Cleavage: *m* not very distinct; *a* and *c* still less so. Fracture subconchoidal to uneven. Brittle. H. = 6·5. G. = 3·35–3·45. Luster vitreous; often inclining to resinous. Color brown to green, and the latter frequently bright and clear; occasionally sulphur-yellow, and also pale blue. Streak white. Subtransparent to faintly subtranslucent. Dichroism not usually strong. Optically −; also + rarely. Birefringence very low. Sometimes abnormally biaxial. Indices: $\omega_y = 1{\cdot}7235$, $\epsilon_y = 1{\cdot}7226$ Ala, Osann.

Comp.—A basic calcium-aluminium silicate, but of uncertain formula; perhaps $Ca_6[Al(OH,F)]Al_2(SiO_4)_5$. Ferric iron replaces part of the aluminium and magnesium the calcium. Fluorine and titanium may be present. The following are typical analyses (Jannasch):

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	Na_2O	Li_2O	H_2O	F.	
1. Vesuvius, $\frac{2}{3}$	36·98	—	16·70	2·99	2·01	0·57	35·67	2·62	0·43	0·08	1 32	1·08	= 100·45
2. Vilui,	36·17	1·30	12·23	2·18	1·49	0·15	35·81	6·05	0·45	—	0·72	0·22	B_2O_3 2·81 = 99·58

Pyr., etc.—B.B. fuses at 3 with intumescence to a greenish or brownish glass. Magnus states that the density after fusion is 2·93–2·945. With the fluxes gives reactions for iron, and some varieties a strong manganese reaction. *Cyprine*, a blue variety, gives a reaction for copper with salt of phosphorus. Partially decomposed by hydrochloric acid, and completely when the mineral has been previously ignited.

Diff.—Characterized by its tetragonal form and easy fusibility. Resembles some brown varieties of garnet, tourmaline, and epidote.

Recognized in thin sections by its high refraction producing a very strong relief and its extremely low birefringence;* also in general by its color, pleochroism, and uniaxial negative character; the latter, on account of the low birefringence, being difficult to determine. The low birefringence, however, aids in distinguishing it from epidote, with which at times it may be confounded.

Obs.—Vesuvianite was first found among the ancient ejections of Vesuvius and the dolomitic blocks of Monte Somma, whence its name. It commonly occurs as a contact mineral from the alteration of impure limestones, then usually associated with lime garnet (grossularite), phlogopite, diopside, wollastonite; also epidote; also in serpentine, chlorite schist, gneiss and related rocks.

Prominent localities are Vesuvius; the Albani Mts.; the Mussa Alp in the Ala valley, in Piedmont; Mt. Monzoni in the Fassathal; at Orawitza and Dognaczka; Haslau near Eger in Bohemia (*egeran*); near Jordansmühl, Silesia; on the Vilui river, near L. Baikal (sometimes called *wiluite* or viluite, like the grossular garnet from the same region); at Arendal, "*colophonite*"; at Egg, near Christiansand.

In N. America, in *Maine* at Phippsburg and Rumford; at Sandford. In *N. Hampshire*, at Warren with cinnamon-stone. In *N. York*, ½ m. S. of Amity. In *New Jersey*, at Newton. In *California* near San Carlos in Inyo Co. In *Canada*, at Calumet Falls, Litchfield, Pontiac Co.; at Grenville in calcite; at Templeton, Ottawa Co., Quebec.

Zircon Group. $\overset{IV}{R}SiO_4$. Tetragonal.

Zircon	$ZrSiO_4$	$\dot{c} = 0{\cdot}6404$
Thorite	$ThSiO_4$	$\dot{c} = 0{\cdot}6402$

This group includes the orthosilicates of zirconium and thorium, both alike in tetragonal crystallization, axial ratio and crystalline habit.

These species are sometimes regarded as oxides and then included in the RUTILE GROUP (p. 343), to which they approximate closely in form. A similar form belongs also to the

* Frequently minerals, which, like vesuvianite, melilite and zoisite, are doubly refracting but of extremely low birefringence (and possibly, where they are positive for one color but negative for another), do not show a gray color between crossed nicols but a curious blue, at times an intense Berlin blue, which is quite distinct from the other blues of the color scale and is known as the "*ultra blue*."

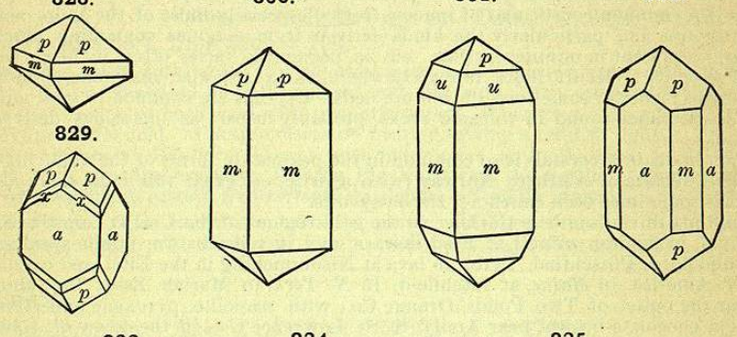
tantalate, Tapiolite, and to the phosphate, Xenotime; further, compound groups consisting of crystals of Xenotime and Zircon in parallel position are not uncommon (Fig. 431, p. 131).

ZIRCON.

