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Antimony
By P. E. Joseph

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ANTIMONY
By P. E. Joseph

Introduction:—
Antimony is a thin white and extremely brittle metal. It has been found in mineral waters, in coal and in river sands. However, it is too rare to be of commercial importance.

During the six years from 1908 to 1913, inclusive, the price of Cookson's antimony ranged from 7.41 to 10.31 cents per pound, with yearly averages of from 8.24 to 8.58 cents per pound. At these prices antimony ores cannot be worked profitably under the high cost prevailing in the mining regions of the United States, unless the deposits are very extensive and advantageously situated, to which conditions the antimony deposits of the United States do not conform. As a result of these conditions, practically all of the antimony metal used here is imported from Europe, mostly from England. At present, however, because of the war and its disturbing effects upon sea traffic, the prices are raised to such an extent as to enable the working of some of the American deposits.

These prices, however, are only temporary, and as soon as the war is over, they will probably drop, and great initial outlay toward the development of antimony mines would not be advisable.

ORES OF ANTIMONY

The minerals of antimony important as ores are stibnite, kermesite and valentinite. Other minerals are sinarmontite, cervantite, voljerite, gugarite, berthierite, swingstonite, and yukesite.

STIBNITE

Composition—Sb₂S₃, antimony sulphide, containing 71.8% antimony and 28.2% sulphur, with sometimes silver and gold.

General Description—A lead gray mineral of bright metallic lustre, occurring in imperfectly crystallized masses, with columnar or bladed structure; less frequently in distinct, prismatic crystals, or confusedly interlaced bunches of needle-like crystals; also in granular to compact masses.

Physical Characteristics—
Hardness (2) scratched by copper coin
Lustre, metallic Opaque.
Streak, lead-gray Tenacity, brittle to sectile.
Color, lead-gray, often with black or iridescent tarnish.
Qualitative Tests—Fuses easily on charcoal, giving a dense sublimate of antimony, and an odor of sulphur dioxide. If some of the powdered ore is heated on charcoal with soda until thoroughly fused, placed on a silver coin, moistened, and crushed, the silver will be tarnished brown to black. In closed tube fuses easily, yielding a little sulphur and a dark sublimate which is brownish red when cold.

The powdered ore is completely soluble in boiling hydrochloric acid, with evolution of hydrogen sulphide, (which has the odor of rotten eggs) and with precipitation of a white basic salt on addition of water, and after this is diluted and hydrogen sulphide added, an orange precipitate will be formed.

Stibnite differs from galena, which it resembles, in cleavage, and from all sulphides by its softness, ease of fusion and cloud-like fumes.

KERMESITE—RED ANTIMONY

Composition—A sulph-oxide of antimony (Sb₂S₃O), containing 75% of antimony, 20% sulphur, and 5% oxygen.

General Description—Occurs in fine hair-like tufts of radiating fibres and needle-like crystals, of a deep cherry-red color and almost metallic lustre.

Physical Characteristics—
Hardness (1-1.5) Scratched by Sp. Gr. (4.5-4.5)
  finger nail. Moderately heavy.
Streak, brownish red.  Tenacity, sectile and in thin leaves slightly flexible.
Color, Dark cherry-red.

Qualitative tests—Same as for stibnite. Kermesite is formed by partial oxidation of stibnite with which it is associated.

VALENTINITE

Composition—Antimony trioxide (Sb₂O₃) containing 83.3% antimony and 16.7% oxygen.

General Description—Small white flat crystals, or radiating groups of silky lustre and white or gray color. Also in spheroidal masses with radiated lamellar (layers and plates) structure.

Physical Characteristics—
Hardness (2.5-3) scratcher by Sp. Gr. (5.57)
  coin. Heavy.
Lustre, adamantine or silky.  Translucent.
Streak, white.
Color, white, gray, pale red.
Qualitative tests—On charcoal, fuses easily, forming a white coating of the oxide. In reducing flame is reduced, but again oxidizes and coats the coal, coloring the flame green. Soluble in hydrochloric acid.

