

the pocket-knife is often sufficient in experienced hands). The second trial should be the determination of the *specific gravity*. Treatment of the powdered mineral with acids may come next; by this means (see pp. 254, 255) a carbonate is readily identified, and also other results obtained. Then should follow blowpipe trials, to ascertain the *fusibility*; the *color* given to the flame, if any; the character of the *sublimate* given off in the tubes and on charcoal; the metal reduced on the latter; the reactions with the *fluxes*, and other points as explained in the preceding pages.

How much the observer learns in the above way, in regard to the nature of his mineral, depends upon his knowledge of the characters of minerals in general, and upon his familiarity with the chemical behavior of the various elementary substances with reagents and before the blowpipe (pp. 264 to 267). If the results of such a preliminary examination are sufficiently definite to suggest that the mineral in hand is one of a small number of species, reference may be made to their full description in Part. IV. of this work for the final decision.

A number of tables, in which the minerals included are arranged according to their crystalline and physical characters, are added in the Appendix. They will in many cases aid the observer in reaching a conclusion in regard to a specimen in hand.

The first of these tables is intended to include all well-defined species, grouped according to the crystalline system to which they belong and arranged under each system in the order of their specific gravities; the hardness is also added in each case. The relative importance of the individual species is shown by the type employed. Following this are minor tables enumerating species characterized by some one of the prominent crystalline forms; that is, those crystallizing in cubes, octahedrons, rhombohedrons, etc. Other tables give the names of species prominent because of their cleavage; structure of different types; hardness; luster; the various colors, etc. The student is recommended to make frequent use of these tables, not simply for aid in the identification of specimens, but rather because they will help him in the difficult task of learning the prominent characters of the more important minerals.

## PART IV. DESCRIPTIVE MINERALOGY.

**489. Scope of Descriptive Mineralogy.**—It is the province of Descriptive Mineralogy to describe each mineral species, as regards: (1) form and structure; (2) physical characters; (3) chemical composition and allied blowpipe characters; (4) occurrence in nature with reference to geographical distribution and association with other species; also in connection with the above to show how it is distinguished from other species. Further, to classify mineral species into more or less comprehensive groups according to those characters regarded as most essential. Other points which may or may not be included are the investigation of the methods of origin of minerals; the changes that they undergo in nature and the results of such alteration; also the methods by which the same compounds may be made in the laboratory; finally, the uses of minerals as ores, for ornament and in the arts.

**490. Scheme of Classification.**—The method of classification adopted in this work, and the one which can alone claim to be thoroughly scientific, is that which places similar chemical compounds together in a common class and which further arranges the mineral species into groups according to the more minute relations existing between them in chemical composition and in crystalline form and other physical properties.

Upon this basis there are recognized eight distinct classes, beginning with the Native Elements; these are enumerated on the following page. Under each of these, sections of different grades are made, also based on chemical relationships. Finally, the mineral species themselves are arranged, as far as possible, in isomorphous groups, including those which have, at once, analogous chemical composition and similar crystallization (see Art. 456). It is unnecessary to take the space here to develop the entire scheme of classification in detail, since a survey of the successive sub-classes under any one of the divisions will make the principles followed entirely clear. A few remarks, only, are added for sake of illustration.

Under the Oxides, for example, the classification is as follows: First, the Oxides of silicon (quartz, tridymite, opal). Second, the Oxides of the semi-metals, tellurium, arsenic, antimony, bismuth, also molybdenum, tungsten. Third, the Oxides of the metals, as copper, zinc, iron, manganese, tin, etc. The third section is then subdivided into the anhydrous and hydrous species. Further, the former fall into the four divisions: Protoxides,  $R_2O$  and  $RO$ ; Sesquioxides,  $R_2O_3$ ; Intermediate oxides,  $RO, R_2O_3$ ; Dioxides,  $RO_2$ . Under each of these heads come finally the individual species, arranged so far as possible in isomorphous groups. Thus we have the Hematite group, the Rutile group, etc.

In regard to the various classes of salts it may be stated that, in general, they are separated into anhydrous, acid, basic and hydrous sections; the special subdivisions called for, however, vary in the different cases.

