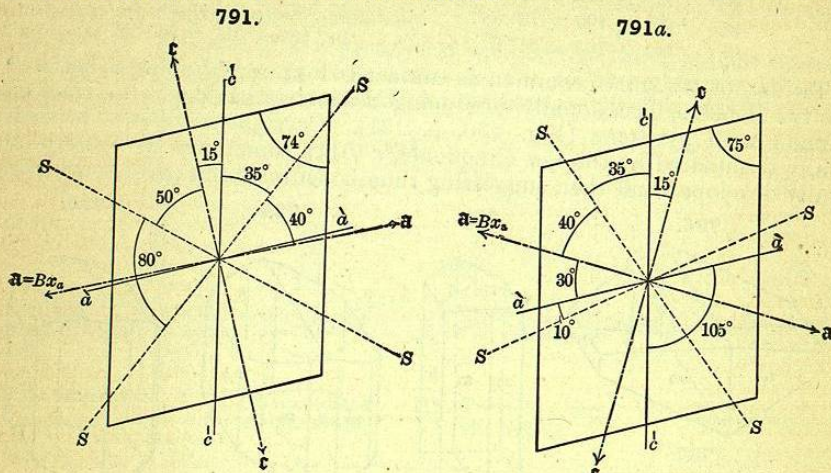


doubtful. The amphibole formulas are in many cases double the corresponding ones for pyroxene. Thus, for most tremolite and actinolite, $\text{Ca} : \text{Mg}(\text{Fe}) = 1 : 3$, and hence tremolite is $\text{CaMg}_3\text{Si}_4\text{O}_{12}$, while diopside is $\text{CaMgSi}_2\text{O}_6$, etc.

Rammelsberg has shown that the composition of most aluminous amphiboles may be expressed in the general form $m\text{RSiO}_3 \cdot n\text{Al}_2\text{O}_3$; while Scharizer, modifying this view, proposes to regard the amphiboles as molecular compounds of $\text{Ca}(\text{Mg}, \text{Fe})_3\text{Si}_4\text{O}_{12}$ (actinolite), and the orthosilicate $(\text{R}_2, \text{R})_3\text{R}_2\text{Si}_3\text{O}_{12}$, for which he uses Breithaupt's name *syntagmatite*, originally given to the Vesuvian hornblende.



The crystallographic position here adopted is that suggested by Tschermak, which best exhibits the relation between amphibole and pyroxene. Some authors retain the former position, according to which $p = (001)$, $r = (\bar{1}11)$, etc. Fig. 791a shows the corresponding optical orientation.

I. Containing little or no Aluminium.

1. **TREMOLITE.** Grammatite, nephrite pt. *Calcium-magnesium amphibole.* Formula $\text{CaMg}_3(\text{SiO}_3)_4 = \text{Silica } 57.7$, magnesia 28.9 , lime $13.4 = 100$. Ferrous iron, replacing the magnesium, present only sparingly, up to 3 p. c. Colors white to dark gray. In distinct crystals, either long-bladed or short and stout. In aggregates long and thin columnar, or fibrous; also compact granular massive (nephrite, p. 401). $G. = 2.9-3.1$. Sometimes transparent and colorless. Optically —. Extinction-angle on b , or $c \wedge b = +16^\circ$ to 18° , hence $\text{Bx}_a \wedge b = -74^\circ$ to -72° . $2V_y = 80^\circ$ to 88° . $\beta_y = 1.621$; $\gamma - \alpha = 0.027$.

Tremolite was named by Pini from the Tremola valley on the south side of the St. Gothard.

2. **ACTINOLITE.** Strahlstein Germ. *Calcium-magnesium-iron amphibole.* Formula $\text{Ca}(\text{Mg}, \text{Fe})_3(\text{SiO}_3)_4$. Color bright green and grayish green. In crystals, either short- or long-bladed, as in tremolite; columnar or fibrous; granular massive. $G. = 3-3.2$. Sometimes transparent. The variety in long bright-green crystals is called *glassy actinolite*; the crystals break easily across the prism. The fibrous and radiated kinds are often called *asbestiform actinolite* and *radiated actinolite*. Actinolite owes its green color to the ferrous iron present.

Pleochroism distinct, increasing as the amount of iron increases, and hence the color becomes darker: c emerald-green, b yellow-green, a greenish yellow.

Absorption $c > b > a$ Zillerthal, Tschermak. Optically —. Extinction-angle on b , $c \wedge b = +15^\circ$ and $\text{Bx}_a \wedge b = -75^\circ$. $2V_y = 80^\circ$; $\rho < v$; $\beta_y = 1.627$; $\gamma - \alpha = 0.025$.

Named actinolite from $\acute{\alpha}\kappa\tau\iota\nu$, a ray, and $\lambda\theta\omicron\varsigma$, stone, a translation of the German *Strahlstein* or *radiated stone*. Name changed to *actinote* by Haüy, without reason.

NEPHRITE. Jade pt. A tough, compact, fine-grained tremolite (or actinolite), breaking with a splintery fracture and glistening luster. $H. = 6-6.5$. $G. = 2.96-3.1$. Named from a supposed efficacy in diseases of the kidney, from $\nu\epsilon\phi\rho\acute{\omicron}\varsigma$, kidney. It varies in color from white (tremolite) to dark green (actinolite), in the latter iron protoxide being present up to 6 or 7 p. c. The latter kind sometimes encloses distinct prismatic crystals of actinolite. A derivation from an original pyroxenic mineral has been suggested in some cases. Nephrite or jade was brought in the form of carved ornaments from Mexico or Peru soon after the discovery of America. A similar stone comes from Eastern Asia, New Zealand and Alaska. See jadeite, p. 393; jade, p. 394.