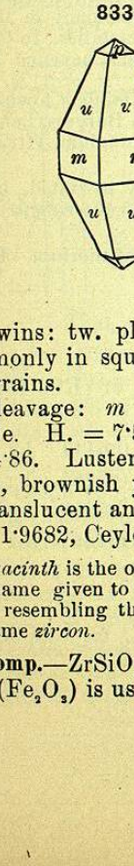
Tetragonal. Axis $\dot{c} = 0{\cdot}64037$.

ee', 101 ∧ 011 = 44° 50′.
ee'', 101 ∧ $\bar{1}01$ = 65° 16′.
pp', 111 ∧ $\bar{1}11$ = 56° 40½′.
uu', 331 ∧ $\bar{3}31$ = 83° 9′.
mp, 110 ∧ 111 = 47° 50′.
mu, 110 ∧ 331 = 20° 12½′.
xx^{vii}, 311 ∧ $3\bar{1}1$ = 32° 57′.
ax, 100 ∧ 311 = 31° 43′.

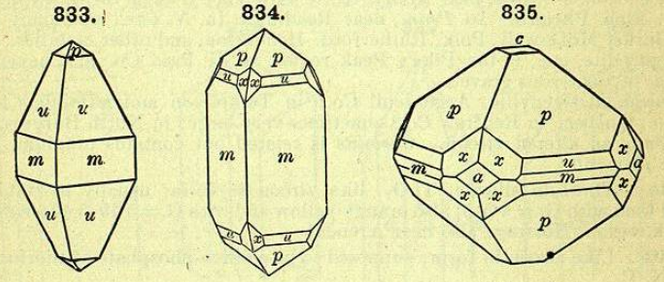
828. 830. 831. 832.



829.



833. 834. 835.



Colorado.

Twins: tw. pl. *e* (101), geniculated twins like rutile (Fig. 374, p. 124). Commonly in square prisms, sometimes pyramidal. Also in irregular forms and grains.

Cleavage: *m* imperfect; *p* (111) less distinct. Fracture conchoidal. Brittle. H. = 7·5. G. = 4·68–4·70 most common, but varying widely to 4·2 and 4·86. Luster adamantine. Colorless, pale yellowish, grayish, yellowish green, brownish yellow, reddish brown. Streak uncolored. Transparent to subtranslucent and opaque. Optically +. Birefringence high. $\omega_y = 1{\cdot}9239$, $\epsilon_y = 1{\cdot}9682$, Ceylon. Sometimes abnormally biaxial.

Hyacinth is the orange, reddish and brownish transparent kind used for gems. *Jargon* is a name given to the colorless or smoky zircons of Ceylon, in allusion to the fact that while resembling the diamond in luster, they are comparatively worthless; thence came the name *zircon*.

Comp.—$ZrSiO_4$ or $ZrO.SiO_4$ = Silica 32·8, zirconia 67·2 = 100. A little iron (Fe_2O_3) is usually present.

Pyr., etc.—Infusible; the colorless varieties are unaltered, the red become colorless, while dark-colored varieties are made white; some varieties glow and increase in density by ignition. Not perceptibly acted upon by salt of phosphorus. In powder decomposed when fused with soda on the platinum wire, and if the product is dissolved in dilute hydrochloric acid it gives the orange color characteristic of zirconia when tested with turmeric paper. Not acted upon by acids except in fine powder with concentrated sulphuric acid. Decomposed by fusion with alkaline carbonates and bisulphates.

Diff.—Characterized by the prevailing square pyramid or square prism; also by its adamantine luster, hardness, high specific gravity, and infusibility; the diamond is optically isotropic.

Recognized in thin sections by its very high relief; very high interference-colors, which approach white of the higher order except in very thin sections; positive uniaxial character. It is distinguished from cassiterite and rutile only by its lack of color, and from the latter also in many cases by method of occurrence.

Obs.—A common constituent of igneous rocks, especially those of the more acid feldspathic groups and particularly the kinds derived from magmas containing much soda. Is generally present in minute crystals, but in pegmatitic facies often in large and well-formed crystals. Occurs more rarely elsewhere, as in granular limestone, chloritic and other schists; gneiss; sometimes in iron-ore beds. Crystals are common in most auriferous sands. Sometimes found in volcanic rocks, probably in part as inclusions derived from older rocks.

Zircon in distinct crystals is so common in the pegmatitic forms of the nephelite-syenite and augite-syenite of southern Norway (with ægirite, etc.) that this rock there and elsewhere has sometimes been called a "zircon-syenite."

Found in alluvial sands in Ceylon; in the gold regions of the Ural, at Laurvik, Norway; at Arendal, in the iron mines; at Fredriksvärn, and in veins in the augite-syenite of the Langesund fiord; Pfitschthal, Tyrol; in lava at Niedermendig in the Eifel, red crystals; etc.

In N. America, in *Maine*, at Litchfield; In *N. York*, in Moriah, Essex Co., cinnamon-red; near the outlet of Two Ponds, Orange Co., with scapolite, pyroxene and titanite; at Warwick, chocolate-brown, near Amity; in St. Lawrence Co., in the town of Hammond; at Rossie, Fine, Pitcairn. In *Penn.*, near Reading. In *N. Car.*, abundant in the gold sands of Burke, McDowell, Polk, Rutherford, Henderson, and other counties. In *Colorado*, with astrophyllite, etc., in the Pike's Peak region in El Paso Co.; at Cheyenne Mt. In *California*, in auriferous gravels.

