

CARBONATES

A. Anhydrous Carbonates

The Anhydrous Carbonates include two distinct isomorphous groups, the **CALCITE GROUP** and the **ARAGONITE GROUP**. The metallic elements present in the former are calcium, magnesium, iron, manganese, zinc and cobalt; in the latter, they are calcium, barium, strontium and lead.

The species included are as follows:

1. Calcite Group. RCO_3 . Rhombohedral

| | | $\gamma\gamma'$ | c |
|------------------------|--|-----------------|--------|
| Calcite | CaCO_3 | 74° 55' | 0·8543 |
| Dolomite | $(\text{Ca}, \text{Mg})\text{CO}_3$ | 73° 45' | 0·8322 |
| Normal Dolomite | $\text{CaCO}_3, \text{MgCO}_3$ | | |
| Ankerite | $\text{CaCO}_3, (\text{Mg}, \text{Fe})\text{CO}_3$ | 73° 48' | 0·8332 |
| Magnesite | MgCO_3 | 72° 36' | 0·8112 |
| Breunnerite | $(\text{Mg}, \text{Fe})\text{CO}_3$ | | |
| Mesitite | $2\text{MgCO}_3, \text{FeCO}_3$ | 72° 46' | 0·8141 |
| Pistomesite | $\text{MgCO}_3, \text{FeCO}_3$ | 72° 42' | 0·8129 |
| Siderite | FeCO_3 | 73° 0' | 0·8184 |
| Oligonite | $(\text{Fe}, \text{Mn})\text{CO}_3$ | | |
| Rhodochrosite | MnCO_3 | 73° 0' | 0·8184 |
| Manganosiderite | $(\text{Mn}, \text{Fe})\text{CO}_3$ | | |
| Manganocalcite pt. | $(\text{Mn}, \text{Ca})\text{CO}_3$ | | |
| Smithsonite | ZnCO_3 | 72° 20' | 0·8063 |
| Monheimite | $(\text{Zn}, \text{Fe})\text{CO}_3$ | | |
| Sphærocobaltite | CoCO_3 | | |

This list gives not only the prominent species of this group, but also some of the isomorphous intermediate compounds.

The **CALCITE GROUP** is characterized by rhombohedral crystallization. All the species show, when distinctly crystallized, perfect rhombohedral cleavage, the angle varying from 75° (and 105°) in calcite to 73° (and 107°) in siderite. This is exhibited in the table above.

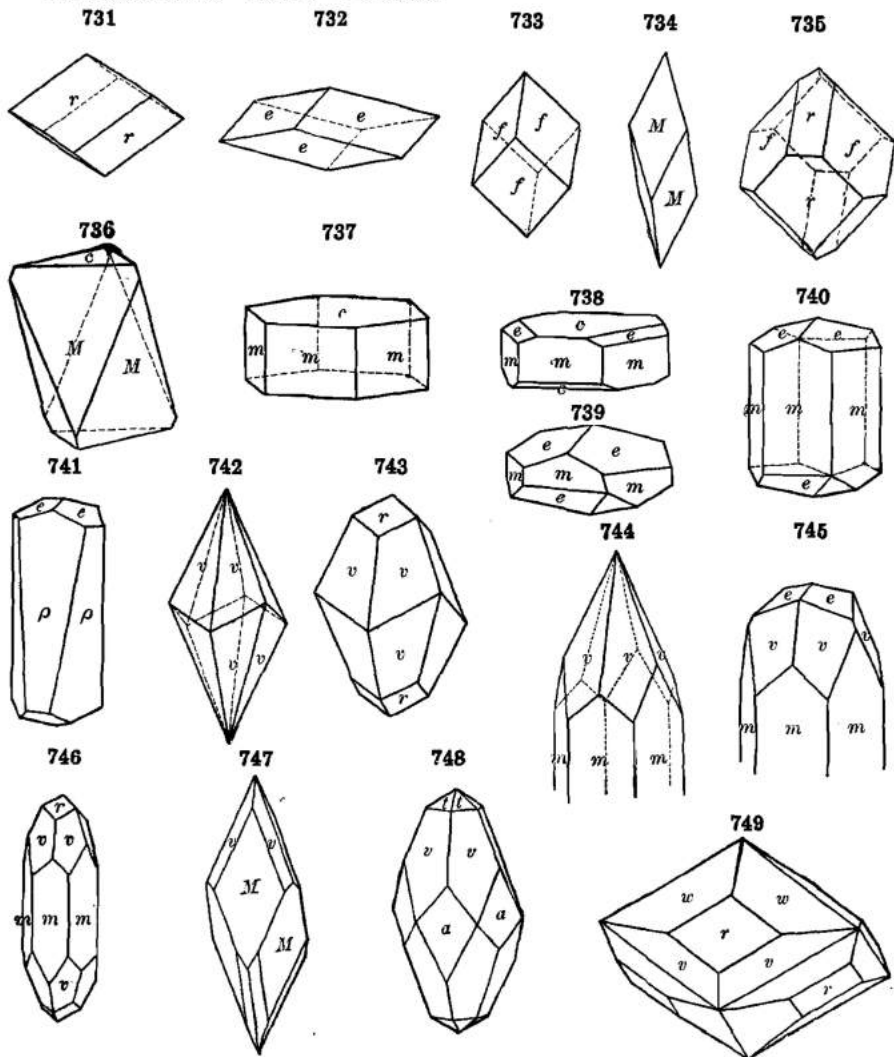
2. Aragonite Group. RCO_3 . Orthorhombic

| | | mm''' | $a : b : c$ |
|---------------------|-------------------------------------|---------|---------------------|
| Aragonite | CaCO_3 | 63° 48' | 0·6224 : 1 : 0·7206 |
| Bromlite | $(\text{Ca}, \text{Ba})\text{CO}_3$ | | |
| Witherite | BaCO_3 | 62° 12' | 0·6032 : 1 : 0·7302 |
| Strontianite | SrCO_3 | 62° 41' | 0·6090 : 1 : 0·7239 |
| Cerussite | PbCO_3 | 62° 46' | 0·6100 : 1 : 0·7230 |

The species of the **ARAGONITE GROUP** crystallize in the orthorhombic system, but the relation to those of the Calcite Group is made more close by the fact that the prismatic angle varies a few degrees only from 60° (and 120°) and the twinned forms with the fundamental prism as twinning-plane are pseudo-hexagonal in character.

1. Calcite Group. RCO_3 . Rhombohedral

CALCITE. Calc Spar; Calcareous Spar.
Rhombohedral. Axis $c = 0.8543$.



| | |
|--------------|--|
| $cr,^*$ | $0001 \wedge 10\bar{1}1 = 44^\circ 36\frac{1}{2}'$ |
| $ce,$ | $0001 \wedge 01\bar{1}2 = 26^\circ 15'$ |
| $me,$ | $10\bar{1}0 \wedge 01\bar{1}2 = 63^\circ 45'$ |
| $rr',$ | $10\bar{1}1 \wedge \bar{1}101 = 74^\circ 55'$ |
| $MM',$ | $40\bar{4}1 \wedge 4401 = 114^\circ 10'$ |
| $ee',$ | $01\bar{1}2 \wedge \bar{1}012 = 45^\circ 3'$ |
| $\phi\phi',$ | $0554 \wedge 5054 = 84^\circ 32\frac{1}{2}'$ |
| $f'f',$ | $0221 \wedge 2021 = 101^\circ 9'$ |

| | |
|------------|---|
| $w',$ | $21\bar{3}1 \wedge \bar{2}3\bar{1}1 = 75^\circ 22'$ |
| $vv',$ | $21\bar{3}1 \wedge 3\bar{1}21 = 35^\circ 36'$ |
| $vv^{vi},$ | $21\bar{3}1 \wedge 12\bar{3}1 = 47^\circ 1\frac{1}{2}'$ |
| $yy',$ | $3251 \wedge 3521 = 70^\circ 59'$ |
| $yy^v,$ | $3251 \wedge 5231 = 45^\circ 32'$ |
| $yy^{vi},$ | $3251 \wedge 2351 = 29^\circ 16'$ |
| $uv',$ | $2134 \wedge 3\bar{1}24 = 20^\circ 36\frac{1}{2}'$ |
| $ww^v,$ | $3145 \wedge 4\bar{1}35 = 16^\circ 0'$ |

* See the stereographic projection, Fig. 269, p. 108.

Habit of crystals very varied, as shown in the figures, from obtuse to acute rhombohedral; from thin tabular to long prismatic; and scalenohedral of many types, often highly modified.

Twins (see Figs. 419-426, p. 168): (1) Tw. pl. $c(0001)$, common, the crystals having the same vertical axis. (2) Tw. pl. $e(01\bar{1}2)$, very common, the vertical axes inclined $127^{\circ} 29\frac{1}{2}'$ and $52^{\circ} 30\frac{1}{2}'$; often producing twinning lamellæ as in Iceland Spar, which are, in many cases, of secondary origin as in granular limestones (Fig. 750); this twinning may be produced artificially (see p. 188). (3) Tw. pl. $r(10\bar{1}1)$, not common; the vertical axes inclined $90^{\circ} 46'$ and $89^{\circ} 14'$. (4) Tw. pl. $f(02\bar{2}1)$, rare; the axes intersect at angles of $53^{\circ} 46'$ and $126^{\circ} 14'$.

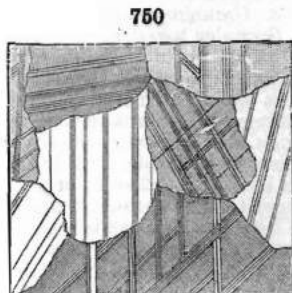
Also fibrous, both coarse and fine; sometimes lamellar; often granular; from coarse to impalpable, and compact to earthy. Also stalactitic, tuberoso, nodular, and other imitative forms.