ASBESTUS. Asbestos. *Asbest Germ.* Tremolite, actinolite, and other varieties of amphibole, excepting those containing much alumina, pass into fibrous varieties, the fibers of which are sometimes very long, fine, flexible, and easily separable by the fingers, and look like flax. These kinds are called *asbestos* (fr. the Greek for *incombustible*). The colors vary from white to green and wood-brown. The name *amianthus* is applied usually to the finer and more silky kinds. Much that is popularly called asbestos is *chrysotile*, or fibrous serpentine, containing 12 to 14 p. c. of water. *Byssolite* is a stiff fibrous variety.

Mountain leather is in thin flexible sheets, made of interlaced fibers; and *mountain cork* the same in thicker pieces; both are so light as to float on water, and they are often hydrous, color white to gray or yellowish. *Mountain wood* is compact fibrous, and gray to brown in color, looking a little like dry wood.

SMARAGDITE. A thin-foliated variety of amphibole, near actinolite in composition but carrying some alumina. It has a light grass-green color, resembling much common green diallage. In many cases derived from pyroxene (diallage) by uralitization, see below. It retains much of the structure of the diallage and also often encloses remnants of the original mineral. It forms, along with whitish or greenish saussurite, a rock called *saussurite-gabbro*, the euphotide of the Alps. The original mineral is from Corsica, and the rock is the *verde di Corsica duro* of the arts.

URALITE. Pyroxene altered to amphibole. The crystals, when distinct, retain the form of the original mineral, but have the cleavage of amphibole. The change usually commences on the surface, transforming the outer layer into an aggregation of slender amphibole prisms, parallel in position to each other and to the parent pyroxene (cf. Fig. 760, p. 386). When the change is complete the entire crystal is made up of a bundle of amphibole needles or fibers. The color varies from white (tremolite) to pale or deep green, the latter the more common. In composition uralite appears to conform nearly to actinolite, as also in optical characters. The most prominent change in composition in passing from the original pyroxene is that corresponding to the difference existing between the two species in general, that is, an increase in the magnesium and decrease in calcium. The change, therefore, is not strictly a case of paramorphism, although usually so designated. Uralite was originally described by Rose in a rock from the Ural. It has since been observed from many localities. The microscopic study of rocks has shown the process of "uralitization" to be very common, and some authors regard many hornblende rocks and schists to represent altered pyroxenic rocks on a large scale.

CUMMINGTONITE. Amphibole-Anthophyllite. *Iron-Magnesium Amphibole.* Here belong certain varieties of amphibole resembling anthophyllite and essentially identical with it in composition, but optically monoclinic. From Kongsberg; Greenland. The original *cummingtonite* is gray to brown in color; usually fibrous or fibro-lamellar, often radiated. $G. = 3.1-3.32$; from Cummington, Mass.

DANNEMORITE. *Iron-Manganese Amphibole.* Color yellowish brown to greenish gray. Columnar or fibrous, like tremolite and asbestos. Contains iron and manganese. From Sweden.

GRÜNERITE. *Iron-Amphibole.* Asbestiform or lamellar-fibrous. Luster silky; color brown; $G. = 3.713$. Formula FeSiO_3 .

3. **RICHTERITE.** *Sodium-Magnesium-Manganese Amphibole.* $(\text{K}, \text{Na}, \text{Mg}, \text{Ca}, \text{Mn})_3(\text{SiO}_3)_4$.

In elongated crystals, seldom terminated. $G. = 3.09$. Color brown, yellow, rose-red. Transparent to translucent. $c \wedge b = +17^\circ-20^\circ$; $\beta_y = 1.63$; $\gamma - \alpha = 0.024$. From Pajsborg and Långban, Sweden. Characterized by the presence of manganese and alkalis in relatively large amount.

Breislakite occurs in wool-like forms at Vesuvius and Capo di Bove. Color dark brown to black, pleochroism strongly marked. Inferred to belong near richterite.

II. Aluminous.

4. ALUMINOUS AMPHIBOLE. Hornblende. Contains alumina or ferric iron, and usually both, with ferrous iron (sometimes manganese), magnesium, calcium, and alkalies. The kinds here included range from the light-colored *edenite*, containing but little iron, through the light to dark green *pargasite*, to the dark-colored or black *hornblende*, the color growing darker with increase in amount of iron. Extinction-angle variable, from 0° to 37° , see below. Pleochroism strong. Absorption usually $c < b < a$.

EDENITE. *Aluminous Magnesium-Calcium Amphibole.* Color white to gray and pale green, and also colorless; $G = 3.0-3.059$. Resembles anthophyllite and tremolite. Named from the locality at Edenville, N. Y. To this variety belong various pale-colored amphiboles, having less than 5 p. c. of iron oxides.

Koksharovite is a variety from the neighborhood of L. Baikal named after the Russian mineralogist, N. von Koksharov.

COMMON HORNBLENDE, PARGASITE. Colors bright or dark green, and bluish green to grayish black and black. $G = 3.05-3.47$. *Pargasite* is usually made to include green and bluish-green kinds, occurring in stout lustrous crystals, or granular; and *Common hornblende* the greenish-black and black kinds, whether in stout crystals or long-bladed, columnar, fibrous, or massive granular. But no line can be drawn between them. The extinction-angle on b , or $c \wedge b = +15^\circ$ to 25° chiefly. Absorption $c > b > a$.

Pargasite occurs at Pargas, Finland, in bluish-green and grayish-black crystals. $c \wedge b = +18^\circ$; $\beta = 1.64$; $\gamma - \alpha = 0.019$; $2V = 59^\circ$. Pleochroism: c greenish blue; b emerald-green; a grn. yellow.