In *Canada*, at Grenville, Argenteuil Co.; in Templeton and adjoining townships in Ottawa Co., Quebec; in Renfrew Co., sometimes very large; in North Burgess, Lanark Co.

Malacon is an altered zircon. *Cyrtolite* is related but contains uranium, yttrium and other rare elements.

Thorite. Thorium silicate, ThO_2, like zircon in form; usually hydrated, black in color, and then with G. = 4·5–5; also orange-yellow and with G. = 5·19–5·40 (*orangite*). From the Brevik region, Norway; also near Arendal.

Auerlite. Like zircon in form; supposed to be a silico-phosphate of thorium. Henderson Co., N. C.

Danburite-Topaz Group. Orthorhombic. $\overset{II}{R}\overset{III}{R}_2(SiO_4)_2$ or $(\overset{III}{R}O)\ \overset{III}{R}SiO_4$.

Danburite	$CaB_2(SiO_4)_2$	$\breve{a} : \bar{b} : \dot{c} = 0{\cdot}5444 : 1 : 0{\cdot}4807$
Topaz	$[Al(F,OH)_2]AlSiO_4$	$\breve{a} : \bar{b} : \dot{c} = 0{\cdot}5285 : 1 : 0{\cdot}4770$
Andalusite	$(AlO)AlSiO_4$	$\frac{1}{2}\bar{b} : \breve{a} : \frac{2}{3}\dot{c} = 0{\cdot}5070 : 1 : 0{\cdot}4749$
		or $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}9861 : 1 : 0{\cdot}7025$

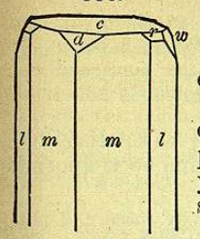
Sillimanite	Al_2SiO_5	Orthorhombic	$\breve{a} : \bar{b} = 0{\cdot}970 : 1$
Cyanite	Al_2SiO_5	Triclinic	

$\breve{a} : \bar{b} : \dot{c} = 0{\cdot}8994 : 1 : 0{\cdot}7090$; $\alpha = 90° 5\frac{1}{2}'$, $\beta = 101° 2'$, $\gamma = 105° 44\frac{1}{2}'$.

DANBURITE.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}5444 : 1 : 0{\cdot}4807$.

836.



mm''', 110 ∧ $1\bar{1}0$ = 57° 8′. dd', 101 ∧ $\bar{1}01$ = 82° 53′.
ll', 120 ∧ $\bar{1}20$ = 85° 8′. ww', 041 ∧ $0\bar{4}1$ = 125° 3′.

Habit prismatic, resembling topaz. Also in indistinct embedded crystals, and disseminated masses.

Cleavage: *c* very indistinct. Fracture uneven to subconchoidal. Brittle. H. = 7–7·25. G. = 2·97–3·02. Color pale wine-yellow to colorless, yellowish white, dark wine-yellow, yellowish brown. Luster vitreous to greasy, on crystal surfaces brilliant. Transparent to translucent. Streak white.

Comp. — $CaB_2(SiO_4)_2$ or $CaO.B_2O_3.2SiO_2$ = Silica 48·8, boron trioxide 28·4, lime 22·8 = 100.

Pyr., etc.—B.B. fuses at 3·5 to a colorless glass, and imparts a green color to the O. F. (boron). Not decomposed by hydrochloric acid, but sufficiently attacked for the solution to give the reaction of boric acid with turmeric paper. When previously ignited gelatinizes with hydrochloric acid. Phosphoresces on heating, giving a reddish light.

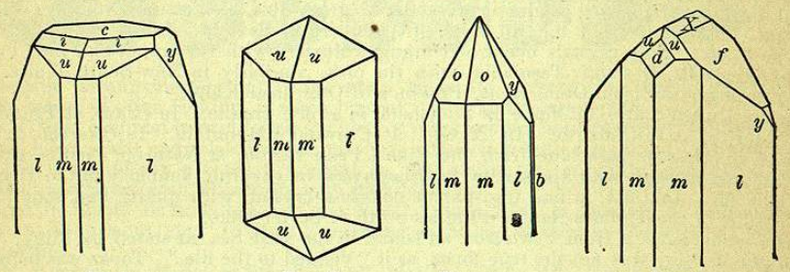
Obs.—Occurs at Danbury, Conn., with microcline and oligoclase in dolomite. At Russell, N. Y., in fine crystals. On the Piz Valatscha, the northern spur of Mt. Skopi south of Dissentis in eastern Switzerland, in slender prismatic crystals.

BARSOWITE. This doubtful species, occurring with blue corundum in the Ural, is by some authors classed with danburite; composition $CaAl_2Si_2O_8$ like anorthite.

TOPAZ.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}52854 : 1 : 0{\cdot}47698$.

837. 838. 839. 840.



Ural. Brazil. Durango. Japan.

mm''', 110 ∧ 110 = 55° 43′. yy', 041 ∧ $0\bar{4}1$ = 124° 41′. uu', 111 ∧ $\bar{1}11$ = 78° 20′.
ll', 120 ∧ $\bar{1}20$ = 89° 49′. ci, 001 ∧ 223 = 34° 14′. uu''', 111 ∧ $1\bar{1}1$ = 39° 0′.
dd', 201 ∧ $\bar{2}01$ = 122° 1′. cu, 001 ∧ 111 = 45° 35′. oo', 221 ∧ $\bar{2}21$ = 105° 7′.
XX', 043 ∧ $0\bar{4}3$ = 64° 55′. co, 001 ∧ 221 = 63° 54′. oo''' 221 ∧ $2\bar{2}1$ = 49° 37½′.
ff', 021 ∧ $0\bar{2}1$ = 87° 18′.

