

kinds of lava, and is sometimes found in them in glassy crystals, as in those of Etna, Vesuvius, the Sandwich Islands at Kilauea.

The labradoritic massive rocks are most common among the formations of the Archæan era. Such are part of those of British America, northern New York, Pennsylvania, Arkansas; those of Greenland, Norway, Finland, Sweden, and probably of the Vosges.

On the coast of Labrador, labradorite is associated with hornblende, hypersthene, and magnetite. It is met with in many places in Quebec. Occurs abundantly through the central Adirondack region in northern New York; in the Wichita Mts., Arkansas.

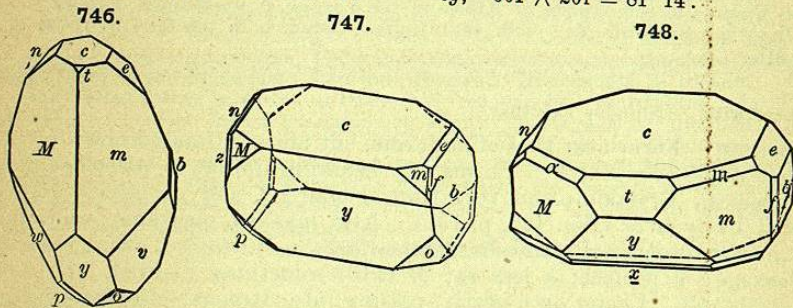
Labradorite was first brought from the Isle of Paul, on the coast of Labrador, by Mr. Wolfe, a Moravian missionary, about the year 1770.

**MASKELYNITE.** In colorless isotropic grains in meteorites; composition near labradorite.

**ANORTHITE.** Indianite.

Triclinic. Axes  $a : b : c = 0.6347 : 1 : 0.5501$ ;  $\alpha = 93^\circ 13'$ ,  $\beta = 115^\circ 55\frac{1}{2}'$ ,  $\gamma = 91^\circ 12'$ .

$bc$ , $010 \wedge 001 = 85^\circ 50'$ .	$cm$ , $001 \wedge 110 = 65^\circ 53'$ .
$mM$ , $110 \wedge \bar{1}\bar{1}0 = 59^\circ 29'$ .	$cM$ , $001 \wedge \bar{1}\bar{1}0 = 69^\circ 20'$ .
$bm$ , $010 \wedge 110 = 58^\circ 4'$ .	$cy$ , $001 \wedge \bar{2}01 = 81^\circ 14'$ .



Twins as with albite (p. 375 and p. 377). Crystals usually prismatic  $\parallel c$  (746, also Fig. 338, p. 108), less often elongated  $\parallel b$ , like pericline (Fig. 747). Also massive, cleavable, with granular or coarse lamellar structure.

Cleavage:  $c$  perfect;  $b$  somewhat less so. Fracture conchoidal to uneven. Brittle.  $H. = 6-6.5$ .  $G. = 2.74-2.76$ . Color white, grayish, reddish. Streak uncolored. Transparent to translucent.

Optically —. Ax. pl. nearly  $\perp e$  (021), and its trace inclined  $60^\circ$  to the edge  $c/e$  from left above behind to right in front below. Extinction-angles on  $c$ ,  $-34^\circ$  to  $-42^\circ$  with edge  $b/c$ ; on  $b$ ,  $-35^\circ$  to  $-43^\circ$  (Fig. 739, p. 375). Dispersion  $\rho < v$ , also inclined.  $2H_{ar} = 84^\circ 50'$ . Birefringence stronger than with albite,  $\gamma - \alpha = 0.013$ .

**Comp.**—A silicate of aluminium and calcium,  $CaAl_2Si_2O_8$  or  $CaO \cdot Al_2O_3 \cdot 2SiO_2$ , = Silica 43.2, alumina 36.7, lime 20.1 = 100. Soda (as  $NaAlSi_3O_8$ ) is usually present in small amount, and as it increases there is a gradual transition through bytownite to labradorite.

**Var.**—*Anorthite* was described from the glassy crystals of Somma; and *christianite* and *biotine* are the same mineral. *Thioursaite* is the same from Iceland. *Indianite* is a white, grayish, or reddish granular anorthite from India, where it occurs as the gangue of corundum, first described in 1802 by Count Bournon. *Cyclopite* occurs in small, transparent, and glassy crystals, tabular  $\parallel b$ , coating cavities in the dolerite of the Cyclopean Islands and near Trezza on Etna. *Amphodelite*, *lepolite*, *latrobite* also belong to anorthite.

**Pyr., etc.**—B.B. fuses at 5 to a colorless glass. Anorthite from Mte. Somma, and indianite from the Carnatic, are decomposed by hydrochloric acid, with separation of gelatinous silica.

**Obs.**—Occurs in some diorites; occasionally in connection with gabbro and serpentine rocks; in some cases along with corundum; in many volcanic rocks, andesites, basalts, etc.; as a constituent of some meteorites (Juvenas, Stannern).

Anorthite (*christianite* and *biotine*) occurs at Mount Vesuvius in isolated blocks among the old lavas in the ravines of Monte Somma; in the Albani Mts.; on the Pesmeda Alp, Monzoni, Tyrol, as a contact mineral; Aranyer Berg, Transylvania, in andesite; on Iceland; near Bogoslovsk in the Ural. In the Cyclopean Islands (*cyclopite*). In the lava of the island of Miyake, Japan.

*Anorthite* was named in 1823 by Rose from  $\alpha\nu\theta\rho\theta\acute{\iota}\varsigma$ , *oblique*, the crystallization being triclinic.