The dark brown to black *hornblendes* from basaltic and other igneous rocks vary somewhat widely in optical characters. The angle $c \wedge b = 0^\circ$ to $+10^\circ$ chiefly; $\beta = 1.725$; $\gamma - \alpha = 0.072$ (maximum). Pleochroism: c brown, b yellow, a yw. green, but variable.

The *Kataforite* of Norway (Brögger) has $c \wedge b = 30^\circ$ to 60° ; absorption $b > c > a$; pleochroism: c yellow, b violet, a yw. brown; it approximates toward arfvedsonite (p. 405).

Kupfferite, from a graphite mine in the Tunkinsk Mts., near L. Baikal, is a deep green amphibole (aluminous) formerly referred to anthophyllite.

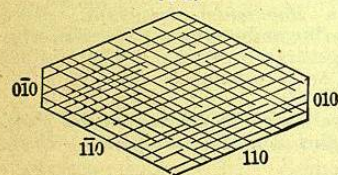
Syntagmatite is the black hornblende of Vesuvius.
Bergamaskite is an iron-amphibole containing almost no magnesia. From Monte Altino, Province of Bergamo, Italy.

Kaersutite is a titaniferous amphibole from Kaersut, Umanaks fiord, North Greenland.
Hastingsite is an amphibole low in silica and high in iron and soda, from the nephelitesyenite of Dungannon, Hastings Co., Ontario.

Pyr.—Essentially the same as for the corresponding varieties of pyroxene, see p. 390.

Diff.—Distinguished from pyroxene (and tourmaline) by its distinct prismatic cleavage, yielding angles of 56° and 124° . Fibrous and columnar forms are much more common than with pyroxene, lamellar and foliated forms rare (see also pp. 390, 398). Crystals often long,

792.



slender, or bladed. Differs from the fibrous zeolites in not gelatinizing with acids. Epidote has a peculiar green color, is more fusible, and shows a different cleavage.
In rock sections amphibole generally shows distinct colors, green, sometimes olive or brown, and is strongly pleochroic. Also recognized by its high relief; generally rather high interference-colors; by the very perfect system of cleavage-cracks crossing at angles of 56° and 124° in sections $\perp b$ (Fig. 792). In sections $\parallel b$ (010) (recognized by yielding no axial figure in convergent light, by showing the highest interference-colors, and by having parallel cleavage-cracks, $\parallel b$), the extinction-direction for common hornblendes makes a small angle ($12^\circ-15^\circ$) with the cleavage-cracks (i.e., with b); further, this direction is positive c (different from common pyroxene and ægirite, cf. Figs. 772 and 776).

Obs.—Amphibole occurs in many crystalline limestones, and granitic and schistose rocks, and sparingly in volcanic rocks. *Tremolite*, the magnesia-lime variety, is especially

common in limestones, particularly magnesian or dolomitic; *actinolite* (also nephrite), the magnesia-lime-iron variety, in steatitic rocks and with serpentine; and dark green and black *hornblende*, in chlorite schist, mica schist, gneiss, and in various other rocks of which it forms a constituent part; brown to black hornblende occurs in trachyte and other eruptive rocks. Asbestos is often found in connection with serpentine.

Hornblende-rock, or *amphibolite*, consists of massive hornblende of a dark greenish black or black color, and has a granular texture. Occasionally the green hornblende, or actinolite, occurs in rock-masses, as at St. Francis, in Canada. *Hornblende-schist* has the same composition as amphibolite, but is schistose or slaty in structure. It often contains a little feldspar. In some varieties of it the hornblende is in part in minute needles. Granite and syenite often contain hornblende, and with diorite it is a common constituent. This is also true of the corresponding forms of gneiss. In these cases it is usually present in small, irregular masses, often fibrous in structure; also as rough bladed crystals.

Prominent foreign localities of amphibole are the following: *Tremolite* (grammatite) in dolomite at Campolongo, Switzerland; also at Orawitza, Rezbánya, Hungary; Gulsjö, Wermland, Sweden. *Actinolite* in the crystalline schists of the Central and Eastern Alps, especially at Greiner in the Zillertal; at Zöblitz in Saxony; Arendal, Norway. *Asbestos* at Sterzing, Zillertal, and elsewhere in Tyrol; in Savoy; also in the island of Corsica. *Pargasite* at Pargas, Finland; Saualpe in Carinthia. *Hornblende* at Arendal and Kongsberg, Norway; in Sweden and Finland; at Vesuvius; Aussig and Teplitz, Bohemia; etc. *Nephrite*, which in the form of "jade" ornaments and utensils is widely distributed among the relics of early man (see jade, p. 394), is obtained at various points in Central Asia. The most important source is that in the Karakash valley in the Kuen Lun Mts. on the southern borders of Turkestan; also other localities in Central Asia. In New Zealand, Nephrite has been found in Europe as a rolled mass at Schwemmsal near Leipzig; in Swiss Lake habitations and similarly elsewhere.