Crystals commonly prismatic, *m* predominating; or *l* (120) and the form then a nearly square prism resembling andalusite. Faces in the prismatic zone often vertically striated, and often showing vicinal planes. Also firm columnar; granular, coarse or fine.

Cleavage: *c* highly perfect. Fracture subconchoidal to uneven. Brittle. H. = 8. G. = 3·4–3·6. Luster vitreous. Color straw-yellow, wine-yellow, white, grayish, greenish, bluish, reddish. Streak uncolored. Transparent to subtranslucent. Optically +. Ax. pl. ∥ *b*. Bx ⊥ *c*. Axial angles variable. $2E_y$ = 112° to 120° 40′. Refractive indices, Brazil (Mühlheims):

For D $\alpha = 1{\cdot}62936$ $\beta = 1{\cdot}63077$ $\gamma = 1{\cdot}63747$ $\therefore$ $2V = 49°\ 31'$

Var.—*Ordinary.* In prismatic crystals usually colorless or pale yellow, less often pale blue, pink, etc. The yellow of the Brazilian crystals is changed by heating to a pale rose-pink. Often contains inclusions of liquid CO_2.

Physalite, or *pyrophysalite*, is a coarse nearly opaque variety, from Finbo; intumesces when heated, hence its name from *φυσαλίς, bubble*, and *πῦρ, fire*. *Pycnite* has a columnar, very compact structure. Rose made out that the cleavage was the same, and the form probably the same; and Des Cloizeaux showed that the optical characters were those of topaz.

Comp.—$(AlF)_2SiO_4$; usually containing hydroxyl and then $[Al(F,OH)]_2SiO_4$ or as given on p. 430. The former requires Silica 32·6, alumina 55·4, fluorine 20·7 = 108·7, deduct (O = 2F) 8·7 = 100.

Pyr., etc.—B.B. infusible. Fused in the closed tube, with previously fused and pulverized salt of phosphorus, etches the glass, giving off silicon fluoride, which forms a ring of SiO_2 above. With cobalt solution the pulverized mineral gives a fine blue on heating. Only partially attacked by sulphuric acid. A variety of topaz from Brazil, when heated, assumes a pink or red hue, resembling the Balas ruby.

Diff.—Characterized by its prismatic crystals with angles of 56° (124°) or 87° (93°); also by the perfect basal cleavage; hardness; infusibility; yields fluorine B.B.

Obs.—Topaz occurs especially in the highly acid igneous rocks of the granite family, as granite and rhyolite, in veins and cavities, where it appears to be the result of fumarole action after the crystallization of the magma; sometimes also in the surrounding schists, gneisses, etc., as a result of such action. In these occurrences often accompanied by fluorite, cassiterite, tourmaline.

Fine topaz comes from the Urals, from Alabashka, in the region of Ekaterinburg; from Miask in the Ilmen Mts; also the gold-washings on the R. Sanarka, in Govt. Orenburg; in Nerchinsk, beyond L. Baikal, in the Adun-Chalon Mts., etc.; in the province of Minas Geraes, Brazil, at Ouro Preto and Villa Rica, of deep yellow color; at the tin mines of Zinnwald and Ehrenfriedersdorf, and smaller crystals at Schneckenstein and Altenberg; sky-blue crystals in Cairngorm, Aberdeenshire; the Mourne mountains, Ireland; on the island of Elba. *Physalite* occurs in crystals of great size, at Fossum, Norway; Finbo, Sweden. *Pycnite* is from the tin mine of Altenberg in Saxony; also of Schlackenwald, Zinnwald, etc. Fine crystals occur at Durango, Mexico, with tin ore; at San Luis Potosi in rhyolite. Mt. Bischoff, Tasmania, with tin ores; similarly in New South Wales. In Japan in pegmatite from Otani-yama, Province of Omi, near Kioto.

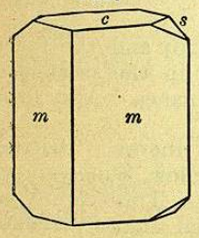
In the United States, in *Maine*, at Stoneham, in albitic granite. In *Conn.*, at Trumbull, with fluorite; at Willimantic. In *N. Car.*, at Crowder's Mountain. In *Colorado*, in fine crystals colorless or pale blue from the Pike's Peak region; at Nathrop, Chaffee Co., in wine-colored crystals with spessartite in lithophyses in rhyolite; similarly in the rhyolite of Chalk Mt. In *Utah*, in fine transparent colorless crystals with quartz and sanidine in the rhyolite of the Thomas Range, 40 miles north of Sevier Lake.

The name topaz is from *τοπάζιος*, an island in the Red Sea, as stated by Pliny. But the topaz of Pliny was not the true topaz, as it "yielded to the file." Topaz was included by Pliny and earlier writers, as well as by many later, under the name *chrysolite*.

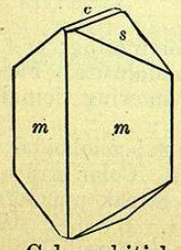
ANDALUSITE.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}9861 : 1 : 0{\cdot}70245$.

841.



