

Knopite. Near perovskite but contains cerium. In black isometric crystals. From Alnö, Sweden.

Dysanalyte. A titano-niobate of calcium and iron. In cubic crystals. From the granular limestone of Vogtsburg, Kaiserstuhlgebirge, Baden. Has previously been called perovskite, but is in fact intermediate between the titanate, perovskite, and the niobates, pyrochlore and koppite.

A related mineral, which has also long passed as perovskite, occurs with magnetite, brookite, rutile, etc., at Magnet Cove, Arkansas. It is in octahedrons or cubo-octahedrons, black or brownish black in color and submetallic in luster.

See also the allied titanate, bixbyite, mentioned on p. 343.

Geikielite. Magnesium titanate, $MgTiO_3$. Massive, as rolled pebbles. H. = 6. G. = 4. Color bluish or brownish black. From Ceylon.

Oxygen Salts.

3. NIOBATES, TANTALATES.

The Niobates (Columbates) and Tantalates are chiefly salts of metaniobic and metatantallic acid, RNb_2O_6 and RTa_2O_6 ; also in part Pyroniobates, $R_2Nb_2O_7$, etc. Titanium is prominent in a number of the species, which are hence intermediate between the niobates and titanates. Niobium and tantalum also enter into the composition of a few rare silicates, as wöhlerite, lävenite, etc.

The following groups may be mentioned:

The isometric PYROCHLORE GROUP, including pyrochlore, microlite, etc.
The tetragonal FERGUSONITE GROUP, including fergusonite and sipylite.
The orthorhombic COLUMBITE GROUP, including columbite and tantalite.
Also the orthorhombic SAMARSKITE GROUP, including ytrotantalite, samarskite, and ännarodite.

The species belonging in this class are for the most part rare, and are hence but briefly described.

PYROCHLORE.

Isometric. Commonly in octahedrons; also in grains.

Cleavage: octahedral, sometimes distinct. Fracture conchoidal. Brittle. H. = 5-5.5. G. = 4.2-4.36. Luster vitreous or resinous, the latter on fracture surfaces. Color brown, dark reddish or blackish brown. Streak light brown, yellowish brown. Subtranslucent to opaque.

Comp.—Chiefly a niobate of the cerium metals, calcium and other bases, with also titanium, thorium, fluorine. Probably essentially a metaniobate with a titanate, $RNb_2O_6 \cdot R(Ti, Th)O_3$; fluorine is also present.

The following are analyses by Rammelsberg:

	G.	Nb ₂ O ₅	TiO ₂	ThO ₂	Ce ₂ O ₃	CaO	FeO	MgO	NaO ₂	F
Miask	4.359	53.19	10.47	7.56	7.00	14.21	1.84	0.22	5.01	—
Fredriksvärn	4.228	47.13	13.52	—	7.30	15.94	10.03	0.19	3.12	2.90

[ign. 1.39 = 101.52]

Obs.—Occurs in elæolite-syenite at Fredriksvärn and Laurvik, Norway; on the island Lövdö, opposite Brevik, and at several points in the Langesund fiord; near Miask in the Ural. Named from $\pi\upsilon\rho$, *fire*, and $\chi\lambda\omega\rho\acute{o}s$, *green*, because B.B. it becomes yellowish green.

Koppite. Essentially a pyroniobate of cerium, calcium, etc., near pyrochlore. In minute brown dodecahedrons. G. = 4.45-4.56. From Schejlingen, Kaiserstuhl, embedded in limestone.

Hatchettolite. A tantaloniobate of uranium, near pyrochlore. In octahedrons with *a* (100) and *m* (311). G. = 4.77-4.90. Color yellowish brown. Occurs with samarskite at the mica mines of Mitchell Co., North Carolina.

Microlite. Essentially a calcium pyrotantalate, $Ca_2Ta_2O_7$, but containing also niobium, fluorine and a variety of bases in small amount. Isometric. Habit octahedral; crystals often very small and highly modified (Fig. 109, p. 40). H. = 5.5. G. = 5.485-5.562; 6.13 Virginia. Color pale yellow to brown, rarely hyacinth-red. From Chesterfield, Mass., in albite; Branchville, Conn.; Utö, Sweden. Also in fine crystals up to 1 in. in diameter at the mica mines at Amelia Court-House, Amelia Co., Va.