**Celsian.**  $BaAl_2Si_2O_8$ , similar to anorthite, but containing barium instead of calcium. Massive, with the usual cleavages  $c$  (001) and  $b$  (010),  $cb = 89^\circ 36'$ .  $H. = 6-6.5$ .  $G. = 3.37$ . Colorless. Extinction: on  $c$ ,  $3^\circ 10'$ ; on  $b$ ,  $26^\circ 45'$ . From Jakobsberg, Sweden.

## II. Metasilicates. $RSiO_3$ .

Salts of Metasilicic Acid,  $H_2SiO_3$ ; characterized by an oxygen ratio of 2 : 1 for silicon to bases. The Division closes with a number of species, in part of somewhat doubtful composition, forming a transition to the Orthosilicates.

The metasilicates include two prominent and well-characterized groups, viz., the Pyroxene Group and the Amphibole Group. There are also others less important.

### Leucite Group. Isometric.

In several respects leucite is allied to the species of the FELDSPAR GROUP, which immediately precede.

<b>Leucite</b>	$KAl(SiO_3)_2$	Isometric at $500^\circ$
		Pseudo-isometric at ordinary temperatures.
<b>Pollucite</b>	$H_2Cs_4Al_4(SiO_3)_8$	Isometric

### LEUCITE. Amphigène.

Isometric at  $500^\circ C.$ ; pseudo-isometric under ordinary conditions (see p. 230). Commonly in crystals varying in angle but little from the tetragonal trisoctahedron  $n$  (211), sometimes with  $a$  (100), and  $d$  (110) as subordinate forms. Faces often showing fine striations due to twinning (Fig. 749). Also in disseminated grains; rarely massive granular.

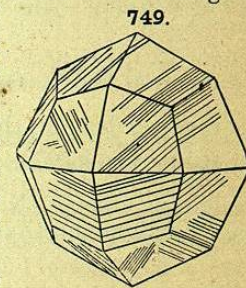
Cleavage:  $d$  (110) very imperfect. Fracture conchoidal. Brittle.  $H. = 5.5-6$ .  $G. = 2.45-2.50$ . Luster vitreous. Color white, ash-gray or smoke-gray. Streak uncolored. Translucent to opaque. Usually shows very feeble double refraction:  $\omega = 1.508$ ,  $\epsilon = 1.509$  (p. 230).

**Comp.**— $KAl(SiO_3)_2$  or  $K_2O \cdot Al_2O_3 \cdot 4SiO_2$ , = Silica 55.0, alumina 23.5, potash 21.5 = 100.

Soda is present only in small quantities, unless as introduced by alteration; traces of lithium, also of rubidium and caesium, have been detected.

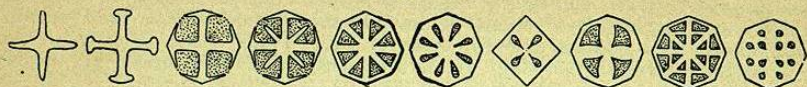
**Pyr., etc.**—B.B. infusible; with cobalt solution gives a blue color (aluminium). Decomposed by hydrochloric acid without gelatinization.

**Diff.**—Characterized by its trapezohedral form, absence of color, and infusibility. It is softer than garnet and harder than analcite; the latter yields water and fuses.



Recognized in thin sections by its extremely low refraction, isotropic character, and the symmetrical arrangement of inclusions (Fig. 750; also Fig. 471, p. 141). Larger crystals

750.



Leucite crystals from the leucitite of the Bearpaw Mts., Montana (Pirsson). These show the progressive growth from skeleton forms to complete crystals with glass inclusions.

are commonly not wholly isotropic and, further, show complicated systems of twinning-lines (Fig. 749); the birefringence is, however, very low, and the colors scarcely rise above dark gray; they are best seen by introduction of the quartz or selenite plate yielding red of the first order. The smaller leucites, which lack this twinning or the inclusions, are only to be distinguished from sodalite or analcite by chemical tests.

Obs.—Leucite occurs only in igneous rocks, and especially in recent lavas, as one of the products of crystallization of magmas rich in potash and low in silica (for which reason this species rather than orthoclase is formed). The larger embedded crystals are commonly anisotropic and show twinning lamellæ; the smaller ones, forming the groundmass, are isotropic and without twinning. Found in leucitites and leucite-basalts, leucitophyres, leucite-phonolites and leucite-tephrites; also in certain rocks occurring in dikes. Very rare in intruded igneous rocks, only one or two instances being known; but its former presence under such conditions is indicated by pseudomorphs, often of large size (*pseudoleucite*) consisting of nephelite and orthoclase, also of analcite.

The prominent localities are, first of all, Vesuvius and Mte. Somma, where it is thickly disseminated through the lava in grains, and in large perfect crystals; also in ejected masses; also near Rome, at Capo di Bove, Rocca Monfina, etc. Further in leucite-tephrite at Proceno near Lake Bolsena in central Italy; also about the Laacher See and at several points in the Eifel; at Rieden near Andernach; at Meiches in the Vogelsgebirge; in the Kaiserstuhlgebirge. Occurs in Brazil, at Pinhalzinho. From the Cerro de las Virgines, Lower California. In the United States it is present in a rock in the Green River Basin at the Leucite Hills, Wyoming; also in the Absaroka range, in northwestern Wyoming; in the Highwood and Bearpaw Mts., Montana (in part *pseudoleucite*). On the shores of Vancouver Island, where magnificent groups of crystals have been found as drift boulders.