Cleavage: $r(10\bar{1}1)$ highly perfect. Parting $\parallel e(01\bar{1}2)$ due to twinning. Fracture conchoidal, obtained with difficulty. $H. = 3$, but varying with the direction on the cleavage face; earthy kinds softer. $G. = 2.714$, in pure crystals, but varying somewhat widely in impure forms, as in those containing iron, manganese, etc. Luster vitreous to subvitreous to earthy. Color white or colorless; also various pale shades of gray, red, green, blue, violet, yellow; also brown and black when impure. Streak white or grayish. Transparent to opaque.

Optically —. Birefringence very high. Refractive indices for the D line: $\omega = 1.65849$, $\epsilon = 1.48625$.

Comp. — Calcium carbonate, $\text{CaCO}_3 =$ Carbon dioxide 44.0, lime 56.0 = 100. Small quantities of magnesium, iron, manganese, zinc, and lead may be present replacing the calcium.

Var. — The varieties are very numerous, and diverse in appearance. They depend mainly on the following points: differences in crystallization and structural condition, presence of impurities, etc., the extremes being perfect crystals and earthy massive forms; also on composition as affected by isomorphous replacement.



Section of crystalline limestone in polarized light.

A. VARIETIES BASED CHIEFLY UPON CRYSTALLIZATION AND ACCIDENTAL IMPURITIES

1. *Ordinary*. In crystals and cleavable masses, the crystals varying very widely in habit as already noted. *Dog-tooth Spar* is an acute scalenohedral form; *Nail-head Spar*, a composite variety having the form suggested by the name. The transparent variety from Iceland, used for polarizing prisms; etc., is called *Iceland Spar* or *Doubly-refracting Spar*. As regards color, crystallized calcite varies from the kinds which are perfectly clear and colorless through yellow, pink, purple, blue, to brown and black. The color is usually pale except as caused by impurities. These impurities may be pyrite, native copper, malachite, sand, etc.; they are sometimes arranged in symmetrical form, as depending upon the growth of the crystals and hence produce many varieties.

Fontainebleau limestone, from Fontainebleau and Nemours, France, contains a large amount of sand, some 50 to 63 p. c. Siliceous calcite crystals come from S. D., Wy., Cal., etc.

2. *Fibrous and lamellar kinds*. *Satin Spar* is fine fibrous, with a silky luster; resembles fibrous gypsum, also called satin spar, but is much harder than gypsum and effervesces with acids. *Lublinit* is a fibrous variety, probably pseudomorphous after some organic material.

Argentine is a pearly lamellar calcite, the lamellæ more or less undulating; color white, grayish, yellowish. *Aphrite*, in its harder and more sparry variety, is a foliated white pearly calcite, near *argentine*; in its softer kinds it approaches chalk, though lighter, pearly in luster, silvery white or yellowish in color, soft and greasy to the touch, and more or less scaly in structure. *Aphrite* has been thought to be aragonite pseudomorphous after gypsum.

3. *Granular massive to cryptocrystalline kinds: Limestone, Marble, Chalk.*

Granular limestone or *Saccharoidal limestone*, so named because like loaf sugar in fracture, varying from coarse to very fine granular, and hence to *compact limestone*; colors are various, as white, yellow, reddish, green; usually they are clouded and give a handsome effect when the material is polished. When such limestones are fit for polishing, or for architectural or ornamental use, they are called *marbles*. Many varieties have special names. *Shell-marble* consists largely of fossil shells; *Lumachelle* or *fire-marble* is a dark brown shell-marble, with brilliant fire-like or chatoyant internal reflections. *Ruin-marble* is a kind of a yellow to brown color, showing, when polished, figures bearing some resemblance to fortifications, temples, etc., in ruins, due to infiltration of iron oxide, etc.

Lithographic stone is a very even-grained compact limestone, of buff or drab color; as that of Solenhofen, Bavaria. *Hydraulic limestone* is an impure limestone which after ignition sets, i. e., takes a solid form under water, due to the formation of a silicate. The French varieties contain 2 or 3 p. c. of magnesia, and 10 to 20 of silica and alumina (or clay). The varieties in the United States contain 20 to 40 p. c. of magnesia, and 12 to 30 p. c. of silica and alumina. *Hard compact limestone* varies from nearly pure white, through grayish, drab, buff, yellowish, and reddish shades, to bluish gray, dark brownish gray, and black, and sometimes variously veined. Many kinds make beautiful marble when polished. Red oxide of iron produces red of different shades. Shades of green are due to iron protoxide, chromium oxide, iron silicate.

Chalk is white, grayish white, or yellowish, and soft enough to leave a trace on a board. It is composed of the shells of minute sea organisms. *Calcareous marl* is a soft earthy deposit, with or without distinct fragments of shells; it generally contains much clay, and graduates into a calcareous clay.

Oolite is a granular limestone, its grains minute concretions, looking somewhat like the roe of fish, the name coming from *ovov, egg*. *Pisolite* consists of concretions as large often as a small pea, or larger, having usually a distinct concentric structure.

Deposited from calcareous springs, streams, or in caverns, etc. (a) *Stalactites* are calcareous cylinders or cones that hang from the roofs of limestone caverns, and which are formed from the waters that drip through the roof; these waters hold some calcium bicarbonate in solution, and leave calcium carbonate to form the stalactite when evaporation takes place. Stalactites vary from transparent to nearly opaque; from a crystalline structure with single cleavage directions to coarse or fine granular cleavable and to radiating fibrous; from a white color and colorless to yellowish gray and brown. (b) *Stalagmite* is the same material covering the floors of caverns, it being made from the waters that drop from the roofs, or from sources over the bottom or sides; cones of it sometimes rise from the floor to meet the stalactites above. It consists of layers, irregularly curved, or bent. Stalagmite, or a solid kind of travertine (see below) when on a large scale, is the alabaster stone of ancient writers, that is, the stone of which ointment vases, of a certain form called *alabasters*, were made. A locality near Thebes, now well known, was largely explored by the ancients, and the material has often been hence called *Egyptian alabaster*. It was also formerly called *onyx* and *onychites* because of its beautiful banded structure. In the arts it is often now called *Oriental alabaster* or *onyx marble*. Very beautiful marble of this kind is obtained in Algeria. *Mexican onyx* is a similar material obtained from Tecali, Puebla, Mexico; also in a beautiful brecciated form from the extinct crater of Zempoaltepec in southern Mexico. Similar kinds occur in Missouri, Arizona, San Luis Obispo Co., California. (c) *Calc-sinter, Travertine, Calc Tufa*. Travertine is of essentially the same origin with stalagmite, but is distinctively a deposit from springs or rivers, especially where in large deposits, as along the river Anio, at Tivoli, near Rome, where the deposit is scores of feet in thickness. Similar material is being deposited at the Mammoth Hot Springs, Yellowstone Park. (d) *Agaric mineral*; Rock-milk is a very soft white material, breaking easily in the fingers, deposited sometimes in caverns, or about sources holding lime in solution. (e) *Rock-meal* is white and light, like cotton, becoming a powder on the slightest pressure.

B. VARIETIES BASED UPON COMPOSITION

These include: *Dolomitic calcite*. Contains magnesium carbonate, thus graduating toward true dolomite. Also *baricalcite* (which contains some BaCO_3); similarly, *stron-*

tianocalcite (SrCO_3), *ferrocalcite* (FeCO_3), *manganocalcite* (MnCO_3) (see under *agolite*, p. 582), *zincocalcite* (ZnCO_3), *plumbocalcite* (PbCO_3), *cobaltocalcite* (CoCO_3).

Pyr., etc. — B.B. infusible, glows, and colors the flame reddish yellow; after ignition the assay reacts alkaline; moistened with hydrochloric acid imparts the characteristic lime color to the flame. In the solid mass effervesces when moistened with hydrochloric acid, and fragments dissolve with brisk effervescence even in cold acid. See further under *aragonite*, p. 447.

Diff. — Distinguishing characters: perfect rhombohedral cleavage; softness, can be scratched with a knife; effervescence in cold dilute acid; infusibility. Less hard and of lower specific gravity than aragonite (which see). Resembles in its different varieties the other rhombohedral carbonates, but is less hard, of lower specific gravity, and more readily attacked by acid. Also resembles some varieties of barite, but has lower specific gravity; it is less hard than feldspar and harder than gypsum.

Micro. — Recognized in thin sections by its low refraction and very high birefringence, the polarization colors in the thinnest sections attaining white of the highest order. The negative interference figure, with many closely crowded colored rings, is also characteristic. The rhombohedral cleavage is often shown in the fine fracture lines; systems of twinned lamellæ often conspicuous (Fig. 750), especially in crystalline limestone.

Artif. — Crystals of calcite are formed when a solution of calcium carbonate in dilute carbonic acid is evaporated slowly at ordinary temperatures. Calcite is formed when aragonite is heated, the transformation being complete at 470° .

Obs. — Calcite, in its various forms, is one of the most widely distributed of minerals. Beds of sedimentary limestone, formed from organic remains, shells, crinoids, corals, etc., yield on metamorphism crystalline limestone or marble, and in connection with these crystallized calcite and also deposits in caves of stalactites and stalagmites often occur. Common with the zeolites in cavities and veins of igneous rocks as a result of alteration, and similarly though less abundant with granite, syenite, etc. A frequent mineral in metalliferous deposits, with lead, copper, silver, etc. Deposited from lime-bearing waters as calc sinter, travertine, etc., especially in connection with hot springs as at the Mammoth Hot Springs in the Yellowstone region.

Some of the best known localities for crystallized calcite are the following: Andreasberg in the Harz Mts.; the mines of Freiberg, Schneeberg, etc., in Saxony; Kapnik in Hungary; Aussig in Bohemia; Bleiberg in Carinthia; Traversella in Piedmont, Italy; Elba. In England at Alston Moor and Egremont in Cumberland; Matlock, Derbyshire; Beer Alston in Devonshire; at numerous points in Cornwall; Weardale in Durham; Stank mine, Lancashire. In twin crystals of great variety and beauty at Guanajuato, Mexico. The *Iceland spar* has been obtained from Iceland near Helgustadir on the Eskefiord. It occurs in a large cavity in basalt. The crystals, usually showing the fundamental rhombohedron, are often coated with tufts of stilbite.

