cyanite, diaspore, and a series of aluminous minerals, in part produced from its alteration. Occasionally found in ejected masses enclosed in younger volcanic rocks, as at Königswinter, Niedermendig, etc. Rarely observed as a contact-mineral. The fine sapphires are usually obtained from the beds of rivers, either in modified hexagonal prisms or in rolled masses, accompanied by grains of magnetite, and several kinds of gems, as spinel, etc. The emery of Asia Minor, Dr. Smith states, occurs in granular limestone.

The best rubies come from the mines in Upper Burma, north of Mandalay, in an area covering 25 to 30 square miles, of which Mogok is the center. The rubies occur *in situ* in crystalline limestone, also in the soil of the hillsides and in gem-bearing gravel. Blue sapphires are brought from Ceylon, often as rolled pebbles, also as well-preserved crystals. Corundum occurs in the Carnatic on the Malabar coast, on the Chantibun hills in Siam, and elsewhere in the East Indies; also near Canton, China. At St. Gothard, it occurs of a red or blue tinge in dolomite, and near Mozzo in Piedmont, in white compact feldspar. Adamantine spar is met with in large coarse, hexagonal pyramids in Gellivara, Sweden. Other localities are in Bohemia, near Petschau; in the Ilmen mountains, not far from Miask; in the gold-washings northeast of Zlatoust. Corundum, sapphires, and less often rubies occur in rolled pebbles in the diamond gravels on the Cudgegong river, at Mudgee and other points in New South Wales. Emery is found in large bowlders at Naxos, Nicaria, and Samos of the Grecian islands; also in Asia Minor, 12 m. E. of Ephesus, near Gumuch-dagh and near Smyrna, associated with margarite, chloritoid, pyrite.

In N. America, in *Massachusetts*, at Chester, with magnetite, diaspore, ripidolite, margarite, etc., mined for use as emery. In *Connecticut*, near Litchfield. In *New York*, at Warwick, bluish and pink, with spinel; Amity, in gran. limestone; emery with magnetite and green spinel (hercynite) in Westchester Co., near Cruger's Station, and elsewhere. In *New Jersey*, at Newton, blue crystals in gran. limestone; at Vernon. In *Pennsylvania*, in Delaware Co., in Aston, near Village Green, in large crystals; at Mineral Hill, in loose cryst.; in Chester Co., at Unionville, abundant in crystals; in large crystals loose in the soil at Shimersville, Lehigh Co. In *Virginia*, in the mica schists of Bull Mt., Patrick Co.

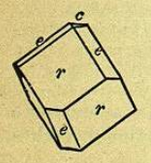
Common at many points along a belt extending from Virginia across western North and South Carolina and Georgia to Dudleyville, Alabama; especially in Madison, Buncombe, Haywood, Jackson, Macon, Clay, and Gaston counties in North Carolina. The localities at which most work has been done are the Culsagee mine, Corundum hill, near Franklin, Macon Co., N. C., and 26 miles S. E. of this, at Laurel Creek, Ga. The corundum occurs in beds in chrysolite (and serpentine) and hornblendic gneiss, associated with a species of the chlorite group, also spinel, etc., and here as elsewhere with many minerals resulting from its alteration. Some fine rubies have been found. Fine pink crystals of corundum occur at Hiawassee, Towns Co., Georgia. In *Colorado*, small blue crystals occur in mica schist near Salida, Chaffee Co. Gem sapphires are found near Helena, Montana, in gold-washings and in bars in the Missouri river, especially the Eldorado bar; at Yogo Gulch on the Judith river and at other points in Montana. In *California*, in Los Angeles Co., in the drift of San Francisqueto Pass. In *Canada*, at Burgess, Ontario, red and blue crystals.

HEMATITE. Eisenglanz, *Germ.*

Rhombohedral. Axis $\dot{c} = 1{\cdot}3656$.

cr, $0001 \wedge 10\bar{1}1 = 57° 37'$.	uu', $10\bar{1}4 \wedge \bar{1}104 = 37° 2'$.
rr', $10\bar{1}1 \wedge \bar{1}101 = 94° 0'$.	nn', $2\bar{2}43 \wedge \bar{2}4\bar{2}3 = 51° 59'$.
dd', $01\bar{1}2 \wedge \bar{1}012 = 64° 51'$.	cn, $0001 \wedge 2\bar{2}43 = 61° 13'$.

656.



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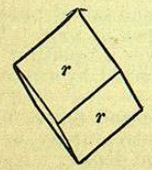

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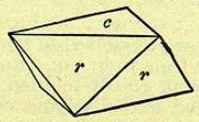

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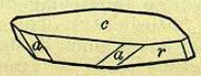

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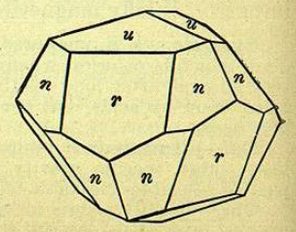


Twins: tw. pl. (1) c, penetration-twins; (2) r, less common, usually as

polysynthetic twinning lamellæ, producing a fine striation on c, and giving rise to a distinct parting or pseudo-cleavage $\parallel r$. Crystals often thick to thin tabular $\parallel c$, and grouped in parallel position or in rosettes; c faces striated $\parallel$ edge c/d and other forms due to oscillatory combination; also in cube-like rhombohedrons; rhombohedral faces u ($10\bar{1}4$) horizontally striated and often rounded over in convex forms. Also columnar to granular, botryoidal, and stalactitic shapes; also lamellar, laminæ joined parallel to c, and variously bent, thick or thin; also granular, friable or compact.

