

Var.—1. Ordinary. Colors gray to white and brown; also green. Usually in indistinct prismatic or columnar forms; also in fibrous aggregates. $G. = 3.226-3.381$. *Unionite* is a very pure zoisite. 2. *Rose-red* or *Thulite*. Fragile; pleochroism strong. 3. *Compact, massive*. Includes the essential part of most saussurite (e.g., in saussurite-gabbro), which has arisen from the alteration of feldspar.

Comp.— $\text{HCa}_2\text{Al}_2\text{Si}_2\text{O}_{13}$ or $4\text{CaO} \cdot 3\text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 \cdot \text{H}_2\text{O} = \text{Silica } 39.7, \text{ alumina } 33.7, \text{ lime } 24.6, \text{ water } 2.0 = 100$. The alumina is sometimes replaced by iron, thus graduating toward epidote, which has the same general formula.

Pyr., etc.—B.B. swells up and fuses at 3-3.5 to a white blebby mass. Not decomposed by acids; when previously ignited gelatinizes with hydrochloric acid. Gives off water when strongly ignited.

Diff.—Characterized by the columnar structure; fusibility with intumescence; resembles some amphibole.

Distinguished in thin sections by its high relief and very low interference-colors; lack of color and biaxial character. From epidote it is distinguished by its lack of color and low birefringence; from vesuvianite by its color and biaxial character. Thin sections frequently show the "ultra blue" (p. 428) between crossed nicols.

Obs.—Occurs especially in those crystalline schists which have been formed by the dynamic metamorphism of basic igneous rocks containing plagioclase rich in lime. Commonly accompanies some one of the amphiboles (actinolite, smaragdite, glaucophane, etc.); thus in amphibolite, glaucophane schist, eclogite; often associated with corundum.

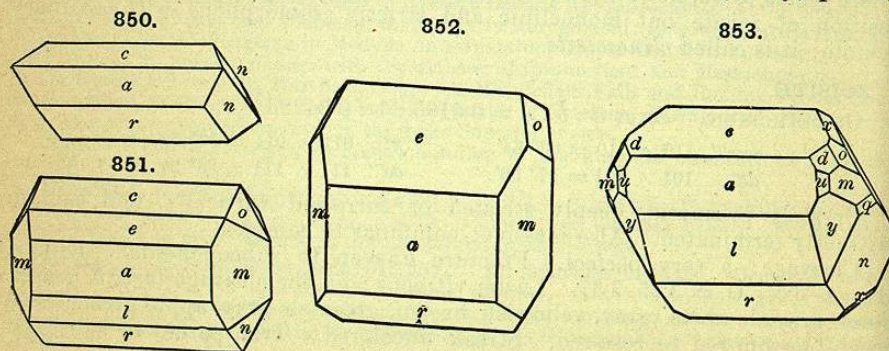
The original zoisite is that of the eclogite of the Saualpe in Carinthia (*sauwalpite*). Other localities are: Rauris in Salzburg; Sterzing, etc., in Tyrol; the Fichtelgebirge in Bavaria; Marschendorf in Moravia; Saasthal in Switzerland; the island of Syra, one of the Cyclades, in glaucophane schist. *Thulite* occurs at Kleppan in Tellemarken, Norway, and at Traversella in Piedmont.

EPIDOTE. Pistacite. Pistazit, *Germ.*

Monoclinic. Axes $a : b : c = 1.5787 : 1 : 1.8036$; $\beta = 64^\circ 37'$.

mm'' , $110 \wedge \bar{1}\bar{1}0 = 109^\circ 56'$	cl , $001 \wedge \bar{2}01 = 89^\circ 26'$
ca , $001 \wedge 100 = 64^\circ 37'$	co , $001 \wedge 011 = 58^\circ 28'$
ce , $001 \wedge 101 = 34^\circ 43'$	cn , $001 \wedge \bar{1}11 = 75^\circ 11'$
cr , $001 \wedge \bar{1}01 = 63^\circ 42'$	an'' , $100 \wedge 11\bar{1} = 69^\circ 2'$
ar' , $100 \wedge 10\bar{1} = 51^\circ 41'$	nr'' , $\bar{1}11 \wedge 11\bar{1} = 70^\circ 29'$