In the United States, crystallized calcite occurs in N. Y., in St. Lawrence Co., especially at the Rossie lead mine; in Jefferson Co., near Oxbow; *dog-tooth spar*, in Niagara Co., near Lockport, with pearl spar, celestite, etc.; in Lewis Co., at Leyden and Lowville, and at the Martinsburg lead mine; at Anthony's Nose on the Hudson, formerly groups of large tabular crystals; twins from Union Springs, Cayuga Co. In N. J., at Bergen, yellow calcite with datolite, etc. In Va., at Wier's cave, *stalactites* of great beauty; also in the large caves of Ky. In pyramidal crystals from Kelly's Island, Lake Erie. At the Lake Superior copper mines, complex crystals often containing scales of native copper. At Warsaw, Ill., in great variety of form, lining geodes and implanted on quartz crystals; at Quincy. In Mo., with dolomite, near St. Louis; also with sphalerite at Joplin and other points in the zinc region in the south-western part of the state, the crystals usually scalenohedral and of a wine-yellow color. Wis., from Hazel Green. From the Bad Lands, S. D. In Nova Scotia, at Partridge Island, a wine-colored calcite, and other interesting varieties.

Use. — In the manufacture of mortars and cements; as a building and ornamental material; as a flux in metallurgical operations; Iceland spar is used to make polarizing prisms; chalk as a fertilizer, in whitewash, etc.

THINOLITE. A tufa deposit of calcium carbonate occurring on an enormous scale in north-western Nev.; also occurs about Mono Lake, Cal. It forms layers of interlaced crystals of a pale yellow or light brown color and often skeleton structure except when covered by subsequent deposit of calcium carbonate.

DOLOMITE. Pearl Spar pt.

Tri-rhombohedral. Axis $c = 0.8322$.

$$cr, 0001 \wedge 10\bar{1}1 = 43^\circ 52'$$

$$rr', 10\bar{1}1 \wedge 1101 = 73^\circ 45'$$

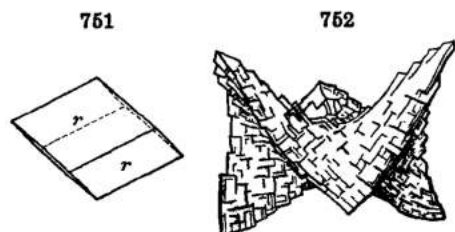
$$MM', 40\bar{4}1 \wedge \bar{4}401 = 113^\circ 53'$$

Habit rhombohedral, usually $r(10\bar{1}1)$ or $M(40\bar{4}1)$; the presence of rhom-

bohedral forms of the second or third series after the phenacite type very characteristic. The r faces commonly curved or made up of sub-individuals, and thus passing into saddle-shaped forms (Fig. 752).

Also granular, coarse or fine, resembling ordinary marble.

Cleavage: $r(10\bar{1}1)$ perfect. Fracture subconchoidal. Brittle.



H. = 3.5-4. G. = 2.8-2.9. Luster vitreous, inclining to pearly in some varieties. Color white, reddish, or greenish white; also rose-red, green, brown, gray and black. Transparent to translucent. Optically -. $\omega = 1.68174$. $\epsilon = 1.50256$.

Comp. — Carbonate of calcium and magnesium $(Ca, Mg)CO_3$; for normal dolomite $CaMgC_2O_6$ or $CaCO_3MgCO_3 =$ Carbon dioxide 47.9, lime 30.4, magnesia 21.7 = 100, or Calcium carbonate 54.35, magnesium carbonate 45.65 = 100. Varieties occur in which the ratio of the two carbonates varies from 1 : 1. The carbonates of iron and manganese also frequently enter replacing the magnesium carbonate and grading to *ankerite*; rarely cobalt and zinc carbonates.

Pyr., etc. — B.B. acts like calcite. In solution gives tests for magnesium and usually for iron. Fragments thrown into cold acid, unlike calcite, are only very slowly acted upon, if at all, while in powder in warm acid the mineral is readily dissolved with effervescence. The ferrous dolomites become brown on exposure.

Diff. — Resembles calcite (see p. 441), but generally to be distinguished in that it does not effervesce readily in the mass in cold acid.

Artif. — Artificial dolomite has been formed in several ways. The results of many experiments would indicate that heat and pressure are favorable for its formation. Sea water in contact with calcium carbonate when heated in a sealed tube produced dolomite. It has been observed that such reactions take place more readily with aragonite than with calcite, indicating the possibility of coral deposits (aragonite) being transformed into dolomite.

Micro. — Similar to calcite in thin sections except that it more often shows crystal outlines and less commonly polysynthetic twinning.

Obs. — Massive dolomite constitutes extensive strata, called limestone strata, in various regions, as in the dolomite region of the southern Tyrol. Crystalline and compact varieties are often associated with serpentine and other magnesian rocks, and with ordinary limestones. Dolomite, as a rock, is of secondary origin, having been transformed from ordinary limestone by the action of solutions containing magnesium. This change, called *dolomitization*, may take place in various ways. The more favorable conditions would involve heat, pressure, high magnesium content of waters and long periods of time. Consequently the older and more deeply buried in the earth's crust the greater is the probability of a limestone being converted into dolomite. Dolomite is also commonly a vein mineral, frequently occurring with various metallic ores. Some prominent localities are: Leogang in Salzburg, Austria; Schemnitz and Kapnik in Hungary; Freiberg in Saxony, Germany. In Switzerland, at Bex, in crystals; also in the Binnental; Traversella in Piedmont and Campolongo, Italy. In unusual dark colored crystals from Teruel, Spain.

In the United States, in Ver., at Roxbury. In N. J., at Hoboken. In N. Y. at Lockport, Niagara Falls, etc.; at the Tilly Foster iron mine, Brewster, Putnam Co., with magnetite, chondrodite. In Pa. at Phoenixville. In saddle-shaped crystals with the sphalerite

of Joplin, Mo. In N. C. at Stony Point, Alexander Co. In fine crystals from Alamosa, Alaska.

Named after Dolomieu (1750-1801), who announced some of the marked characteristics of the rock in 1791 — its not effervescing with acids, while burning like limestone, and solubility after heating in acids.

Use. — As a building and ornamental stone; for the manufacture of certain cements; for the production of magnesia used in the preparation of refractory linings in metallurgical furnaces.

Ankerite. $\text{CaCO}_3(\text{Mg, Fe, Mn})\text{CO}_3$, or for normal ankerite $2\text{CaCO}_3 \cdot \text{MgCO}_3 \cdot \text{FeCO}_3$. In rhombohedral crystals; $r'10\bar{1}1 \wedge \bar{1}101 = 73^\circ 48'$ also crystalline massive, granular, compact. $G. = 2.95-3.1$. Color white, gray, reddish. Occurs with siderite at the Styrian mines. From Traversella, Italy. With the hematite of northern New York.

MAGNESITE.

Rhombohedral Axis: $c = 0.8112$. $r'1011 \wedge \bar{1}101 = 72^\circ 36'$. Crystals rare, usually rhombohedral, also prismatic. Commonly massive; granular cleavable to very compact; earthy.

Cleavage: $r(10\bar{1}1)$ perfect. Fracture flat conchoidal. Brittle. $H. = 3.5-4.5$. $G. = 3.0-3.12$, cryst. Luster vitreous; fibrous varieties sometimes silky. Color white, yellowish, or grayish white, brown. Transparent to opaque. Optically —. $\omega = 1.717$. $\epsilon = 1.515$.

Comp. — Magnesium carbonate, $\text{MgCO}_3 = \text{Carbon dioxide } 52.4$, magnesia $47.6 = 100$. Iron carbonate is often present.

Brunnerite contains several p. c. of FeO ; $G. = 3-3.2$; white, yellowish, brownish, rarely black and bituminous; often becoming brown on exposure, and hence called *Brown Spar*.

Pyr., etc. — B.B. resembles calcite and dolomite, and like the latter is but slightly acted upon by cold acids; in powder is readily dissolved with effervescence in warm hydrochloric acid. In solution gives strong test for magnesium with little or no calcium.

Obs. — Found as a secondary mineral formed by the alteration of various magnesian minerals; in talcose schist, serpentine and other magnesian rocks, also gypsum; as veins in serpentine, or mixed with it so as to form a variety of verd-antique marble. Occurs at Hrubuschütz in Moravia; at Kraubat and Maria-Zell, Styria; Greiner in the Zillertal, Tyrol, Austria; Snarum, Norway.

In the United States, in Mass., at Bolton; at Roxbury, veining serpentine; in Md., at Barehills, near Baltimore; in Pa., in crystals, at West Goshen, Chester Co., near Texas, Lancaster Co.; in Cal. it is mined in Tulare, Kern, Santa Clara, Sonoma Cos. and elsewhere. A white saccharoidal magnesite resembling statuary marble has been found as loose blocks on an island in the St. Lawrence River, near the Thousand Island Park. In small prismatic crystals from Orangedale, Nova Scotia.

Use. — In the preparation of magnesite brick for the linings of metallurgical furnaces; in the manufacture of various chemical compounds, as epsom salts, magnesia, etc.

Intermediate between magnesite and siderite are:

MESITITE. $2\text{MgCO}_3 \cdot \text{FeCO}_3$. $r'10\bar{1}1 \wedge \bar{1}101 = 72^\circ 46'$. $G. = 3.35-3.36$. Usually in flat rhombohedrons ($e, 01\bar{1}2$) with rounded faces. Traversella, Piedmont, Italy.

PISTOMESITE. $\text{MgCO}_3 \cdot \text{FeCO}_3 = \text{Magnesium carbonate } 42.0$, iron carbonate $58.0 = 100$. $r'10\bar{1}1 \wedge \bar{1}101 = 72^\circ 42'$. $G. = 3.42$. Thurnberg, Salzburg, Austria; also Traversella, Italy.