In the United States, in *Maine*, black crystals occur at Thomaston; *pargasite* at Phippsburg. In *Vermont*, actinolite in the steatite quarries of Windham and New Fane. In *Mass.*, tremolite at Lee; black crystals at Chester; asbestos at Pelham; *cummingtonite* at Cummington. In *Conn.*, in large flattened white crystals and in bladed and fibrous forms (tremolite) in dolomite, at Canaan. In *N. York*, Warwick, Orange Co.; near Edenville; near Amity; at the Stirling mines, Orange Co.; in short green crystals at Gouverneur, St. Lawrence Co.; with pyroxene at Russell; a black variety at Pierrepont; at Macomb; Pitcairn; tremolite at Fine; in Rossie, 2 m. N. of Oxbow; in large white crystals at Diana, Lewis Co.; asbestos near Greenwood Furnace. In *N. Jersey*, tremolite or gray amphibole in good crystals at Broom, and other varieties of the species at Franklin and Newton, radiated actinolite. In *Penn.*, actinolite at Mineral Hill, in Delaware Co.; at Unionville; at Kennett, Chester Co. In *Maryland*, actinolite and asbestos at the Bare Hills in serpentine; asbestos is mined at Pylesville, Harford Co. In *Virginia*, actinolite at Willis's Mt., in Buckingham Co.; asbestos at Barnett's Mills, Fauquier Co. Nephrite occurs in Alaska.

In Canada, tremolite is abundant in the Laurentian limestones, at Calumet Falls, Litchfield, Pontiac Co., Quebec; also at Blythfield, Renfrew Co., and Dalhousie, Lanark Co. Black hornblende at various localities in Quebec and Ontario with pyroxene, apatite, titanite, etc., as in Renfrew Co. Asbestos and mountain cork at Buckingham, Ottawa Co., Quebec; a bed of actinolite at St. Francis, Beauce Co., Quebec; nephrite has been found in British Columbia and Northwest Territory.

GLAUCOPHANE.

Monoclinic; near amphibole in form. Crystals prismatic in habit, usually indistinct; commonly massive, fibrous, or columnar to granular.

Cleavage: m perfect. Fracture conchoidal to uneven. Brittle. $H = 6-6.5$. $G = 3.103-3.113$. Luster vitreous to pearly. Color azure-blue, lavender-blue, bluish black, grayish. Streak grayish blue. Translucent. Pleochroism strongly marked: c sky-blue to ultramarine-blue, b reddish or bluish violet, a yellowish green to colorless. Absorption $c > b > a$. Optically +. Ax. $\parallel b$. $c \wedge b = 4^\circ$ to 6° , rarely higher values. $2E_{a,r} = 84^\circ 42'$. $\beta = 1.6442$ (gastaldite); $\gamma - \alpha = 0.022$.

Comp.—Essentially $NaAl(SiO_3)_2 \cdot (Fe, Mg)SiO_3$. If $Mg : Fe = 2 : 1$, the formula requires: Silica 57.6, alumina 16.3, iron protoxide 7.7, magnesia 8.5, soda 9.9 = 100.

Obs.—Occurs as the hornblende constituent of certain crystalline schists, called *glaucophane-schists*, or glaucophanite; also more or less prominent in mica schists, amphibolites, gneiss, eclogites, etc. It is often associated with mica, garnet, diallage and omphacite, epidote and zoisite, etc. First described from the island of Syra, one of the Cyclades; since shown to be rather widely distributed, as on the southern slope of the Alps (*gastaldite*), Corsica, Japan, etc. *Rhodusite* is a fibrous variety from the Is. Rhodus.

In the U. S., glaucophane schists have been described from the Coast Ranges of California, as at Sulphur Bank, Lake Co.

Glaucophane is named from *γλαυκός*, *bluish green*, and *φαίνεσθαι*, *to appear*.

RIEBECKITE.

Monoclinic. Axes $a : b : c = 0.5475 : 1 : 0.2925$; $\beta = 76^\circ 10'$. In embedded prismatic crystals, longitudinally striated. Cleavage: prismatic (56°) perfect. Luster vitreous. Color black. Pleochroism very strongly marked: *c* green, *b* (= \bar{b}) deep blue, *a* (nearly $\parallel c$) dark blue. Optically —. Extinction-angle small, $a \wedge c = 4^\circ - 5^\circ$ ($\pm ?$). Axial angle large.

Comp.—Essentially $2\text{NaFe}(\text{SiO}_3)_2 \cdot \text{FeSiO}_3$, = Silica 50.5, iron sesquioxide 26.9, iron protoxide 12.1, soda 10.5 = 100. It corresponds closely to acmite (*ægirite*) among the pyroxenes.

Obs.—Originally described from the granite and syenite of the island of Socotra in the Indian Ocean, 120 m. N. E. of Cape Guardafui, the eastern extremity of Africa; occurs in groups of prismatic crystals, often radiating and closely resembling tourmaline; also in granophyre blocks found at Ailsa Crag and at other points in Scotland and Ireland. A similar amphibole occurs at Mynydd Mawr, Carnarvonshire, Wales. Also another in granulite in Corsica. A so-called arfvedsonite from St. Peter's Dome, Pike's Peak region, El Paso Co., Colorado, occurring with astrophyllite and zircon, is shown by Lacroix to be near riebeckite. Extinction-angle on *b*, $a \wedge c = 3^\circ$ to 4° .

CROCIDOLITE. Blue Asbestos.

Fibrous, asbestos-like; fibers long but delicate, and easily separable. Also massive or earthy. Cleavage: prismatic, 56° . $H. = 4$. $G. = 3.20-3.30$. Luster silky; dull. Color and streak lavender-blue or leek green. Opaque. Fibers somewhat elastic. Pleochroism: *c* green, *b* violet, *a* blue. Optically +. Extinction-angle on *b*, inclined 18° to 20° with \bar{c} . $2E = 95^\circ$ approx. $\gamma - \alpha = 0.025$.

Comp.— $\text{NaFe}(\text{SiO}_3)_2 \cdot \text{FeSiO}_3$ (nearly) = Silica 49.6, iron sesquioxide 22.0, iron protoxide 19.8, soda 8.6 = 100.