Twins: tw. pl. a common, often as embedded tw. lamellæ. Crystals usually prismatic \parallel the ortho-axis b and terminated at one extremity only; passing

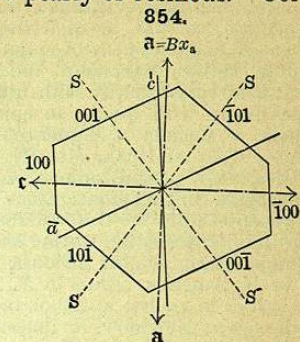


into acicular forms; the faces in the zone ac deeply striated. Also fibrous, divergent or parallel; granular, particles of various sizes, sometimes fine granular, and forming rock-masses.

Cleavage: c perfect; a imperfect. Fracture uneven. Brittle. $H. = 6-7$. $G. = 3.25-3.5$. Luster vitreous; on c inclining to pearly or resinous. Color pistachio-green or yellowish green to brownish green, greenish black, and black; sometimes clear red and yellow; also gray and grayish white, rarely colorless. Streak uncolored, grayish. Transparent to opaque; generally sub-translucent.

Pleochroism strong: vibrations $\parallel c$ green, b brown and strongly absorbed, a yellow. Absorption usually $b > c > a$; but sometimes $c > b > a$ in the variety of epidote common in rocks. Often exhibits idiophanous figures; best in sections normal to an optic axis, but often to be observed in natural crystals (Sulzbach), especially if flattened $\parallel r$ ($\bar{1}01$). (See p. 218.) Optically —.

Ax. pl. $\parallel b$. $Bx_{ar} \wedge c = -2^\circ 56'$. Hence $c \perp a$ (100) nearly. Dispersion inclined, strongly marked; of the axes feeble, $\rho > v$. $2H_{ay} = 91^\circ 20'$. $\beta_y = 1.75702$. Birefringence high, $\gamma - \alpha = 0.038 - 0.056$.



Var.—Epidote has ordinarily a peculiar yellowish green (pistachio) color, seldom found in other minerals. But this color passes into dark and light shades—black on one side and brown on the other; red, yellow and colorless varieties also occur.

Var. 1. Ordinary. Color green of some shade, as described, the pistachio tint rarely absent. (a) In crystals. (b) Fibrous. (c) Granular massive. (d) *Scorza* is epidote sand from the gold washings in Transylvania. The Arendal epidote (*Arendalite*) is mostly in dark green crystals; that of Bourg d'Oisans Dauphiné (*Thalite*, *Delphinite*, *Oisanite*) in yellowish-green crystals, sometimes transparent. *Puschkinite* includes crystals from the auriferous sands of Ekaterinburg, Ural. *Achmatite* is ordinary epidote from Achmatovsk, Ural. A variety from Garda, Hoste Is., Terra del Fuego, is colorless and resembles zoisite.

2. The *Bucklandite* from Achmatovsk, described by Hermann, is black with a tinge of green, and differs from ordinary epidote in having the crystals nearly symmetrical and not, like other epidote, lengthened in the direction of the orthodiagonal. $G. = 3.51$.

3. *Withamite*. Carmine-red to straw-yellow, strongly pleochroic; deep crimson and straw-yellow. $H. = 6-6.5$; $G. = 3.137$; in small radiated groups. From Glencoe, in Argyleshire, Scotland. Sometimes referred to piedmontite, but contains little MnO .