Valentinite is formed by oxidation and decomposition of stibnite and other antimony ores.

Other minerals are: Senarmontite, $\text{Sb}_2\text{O}_3$, containing 83.3\% antimony. Cervanite $\text{Sb}_2\text{O}_3$, $\text{Sb}_2\text{O}_5$, containing 78.9\% antimony.

**GEOLOGICAL OCCURRENCE**

Antimony ores occur most abundantly in fissure veins in both igneous and sedimentary rocks. They are also found as flats, pitches and as impregnations. The gangue minerals are quartz, calcite, and barite, in order of importance. The ores of antimony are usually associated with gold and silver ores, cinnebar, galena, and sphalerite.

These ores are not confined to any definite geological horizon. In Appalachia they occur in association with older crystalline schists; in Arkansas they are found in the Carboniferous rocks, and in Tuscany they occur between Peruvian shales and the Eocene limestones.

**PRODUCTION OF ANTIMONY IN THE UNITED STATES**

Antimony, for the consumption in the United States is derived from six sources:

1. Antimonial, or hard lead obtained in the smelting of foreign and domestic ores.
2. Imported regulus or metal.
3. Imported antimony ores.
4. Domestic antimony ores.
5. Antimony recovered from electrolytic refining of copper and lead.
6. Antimony recovered from the drosses of old type metal, scraps, old alloys, etc.

The following table shows the production and consumption of antimony in the United States, in short tons, for the period of ten years ending in 1914.
Arizona State Bureau of Mines

<table>
<thead>
<tr>
<th>Imports, Antimony Content</th>
<th>Production</th>
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<tbody>
<tr>
<td></td>
<td>In Hard Lead</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td>From Domestic Ores</td>
</tr>
<tr>
<td>YEAR</td>
<td>Metals or Ores</td>
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<tr>
<td>1905</td>
<td>2,869</td>
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<tr>
<td>1906</td>
<td>3,950</td>
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<tr>
<td>1907</td>
<td>4,331</td>
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<tr>
<td>1908</td>
<td>4,057</td>
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<tr>
<td>1909</td>
<td>4,826</td>
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<tr>
<td>1910</td>
<td>4,950</td>
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<tr>
<td>1911</td>
<td>5,479</td>
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<tr>
<td>1912</td>
<td>6,969</td>
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<tr>
<td>1913</td>
<td>7,667</td>
</tr>
<tr>
<td>1914</td>
<td>6,035</td>
</tr>
</tbody>
</table>

GEOGRAPHICAL DISTRIBUTION

Small quantities of antimony ores are found in the Appalachian region, in Maryland, New Hampshire and Maine, but none of the deposits are of any commercial value.

Antimony deposits occur and have been mined in the Coeur l'Alene District, Idaho. The content of the ore is very variable, running from 12 to 60 per cent in antimony; from 8 to 10 oz. in silver and from 90 cents to $1. in gold. At present, however, there is no production of antimony reported from Idaho.

In Nevada, which has been an important producer, exceptionally pure stibnite occurs with very little gangue mineral, near Austin, in well defined contact fissures between shale forming the footwall and calcareous sandstone and lime porphyries forming the hanging wall.

In California stibnite is found in well defined fissure veins in association with quartz.

Auriferous and argentiferous native antimony and stibnite are found in York County, New Brunswick, in fissure veins cutting across black slates, with calcite and quartz as gangue minerals.

The State Smelting & Refining Co. of Seattle, Wash., is operating deposits of antimony, believed to be of great extent and of fair grade.

In Arizona, stibnite is found in the Vanderbilt mine in the Cerbat District, Mohave County. In Yavapai County, stibnite is of common occurrence in silver. It is also found in ores of the Bradshaw mount-
ains, where it carries gold. It is mined here and in several other localities. But none of the antimony deposits in Arizona have been sufficiently developed, and are of practically no commercial value under prevailing conditions.