842.



mm''', $110 \wedge 1\bar{1}0 = 89°\ 12'$.
ss', $011 \wedge 0\bar{1}1 = 70°\ 10'$.

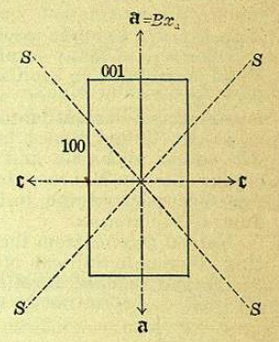
Usually in coarse prismatic forms, the prisms nearly square in form. Massive, imperfectly columnar; sometimes radiated and granular.

Cleavage: m distinct, sometimes perfect (Brazil); a less perfect: b in traces. Fracture uneven, subconchoidal. Brittle. H. = 7·5. G. = 3·16–3·20. Luster vitreous; often weak. Color whitish, rose-red, flesh-red, violet, pearl-gray red-

dish brown, olive-green. Streak uncolored. Transparent to opaque, usually subtranslucent. Pleochroism strong in some colored varieties. Absorption strong, $a > b > c$. Sections normal to an optic axis are idiophanous or show the polarization-brushes distinctly (p. 219). Optically −. Ax. pl. ∥ b. $Bx \perp c$. $2H_r = 96°\ 30'$ Brazil; $\beta_r = 1{\cdot}638$; $\gamma - \alpha = 0{\cdot}011$.

Chiastolite, or *Macle* is a variety in stout crystals having the axis and angles of a different color from the rest, owing to a regular arrangement of carbonaceous impurities through the interior, and hence exhibiting a colored cross, or a tesselated appearance in a transverse section. Fig. 844 shows sections of a crystal.

843.



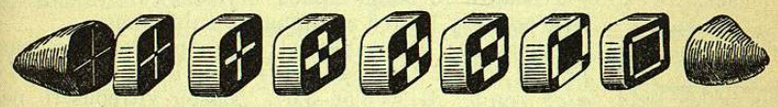
Comp.—$Al_2SiO_5 = (AlO)AlSiO_4$ or $Al_2O_3.SiO_2$ = Silica 36·8, alumina 63·2 = 100. Manganese is sometimes present, as in manganandalusite.

Pyr., etc.—B.B. infusible. With cobalt solution gives a blue color after ignition. Not decomposed by acids. Decomposed on fusion with caustic alkalies and alkaline carbonates.

Diff.—Characterized by the nearly square prism, pleochroism, hardness, infusibility; reaction for alumina B.B.

Distinguished in thin sections by its high relief; low interference-colors, which are only slightly above those of quartz; negative biaxial character; negative extension of the crystals (diff. from sillimanite); rather distinct prismatic cleavage and the constant parallel extinction (diff. from pyroxenes, which have also greater birefringence); also by its

844.



characteristic arrangement of impurities when these are present (Fig. 844). The pleochroism, which is often lacking, is when present strong and characteristic.

Obs.—Most common in argillaceous schist, or other schists imperfectly crystalline; also in gneiss, mica schist and related rocks; rarely in connection with serpentine. The variety chiastolite is commonly a contact mineral in clay-slates, *e.g.*, adjoining granitic dikes. Sometimes associated with sillimanite with parallel axes.

Found in Spain, in Andalusia; in the Tyrol, Lisens Alp; in Saxony, at Bräunsdorf; Bavaria, at Wunsiedel, etc. In Brazil, province of Minas Geraes, in fine crystals and as rolled pebbles.

In N. America, in *Maine*, at Standish. *N. Hamp.*, White Mtn. Notch; *Mass.*, at Westford; Lancaster, both varieties; Sterling, chiastolite. *Conn.*, at Litchfield and Washington. *Penn.*, in Delaware Co., near Leiperville, large cryst.; Upper Providence.

Named from Andalusia, the first locality noted. The name *macle* is from the Latin *macula*, a spot. Chiastolite is from *χιάστος, arranged diagonally*, and hence from *chi*, the Greek name for the letter X.

SILLIMANITE. Fibrolite.

Orthorhombic. Axes $\breve{a} : \bar{b} = 0{\cdot}970 : 1$. $mm''' = 88°\ 15'$, hh' $(230 \wedge \bar{2}30) = 69°$. Prismatic faces striated and rounded. Commonly in long slender crystals not distinctly terminated; often in close parallel groups, passing into fibrous and columnar massive forms; sometimes radiating.

Cleavage: b very perfect. Fracture uneven. H. = 6–7. G. = 3·23–3·24. Luster vitreous, approaching subadamantine. Color hair-brown, grayish brown, grayish white, grayish green, pale olive-green. Streak uncolored. Transparent to translucent. Pleochroism sometimes distinct. Optically +.

Double refraction strong. Ax. pl. ∥ *b*. Bx ⊥ *c*. Dispersion $\rho > v$. $2E_r = 44°$. $\beta = 1{\cdot}661$; $\gamma - \alpha = 0{\cdot}021$.

Pyr.—Same as andalusite.

Diff.—Characterized by its fibrous or columnar form; perfect cleavage; infusibility; reaction for alumina.

In thin sections recognized by its form, usually with transverse fractures; parallel extinction; high interference-colors.

Obs.—Often present in the quartz of gneisses and sometimes granites in very slender, minute prisms commonly aggregated together and sometimes intergrown with andalusite; iolite is also a common associate; rarely as a contact mineral; often occurs with corundum.