Parting: c, due to lamellar structure; also r, caused by twinning. Fracture subconchoidal to uneven. Brittle in compact forms; elastic in thin laminæ; soft and unctuous in some loosely adherent scaly varieties. H. = 5·5–6·5. G. = 4·9–5·3; of crystals mostly 5·20–5·25; of some compact varieties, as low as 4·2. Luster metallic and occasionally splendent; sometimes dull. Color dark steel-gray or iron-black; in very thin particles blood-red by transmitted light; when earthy, red. Streak cherry-red or reddish brown. Opaque, except when in very thin laminæ.

Var. 1. *Specular*. Luster metallic, and crystals often splendent, whence the name *specular iron* (Glanzeisenerz *Germ.*). When the structure is foliated or micaceous, the ore is called *micaceous* hematite (Eisenglimmer *Germ.*); some of the micaceous varieties are soft and unctuous (Eisenrahm *Germ.*). Some varieties are magnetic, but probably from admixed magnetite (Arts. **424**, **426**).

2. *Compact columnar;* or fibrous. The masses often long radiating; luster submetallic to metallic; color brownish red to iron-black. Sometimes called *red hematite*, to contrast it with limonite and turgite. Often in reniform masses with smooth fracture, called *kidney ore*.

3. *Red Ocherous*. Red and earthy. *Reddle* and *red chalk* are red ocher, mixed with more or less clay.

4. *Clay Iron-stone; Argillaceous hematite*. Hard, brownish black to reddish brown, often in part deep red; of submetallic to unmetallic luster; and affording, like all the preceding, a red streak. It consists of oxide of iron with clay or sand, and sometimes other impurities.

Comp.—Iron sesquioxide, Fe_2O_3 = Oxygen 30, iron 70 = 100. Sometimes contains titanium and magnesium, and is thus closely related to ilmenite, p. 336.

Pyr., etc.—B.B. infusible; on charcoal in R.F. becomes magnetic; with borax gives the iron reactions. With soda on charcoal in R.F. is reduced to a gray magnetic metallic powder. Soluble in concentrated hydrochloric acid.

Diff.—Distinguished from magnetite by its *red streak*, also from limonite by the same means, as well as by its not containing water; from turgite by its greater hardness and by not decrepitating B.B. It is *hard* in all but some micaceous varieties (hence easily distinguished from the black sulphides); also *infusible*, and B.B. becomes strongly magnetic.

Obs.—This ore occurs in rocks of all ages. The specular variety is mostly confined to crystalline or metamorphic rocks, but is also a result of igneous action about some volcanoes, as at Vesuvius. Many of the geological formations contain the argillaceous variety or clay iron-stone, which is mostly a marsh-formation, or a deposit over the bottom of shallow, stagnant water; but this kind of clay iron-stone (that giving a red powder) is less common than the corresponding variety of limonite. The beds that occur in metamorphic rocks are sometimes of very great thickness, and, like those of magnetite in the same situation, have resulted from the alteration of stratified beds of ore, originally of marsh origin, which were formed at the same time with the enclosing rocks, and underwent metamorphism, or a change to the crystalline condition, at the same time.

Beautiful crystallizations of this species are brought from the island of Elba, which has afforded it from a very remote period; the surfaces of the crystals often present an irised tarnish and brilliant luster. St. Gothard affords beautiful specimens, composed of crystallized tables grouped in the form of rosettes (*Eisenrosen*): near Limoges, France, in large crystals; fine crystals are the result of volcanic action at Etna and Vesuvius. Arendal in Norway, Långban and Nordmark in Sweden, Framont in Lorraine, Dauphiné, Binnenthal and Tavetsch, Switzerland, also Cleator Moor in Cumberland, afford splendid specimens.

Red hematite occurs in reniform masses of a fibrous concentric structure, near Ulverstone in Lancashire, in Saxony, Bohemia, and the Harz.

In *N. America*, widely distributed, and sometimes in beds of vast thickness in rocks of the Archæan age, as in the upper peninsula of Michigan, in the Marquette district, also in Menominee county and west of Lake Agogebic in Gogebic county; further through northern Wisconsin, in Florence, Ashland and Dodge Cos., and in Minnesota near Vermilion lake, St. Louis Co.; in Missouri, at the Pilot Knob and the Iron Mtn.

In New York, in Oneida, Herkimer, Madison, Wayne Cos., a lenticular argillaceous var., constituting one or two beds in the Clinton group of the Upper Silurian; the same in Pennsylvania, and as far south as Alabama; and in Canada, and Wisconsin to the west; in Alabama there are extensive beds; prominent mines are near Birmingham. Besides these regions of enormous beds, there are numerous others of workable value, either crystallized or argillaceous. Some of these localities, interesting for their specimens, are in northern New York, at Gouverneur, Antwerp, Hermon, Edwards, Fowler, Canton, etc.; Woodstock and Aroostook, Me.; at Hawley, Mass., a micaceous variety; in North and South Carolina a micaceous variety in schistose rocks, constituting the so-called *specular schist*, or *itabirite*.