*Pseudoleucite* (see above) occurs in the phonolite (*tinguite*) of the Serra de Tingua, Brazil; at Magnet Cove, Arkansas; near Hamburg, N. J.; Montana; also in the Cariboo Distr., British Columbia.

Named from *λευκός*, *white*, in allusion to its color.

**Pollucite.** Essentially  $H_2O \cdot 2Ca_2O \cdot 2Al_2O_3 \cdot 9SiO_2$ . Isometric; often in cubes; also massive.  $H = 6.5$ .  $G = 2.901$ . Colorless. Occurs very sparingly in the island of Elba; with petalite (*castorite*); also at Hebron and Rumford, Me.

### Pyroxene Group.

Orthorhombic, Monoclinic, Triclinic.

Composition for the most part that of a metasilicate,  $RSiO_3$ , with  $R = Ca, Mg, Fe$  chiefly, also  $Mn, Zn$ . Further  $RSiO_3$ , with  $\bar{R}(Fe, Al)_2SiO_6$ , less often containing alkalis ( $Na, K$ ), and then  $RSiO_3$ , with  $\bar{R}Al(SiO_3)_2$ . Rarely including zirconium and titanium, also fluorine.

#### $\alpha$ . Orthorhombic Section.

		$\bar{a} : \bar{b} : \bar{c}$	or	$\bar{b} : \bar{a} : \bar{c}$
<b>Enstatite</b>	$MgSiO_3$	0.9702 : 1 : 0.5710		1.0307 : 1 : 0.5885
<b>Bronzite</b>	$(Mg, Fe)SiO_3$			
<b>Hypersthene</b>	$(Fe, Mg)SiO_3$	0.9713 : 1 : 0.5704		1.0319 : 1 : 0.5872

The second set of axial ratios, with  $\bar{a} = 1$ , brings out the similarity of the form to the monoclinic species.

### $\beta$ . Monoclinic Section.

#### Pyroxene

$\bar{a} : \bar{b} : \bar{c}$   $\beta$   
1.0921 : 1 : 0.5893  $74^\circ 10'$

##### I. NON-ALUMINOUS VARIETIES:

- DIOPSIDE  $\left\{ \begin{array}{l} CaMg(SiO_3)_2 \\ Ca(Mg, Fe)(SiO_3)_2 \end{array} \right.$   
Malacolite, Salite, Diallage, etc.
- HEDENBERGITE  $CaFe(SiO_3)_2$   
Manganhedenbergite  $Ca(Fe, Mn)(SiO_3)_2$
- SCHEFFERITE  $(Ca, Mg)(Fe, Mn)(SiO_3)_2$   
Jeffersonite  $(Ca, Mg)(Fe, Mn, Zn)(SiO_3)_2$

##### II. ALUMINOUS VARIETIES:

- AUGITE  $\left\{ \begin{array}{l} Ca(Mg, Fe)(SiO_3)_2 \\ \text{with } (Mg, Fe)(Al, Fe)_2SiO_6 \end{array} \right.$   
Leucaugite, Fassaite, Augite, Ægirite-augite.

		$\bar{a} : \bar{b} : \bar{c}$	$\beta$
<b>Acmite</b> (Ægirite)	$NaFe^{III}(SiO_3)_2$	1.0996 : 1 : 0.6012	$73^\circ 11'$
<b>Spodumene</b>	$LiAl(SiO_3)_2$	1.1238 : 1 : 0.6355	$69^\circ 40'$
<b>Jadeite</b>	$NaAl(SiO_3)_2$	1.103 : 1 : 0.613	$72^\circ 44\frac{1}{2}'$
		$\bar{a} : \bar{b} : \bar{c}$	$\beta$
<b>Wollastonite</b>	$CaSiO_3$	1.0531 : 1 : 0.9676	$84^\circ 30'$
<b>Pectolite</b>	$HNaCa_2(SiO_3)_3$	1.1140 : 1 : 0.9864	$84^\circ 40'$

#### $\gamma$ . Triclinic Section.

		$\bar{a} : \bar{b} : \bar{c}$	$\alpha$	$\beta$	$\gamma$
<b>Rhodonite</b>	$MnSiO_3$	1.0729 : 1 : 0.6213	$103^\circ 18'$	$108^\circ 44'$	$81^\circ 39'$
	also $(Mn, Ca)SiO_3$				
	$(Mn, Fe)SiO_3$				
	$(Mn, Zn, Fe, Ca)SiO_3$				
<b>Babingtonite</b>		1.0691 : 1 : 0.6308	$104^\circ 21\frac{1}{2}'$	$108^\circ 31'$	$83^\circ 34'$
	$(Ca, Fe, Mn)SiO_3 \cdot Fe_2(SiO_3)_3$				

The rare species Rosenbuschite, Låvenite, Wöhlerite also belong under the monoclinic section and Hiertdahlite under the triclinic section of this group.

The PYROXENE GROUP embraces a number of species which, while falling in different systems—orthorhombic, monoclinic, and triclinic—are yet closely related in form. Thus all have a fundamental prism with an angle of  $93^\circ$  and  $87^\circ$ , parallel to which there is more or less distinct cleavage. Further, the angles in other prominent zones show a considerable degree of similarity. In composition the metasilicates of calcium, magnesium, and ferrous iron are most prominent, while compounds of the form  $\bar{R}(Al, Fe)_2SiO_6$ ,  $\bar{R}Al(SiO_3)_2$ , are also important.

