends itself to small operations. However, the deposits in the United States are of relatively low grade as compared with foreign (European) ores, and most of our mercury comes from abroad.

Historically, the price of mercury has varied between wide limits; in recent years it has ranged between $185 and $215 per flask of 76 pounds.

Buyers of quicksilver include the following:

Coast Chemical Division, 275 Brannon St., San Francisco, Calif.

F. W. Berk and Company Inc., 55 New Montgomery St., San Francisco, Calif.

Quicksilver Products, Inc., 407 Sansome St., San Francisco, Calif.

Van Waters & Rogers, Inc., 1400 16th St., San Francisco 18, Calif.

## MOLYBDENUM

The only major ore of molybdenum is molybdenite, the soft blue-gray molybdenum sulfide. Molybdenite is found generally in granitic rocks and may be associated with ores of tin, tungsten, and copper. In the United States the principal deposits occur as disseminated, massive low-grade ores, and, except for one major operator, molybdenite is obtained as a secondary product during the concentration of the porphyry copper ores.

Molybdenum is a strategic metal of economic importance; it is used as a ferroalloy and also has other uses, such as in lubricants and pigments. The price of the finished metal has been consistently strong, and the general market outlook is considered favorable.

Possible buyers of molybdenum concentrates include:

Climax Molybdenum Company, Climax, Colo.

Molybdenum Corporation of America, 375 Park Ave., New York, N.Y.

S. W. Shattuck Chemical Company, Denver, Colo.

## NICKEL

Nickel is obtained from the nickel sulfide ores of the Sudbury district, Ontario, Canada, and from weathered laterite deposits formed from a nickel-rich ultramafic rock. The production of nickel within the United States is only about 15 percent of actual consumption and as a result we depend on imports to fill our needs. The demand for nickel has been strong, and the market for this strategic metal should continue to be good.

Possible buyers of nickel concentrates include:

International Bartering Co., 52 Broadway, New York 4, N.Y.

Sherritt Gordon Co., Fort Saskatchewan, Alberta, Canada

## TIN

Cassiterite, the tin oxide and only commercial ore of tin, is found in granitic rocks and pegmatites; it is fairly widespread in occurrence, but concentrations of the mineral to form ore deposits are quite limited. Cassiterite is mined from placer deposits in the Far East and from lode deposits in Bolivia. Some tin has been mined in Alaska from placer and lode deposits.

The principal use of tin is in plating and various alloys, hence the market demand and price are associated with activity in the steel industry. The price of tin is controlled by cartel agreement and has been quite stable.

Possible buyers of tin concentrates include:

Wah Chang Corporation, Woolworth Building, New York 7, N.Y.

W. R. Grace and Company, Hanover Square, New York, N.Y.

## TITANIUM

There are two principal ores of titanium: rutile—the titanium oxide, and ilmenite—the iron titanium oxide. Both of these minerals are widespread in their occurrences, but high concentrations are not common. In general, rutile is the raw material from which titanium metal is extracted, and ilmenite is the raw material source of titanium oxide pigments. The ore is mined in the eastern United States and Canada from lode deposits and in the Far East from placer deposits.

Titanium metal gives highly desirable characteristics to metal alloys; however, the metal is difficult and expensive to extract. Because of technical difficulties in extraction and processing, the prices of the raw ore and of the finished metal are at wide variance.

Possible buyers of titanium mineral concentrates include:

E. I. du Pont de Nemours and Co., Wilmington 98, Del.

National Lead Company, 111 Broadway, New York 6, N.Y.

Union Carbide Metals Co., 30 E. 42nd St., New York 7, N.Y.

## TUNGSTEN

The two principal ores of tungsten are wolframite and scheelite, both found in granitic rocks and commonly associated with molybdenite and other sulfides. The grade of domestic ores is relatively low, hence domestic production is limited to a few states and most of the domestic requirement is met by imports.

Tungsten is used in metal alloys, and as such has proved to be a valuable and strategic element in times of national emergency. In the past it has been supported by a Government-controlled price for stockpiling purposes, but it is now free to follow the law of supply and demand.

Possible buyers of tungsten concentrates include the following:

Salt Lake Tungsten Company, 2160 Indiana Ave., Salt Lake City, Utah

Union Carbide Nuclear Co., Bishop, Calif.

Wah Chang Corporation, Woolworth Building, New York 7, N.Y.

## ZINC

The principal ore of zinc is sphalerite, the common zinc sulfide, which may contain varying amounts of iron. Zinc ores are usually associated with lead and copper ores, and not infrequently with sulfides of arsenic.

The principal uses of zinc are in galvanizing and die casting, hence markets depend on activity in the steel industry and automobile production. A lesser use of zinc is as zinc oxide in the rubber and paint industries.

In disposing of zinc concentrates to a custom smelter, the shipper should realize that deductions and smelter treatment charges are high, and hence returns on shipments are low when compared with the price of the refined metal. Losses during the reduction process and the general complexity of the zinc plants account for this price differential. For calculating approximate smelter returns from a shipment of zinc concentrates, a realistic approach is to base the return on a price that is one-half of the quoted price of electrolytic zinc.

Markets for zinc ores and concentrates include the following:

The Anaconda Company, Great Falls, Mont.

The Bunker Hill Company, Kellogg, Idaho

Consolidated Mining & Smelting Company, Trail, B. C., Canada

## PRECIOUS METALS

The term "precious metals" is applied to the uncommon and highly valuable metals, especially gold, silver, and platinum. The following table summarizes market information on these metals.

