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Magnesite

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Hanks, Henry G.—A history and description of magnesia and its base and compounds, with particular reference to magnesite, etc. 27 pp. San Francisco. C. A. Murdock & Co., 1895.


Scherer, Robt.—Der Magnesite, sein Vohrommen, seine Gewinning und technische Verwertung, pp VIII and 256. fig. 22. A Hartleben, Vienna & Liepsig, 1908.


Watts, Oliver P.—The making of magnesia crucibles. Wis. Eng'r, Nov., 1912.


Dana’s Mineralogy, pp. 358-359.

Reis, Heinrich. Economic Geology, pp. 249-251.
MAGNESITE

BY FRANK L. CULIN, JR.

The only production of magnesite in the United States is from California where a very few mines had a total output of $77,000 in 1913. None of the magnesite mined is sold crude, but it is all calcined before shipment from the mines.

By far the greater part of the domestic product is consumed in calcined form as a digester for wood pulp in paper manufacture. Some, however, is used in making plastic material for flooring, tiles, wainscoating, artificial marble, paint and fireproofing.

The California manufacturers of carbon dioxide who have been using limestone for making their gas are making comparative experimental tests with the intention, if desirable, of resuming the use of magnesite as a source of the gas, as was formerly done.

There are two principal markets for magnesite in the United States—the eastern, centering at New York City, and the western, centering at San Francisco and Los Angeles. Most of the product handled in New York is imported from Austria-Hungary and Greece either direct or by way of Germany. The western markets also handle a large quantity of imported Grecian magnesite, in addition to the total western output.

ORES

Magnesium is a very widely distributed element, occurring in the form of carbonates, aluminates, borates, silicates, sulphates, hydrates, etc. However, it is of commercial importance only when it occurs as magnesite, MgCO₃; dolomite, (Ca,Mg)CO₃, and epsomite ( epsom salts) MgSO₄·7 H₂O.

Magnesium is an important constituent of serpentines, olivines, and other basic rocks.

MINERALS

Although magnesium is an element of wide spread occurrence, the magnesium minerals of sufficient quantity to be of any commercial importance are few. These are magnesite, dolomite, and epsomite.

MAGNESITE

CO₃, 52.4%: Magnesia, MgO, 47.6%.

Form—Magnesite occurs in cleavable or compact porcelain like
masses. It sometimes has a botryoidal surface, but is rarely crystalline. It is sometimes fibrous.
Color—White, yellowish, grayish white, brown.
Lustre—Vitreous to dull, sometimes silky in fibrous varieties.
Hardness—Moderate (4 to 4.5).
Weight—Rather light—Sp Gr.=3.
Streak—White.
Occurrence—In veins is serpentine (compact massive variety).
In talc schists (cleavable variety).
Blowpipe Tests—Infusible. Turns pink when heated with cobalt nitrate solution. Soluble in hot hydrochloric acid with effervescence.

**EPSOMITE**

Composition—Calcium magnesium carbonate. CaMg(CO\(_3\))\(_2\), carbon dioxide (CO\(_2\)) 47.9%: lime, CaO, 30.4%: magnesia, MgO, 21.7%. It often contains iron.
Form—Dolomite is found in crystal druses, in cleavable masses, and in granular masses.
Hardness—Moderate (3.5-4).
Weight—Light (Sp. Gr. 2.8).
Color—White, pink, gray, but rarely colorless.
Lustre—Pearly or vitreous.
Streak—White.
2. Essential constituent of dolomitic or magnesian limestone.
3. In veins with calcite.
Blowpipe tests—Infusible and colors the flame yellowish red. Large fragments are only slightly attacked by cold dilute hydrochloric acid. (Distinction from calcite). In concentrated solutions sulphuric acid gives a white chrystalline precipitate.

**EPSOMITE**

Composition—Hydrous magnesium sulphate. MgSO\(_4\), 7H\(_2\)O, sulphur trioxide (SO\(_3\)) 32.5%: magnesia (OMg) 16.3%: water (H\(_2\)O) 51.2%.
Form—Epsomite is found in fibrous masses, in crusts, and occasionally in prismatic crystals.
Hardness—Soft (2 to 2.5).
Weight—Light (Sp. Gr.<1.7).
Color—White.
Occurrence—In lake deposits.
Mineral Technology Series No. 7


USES OF MAGNESITE

The principal uses of magnesite may be summarized as follows:

1. Various refractory uses, as brick, furnace hearths, crucibles, etc.
2. As magnesium sulphite for the digestion and whitening of wood pulp paper.
3. In crude form for the manufacture of carbon dioxide.
4. Calcined and ground for oxychloride or sorel cement.
5. Miscellaneous applications in crude or calcined form.
6. Miscellaneous uses of refined magnesia salts.

Refractory Uses—The refractory uses of calcined cagnesite constitute probably its most important application. Made into refractory bricks, it finds an important use as the linings of basic steel furnaces. In “dead-burned” calcined form, either as brick or as originally burned, the magnesia is used as a refractory lining for open hearth furnaces and converters in the steel industry, for rotary kiln lining in Portland cement manufacture, for furnace hearths, for crucibles, and for cupels.