Magnesium and calcium replace part of the ferrous iron, and hydrogen part of the sodium.

Pyr., etc.—In the closed tube yields a small amount of alkaline water. B.B. fuses easily with intumescence to a black magnetic glass, coloring the flame yellow (soda). With the fluxes gives reactions for iron. Unacted upon by acids.

Obs.—Occurs in South Africa, in Griqualand-West, north of the Orange river, in a range of quartzose schists called the Asbestos Mountains. In a micaceous porphyry near Framont, in the Vosges. At Golling in Salzburg. In the U. S., at Beacon Pole Hill, near Cumberland, R. I. Emerald Mine, Buckingham, and Perkin's Mill, Templeton, Ottawa Co., Ontario, Canada.

Abriachanite is an earthy amorphous form occurring in the Abriachan district, near Loch Ness, Scotland. Crocidolite is named from *κροκίς*, *woof*, in allusion to its fibrous structure.

The South African mineral is largely altered by both oxidation of the iron and infiltration of silica, resulting in a compact siliceous stone of delicate fibrous structure, chatoyant luster, and bright yellow to brown color, popularly called *tiger-eye* (also *cat's-eye* and *Faserquarz*, *Tigerauge*, *Falkenaug* (bluish var.) *Germ.*). Many varieties occur forming

transitions from the original blue mineral to the final product; also varieties depending upon the extent to which the original mineral has penetrated the quartz.

ARFVEDSONITE.

Monoclinic. Axes $a : b : c = 0.5569 : 1 : 0.2978$; $\beta = 73^\circ 2'$.

Crystals long prisms, often tabular $\parallel b$, but seldom distinctly terminated; angles near those of amphibole; also in prismatic aggregates. Twins: tw. pl. *a*. Cleavage: prismatic, perfect; *b* less perfect. Fracture uneven. Brittle.

$H. = 6$. $G. = 3.44-3.45$. Luster vitreous. Color pure black; in thin scales deep green. Streak deep bluish gray. Opaque except in thin splinters. Pleochroism strongly marked: *c* deep greenish blue, *b* lavender, *a* pale greenish yellow. Absorption $c > b > a$; sections $\parallel a$ are deep greenish blue, $\parallel b$ olive-green. $\beta = 1.707$; $\gamma - \alpha = 0.027$. Extinction-angle on *b*, with \bar{c} , $= 14^\circ$.

Comp.—A slightly basic metasilicate of sodium, calcium, and ferrous iron chiefly; an analysis by Lorenzen gives:

	G.	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O	H ₂ O
Kangerdluarsuk	3.44	43.85	4.45	3.80	33.43	0.45	1.81	4.65	8.15	1.06	0.15 = 100.80

The supposed arfvedsonite from Greenland analyzed by von Kobell, Rbg., etc., has been shown to be *ægirite*; that from Pike's Peak, Colorado, analyzed by Koenig, has been referred to *riebeckite*.

Pyr., etc.—B.B. fuses at 2 with intumescence to a black magnetic globule; colors the flame yellow (soda); with the fluxes gives reactions for iron and manganese. Not acted upon by acids.

Obs.—Arfvedsonite and amphiboles of similar character, containing much iron and soda, are common constituents of certain igneous rock which are rich in alkalis, as nephelite-syenite, phonolite, etc. Large and distinct crystals are found only in the pegmatite veins in such rocks, as at Kangerdluarsuk, Greenland, where the associated minerals are sodalite, eudialyte, feldspar, etc. Arfvedsonite occurs also in the nephelite-syenites and related rocks of the Christiania region in southern Norway; on the Kola peninsula in Russian Lapland; Dungannon township, Ontario; Trans Pecos district, Texas. The related brownish pleochroic amphiboles (cf. *barkevikite*) occur in similar rocks at Montreal, Canada; Red Hill, New Hampshire; Salem, Mass.; Magnet Cove, Ark.; Black Hills, So. Dakota; Square Butte, Montana, etc.

Crossite is a soda-amphibole near arfvedsonite ($7.62\text{Na}_2\text{O}$) from a rock in the neighborhood of San Francisco.

BARKEVIKITE. An amphibole near arfvedsonite but more basic. In prismatic crystals. Cleavage: prismatic ($55^\circ 44'$). $G. = 3.428$. Color deep velvet-black. Pleochroism marked, colors brownish. Extinction-angle with \bar{c} on *b* = $12\frac{1}{2}^\circ$. Occurs at the wöhrerite locality near Barkevik, on the Langesund fiord, and elsewhere in southern Norway.

Ænigmatite. Cossyrite. Essentially a titano-silicate of ferrous iron and sodium, but containing also aluminium and ferric iron. In prismatic triclinic crystals. Cleavage: prismatic, distinct (66°). $G. = 3.74-3.80$. Color black. *Ænigmatite* is from the sodalite-syenite of Tunugdliarfik and Kangerdluarsuk, Greenland. *Cossyrite* occurs in minute crystals embedded in the liparite lavas of the island Pantellaria (ancient name Cossyra).

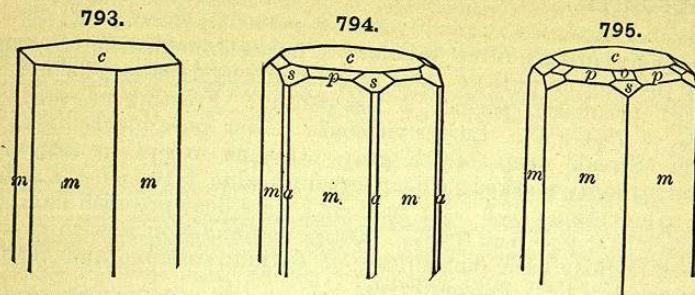
BERYL.