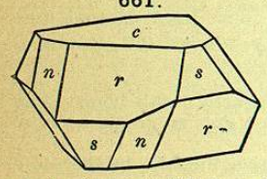
Named *hematite* from *αἷμα, blood.*

MARTITE. Iron sesquioxide under an isometric form, occurring in octahedrons or dodecahedrons like magnetite, and believed to be pseudomorphous after magnetite; perhaps in part also after pyrite. Parting octahedral like magnetite. Fracture conchoidal. H. = 6–7. G. = 4·8 (Brazil) to 5·3 (Monroe). Luster submetallic. Color iron-black, sometimes with a bronzed tarnish. Streak reddish brown or purplish brown. Not magnetic, or only feebly so. The crystals are sometimes embedded in the massive sesquioxide. They are distinguished from magnetite by the red streak, and very feeble, if any, action on the magnetic needle. Found in the Marquette iron region south of Lake Superior, where crystals are common in the ore; Monroe, N. Y.; Digby Co., N. S.; at the Cerro de Mercado, Durango, Mexico, in large octahedrons; in the schists of Minas Geraes, Brazil; near Rittersgrün, Saxony.

ILMENITE or MENACCANITE. Titanic Iron Ore. Titaneisen *Germ.*

Tri-rhombohedral; Axis $\dot{c} = 1{\cdot}3846$.

661.



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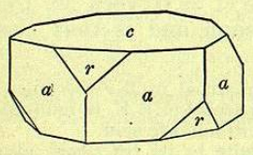


cr, $0001 \wedge 10\bar{1}1 = 57° 58\frac{1}{2}'$.
rr', $10\bar{1}1 \wedge \bar{1}101 = 94° 29'$.
cn, $0001 \wedge 22\bar{4}3 = 61° 33'$.

Crystals usually thick tabular; also acute rhombohedral. Often in thin plates or laminæ. Massive, compact; in embedded grains, also loose as sand.

Fracture conchoidal. H. = 5–6. G. = 4·5–5. Luster submetallic. Color iron-black. Streak submetallic, powder black to brownish red. Opaque. Influences slightly the magnetic needle.

Comp., Var.—If normal, $FeTiO_3$ or FeO,TiO_2 = Oxygen 31·6, titanium 31·6, iron 36·8 = 100. Sometimes written $(Fe,Ti)_2O_3$, but probably to be regarded as an iron titanate. Sometimes also contains magnesium (*picrotitanite*), replacing the ferrous iron; hence the general formula $(Fe,Mg)O.TiO_2$ (Penfield).

Pyr., etc.—B.B. infusible in O.F., although slightly rounded on the edges in R.F. With borax and salt of phosphorus reacts for iron in O.F., and with the latter flux assumes a more or less intense brownish-red color in R.F.; this treated with tin on charcoal changes to a violet-red color when the amount of titanium is not too small. The pulverized mineral, heated with hydrochloric acid, is slowly dissolved to a yellow solution, which, filtered from the undecomposed mineral and boiled with the addition of tin-foil, assumes a beautiful blue or violet color. Decomposed by fusion with bisulphate of sodium or potassium.

Diff.—Resembles hematite, but has a submetallic, nearly black, streak; not magnetic like magnetite.

Obs.—Occurs, as an accessory component, in many igneous rocks in grains, assuming

the place of magnetite, especially in gabbros and diorites. In these occurrences, it is often found in veins or large segregated masses near the borders of the igneous rock where it is supposed to have formed by local differentiation or fractional crystallization in the molten mass. Some principal European localities are St. Cristophe, Dauphiné (var. *crichtonite*); Miask in the Ilmen Mts. (*ilmenite*); in the form of sand at Menaccan, Cornwall (*menaccanite*); Gastein in Tyrol (*kibdelophane*); Iserwiese (*iserine*). One of the most remarkable is at Kragerö, Norway, where it occurs in veins or beds in diorite, which sometimes afford crystals weighing over 16 pounds. Others are Egersund, Arendal, Snarum in Norway; St. Gothard, etc.

Fine crystals, sometimes an inch in diameter, occur in Warwick, Amity, and Monroe, Orange Co., N. Y.; Litchfield, Conn. (*washingtonite*). Vast deposits or beds of titanic ore occur at Bay St. Paul in Quebec, Canada, in syenite; also in the Seignory of St. Francis, Beauce Co. Grains are found in the gold sand of California.

The titanic iron of massive rocks is extensively altered to a dull white opaque substance, called *leucoxene* by Gümbel. This for the most part is to be identified with titanite.

Pyrophanite. Manganese titanate, $MnTiO_3$. In thin tabular rhombohedral crystals and scales, near ilmenite in form (p. 332). H. = 5. G. = 4·537. Luster vitreous to submetallic. Color deep blood-red. Streak ocher-yellow. From the Harstig mine, Pajsberg, Sweden.

III. Intermediate Oxides.

The species here included are retained among the oxides, although chemically considered they are properly oxygen-salts, aluminates, ferrates, manganates, etc., and hence in a strict classification to be placed in section 5 of the Oxygen-salts. The one well-characterized group is the Spinel Group.