PYRRHITE. Probably a niobate related to pyrochlore, and perhaps identical with microlite. Occurs in minute orange-yellow octahedrons. From Alabashka, near Mursinka in the Ural.

FERGUSONITE. Tyrite. Bragite.

Tetragonal-pyramidal. Axis $c = 1.4643$. Crystals pyramidal or prismatic in habit.

Cleavage: s (111) in traces. Fracture subconchoidal. Brittle. $H. = 5.5-6$. $G. = 5.8$, diminishing to 4.3 when largely hydrated. Luster externally dull, on the fracture brilliantly vitreous and submetallic. Color brownish black; in thin scales pale liver-brown. Streak pale brown. Subtranslucent to opaque.

Comp.—Essentially a metaniobate (and tantalate) of yttrium with erbium, cerium, uranium, etc., in varying amounts; also iron, calcium, etc. General formula $\bar{R}(Nb, Ta)O_4$, with $\bar{R} = Y, Er, Ce$.

Water is usually present and sometimes in considerable amount, but probably not an original constituent; the specific gravity falls as the amount increases. Analyses by Rammsberg:

	G.	Nb ₂ O ₅	Ta ₂ O ₅	UO ₂	WO ₃	SnO ₂	Y ₂ O ₃	Er ₂ O ₃	Ce ₂ O ₃	FeO	CaO	H ₂ O
Greenland, <i>Ferg.</i>	5.577	44.45	6.30	2.58	0.15	0.47	24.87	9.81	7.63 ^a	0.74	0.61	1.49
												[= 99.10
Ytterby, <i>yo.</i>	4.774	28.14	27.04	2.13	—	—	24.45	8.26	—	0.72	4.17	5.12
												[= 100.03

^a Incl. 5.63 Di₂O₃, La₂O₃.

Obs.—From Cape Farewell in Greenland, in quartz; also at Ytterby, Sweden, and Kårarfvet. *Tyrite* is associated with euxenite at Hampemyr on the island of Tromö, and Helle on the mainland; *bragite* is from Helle, Narestö, etc., Norway.

Found in the U. S., at Rockport, Mass., in granite; in the Brindletown gold district, Burke Co., N. C., in gold washings; with zircon in Anderson Co., S. Carolina; at the gadolinite locality in Llano Co., Texas, in considerable quantity.

Sipylite. A niobate of erbium chiefly, also the cerium metals, etc., near fergusonite in form. Rarely in octahedral crystals. Usually in irregular masses. $G. = 4.89$. Color brownish black to brownish orange. Occurs sparingly with allanite in Amherst Co., Virginia.

COLUMBITE-TANTALITE.

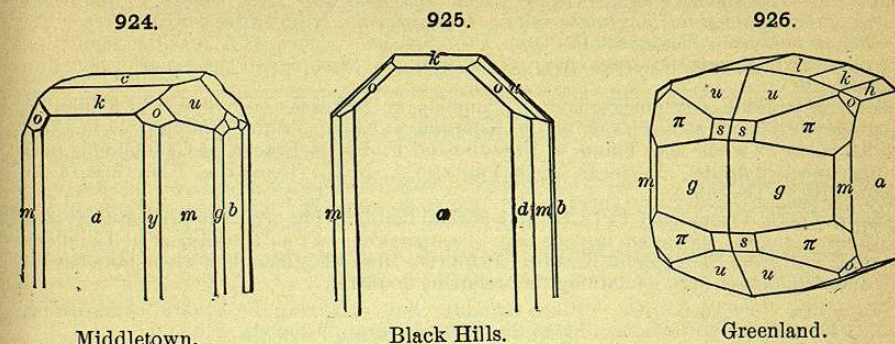
Orthorhombic. Axes $a : b : c = 0.8285 : 1 : 0.8898$.