Hexagonal. Axis $c = 0.4989$.

Crystals usually long prismatic, often striated vertically, rarely transversely; distinct terminations exceptional. Occasionally in large masses, coarse columnar or granular to compact.

Cleavage: *c* imperfect and indistinct. Fracture conchoidal to uneven. Brittle. $H. = 7.5-8$. $G. = 2.63-2.80$; usually $2.69-2.70$. Luster vitreous, sometime resinous. Colors emerald-green, pale green, passing into light blue,

yellow and white; also pale rose-red. Streak white. Transparent to subtranslucent. Dichroism more or less distinct. Optically —. Birefringence low. Often abnormally biaxial. $\omega = 1.5820$, $\epsilon = 1.5765$ aquamarine.



$$\begin{aligned} cp, 0001 \wedge 10\bar{1}1 &= 29^\circ 56\frac{1}{2}' \\ co, 0001 \wedge 11\bar{2}2 &= 26^\circ 31' \end{aligned}$$

$$\begin{aligned} cs, 0001 \wedge 11\bar{2}1 &= 44^\circ 56' \\ pp', 10\bar{1}1 \wedge 01\bar{1}1 &= 28^\circ 54\frac{1}{2}' \end{aligned}$$

Var.—1. Emerald. Color bright emerald-green, due to the presence of a little chromium; highly prized as a gem when clear and free from flaws.

2. Ordinary; Beryl. Generally in hexagonal prisms, often coarse and large; green the common color. The principal kinds are: (a) colorless; (b) bluish green, called *aquamarine*; (c) apple-green; (d) greenish yellow to iron-yellow and honey-yellow; sometimes a clear bright yellow as in the *golden beryl*; (e) pale yellowish green; (f) clear sapphire-blue; (g) pale sky-blue; (h) the pale violet or reddish; (i) the opaque brownish yellow, of waxy or greasy luster. The *oriental emerald* of jewelry is emerald-colored sapphire.

Comp.— $\text{Be}_3\text{Al}_2(\text{SiO}_3)_6$ or $3\text{BeO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 = \text{Silica } 67.0$, alumina 19.0 , glucina $14.0 = 100$.

Alkalies (Na_2O , Li_2O , Cs_2O) are sometimes present replacing the beryllium, from 0.25 to 5 p. c.; also chemically combined water, including which the formula becomes $\text{H}_2\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{37}$.

Pyr., etc.—B.B. alone, unchanged or, if clear, becomes milky white and clouded; at a high temperature the edges are rounded, and ultimately a vesicular scoria is formed. Fusibility = 5.5, but somewhat lower for beryls rich in alkalies. Glass with borax, clear and colorless for beryl, a fine green for emerald. Unacted upon by acids.

Diff.—Characterized by its green or greenish-blue color, glassy luster and hexagonal form; rarely massive, then easily mistaken for quartz. Distinguished from apatite by its hardness, not being scratched by a knife, also harder than green tourmaline; from chrysoberyl by its form; from euclase and topaz by its imperfect cleavage.

Obs.—Beryl is a common accessory mineral in granite veins, especially in those of a pegmatitic character. Emeralds occur in clay slate, in isolated crystals or in nests, near Muso, etc., 75 m. N.N.E. of Bogotá, Colombia. Emeralds of less beauty, but larger, occur in Siberia, on the river Tokovoya, N. of Ekaterinburg, embedded in mica schist. Emeralds of large size, though not of uniform color or free from flaws, have been obtained in Alexander Co., N. C.

Transparent beryls are found in Siberia, India and Brazil. In Siberia they occur at Mursinka and Shaitanka, near Ekaterinburg; near Miask with topaz; in the mountains of Adun-Chalon with topaz, in E. Siberia. Beautiful crystals also occur at Elba; the tin mines of Ehrenfriedersdorf in Saxony, and Schlackenwald in Bohemia. Other localities are the Mourne Mts., Ireland; yellowish green at Rubislaw, near Aberdeen, Scotland (*Davidsonite*); Limoges in France; Finbo and Broddbo in Sweden; Tamela in Finland; Pitsch-Joch, Tyrol; Bodenmais and Rabenstein in Bavaria; in New South Wales.

In the United States, beryls of gigantic dimensions have been found in *N. Hamp.*, at Acworth and Grafton, and in *Mass.*, at Royalston. In *Maine*, at Albany; Norway; Bethel; at Hebron, a caesium beryl (Cs_2O , 3.60 p. c.), associated with pollucite; in Paris, with black tourmaline; at Topsham, pale green or yellowish. In *Mass.*, at Barre; at Goshen (*Goshenite*), and at Chesterfield. In *Conn.*, at Haddam, and at the Middletown and Portland feldspar quarries; at New Milford, of a clear golden yellow to dark amber color; Branchville. In

Penn., at Leiper ville and Chester; at Mineral Hill. In *Virginia*, at Amelia Court-House, sometimes white. In *N. Carolina*, in Alexander Co., near Stony Point, fine emeralds; in Mitchell Co.; Morganton, Burke Co., and elsewhere. In *Alabama*, Coosa Co., of a light yellow color. In *Colorado*, near the summit of Mt. Antero, beautiful aquamarines. In *S. Dakota*, in the Black Hills in large crystals.