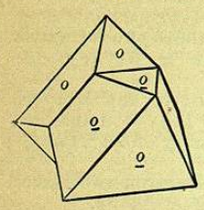
Spinel Group. $\overset{II\,III}{RR_2O_4}$ or $\overset{II}{R}O.\overset{III}{R}_2O_3$. Isometric.	
Spinel	$MgO.Al_2O_3$
Ceylonite	$(Mg,Fe)O.Al_2O_3$
Chlorospinel	$MgO.(Al,Fe)_2O_3$
Picotite	$(Mg,Fe)O.(Al,Cr)_2O_3$
Hercynite	$FeO.Al_2O_3$
Gahnite (Automolite)	$ZnO.Al_2O_3$
Dysluite	$(Zn,Fe,Mn)O.(Al,Fe)_2O_3$
Kreittonite	$(Zn,Fe,Mg)O.(Al,Fe)_2O_3$
Magnetite	$FeO.Fe_2O_3$
	$(Fe,Mg)O.Fe_2O_3$
Magnesioferrite	$MgO.Fe_2O_3$
Franklinite	$(Fe,Zn,Mn)O.(Fe,Mn)_2O_3$
Jacobsite	$(Mn,Mg)O.(Fe,Mn)_2O_3$
Chromite	$FeO.Cr_2O_3$
	$(Fe,Mg)O.(Cr,Fe)_2O_3$

The species of Spinel Group are characterized by isometric crystallization, and, further, the octahedron is throughout the common form. All of the species are *hard;* those with unmetallic luster up to 7·5–8, the others from 5·5 to 6·5.

SPINEL.

Isometric. Usually in octahedrons, rarely cubic. Twins: tw.-pl. and comp.-face *o* common (Fig. 663), hence often called *spinel-twins;* also repeated and polysynthetic, producing tw. lamellæ.

663.



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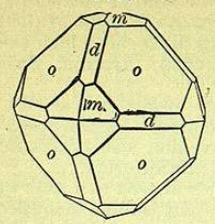


Cleavage: *o* imperfect. Fracture conchoidal. Brittle. H. = 8. G. = 3·5–4·1. Luster vitreous; splendent to nearly dull. Color red of various shades, passing into blue, green, yellow, brown and black; occasionally almost white. Streak white. Transparent to nearly opaque. Refractive index: n_y = 1·7155 Na, Dx.

Comp., Var.—Magnesium aluminate, $MgAl_2O_4$ or $MgO.Al_2O_3$ = Alumina 71·8, magnesia 28·2 = 100. The magnesium may be in part replaced by ferrous iron or manganese, and the aluminium by ferric iron and chromium.

Var.—Ruby Spinel or *Magnesia Spinel.*—Clear red or reddish; transparent to translucent; sometimes subtranslucent. G. = 3·63–3·71. Composition normal, with little or no iron, and sometimes chromium oxide to which the red color has been ascribed. The varieties are: (*a*) *Spinel-Ruby*, deep red; (*b*) *Balas-Ruby*, rose-red; (*c*) *Rubicelle*, yellow or orange-red; (*d*) *Almandine*, violet.

Ceylonite or *Pleonaste, Iron-Magnesia Spinel.*—Color dark green, brown to black, mostly opaque or nearly so; G. = 3·5–3·6. Contains iron replacing the magnesium and perhaps also the aluminium, hence the formula $(Mg,Fe)O.Al_2O_3$ or $(Mg,Fe)O.(Al,Fe)_2O_3$.

Chlorospinel or *Magnesia-Iron Spinel.*—Color grass-green, owing to the presence of copper; G. = 3·591–3·594. Contains iron replacing the aluminium, $MgO.(Al,Fe)_2O_3$.

Picotite or *Chrome-Spinel.*—Contains chromium and also has the magnesium largely replaced by iron, $(Mg,Fe)O.(Al,Cr)_2O_3$, hence lying between spinel proper and chromite. G. = 4·08. Color dark yellowish brown or greenish brown. Translucent to nearly opaque.

Pyr., etc.—B.B. alone infusible. Slowly soluble in borax, more readily in salt of phosphorus, with which it gives a reddish bead while hot, becoming faint chrome-green on cooling. Black varieties give reactions for iron with the fluxes. Soluble with difficulty in concentrated sulphuric acid. Decomposed by fusion with potassium bisulphate.

Diff.—Distinguished by its octahedral form, hardness, and infusibility; zircon has a higher specific gravity; the true ruby (p. 333) is harder and is distinguished optically; garnet is softer and fusible.

Obs.—Spinel occurs embedded in granular limestone, and with calcite in serpentine, gneiss, and allied rocks. Ruby spinel is a common associate of the true ruby. Common spinel is often associated with chondrodite. It also occupies the cavities of masses ejected from some volcanoes. Spinel (common spinel, also picotite and chromite) occurs as an accessory constituent in many basic igneous rocks, especially those of the peridotite group; it is the result of the crystallization of a magma very low in silica, high in magnesia and containing alumina; since, as in many of the peridotites alkalies are absent, feldspars cannot form, and the Al_2O_3 and Cr_2O_3 (also Fe_2O_3 perhaps) are compelled to form spinel (or corundum). The serpentines which yield spinel are altered peridotites.

In Ceylon, in Siam, and other eastern countries, occurs of beautiful colors, as rolled pebbles; in upper Burma with the ruby (cf. p. 334). Pleonaste is found at Candy, in Ceylon; at Åker, in Sweden, a pale blue and pearl-gray variety in limestone; small black splendent crystals occur in the ancient ejected masses of Monte Somma; also at Pargas, Finland, with chondrodite, etc.; in compact gehlenite at Monzoni, in the Fassa valley.

From Amity, N. Y., to Andover, N. J., a distance of about 30 miles, is a region of granular limestone and serpentine, in which localities of spinel abound; colors, green, black, brown, and less commonly red, along with chondrodite and other minerals. Localities are numerous about Warwick, and also at Monroe and Cornwall; Gouverneur, 2 m. N. and ¾ m. W. of Somerville, St. Lawrence Co.; green, blue, and occasionally red varieties occur at Bolton, Boxborough, etc., Mass. Franklin, N. J., affords crystals of various shades of black, blue, green, and red; Newton, Sterling, Sparta, Hamburgh and Vernon, N. J., are other localities. With the corundum of North Carolina, as at the Culsagee mine, near Franklin, Macon Co.; similarly at Dudleyville, Alabama. Spinel ruby at Gold Bluff, Humboldt Co., Cal.

