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# DIAMONDS

## Introduction:

Diamonds are almost unique in that, aside from their unique quality of hardness, they are valued for personal adornment with almost superstitious regard, and at the same time possess qualities which make them essential to industry. As evidence of essentiality, Germany is reported to be using gem stones now for industrial purposes since her outside sources of industrial diamonds were cut off. It is something of a paradox, or more precisely a commentary on human nature, that gem diamonds have a far higher money value than the infinitely more useful but unbeautiful industrial diamonds. A similar quirk in human estimates of value places the monetary worth of a motion picture star far beyond that of a doctor of medicine.

The diamond is the most universally valued of gems. Especially large and perfect stones have a price governed only by what people of wealth are willing to pay. In general, production and marketing are strictly controlled, the money value of cut gem diamonds remaining remarkably constant. The fluctuations in unit commercial values over the years have been small compared to other commodities; the general trend of price has been and is upward. For this reason diamonds have been employed in many countries as "investments." In other words, a person could have more confidence in the value of diamonds than in the money he possessed. Gold, like the diamond, is desired for "investment" or as a safer possession than money, but for the past several years gold as bullion or as coins may not be bought or sold in most countries without government permission. On the other hand a gem diamond may be marketed with ease almost anywhere. Moreover the diamond represents a very concentrated money value and therefore a great wealth may be hoarded and secreted in a very small space.

Because of its hardness there is no satisfactory substitute for the diamond in certain industrial processes and activities. A warring nation is greatly handicapped if supplies are cut off, and since the allies control all diamond-producing centers of consequence Germany has suffered for lack of the industrial varieties.

## History:

Of all the well known gem minerals, use of the diamond for adornment is probably the youngest, dating from the fifth or sixth centuries B.C. The other well known precious gems were discovered and cherished at a much earlier period in history. In ancient times diamonds came almost exclusively from India and Borneo. In the 18th century, diamonds were identified in Brazil and, until they were discovered in South Africa, Brazil was the source of nearly all the world's new diamonds.

In 1867 a diamond was found near Hopetown in Cape Colony. This started the great diamond industry in South Africa. At first, placers yielded all the stones, and then the great kimberlite pipes were found and Kimberley became the center of world production. These discoveries had far-reaching political as well as economic consequences. Cecil Rhodes' control of the mines, his political leadership, the part played by John Hays Hammond, the American mining engineer, and finally the Boer war - all were intimately associated with the development of the South African diamond industry.

Very important deposits were later found in Southwest Africa, at the time a German colony; in Belgian Congo; in Angola; in the Gold Coast Colony; French Congo; Tanganyika; Sierra Leone; and most recently in newly discovered placers in the Union of South Africa and Cape Colony.

Physical and chemical properties:

The diamond is the hardest substance known and is designated as 10 in Mohs' scale. In Gems and Gem Materials by Kraus and Holden it is stated that diamonds show a variation in hardness according to locality. Stones from Borneo and Australia are the hardest; those from South Africa are the softest. The specific gravity is close to 3.5 when crystals are pure. The carbonado variety ranges from 3.15 to 3.29, according to Dana.

Diamonds crystallize in the isometric system and commonly occur as octahedrons (8 sides) and dodecahedrons (12 sides) or in combinations of these forms. Distortion, rounding, and twinning are usual habits. Octahedral cleavage is perfect, this property being of major importance to diamond cutters.

Stones vary in color but the most common variety is white, sometimes with pale tints of yellow or brown. Red and blue diamonds are rare. Carbonados or "black diamonds" are dark brown in color. The "blue-white" stones - those which are transparent with a blue tint - are prized highly.

Diamonds range from transparent to opaque. Only transparent or nearly transparent stones are valuable as gems. All others are used in industry. Both index of refraction and dispersion are high. Luster of the rough stone is dull; the cut stone is adamantine and, of course, brilliant. In fact, the name adamantine is derived from adamas, the name given to diamonds by the ancients. Hence the word adamant. The diamond is transparent to X-rays; paste imitations are not. The mineral is a good conductor of heat but a poor conductor of electricity.

Chemically the diamond is pure carbon. It is not affected by acids.

Geological associations:

Diamonds have been found in pipes and dikes of the ultrabasic igneous rock, peridotite, in andesitic breccias, and in placers.