Comp.— $\text{HCa}_2(\text{Al}, \text{Fe})_2\text{Si}_2\text{O}_{13}$ or $\text{H}_2\text{O} \cdot 4\text{CaO} \cdot 3(\text{Al}, \text{Fe})_2\text{O}_3 \cdot 6\text{SiO}_2$, the ratio of aluminium to iron varies commonly from 6 : 1 to 3 : 2. Percentage composition:

For $\text{Al} : \text{Fe} = 3 : 1$ SiO_2 37.87, Al_2O_3 24.13, Fe_2O_3 12.60, CaO 23.51, H_2O 1.89 = 100

Clinozoisite is an epidote without iron, having the composition of zoisite; *fouqueite* is probably the same from an anorthite-gneiss in Ceylon. *Picroepidote* is supposed to contain Mg in place of Ca .

Pyr., etc.—In the closed tube gives water on strong ignition. B.B. fuses with intumescence at 3-3.5 to a dark brown or black mass which is generally magnetic. Reacts for iron and sometimes for manganese with the fluxes. Partially decomposed by hydrochloric acid, but when previously ignited, gelatinizes with acid. Decomposed on fusion with alkaline carbonates.

Diff.—Characterized often by its peculiar yellowish-green (pistachio) color; readily fusible and yields a magnetic globule B.B. Prismatic forms often longitudinally striated, but they have not the angle, cleavage or brittleness of tremolite; tourmaline has no distinct cleavage, is less fusible (in common forms) and usually shows its hexagonal form.

Recognized in thin sections by its high refraction; strong interference-colors rising into those of the third order in ordinary sections; decided color and striking pleochroism; also by the fact that the plane of the optic axes lies transversely to the elongation of the crystals.

Obs.—Epidote is commonly formed by the metamorphism (both local igneous and of general dynamic character) of impure calcareous sedimentary rocks or igneous rocks containing much lime. It thus often occurs in gneissic rocks, mica schist, amphibole schist, serpentine; so also in quartzites and sandstones altered by neighboring igneous rocks. Often accompanies beds of magnetite or hematite in such rocks. Has also been found in granite (Hobbs, Maryland), and regarded as an original mineral.

It is often associated with quartz, feldspar, actinolite, axinite, chlorite, etc. It sometimes forms with quartz an epidote rock, called *epidosite*. A similar rock exists at Melbourne in Canada. A gneissoid rock consisting of flesh-colored orthoclase, quartz and epidote from the Unaka Mts. (N. C. and Tenn.) has been called unakyte.

Beautiful crystallizations come from Bourg d'Oisans, Dauphiné; the Ala valley and Traversella, in Piedmont; Elba; Zermatt; Zillertal in Tyrol; also in fine crystals from the Knappenwand in the Untersulzbachthal, Pinzgau, associated with asbestos, adularia, apatite, titanite, scheelite; further at Striegau, Silesia; Zöptau, Moravia; Arendal, Norway; the Achmatovsk mine near Zlatoust, Ural.

In N. America, occurs in N. Hamp., at Franconia. In Mass., at Hadlyme and Chester, in crystals in gneiss; at Athol, in syenitic gneiss, in fine crystals, 2 m. S. W. of the center of the town; Newbury, in limestone. In Conn., at Haddam, in large splendid crystals. In N. York, near Amity; Monroe, Orange Co.; Warwick, pale yellowish green, with titanite and pyroxene. In N. Carolina, at Hampton's, Yancey Co.; White's mill, Gaston Co.; Franklin, Macon Co.; in crystals and crystalline masses in quartz at White Plains, Alexander Co. In Michigan, in the Lake Superior region, at many of the mines.

Epidote was named by Haly, from the Greek *ἐπίδοσις*, *increase*, translated by him, "qui à reçu un accroissement," the base of the prism (rhomboidal prism) having one side longer than the other. *Pistacite*, from *πιστακία*, the *pistachio-nut*, refers to the color.