Table 2.—Precious metals

| Metal | Source | Marketable form | Price * |
|---|---|---|---|
| Gold | Byproduct of base metal sulfides | Sold with sulfide concentrate to smelter | $32-$33 per troy oz. |
| | Disseminated gold ore | Sold to the U.S. Mint as gold bullion | $34.91 per troy oz. |
| Silver | Byproduct of base metal sulfides | Sold with sulfide concentrate to smelter | Approx. $1.27 per troy oz. |
| | Primary silver ores | Sold to U.S. Mint as silver bullion | $0.905 is the official U.S. Treasury price |
| Platinum | Byproduct of nickel ores | Sold with concentrate to smelter | Market price less deductions |
| | Placer deposits and platinum ores | Sold as platinum bullion | $77-$80 per troy oz. |

* The prices are for March 1963.

## GOLD

The precious metals gold and silver have a historical background that needs no amplification. It is sufficient to say that gold was one of the driving forces that helped to develop the western United States.

Gold may occur in a "free" state, in which it can be liberated and recovered by simple crushing coupled with gravity concentration and amalgamation. However, most significant gold deposits found today are either associated with base metal sulfides or are finely disseminated gold particles that can be recovered only by the cyanidation process.

A limited quantity of gold is still being produced from placer operations, but this type of mining is slowly decreasing. A large part of the gold now produced is recovered as a byproduct from the mining of base metals, particularly copper.

Gold that has not been smelted or treated chemically may be sold by a producer directly to a buyer at an agreed price. On the other hand, gold that has been smelted must by law be sold to the United States Mint or to a licensed gold buyer.

The price paid by the Mint for gold bullion, or gold in other acceptable form, is $35 per troy ounce, 1,000 fine, less a small handling charge. The net return is about $34.91 per ounce. The price paid by the smelters varies, depending on the gold content in the shipment, but is about $32 to $33 per ounce.

Gold and gold ore buyers are as follows:

Custom smelters of copper and lead. (See page 27.)

U.S. Government Mint, Denver 2, Colo.

(Any questions concerning a gold license and the sale of gold should be directed to the Mint.)

## SILVER

The most important silver-producing mineral being mined at the present time is tetrahedrite, a copper antimony sulfide that commonly contains a small amount of precious metal. Most of the silver not obtained from tetrahedrite comes as a byproduct in base metal production, particularly from lead and copper.

Buyers of silver and silver ore include:

Custom smelters of copper and lead. (See page 27.)

Handy & Harman, 82 Fulton Street, New York 38, N.Y.

U.S. Government Mint, Denver 2, Colo.

## PLATINUM

Platinum is the highly valuable precious metal that occurs as stream placer deposits under much the same conditions as gold. Platinum is also found associated with nickel-cobalt ores.

The only operating platinum mine in North America is a placer operation in Alaska. Apart from this, the metal is produced in the smelting of the nickeliferous sulfides found principally in Ontario, Canada.

Platinum is not purchased by the United States Mint. Any mining operation of gold with contained platinum is faced with the problem of separation before marketing.

Possible buyers of platinum include:

Handy & Harman, 82 Fulton Street, New York 38, N.Y.

Wildberg Brothers Smelting & Refining, 349 Butler Avenue, P. O. Box 468, South San Francisco, Calif.

## MINOR METALS

### BERYLLIUM

The principal ore of beryllium is beryl, frequently considered to be a nonmetallic mineral because of its physical characteristics. However, other beryllium minerals are now being investigated with increasing interest. Beryl is generally mined from pegmatites and sold direct as hand-cobbed ore or mechanical concentrates.

The metal beryllium has a limited demand but an important use in high-temperature alloys.

Buyers of beryllium ores include:

Beryl Ores Co., Arvada, Colo.

The Beryllium Corporation, P. O. Box 1462, Reading, Pa.

U.S. Government Buying Dept., Custer, S. Dak.

### BISMUTH

Bismuth is found in nature associated with lead ores and is usually obtained as a byproduct in the refinement of lead metal. As a rule, no payment is made for bismuth contained in concentrates consigned to a smelter.

Possible buyers for bismuth metal and (or) concentrates include:

American Metal Climax, Inc., 61 Broadway, New York 6, N.Y.

J. E. De Sousa Co., Inc., 100 Church Street, New York 7, N.Y.

National Lead Co., 111 Broadway, New York 6, N.Y.

Table 3.—Minor metals

| Metal | Source | Marketable form | Price* |
|---|---|---|---|
| Beryllium | Beryl, $Be_3Al_2Si_6O_{18}$ | Minimum 10% BeO concentrate | $29-$32 per short ton unit of BeO |
| Bismuth | Smelter byproduct | Metal | $2.25 per lb. |
| Boron | Boron salts | $B_2O_3$ concentrate | $47.50 per ton |
| Cadmium | Zinc smelter byproduct | Metal | $1.85 per lb. |
| Cobalt | Cobaltite, CoAsS | Concentrate of cobalt sulfide-arsenides | $1.50 per lb. of contained metal |
| Columbium-tantalum | Columbite and tantalite | Concentrate of 65% $Cb_2O_5$ and $Ta_2O_5$ | Ratio 10:1, $0.90-$1.00<br>Ratio 8½:1, $0.85-$0.90 |
| Germanium | Zinc smelter byproduct | Metal | Variable; $26.65 per gram |
| Lithium | Spodumene, $LiAlSi_2O_6$ and lepidolite | Raw mineral or concentrate | Variable; $9-$11 per unit of $Li_2O$ |
| Rare earths | Group of rare oxides (monazite is typical) | Oxide concentrate | Variable |
| Selenium | Copper smelter byproduct | Metal | $4.50-$6.00 per lb. |
| Tellurium | Smelter byproduct | Metal | $6.00 per lb. |
| Thorium | Oxides of thorium | Metal | Variable |
| Uranium | Carnotite and uraninite | Oxides of uranium | $8 per lb. of $U_3O_8$ |
| Vanadium | Uranium-vanadium ores | Concentrate of $V_2O_5$ | Variable; $0.31 per lb. of $V_2O_5$ |
| Zirconium | Zircon placer sands | Concentrate of sands | Variable; $50 per long ton |

*The prices quoted are for March 1963. Prices for the minor metals vary widely and may be quoted in various ways.