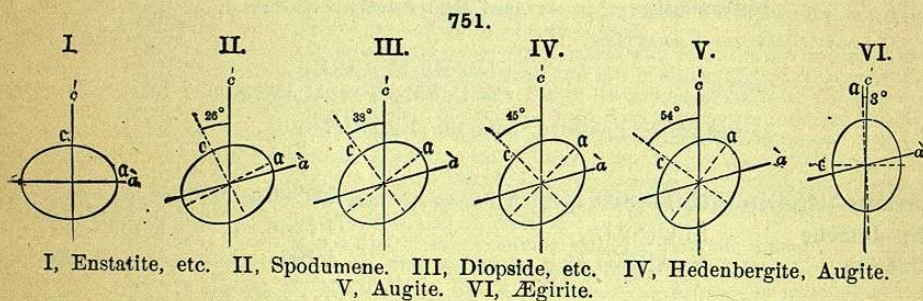
The species of the pyroxene group are closely related in composition to the corresponding species of the amphibole group, which also embraces members in the orthorhombic, monoclinic, and triclinic systems. In a number of cases the same chemical compound appears in each group; furthermore, a change

by paramorphism of pyroxene to amphibole is often observed. In form also the two groups are related, as shown in the axial ratio; also in the parallel growth of crystals of monoclinic amphibole upon or about those of pyroxene (Fig. 430, p. 131). The axial ratios for the typical monoclinic species are:

Pyroxene	$a : b : c = 1.0921 : 1 : 0.5893$	$\beta = 74^\circ 10'$
Amphibole	$a : \frac{1}{2}b : c = 1.1022 : 1 : 0.5875$	$\beta = 73^\circ 58'$

See further on p. 398.

The optical relations of the prominent members of the Pyroxene Group, especially as regards the connection between the position of the ether-axes and the crystallographic axes are exemplified in the following figures (Cross).



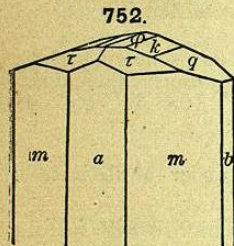
I, Enstatite, etc. II, Spodumene. III, Diopside, etc. IV, Hedenbergite, Augite. V, Augite. VI, Ægirite.

A corresponding exhibition of the prominent amphiboles is given under that group, Fig. 785, p. 398.

$\alpha$ . Orthorhombic Section.

ENSTATITE.

Orthorhombic. Axes  $a : b : c = 0.9702 : 1 : 0.5710$ .



Bamle.

$mm''$ ,  $110 \wedge \bar{1}10 = 88^\circ 16'$ .  $\tau\tau'$ ,  $223 \wedge \bar{2}23 = 40^\circ 16\frac{1}{2}'$ .  
 $qq'$ ,  $023 \wedge 0\bar{2}3 = 41^\circ 41'$ .  $\tau\tau''$ ,  $223 \wedge \bar{2}\bar{2}3 = 39^\circ 1\frac{1}{2}'$ .

Twins rare: tw. pl.  $h$  (014) as twinning lamellæ; also tw. pl. (101) as stellate twins crossing at angles of nearly  $60^\circ$ , sometimes six-rayed. Distinct crystals rare, habit prismatic. Usually massive, fibrous, or lamellar.

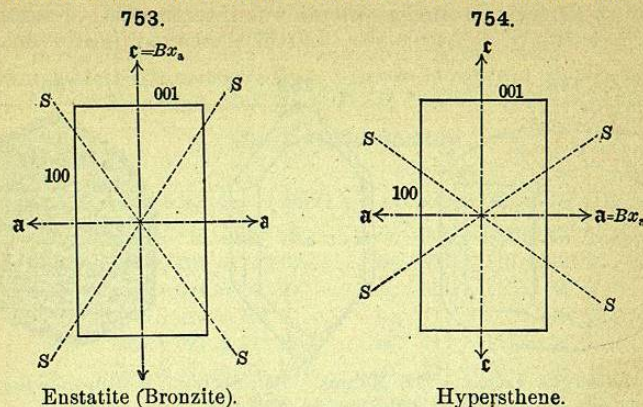
Cleavage:  $m$  rather easy. Parting  $\parallel b$ ; also  $a$ . Fracture uneven. Brittle.  $H. = 5.5$ .  $G. = 3.1-3.3$ . Luster a little pearly on cleavage-surfaces to vitreous; often

metallic in the bronzite variety. Color grayish, yellowish or greenish white, to olive-green and brown. Streak uncolored, grayish. Translucent to nearly opaque. Pleochroism weak, more marked in varieties relatively rich in iron. Optically +. Ax.-pl.  $\parallel b$ .  $Bx \perp c$ . Dispersion  $\rho < v$  weak. Axial angle large and variable, increasing with the amount of iron, usually about  $90^\circ$  for FeO = 10 p. c.  $\beta_y = 1.669$ ;  $\gamma - \alpha = 0.009$ .

Comp., Var.— $MgSiO_3$  or  $MgO.SiO_2 =$  Silica 60, magnesia 40 = 100. Also  $(Mg,Fe)SiO_3$ , with  $Mg : Fe = 8 : 1, 6 : 1, 3 : 1$ , etc.