As is seen from the above, the production of antimony in the United States is comparatively small. The low price of the metal and the difficulty of smelting the ores, prevent the working of the American deposits, which are small and far from the market. While the foreign deposits are more or less extensive, labor conditions are cheap as compared with those of the United States, ocean freight rates small, and duty on crude antimony low. As a result the foreign antimony can be produced at a much lower price than that in the United States.

**METALLURGY OF ANTIMONY**

Antimony may be extracted from its ore by the following processes:

1. Roasting method, which is applicable to sulphide ores. The ore is crushed and roasted, the liquidated sulphide drawn off in inclined iron pipes. The sulphide is then roasted in a current of air, resulting in the formation of the trioxide. This is reduced to the metallic state by common salt or scrap iron. The crude metal is then further refined by roasting with scrap iron.

2. The crucible method, applicable to native antimony and stibnite: The ore is crushed, and heated in large graphite crucibles with scrap iron. The sulphur, if present, combines with the iron, and the antimony, due to its higher specific gravity, sinks to the bottom of the crucible, as a bluish-white metal.

3. The wet method: Stibnite is dissolved in hot hydrochloric acid and precipitated from solution by iron or zinc. It may also be precipitated as the oxychloride by pouring it into water.

4. The reduction process, applicable to the oxides, which are reduced to the metallic state by smelting with carbon.

5. The electrolytic method.

**PRICES**

The price of antimony has not fluctuated greatly during the period of 1906-1913, and the first half of 1914, the market being in a stagnant condition. Cookson’s averaged 8.28 cents per pound. Hallett’s, 6.95 cents per pound, and ordinary grades averaged 5.87 cents per pound. After the outbreak of the war, however, the price rose gradually, though unsteadily, till at the end of 1915 Chinese, Japanese and American antimony was quoted at 40 cents a pound, and prices for ore ranged from $1 to $210 per unit. At present antimony, Chinese
and other brands, are sold at 44 to 44½ cents per pound. Antimony ore has sold for $2.25 per unit.

USES OF ANTIMONY

Antimony is used extensively in alloys. In general a mixture of antimony with other metals renders them more lustrous, hard, and somewhat brittle. The alloys of antimony expand on cooling and make fine sharp and hard castings. An alloy consisting of 86.5 per cent lead and 13.5 per cent antimony is four times as hard as pure lead. An alloy consisting of 35.86 per cent lead and 64.14 per cent antimony is 11.7 times as hard as pure lead.

Antimony is used in making type metal which is composed of lead, antimony and often tin in varying proportions. Two of the alloys used in making type metal have the following compositions:

1. 75% lead, and 25% antimony.
2. 75% lead, and 20% antimony and 5% tin.

Type metal must cast readily and be capable of taking sharp impressions. It must be hard enough to resist crushing in the press and so soft that its edges will not cut the paper in the process of printing. Another alloy consisting of lead, antimony and tin is used for the manufacture of stenotype metal.

Babbitt, which is a series of antifriction alloys used extensively in the journals of cars, locomotives and other rapidly moving machinery, consists of antimony, tin and copper, with small amounts of lead, zinc, bismuth and nickel. The copper may be entirely replaced by antimony, or the antimony by the copper.

Antimony alloys with aluminum are superior to aluminum in hardness, tenacity, elasticity and malleability. It resists the corrosive action of the atmosphere better than any other metal or the alloys themselves. As the percentage of antimony in the alloys increase, the hardness also increases, but the alloy decreases in tenacity and malleability. However, in many cases, the presence of antimony is very undesirable and injurious. With copper it is one of the most injurious impurities, as it causes cracks in the rolling of the metal. It is also an injurious constituent in bronze and brass.

Antimony is used in dyeing as a mordant, for vegetable colors. It is used in medicine and as a pigment. It plays an important part in the refining of gold and is used in the manufacture of matches and percussion caps. The pentasulphide is used in the manufacture of vulcanized rubber and in many forms of fire works. The trisulphide is used in certain paints. It is also used in lining of lead chambers for the manufacture of sulphuric acid.