Piedmontite. Similar in angle to ordinary epidote, but contains 5 to 15 p. c. Mn_2O_3 . H. = 6.5. G. = 3.404. Color reddish brown and reddish black. Pleochroism strong. Absorption $a > b > c$. Optically +. Ax. pl. $\parallel b$. $Bx_a \wedge c = +82^\circ 34'$, $a \wedge c = -6^\circ$ to -3° . Occurs with manganese ores at St. Marcel, Piedmont. In crystalline schists on Ile de Groix, France; in glaucophane-schist, in Japan. Occasionally in quartz porphyry, as in the antique red porphyry of Egypt, also that of South Mountain, Penn.

ALLANITE. Orthite.

Monoclinic. Axes, p. 437. In angle near epidote. Crystals often tabular $\parallel a$; also long and slender to acicular prismatic by elongation \parallel axis b . Also massive and in embedded grains.

Cleavage: a and c in traces; also m sometimes observed. Fracture uneven or subconchoidal. Brittle. H. = 5.5-6. G. = 3.0-4.2. Luster submetallic, pitchy or resinous. Color brown to black. Subtranslucent to opaque. Pleochroism strong: c brownish yellow, b reddish brown, a greenish brown. Optically -. Ax. pl. $\parallel b$. $Bx_a \wedge c = 32\frac{1}{2}^\circ$ approx. $\beta = 1.682$. Birefringence low; $\gamma - \alpha = 0.032$. Also isotropic and amorphous by alteration analogous to gadolinite.

Var.—*Allanite*. The original mineral was from East Greenland, in tabular crystals or plates. Color black or brownish black. G. = 3.50-3.95. *Bucklandite* is anhydrous allanite in small black crystals from a magnetite mine near Arendal, Norway. *Bagratiomite* occurs in black crystals which are like the bucklandite of Achmatovsk (epidote).

Orthite included, in its original use, the slender or acicular prismatic crystals, containing some water, from Finbo, near Falun, Sweden. But these graduate into massive forms, and some orthites are anhydrous, or as nearly so as most allanite. The name is from *ὀρθός*, *straight*.

Comp.—Like epidote $HRR_2Si_2O_7$, or $H_2O.4RO.3R_2O_3.6SiO_2$ with $R = Ca$ and Fe , and $R = Al, Fe$, the cerium metals Ce, Di, La , and in smaller amounts those of the yttrium group. Some varieties contain considerable water, but probably by alteration.

Pyr., etc.—Some varieties give much water in the closed tube, and all kinds yield a small amount on strong ignition. B.B. fuses easily and swells up (F. = 2.5) to a dark, blebby,

magnetic glass. With the fluxes reacts for iron. Most varieties gelatinize with hydrochloric acid, but if previously ignited are not decomposed by acid.

Obs.—Occurs in albitic and common feldspathic granite, gneiss, syenite, zircon-syenite, porphyry. Thus in Greenland; Norway; Sweden; Striegau, Silesia. Also in white limestone as at Auerbach on the Bergstrasse; often in mines of magnetic iron. Rather common as an accessory constituent in many rocks, as in andesite, diorite, dacite, rhyolite, the tonalite of Mt. Adamello, the scapolite rocks of Ödegaarden, Norway, etc. Sometimes inclosed as a nucleus in crystals of the isomorphous species, epidote.

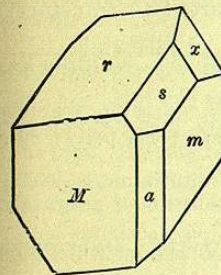
At Vesuvius in ejected masses with sanidine, sodalite, nephelite, hornblende, etc. Similarly in trachytic ejected masses at the Laacher See (*bucklandite*).

In Mass., at the Bolton quarry. In N. York, Moriah, Essex Co., with magnetite and apatite; at Monroe, Orange Co. In N. Jersey, at Franklin Furnace with feldspar and magnetite. In Penn., at S. Mountain, near Bethlehem, in large crystals; at E. Bradford; near Eckhardt's furnace, Berks Co., abundant. In Virginia, in large masses in Amherst Co.; also in Bedford, Nelson, and Amelia counties. In N. Carolina, at many points. At the Devil's Head Mt., Douglas Co., Colorado.