## BORON

The element boron has received considerable publicity of late and has limited occurrences but growing uses. Borate minerals are found in the desert areas of the Southwest, where

they are mined for borax and boric acid. The chemical industry is the only important user of borate minerals.

Possible buyers include:

American Potash & Chemical Corp., 3030 W. 6th Street, Los Angeles 54, Calif.

Stauffer Chemical Co., 636 California St., San Francisco 8, Calif.

U. S. Borax Co., Boron, Calif.

## CADMIUM

Cadmium is obtained as a byproduct from zinc ores, hence its production is allied with the production of zinc. No ore is mined solely as a source of cadmium. The only cadmium mineral of any significance is greenockite, a cadmium sulfide, and it is not common in occurrence. The cadmium content of zinc concentrates normally ranges from 0.17 to 1.4 percent.

## COBALT

Cobalt is a relatively rare element that occurs in a series of sulfides commonly associated with nickel. A major use of cobalt is in the manufacture of permanent magnets, and its market is closely linked to that of nickel.

## COLUMBIUM-TANTALUM

Columbite and tantalite ores are referred to as one because of their similarity and common occurrence. Demand for these metals is limited, and production at present is from foreign sources.

Possible buyers of these ores include:

E. I. du Pont de Nemours & Co., Wilmington 98, Del.

Union Carbide Metals Co., 30 E. 42nd Street, New York 7, N.Y.

Wah Chang Corp., Woolworth Building, New York 7, N.Y.

## GERMANIUM

Germanium is obtained as a byproduct in smelter operations, but there has been some reported activity in mineral exploration for the element itself. The demand for germanium in the electronics field is increasing, and the principal producers are the large zinc companies.

## LITHIUM

The principal ores of lithium are spodumene and lepidolite from both domestic and foreign sources. Consumption is by the chemical, glass, and ceramics industries. Lithium metal is the subject of current widespread research.

Possible buyers include:

American Potash & Chemical Corp., 3030 W. 6th Street, Los Angeles 54, Calif.

Foote Mineral Co., 18 W. Chelton Ave., Philadelphia 44, Pa.

J. E. De Sousa Co., Inc., 100 Church Street, New York 7, N.Y.

Lithium Corp. of America, Bessemer City, N.C.

## RARE EARTHS

The so-called rare earth metals obtained from the rare earth minerals, of which monazite is perhaps the best known, are relatively abundant in occurrence but have a limited use. Principal uses to date are in the manufacture of flints, carbon arcs, high-temperature alloys, and optical glass. Rare earths are closely linked to thorium, as this element is contained within the various rare earth minerals. Monazite is mined in this country and is also imported.

Possible buyers of rare earths include:

J. E. De Sousa Co., Inc., 100 Church St., New York 7, N.Y.

Lindsay Chemical Division, American Potash & Chemical Corp., West Chicago, Ill.

Research Chemicals Division, Nuclear Corp. of America, Burbank, Calif.

Vitro Chemical Company, Chattanooga, Tenn.

## SELENIUM

Selenium is a strategic metal obtained as a byproduct in the electrolytic refining of copper. Its production, then, is linked to refined copper and the large copper-producing companies.

## TELLURIUM

Tellurium has been known for years as the element that in nature combines with gold to form the famous gold tellurides associated with early western mining. Tellurium has received some attention of late as a possibly valuable metal within its own right; however, the interest to date is still academic.

## THORIUM

Thorium received considerable publicity along with uranium but never approached in importance its more famous associate. Thorium minerals are widespread, but unfortunately are rarely found in nature in such concentrated form that they can be classified as ore deposits. Thorium is used in industry for the manufacture of gas mantles, in the chemical and ceramic industries, and lately in the manufacture of high-temperature-resistant alloys. The U.S. Atomic Energy Commission continues to carry on research in the use of thorium for reactor fuel, and there is a possibility of future markets in this field.

Possible buyers of thorium are those listed under Rare Earths.

## URANIUM

Uranium is now being produced by mining companies in several of the western states and is sold to the Atomic Energy Commission under firm contract. The A. E. C. demands have been drastically reduced, and the future of uranium mining beyond 1965 is now a matter of some doubt. At present (1963), about the only market for uranium ores consists of mining companies

with existing government contracts. The Dawn Mining Company, Ford, Wash., purchases a limited amount of uranium ores from the Northwest.

## VANADIUM

Vanadium is used principally in certain types of alloy steel, and hence its consumption is tied to steel production. Vanadium is produced as a byproduct in uranium production, but has been produced in the past from the vanadium ore, roscoelite, and may well be produced from this source in the future.

Possible buyers of roscoelite ores are the steel and chemical companies.

## ZIRCONIUM

The metal zirconium has received considerable publicity of late because of its use in atomic-powered ships and electrical power stations. Despite this, the actual demand for this metal is quite small. The common mineral zircon, mined from placer deposits, both domestic and foreign, is the source of zirconium.

Possible buyers of zircon sand concentrates include:

Stauffer Chemical Co., 636 California Street, San Francisco 8, Calif.

Union Carbide Metals Co., 30 E. 42nd Street, New York 7, N.Y.

Wah Chang Corp., Woolworth Building, New York 7, N.Y.

## SELLING METALLIC ORES

There is a ready market for ores and concentrates of copper, lead, and zinc at the custom smelters located throughout the West. The custom smelters receive the concentrates, extract the metal, and sell the metal at existing market prices. The price that a shipper receives for his concentrate depends upon the metal prices on the day of delivery at the smelter, less conventional deductions and smelter charges.

Smelter schedules, available from the smelters, list (a) the treatment charge, (b) penalties against constituents that add to the problems and cost of smelting, and (c) payments for the contained metals in the ore.