Good black spinel is found in Burgess, Ontario; a bluish spinel having a rough cubic form occurs at Wakefield, Ottawa Co.; blue with clintonite at Daillebout, Joliette Co., Quebec.

Hercynite. Iron Spinel, $FeAl_2O_4$. Isometric; massive, fine granular. H. = 7·5–8. G. = 3·91–3·95. Color black. From Ronsberg, at the eastern foot of the Böhmerwald. A related iron-alumina spinel, with about 9 p. c. MgO, occurs with magnetite and corundum in Cortlandt township, Westchester Co., N. Y.

GAHNITE. Zinc-Spinel.

Isometric. Habit octahedral, often with faces striated ‖ edge *d/o*; also less commonly in dodecahedrons and modified cubes. Twins: tw.-pl. *o*.

Cleavage: *o* indistinct. Fracture conchoidal to uneven. Brittle. H. = 7·5–8. G. = 4·0–4·6. Luster vitreous, or somewhat greasy. Color dark green, grayish green, deep leek-green, greenish black, bluish black, yellowish, or grayish brown; streak grayish. Subtransparent to nearly opaque.

Comp., Var.—Zinc aluminate, $ZnAl_2O_4$ = Alumina 55·7, zinc oxide 44·3 = 100. The zinc is sometimes replaced by manganese or ferrous iron, the aluminium by ferric iron.

Var.—Automolite, or *Zinc Gahnite.*—$ZnAl_2O_4$, with sometimes a little iron. G. = 4·1–4·6. Colors as above given.

Dysluite, or *Zinc-Manganese-Iron Gahnite.*—$(Zn,Fe,Mn)O.(Al,Fe)_2O_3$. Color yellowish brown or grayish brown. G. = 4–4·6.

Kreittonite, or *Zinc-Iron Gahnite.*—$(ZnFe,Mg)O.(Al,Fe)_2O_3$. In crystals, and granular massive. H = 7–8. G. = 4·48–4·89. Color velvet-black to greenish black; powder grayish green. Opaque.

Pyr., etc.—Gives a coating of zinc oxide when treated with a mixture of borax and soda on charcoal; otherwise like spinel.

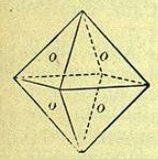
Obs.—Occurs in talcose schist at Falun, Sweden (*automolite*); at Tiriola, Calabria; at Bodenmais, Bavaria (*kreittonite*); Minas Geraes, Brazil. In the U. S., at Franklin Furnace, N. J., with franklinite and willemite; also at Sterling Hill, N. J. (*dysluite*); with pyrite at Rowe, Mass.; at a feldspar quarry in Delaware Co., Penn.; sparingly at the Deake mica mine, Mitchell Co., N. C.; at the Canton Mine, Georgia; with galena, chalcopyrite, pyrite at the Cotopaxi mine, Chaffee Co., Colo.

Named after the Swedish chemist Gahn. The name *Automolite*, of Ekeberg, is from *αὐτόμολος, a deserter*, alluding to the fact of the zinc occurring in an unexpected place.

MAGNETITE. Magnetic Iron Ore. Magneteisenstein, Magneteisenerz.

Isometric. Most commonly in octahedrons, also in dodecahedrons with faces striated ‖ edge *d/o* from oscillatory combination; in dendrites between plates of mica; crystals sometimes highly modified; cubic forms rare. Twins: tw.-pl. *o*, sometimes as polysynthetic twinning lamellæ, producing

665.



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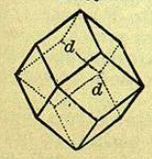

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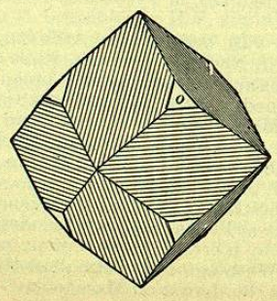

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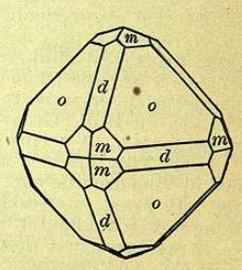

striations on an octahedral face and often a pseudo-cleavage (Fig. 456, p. 136). Massive with laminated structure; granular, coarse or fine; impalpable.

Cleavage not distinct; parting octahedral, often highly developed. Fracture subconchoidal to uneven. Brittle. H. = 5·5–6·5. G. = 5·168–5·180 crystals. Luster metallic and splendent to submetallic and rather dull. Color iron-black. Streak black. Opaque, but in thin dendrites in mica nearly transparent and pale brown to black. Strongly magnetic; sometimes possessing polarity (lodestone).

Comp., Var.—$\overset{II}{Fe}\overset{III}{Fe_2}O_4$ or $FeO.Fe_2O_3$ = Iron sesquioxide 69·0, iron protoxide 31·0 = 100; or, Oxygen 27·6, iron 72·4 = 100. The ferrous iron sometimes replaced by magnesium, and rarely nickel; also sometimes contains titanium (up to 6 p. c. TiO_2).

