readily dissolves it, while hydrofluoric acid is without action. Sulphuretted hydrogen is decomposed with the formation of a black coating of silver sulphide; this is the explanation of the black tarnish seen when silver is exposed to the fumes of coal gas, and other sulphuretted compounds, such as occur in eggs. The so-called “ oxidized ” silver is a copper-silver alloy coated superficially with a layer of the sulphides by immersion in sodium sulphide or otherwise. Silver combines with the free halogens on heating and also with sulphur.

*Molecular silver* is a grey, powder obtained by leaving metallic zinc in contact with silver chloride which has been precipitated in the cold and washed till nearly free from acid. The powder is separated from the zinc, washed with hydrochloric acid, dried in the air, and then gently heated to 150°. It assumes a metallic lustre on burnishing or heating to redness. It receives application in synthetic organic chemistry by virtue of its power to remove the halogen atoms from alkyl haloids, and so effect the combination of the two alkyl residues.

*Colloidal silver* is the name given by Carey Lea to the precipitates obtained by adding reducing solutions, such as ferrous sulphate, tartrates, citrates, tannin, &c., or to silver solutions. They dissolve in water to form solutions, which do not penetrate parchment membranes, hence the name colloidal. Many other methods of preparing these substances are known. Bredig's process consists in passing an electric arc between silver electrodes under water, when a brown solution is obtained.

*Production.—*The economic questions which attend the production of silver and the influence which gold and silver exercise on prices are treated in the articles Money and Bi­metallism; the reader is referred to the former article for the history of silver production and to the topographical headings for the production of specific countries. Since the middle of the 19th century the annual production has increased: the following table gives the average annual production in 1000 oz. over certain periods:—

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1841-1850. | 1851-1860. | 1861-1865. | 1866-1870. | 1871-1875. | 1876-1880. | 1881-1885. | 1886-1890. | 1891-1895. |
| 25,090 | 28,792 | 35,402 | 43,052 | 63,318 | 78.777 | 87,272 | 110,356 | 158,942 |
| 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. |
| 180,093 | 174,851 | 164,560 | 170,128 | 182,262 | 189,830 | 165,640 | 184,894 | 203,186 |

Over two-thirds of the world’s supply is derived from Mexico and the United States. The Mexican mines first sent supplies to Europe in the 16th century, and during the period 1781-1800 yielded two- thirds of the world’s production. Although the production has de­creased relatively, yet it has increased enormously absolutely ; in 1900, it was 55,804,420 oz., being second to the United States; in 1905 it was 73,838,066 oz., establishing a record for any single country. The United States came into prominence in about 1860, and the discovery of the famous Comstock lode in Nevada led to an enormous increase in the production. The production of this lode declined in 1876, but the total production of this country was in­creased by discoveries in Colorado (Leadville) and Nevada (Eureka) ; and in more recent years silver-producing areas in other states (Montana, Utah, Idaho) have been exploited. In i860 the pro­duction was 116,019 oz., which increased to 1,546,920 in 1861; in 1872 it was 22,254,002 oz.; in 1888, 45,792,682; in 1890, 54,516,300 oz.; in 1900, 57,647,000; and in 1905, 58,918,839 oz. S. America has furnished European supplies since the discovery of the Potosi mines of Peru in 1533; Bolivia and Chile are also notable producers. Of European producers, Germany, Spain and Austria are the most important; Greece, Italy, France, Turkey and Russia occupy secondary positions. The German mines were worked in the 10th century; at the beginning of the 16th century the production was over 400,000 oz. annually ; this dropped in the following century to about one-half; it then recovered, and in recent times has enor­mously increased, attaining 12,535,238 oz. in 1905. The mines of Spain, neglected late in the 15th century on the advent of supplies from America, came into note in 1827; the output has since greatly increased, amounting to 3,774,989 oz. in 1905. Austria-Hungary was producing twice as much as Germany, and about one-half of the total European production, in the 16th century; the yield diminished in the ensuing century, to be subsequently increased. The output was about 1,800,000 oz. in 1905. The total European supply was about 17,000,000 oz. in 1900 and about 18,600,000 oz. in 1905. Of other countries we may notice Canada, which produced 4,468,225 oz. in 1900 and 5,974,875 oz. in 1905, and Japan, which produced about