Observed in many localities, thus near Moldau in Bohemia (*Faserkiesel*); at Fassa in Tyrol (*bucholzite*); in the Carnatic with corundum (*fibrolite*); at Bodenmais, Bavaria; Freiberg, Saxony; in France, near Pontgibaud and other points in Auvergne; forms rolled masses in the diamantiferous sands of Minas Geraes, Brazil.

In the United States, in *Massachusetts*, at Worcester. In *Connecticut*, near Norwich, with zircon, monazite and corundum; at Willimantic. In *N. York*, at Yorktown, Westchester Co.; in Monroe, Orange Co. (*monrolite*). In *Penn.*, at Chester on the Delaware, near Queensbury forge; in Delaware Co.; *Delaware*, at Brandywine Springs. With corundum in *N. Carolina*.

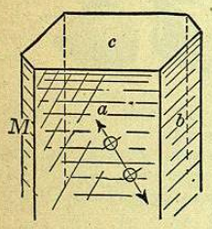
Named *fibrolite* from the fibrous massive variety (*Germ.*, Faserkiesel); *sillimanite*, after Prof. Benjamin Silliman of New Haven (1779–1864).

Bamlite, xenolite, wörthite probably belong to sillimanite; the last is altered.

CYANITE. Kyanite. Disthene.

Triclinic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}8994 : 1 : 0{\cdot}7090$; $\alpha = 90° 5\frac{1}{2}'$, $\beta = 101° 2'$, $\gamma = 105° 44\frac{1}{2}'$. *ac*, $100 \wedge 001 = 78° 30'$; *bc*, $010 \wedge 001 = 86° 45'$;

845.



Usually in long bladed crystals, rarely terminated. Also coarsely bladed columnar to subfibrous.

Cleavage: *a* very perfect; *b* less perfect; also parting ∥ *c*. H. = 5–7·25; the least, 4–5, on *a* ∥ *ċ*; 6–7 on *a* ∥ edge *a*/*c*; 7 on *b*. G. = 3·56–3·67. Luster vitreous to pearly. Color blue, white; blue along the center of the blades or crystals with white margins; also gray, green, black. Streak uncolored. Translucent to transparent. Pleochroism distinct in colored varieties. Optically −. Ax. pl. nearly ⊥ *a* and inclined to edge *a*/*b* on *a* about 30°, and about 7½ on *b*. $2H_{a,r} = 99° 18'$ Pfitschthal.

Comp.—Empirical formula Al_2SiO_5 or $Al_2O_3.SiO_2$, like andalusite and sillimanite. Perhaps a basic metasilicate, $(AlO)_2SiO_3$.

Pyr., etc.—Same as for andalusite. At a high temperature (1320°–1380°) cyanite assumes the physical characters of sillimanite.

Diff.—Characterized by the bladed form; common blue color; varying hardness; infusibility; reaction for alumina.

Obs.—Occurs principally in gneiss and mica schist (both the ordinary variety with muscovite and also that with paragonite) often accompanied by garnet and sometimes by staurolite; also in eclogite. It is often associated with corundum.

Found in transparent crystals at Monte Campione in the St. Gothard region in Switzerland in paragonite schist; on Mt. Greiner, Zillerthal, and in the Pfitschthal (*rhætizite*, white) in Tyrol; in eclogite of the Saualpe, Carinthia; Horrsjöberg in Wermland, Sweden; Villa Rica, Brazil, etc.

In *Mass.*, at Chesterfield, with garnet in mica schist. In *Conn.*, at Litchfield and Washington. In *Vermont*, at Thetford. In *Penn.*, in Chester Co. and in Delaware Co. In *Virginia*, Buckingham Co. In *N. Carolina*, with rutile, lazulite, etc., at Crowder's Mt., Gaston Co.; in Gaston and Rutherford counties associated with corundum, damourite; beautiful clear green in Yancey Co. Named from *κυανός*, *blue*.

Datolite Group. Monoclinic.

Basic Orthosilicates. $\overset{II}{H}\overset{III}{R}SiO_5$ or $\overset{II}{R}_2\overset{III}{R}_2(SiO_5)_2$. Oxygen ratio for R : Si = 3 : 2.

$\overset{II}{R}$ = Ca,Be,Fe, chiefly; $\overset{III}{R}$ = Boron, the yttrium (and cerium) metals, etc.

	$\dot{a} : \breve{b} : \dot{c}$	β
Datolite	0·6345 : 1 : 1·2657	89° 51′
$HCaBSiO_5$ or $Ca(BOH)SiO_4$		
Homilite	0·6249 : 1 : 1·2824	89° 21′
$Ca_2FeB_2Si_2O_{10}$ or $Ca_2Fe(BO)_2(SiO_4)_2$		
	$2\dot{a} : \breve{b} : 4\dot{c}$	β
Euclase	0·6474 : 1 : 1·3330	79° 44′
$HBeAlSiO_5$ or $Be(AlOH)SiO_4$	$\dot{a}$	
Gadolinite	0·6273 : 1 : 1·3215	89° 26½′
$Be_2FeY_2Si_2O_{10}$ or $Be_2Fe(YO)_2(SiO_4)_2$		

The species of the DATOLITE GROUP are usually regarded as basic orthosilicates, the formulas being taken in the second form given above. They all crystallize in monoclinic system, and all but Euclase conform closely in axial ratio; with the latter there is also a distinct morphological relationship.