A custom copper smelter is interested in purchasing ores and concentrates of copper, gold, and silver. It will not pay for lead and zinc and, on the contrary, will penalize the shipper if the zinc content in the copper concentrate is too high. Other elements such as arsenic, antimony, and bismuth are objectionable and the shipper will be penalized if they exceed a set minimum.

A custom lead smelter that purchases ores and concentrates of lead, gold, and silver will pay for copper at a reduced rate. A lead smelter will also deduct for excessive zinc and other impurities. A zinc smelter is interested primarily in zinc ores and concentrates.

It is apparent, then, that a complex sulfide ore will have to be separated into its various components if it is to be effectively and efficiently exploited. This is accomplished by differential flotation, after which the concentrates of copper, lead, and zinc are shipped to the appropriate smelters.

# SMELTER SCHEDULES

## Copper Ore

An approximate open-smelter schedule for a typical copper smelter is as follows:

| | |
|---|---|
| Delivery | F.o.b. receiving smelter |
| Payment: | |
| Gold | If 0.03 troy ounces per ton or over, pay for 91.14 percent at the U.S. Mint price. |
| Silver | If 1 troy ounce per ton or over, pay for 95 percent at the Handy & Harmon quotation, less 1 cent per troy ounce of silver paid for. Minimum deduction, 1 ounce. |
| Copper | Deduct 1.3 units* and pay for 100 percent of the remaining copper at the Engineering and Mining Journal export refinery quotation, less a deduction of 2.75 cents per pound. |
| Deductions: | |
| Treatment charge | $12.50 to $15.00 per net dry ton of 2,000 pounds |
| Zinc | 7 percent free; charge for excess at 30 cents per unit. |
| Arsenic | 1 percent free; charge for excess at 75 cents per unit. |
| Antimony | 1 percent free; charge for excess at $1.00 per unit. |
| Bismuth | 0.05 percent free; charge for excess at 50 cents per pound. |

*A unit equals 1 percent of a ton (20 pounds).

Example of payment calculation for copper ore or concentrate

Assume a shipment of 50 tons of copper sulfide ore that averages 4 percent copper, 0.04 oz gold, 0.8 oz silver, and has no impurities. This mine is located in a mountainous area remote from the smelter, and freight charges are $6.00 per ton.

Situation "A" – The ore is shipped direct to the smelter without concentration, and the following calculations are made:

Payment:

| | | |
|---|---|---|
| Gold | 0.04 oz. X 91.14% X $35.00 = $1.27596 per ton, | |
| | and 50 tons X $1.27596 = | $63.80 |
| Silver | No payment | |
| Copper | 4% = 4 units (80 lb.) | |
| | deduct 1.3 units (26 lb.), leaves net of 54 lb. | |
| | Assume market price of Cu to be 31 cts. per lb. | |
| | ∴ 31.00 - 2.75 = 28.25 cts. to be paid, | |
| | or 54 X .2825 = $15.255 per ton, | |
| | and 50 tons X $15.255 = | $762.75 |
| | Total payment | $826.55 |

Deductions:

| | |
|---|---|
| Treatment charge at $12.50 per ton | |
| ∴ Total treatment charge = $12.50 X 50 = | $625.00 |
| Freight charge at $6.00 per ton | |
| ∴ Total freight charge = $6.00 X 50 = | $300.00 |
| Total deductions | $925.00 |

Thus $826.55 - $925.00 = $98.45 net loss

And loss per ton is $\frac{\$98.45}{50} = \$1.97$

Situation "B" — The ore is concentrated in a mill at 5:1 ratio, giving a copper concentrate of 20 percent and reducing the tonnage to be shipped from 50 tons to 10 tons. Since the gold and silver are contained within the copper sulfide mineral, they are similarly upgraded.

Payment:

| | | |
|---|---|---|
| Gold | 0.04 oz. X 5 = 0.20 oz. per ton, | |
| | and 10 tons X 0.20 = 2.0 oz. | |
| | ∴ 2.0 X 91.14% X $35.00 = | $63.80 |
| Silver | 0.8 oz. X 5 = 4.0 oz. per ton | |
| | Deduct 1 oz. per ton, leaves 3.0 oz. per ton, | |
| | and 10 tons X 3.0 = 30 oz. | |
| | Assume the market price of silver to be 90 cts. | |
| | ∴ 90 - 1 = 89 cts. per oz. to be paid, | |
| | and 30 oz. X .89= | $26.70 |
| Copper | 20% Cu = 20 units (400 lb.) | |
| | Deduct 1.3 units (26 lb.), leaves net of 374 lb. | |
| | ∴ 31.00 - 2.75 = 28.25 cts. to be paid, | |
| | or 374 lbs. X .2825 = $105.655 per ton, | |
| | and 10 tons X $105.655= | $1,056.55 |
| | Total payment | $1,147.05 |

Deductions:

| | |
|---|---|
| Treatment charge at $12.50 per ton | |
| ∴ Total treatment charge = $12.50 X 10 = | $125.00 |
| Freight charge at $6.00 per ton | |
| ∴ Total freight charge = $6.00 X 10 = | $60.00 |
| Total deductions | $185.00 |

Thus $1,147.05-$185.00 = $962.05 net return

Since the original ore mined represents 50 tons before concentration, the net return per ton of raw ore mined is $\frac{\$962.05}{50} = \$19.24$

This example does not take into consideration the cost of mining and milling, but it does show the necessity of concentrating a low-grade ore.