Endialyte. Essentially a metasilicate of $\text{Zr, Fe(Mn), Ca, Na}$, etc. In red to brown tabular or rhombohedral crystals; also massive. $H. = 5-5.5$. $G. = 2.9-3.0$. Optically +. From Kangerdluarsuk, West Greenland, etc., with arfvedsonite and sodalite; at Lujaor on the Kola peninsula, Russian Lapland, in eläolite-syenite, there forming a main constituent of the rock-mass. *Eucolite*, from islands of the Langesund fiord in Norway, is similar (but optically —). Endialyte and eucolite also occur at Magnet Cove, in Arkansas, of a rich crimson to peach-blossom red color, in feldspar, with eläolite and ägirite.

Elpidite. $\text{Na}_2\text{O} \cdot \text{ZrO}_2 \cdot 6\text{SiO}_2 \cdot 3\text{H}_2\text{O}$.—Massive, fibrous. $G. = 2.54$. Southern Greenland.

The following are rare species of complex composition, all from the Langesund fiord region of southern Norway:

Catapleite. $\text{H}_2(\text{Na}_2, \text{Ca})\text{ZrSi}_3\text{O}_{11}$. In thin tabular hexagonal prisms. $H. = 6$. $G. = 2.8$. Color light yellow to yellowish brown. *Natron-catapleite*, or soda-catapleite, contains only sodium; color blue to gray and white; on heating the blue color disappears.

Cappelenite. A boro-silicate of yttrium and barium. In greenish-brown hexagonal crystals.

Melanocerite. A fluo-silicate of the cerium and yttrium metals and calcium chiefly (also B, Ta, etc.). In brown to black tabular rhombohedral crystals.

Caryocerite. Near melanocerite, containing ThO_2 .

STREENSTRUPINE (from Greenland) is allied to the two last-named species.

Tritomite. A fluo-silicate of thorium, the cerium and yttrium metals and calcium, with boron. In dark brown crystals of acute triangular pyramidal form.

The following are also from the same region:

Leucophanite. $\text{Na}(\text{BeF})\text{Ca}(\text{SiO}_3)_2$. In glassy greenish tabular crystals (orthorhombic-sphenoidal). $H. = 4$. $G. = 2.96$.

Meliphanite. A fluo-silicate of beryllium, calcium, and sodium near leucophanite. In low square pyramids (tetragonal). Color yellow. $H. = 5-5.5$. $G. = 3.01$.

IOLITE. Cordierite. Dichroite.

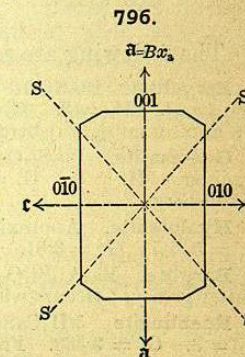
Orthorhombic. Axes $a : b : c = 0.5871 : 1 : 0.5585$.

Twins: tw. pl. m , also d (130), both yielding pseudo-hexagonal forms. Habit short prismatic ($mm''' = 60^\circ 50'$) (Fig. 299, p. 94). As embedded grains; also massive, compact.

Cleavage: b distinct; a and c indistinct. Crystals often show a lamellar structure $\parallel c$, especially when slightly altered. Fracture subconchoidal. Brittle. $H. = 7-7.5$. $G. = 2.60-2.66$. Luster vitreous. Color various shades of blue, light or dark, smoky blue. Transparent to translucent. Pleochroism strongly marked except in thin sections. Axial colors variable. Thus:

Bodenmais $c (= \bar{b})$ dark Berlin-blue $b (= \bar{a})$ light Berlin-blue $a (= \bar{b})$ yellowish white

Absorption $c (\bar{b}) > b (\bar{a}) > a (\bar{c})$. Pleochroic halos common, often bright yellow; best seen in sections $\parallel c$. Exhibits idiophanous figures. Optically —. Ax. pl. $\parallel a$. $Bx. \perp c$. Dispersion feeble, $\rho < v$. $2V = 70^\circ 23'$ (also 40° to 84°). $\beta_\gamma = 1.549$; $\gamma - \alpha = 0.008$.



Comp.— $H_2(Mg,Fe)_4Al_2Si_6O_{37}$ or $H_2O.4(Mg,FeO).4Al_2O_3.10SiO_2$. If Mg : Fe = 7 : 2, the percentage composition is: Silica 49.4, alumina 33.6, iron protoxide 5.3, magnesia 10.2, water 1.5 = 100. Ferrous iron replaces part of the magnesium. Calcium is also present in small amount.

Pyr., etc.—B.B. loses transparency and fuses at 5-5.5. Only partially decomposed by acids. Decomposed on fusion with alkaline carbonates.

Diff.—Characterized by its vitreous luster, color and pleochroism; fusible on the edges unlike quartz; less hard than sapphire.

Recognized in thin sections by lack of color; low refraction and low interference-colors; it is very similar to quartz, but distinguished by its biaxial character; in volcanic rocks commonly shows distinct crystal outlines and a twinning of three individuals like aragonite. In the gneisses, etc., it is in formless grains, but the common occurrence of inclusions, especially of sillimanite needles, the pleochroic halos of a yellow color around small inclusions, particularly zircons, and the constant tendency to alteration to micaceous pinite seen along cleavages, help to distinguish it.

Obs.—Occurs in granite, gneiss (*cordierite-gneiss*), hornblende, chloritic and talcose schist, and allied rocks, with quartz, orthoclase or albite, tourmaline, hornblende, andalusite, sillimanite, garnet, and sometimes beryl. Less commonly in or connected with igneous rocks, thus formed directly from the magma, as in andesite, etc.; also in ejected masses (in fragments of older rocks); further formed as a contact-mineral in connection with eruptive dikes, as in slates adjoining granite.