It is commonly assumed that the most refractory magnesite is the dead burned product derived from magnesite containing little or no lime, silica oxide of iron or alumina. The presence of lime in magnesite bricks used for high temperatures is said to cause them to disintegrate more readily, and in basic steel furnaces the lime is believed to cause the phosphorus to pass into the hearth instead of the slag, the hearth thereby becoming rotten. Silica, oxide of iron and alumina are supposed to have a tendency to lower the fusing point. On the other hand, there is a decided preference in refractory uses for the magnesites carrying a certain percentage of iron, as do the Austrian and Hungarian products, for use in the manufacture of brick. The iron probably does lower the fusing point, but with the result that the shrinkage of the material after calcining is very much less, and the bricks made from it are more satisfactorily burned and hold their shape better. The whiter and purer grades of magnesite are more refractory, but they require a much greater heat for calcining—and it is very difficult to calcine them to a point where they will not shrink further.

Use in paper-manufacturing industry—The availability of magnesite in the California deposits had led to its considerable use in the manufacture of wood-pulp paper on the Pacific Coast. Magnesia, in
the form of bi-sulphite, is said to have a more solvent action on the
free resins of the wood than lime, and it also has an additional ad-
vantange in that the residues left in the paper stock are not afterwards
injurious to sizing agents.

The process of making paper in which magnesite is used is known
as the sulphide process. The wood (mostly from coniferous trees)
is boiled with a disintegrating agent, so that it breaks down into a
mass of pulp, which is afterwards rolled into paper. The disinte-
grating agent in the sulphite process is sulphurous acid, or common
bi-sulphite of calcium or magnesium. Magnesium bi-sulphite is
more stable and it dissolves the non-cellulose matter even more
completely than calcium bi-sulphite. Sodium bi-sulphite gives a bet-
ter product than either of the two mentioned, and strong liquors
can be made from it, but it is too expensive for general use.

The greater part of the California magnesite is now used in the
manufacture of paper by this process. The Portesville deposits, for
years the largest producers, were worked primarily for the use
of paper makers.

Manufacture of carbon dioxide—The manufacture of carbon di-
obide from magnesite consists in the decomposition of the magne-
sium carbonate by roasting, with the recovery, purification, and com-
pression of the carbon dioxide gas, the residual magnesia being also
available as one of the important products of the process. The oper-
ation of this process is described by Hess, with a diagram showing
details of one of the plants. It is understood that the use of mag-
nesite for this purpose has now been chiefly or wholly abandoned on
the Pacific Coast, as the gas can be produced more cheaply as a bi-
product in other processes, as, for instance, as one of the products
of a distillery, and also from limestone. Carbon dioxide is, how-
ever, manufactured in this way from the imported magnesites in the
eastern part of the country, in which case the magnesia is sometimes
considered as a by-product in the manufacture of the gas. In other
cases, however, the imported product is calcined for the sake of the
magnesia alone, without any attempt to save the gas.

Oxychloride or Sorel Cement—The use of magnesite for the
manufacture of cement is apparently a promising field, and the pro-
duct is likely to find an increasing use. This product is known as
oxychloride or Sorel cement. Its manufacture is based on the fact
that a mixture of finely ground calcined magnesite, when wet with
a solution of magnesium chloride of a certain strength, will set as
an exceedingly strong cement. This mixture is generally modified
by the addition of various filler materials, such as wood, flour cork,
talc, silex, asbestos, clay, marble, dust, sand, and other materials, besides coloring matter. The cement thus produced is put out under many trade names, especially referred to as sanitary flooring. When well laid, magnesite cement flooring has some decided advantages over other cements for this purpose. It produces a smooth, even floor, which, when successfully put down, may be laid in large areas without cracking. It takes colors advantageously, and is susceptible to good polish by oiling or waxing. It is laid in a plastic state on wood, steel, or concrete. Its surface seems to have a resilience not given by ordinary cement, and it does not pulverize or grind to dust. This cement is said to have found a very extensive use abroad as flooring, and to be gradually coming into more extended use in this country. It has also found a use in the manufacture of artificial marble and fine tiles.

Miscellaneous application in crude or calcined form—Magnesia finds numerous miscellaneous applications in both crude and calcined form, among which may be mentioned its use in pipe covering as a non-conductor of heat, where it is commonly mixed with asbestos fibre. For this, the “light carbonate” is used, which is made from dolomite. Magnesia is said to be used as an absorbent in the manufacture of dynamite. It is said to be used also as an adulterant in paint, and to prevent scale in boilers in which sulphurous waters are used. It has been tried with some success as a binder for briquetting coal, but it increases the ash without adding to the combustible portion of the fuel.

The use of fine ground magnesia in a fire proof or fire-retarding paint is also reported to be coming to the front. Wood or budlap coated with a paint made of magnesia and magnesium chloride solution are said to resist fire, so that, although they can be burned by direct application of heat and flames, the fire will not spread beyond the areas actually exposed to the flame.