Var.—*Ordinary.*—(*a*) In crystals. (*b*) Massive, with pseudo-cleavage, also granular, coarse or fine. (*c*) As loose sand. (*d*) Ocherous: a black earthy kind. Ordinary magnetite is attracted by a magnet but has no power of attracting particles of iron itself. The property of polarity which distinguishes the *lodestone* (less properly written loadstone) is exceptional.

Magnesian. Talk-Eisenerz.—G. = 4·41–4·42; luster submetallic; weak magnetic; in crystals from Sparta, N. J., and elsewhere.

Manganesian.—Containing 3·8 to 6·3 p. c. manganese (*Manganmagnetite*). From Vester Silfberg, Sweden.

Pyr., etc.—B.B. very difficultly fusible. In O.F. loses its influence on the magnet. With the fluxes reacts like hematite. Soluble in hydrochloric acid.

Diff.—Distinguished from other members of the spinel group, as also from garnet, by its being attracted by the magnet, as well as by its high specific gravity; franklinite and chromite are only feebly magnetic (if at all), and have a brown or blackish-brown streak; also, when massive, by its black streak from hematite and limonite; much harder than tetrahedrite.

Obs.—Magnetite is mostly confined to crystalline rocks, and is most abundant in metamorphic rocks, though widely distributed also in grains in eruptive rocks. In the Archæan rocks the beds are of immense extent, and occur under the same conditions as those of hematite. It is an ingredient in most of the massive variety of corundum called emery. The earthy magnetite is found in bogs like bog-iron ore. Occurs in meteorites, and forms the crust of meteoric irons.

Present in dendrite-like forms in the mica of many localities following the direction of the lines of the percussion-figure, and perhaps of secondary origin. A common alteration-product of minerals containing iron protoxide, *e.g.*, present in veins in the serpentine resulting from altered chrysolite.

The beds of ore at Arendal, Norway, and nearly all the celebrated iron mines of Sweden, consist of massive magnetite, as at Dannemora and the Täberg in Småland. Falun, in Sweden, and Corsica, afford octahedral crystals, embedded in chlorite slate. Splendid dodecahedral crystals occur at Nordmark in Wermland. The most powerful native magnets are found in Siberia, and in the Harz; they are also obtained on the island of Elba. Other localities for the crystallized mineral are Traversella in Piedmont; Achmatovsk in the Ural; Scalotta, near Predazzo, in Tyrol, also Rothenkopf and Wildkreuzjoch; the Binnenthal, Switzerland.

In N. America, it constitutes vast beds in the Archæan, in the Adirondack region, Warren, Essex, and Clinton Cos., in Northern N. York, while in St. Lawrence Co. the iron ore is mainly hematite; fine crystals and masses showing broad parting surfaces and yielding large pseudo-crystals are obtained at Port Henry, Essex Co.; similarly in New Jersey; in Canada, in Hull, Grenville, Madoc, etc.; at Cornwall in Pennsylvania, and Magnet Cove, Arkansas. It occurs also in *N. York*, in Saratoga, Herkimer, Orange, and Putnam Cos.; at the Tilly Foster iron mine, Brewster, Putnam Co., in crystals and massive accompanied by chondrodite, etc. In *N. Jersey*, at Hamburg, near Franklin Furnace and elsewhere. In *Penn.*, at Goshen, Chester Co., and at the French Creek mines; delineations forming hexagonal figures, in mica at Pennsbury. Good lodestones are obtained at Magnet Cove, Arkansas. In *California*, in Sierra Co., abundant, massive, and in crystals; in Plumas Co.; and elsewhere. In Washington, in large deposits

Named from the loc. *Magnesia*, bordering on Macedonia. But Pliny favors Nicander's derivation from Magnes, who first discovered it, as the fable runs, by finding, on taking his herds to pasture, that the nails of his shoes and the iron ferrule of his staff adhered to the ground.

FRANKLINITE.

Isometric. Habit octahedral; edges often rounded, and crystals passing into rounded grains. Massive, granular, coarse or fine to compact.

Pseudo-cleavage, or parting, octahedral, as in magnetite. Fracture conchoidal to uneven. Brittle. H. = 5·5–6·5. G. = 5·07–5·22. Luster metallic, sometimes dull. Color iron-black. Streak reddish brown or black. Opaque. Slightly magnetic.

Comp.—$(Fe,Zn,Mn)O.(Fe,Mn)_2O_3$, but varying rather widely in the relative quantities of the different metals present, while conforming to the general formula of the spinel group.

Pyr., etc.—B.B. infusible. With borax in O.F. gives a reddish amethystine bead (manganese), and in R.F. this becomes bottle-green (iron). With soda gives a bluish-green manganate, and on charcoal a faint coating of zinc oxide, which is much more marked when a mixture with borax and soda is used. Soluble in hydrochloric acid, sometimes with evolution of a small amount of chlorine.

Diff.—Resembles magnetite, but is only slightly attracted by the magnet, and has a dark brown streak; it also reacts for zinc on charcoal B.B.

Obs.—Occurs in cubic crystals near Eibach in Nassau; in amorphous masses at Altenberg, near Aix-la-Chapelle. Abundant at Mine Hill, Franklin Furnace, N. J., with willemite and zincite in granular limestone; also at Sterling Hill, two miles distant, associated with willemite.

Magnesioferrite. Magnoferrite. $MgFeO_4$. In octahedrons. H. = 6–6·5. G. = 4·568–4·654. Luster, color, and streak as in magnetite. Strongly magnetic. Formed about the fumaroles of Vesuvius, and especially those of the eruption of 1855.