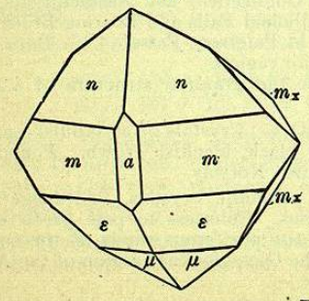
DATOLITE.

Monoclinic. Axes $\dot{a} : \breve{b} : \dot{c} = 0{\cdot}6345 : 1 : 1{\cdot}2657$; $\beta = 89° 51\frac{1}{3}'$.

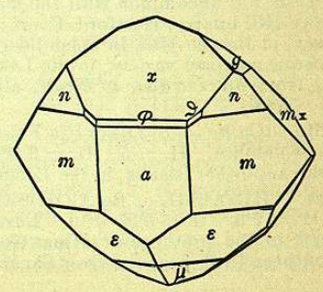
mm''',	$110 \wedge 1\bar{1}0 = 64° 47'$.	cn,	$001 \wedge 111 = 66° 57'$.
ac,	$100 \wedge 001 = 89° 51'$.	cm,	$001 \wedge 110 = 89° 53'$.
ax,	$100 \wedge 101 = 45° 0'$.	$c\epsilon$,	$001 \wedge \bar{1}12 = 49° 49'$.
gg',	$012 \wedge 0\bar{1}2 = 64° 39\frac{1}{3}'$.	nn',	$111 \wedge 1\bar{1}1 = 59° 4\frac{1}{2}'$.
$m_x m_x'$,	$011 \wedge 0\bar{1}1 = 103° 23'$.	$\epsilon\epsilon'$,	$\bar{1}12 \wedge \bar{1}\bar{1}2 = 48° 19\frac{1}{3}'$.

Crystals varied in habit; usually short prismatic with either *m* or m_x predominating; sometimes tabular ∥ *x* (201); also of other types, and often highly modified (Figs. 846–849). Also botryoidal and globular, having a columnar structure; divergent and radiating; sometimes massive, granular to compact and crypto-crystalline.

846.



847.



Bergen Hill.

Cleavage not observed. Fracture conchoidal to uneven. Brittle. H. = 5–5·5. G. = 2·9–3·0. Luster vitreous, rarely subresinous on a surface of frac-

ture. Color white; sometimes grayish, pale green, yellow, red, or amethystine, rarely dirty olive-green or honey-yellow. Streak white. Transparent to translucent; rarely opaque white.

Var.—1. *Ordinary.* In glassy crystals of varied habit, usually with a greenish tinge. The angles in the prismatic and clinodome zones vary but little, e.g., $110 \wedge \bar{1}10 = 64° 47'$, while $011 \wedge 0\bar{1}1 = 66° 37'$, etc. 2. *Compact massive.* White opaque cream-colored, pink; breaking with the surface of porcelain or Wedgewood ware. From the L. Superior region. 3. *Botryoidal; Botryolite.* Radiated columnar, having a botryoidal surface, and containing more water than the crystals, but optically identical.

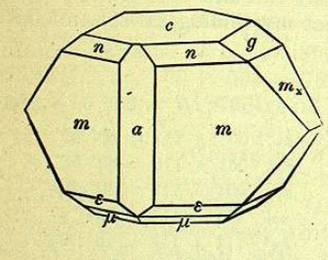
Comp.—A basic orthosilicate of boron and calcium; empirically $HCaBSiO_5$ or $H_2O.2CaO.B_2O_3.2SiO_2$; this may be written $Ca(BOH)SiO_4$ = Silica 37·6, boron trioxide 21·8, lime 35·0, water 5·6 = 100.

Pyr., etc.—In the closed tube gives off much water. B B. fuses at 2 with intumescence to a clear glass, coloring the flame bright green. Gelatinizes with hydrochloric acid.

Diff.—Characterized by its glassy, greenish, complex crystals; easy fusibility and green flame B B.

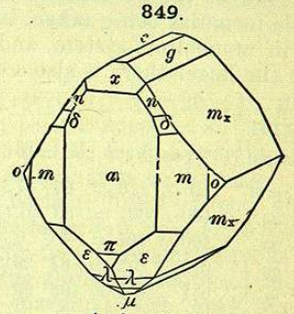
Obs.—Datolite is found chiefly as a secondary mineral in veins and cavities in basic eruptive rocks, often associated with calcite, prehnite and various zeolites; sometimes associated with danburite; also in gneiss, diorite, and serpentine; in metallic veins; sometimes in beds of iron ore. Found in Scotland, in trap, at the Kilpatrick Hills, etc.; in a bed of magnetite at Arendal in Norway (*botryolite*); at Utö in Sweden; at Andreasberg in diabase and in veins of silver ores; in Rhenish Bavaria (the *humboldtite*); at the Seisser Alp, Tyrol, and at Theiss, near Claussen, in geodes in amygdaloid; in granite at Baveno near Lago Maggiore; at Toggiana in Modena, in serpentine; Monte Catini in Tuscany.

848.



Bergen Hill.

849.



Andreasberg.

In the U. S. not uncommon with the diabase of Connecticut and Massachusetts. Thus at the Rocky Hill quarry, Hartford, Conn.; at Middlefield Falls and Roaring Brook, Conn. In N. Jersey, at Bergen Hill, in splendid crystals; at Paterson, Passaic Co. Both crystals and the opaque compact variety, in the Lake Superior region.