For an explanation of the abbreviations used in the description of species, see p. 4.



## SCHEME OF CLASSIFICATION.

- I. NATIVE ELEMENTS.
- II. SULPHIDES, SELENIDES, TELLURIDES, ARSENIDES, ANTIMONIDES.
- III. Sulpho-salts.—SULPHARSENITES, SULPHANTIMONITES, SULPHOBISMUTHITES.
- IV. Haloids.—CHLORIDES, BROMIDES, IODIDES; FLUORIDES.
- V. OXIDES.
- VI. Oxygen Salts.
  1. CARBONATES.
  2. SILICATES, TITANATES.
  3. NIOBATES, TANTALATES.
  4. PHOSPHATES, ARSENATES, VANADATES; ANTIMONATES. NITRATES.
  5. BORATES. URANATES.
  6. SULPHATES, CHROMATES, TELLURATES.
  7. TUNGSTATES, MOLYBDATES.
- VII. Salts of Organic Acids: Oxalates, Mellates, etc.
- VIII. HYDROCARBON COMPOUNDS.

## I. NATIVE ELEMENTS.

The NATIVE ELEMENTS are divided into the two distinct sections of the Metals and the Non-metals, and these are connected by the transition class of the Semi-metals. The distinction between them as regards physical characters and chemical relations has already been given (Art. 437).

The only *non-metals* present among minerals are carbon, sulphur, and selenium; the last, in one of its allotropic forms, is closely related to the semi-metal tellurium.

The native *semi-metals* form a distinct group by themselves, since all crystallize in the rhombohedral system with a fundamental angle differing a few degrees only from  $90^\circ$ , as shown in the following list:

Tellurium, $rr' = 93^\circ 3'$ .	Arsenic, $rr' = 94^\circ 54'$ .
Antimony, $rr' = 92^\circ 53'$ .	Bismuth, $rr' = 92^\circ 20'$ .

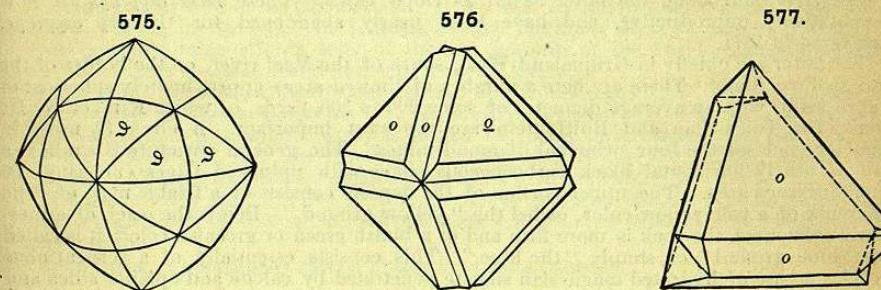
An artificial form of selenium is known with metallic luster and rhombohedral in crystallization, with  $rr' = 93^\circ$ . Zinc (also only artif.) is rhombohedral ( $rr' = 93^\circ 46'$ ) and connects the semi-metals to the true metals.

Among the *metals* the isometric GOLD GROUP is prominent, including gold, silver, copper, mercury, amalgam (AgHg), and lead.

Another related isometric group includes the metals platinum, iridium, palladium, and iron; further palladium is rhombohedral and also iridosmine (IrOs).

## DIAMOND.

Isometric and probably tetrahedral, but the + and - forms not distinguished. Commonly in octahedrons, also hexoctahedrons and other forms; faces frequently rounded or striated and with triangular depressions (on *o*).



Twins common with tw. pl. *o*. Crystals often distorted. In spherical forms; massive.

Cleavage: *o* highly perfect. Fracture conchoidal. Brittle. H. = 10. G. = 3.516-3.525 crystals. Luster adamantine to greasy. Color white or colorless; occasionally various pale shades of yellow, red, orange, green, blue, brown; sometimes black. Usually transparent; also translucent, opaque. Refractive and dispersive power high; index  $n_y = 2.4195$ . (See Art. 305.)