The pipe deposits of commercial importance are almost exclusively in South Africa. Here the diamond-bearing rock is called kimberlite and is generally a serpentinized, magnesium-rich peridotite. Of the known occurrences of kimberlite only a few contain diamonds. Owing to surface concentration, values in the kimberlite pipes decrease with depth. The rock weathers readily, the weathered portion being called "yellow ground." Below this altered zone the partly weathered and unweathered rock is called "blue ground" because of its color. In Economic Geology of Mineral Deposits by Lilley it is stated that in 1904 at the Premier Mine the average recovery from 1600 pounds of rock was 0.798 of a carat, while in 1929 the comparable recovery was 0.164 of a carat.

No satisfactory theory concerning the origin of carbon in the igneous rock and the formation of the diamonds has been submitted. Obscure also is the reason for the occurrence of diamonds in some kimberlite bodies and not in others. Lilley[1] states that, according to conclusive evidence, the igneous action which formed the kimberlite bodies was

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1 Idem.

of the explosive type. The possibility that the origin of the diamonds is connected with underlying rocks has been suggested; also that there may be a genetic relationship between the diamond and the carbonaceous shales surrounding the igneous rock. Artificial diamonds of minute size have been made in the electric arc. Infinitely greater temperatures undoubtedly obtain in deep-seated magmas.

Although the specific gravity of the diamond is only a little greater than that of the other minerals with which it is associated, this difference together with its hardness and its resistance to chemical action results in the formation of diamond placers both by stream and marine action. Wind action is also reported to be an influencing factor in some placers. Some of the deposits are undoubtedly formed by the re-working and reconcentration of alluvial deposits formed in earlier time. Although the kimberlite mines formerly accounted for a considerable part of South African production, they were closed due to war conditions. Present production is wholly from placers in various parts of the world but mainly from Africa.

Sources of supply:

As stated above, India was the main source of diamonds in ancient times, but its present day production is inconsiderable. Borneo has been a small producer for centuries. Discovery of diamonds in Brazil made that country the main source of new stones for more than a century. Production comes from the states of Minas Geraes and Bahia. With the discoveries in South Africa and later in the Congo and Gold Coast, Africa became the great center of world production. In recent years the Belgian Congo region has been by far the most prolific of all the districts in Africa, but this region's proportion of industrial diamonds is relatively large.

A moderate production is maintained from stream placers in British Guiana, and some diamonds have been found in Venezuela and Colombia. Mexico has produced a few stones.

In 1906 diamonds were discovered in Pike County, Arkansas, in a rock quite similar to kimberlite. According to Kraus and Holden[1] about 10,000 stones have been recovered from this locality, the largest of which weighed 40.22 carats. Single diamonds have been found in several other states in this country. Diamonds have reportedly been found in Idaho and Oregon in connection with the recovery of platinum in gold placers.

A small production has been maintained in Australia principally from New South Wales. Some stones have been found in other localities chiefly in connection with gold placer mining.

In Russia diamonds were found in stream gravels in 1829. There has since been a small production chiefly in connection with recovery of gold. New discoveries were reported in 1938 and 1939 in the Yenisei and Kola regions, but only a relatively few diamonds were recovered.

The following world production for 1941 by countries, arranged in order of their importance, was obtained from the U. S. Bureau of Mines Minerals Yearbook.

| Country | Metric carats[2] |
|---|---|
| Belgian Congo | 6,106,000 |
| Sierra Leone | 850,000 |
| Angola | 787,000 |
| Gold Coast (exports) | 743,000 |
| Brazil | 325,000 |
| Union of South Africa | 112,300 |
| South-West Africa | 46,614 |
| French West Africa | 35,000 |

[1] Op. cit.

[2] A metric carat is 200 milligrams or 0.2 of a gram or 3.086 grains troy. Not to be confused with the carat used to express fineness of gold which is 1/24 part; that is, 14-carat gold is 14/24 pure gold.

| Country (cont.) | Metric carats (cont.) |
|---|---|
| British Guiana | 27,000 |
| French Equatorial Africa | 20,000 |
| Tanganyika (estimated) | 1,750 |
| Other countries[1] | 34,350 |
| Total World production | 9,088,014 |
| Total African production | 8,701,664 |

**Economics:**

Diamonds are classified according to physical properties into the gem varieties, bortz or bort, ballas, and carbonado.

Gem stones must be well crystallized and transparent or nearly transparent. Expert cutting develops the brilliancy of the gem.

Bortz, or bort, is the name given to poorly crystallized stones of dark color, often with fibrous structure. The name is also given to fragments unfit for gem material.