Var.—1. With little or no iron; Enstatite. Color white, yellowish, grayish, or greenish white; luster vitreous to pearly;  $G. = 3.10-3.13$ . Chladnité (Shepardite of Rose), which

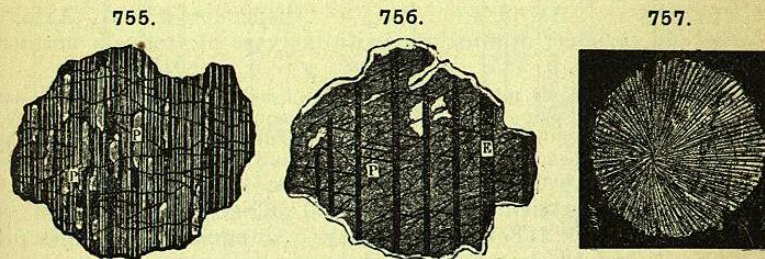
makes up 90 p. c. of the Bishopville meteorite, belongs here and is the purest kind. Victorite, occurring in the Deesa meteoric iron in rosettes of acicular crystals, is similar.



Enstatite (Bronzite).

Hypersthene.

2. Ferriferous; Bronzite. Color grayish green to olive-green and brown. Luster or cleavage-surface often adamantine-pearly to submetallic or bronze-like; this, however, is usually of secondary origin and is not essential. With the increase of iron (above 12 to 14 p. c.) bronzite passes to hypersthene, the optic axial angle changing so that in the latter  $a = Bx_a$  and  $Bx_a \perp a$ . This is illustrated by Figs. 753, 754.



Figs. 755, Bronzite enclosing laminae of diallage (P) 756, Diallage (P) enclosing laminae of bronzite (E). From Lacroix. 757, Enstatite Chondrule from the Knyahinya Meteorite.

Pyr., etc.—B.B. almost infusible, being only slightly rounded on the thin edges;  $F. = 6$ . Insoluble in hydrochloric acid.

Obs.—Enstatite (incl. bronzite) is a common constituent of peridotites and the serpentines derived from them; it also occurs in crystalline schists. It is often associated in parallel growth with a monoclinic pyroxene, e.g., diallage (Figs. 755, 756). A common mineral in meteoric stones often occurring in chondrules with eccentric radiated structure (Fig. 757).

Occurs near Alosthal in Moravia, in serpentine; at Kupferberg in Bavaria; at Baste in the Harz (protobastite); in the so-called olivine bombs of the Dreiser Weher in the Eifel; in immense crystals, in part altered, at the apatite deposits of Kjørrestad near Bamle, Norway; in the peridotite associated with the diamond deposits of South Africa.

In the U. S., in New York at the Tilly Foster magnetite mine, Brewster, Putnam Co., with chondrodite; at Edwards, N. Y.

Named from ἐνστατης, an opponent, because so refractory. The name bronzite has priority, but a bronze luster is not essential, and is far from universal.

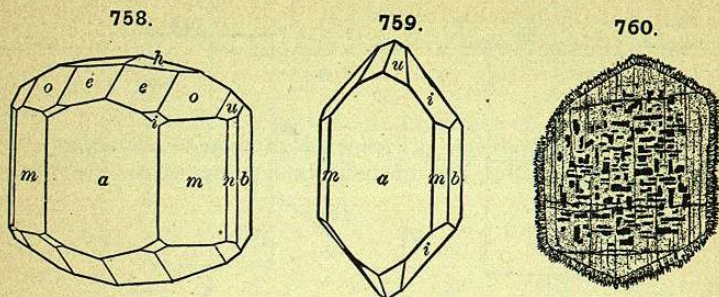
HYPERSTHENE.

Orthorhombic. Axes  $a : b : c = 0.9713 : 1 : 0.5704$ .

$mm''$ ,  $110 \wedge \bar{1}10 = 88^\circ 20'$ .  $oo''$ ,  $111 \wedge \bar{1}\bar{1}1 = 52^\circ 23'$ .  
 $hh'$ ,  $014 \wedge 0\bar{1}4 = 16^\circ 14'$ .  $uu''$ ,  $232 \wedge \bar{2}\bar{3}2 = 72^\circ 50'$ .

Crystals rare, habit prismatic, often tabular  $\parallel a$ , less often  $\parallel b$ . Usually foliated massive; sometimes in embedded spherical forms.

Cleavage:  $b$  perfect;  $m$  and  $a$  distinct but interrupted. Fracture uneven. Brittle.  $H. = 5-6$ .  $G. = 3.40-3.50$ . Luster somewhat pearly on a cleavage-



Figs. 758, *Amblystegite*, Laach. 759, Málnás. 760, Section  $\parallel b$  (010) showing inclusions ( $\times 3$ ); the exterior transformed to actinolite; from Lacroix.

surface, and sometimes metalloidal. Color dark brownish green, grayish black, greenish black, pinchbeck-brown. Streak grayish, brownish gray. Translucent to nearly opaque. Pleochroism often strong, especially in the kinds with high iron percentage; thus  $\parallel a$  or  $\bar{a}$  brownish red,  $b$  or  $\bar{b}$  reddish yellow,  $c$  or  $\bar{c}$  green. Optically -. Ax. pl.  $\parallel b$ .  $Bx \perp a$ . Dispersion  $\rho > v$ . Axial angle rather large and variable, diminishing with increase of iron, cf. enstatite, p. 384, and Figs. 753, 754, p. 385.  $\beta = 1.702$ ;  $\gamma - \alpha = 0.013$ .

Hypersthene often encloses minute tabular scales, usually of a brown color, arranged mostly parallel to the basal plane (Fig. 760), also less frequently vertical or inclined  $30^\circ$  to  $\bar{c}$ ; they may be brookite (göthite, hematite), but their true nature is doubtful. They are the cause of the peculiar metalloidal luster or schiller, and are often of secondary origin, being developed along the so-called "solution-planes" (p. 149).