yy' , $210 \wedge 2\bar{1}0 = 45^\circ 0'$	ce , $001 \wedge 021 = 60^\circ 40'$
mm'' , $110 \wedge 1\bar{1}0 = 79^\circ 17'$	ao , $100 \wedge 111 = 51^\circ 16'$
gg' , $130 \wedge \bar{1}30 = 43^\circ 50'$	cu , $001 \wedge 133 = 43^\circ 48'$
ck , $001 \wedge 103 = 19^\circ 42'$	uu' , $133 \wedge \bar{1}33 = 29^\circ 57'$
cg , $001 \wedge 023 = 30^\circ 41'$	uu'' , $133 \wedge \bar{1}\bar{3}3 = 79^\circ 54'$

Twins: tw. pl. e (021) common, usually contact-twins, heart-shaped (Figs. 347, p. 118), also penetration-twins; further tw. pl. g (023) rare (Fig. 404, p. 281). Crystals short prismatic, often rectangular prisms with the pinacoids, $a b c$, prominent; also thin tabular $\parallel a$; the pyramids often but slightly developed, sometimes, however, acutely terminated by u (133) alone. Also in large groups of parallel crystals, and massive.

Cleavage: a rather distinct; b less so. Fracture subconchoidal to uneven. Brittle. $H. = 6$. $G. = 5.3-7.3$, varying with the composition (see below). Luster submetallic, often very brilliant, sub-resinous. Color iron-black, grayish

and brownish black, opaque; rarely reddish brown and translucent; frequently iridescent. Streak dark red to black.



Middletown.

Black Hills.

Greenland.

Comp., Var.—Niobate and tantalate of iron and manganese, $(Fe, Mn)(Nb, Ta)_2O_6$, passing by insensible gradations from normal COLUMBITE, the nearly pure niobate, to normal TANTALITE, the nearly pure tantalate. The iron and manganese also vary widely. Tin and wolfram are present in small amount. The percentage composition for $FeNb_2O_6 =$ Niobium pentoxide 82.7, iron protoxide 17.3 = 100; for $FeTa_2O_6 =$ Tantalum pentoxide 86.1, iron protoxide 13.9 = 100

In some varieties, *manganocolumbite* or *manganotantalite*, the iron is largely replaced by manganese.

The connection between the specific gravity and the percentage of metallic acids is shown in the following table:

	G.	Ta ₂ O ₅		G.	Ta ₂ O ₅
Greenland	5.36	3.3	Bodenmais	5.92	27.1
Acworth, N. H.	5.65	15.8	Haddam	6.05	30.4
Limoges	5.70	13.8	Bodenmais	6.06	35.4
Bodenmais (<i>Dianite</i>)	5.74	13.4	Haddam	6.13	31.5
Haddam	5.85	10.0	<i>Tantalite</i>	7.03	65.6

Diff.—Distinguished (from black tourmaline, etc.) by orthorhombic crystallization, rectangular forms common; high specific gravity; submetallic luster, often with iridescent surface; cleavage much less distinct than for wolframite.

Pyrr., etc.—For *tantalite*, B. B. alone unaltered. With salt of phosphorus dissolves slowly, giving an iron glass, which in R. F. is pale yellow on cooling; treated with tin on charcoal it becomes green. Decomposed on fusion with potassium bisulphate in the platinum spoon, and gives on treatment with dilute hydrochloric acid a yellow solution and a heavy white powder, which, on addition of metallic zinc, assumes a smalt-blue color; on dilution with water the blue color soon disappears. *Columbite*, when decomposed by fusion with caustic potash, and treated with hydrochloric and sulphuric acids, gives, on the addition of zinc, a blue color more lasting than with tantalite. Partially decomposed when the powdered mineral is evaporated to dryness with concentrated sulphuric acid, its color is changed to white, light gray, or yellow, and when boiled with hydrochloric acid and metallic zinc it gives a beautiful blue.