AXINITE.

Triclinic. Axes $\tilde{a} : \tilde{b} : \tilde{c} = 0.4921 : 1 : 0.4797$; $\alpha = 82^\circ 54'$, $\beta = 91^\circ 52'$, $\gamma = 131^\circ 32'$.

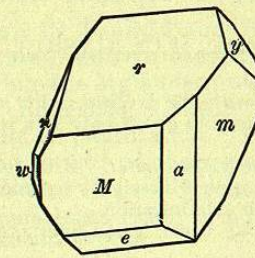
855.



Dauphiné.

$am, 100 \wedge 100 = 15^\circ 34'$
 $aM, 100 \wedge 110 = 28^\circ 55'$
 $as, 100 \wedge 201 = 21^\circ 37'$

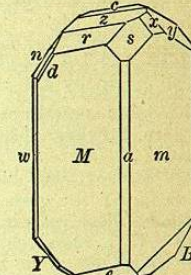
856.



Poloma.

$Mr, 110 \wedge 111 = 45^\circ 15'$
 $mr, 110 \wedge 111 = 64^\circ 22'$
 $ms, 110 \wedge 201 = 27^\circ 57'$

857.



Bethlehem, Pa.

Crystals usually broad and acute-edged, but varied in habit. Also massive, lamellar, lamellæ often curved; sometimes granular.

Cleavage: b distinct. Fracture conchoidal. Brittle. H. = 6.5-7. G. = 3.271-3.294. Luster highly glassy. Color clove-brown, plum-blue, and pearl-gray; also honey-yellow, greenish yellow. Streak uncolored. Transparent to subtranslucent. Pleochroism strong. Optically -. Ax. pl. and Bx_a approximately $\perp x$ (111). Axial angles variable. $2H_{ar} = 87^\circ 30'$; $\beta_r = 1.678$. Pyroelectric (p. 234).

Comp.—A boro-silicate of aluminium and calcium with varying amounts of iron and manganese. Perhaps $H_2R_4(BO)Al_3(SiO_4)_6$ (Whitfield.) R = Calcium chiefly, sometimes in large excess, again in smaller amount and manganese prominent; iron is present in small quantity, also magnesium and basic hydrogen.

Analyses. 1, Whitfield; 2, Genth.

	G.	SiO ₂	B ₂ O ₃	Al ₂ O ₃	Fe ₂ O ₃	FeO	MnO	CaO	MgO	ign.
1. Bourg d'Oisans		41.53	4.62	17.90	3.90	4.02	3.79	21.66	0.74	2.16 = 100.32
2. Franklin, <i>cryst.</i>	3.358	42.77	5.10	16.73	1.03	1.60*	13.69	18.25	0.23	0.76 = 100.16

*ZnO, including 0.12 CuO.

Pyr., etc.—B.B. fuses readily with intumescence, imparts a pale green color to the O.F.,

and fuses at 2 to a dark green to black glass; with borax in O.F. gives an amethystine bead (manganese), which in R.F. becomes yellow (iron). Fused with a mixture of bisulphate of potash and fluor on the platinum loop colors the flame green (boric acid). Not decomposed by acids, but when previously ignited, gelatinizes with hydrochloric acid.

Obs.—Axinite occurs in clove-brown crystals, near Bourg d'Oisans in Dauphiné; at Andreasberg; Striegau, Silesia; on Mt. Skopi, in eastern Switzerland; Elba; at the silver mines of Kongsberg, Norway; Nordmark, Sweden; near Miask in the Ural; in Cornwall, of a dark color, at the Botallack mine near St. Just, etc.

In the U. S., at Phippsburg, Maine; Franklin Furnace, N. J., honey-yellow; at Bethlehem, Pa.