Var.—1. *Ordinary*. In crystals usually with rounded faces and varying from those which are colorless and free from flaws (*first water*) through many faint shades of color, yellow the most common; often full of flaws and hence of value only for cutting purposes.



2. *Bort* or *Boort*; rounded forms with rough exterior and radiated or confused crystalline structure.

3. *Carbonado* or *Carbon*; black diamond. Massive, crystalline, granular to compact, without cleavage. Color black or grayish black. Opaque. Obtained chiefly from Bahia, Brazil.

**Comp.**—Pure carbon; the variety carbonado yields on combustion a slight ash.

**Pyr., etc.**—Unaffected by heat except at very high temperatures, when (in an oxygen atmosphere) it burns to carbon dioxide (CO<sub>2</sub>); out of contact with the air transformed into a kind of coke. Not acted upon by acids or alkalies.

**Diff.**—Distinguished (*e.g.*, from quartz crystal) by its extreme hardness and brilliant adamantine luster; the form, cleavage, and high specific gravity are also distinctive characters; it is optically isotropic; transparent to X-rays.

**Obs.**—The diamond occurs chiefly in alluvial deposits of gravel, sand, or clay, associated with quartz, gold, platinum, zircon, octahedrite, rutile, brookite, hematite, ilmenite, and also andalusite, chrysoberyl, topaz, corundum, tourmaline, garnet, etc.; the associated minerals being those common in granitic rocks or granitic veins. Also found in quartzose conglomerates, and further in connection with the laminated granular quartz rock or quartzose hydromica schist, *itacolunyte*, which in thin slabs is more or less flexible. This rock occurs at the mines of Brazil and the Urals; and also in Georgia and North Carolina, where a few diamonds have been found.

It has been reported as occurring *in situ* in a pegmatite vein in gneiss at Bellary in India. It occurs further in connection with an eruptive peridotite in South Africa. It has been noted as grayish particles forming one per cent of the meteorite which fell at Novo-Urei, Russia, Sept. 22, 1886; also in the form of black diamond (H. = 9) in the meteorite of Carcote, Chili; in the meteoric iron of Cañon Diablo, Arizona. It has been formed artificially by Moissan.

India was the chief source of diamonds from very early times down to the discovery of the Brazilian mines; the yield is now small. Of the localities, that in southern India, in the Madras presidency, included the famous "Golconda mines." The diamond deposits of Brazil have been worked since the early part of the 18th century, and have yielded very largely, although at the present time the amount obtained is small. The most important region was that near Diamantina in the province of Minas Geraes; also from Bahia, etc.

The discovery of diamonds in South Africa dates from 1867. They were first found in the gravel of the Vaal river; they occur from Potchefstroom down to the junction with the Orange river, and along the latter as far as Hope Town. These *river diggings* are now comparatively unproductive, and have been nearly abandoned for the *dry diggings*, discovered in 1871.

The latter are chiefly in Griqualand-West, south of the Vaal river, on the border of the Orange Free State. There are here a number of limited areas approximately spherical or oval in form, with an average diameter of some 200 to 300 yards, of which Kimberley, De Beer's, Du Toit's Pan and Bultfontein are the most important. A circle  $3\frac{1}{2}$  miles in diameter encloses the four principal diamond mines. The general structure is similar: a wall of nearly horizontal black carbonaceous shale with upturned edges enclosing the diamantiferous area. The upper portion of the deposit consists of a friable mass of little coherence of a pale yellow color, called the "yellow ground." Below the reach of atmospheric influences, the rock is more firm and of a bluish green or greenish color; it is called the "blue ground" or simply "the blue." This consists essentially of a serpentine breccia: a base of hydrated magnesian silicate penetrated by calcite and opaline silica and enclosing fragments of bronzite, diallage, also garnet, magnetite, and ilmenite, and less commonly smaragdite, pyrite, zircon, etc. The diamonds are rather abundantly disseminated through the mass, in some claims to the amount of 4 to 6 carats per cubic yard. The original rock seems to have been a peculiar type of peridotite. These areas are believed to be volcanic pipes, and the occurrence of the diamonds is obviously connected with the eruptive outflow, they having probably been brought up from underlying rocks. The South African mines in Griqualand up to June 1896 are estimated to have yielded 60 million carats (13 tons) of diamonds, valued at about 370 million dollars.