Named from *δατέϊσθαι, to divide*, alluding to the granular structure of a massive variety.

Homilite. $(Ca,Fe)_3B_2Si_2O_{10}$ or $(Ca,Fe)_3(BO)_2(SiO_4)_2$. Crystals often tabular $\parallel c$; angles near those of datolite. H. = 5. G. = 3·38. Color black, blackish brown. Found on the island Stokö and other islands, in the Langesund fiord, Norway.

Euclase. $HBeAlSiO_5$ or $Be(AlOH)SiO_4$. In prismatic crystals. Cleavage: $b(010)$ perfect. H. = 7·5. G = 3·05–3·10. Luster vitreous. Colorless to pale green or blue. From Brazil, in the province of Minas Geraes; in the auriferous sands of the Orenburg district, southern Ural, near the river Sanárka; in the Glossglockner region of the Austrian Alps.

Gadolinite. $Be_2FeY_2Si_2O_{10}$ or $Be_2Fe(YO)_2SiO_4)_2$. Crystals, often prismatic, rough and coarse; commonly in masses. Cleavage none. Fracture conchoidal or splintery. Brittle. H. = 6·5–7. G. = 4·0–4·5; normally 4·36–4·47 (anisotropic), 4·24–4·29 (isotropic and amorphous from alteration). Luster vitreous to greasy. Color black, greenish black, also brown. From near Falun and Ytterby, Sweden; Hitterö, Norway; also in Llano Co., Texas, in nodular masses and rough crystals, sometimes up to 40 or 60 pounds in weight.

The yttrium earths or "gadolinite-earths" (partly replaced by the oxides of cerium, lanthanum and didymium) form a complex group which contains considerable erbium, also several new elements (ytterbium, scandium, etc.) of more or less definite character.

Yttrialite. A silicate of thorium and the yttrium metals chiefly. Massive; amorphous. G. = 4·575. Color on the fresh fracture olive-green, changing to orange-yellow on surface. Associated with the gadolinite of Llano Co., Texas.

Rowlandite. An yttrium silicate, occurring massive with gadolinite of Llano Co., Texas; color drab-green.

Mackintoshite. Silicate of uranium, thorium, cerium, etc. Massive. Color black. Llano Co., Texas.

Epidote Group. Orthorhombic and Monoclinic.

Basic Orthosilicates, $H\overset{II}{R}_2\overset{III}{R}_3Si_3O_{13}$ or $\overset{II}{R}_2(\overset{III}{R}OH)\overset{III}{R}_2(SiO_4)_3$

$\overset{II}{R}$ = Ca,Fe; $\overset{III}{R}$ = Al,Fe,Mn,Ce, etc.

α. Orthorhombic Section.

		$\breve{a} : \bar{b} : \dot{c}$
Zoisite	$Ca_2(AlOH)Al_2(SiO_4)_3$	0·6196 : 1 : 0·3429

β. Monoclinic Section.

		$\dot{a} : b : \dot{c}$	
Epidote	$m Ca_2(AlOH)Al_2(SiO_4)_3$ + $n Ca_2(FeOH)Fe_2(SiO_4)_3$	1·5787 : 1 : 1·8036	64° 37′
Piedmontite	$Ca_2(AlOH)(Al,Mn)_2(SiO_4)_3$	1·6100 : 1 : 1·8326	64° 39′
Allanite	$(Ca,Fe)_2(AlOH)(Al,Ce,Fe)_2(SiO_4)_3$	1·5509 : 1 : 1·7691	64° 59″

The Epidote Group includes the above complex orthosilicates. The monoclinic species agree closely in form. To them the orthorhombic species zoisite is also related in angle, its prismatic zone corresponding to the monoclinic orthodomes, etc. Thus we have:

Zoisite mm''', $110 \wedge 110 = 63° 34'$. Epidote cr, $001 \wedge \bar{1}01 = 63° 42'$.
uu', $021 \wedge 0\bar{2}1 = 68° 54'$. mm', $110 \wedge \bar{1}10 = 70° 4'$, etc.

There seems to be, however, a monoclinic calcium compound, having the composition of zoisite, but monoclinic and strictly isomorphous with ordinary epidote; it is called *clinozoisite*.

ZOISITE.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·6196 : 1 : 0·34295$.

mm''', $110 \wedge 1\bar{1}0 = 63° 34'$. ff'', $011 \wedge 0\bar{1}1 = 37° 52'$.
dd', $101 \wedge \bar{1}01 = 57° 56'$. oo''', $111 \wedge 1\bar{1}1 = 33° 24'$.

Crystals prismatic, deeply striated or furrowed vertically, and seldom distinctly terminated. Also massive; columnar to compact.

Cleavage: b very perfect. Fracture uneven to subconchoidal. Brittle. H. = 6–6·5. G. = 3·25–3·37. Luster vitreous; on the cleavage-face, b, pearly. Color grayish white, gray, yellowish brown, greenish gray, apple-green; also peach-blossom-red to rose-red. Streak uncolored. Transparent to subtranslucent.

Pleochroism strong in pink varieties. Optically +. Ax. pl. usually $\parallel b$; also $\parallel c$. Bx $\perp a$. Dispersion strong, $\rho < v$; also $\rho > v$. Axial angle variable even in the same crystal. $2E_r = 42°–90°$. $\beta = 1·696$; $\gamma - \alpha = 0·006$.