Jacobsite. $(Mn,Mg)O.(Fe,Mn)_2O_3$. Isometric; in distorted octahedrons. H. = 6. G. = 4·75. Color deep black. Magnetic. From Jakobsberg, in Nordmark, Wermland, Sweden; also at Långban.

CHROMITE.

Isometric. In octahedrons. Commonly massive; fine granular to compact.

Fracture uneven. Brittle. H. = 5·5. G. = 4·32–4·57. Luster submetallic to metallic. Color between iron-black and brownish black, but sometimes yellowish red in very thin sections. Streak brown. Translucent to opaque. Sometimes feebly magnetic.

Comp.—$FeCr_2O_4$ or FeO,Cr_2O_3 = Chromium sesquioxide 68·0, iron protoxide 32·0 = 100.

The iron may be replaced by magnesium; also the chromium by aluminium and ferric iron. The varieties containing but little chromium (up to 10 p. c.) are hardly more than varieties of spinel and are classed under picotite, p. 338.

Pyr., etc.—B.B. in O.F. infusible; in R.F. slightly rounded on the edges, and becomes magnetic. With borax and salt of phosphorus gives beads which, while hot, show only a reaction for iron, but on cooling become chrome-green; the green color is heightened by fusion on charcoal with metallic tin. Not acted upon by acids, but decomposed by fusion with potassium or sodium bisulphate.

Diff.—Distinguished from magnetite by feebly magnetic properties, streak and by yielding the reaction for chromic acid with the blowpipe.

Obs.—Occurs in serpentine, forming veins, or in embedded masses. It assists in giving the variegated color to verde-antique marble. Not uncommon in meteoric irons, sometimes in nodules as in the Coahuila iron, less often in crystals (Lodran).

Occurs in the Gulsen mountains, near Kraubat in Styria; in crystals in the islands of Unst and Fetlar, in Shetland; in the province of Trondhjem in Norway; in the Department du Var in France; in Silesia and Bohemia; abundant in Asia Minor; in the Eastern and Western Urals; in New Caledonia, affording ore for commerce.

At Baltimore, Md., in the Bare Hills, in veins or masses in serpentine; also in Montgomery Co., etc. In Pennsylvania, Chester Co., near Unionville, abundant; at Wood's Mine, near Texas, Lancaster Co., very abundant. Massive and in crystals at Hoboken, N.

J., in serpentine and dolomite. In the southwestern part of the town of New Fane, etc., Vt. In California, in Monterey Co.; also Santa Clara Co., near the N. Almaden mine.

CHRYSOBERYL. Cymophane.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}4701 : 1 : 0{\cdot}5800$.

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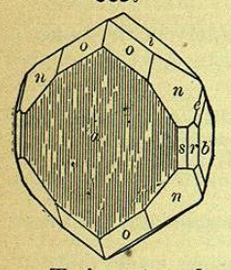

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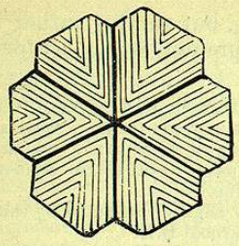

mm''',	$110 \wedge 1\bar{1}0$ =	50° 21′.
ss',	$120 \wedge \bar{1}20$ =	93° 32′.
xx',	$101 \wedge \bar{1}01$ =	101° 57′.
ii',	$011 \wedge 0\bar{1}1$ =	60° 14′.
$\rho\rho'$,	$031 \wedge 0\bar{3}1$ =	120° 14′.
oo',	$111 \wedge \bar{1}11$ =	93° 44′.
oo''',	$111 \wedge 1\bar{1}1$ =	40° 7′.
nn',	$121 \wedge \bar{1}21$ =	77° 43′.

Twins: tw. pl. ρ (031), both contact- and penetration-twins; often repeated and forming pseudo-hexagonal crystals with or without re-entrant angles (Fig. 357, p. 122). Crystals generally tabular $\parallel a$. Face a striated vertically, in twins a feather-like striation (Fig. 670).

Cleavage: i (011) quite distinct; b imperfect; a more so. Fracture uneven to conchoidal. Brittle. H. = 8·5. G. = 3·5–3·84. Luster vitreous. Color asparagus-green, grass-green, emerald-green, greenish white, and yellowish green; greenish brown; yellow; sometimes raspberry- or columbine-red by transmitted light. Streak uncolored. Transparent to translucent. Sometimes a bluish opalescence or chatoyancy, and asteriated. Pleochroic, vibrations $\parallel$ b (= $\bar{b}$) orange-yellow, c (= $\dot{c}$) emerald-green, a (= $\breve{a}$) columbine-red. Optically +. Ax. pl. $\parallel b$. Bx $\perp c$. $\beta = 1{\cdot}7484$. $2E = 84° 43'$.

Var. 1. *Ordinary.*—Color pale-green, being colored by iron; also yellow and transparent and then used as a gem.

2. *Alexandrite.*—Color emerald-green, but columbine-red by transmitted light; valued as a gem. G. = 3·644, mean of results. Supposed to be colored by chromium. Crystals often very large, and in twins, like Fig. 357, either six-sided or six-rayed.

3. *Cat's-eye.*—Color greenish and exhibiting a fine chatoyant effect; from Ceylon.

Comp.—Beryllium aluminate, $BeAl_2O_4$ or $BeO.Al_2O_3$ = Alumina 80·2, glucina 19·8 = 100.