Diamonds are also obtained in Borneo, associated with platinum, etc.; in Australia, and the Urals.

In the U. S. a few crystals have been met with in No. Carolina, Georgia, and Virginia; several have been found in Wisconsin, also in California at several points. Reported from Idaho and from Oregon with platinum.

Some of the famous diamonds of the world with their weights are as follows: the

Kohinoor, which weighed when brought to England 186 carats, and as recut as a brilliant, 106 carats; the Orlov, 193 carats; the Regent or Pitt, 137 carats; the Florentine or Grand Duke of Tuscany, 133 carats; the Sancy, 53 carats. The "Star of the South," found in Brazil in 1853, weighed before and after cutting respectively 254 and 125 carats. Also famous because of the rarity of their color are the green diamond of Dresden, 40 carats, and the deep blue Hope diamond from India, weighing 44 carats. The history of the above stones and of others is given in many works on gems.

South Africa has yielded some very large stones. Among these may be mentioned the following: The Victoria (or the Imperial) from one of the Kimberley mines weighed as found 457 carats; the Stewart weighed before and after cutting 288 and 120 carats respectively; the Tiffany diamond, of a brilliant golden yellow, weighs, cut as a double brilliant, 125 carats. The Excelsior from Jagersfontein weighed when found 971 carats and was 3 inches in its largest dimension; this is the largest ever known to have been discovered.

**CLIFTONITE.**—Carbon in minute cubic crystals. H. = 2.5. G. = 2.12. Color and streak black; from the Younegin, West Australia, meteoric iron, found in 1884.

#### GRAPHITE. Plumbago. Black Lead.

Rhombohedral. In six-sided tabular crystals. Commonly in embedded foliated masses, also columnar or radiated; scaly or slaty; granular to compact; earthy.

Cleavage: basal, perfect. Thin laminae flexible, inelastic. Feel greasy. H. = 1-2. G. = 2.09-2.23. Luster metallic, sometimes dull, earthy. Color iron-black to dark steel-gray. Opaque. A conductor of electricity.

**Comp.**—Carbon, like the diamond; often impure from the presence of iron sesquioxide, clay, etc.

**Pyr., etc.**—At a high temperature some graphite burns more easily than diamond, other varieties less so. B.B. infusible. Unaltered by acids.

**Diff.**—Characterized by its extreme softness (soapy feel); iron-black color; metallic luster; low specific gravity; also by infusibility. Cf. molybdenite, p. 285.

**Obs.**—Graphite occurs in beds and embedded masses, laminae, or scales in granite, gneiss, mica schist, crystalline limestone. It is in some places a result of the alteration by heat of coal. Often observed in meteoric irons. A common furnace product.

Occurs at Borrowdale in Cumberland; at Arendal in Norway, in quartz; in the Ural, Finland; Passau in Bavaria. In Irkutsk, in the Tunkinsk Mts., in eastern Siberia, the Alibert graphite mine affords some of the best graphite of the world. Large quantities are brought from the East Indies, especially from Ceylon.

Forms beds in gneiss, at Sturbridge, Mass.; at Ticonderoga, N. Y., with pyroxene and titanite; and at Hillsdale, Columbia Co., N. Y.; Byers, Chester Co., Pa.; Loudon Co., Va.; Wake Co., N. C. A graphitic earth is mined for paint in Arkansas. In California, in Alpine Co., Kern Co., etc. In Humboldt Co., Nevada; Beaver Co., Utah; Albany Co., Wyoming. A large deposit occurs at St. John, New Brunswick.

The name *black lead*, applied to this species, is inappropriate, as it contains no lead. The name graphite, of Werner, is derived from *γράφειν*, to write, alluding to its use for "lead" pencils.

**SCHUNGITE.** Amorphous carbon observed in some schists.

#### SULPHUR.

Orthorhombic. Axes  $a : b : c = 0.8131 : 1 : 1.9034$ .