Named from *ἀξίτην*, an *axe*, in allusion to the form of the crystals.

PREHNITE.

Orthorhombic-hemimorphic. Axes $\tilde{a} : \tilde{b} : \tilde{c} = 0.8401 : 1 : 0.5549$.

Distinct individual crystals rare; usually tabular $\parallel c$; sometimes prismatic $mm''' = 80^\circ 4'$; again acute pyramidal. Commonly in groups of tabular crystals, united by c making broken forms, often barrel-shaped. Reniform, globular, and stalactitic with a crystalline surface. Structure imperfectly columnar or lamellar, strongly coherent; also compact granular or impalpable.

Cleavage: c distinct. Fracture uneven. Brittle. $H. = 6-6.5$. $G. = 2.80-2.95$. Luster vitreous; c weak pearly. Color light green, oil-green, passing into white and gray; often fading on exposure. Subtransparent to translucent. Streak uncolored.

Comp.—An acid orthosilicate, $H_2Ca_2Al_2(SiO_4)_2 =$ Silica 43.7, alumina 24.8, lime 27.1, water 4.4 = 100.

Prehnite is sometimes classed with the zeolites, with which it is often associated; the water here, however, has been shown to go off only at a red heat, and hence plays a different part.

Fyr., etc.—In the closed tube yields water. B.B. fuses at 2 with intumescence to a blebby enamel-like glass. Decomposed slowly by hydrochloric acid without gelatinizing; after fusion dissolves readily with gelatinization.

Diff.—B.B. fuses readily, unlike beryl, green quartz, and chalcedony. Its hardness is greater than that of the zeolites.

Obs.—Occurs chiefly in basic eruptive rocks, basalt, diabase, etc., as a secondary mineral in veins and cavities, often associated with some of the zeolites, also datolite, pectolite, calcite, but commonly one of the first formed of the series; also less often in granite, gneiss, syenite, and then frequently associated with epidote; sometimes associated with native copper, as in the L. Superior region.

At St. Christophe, near Bourg d'Oisans in Dauphiné; Fassathal, Tyrol; the Ala valley in Piedmont; in the Harz, near Andreasberg; in granite at Striegau, Silesia; Arendal, Norway; Ædelfors in Sweden (*edelite*); at Corstorphine Hill, near Edinburgh; Mourne Mts., Ireland.

In the United States, finely crystallized at Farmington, Conn.; Paterson and Bergen Hill, N. J.; in syenite, at Somerville, Mass.; on north shore of Lake Superior, and the copper region.

Named (1790) after Col. Prehn, who brought the mineral from the Cape of Good Hope.

Harstigitite. An acid orthosilicate of manganese and calcium. In small colorless prismatic crystals. $H. = 5.5$. $G. = 3.049$. From the Harstig mine, near Pajsberg, Wernland, Sweden.

Cuspidine. Contains silica, lime, fluorine, and from alteration carbon dioxide; formula doubtful. In minute spear-shaped crystals $H. = 5-6$. $G. = 2.853-2.860$. Color pale rose-red. From Vesuvius, in ejected masses in the tufa of Monte Somma.

IV. Subsilicates.

The species here included are basic salts, for the most part to be referred either to the metasilicates or orthosilicates, like many basic compounds already included in the preceding pages. Until their constitution is definitely settled, however, they are more conveniently grouped by themselves as SUBSILICATES.

It may be noted that those species having an oxygen ratio of silicon to bases of 2 : 3, like topaz, andalusite, sillimanite, datolite, etc., also calamine, carpholite, and perhaps tourmaline, are sometimes regarded as salts of the hypothetical parasilicic acid, H_2SiO_3 .

The only prominent group in this subdivision is the HUMITE GROUP.

Humite Group.