**Comp., Var.**— $(Fe, Mg)SiO_3$  with  $Fe : Mg = 1 : 3$  ( $FeO = 16.7$  p. c.),  $1 : 2$  ( $FeO = 21.7$  p. c.) to nearly  $1 : 1$  ( $FeO = 31.0$  p. c.). Alumina is sometimes present (up to 10 p. c.) and the composition then approximates to the aluminous pyroxenes.

Of the orthorhombic magnesium-iron metasilicates, those with  $FeO > 12$  to 15 p. c. are usually to be classed with hypersthene, which is further characterized by being optically negative and having dispersion  $\rho > v$ .

**Fyr., etc.**—B.B. fuses to a black enamel, and on charcoal yields a magnetic mass; fuses more easily with increasing amount of iron. Partially decomposed by hydrochloric acid.

**Obs.**—Hypersthene, associated with a triclinic feldspar (labradorite), is common in certain granular eruptive rocks, as norite, hyperite, gabbro, also in some andesites (*hypersthene-andesite*), a rock recently shown to occur rather extensively in widely separated regions.

It occurs at Isle St. Paul; Labrador; in Greenland; at Farsund and elsewhere in Norway; Elfdalen in Sweden; Penig in Saxony; Ronsberg in Bohemia; the Tyrol; Neurode in Silesia; Bodenmais, Bavaria. *Amblystegite* is from the Laacher See. *Szaboite* occurs with pseudobrookite and tridymite, in cavities in the andesite of the Aranyer Berg, Transylvania, and elsewhere.

Occurs in the norites of the Cortlandt region on the Hudson river, N. Y.; also common with labradorite in the Adirondack Archæan region of northern New York and northward in Canada. In the hypersthene-andesites of Mt. Shasta, California; Buffalo Peaks, Colorado, and other points.

*Hypersthene* is named from  $\upsilon\pi\acute{\epsilon}\rho$  and  $\sigma\theta\acute{\epsilon}\nu\omicron\varsigma$ , *very strong, or tough*.

**BASTITE, OR SCHILLER SPAR.** An altered enstatite (or bronzite) having approximately the composition of serpentine. It occurs in foliated form in certain granular eruptive

rocks and is characterized by a bronze-like metalloidal luster or schiller on the chief cleavage-face ( $b$ ), which "schillerization" (p. 190) is of secondary origin.  $H. = 3.5-4$ .  $G. = 2.5-2.7$ . Color leek-green to olive- and pistachio-green, and pinchbeck-brown. Pleochroism not marked. Optically -. Double refraction weak. Ax. pl.  $\parallel a$  (hence normal to that of enstatite).  $Bx \perp b$ . Dispersion  $\rho > v$ . The original bastite was from Baste near Harzburg in the Harz; also from Todtmoos in the Schwarzwald.

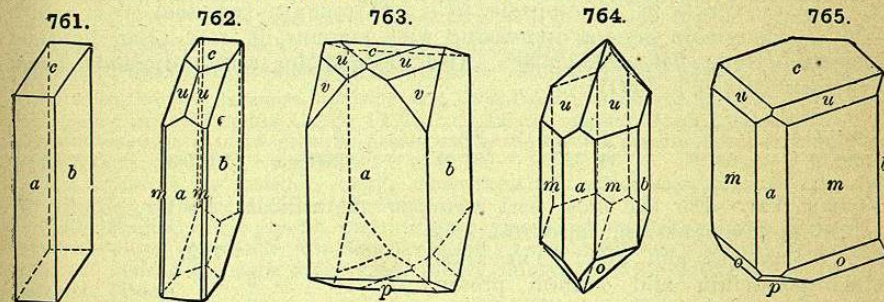
**PECKHAMITE**,  $2(Mg, Fe)SiO_3 \cdot (Mg, Fe)SiO_4$ . Occurs in rounded nodules in the meteorite of Estherville, Emmet Co., Iowa, May 10, 1879.  $G. = 3.23$ . Color light greenish yellow.

### $\beta$ . Monoclinic Section.

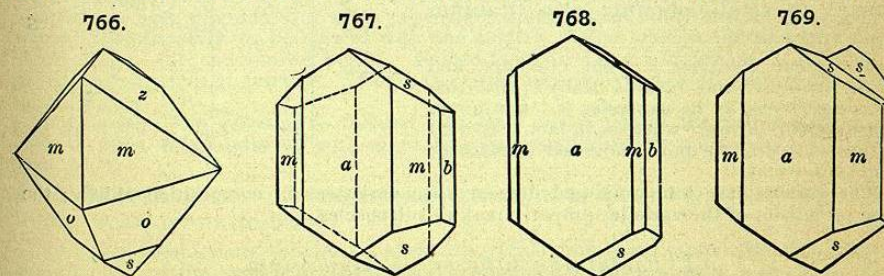
#### PYROXENE.

Monoclinic. Axes  $a : b : c = 1.0921 : 1 : 0.5893$ ;  $\beta = 74^\circ 10'$ .