Miscellaneous uses of refined magnesia salts—Among these may be suggested those for toilet and medicinal purposes. The commercial preparation known as magnesia alba is a basic carbonate of slightly varying composition, according to the conditions of production. It is usually prepared by precipitation of either the commercial sulphate or chloride of magnesium with sodium carbonate. Epsom salts (magnesium sulphate) is derived from the deposits at Stassfurt, and is imported on a considerable scale, but it is also manufactured by chemical treatment of magnesite. Its principal use is said to be in warp sizing or weighting in cotton mills. Very considerable quantities of magnesium chloride are also imported from the German fields.
for use in the oxychloride cement and for other purposes. The hydrate is used in sugar manufacture. A considerable quantity of magnesia, quoted as “calcined medicinal,” is imported annually, probably representing a purified product for medicinal or other uses.

METHODS OF EXTRACTION OR PURIFICATION

Magnesite is marketed and used in various forms for different purposes, either raw or crude as mined, or calcined, which results principally in the expelling of the carbon-dioxide and moisture of the original carbonate, the residue or calcined magnesite being chiefly the oxide, also known as magnesia.

The calcined magnesites are either the so-called “caustic” or the “dead-burned.” The “caustic” magnesite intended for plastic or cement uses is burned at somewhat lower temperatures than the dead burned, and usually retains a small percentage of carbon dioxide, which permits the material to react with the chloride salts used in cement. The “dead-burned” is roasted beyond the point at which all carbon dioxide would be extracted, heating being carried to incipient fusion, whereby practically all shrinkage is taken up, so that forms moulded of this crushed material, and held by a satisfactory binder, will shrink but little more with further heating.

Magnesite is made from dolomite by precipitation—in this form it is known as the “light carbonate.” Epsom salts occur in large deposits in nature, but are made by chemical process from magnesite.

THE MAGNESITE INDUSTRY

Magnesite in the United States is mined only in the State of California, and almost, if not all, of this product is used on the Pacific Coast. It finds its chief use in this market in the paper manufacturing industry, though it is used to some extent for refractories, and sorel cement.

The larger part of the magnesite used in the United States comes from foreign countries and is handled through the eastern markets. As mentioned before, this product is imported from Austria-Hungary or Greece. Most of the magnesite from Austria-Hungary is of the iron-bearing variety, used for refractories. Philadelphia is the main market for this product. The Grecian magnesite is used for plastic or cement forms. New York receives most of the Grecian material.

GEOLOGICAL CONDITIONS AND RELATIONS

Magnesite commonly occurs in veins or in masses replacing other rocks rich in magnesia, such as serpentine, talcose schist, etc.
In California, the much fractured and faulted serpentines of the Coast Ranges appear to have been derived from olivine pyroxene rocks, and the magnesite may have been formed from both the serpentine making minerals and the serpentine itself. It originated probably by the breaking down of the latter by water charged with CO₂, which united with the MgO to form magnesium carbonate. This magnesite was then precipitated in veins, while the silica was removed and often deposited as opal or quartz in other veins, or with the magnesite. In some cases the magnesite forms a network of veins in the serpentine, but since its origin is due to the action of surface waters, the deposits may be of limited depth.

PRICES AND ECONOMIC CONSIDERATIONS

The price of magnesite has varied somewhat of recent years. This is especially true of the imported product, due to unsettled conditions in Europe.

According to the United States Mineral Resources for 1913, part 2, the following prices were current during 1913:

New York Market—
Grecian—calcined “caustic,” fine ground, in paper
  lined barrels .................................................. $25.00 to $35.00
Grecian—calcined “caustic,” not ground, in sacks...$17.50 to $20.00
Grecian—crude, bulk ........................................... $ 7.00 to $ 8.00
Austrian—calcined, dead burned, crushed or fine
  ground (bulk) .................................................. $16.15 to $16.25
Pacific Coast: San Francisco or Los Angeles markets:
Domestic—calcined “caustic,” fine ground, in paper
  lined barrels .................................................. $30.00 to $35.00
Domestic—calcined, not ground, dead burned, in
  sacks .............................................................. $20.00 to $25.00
Norwegian—calcined, dead burned, crushed, or fine ground...$25.00

The value assigned to the domestic production is based on the figure $17.50 a ton for ordinary run calcined, unground magnesite at the mine or point of shipment, which is assumed to be approximately equivalent to $8 a ton for the raw magnesite.

In the opening and development of magnesite mines, their nearness to railroad transportation seems to be of more importance than the character or extent of the deposits. Certain deposits of great extent and good quality in California lie idle because they are far removed from railroads, while smaller deposits close to railroads are being worked.
The opening of the Panama Canal and the difficulty of obtaining the European product may make it possible for the California product to break into the eastern markets.

FUTURE OF THE INDUSTRY

The future of the magnesite industry is well assured. Its use as a refractory material is a necessary one, and one that is liable to growth and not to decrease. On the Pacific coast it has a secure place in the paper industry. A growing field for magnesite seems to be in the manufacture of oxychloride, or sorel cement. Magnesite also finds numerous miscellaneous applications (see uses) in which it gives excellent satisfaction, and will no doubt continue to be sued for these purposes. It is also possible that magnesite may come into use as an important source of carbon dioxide in the future.