Ballas is the name given the hard tough masses of very small diamond crystals which are arranged somewhat concentrically.

Carbonado, also called carbon and black diamond, is an opaque, black, dark brown, or grey diamond. It possesses no cleavage and is characterized by its toughness. Carbonados were formerly widely used in diamond drilling. Bortz is now replacing carbonado to a considerable extent. The principal source is Bahia, Brazil.

In ancient times diamonds were owned only by kings or families of great wealth. Gradually, because of their indestructability and the continued increase in supply of new stones, possession of diamonds became somewhat more common, but with little decrease in popular regard. Improvement in the art of cutting was an important factor in popularizing the gem.

During the past century, production has increased tremendously. Value of annual production in the last of the 18th and first of the 19th centuries was from $2,000,000 to $4,000,000; in the late 20's it rose to $85,000,000. After the depression struck, production dropped but in the late 1930's it was increasing up to the time of World War II. In 1939 production was approximately 11,330,000 carats valued at about $39,270,000. It has been estimated that total world production has approximated 300,000,000 carats, or over 66 tons.

It is reported that only about one quarter of a normal year's production is colorless gem material, and only about 5 percent of this quarter is made up of fine rough stones weighing 2 carats or more. The U. S. Bureau of Mines states that in 1941 gem stones represented 22 percent of the total world production.

The sale of diamonds to the trade is very closely controlled. The Diamond Trading Company, an English corporation, controls the sale of about 95% of the world production. Formerly the diamond cutting industry centered in Belgium and Holland. At the start of the European conflict some cutters escaped but most of them were unable to leave the Low Countries and France. Several hundred cutters were able to reach New York, which is now the leading diamond cutting center.

The past several years have seen a tremendous increase in the use of industrial diamonds. Mineral Industry states that in the 1920's the average annual importation of industrial diamonds into the United States was 38,500 carats. In 1939 imports were 3,568,730 carats. According to the U. S. Bureau of Mines, the consumption of industrial diamonds in 1942 was expected to be about 7,500,000 carats. Expansion in diamond core drilling, in use of diamond-set tools, of diamond dies for fine wire drawing, and use in bonded wheels

[1] Includes Borneo, India, Australia (New South Wales), Liberia, U.S.S.R., and Venezuela.

and tools, together with various other uses where the best abrasive obtainable is demanded, all have contributed to the increased consumption of industrial diamonds. The application of powder metallurgy to forming of small bort in diamond drill bits has been an important development in the industry.

Prices:

The following table from Mineral Industry (1939) gives unit prices of diamonds (per carat) for 1929 to 1939 inclusive.

| | Rough | Cut | Industrial |
|---|---|---|---|
| 1929..... | $28 | $101 | $87 |
| 1930..... | 27 | 79 | 19 |
| 1931..... | 45 | 59 | 15 |
| 1932..... | 38 | 43 | 6.48 |
| 1933..... | 53 | 47 | 4.79 |
| 1934..... | 63 | 48 | 5.40 |
| 1935..... | 54 | 47 | 4.50 |
| 1936..... | 64 | 51 | 3.71 |
| 1937..... | 80 | 56 | 3.47 |
| 1938..... | 78 | 51 | 3.02 |
| 1939..... | 52 | 56 | 2.73 |

In 1941 average price per carat of industrial diamonds was $2.55 (U. S. Bureau of Mines Minerals Yearbook).

References:

Minerals Yearbook, 1941, U. S. Bureau of Mines.

Gems and Gem Materials, Kraus and Holden.

Economic Geology of Mineral Deposits, Ernest R. Lilley, 1936.

Industrial Minerals and Rocks, American Inst. of Mining and Metallurgical Engineers, 1937.

The Mineral Industry, 1939.

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CLEARING HOUSE

79 CH Philip S. Hoyt, Van Horn, Texas, desires to obtain workable deposit of yellow ochre. An inspection sample should be sent to Mr. Hoyt. If sample is satisfactory an examination will be made.

80 CH Mr. John W. Opp, Jacksonville, Oregon, desires to lease his property consisting of 373 acres patented, known as the Opp mine, located about $1\frac{1}{2}$ miles west of Jacksonville in western Jackson County. Has produced about $400,000 in gold. Over 10,000 feet of development work done, most of which is still open. All workings have track and pipe; plenty of water for milling; electric power at property; up-to-date mine assay map available.