670,000 oz. in 1880 and 3,215,000 oz. in 1905. Australia came into notice chiefly by reason of the discoveries at Broken Hill, New South Wales; these mines producing 36,608 oz. in 1885, 1,016,269 in 1886, and 7,727,877 oz. in 1890. The total Australasian production in 1900 was 14,063,244 oz. and 14,362,639 oz. in 1905.

*Metallurgy.*

From the metallurgical point of view, silver ores may be classified as real silver ores and argentiferous ores. The former consist of silver minerals and gangue (vein matter, country-rock). The leading silver minerals are native silver; argentite or silver glance, Ag2S, usually containing small amounts of lead, copper and tin; dyscrasite or antimonial silver, Ag2Sb to Ag13Sb, an isomorphous mixture of silver and antimony; proustite or light red silver ore, Ag3AsS3; pyrargyrite or dark red silver ore, Ag3SbS3; stephanite, Ag6SbS4; miargyrite, AgSbS2; stromeyerite, CuAgS; polybasite, 9(Cu2S,Ag2S)∙(Sb2S3,As2S3) ; cerargyrite or horn silver, AgCl; bromite or bromargyrite, AgBr; embolite, Ag(Cl,Br); iodite or iodargyrite, AgI. Metalli­ferous products containing silver arise in many operations; the chief products which may yield silver economically are copper and lead mattes, burnt argentiferous pyrites and certain drosses and scums. Argentiferous ores consist of silver-bearing base-metal minerals and gangue. Lead and copper ores, carrying silver in some form or other, are the leading representatives. The silver is extracted from the gangue with the base metal, usually by smelting, and the two are then separated by special processes (see Lead).

*Milling, i.e.* amalgamation and lixiviation, is cheaper than smelting, but the yield in silver is lower. Often it is more profitable to smelt real silver ores with argentiferous ores than to mill them, the greater cost being more than balanced by the increased yield. Milling is practised mainly in isolated localities near the mine producing the ore. As any given region is opened up by rail­ways, cheapening transportation, milling is apt to give way to smelt­

ing. Thus on the American continent, which produces the bulk of the world’s silver, milling is still prominent in S. America and Mexico, while in the United States it has to a considerable extent been replaced by smelting.

*Amalgamation* is based on the property of quicksilver to extract the silver from finely-pulverized ore and collect it in the form of an amalgam. When the rock has been separated from the amalgam by a washing operation, the quicksilver is recovered by distillation in an iron retort, and the remaining crude retort- silver melted into bars and shipped to a refinery, which removes the impurities, the leading one of which is copper. A silver ore is either free-milling or refractory, that is, the silver mineral is readily amalgamated or it is not. In free-milling ore the silver is present either in the native state, or as chloride or as simple sulphide. Complex silver minerals (sulph-arsenides and anti­monides) which are difficult to amalgamate must be made amenable to quicksilver, and the simplest way of doing this is to convert the silver into chloride. This is imperfectly accom­plished, in the wet way, by cupric and cuprous chloride solutions, but completely so, in the dry way, by roasting with salt (chloridizing roasting). According as a preliminary chloridizing roast has or has not been given, the process is classed as roast-amalga­mation or raw-amalgamation. The leading raw-amalgamation processes are the Patio and Washoe; then follow the Cazo, Fondon and Kröhnke; of the roast-amalgamation processes, the European Barrel or Freiberg, the Reese River and the Francke-Tina are the most important.

The *Patio* process, sometimes named the American-hcap-amalga- mation process, which is carried out principally in Mexico, aims at