## Lead Ore

An approximate open-smelter schedule for a typical lead smelter is as follows:

| | |
|---|---|
| Delivery | F.o.b. receiving smelter |
| Payment: | |
| Gold | If 0.03 troy ounces per ton or over, pay for 91.14 percent at the United States Mint price. |
| Silver | If 1 troy ounce per ton or over, pay for 95 percent at the Handy & Harman quotation, less 1 cent per ounce of silver paid for. Minimum deduction, 1 ounce. |
| Lead | Deduct 1.5 units from the wet-lead assay and pay for 95 percent of the remaining lead at the New York price, less a deduction of 1.75 cents per pound. |
| Copper | Deduct 1.3 units, and pay for 100 percent of the remaining copper at the Engineering and Mining Journal export refinery quotation, less a deduction of 8 cents per pound. |
| Deductions: | |
| Treatment charge | $15 per net dry ton of 2,000 pounds |
| Zinc | 7 percent free; charge for excess at 30 cents per unit. |
| Arsenic | 1 percent free; charge for excess at 75 cents per unit. |
| Antimony | 1 percent free; charge for excess at $1.00 per unit. |
| Bismuth | 0.05 percent free; charge for excess at 50 cents per pound. |

## Example of payment calculation for lead ore

Assume a lead sulfide ore containing silver and zinc that assays 20 percent lead, 6 oz. silver, trace of gold, and 10 percent zinc. Freight rates from mine to smelter are $5.00 per ton.

Calculations for a ton of this ore are as follows:

Payment:

| | | |
|---|---|---|
| Gold | No payment | |
| Silver | Assume market price of silver to be 90 cts. | |
| | And 90 - 1 = 89 cts. per oz. to be paid | |
| | Deduct 1 oz. per ton, leaves 5 oz. per ton | |
| | ∴ 5 oz. X .89 = | $4.45 |
| Lead | 20% lead = 20 units (400 lb.) | |
| | Deduct 1.5 units (30 lb.), leaves net of 370 lb. | |
| | Assume market price of lead to be 11.75 cts. per lb. | |
| | ∴ 11.75 - 1.75 = 10 cts. per lb. to be paid, | |
| | or 370 lb. X 95% X .10 = | $35.15 |
| | Total payment | $39.60 |

Deductions:

| | |
|---|---|
| Treatment charge at $15. per ton = | $15.00 |
| Freight charge at $5 per ton = | $5.00 |
| Zinc content is 10 units, and thus | |
| charge is (10 - 7) = 3 units X 30 cts. = | $0.90 |
| Total deductions | $20.90 |

Thus $39.60 - $20.90 = $18.70 net return per ton.

Table 4.—Copper, lead, and zinc smelters in the western United States, Canada, and Mexico

| Type of ores and concentrates purchased | Company | Location |
|---|---|---|
| Lead, gold, and silver | The Bunker Hill Co. | Kellogg, Idaho |
| Lead, gold, and silver | International Smelting and Refining Co. | Tooele, Utah |
| Lead, gold, and silver | American Smelting and Refining Co. | East Helena, Mont. |
| Lead, gold, and silver | American Smelting and Refining Co. | Selby, Calif. |
| Lead, gold, and silver | American Smelting and Refining Co. | El Paso, Tex. |
| Lead, gold, and silver | American Smelting and Refining Co. | Chihuahua, Mexico |
| Lead, gold, and silver | The Consolidated Mining & Smelting Co. of Canada, Ltd. | Trail, B. C., Canada |
| Copper, gold, and silver | The Anaconda Co. | Anaconda, Mont. |
| Copper, gold, and silver | Magma Copper Co. | Superior, Ariz. |
| Copper, gold, and silver | Inspiration Consolidated Copper Co. | Inspiration, Ariz. |
| Copper, gold, and silver | American Smelting and Refining Co. | Tacoma, Wash. |
| Copper, gold, and silver | American Smelting and Refining Co. | Hayden, Ariz. |
| Copper, gold, and silver | American Smelting and Refining Co. | El Paso, Tex. |
| Copper, gold, and silver | American Smelting and Refining Co. | San Luis Potosi, Mexico |
| Zinc | The Bunker Hill Co. | Kellogg, Idaho |
| Zinc | American Zinc, Lead and Smelting Co. | 927 Old National Bank Bldg. Spokane, Wash. |
| Zinc | The Anaconda Co. | Great Falls, Mont. |
| Zinc | International Smelting and Refining Co. | Tooele, Utah |
| Zinc | American Smelting and Refining Co. | Amarillo, Tex. |
| Zinc | American Smelting and Refining Co. | Corpus Christi, Tex. |
| Zinc | American Smelting and Refining Co. | Rosita, Coah., Mexico |
| Zinc | The Consolidated Mining & Smelting Co. of Canada, Ltd. | Trail, B. C., Canada |

(Other smelters not listed may accept custom ores and concentrates, depending on their needs and the market conditions.)