Occurs at Bodenmais, Bavaria, in granite, with pyrrhotite, etc.; Orijärvi, in Finland (*steinheilite*); Tunaberg, in Sweden; in colorless crystals from Brazil; Ceylon affords a transparent variety, the *saphir d'eau* of jewelers.

In the U. S., at Haddam, Conn., associated with tourmaline in a granitic vein in gneiss. At Brimfield, Mass.; at Richmond, N. H.

Named *Iolite* from *iov, violet*, and *lithos, stone*; *Dichroite* (from *δixpooς, two-colored*), from its dichroism; *Cordierite*, after Cordier, the French geologist (1777-1861).

The alteration of iolite takes place so readily by ordinary exposure, that the mineral is most commonly found in an altered state, or enclosed in the altered iolite. This change may be a simple hydration; or a removal of part of the protoxide bases by carbon dioxide; or the introduction of oxide of iron; or of alkalis, forming pinite and mica. The first step in the change consists in a division of the prisms of iolite into plates parallel to the base, and a pearly foliation of the surfaces of these plates; with a change of color to grayish green and greenish gray, and sometimes brownish gray. As the alteration proceeds, the foliation becomes more complete; afterward it may be lost. The mineral in this altered condition has many names: as *hydrous iolite* (incl. *bonsdorffite* and *auralite*) from Åbo, Finland; *fahlunite* from Falun, Sweden, also *pyrrargillite* from Helsingfors; *esmarkite* and *praseolite* from near Brevik, Norway, also *raumite* from Raumo, Finland, and *peplolite* from Ramsberg, Sweden; *chlorophyllite* from Unity, Me.; *aspasiolite*; and *polychroilite* from Kragerö. There are further alkaline kinds, as *pinite*, *cataspilite*, *gigantolite*, *iberite*, belonging to the Mica Group.

The following are rare lead and barium silicates:

Barysilite. $Pb_3Si_2O_7$. In embedded masses with curved lamellar structure. Cleavage: basal. H. = 3. G. = 6.11-6.55. Color white; tarnishing on exposure. From the Harstig mine, Pajsberg, Sweden.

Ganomalite. $Pb_3Si_2O_7.(Ca,Mn)_2SiO_4$. In prismatic crystals (tetragonal); also massive, granular. H. = 3. G. = 5.74. Colorless to gray. From Långban, Sweden; also Jakobsberg.

Hyalotekite. Approximately $(Pb,Ba,Ca)_3(SiO_3)_{12}$. Massive; coarsely crystalline. H. = 5-5.5. G. = 3.81. Color white to pearly gray. From Långban, Sweden.

Barylite. $Ba_4Al_4Si_4O_{24}$. In groups of colorless prismatic crystals. H. = 7. G. = 4.03. Luster greasy. Occurs with hedyphane in crystalline limestone at Långban, Sweden.

Roebblingite. $5(H_2CaSiO_4).2(CaPbSO_4)$. In dense, white, compact, crystalline masses. H. = 3. G. = 3.433. From Franklin Furnace, N. J.

III. Orthosilicates. R_2SiO_4 .

Salts of Orthosilicic Acid, H_2SiO_4 ; characterized by an oxygen ratio of 1 : 1 for silicon to bases.

The following list includes the more prominent groups among the Orthosilicates.

A number of basic orthosilicates are here included, which yield water upon ignition; also others which are more or less basic than a normal orthosilicate, but which are of necessity introduced here in the classification, because of their relationship to other normal salts. The MICA GROUP is so closely related to many Hydrous Silicates that (with also Talc, Kaolinite, and some others) it is described later with them.

Nephelite Group. Hexagonal.	Scapolite Group. Tetragonal-pyramidal.
Sodalite Group. Isometric.	Zircon Group. Tetragonal.
Helvite Group. Isometric-tetrahedral.	Danburite Group. Orthorhombic.
Garnet Group. Isometric.	Datolite Group. Monoclinic.
Chrysolite Group. Orthorhombic.	Epidote Group. Monoclinic.
Phenacite Group. Tri-rhombohedral.	

Nephelite Group. Hexagonal.

Typical formula $\bar{R}AlSiO_4$.

Nephelite	$K_2Na_4Al_2Si_6O_{34}$	$d = 0.8389$
Soda-nephelite (artif.)	$NaAlSiO_4$	
Eucryptite	$LiAlSiO_4$	Kaliophilite $KAlSiO_4$
Cancrinite	$H_2Na_4Ca(NaCO_3)_2Al_2(SiO_4)_6$	$2d = 0.8448$
Microsommitte	$(Na,K)_{10}Ca_4Al_2Si_{11}O_{52}S_2Cl_4$	$2d = 0.8367$

The species of the NEPHELITE GROUP are hexagonal in crystallization and have in part the typical orthosilicate formula $\bar{R}AlSiO_4$. From this formula nephelite itself deviates somewhat, though an artificial soda-nephelite, $NaAlSiO_4$, conforms to it. The species Cancrinite and Microsommitte are related in form and also in composition, though in the latter respect somewhat complex. They serve to connect this group with the sodalite group following.

NEPHELITE. Nepheline.

Hexagonal-hemimorphic (p. 73). Axis $d = 0.83893$.

In thick six- or twelve-sided prisms with plane or modified summits. Also massive compact, and in embedded grains; structure sometimes thin columnar.

Cleavage: *m* distinct; *c* imperfect. Fracture subconchoidal. Brittle. H. = 5.5-6. G. = 2.55-2.65. Luster vitreous to greasy; a little opalescent in some varieties. Colorless, white, or yellowish; also when massive, dark green, greenish or bluish gray, brownish red and brick-red. Transparent to opaque. Optically —. Indices: $\omega_y = 1.542$, $\epsilon_y = 1.538$.