$mm''$ , $110 \wedge \bar{1}\bar{1}0 = 92^\circ 50'$ .	$cv$ , $001 \wedge 221 = 49^\circ 54'$ .
$ca$ , $001 \wedge 100 = 74^\circ 10'$ .	$cm$ , $001 \wedge 110 = 79^\circ 9\frac{1}{2}'$ .
$cp$ , $001 \wedge \bar{1}01 = 31^\circ 20'$ .	$cs$ , $001 \wedge \bar{1}11 = 42^\circ 2'$ .
$ee'$ , $011 \wedge 0\bar{1}1 = 59^\circ 6'$ .	$uu'$ , $111 \wedge \bar{1}\bar{1}1 = 48^\circ 29'$ .
$zz'$ , $021 \wedge 0\bar{2}1 = 97^\circ 11'$ .	$ss'$ , $\bar{1}11 \wedge \bar{1}\bar{1}1 = 59^\circ 11'$ .
$cu$ , $001 \wedge 111 = 33^\circ 49\frac{1}{2}'$ .	$oo'$ , $221 \wedge \bar{2}\bar{2}1 = 84^\circ 11'$ .



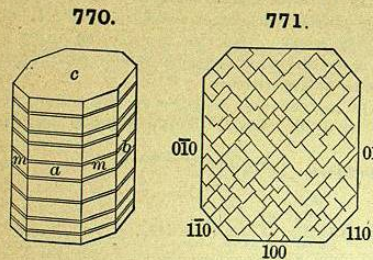
Twins: tv. pl. (1)  $a$ , contact-twins, common (Fig. 769), sometimes polysynthetic. (2)  $c$ , as twinning lamellæ producing striations on the vertical faces and pseudo-cleavage or parting  $\parallel c$  (Fig. 770); very common, often secondary. (3)  $y$  (101) cruciform-twins, not common (Fig. 421, p. 130). (4)  $W$  (122) the vertical axes crossing at angles of nearly  $60^\circ$ ; sometimes repeated as a six-rayed star (Fig. 420, p. 130). Crystals usually prismatic in habit, often short and thick, and either a square prism ( $a, b$  prominent), or nearly square



( $93^\circ, 87^\circ$ ) with  $m$  predominating; sometimes a nearly symmetrical 8-sided prism with  $a, b, m$  (Fig. 770). Often coarsely lamellar,  $\parallel c$  or  $a$ . Also granular, coarse or fine; rarely fibrous or columnar.

Cleavage:  $m$  sometimes rather perfect, but interrupted, often only observed

in thin sections  $\perp c$  (Fig. 771). Parting  $\parallel c$ , due to twinning, often prominent, especially in large crystals and lamellar masses (Fig. 770); also  $\parallel a$  less distinct and not so common. Fracture uneven to conchoidal. Brittle.  $H. = 5-6$ .  $G. = 3.2-3.6$ , varying with the composition. Luster vitreous inclining to resinous; often dull; sometimes pearly  $\parallel c$  in kinds showing parting. Color usually green of various dull shades, varying from nearly colorless, white, or grayish white to brown and black; rarely bright



green, as in kinds containing chromium; also blue. Streak white to gray and grayish green. Transparent to opaque. Pleochroism usually weak, even in dark-colored varieties; sometimes marked, especially in violet-brown kinds containing titanium.

Optically +. Birefringence strong,  $(\gamma - \alpha) = 0.02 - 0.03$ . Ax. pl.  $\parallel b$ .  $Bx_a \wedge c = c \wedge c' = +36^\circ$  in diopside, to  $+52^\circ$  in augite (wh. see), or  $cc = 20^\circ$  to  $36^\circ$ , the angle in general increasing with amount of iron. For diopside from Ala (Dx.):  $2E_y = 111^\circ 20'$ . Also (Flink) for white diopside from Nordmark (2.49 p. c. FeO):

$Bx_a \wedge c'$	$2V_r$	$2V_y$	$2V_{gr}$	$\beta_r$	$\beta_y$	$\beta_{gr}$
$+38^\circ 3\frac{1}{2}'$	$59^\circ 9'$	$58^\circ 52'$	$58^\circ 40'$	1.68978	1.69359	1.69869

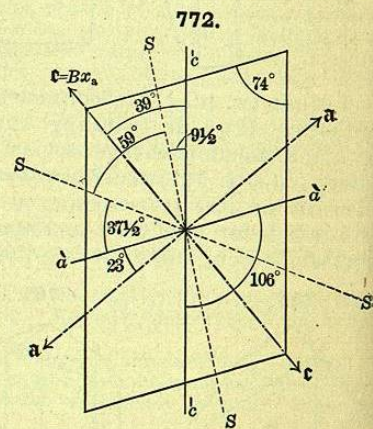
**Comp., Var.**—For the most part a normal metasilicate,  $RSiO_3$ , chiefly of calcium and magnesium, also iron, less often manganese and zinc. The alkali metals potassium and sodium present rarely, except in very small amount. Also in certain varieties containing the trivalent metals aluminium, ferric iron, and manganese. These last varieties may be most simply considered as molecular compounds of  $Ca(Mg,Fe)Si_2O_6$  and  $(Mg,Fe)(Al,Fe)_2SiO_6$ , as suggested by Tschermak. Chromium is sometimes present in small amount; also titanium replacing silicon.

The name *Pyroxene* is from  $\pi\upsilon\rho$ , fire, and  $\xi\nu\omicron\varsigma$ , stranger, and records Haly's idea that the mineral was, as he expresses it, "a stranger in the domain of fire," whereas, in fact, it is, next to the feldspars, the most universal constituent of igneous rocks.

The varieties are numerous and depend upon variations in composition chiefly; the more prominent of the varieties properly rank as sub-species.