Obs.—Columbite occurs at Rabenstein and Bodenmais, Bavaria, in granite; Tammela, in Finland; Chanteloube, near Limoges, in pegmatite with tantalite; near Miask, in the Ilmen Mts., with samarskite; in the gold-washings of the Sanarka region in the Ural; in Greenland, in cryolite, at Ivigtut (or Evigtok), in brilliant crystals.

In the United States, in *Maine*, at Standish, in splendid crystals in granite; also at Stoneham with cassiterite, etc. In *N. Hampshire*, at Acworth, at the mica mine. In *Mass.*, at Chesterfield; Northfield, Mass. In *Connecticut*, at Haddam, in a granite vein; near Middletown; at Branchville, Fairfield Co., in a vein of albitic granite, in large crystals and aggregates of crystals, also in minute translucent crystals (*manganocolumbite*), upon spodumene. In *N. York*, at Greenfield, with chrysoberyl. In *Penn.*, Mineral Hill, Dela-

ware Co. In *Virginia*, Amelia Co., in fine splendid crystals with microlite, monazite, etc. In *N. Carolina*, with samarskite at the mica mines of Mitchell Co. In *Colorado*, on microcline at the Pike's Peak region; Turkey Creek, Jefferson Co. In *S. Dakota*, in the Black Hills region, common in the granite veins. In *California*, King's Creek distr., Fresno Co. *Manganantalite* (Nordenskiöld) from Utö, Sweden, occurs with petalite, lepidolite, microlite, etc. *Manganotantalite* (Arzruni) is from gold-washings in the Sanarka region in the Ural.

Massive tantalite occurs in Finland, in Tammela, at Härkäsaari near Torro; in Kimito, at Skogböle; in Somero at Kaidasuo, and in Kuortane at Katiala, with lepidolite, tourmaline, and beryl; in Sweden, near Falun, at Broddbo and Finbo; in France, at Chanteloube near Limoges, in pegmatite. In the U. S., in Yancey Co., N. C.; Coosa Co., Ala.; also in the Black Hills, S. Dakota.

SKOGBÖLITE is essentially $FeTa_2O_6$, like normal tantalite, but occurs in prismatic crystals of different angles; the prism is near that of samarskite. From Härkäsaari in Tammela, Finland; also from Skogböle in Kimito. IXIOLITE, from Skogböle, is a niobo-tantalate of iron and manganese; also containing tin; relations doubtful.

Tapiolite. $Fe(Ta,Nb)_2O_6$. Like tantalite, but occurring in square octahedrons. G. = 7.496. Color pure black. From the Kulmala farm, Tammela, Finland.

YTTROTANTALITE.

Orthorhombic. Axes $\ddot{a} : \ddot{b} : \ddot{c} = 0.5412 : 1 : 1.1330$. Crystals prismatic, $mm''' = 56^\circ 50'$.

Cleavage: \ddot{b} very indistinct. Fracture small conchoidal. H. = 5-5.5. G. = 5.5-5.9. Luster submetallic to vitreous and greasy. Color black, brown, brownish yellow, straw-yellow. Streak gray to colorless. Opaque to sub-translucent.

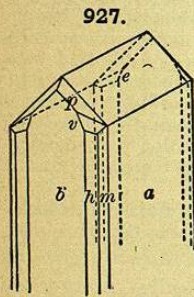
Comp.—Essentially $\overset{II}{R}\overset{III}{R}_2(Ta,Nb)_4O_{15} + 4H_2O$, with $\overset{II}{R} = Fe, Ca, \overset{III}{R} = Y, Er, Ce$, etc. The water may be secondary. Analysis by Rammelsberg:

	Ta ₂ O ₅	Nb ₂ O ₅	WO ₃	SnO ₂	Y ₂ O ₃	Er ₂ O ₃	Ce ₂ O ₃	UO ₂	FeO	CaO	H ₂ O
G. = 5.425	46.25	12.32	2.36	1.12	10.52	6.71	2.22	1.61	3.80	5.73	6.31
	[= 98.95]										

The so-called yellow yttrotantalite of Ytterby and Kärarvet belongs to fergusonite.