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## MERCURY PRODUCTION IN THE UNITED STATES IN 1943[1]

The trend of production of mercury in the United States was sharply upward after the outbreak of war in Europe in 1939, and the uptrend has been continuous ever since, according to the Bureau of Mines, United States Department of the Interior. Preliminary data for 1943 indicate that the output for that year amounted to about 53,500 flasks, compared with 50,846 in 1942; it was the largest annual production since 1881.

The following table gives a comparison of preliminary figures for 1943 with final ones for 1942. The 1943 totals are estimates based on monthly reports for mines that accounted for about 95 percent of the 1942 production.

Mercury produced in the United States in 1942 and 1943 (estimated), in flasks of 76 pounds

| State | 1942 | 1943 |
|---|---|---|
| Arizona | 701 | 600 |
| Arkansas | 2,392 | 1,600 |
| California | 29,906 | 35,000 |
| Nevada | 5,201 | 4,900 |
| Oregon | 6,935 | 4,800 |
| Alaska, Idaho, Texas, Utah and Washington | 5,711 | 6,600 |
| | 50,846 | 53,500 |

As will be seen from the table above, the favorable production record for 1943 was made possible mainly by expansion in output of California mines. The increased amount produced in California more than offset losses in Oregon, Texas, Arkansas, Nevada, and Arizona. Noteworthy production gains were also made in Idaho and Alaska in 1943.

The record-breaking prices for mercury during the past 4 years have caused the opening of several new mines and the reopening of numerous idle ones. In 1939, 107 mines reported mercury production whereas in 1943 the number of active producers probably totaled 175. The number in 1943 represents a recession from the peak of 197 reached in 1941, some properties having closed due to exhaustion of ore reserves and other causes. In periods of what are termed "normal" prices a relatively few properties dominate mercury production in the United States. This condition changes when prices are high and more properties attain larger production. For example, 16 mines produced 88 percent of the total output in 1939, compared with 34 mines (more than twice as many) that accounted for just over 90 percent in 1943.

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The average quoted price for mercury at New York stood at $196.00 a flask from November 1942 until the last week in September 1943. The average monthly quotation was $195.72 for September, $195.00 for October, $193.70 for November and $190.08 for December 1943.

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[1] Reprint of part of U. S. Bureau of Mines Mineral Market Report No. MMS 1120 released January 14, 1944.

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## WHAT'S IN A GLAZE?

### Introduction

Any piece of tableware, be it Wedgewood's best, Spode's finest, or just that cereal bowl obtained with a box-top and ten cents to cover postage, is essentially a baked clay body covered with a glaze. A glaze is a coating applied to a ceramic body. The coating becomes a glass on firing and provides an impervious covering as well as decoration for the product.

The development of fine china and glazes has tested the ingenuity of man throughout the ages, and the number of glaze formulas used since the beginning of ceramic history is infinite. There are several reasons for this: First, because of the wide variety of clays and ceramic body mixtures, it has been necessary in most cases to develop new glazes or alter known glazes to fit each new ceramic body; second, before the discovery in Europe of white-burning clays the desire to copy the white porcelain of the Chinese brought about the development of majolica, faience, and other ingenious imitations; third, for centuries, both glaze and body formulas were regarded as trade secrets, and each craftsman was forced to develop his own compositions; fourth, the artist has always been called upon to produce new and different effects in order to please the buying public; and finally, within the last century glazed ware has been used for wall tile, insulators, sanitary ware, chemical ware, etc., in which specific requirements such as hardness, resistance to moisture, frost, heat and resistance to chemical action had to be satisfied.

Exhaustive technical studies of the effects of various materials as well as methods of preparation, application, and firing on the properties of glazes have enabled workers to fit a glaze to a body more perfectly. Thus scientific rather than hit-and-miss methods are now used to make glazes which must meet specific requirements.

### Glazes in general

Most glazes are prepared by mixing the constituents with water until the consistency of cream is reached. The glaze "slip", as the mix is called, is then applied to the body by spraying or dipping. The consistency of the slip is controlled by adjusting its specific gravity which should be about 1.75. Gelatin, dextrine, or gum tragacanth is often added to the glaze slip to improve the adherence as well as to add smoothness of flow. When the glaze is thoroughly dried, the ware is fired. An exception to these methods of application is the salt glaze, which is formed by vaporizing common salt in the kiln during the firing of the ware.

The composition of the fired glaze is different from the composition of the raw glaze. Likewise the composition of a glaze applied to a body and fired differs from the composition of the glaze when fired alone. The chemical changes which take place in the firing

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