SIDERITE. Chalybite, Spathic Iron.

Rhombohedral. Axis $c = 0.8184$.

| | | | |
|--------|---|----------|---|
| r , | $0001 \wedge 10\bar{1}1 = 43^\circ 23'$ | $r'r'$, | $1011 \wedge 1101 = 73^\circ 0'$ |
| cM , | $0001 \wedge 40\bar{4}1 = 75^\circ 11'$ | MM' , | $40\bar{4}1 \wedge \bar{4}401 = 113^\circ 42'$ |
| cs , | $0001 \wedge 05\bar{5}1 = 78^\circ 3'$ | ss' , | $05\bar{5}1 \wedge 50\bar{5}1 = 115^\circ 50'$ |
| cd , | $0001 \wedge 08\bar{8}1 = 82^\circ 28'$ | dd' , | $08\bar{8}1 \wedge 80\bar{8}1 = 118^\circ 18\frac{1}{2}'$ |

Crystals commonly rhombohedral r (1011) or $e(0112)$ the faces often curved and built up of sub-individuals like dolomite. Often cleavable massive

to coarse or fine granular. Also in botryoidal and globular forms, subfibrous within, occasionally silky fibrous; compact and earthy.

Cleavage: $r(10\bar{1}1)$ perfect. Fracture uneven or subconchoidal. Brittle. $H. = 3.5-4$. $G. = 3.83-3.88$. Luster vitreous, inclining to pearly. Color ash-gray, yellowish gray, greenish gray, also brown and brownish red, rarely green; and sometimes white. Streak white. Translucent to subtranslucent. Optically —. $\omega = 1.873$. $\epsilon = 1.633$.

Comp. — Iron protocarbonate, $FeCO_3 =$ Carbon dioxide 37.9, iron protoxide 62.1 = 100 ($Fe = 48.2$ p. c.). Manganese may be present (as in *oligonite*, *manganospherite*), also magnesium and calcium.

Pyr., etc. — In the closed tube decrepitates, gives off CO_2 , blackens and becomes magnetic. B.B. blackens and fuses at 4.5-5. With the fluxes reacts for iron, and with soda and niter on platinum foil generally gives a manganese reaction. Only slowly acted upon by cold acid, but dissolves with brisk effervescence in hot hydrochloric acid. Exposure to the atmosphere darkens its color, rendering it often of a blackish brown or brownish red color.

Diff. — Characterized by rhombohedral form and cleavage. Specific gravity higher than that of calcite, dolomite and ankerite. Resembles some sphalerite but lacks the resinous luster, differs in cleavage angle and yields CO_2 (not H_2S) with hydrochloric acid.

Obs. — Siderite may form as "bog ore" by the action, out of contact with the air, of organic matter in a bicarbonate solution. It may also be formed by the action of ferrous solutions upon limestones. It frequently occurs also as a vein mineral. It occurs in many of the rock strata, in gneiss, mica slate, clay slate, and as clay iron-stone in connection with the Coal formation and many other stratified deposits. It is often associated with metallic ores. At Freiberg, Saxony, it occurs in silver mines. In Cornwall it accompanies tin. It is also found accompanying copper and iron pyrites, galena, chalcocite, tetrahedrite. Occasionally it is to be met with in trap rocks as *spherosiderite* in globular concretions. Extensive deposits occur in the Eastern Alps, in Styria and Carinthia at Tavetsch, Switzerland. At Harzgerode and elsewhere in the Harz Mts., it occurs in fine crystals in gray-wacke; also in Cornwall of varied habit at many localities; at Alston-Moor, and Tavistock, Devonshire. In large rhombohedrons from Allevard, France. Fine cleavage masses occur with cryolite in Greenland.

In the United States, in Ver., at Plymouth. In Mass., at Sterling. In Conn., at Roxbury, an extensive vein in quartz, traversing gneiss. In N. Y., a series of deposits occur in Columbia Co.; at the Rossie iron mines, St. Lawrence Co. In N. C., at Fentress and Harlem mines. The argillaceous carbonate, in nodules and beds (clay ironstone), is abundant in the coal regions of Pa., Ohio, and many parts of the country. In a clay-bed under the Tertiary along the west side of Chesapeake Bay for 50 m.

Use. — An ore of iron.

RHODOCHROSITE. *Diagolite*.

Rhombohedral. Axis $c = 0.8184$, $rr' 10\bar{1}1 \wedge \bar{1}101 = 73^\circ 0'$. Distinct crystals not common; usually the rhombohedron $r(10\bar{1}1)$; also $e(01\bar{1}2)$, with rounded striated faces. Cleavable, massive to granular-massive and compact. Also globular and botryoidal, with columnar structure, sometimes indistinct; incrusting.

Cleavage: $r(10\bar{1}1)$ perfect. Fracture uneven. Brittle. $H. = 3.5-4.5$. $G. = 3.45-3.60$ and higher. Luster vitreous, inclining to pearly. Color shades of rose-red; yellowish gray, fawn-colored, dark red, brown. Streak white. Translucent to subtranslucent. Optically —. $\omega = 1.820$. $\epsilon = 1.600$.

Comp. — Manganese protocarbonate, $MnCO_3 =$ Carbon dioxide 38.3, manganese protoxide 61.7 = 100. Iron carbonate is usually present even up to 40 p. c., as in *manganosiderite*; sometimes the carbonate of calcium, as in *manganocalcite*, also magnesium, zinc, and rarely cobalt.

Pyr., etc. — B.B. changes to gray, brown, and black, and decrepitates strongly, but is infusible. With salt of phosphorus and borax in O.F. gives an amethystine-colored bead, in R.F. becomes colorless. With soda in O.F. a bluish green manganate. Dissolves with

effervescence in warm hydrochloric acid. On exposure to the air changes to brown, and some bright rose-red varieties become paler.

Diff. — Characterized by its pink color, rhombohedral form and cleavage, effervescence in acids.

Obs. — Occurs commonly in veins along with ores of silver, lead and copper, and with other ores of manganese. Found at Schemnitz and Kapnik in Hungary; Nagyág in Transylvania; *ponite* is a ferriferous variety from Roumania; in Germany at Freiberg in Saxony; at Diez near Oberneisen in Nassau; at Daaden, Rheinprovinz; in Belgium at Moët-Fontaine in the Ardennes. A variety containing 45 per cent of zinc carbonate from Rosseto, Elba, has been called *zincorodochrosite*. In the United States at Branchville, Conn.; in N. J., with franklinite at Mine Hill, Franklin Furnace. In Col., at the John Reed mine, Alicante, Lake Co., in beautiful clear rhombohedrons; also at the Oulay mine, near Lake City and Alma, Park Co.; in Chaffee, Gilpin and Ouray Cos. In Mon., at Butte City. Abundant at the silver mines of Austin, Nev. At Placentia Bay, Newfoundland.

Named *rodochrosite* from *ῥόδον*, a *rose*, and *χρῶσις*, *color*; and *diatopite*, from *διατοπή*, *doubt*.

Use. — A minor ore of manganese.

SMITHSONITE. Calamine pt. Dry-bone ore *Miners*.

Rhombohedral. Axis $c = 0.8063$. $rr' 10\bar{1}1 \wedge \bar{1}101 = 72^\circ 20'$. Rarely well crystallized; faces $r(10\bar{1}1)$ generally curved and rough. Usually reniform, botryoidal, or stalactitic, and in crystalline incrustations; also granular, and sometimes impalpable, occasionally earthy and friable.

Cleavable: $r(10\bar{1}1)$ perfect. Fracture uneven to imperfectly conchoidal. Brittle. H. = 5. G. = 4.30–4.45. Luster vitreous, inclining to pearly. Streak white. Color white, often grayish, greenish, brownish white, sometimes green, blue and brown. Subtransparent to translucent. Optically —. $\omega = 1.818$. $\epsilon = 1.618$.

Comp. — Zinc carbonate, $ZnCO_3 =$ Carbon dioxide 35.2, zinc protoxide 64.8 = 100. Iron carbonate is often present (as in *monheimite*); also manganese and cobalt carbonates; further calcium and magnesium carbonates in traces; rarely cadmium and indium.

Pyr., etc. — In the closed tube loses carbon dioxide, and, if pure, is yellow while hot and white on cooling. B.B. infusible, giving characteristic zinc flame; moistened with cobalt solution and heated in O.F. gives a green color on cooling. With soda on charcoal coats the coal with the oxide, which is yellow while hot and white on cooling; this coating, moistened with cobalt solution, gives a green color after heating in O.F. Soluble in hydrochloric acid with effervescence.

Diff. — Distinguished from calamine, which it often closely resembles, by its effervescence in acids.

Obs. — Found both in veins and beds, especially in company with galena and sphalerite; also with copper and iron ores. It usually occurs in calcareous rocks, and is generally associated with calamine, and sometimes with limonite. It frequently replaces limestone, pseudomorphs after calcite crystals being often observed. Commonly a secondary mineral and is often produced by the action of carbonated waters upon zinc sulphide. Often is in a porous, honey-comb-like material, known commonly as "dry-bone" ore.

Found at Nerchinsk in Siberia; at Dognaczka in Hungary; Bleiberg and Raibel in Carinthia; Wiesloch in Baden and at Altenberg, Germany. Moresnet in Belgium and Altenberg. In the province of Santander, Spain, at Puente Viego. In England, at Roughten Gill, Alston Moor, near Matlock, in the Mendip Hills, and elsewhere; in Ireland, at Donegal. At Laurion, Greece, varieties of many colors; from Sardinia. From Broken Hill, New South Wales.