#### I. Containing little or no Aluminium.

1. DIOPSIDE. Malacolite, Alalite. Calcium-magnesium pyroxene. Formula  $CaMg(SiO_3)_2 =$  Silica 55.6, lime 25.9, magnesia 18.5 = 100. Color white, yellowish, grayish white to pale green, and finally to dark green and nearly black; sometimes transparent and colorless, also rarely a fine blue. In pris-



matic crystals, often slender; also granular and columnar to lamellar massive.  $G. = 3.2-3.38$ .  $Bx_a \wedge c = +36^\circ$  and upwards.  $\gamma - \alpha = 0.03$ . Iron is present usually in small amount as noted below, and the amount increases as it graduates toward true hedenbergite.

The following belong here: *Chrome-diopside*, contains chromium (1 to 2.8 p. c.  $Cr_2O_3$ ), often a bright green.

*Malacolite*, as originally described, was a pale-colored translucent variety from Sala, Sweden.

*Alalite* occurs in broad right-angled prisms, colorless to faint greenish or clear green, from the Mussa Alp in the Ala valley, Piedmont.

*Traversellite*, from Traversella, is similar.

*Violan* is a fine blue diopside from St. Marcel, Piedmont, Italy; occurring in prismatic crystals and massive.

*Canaanite* is a grayish-white or bluish-white pyroxene rock occurring with dolomite at Canaan, Conn.

*Lavrovite* is a pyroxene, colored green by vanadium, from the neighborhood of Lake Baikal, in eastern Siberia.

*Diopside* is named from  $\delta\iota\varsigma$ , twice or double, and  $\psi\upsilon\iota\varsigma$ , appearance. *Malacolite* is from  $\mu\alpha\lambda\alpha\kappa\acute{o}\varsigma$ , soft, because softer than feldspar, with which it was associated.

2. HEDENBERGITE. Calcium-iron pyroxene. Formula  $CaFe(SiO_3)_2 =$  Silica 48.4, iron protoxide 29.4, lime 22.2 = 100. Color black. In crystals, and also lamellar massive.  $G. = 3.5-3.58$ .  $Bx_a \wedge c = +48^\circ$ . Manganese is present in *manganhedenbergite* to 6.5 p. c. Color grayish green.  $G. = 3.55$ .

Between the two extremes, diopside and hedenbergite, there are numerous transitions conforming to the formula  $Ca(Mg,Fe)Si_2O_6$ . As the amount of iron increases the color changes from light to dark green to nearly black, the specific gravity increases from 3.2 to 3.6, and the angle  $Bx_a \wedge c$  also from  $36^\circ$  to  $48^\circ$ .

The following are varieties, coming under these two sub-species, based in part upon structure, in part on peculiarities of composition.

*Salite* (Sahlite), color grayish green to deep green and black; sometimes grayish and yellowish white; in crystals; also lamellar (parting  $\parallel c$ ) and granular massive; from Sala in Sweden. *Baikalite*, a dark dingy green variety, in crystals, with parting  $\parallel c$ ; from Lake Baikal, in Siberia.

*Coccolite* is a granular variety, embedded in calcite, also forming loosely coherent to compact aggregates; color varying from white to pale green to dark green, and then containing considerable iron; the latter the original coccolite. Named from  $\kappa\acute{o}\kappa\kappa\omicron\varsigma$ , a grain.

**DIALLAGES.** A lamellar or thin-foliated pyroxene, characterized by a fine lamellar structure and parting  $\parallel a$ , with also parting  $\parallel b$ , and less often  $\parallel c$ . Also a fibrous structure  $\parallel c$ . Twinning  $\parallel a$ , often polysynthetic; interlamination with an orthorhombic pyroxene common (Figs. 755 and 756, p. 386). Color grayish green to bright grass-green, and deep green; also brown. Luster of surface  $a$  often pearly, sometimes metalloidal or exhibiting schiller and resembling bronzite, from the presence of microscopic inclusions of secondary origin.  $Bx_a \wedge c = +39$  to  $40^\circ$ ;  $\beta = 1.681$ ;  $\gamma - \alpha = 0.024$ .  $H. = 4$ ;  $G. = 3.2-3.35$ . In composition near diopside, but often containing alumina and sometimes in considerable amount, then properly to be classed with the augites. Often changed to amphibole, see smaragdite, p. 401, and uralite, p. 401. Named from  $\delta\iota\alpha\lambda\lambda\alpha\gamma\eta$ , difference, in allusion to the dissimilar planes of fracture. This is the characteristic pyroxene of gabbro, and other related rocks.

*Omphacite*. The granular to foliated pyroxenic constituent of the garnet-rock called eclogite, often interlaminated with amphibole (smaragdite); color grass-green. Contains some  $Al_2O_3$ .

3. SCHEFFERITE. A manganese pyroxene, sometimes also containing much iron. Color brown to black.

In crystals, sometimes tabular  $\parallel c$ , also with  $p$  ( $\bar{1}01$ ) prominent, more often elongated in the direction of the zone  $b : p$  ( $101$ ), rarely prismatic,  $\parallel c$ . Twins, with  $a$  as tw. pl. very common. Also crystalline, massive. Cleavage prismatic, very distinct. Color yellowish brown to reddish brown; also black (*iron-schefferite*). Optically +.  $Bx_a \wedge c = c \wedge c' = 44^\circ 25\frac{1}{2}'$ . The iron-schefferite from Pajsberg is black in color and has  $c \wedge c' = +49^\circ$  to  $59^\circ$  for different zones in the same crystal. The brown iron-schefferite (*urbanite*) from Långban has  $c \wedge c' = 69^\circ 3'$ . It resembles garnet in appearance.