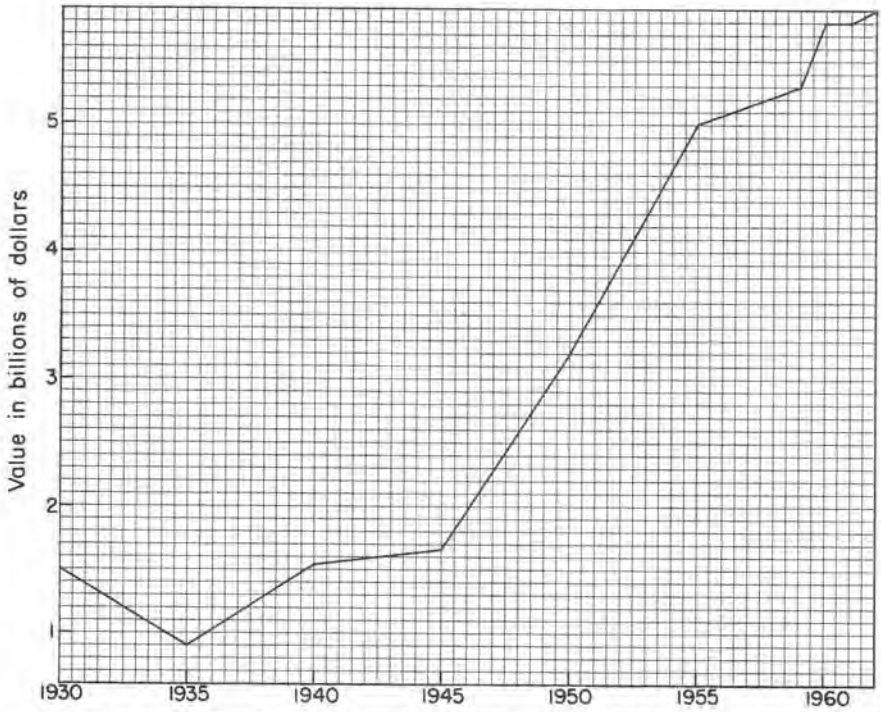


FIGURE 1.—VALUE OF METALLIC AND NONMETALLIC MINERALS PRODUCED IN THE UNITED STATES, 1930-1962.*

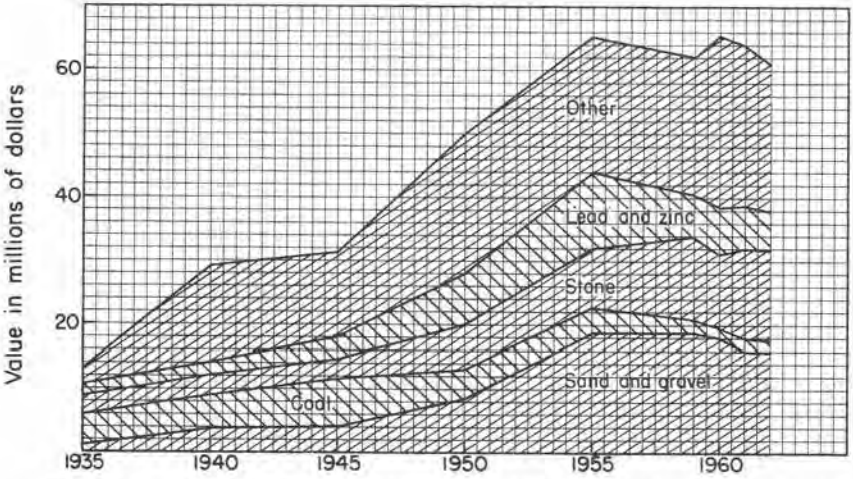


FIGURE 2.— VALUE OF SAND AND GRAVEL, COAL, STONE, LEAD AND ZINC, AND TOTAL VALUE OF MINERAL PRODUCTION IN WASHINGTON, 1935-1962.*

*Source - U.S. Bureau of Mines Minerals Yearbook, 1961, and other U.S.B.M. sources.

# NONMETALLIC MINERALS

Since World War II the growth in the production of nonmetallic minerals has been very rapid. In 1940 the United States nonmetallic mineral production, excepting fuels, was about 825 million dollars; in 1960 the production was over 3,730 million dollars. This growth is allied with the increase in our gross national productivity, which has created for many industrial minerals a demand where none or little existed before. Nonmetallics have a low unit value in their crude state, and because of freight costs mining is restricted to within relatively short distances from industrial centers. The problem of transportation costs and their influence on the value of a low-grade mineral deposit is frequently underrated. For instance, of two mineral deposits that possess similar characteristics, one may be located close to a large city and hence be classified as an ore deposit and the other may be located in a remote area and be considered worthless.

Most nonmetallics are mined by open-pit method, although some, such as potash, barite, and fluorite, may be mined by conventional underground methods.

Table 5.—Common nonmetallic minerals

| Name | Chemical composition | Marketable form | Price |
|---|---|---|---|
| Asbestos (chrysotile) | Hydrous magnesium silicate | Graded, classified, and sold according to the length of the fibers; 3/4" and shorter | $29-$1,522 per ton |
| Barite | $BaSO_4$ | At least 90% $BaSO_4$ | $12-$23 per ton, depending on location |
| Clay | Groups of hydrous aluminum, magnesium, and iron silicates | Generally low in iron | Varies |
| Feldspar | Orthoclase, $KAlSi_3O_8$<br>Plagioclase, $(Na,Ca)AlSi_3O_8$ | Depends on use; ceramic grade for glass specifies less than 0.10% Fe | $7.50-$22 per ton |
| Fluorite | $CaF_2$ | Acid grade, 97% $CaF_2$<br>Ceramic grade, 88-96% $CaF_2$<br>Metallurgical, 60-72% $CaF_2$<br>(Should be low in silica, sulfur, and iron) | $45 per ton<br>$41-$43 per ton<br>$32-$39 per ton |

Table 5.—Common nonmetallic minerals—Continued

| Name | Chemical composition | Marketable form | Price |
|---|---|---|---|
| Gypsum | $CaSO_4 \cdot 2H_2O$ | Gypsum rock | Crude rock sells at approximately $3-$4 per ton |
| Limestone | $CaCO_3$ | Varies from 85% for agricultural limestone to 99% for chemical grade | Approx. $3 per ton at quarry, but may vary widely |
| Mica | Hydrous potassium, magnesium, aluminum silicates | Muscovite or phlogopite, low in iron | From 7 cents per lb. for punch mica to $8 per lb. for clear sheets |
| Potash (sylvite) | KCl | High-grade salt | Converted to $K_2O$ it sells at $30-$35 per ton depending on location |
| Phosphate | Derived from apatite, $Ca_5(F,Cl,OH)(PO_4)_3$ | Dried phosphate rock sold on the basis of tricalcium phosphate content, 66-77% | $5-$8 per long ton |
| Silica | $SiO_2$ | For glass sand must have at least 99% $SiO_2$ and only a trace of iron | $7.50-$8.50 per ton |
| Sulfur | S | Sulfur | $20-$25 per ton |
| Talc and soapstone | $H_2Mg_3(SiO_3)_4$ | Crude stone | About $6 per ton |

## ASBESTOS

Asbestos is a fibrous mineral, a hydrous aluminum silicate that is formed by alteration of serpentine rock. It is used mainly as a nonconductive, noncorrosive fireproof fiber, and as such has very little competition.