In the United States, in Pa., at Lancaster abundant, the variety called "dry-bone"; at the Ueberroth mine, near Bethlehem, in scalenohedrons. In Wis., at Mineral Point, Shullsburg, etc., pseudomorphs after sphalerite and calcite. In Ia., at Ewing's diggings, N. W. of Dubuque, etc. In south-western Mo., associated with sphalerite and calamine. In Ark., at Calamine, Lawrence Co.; in Marion Co. A pink cobaltiferous variety occurs at Boleo, Lower California. In N. M. from Socorro Co. and in translucent green botryoidal masses from Kelly. In Tooele Co., Utah.

Named after James Smithson (1754–1829), who founded the Smithsonian Institution in Washington. The name calamine is frequently used in England, cf. calamine, p. 539.

Use. — An ore of zinc.

Sphaerocobaltite. Cobalt protocarbonate, CoCO_3 . Rhombohedral. In small spherical masses, with crystalline surface, rarely in crystals. $G. = 4.02\text{--}4.13$. Color rose-red. From Schneeberg, Saxony. From Boleo, Lower California.

2. Aragonite Group. RCO_3 . Orthorhombic

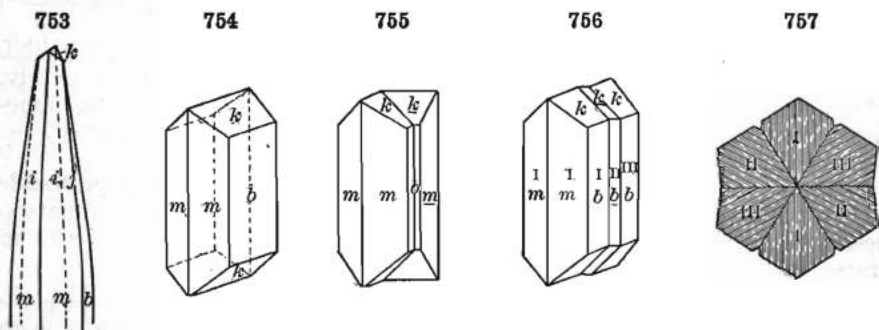
For list of species, see p. 437.

ARAGONITE.

Orthorhombic. Axes $a : b : c = 0.62244 : 1 : 0.72056$.

$$\begin{aligned} mm''', & 110 \wedge \bar{1}\bar{1}0 = 63^\circ 48'. \\ kk', & 011 \wedge 0\bar{1}1 = 71^\circ 33'. \\ pp', & 111 \wedge \bar{1}\bar{1}1 = 86^\circ 24\frac{1}{2}'. \\ pp''', & 111 \wedge \bar{1}\bar{1}1 = 50^\circ 27'. \end{aligned}$$

Crystals often acicular, and characterized by the presence of acute domes or pyramids. Twins: tw. pl. $m(110)$ commonly repeated, producing pseudo-



hexagonal forms (see Figs. 755–757). Also globular, reniform, and coralloidal shapes; sometimes columnar, straight or divergent; also stalactitic; incrusting.

Cleavage: $b(010)$ distinct; also $m(110)$; $k(011)$ imperfect. Fracture subconchoidal. Brittle. $H. = 3.5\text{--}4$. $G. = 2.93\text{--}2.95$. Luster vitreous, inclining to resinous on surfaces of fracture. Color white; also gray, yellow, green and violet; streak uncolored. Transparent to translucent. Optically —. Ax. pl. $\parallel a(100)$. $Bx \perp c(001)$. Dispersion $\rho > v$ small. $2E = 30^\circ 54'$. $\alpha = 1.531$. $\beta = 1.682$. $\gamma = 1.686$.

Comp. — Calcium carbonate, CaCO_3 = Carbon dioxide 44.0, lime 56.0 = 100. Some varieties contain a little strontium, others lead, and rarely zinc.

Aragonite changes to calcite at 470° .

Var. — *Ordinary.* (a) Crystallized in simple or compound crystals, the latter much the most common; often in radiating groups of acicular crystals. Columnar; also fine fibrous with silky luster. (c) Massive.

Stalactitic or stalagmitic: Either compact or fibrous in structure, as with calcite; *Sprudelstein* is stalactitic from Carlsbad, Bohemia. *Coralloidal:* In groupings of delicate interlacing and coalescing stems, of a snow-white color, and looking a little like coral; often called *Floßferri*. *Tarnowitzite* is a kind containing lead carbonate (4 to 8 p. c.), from Tarnowitz in Silesia; with $G. = 2.99$. *Zeyringite* is a calcareous sinter, probably aragonite, colored greenish white or sky-blue with nickel, from Zeyring, Styria. *Nicholsonite* is aragonite containing zinc from Leadville, Col., and the Tintic District, Utah.

Pyr., etc. — B.B. whitens and falls to pieces, and sometimes, when containing strontia, imparts a more intensely red color to the flame than lime; otherwise reacts like calcite. When immersed in cobalt nitrate solution powder turns lilac and the color persists on boiling while calcite under like conditions remains uncolored or becomes blue on long boiling. It is stated that these tests are not always strictly reliable.

Diff. — Distinguished from calcite by higher specific gravity and absence of rhombohedral cleavage; from the zeolites (*e.g.*, natrolite), etc., by effervescence in acid. Strontianite and witherite are fusible, higher in specific gravity and yield distinctive flames B.B. The resinous luster on fracture surfaces is to be noted.

Artif. — Aragonite will form when solutions of calcium carbonate are evaporated at temperatures from 80° to 100°; it will form at lower temperatures if the solution contains some sulphate or small amounts of the carbonates of strontium or lead.

Obs. — The most common repositories of aragonite are beds of gypsum; also beds of iron ore, as the Styrian mines, where it occurs in coralloidal forms, and is denominated *floss-ferri*, "flower of iron"; in cavities in basalt and lavas; often associated with copper and iron pyrites, galena, and malachite. It constitutes the pearly layer of shells and the skeleton material of corals.

First discovered in Aragon, Spain (whence its name), at Molina and Valencia, in six-sided prisms, with gypsum, similarly at Dax, France. Prominent localities are Bilin, Bohemia; Racanbunto, Silesia; Leogang in Salzburg, Austria; Herregrund, Hungary; with sulphur in Sicily in fine prisms; also at Alston Moor and elsewhere, England, fine tapering crystals. In twins frequently replaced by native copper from Coro-Coro, Bolivia.

In fibrous crusts at Hoboken, N. J.; at Edenville and Rossie, N. Y.; Wood's Mine, Lancaster Co., Pa.; Warsaw, Ill., lining geodes; Mine-la-Motte, Mo., in crystals. *Floss-ferri* in the Organ Mts., N. M.; from Bisbee, Ariz.

Ktypeite is calcium carbonate in the form of pisolites from Carlsbad, Bohemia, and Hammam-Meskoutine, Algeria. $G. = 2.58-2.70$. Decrepitates when heated and changes to calcite.

WITHERITE.

Orthorhombic. Axes $a : b : c = 0.6032 : 1 : 0.7302$. Crystals always repeated twins, simulating hexagonal pyramids. Also massive, columnar or granular.

Cleavage: $b(010)$ distinct; $m(110)$ imperfect. Fracture uneven. Brittle. $H. = 3-3.75$. $G. = 4.27-4.35$. Luster vitreous, inclining to resinous on surfaces of fracture. Color white, yellowish, grayish. Streak white. Subtransparent to translucent. Optically —. $\alpha = 1.529$. $\beta = 1.676$. $\gamma = 1.677$.

Comp. — Barium carbonate, $BaCO_3 =$ Carbon dioxide 22.3, baryta 77.7 = 100.

Pyr., etc. — B.B. fuses at 2 to a bead, coloring the flame yellowish green; after fusion reacts alkaline. B.B. on charcoal with soda fuses easily, and is absorbed by the coal. Soluble in dilute hydrochloric acid; this solution, even when very much diluted, gives with sulphuric acid a white precipitate which is insoluble in acids.

Diff. — Distinguished by its high specific gravity; effervescence in acid; green coloration of the flame B.B. Barite is insoluble in hydrochloric acid.

Obs. — Occurs at Alston Moor in Cumberland, with galena; at Fallowfield near Hexham in Northumberland; Tarnowitz in Silesia. Leogang in Salzburg, Austria. Near Lexington, Ky., with barite. In a silver-bearing vein near Rabbit Mt., Thunder Bay, Lake Superior. From Tsubaki mine, Prov. Ugo, Japan.

Use. — A minor source of barium compounds.

Bromlite. $(Ba,Ca)CO_3$. In pseudo-hexagonal pyramids (Figs. 611, 612, p. 299). Indices, 1.525-1.670. Bromley Hill, near Alston, Cumberland, England.

STRONTIANITE.

Orthorhombic. Axes $a : b : c = 0.6090 : 1 : 0.7239$.

Crystals often acicular or acute spear-shaped, like aragonite. Twins: tw. $pl. m(110)$ common. Also columnar, fibrous and granular.

Cleavage: $m(110)$ nearly perfect; $b(010)$ in traces. Fracture uneven. Brittle. $H. = 3.5-4$. $G. = 3.680-3.714$. Luster vitreous; inclining to

resinous on faces of fracture. Color pale asparagus-green, apple-green; also white, gray, yellow, and yellowish brown. Streak white. Transparent to translucent. Optically —. Ax. pl. $\parallel b(010)$. $Bx \perp c(001)$. Dispersion $\rho < \nu$ small. $2E_r = 12^\circ 17'$. $\alpha = 2.520$. $\beta = 1.667$. $\gamma = 1.667$.

Comp. — Strontium carbonate, $SrCO_3 =$ Carbon dioxide 29.9, strontia 70.1 = 100. A little calcium is sometimes present.

Pyr., etc. — B.B. swells up, throws out minute sprouts, fuses only on the thin edges, and colors the flame strontia-red; the assay reacts alkaline after ignition. Moistened with hydrochloric acid and treated either B.B. or in the naked lamp gives an intense red color. Soluble in hydrochloric acid; the mediumly dilute solution when treated with sulphuric acid gives a white precipitate.