Pyr., etc.—B.B. alone unaltered; with soda, the surface is merely rendered dull. With borax or salt of phosphorus fuses with great difficulty. With cobalt solution, the powdered mineral gives a bluish color. Not attacked by acids.

Diff.—Distinguished by its extreme hardness, greater than that of topaz; by its infusibility; also characterized by its tabular crystallization, in contrast with beryl.

Obs.—In Minas Geraes, Brazil, and also in Ceylon, in rolled pebbles; at Marschendorf in Moravia; in the Ural, 85 versts from Ekaterinburg, in mica slate with beryl and phenacite, the variety *alexandrite;* in the Orenburg district, S. Ural, yellow; in the Mourne Mts., Ireland.

In the U. S., at Haddam, Ct., in granite traversing gneiss, with tourmaline, garnet, beryl; at Greenfield, near Saratoga, N. Y., with tourmaline, garnet, and apatite; Norway, Me., in granite with garnet; also at Stoneham, with fibrolite, etc.

Chrysoberyl is from *χρύσος, golden, βήρυλλος, beryl. Cymophane*, from *κῦμα, wave*, and *φαίνω, appear*, alludes to a peculiar opalescence the crystals sometimes exhibit. *Alexandrite* is after the Czar of Russia, Alexander I.

Hausmannite. Mn_3O_4 or $MnO.M_2O_3$. In tetragonal octahedrons and twins (Fig. 376, p. 125); also granular massive, particles strongly coherent. H. = 5–5·5. G. = 4·856. Luster submetallic. Color brownish black. Streak chestnut-brown. Occurs near Ilmenau in Thuringia; Ilefeld in the Harz; Filipstad, Långban, Nordmark, in Sweden.

Minium. Mennige *Germ.* Pb_3O_4 or $2PbO.PbO_2$. Pulverulent, as crystalline scales. G. = 4·6. Color vivid red, mixed with yellow; streak orange-yellow. Occurs at Bleialf in the Eifel; Badenweiler in Baden, etc.

Crednerite. $Cu_3Mn_4O_9$ or $3CuO.2Mn_2O_3$. Foliated crystalline. H. = 4·5. G. = 4·9–5·1. Luster metallic. Color iron-black to steel-gray. Streak black, brownish. From Friedrichsrode.

Pseudobrookite. Probably $Fe_4(TiO_4)_3$. Usually in minute orthorhombic crystals, tabular $\parallel a$ and often prismatic $\parallel \bar{b}$. G. = 4·4–4·98. Color dark brown to black. Streak ocher-yellow. Found with hypersthene (szaboite) in cavities of the andesite of Aranyer Berg, Transylvania, and elsewhere; on recent lava (1872) from Vesuvius; at Havredal, Bamle, Norway, embedded in kjerulfine (wagnerite) altered to apatite.

BRAUNITE.

Tetragonal. Axis $\dot{c} = 0{\cdot}9850$. Commonly in octahedrons, nearly isometric in angle ($pp' = 70° 7'$). Also massive.

Cleavage: p perfect. Fracture uneven to subconchoidal. Brittle. H. = 6–6·5. G. = 4·75–4·82. Luster submetallic. Color dark brownish black to steel-gray. Streak same.

Comp.—$3Mn_2O_3.MnSiO_3$ = Silica 10·0, manganese protoxide 11·7, manganese sesquioxide 78·3 = 100.

Pyr., etc.—B.B. infusible. With borax and salt of phosphorus gives an amethystine bead in O.F., becoming colorless in R.F. With soda gives a bluish-green bead. Dissolves in hydrochloric acid evolving chlorine, and leaving a residue of gelatinous or flocculent silica (Rg.). Marceline gelatinizes with acids.

Obs.—Occurs in veins traversing porphyry, at Oehrenstock, near Ilmenau; near Ilefeld in the Harz; St. Marcel in Piedmont; at Elba; at Botnedal, Upper Tellemark, in Norway; at the manganese mines of Jakobsberg, Sweden, also at Långban, and at the Sjö mine, Grythyttan, Örebro. *Marceline* (heterocline) from St. Marcel, Piedmont, is impure braunite.

Bixbyite. Essentially $FeO.MnO_2$. In black isometric crystals. H. = 6–6.5. G. = 4·945. Occurs with topaz in cavities in rhyolite; from Utah.

IV. Dioxides, RO_2.

Rutile Group. Tetragonal.

		$\dot{c}$			$\dot{c}$
Cassiterite	SnO_2	0·6723	**Rutile**	TiO_2	0·6442
Polianite	MnO_2	0·6647	**Plattnerite**	PbO_2	0·6764

The Rutile Group includes the dioxides of the elements tin, manganese, titanium, and lead. These compounds crystallize in the tetragonal system with closely similar angles and axial ratio; furthermore in habit and method of twinning there is much similarity between the two best known species included here.

With the Rutile Group is also sometimes included Zircon, $ZrO_2.SiO_2$; $\dot{c} = 0{\cdot}6404$. In this work, however, Zircon is classed among the silicates, with the allied species Thorite, $ThO_2.SiO_2$, $\dot{c} = 0{\cdot}6402$.

A tetragonal form, approximating closely to that of the species of the Rutile Group, belongs also to a number of other species, as Sellaite, MgF_2; Tapiolite, $Fe(Ta,Nb)_2O_6$; Xenotime, YPO_4, etc.

It may be added that ZrO_2, as the species Baddeleyite, crystallizes in the monoclinic system.