There are two types of asbestos — the amphibole variety and chrysotile (serpentine); the latter is by far the most in demand.

Asbestos mining in the United States is limited, and the bulk of our industrial needs is supplied by Canadian imports from the Province of Quebec and to a lesser extent from British Columbia. Chrysotile is a strategic mineral on the list of critical raw materials that are in demand in times of national emergency. Because of its short supply in the United States, there is a ready market for this material and domestic sources of asbestos are being actively sought.

Possible buyers of asbestos include:

Johns Manville Sales Corp., 22 E. 40th St., New York 16, N.Y.

Pabco Products Inc., 1550 Powell St., Emeryville, Calif.

Union Asbestos & Rubber Co., 332 S. Michigan Ave., Chicago 4, Ill.

## BARITE

Barite is a heavy sulfate mineral found as residual deposits, vein deposits, replacement deposits, and as a gangue mineral in veins. The mineral may be marketed in its natural state, but usually must be processed to upgrade it to the minimum required by industry.

Barite is used principally in high specific gravity well-drilling mud. It has additional uses in glass, pigments, filters, and chemicals. Crude barite for drilling mud has a relatively low value, and its market depends directly on the activity of exploration drilling.

Possible buyers of barite include:

General Paint Corp., 2627 Army St., San Francisco 19, Calif.

The Glidden Co., Chemical and Pigment Division, 766 50th Ave., Oakland 1, Calif.

Industrial Minerals and Chemical Co., Sixth and Gilman Sts., Berkeley, Calif.

Latchford-Marble Glass Co., P. O. Box 4707, Los Angeles, Calif.

National Lead Company, P. O. Box 1675, Houston 1, Tex.

Owens-Illinois Pacific Coast Co., 135 Stockton St., San Francisco, Calif.

Ray R. Kelly, 1022 North "G" St., Tacoma, Wash.

## CLAY

Clays suitable for the making of brick and similar clay products are hydrous aluminum silicates that have the ability to become hardened when subjected to baking and are highly resistant to chemical action even at high temperatures. The value of a particular clay can be determined only by laboratory tests or by actual use in a commercial plant.

To be of commercial value, clay deposits must be located near industrial centers.

Possible buyers of clay are:

Builders Brick Co., 3800 Ninth Ave. S., Seattle 8, Wash.

Chehalis Brick & Tile Co., Box 868, Chehalis, Wash.

Granger Clay Products Co., 515 S. Fifth Ave., Yakima, Wash.

International Pipe and Ceramics Corp., 1500 Walla Walla Ave., Renton, Wash.

Lowell Brick & Tile Co., P. O. Box 277, Lowell, Wash.

## FELDSPAR

The feldspars are a group of hard, light-colored aluminum silicates of potassium, sodium, and calcium. They are used principally by the ceramic industry in the manufacture of porcelain and glass and similar products.

To be of marketable value, the deposit should be of good grade and near an industrial center.

Possible buyers of feldspar include:

Dominion Glass Company Ltd., Redcliff, Alberta, Canada

Donnelly-Kelley Glass Co., 49 Fenlon St., Holland, Mich.

Owens-Pacific Coast Co., 15 H and Folsom Sts., San Francisco, Calif.

Porcelain Products Co., Inc., 1941 Broadway, Parkersburg, W. Va.

## FLUORITE

Fluorite, also known as fluorspar, is a calcium fluoride mineral that is used principally as a flux in steelmaking. Secondary but growing uses are in the ceramic industry and the chemical industry, including the manufacture of synthetic cryolite for aluminum reduction.

Fluorite is found in veins, as massive deposits, associated with limestone deposits, and also as a gangue mineral in veins. In general, it must be processed before it can be marketed; minimum grade for the chemical industry is 97 percent $CaF_2$, and metallurgical-grade fluorite may be of lower grade, depending upon the silica content.

A large part of the fluorite used in the United States is imported from Mexico, either through brokers or directly from mines owned by the large steel and aluminum companies. At present there are adequate supplies of this mineral, and future demand will depend largely on activity in steelmaking and aluminum reduction.

Possible buyers of fluorite include:

Balfour, Guthrie & Co., Los Angeles, Calif.

Bradley & Ekstrom, Inc., 24 California St., San Francisco, Calif.

Stauffer Chemical Company, 636 California St., San Francisco 8, Calif.

## GYPSUM

Gypsum is a hydrous calcium sulfate found generally in massive bedded deposits. Its chief use is as a building material for indoor purposes. It is used in smaller amounts in the manufacture of portland cement.

Gypsum deposits and processing plants are widespread throughout the country. The demand for this mineral presumably will increase and will depend to a large extent on activity in residential construction.

Possible buyers of gypsum include:

Ideal Cement Co., 1320 Washington Bldg., Seattle 1, Wash., and P. O. Box 34, Spokane 10, Wash.

Kaiser Gypsum Co., Inc., 5931 E. Marginal Way S., Seattle, Wash.

Lehigh Portland Cement Co., Metaline Falls, Wash.

Lone Star Cement Corp., 120 Sixth Ave. N., Seattle 9, Wash.

The Olympic Portland Cement Co., P. O. Box 17, Bellingham, Wash.

## LIMESTONE

Limestone (calcium carbonate) is perhaps the most widely known and widely used industrial mineral. It is used as a flux in the metallurgical field, as the chief raw material in the manufacture of cement, as a soil conditioner in agriculture, as a chemical raw material, and in numerous miscellaneous fields.

Limestone is widespread and usually occurs in massive deposits. In general, it is found in beds that are relatively pure, and hence it may be crushed and sized directly for marketing.

High-purity limestone suitable for the chemical industry may command a price of about $6.00 per ton, but the average price for limestone is about $3.00 per ton.

Possible purchasers of limestone include the pulp and paper plants, sugar refineries, portland cement plants, building contractors for stone work, and feed stores and co-ops for agricultural purposes. Some of these are:

Boise Cascade Kraft Corp., P. O. Box 500, Wallula, Wash.