Diff. — Differs from related minerals, not carbonates, in effervescing with acids; has a higher specific gravity than aragonite and lower than witherite; colors the flame red B.B.

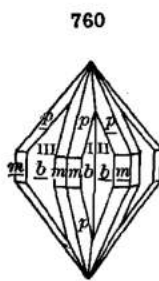
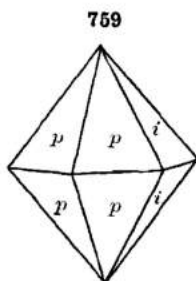
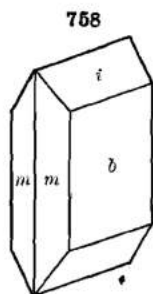
Obs. — Occurs at Strontian in Argyllshire and in Yorkshire, England; Claustal in the Harz Mts., Germany; Bräunsdorf, near Freiberg, Saxony; Leogang in Salzburg, Austria; near Brixlegg, Tyrol, Austria (*calciostromianite*); in Westphalia, Germany in fine crystals near Hamm, and at the Wilhelmine mine near Altahlen.

In the United States, occurs in N. Y. at Schoharie, at Muscalonge Lake, Chaumont Bay and Theresa, in Jefferson Co.; Mifflin Co., Pa.

Use. — A minor source of strontium compounds.

CERUSSITE. White Lead Ore.

Orthorhombic. Axes $a : b : c = 0.60997 : 1 : 0.72300$.



mm''' , $110 \wedge \bar{1}\bar{1}0 = 62^\circ 46'$.
 kk' , $011 \wedge 0\bar{1}\bar{1} = 71^\circ 44'$.
 ii' , $021 \wedge 0\bar{2}\bar{1} = 110^\circ 40'$.
 cp , $001 \wedge 111 = 54^\circ 14'$.
 pp' , $111 \wedge \bar{1}\bar{1}\bar{1} = 87^\circ 42'$.
 pp'' , $111 \wedge \bar{1}\bar{1}1 = 49^\circ 59\frac{1}{2}'$.

Simple crystals often tabular $\parallel b(010)$, prismatic $\parallel c$ axis; also pyramidal. Twins: tw. pl. $m(110)$ very common, contact- and penetration twins, often repeated

yielding six-rayed stellate groups. Crystals grouped in clusters, and aggregates. Rarely fibrous, often granular massive and compact; earthy. Sometimes stalactitic.

Cleavage: $m(110)$ and $i(021)$ distinct; $b(010)$ and $x(012)$ in traces. Fracture conchoidal. Very brittle. $H. = 3-3.5$. $G. = 6.46-6.574$. Luster adamantine, inclining to vitreous, resinous, or pearly; sometimes submetallic. Color white, gray, grayish black, sometimes tinged blue or green (copper); streak uncolored. Transparent to subtranslucent. Optically —. Ax. pl. $\parallel b(010)$. $Bx \perp c(001)$. Dispersion $\rho > \nu$ large. $2V = 8^\circ 14'$. $\alpha = 1.804$. $\beta = 2.076$. $\gamma = 2.078$.

Comp. — Lead carbonate, $PbCO_3 =$ Carbon dioxide 16.5, lead oxide 83.5 = 100.

Pyr., etc. — In the closed tube decrepitates, loses carbon dioxide, turns first yellow, and at a higher temperature dark red, but becomes again yellow on cooling. B.B. on charcoal fuses very easily, and in R.F. yields metallic lead. Soluble in dilute nitric acid with effervescence.

Diff. — Characterized by high specific gravity and adamantine luster; also by yielding lead B.B. Unlike anglesite, it effervesces with nitric acid.

Artif. — Cerussite has been produced artificially by the slow diffusion of a carbonate solution into a lead solution through a porous membrane; by the action of a carbonate solution upon a lead plate.

Obs. — A secondary mineral occurring in connection with other lead minerals, and is formed from galena, which, as it passes to a sulphate, may be changed to carbonate by means of solutions of calcium bicarbonate. It is found in Germany at Johanngeorgenstadt in beautiful crystals; Friedrichsseggen, Nassau; Badenweiler, Baden; at Claustal in the Harz Mts. Other important localities are Monte Poni, Sardinia; at Bleiberg in Carinthia; at Mics and Příbram, Bohemia; in England, in Cornwall; at East Tamar mine, Devonshire; near Matlock and Wirksworth, Derbyshire; at Leadhill and Wanlockhead, Scotland. Fine crystals from Broken Hill, New South Wales.

Found in Pa., at Phenixville. In Va., at Austin's mines, Wythe Co. In N. C., in King's mine. In lead mines of Wis. but rarely in crystals; at Hazelgreen, crystals coating galena. In Col., at Leadville, and elsewhere. In Ariz., at the Flux mine, Pima Co., in large crystalline masses; in crystals at the Red Cloud mine, Yuma Co. In Utah from Flagstaff mine; in Idaho at Wardner and Kingston.

Use. — An ore of lead.

BARYTOCALCITE.

Monoclinic. Axes $a : b : c = 0.7717 : 1 : 0.6254$; $\beta = 73^\circ 52'$. In crystals; also massive.

Cleavage: $m(110)$ perfect; $c(001)$ less so. Fracture uneven to subconchoidal. Brittle. $H. = 4$. $G. = 3.64-3.66$. Luster vitreous, inclining to resinous. Color white, grayish, greenish or yellowish. Streak white. Transparent to translucent. Optically —. $\alpha = 1.525$. $\beta = 1.684$. $\gamma = 1.686$.

Comp. — Carbonate of barium and calcium, $\text{BaCO}_3 \cdot \text{CaCO}_3 = \text{Carbon dioxide } 29.6, \text{ baryta } 51.5, \text{ lime } 18.9 = 100$.

Pyr., etc. — B.B. colors the flame yellowish green, and at a high temperature fuses on the thin edges and assumes a pale green color; the assay reacts alkaline after ignition. Soluble in dilute hydrochloric acid with effervescence. Dilute solution gives an abundant precipitate, BaSO_4 , with a few drops of sulphuric acid.

Obs. — Occurs at Alston Moor in Cumberland, England, in limestone with barite and fluorite.

ROSASITE. $2\text{CuO} \cdot 3\text{CuCO}_3 \cdot 5\text{ZnCO}_3?$. Mammillary fibrous of a bright green to sky-blue color. From Rosas mine at Sulcis, Sardinia.

Bismutosphärite. $\text{Bi}_2(\text{CO}_3)_2 \cdot 2\text{Bi}_2\text{O}_3$. In spherical forms with radiated structure. $G. = 7.42$. Color yellow to gray or blackish brown. From Schneeberg, Saxony. Also sparingly at Willimantic and Portland, Conn., as a result of the alteration of bismuthinite. From the Stewart mine, Pala, San Diego Co., Cal.

Rutherfordine. Uranyl carbonate, UO_2CO_3 . A yellow ochre resulting from alteration of uraninite. $G. = 4.8$. From Uruguru Mts., German East Africa.

Parisite. A fluocarbonate of the cerium metals, $[(\text{Ce}, \text{La}, \text{Di})\text{F}]_2\text{Ca}(\text{CO}_3)_2$. Rhombohedral. Crystals small and slender. Habit pyramidal or prismatic. Crystals horizontally grooved due to oscillatory combination of faces. $H. = 4.5$. $G. = 4.358$. Color brownish yellow. Optically +. $\omega = 1.676$. $\epsilon = 1.757$. From the emerald mines, Muso, Colombia; Ravalli, Mon.; Quincy, Mass.; Montorfano, Italy; Narsarsuk, Greenland (*synchisite*).

Cordylite is a parisite containing barium from Narsarsuk, South Greenland. Other material from Narsarsuk thought to be a new species and named *synchisite* is parisite.

Bastnäsité. Hamartite. A fluocarbonate of the cerium metals $(\text{RF})\text{CO}_3$. $H. = 4.5$. $G. = 4.948$. Color wax-yellow to reddish brown. Uniaxial, +. Strong birefringence. $\omega = 1.715$. From the Bastnäs mine, Riddarhyttan, Sweden. Also in parallel growth with tysonite in the granite of the Pike's Peak region in Colorado. Found to the east of Amboitra, Madagascar.

Ancylite. $4\text{Ce}(\text{OH})\text{CO}_3 \cdot 3\text{SrCO}_3 \cdot 3\text{H}_2\text{O}$. Orthorhombic. In small pyramids with curved faces and edges. $H. = 4.5$. $G. = 3.9$. Color light yellow, orange, brown, gray. Infusible. From Narsarsuk, Greenland. *Weibyeite* is a related mineral.

Ambatoarinite. A carbonate of strontium and the rare earths. Orthorhombic? In crystals with parallel axes, forming skeleton-like groups. Index, > 1.66 . From Ambatoarina, near Amboitra, Madagascar.

PHOSGENITE.

Tetragonal. Axis $c = 1.0876$. Crystals prismatic; sometimes tabular || $c(001)$.

Cleavage: $m(110)$, $a(100)$ distinct; also $c(001)$. Rather sectile. $H. = 2.75-3$. $G. = 6.0-6.3$. Luster adamantine. Color white, gray, and yellow. Streak white. Transparent to translucent. Optically +. $\omega = 2.114$. $\epsilon = 2.140$.

Comp. — Chlorocarbonate of lead, $(PbCl)_2CO_3$ or $PbCO_3.PbCl_2 =$ Lead carbonate 49.0, lead chloride 51.0 = 100.

Pyr., etc. — B.B. melts readily to a yellow globule, which on cooling becomes white and crystalline. On charcoal in R.F. gives metallic lead, with a white coating of lead chloride. Dissolves with effervescence in dilute nitric acid and solution reacts for chlorine with silver nitrate.

Obs. — At Cromford near Matlock in Derbyshire; at Gibbas, Monte Poni and Montevocchio in Sardinia. From Broken Hill, New South Wales; Dundas, Tasmania.