			$\tilde{a} : \tilde{b} : \tilde{c}$	β
Prolectite	$[Mg(F,OH)]_2Mg[SiO_4]_2?$	Monoclinic	1.0803:1:1.8861	90°
Chondrodite	$[Mg(F,OH)]_2Mg_2[SiO_4]_2$	Monoclinic	1.0863:1:3.1447	90°
			$\tilde{b} : \tilde{a} : \tilde{c}$	
Humite	$[Mg(F,OH)]_2Mg_2[SiO_4]_2$	Orthorhombic	1.0802:1:4.4033	—
Clinohumite	$[Mg(F,OH)]_2Mg_2[SiO_4]_2$	Monoclinic	1.0803:1:5.6588	90°

The species here included form a remarkable series both as regards crystalline form and chemical composition. In crystallization they have sensibly the same ratio for the lateral axes, while the vertical axes are almost exactly in the ratio of the numbers 3:5:7:9 (see also below). Furthermore, though one species is orthorhombic, the others monoclinic, they here also correspond closely, since the axial angle β in the latter cases does not sensibly differ from 90°.

In composition, as shown by Penfield and Howe (also Sjögren), the last three species are basic orthosilicates in each of which the univalent group (MgF) or (MgOH) enters, while the Mg atoms present are in the ratio of 3:5:7. The composition given for Prolectite is theoretical only, being that which would be expected from its crystallization. In physical characters these species are very similar, and several of them may occur together at the same locality and even intercrystallized in parallel lamellæ.

The species of the group approximate closely in angle to chrysolite and chrysoberyl. The axial ratios may be compared as follows:

Prolectite.....	$\tilde{a} : \tilde{b} : \frac{1}{3}\tilde{c} = 1.0803 : 1 : 0.6287$
Chondrodite.....	$\tilde{a} : \tilde{b} : \frac{1}{3}\tilde{c} = 1.0863 : 1 : 0.6289$
Humite.....	$\tilde{a} : \tilde{b} : \frac{1}{3}\tilde{c} = 1.0802 : 1 : 0.6291$
Clinohumite.....	$\tilde{a} : \tilde{b} : \frac{1}{3}\tilde{c} = 1.0803 : 1 : 0.6288$
Chrysolite.....	$\tilde{b} : 2\tilde{a} : \tilde{c} = 1.0735 : 1 : 0.6296$
Chrysoberyl.....	$\tilde{b} : 2\tilde{a} : \tilde{c} = 1.0637 : 1 : 0.6170$

CHONDRODITE—HUMITE—CLINOHUMITE.

Axial ratios as given above. Habit varied, Figs. 858 to 866. Twins common, the twinning planes inclined 60°, also 30°, to c in the brachydome or clinodome zone, hence the axes crossing at angles near 60°; often repeated as trillings and as polysynthetic lamellæ (cf. Fig. 556, p. 226). Also twins, with c (001) as tw. plane. Two of the three species are often twinned together.

Cleavage: c sometimes distinct. Fracture subconchoidal to uneven. Brittle. $H. = 6-6.5$. $G. = 3.1-3.2$. Luster vitreous to resinous. Color white, light yellow, honey-yellow to chestnut-brown and garnet- or hyacinth-red. Pleochroism sometimes distinct. Optically +.

Chondrodite. Absorption $a > c > b$. Optically +. Ax. pl. and $Bx_a \perp b$. $Bx_o \wedge \tilde{c} = a \wedge \tilde{b} = +25^\circ 52'$ Brewster; $28^\circ 56'$ Kaveltorp; 30° approx., Mte. Somma. $\beta = 1.619$; $\gamma - \alpha = 0.032$. $2H_{a,r} = 86^\circ$ to 89° .

Humite. Ax. pl. $\parallel c$. $Bx \perp a$. $\gamma - \alpha = 0.035$.

Clinohumite. Ax. pl. and $Bx_a \perp b$. $Bx_o \wedge \tilde{c} = a \wedge \tilde{b} = +11^\circ-12^\circ$; $7\frac{1}{2}^\circ$ approx., Brewster. $2H_{a,r} = 85^\circ$.