The Chas. H. Lilly Co., 1900 Alaskan Way, Seattle, Wash.

Columbia River Paper Mills, Vancouver, Wash.

Crown Zellerbach Corp., Camas, Wash., and Port Townsend, Wash.

Everett Pulp and Paper Co., Lowell, Wash.

Fiberboard Products, Inc., Port Angeles, Wash.

Ideal Cement Co., 1320 Washington Bldg., Seattle 1, Wash., and P. O. Box 34, Spokane 10, Wash.

Inland Empire Paper Co., Millwood, Wash.

Lehigh Portland Cement Co., Metaline Falls, Wash.

Longview Fibre Co., Longview, Wash.

Manufacturers Mineral Co., P. O. Box 3543, Seattle 24, Wash.

Northwestern Glass Co., 5801 E. Marginal Way S., Seattle 4, Wash.

The Olympic Portland Cement Co., P. O. Box 17, Bellingham, Wash.

Portco Corp., Paper Products Division, Vancouver, Wash.

Potlach Forests, Inc., Lewiston, Idaho

Puget Sound Pulp and Timber Co., Bellingham, Wash.

Rayonier, Inc., Hoquiam, Wash.

Reichhold Chemicals, Inc., Tacoma, Wash.

Scott Paper Co., Everett, Wash.

St. Regis Paper Co., Tacoma, Wash.

Stauffer Chemical Co., 2545 Lincoln, Tacoma, Wash.

Utah-Idaho Sugar Co., Toppenish, Wash., and Moses Lake, Wash.

Weyerhaeuser Company, Tacoma, Wash., Everett, Wash., and Cosmopolis, Wash.

## MICA

Mica suitable for marketing is the light-colored muscovite or phlogopite, the hydrous potassium, magnesium, aluminum silicates that have little or no iron content. Mica is found in pegmatites and may be mined in large sheets that are suitable for direct marketing or as flake mica that must be processed. A large part of the mica used in the United States comes from foreign sources.

Mica is used principally in the electronics industry. It is a strategic material that is expected to continue in good demand.

Possible buyers of block mica include:

General Electric Co., 1 River Road, Schenectady, N.Y.

Imperial Milling Co., 2738 Merced Ave., El Monte, Calif.

International Minerals & Chemical Corp., Old Orchard Road, Skokie, Ill.

Western Electric Co., Inc., 195 Broadway, New York 17, N.Y.

## POTASH AND PHOSPHATE

Potash and phosphate are two nonmetallic materials that are processed and used as fertilizers. The raw materials, as such, have a low value, as they must be chemically treated and converted to forms that are water soluble and suitable as plant foods.

West coast producers of phosphate products are:

Monsanto Chemical Company, Long Beach, Calif.

Westvaco Chemical Division of Food Machinery and Chemical Corp., Pocatello, Idaho

## SILICA

Deposits of silica are widespread, but most deposits have impurities that make them unsuitable for use. To be considered as a suitable source of glass sand, a silica must contain at least 99 percent $SiO_2$ with only a trace of iron, or be amenable to concentration to these specifications.

The market for silica is a selective, competitive one and is generally restricted to the near vicinity of an industrial center. The silica deposits of Washington supply silica mainly to the State's glass and ferroalloys industries.

Possible buyers of silica are:

The Carborundum Co., Lower River Road, Vancouver, Wash.

Keokuk Electro-Metals Co., Box 361, Wenatchee, Wash.

Manufacturers Mineral Co., P. O. Box 3543, Seattle 24, Wash.

National Metallurgical Corp., Springfield, Oreg.

Northwestern Glass Co., 5801 E. Marginal Way S., Seattle 4, Wash.

Ohio Ferro-Alloys Corp., 3002 Taylor Way, Tacoma, Wash.

Owens-Illinois Glass Co., 5535 N.E. 101st Ave., Portland, Oreg.

Pacific Silica Co., 3300 First Ave. S., Seattle 4, Wash.

Philadelphia Quartz Company of California, 1202 Taylor Way, Tacoma, Wash.

## SULFUR

Sulfur is mined principally from boreholes drilled into sulfur horizons that are found in the sedimentary rocks bordering the Gulf of Mexico. In some instances, high-sulfide minerals, such as iron pyrite, may be mined for their sulfur content if they are strategically located to take advantage of a local industry.

The principal use of sulfur is in the manufacture of sulfuric acid. The acid may also be manufactured directly from the waste gases of metallurgical plants. Sulfur is also used by pulp manufacturers that use the sulfite process, and is used in agriculture as a soil conditioner and in insecticides.

## TALC AND SOAPSTONE

Talc is a hydrous magnesium silicate mineral that has many industrial uses. Properties that make it desirable are: extreme softness and smoothness, good luster, low moisture content, oil and grease absorption, chemical inertness, high fusion point, good retention for filler purposes, and low electrical and heat conductivity.

About 82 percent of the domestically produced talc is consumed by the ceramic, paint, rubber, insecticide, roofing, and paper industries. Other uses include polishing agents, toilet preparations, pharmaceuticals, and as a filler in cotton textiles, asphalt, plaster, flooring compounds, linoleum, and plastics.

Soapstone is a massive impure talc and is applicable to the same uses as talc except those in which gritty or non-acid-resistant particles might be harmful. Washington deposits of pure talc are small. Those referred to as "talc" are largely soapstone containing small lenses of talc.

The following companies have purchased talc and soapstone in the past and are possible buyers:

Manufacturers Mineral Co., P. O. Box 3543, Seattle 24, Wash.

Miller Products Co., 7737 N.E. Killingsworth, Portland, Oreg.

Northwest Talc & Magnesium Co., P. O. Box 324, Clear Lake, Wash.

Stauffer Chemical Co., 2545 Lincoln, Tacoma, Wash.

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