Northupite. $MgCO_3.Na_2CO_3.NaCl$. In isometric octahedrons. $H. = 3.5-4$. $G. = 2.38$. White to yellow or gray. $n = 1.514$. From Borax Lake, San Bernardino Co., Cal.

Tychite. $2MgCO_3.2Na_2CO_3.Na_2SO_4$. Isometric. Octahedral habit. $H. = 3.5$. $G. = 2.5$. $n = 1.51$. Very rare. From Borax Lake, San Bernardino Co., Cal., associated with northupite.

B. ACID, BASIC, AND HYDROUS CARBONATES

Teschemacherite. Acid ammonium carbonate, HNH_4CO_3 . Orthorhombic. In yellowish to white crystals. $G. = 1.45$. Indices, 1.423-1.536. From guano deposits of Africa, Patagonia, the Chincha Islands.

MALACHITE.

Monoclinic. Axes $a : b : c = 0.8809 : 1 : 0.4012$; $\beta = 61^\circ 50'$.

Crystals rarely distinct, usually slender, acicular prisms ($mm'''' 110 \wedge \bar{1}\bar{1}0 = 75^\circ 40'$), grouped in tufts and rosettes. Twins: tw. pl. $a(100)$ common. Commonly massive or incrusting, with surface botryoidal, or stalactitic, and structure divergent; often delicately compact fibrous, and banded in color; frequently granular or earthy.

Cleavage: $c(001)$ perfect; $b(010)$ less so. Fracture subconchoidal, uneven. Brittle. $H. = 3.5-4$. $G. = 3.9-4.03$. Luster of crystals admantine, inclining to vitreous; of fibrous varieties more or less silky; often dull and earthy. Color bright green. Streak paler green. Translucent to sub-translucent to opaque. Optically -. $\beta = 1.88$.

Comp. — Basic cupric carbonate, $CuCO_3.Cu(OH)_2 =$ Carbon dioxide 19.9, cupric oxide 71.9, water 8.2 = 100.

Pyr., etc. — In the closed tube blackens and yields water. B.B. fuses at 2, coloring the flame emerald-green; on charcoal is reduced to metallic copper; with the fluxes reacts like cuprite. Soluble in acids with effervescence.

Diff. — Characterized by green color and copper reactions B.B.; differs from other copper ores of a green color in its effervescence with acids.

Artif. — Malachite has been formed artificially by heating precipitated copper carbonate with a solution of ammonium carbonate for several days.

Obs. — Common with other ores of copper and as a product of their alteration; thus as a pseudomorph after cuprite and azurite. Occurs abundantly in the Ural Mts.; at Chessy in France; in Cornwall and in Cumberland, England; in Germany at Rheinbreitbach; Dillenburg, Nassau; Betzdorf near Siegen. At the copper mines of Nizhni Tagilsk, Russia; with the copper ores of Cuba; Chile; at the Cobar mines and elsewhere in New South Wales; South Australia; Rhodesia. In crystals from Katanga, Congo, and Mindouli, French Congo.

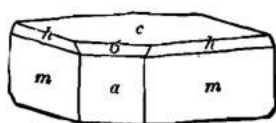
Occurs in N. J., at Schuyler's mines, and at New Brunswick. In Pa., at Cornwall, Lebanon Co.; at the Perkiomen and Phenixville lead-mines. In Wis., at the copper mines, of Mineral Point, and elsewhere. Abundantly in fine masses and acicular crystals, with calcite at the Copper Queen mine, Bisbee, Cochise Co., Ariz.; also in Graham Co., at Morenci (6 m. from Clifton), in stalactitic forms of malachite and azurite in concentric bands. At the Santa Rita mines, Grant Co., and elsewhere in N. M. Tintic district, Utah. In pseudomorphs from Good Springs, Nev. Named from $\mu\alpha\lambda\alpha\chi\eta$, *mallows*, in allusion to the green color.

Use. — An ore of copper; at times as an ornamental stone.

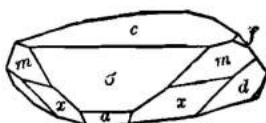
AZURITE.

Monoclinic. Axes $a : b : c = 0.8501 : 1 : 0.8805$; $\beta = 87^\circ 36'$.

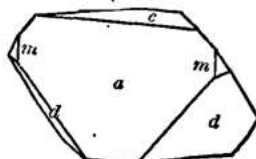
761



762



763



$$mm''', 110 \wedge \bar{1}\bar{1}0 = 80^\circ 41'.$$

$$ac, 100 \wedge 001 = 87^\circ 36'.$$

$$c\sigma, 001 \wedge 101 = 44^\circ 46'.$$

$$ll', 023 \wedge 0\bar{2}3 = 60^\circ 47'.$$

$$pp', 021 \wedge 0\bar{2}1 = 120^\circ 47'.$$

$$cm, 001 \wedge \bar{1}10 = 88^\circ 10'.$$

$$cd, 001 \wedge \bar{2}43 = 54^\circ 29'.$$

$$hh'', 221 \wedge \bar{2}\bar{2}1 = 73^\circ 56'.$$

Crystals varied in habit and highly modified. Also massive, and presenting imitative shapes, having a columnar composition; also dull and earthy.

Cleavage: $p(021)$ perfect but interrupted; $a(100)$ less perfect; $m(110)$ in traces. Fracture conchoidal. Brittle. H. = 3.5-4. G. = 3.77-3.83. Luster vitreous, almost adamantine. Color various shades of azure-blue, passing into Berlin-blue. Streak blue, lighter than the color. Transparent to sub-transparent. $\alpha = 1.730$. $\beta = 1.758$. $\gamma = 1.838$.

Comp. — Basic cupric carbonate, $2\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2 = \text{Carbon dioxide } 25.6$, cupric oxide 69.2, water 5.2 = 100.

Pyr., etc. — Same as in malachite.

Diff. — Characterized by its blue color; effervescence in nitric acid; copper reactions B.B.

Artif. — Azurite has been formed by allowing a solution of copper nitrate to lie in contact with fragments of calcite for several years.

Obs. — Occurs in splendid crystallizations in France at Chessy, near Lyons, whence it derived the name *Chessy Copper* or *chessylite*. Also in fine crystals in Siberia; Moldavia in the Banat, Hungary; at Wheel Buller, near Redruth in Cornwall; in Devonshire and Derbyshire, England; at Broken Hill and elsewhere in New South Wales; South Australia.

Occurs in Pa., at Phenixville, in crystals. In N. J., near New Brunswick. In Wis., near Mineral Point. In Ariz., at the Longfellow and other mines in Graham Co.; with malachite in beautiful crystals at the Copper Queen mine, Bisbee; at Morenci. In Grant Co., N. M. At the Mammoth mine in the Tintic district and in Tooele Co., Utah. In Cal., Calaveras Co., at Hughes's mine, in crystals.

Use. — An ore of copper.

Aurichalcite. A basic carbonate of zinc and copper, $2(\text{Zn}, \text{Cu})\text{CO}_3 \cdot 3(\text{Zn}, \text{Cu})(\text{OH})_2$. Orthorhombic? In drusy incrustations. G. = 3.54-3.64. Luster pearly. Color pale green to sky-blue. Indices, 1.634-1.682. From the Altai Mts., Mongolia; Chessy, near Lyons, France; Rezbánya, Hungary; Ondárroa, Vizcaya, Spain; Chihuahua, Mexico. In the United States, at Lancaster, Pa.; Salida, Col.; the Santa Caterina Mts., Ariz.; Beaver Co., Utah; Kelly, N. M.

Hydrozincite. A basic zinc carbonate, perhaps $\text{ZnCO}_3 \cdot 2\text{Zn}(\text{OH})_2$. Massive, fibrous, earthy or compact, as incrustations. G. = 3.58-3.8. Color white, grayish or yellowish.

Index, 1·695. Occurs at mines of zinc, as a result of alteration. In great quantities at the Dolores mine, Santander, Spain. From Chihuahua, Mexico; Bleyberg, Belgium; Malifidano, Sardinia. In the United States at Friedensville, Pa.; at Linden, in Wis.; Granby, Mo.

OTAVITE. A basic cadmium carbonate of uncertain composition. In crusts showing minute rhombohedral crystals. Color white to reddish. From the Otavi district, German Southwest Africa.

Hydrocerussite. A basic lead carbonate, probably $2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$. In thin colorless hexagonal plates. Index, 2·07. Occurs as a coating on native lead, at Långban, Sweden; with galena at Wanlockhead, Scotland.

Dundasite. A basic carbonate of lead and aluminium, $\text{Pb}(\text{AlO})_2(\text{CO}_3)_2 \cdot 4\text{H}_2\text{O}$. In small spherical aggregates of radiating acicular crystals. Color white. From Dundas and Mt. Read, Tasmania, and from near Trefriw, Carnarvonshire, Wales; Wensley, Derbyshire; near Maam, County Galway, Ireland.

Dawsonite. A basic carbonate of aluminium and sodium, $\text{Na}_3\text{Al}(\text{CO}_3)_2 \cdot 2\text{Al}(\text{OH})_2$. Orthorhombic. In thin incrustations of white radiating bladed crystals. Perfect cleavage, m (110). $G. = 2\cdot40$. Indices, 1·466–1·596. Found on a feldspathic dike near McGill College, Montreal. From the province of Siena, Pian Castagnaio, Tuscany, Italy

Thermonatrite. Hydrus sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$. $G. = 1\cdot5\text{--}1\cdot6$. Occurs in various lakes, and as an efflorescence over the soil in many dry regions.

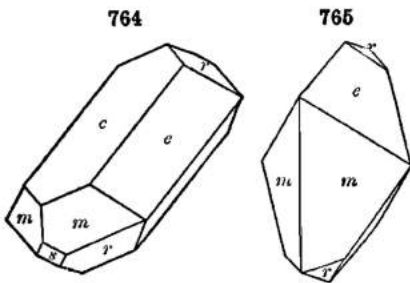
Nesquehonite. Hydrus magnesium carbonate, $\text{MgCO}_3 \cdot 3\text{H}_2\text{O}$. In radiating groups of prismatic crystals. $G. = 1\cdot83\text{--}1\cdot85$. Colorless to white. Biaxial, —. Indices, 1·495–1·526. From a coal mine at Nesquehoning, Schuylkill Co., Pa. See Iansfordite, p. 453.

Natron. Hydrus sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$. Occurring in nature only in solution, as in the soda lakes of Egypt, and elsewhere, or mixed with the other sodium carbonates.

Pirssonite. $\text{CaCO}_3 \cdot \text{Na}_2\text{CO}_3 \cdot 2\text{H}_2\text{O}$. In prismatic crystals, orthorhombic-hemimorphic. $H. = 3$. $G. = 2\cdot35$. Colorless to white. Optically +. Indices, 1·504–1·575. Borax Lake, San Bernardino, Cal.

GAY-LUSSITE.

Monoclinic. Axes $a : b : c = 1\cdot4897 : 1 : 1\cdot4442$; $\beta = 78^\circ 27'$.



mm'' , $110 \wedge \bar{1}\bar{1}0 = 111^\circ 10'$.
 ee' , $011 \wedge 0\bar{1}1 = 109^\circ 30'$.
 me , $110 \wedge 011 = 42^\circ 21'$.
 rr' , $\bar{1}\bar{1}2 \wedge \bar{1}\bar{1}2 = 69^\circ 29'$.

Crystals often elongated $\parallel a$ axis; also flattened wedge-shaped. Cleavage: m (110) perfect; c (001) rather difficult. Fracture conchoidal. Very brittle. $H. = 2\text{--}3$. $G. = 1\cdot93\text{--}1\cdot95$. Luster vitreous. Color white, yellowish white. Streak uncolored to grayish. Translucent. Optically —. $\alpha = 1\cdot444$, $\beta = 1\cdot517$, $\gamma = 1\cdot518$.

Comp. — Hydrus carbonate of calcium and sodium, $\text{CaCO}_3 \cdot \text{Na}_2\text{CO}_3 \cdot 5\text{H}_2\text{O} =$ Calcium carbonate 33·8, sodium carbonate 35·8, water 30·4 = 100.

Pyr., etc. — Heated in a closed tube decrepitates and becomes opaque. B.B. fuses easily to a white enamel, and colors the flame intensely yellow. Dissolves in acids with a brisk effervescence; partly soluble in water, and reddens turmeric paper.

Obs. — Abundant at Lagunilla, near Merida, in Venezuela, in crystals disseminated at the bottom of a small lake, in a bed of clay, covering *trona*. Also abundant in Little Salt Lake, or Soda Lake, in the Carson desert near Ragtown, Nev., deposited upon the evaporation of the water. From Sweetwater Valley, Wy. Named after Gay Lussac, the French chemist (1778–1850).

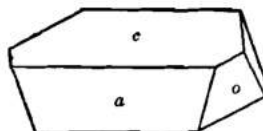
Lanthanite. $\text{La}_2(\text{CO}_3)_3 \cdot 9\text{H}_2\text{O}$. In thin tabular orthorhombic crystals; also granular, earthy. $G. = 2.605$. Color grayish white, pink, yellowish. Optically —. Found coating cerite at Bastnäs, Sweden; with zinc ores of the Saucon valley, Lehigh Co., Pa.; at the Sandford iron-ore bed, Moriah, N. Y.

TRONA. Urao.

Monoclinic. Axes $a : b : c = 2.8460 : 1 : 2.9700$; $\beta = 77^\circ 23'$.

ca , $001 \wedge 100 = 77^\circ 23'$.
 co , $001 \wedge \bar{1}11 = 75^\circ 53\frac{1}{2}'$.
 oo'' , $\bar{1}11 \wedge 11\bar{1} = 47^\circ 35\frac{1}{2}'$.

766



Often fibrous or columnar massive.

Cleavage: a (100) perfect; o ($\bar{1}11$); c (001) in traces.

Fracture uneven to subconchoidal. $H. = 2.5-3$.

$G. = 2.11-2.14$. Luster vitreous, glistening. Color

gray or yellowish white. Translucent. Taste

alkaline. Optically —.

Index, 1.507.

Comp. — $\text{Na}_2\text{CO}_3 \cdot \text{HN}_2\text{CO}_3 \cdot 2\text{H}_2\text{O}$ or $3\text{Na}_2\text{O} \cdot 4\text{CO}_3 \cdot 5\text{H}_2\text{O} =$ Carbon dioxide 38.9, soda 41.2, water 19.9 = 100.

Chatard established the above composition for urao, and showed that trona, sometimes called "sesquicarbonate of soda," is an impure form of the same compound.

Pyr., etc. — In the closed tube yields water and carbon dioxide. B.B. imparts an intensely yellow color to the flame. Soluble in water, and effervesces with acids. Reacts alkaline with moistened test-paper.

Obs. — Found in the province of Fezzan, Africa, forming thin superficial crusts; Natroun lakes, Egypt; from Vesuvius; at the bottom of a lake at Lagunilla, Venezuela. Efflorescences of trona occur near the Sweetwater river, Rocky Mountains. An extensive bed in Churchill Co., Nev. In fine crystals at Borax lake, San Bernardino Co., Cal., with hanksite, glauberite, thenardite, etc.

Hydromagnesite. Basic magnesium carbonate, $3\text{MgCO}_3 \cdot \text{Mg}(\text{OH})_2 \cdot 3\text{H}_2\text{O}$. Crystals small, tufted. Also amorphous; as chalky crusts. Color and streak white. Index, 1.530. Often occurs with serpentine; thus at Hrubschütz, in Moravia; at Kraubat, Styria, etc. Also similarly near Texas, Pa.; Hoboken, N. J. Material closely similar from saline crusts on lava at Alphaerössa, Santorin Island, has been called *giorgiosite*.

Hydrogiobertite. $\text{MgCO}_3 \cdot \text{Mg}(\text{OH})_2 \cdot 2\text{H}_2\text{O}$. In light gray spherical forms. From the neighborhood of Pollena, Italy. Deposited from Phillips Springs, Napa Co., Cal.

Artinite. $\text{MgCO}_3 \cdot \text{Mg}(\text{OH})_2 \cdot 3\text{H}_2\text{O}$. Orthorhombic. Radiating fibrous. $H. = 2.0$. $G. = 2.0$. White. $\beta = 1.54$. From Val Laterna and Emarede, Val Aosta, Piedmont, Italy.

Lansfordite. $3\text{MgCO}_3 \cdot \text{Mg}(\text{OH})_2 \cdot 21\text{H}_2\text{O}$. Biaxial —. Indices, 1.42–1.503. Occurs as small stalactites in the anthracite mine at Nesquehoning near Lansford, Schuylkill Co., Pa.; changed on exposure to nesquehonite.

Brugnatellite. $\text{MgCO}_3 \cdot 5\text{Mg}(\text{OH})_2 \cdot \text{Fe}(\text{OH})_3 \cdot 4\text{H}_2\text{O}$. Micaceous, lamellar. Perfect cleavage. Color flesh-pink. $\omega = 1.53$. Found in an old asbestos mine at Torre Santa Maria, Val Malenco, Lombardy, Italy.

GAJITE. A basic hydrous calcium, magnesium carbonate. Rhombohedral cleavage. Granular structure. $H. = 3.5$. $G. = 2.62$. Color, white. Strong birefringence. Found near Plešće, in the district Gorski kotar, Croatia.

Stichtite. $2\text{MgCO}_3 \cdot 5\text{Mg}(\text{OH})_2 \cdot 2\text{Cr}(\text{OH})_3$. Micaceous. In scales. $G. = 2.16$. Color lilac. Optically uniaxial or feebly biaxial. Optically —. Index, 1.54. An alteration product of *serpentine* from Dundas, Tasmania.

Zaratite. Emerald Nickel. $\text{NiCO}_3 \cdot 2\text{Ni}(\text{OH})_2 \cdot 4\text{H}_2\text{O}$. In mammillary incrustations; also massive, compact. Color emerald-green. Occurs on chromite at Texas, Lancaster Co., Pa.; at Swinness, Unst, Shetland; Igdlökunguak, Greenland.

Remingtonite. A hydrous cobalt carbonate. A rose-colored incrustation, soft and earthy. From a copper mine near Finksburg, Carroll Co., Md.; Boleo, Lower California.

Tengerite. A supposed yttrium carbonate. In white pulverulent coatings. On gadolinite at Ytterby, Sweden. A similar mineral is associated with the gadolinite of Llano Co., Tex.

Bismutite. A basic bismuth carbonate, perhaps $\text{Bi}_2\text{O}_3 \cdot \text{CO}_2 \cdot \text{H}_2\text{O}$. Incrusting, or earthy and pulverulent; amorphous. G. = 6.86–6.9 Breith.; 7.67 Rg. Color white, green, yellow and gray. Index, 2.25. Occurs in Germany, at Schneeberg and Johanngeorgenstadt, with native bismuth, and at Joachimstal, Bohemia. In the United States, in S. C., at Brewer's mine; in Gaston Co., N. C.

Uranothallite. $2\text{CaCO}_3 \cdot \text{U}(\text{CO}_3)_2 \cdot 10\text{H}_2\text{O}$. In scaly or granular crystalline aggregates. Color siskin-green. Occurs on uraninite at Joachimstal, Bohemia.

Liebigite. A hydrous carbonate of uranium and calcium. In mammillary concretions, or thin coatings. Color apple-green. Occurs on uraninite near Adrianople, Turkey; also Johanngeorgenstadt, Germany, and Joachimstal, Bohemia.

Voglite. A hydrous carbonate of uranium, calcium and copper. In aggregations of crystalline scales. Color emerald-green to bright grass-green. From the Elias mine, near Joachimstal, on uraninite, Bohemia.