Obs.—Occurs in Sweden at Ytterby, near Vaxholm, in red feldspar; at Finbo and Broddbo, near Falun.

SAMARSKITE.



Orthorhombic. Axes $\ddot{a} : \ddot{b} : \ddot{c} = 0.5456 : 1 : 0.5178$. Crystals rectangular prisms (\ddot{a} , \ddot{b}), with \ddot{c} (101) prominent. Angles, $mm''' = 57^\circ 14'$; $ee' = 87^\circ$. Faces rough. Commonly massive, and in flattened embedded grains.

Cleavage: \ddot{b} imperfect. Fracture conchoidal. Brittle. H. = 5-6. G. = 5.6-5.8. Luster vitreous to resinous, splendid. Color velvet-black. Streak dark reddish brown. Nearly opaque.

Comp.— $\overset{II}{R}_3\overset{III}{R}_2(Nb,Ta)_6O_{21}$, according to Rg., with $\overset{II}{R} = Fe, Ca, UO_2$, etc.; $\overset{III}{R}$ = cerium and yttrium metals chiefly. Analyses by Rammelsberg:

	G.	Ta ₂ O ₅	Nb ₂ O ₅	SnO ₂	WO ₃	UO ₂	Ce ₂ O ₃ ^a	Y ₂ O ₃	Er ₂ O ₃	FeO	TiO ₂
N. Carolina	5.839	14.36	41.07	0.16	10.90	2.37	6.10	10.80	14.61	0.56 ^b	= 100.93
Miask	5.672	—	55.34	0.22	11.94	4.33	8.80	3.82	14.30	1.08	= 99.83

^a Incl. Di_2O_3, La_2O_3 .

^b Incl. SiO_2 .

Pyr., etc.—In the closed tube decrepitates, glows, cracks open, and turns black. B.B. fuses on the edges to a black glass. With salt of phosphorus in both flames an emerald-green bead. With soda yields a manganese reaction. Decomposed on fusion with potassium bisulphate, yielding a yellow mass which on treatment with dilute hydrochloric acid separates white tantallic acid, and on boiling with metallic zinc gives a fine blue color. In powder sufficiently decomposed on boiling with concentrated sulphuric acid to give the blue reduction test when the acid fluid is treated with metallic zinc or tin.

Obs.—Occurs in reddish brown feldspar, with æschynite and columbite in the Ilmen mountains, near Miask. In the United States, rather abundant and sometimes in large masses, up to 20 lbs., at the mica mines in Mitchell Co., N. Carolina, intimately associated with columbite; sparingly elsewhere.

Ännerödite. Essentially a pyro-niobate of uranium and yttrium. In prismatic crystals, often resembling columbite. H. = 6. G. = 5.7. Color black. From the pegmatite vein at Änneröd, near Moss, Norway.

Hielmite. A stanno-tantalate (and niobate) of yttrium, iron, manganese, calcium. Crystals (orthorhombic) usually rough; massive. G. = 5.82. Color pure black. From the Kärarvet mine, Falun, Sweden.

Æschynite. A niobate and titanate (thorate) of the cerium metals chiefly, also in small amount iron, calcium, etc. Crystals prismatic, orthorhombic. Fracture small conchoidal. Brittle. H. = 5-6. G. = 4.93 Hitterö; 5.168 Miask. Luster submetallic to resinous, nearly dull. Color nearly black, inclining to brownish yellow when translucent. Analysis by Rammelsberg:

	Nb ₂ O ₅	TiO ₂	ThO ₂	Ce ₂ O ₃	La ₂ (Di ₂)O ₃	Y ₂ O ₃	Er ₂ O ₃	FeO	CaO
G. = 5.168	32.51	21.20	17.55	19.41	3.10	3.34	2.50	99.61	

From Miask in the Ilmen Mts., in feldspar with mica and zircon; also with euclase in the gold sands of the Orenburg District, Southern Ural. From Hitterö, Norway. Named from *αἰσχυνή*, *shame*, by Berzelius, in allusion to the inability of chemical science, at the time of its discovery, to separate some of its constituents.

Polymignite. A niobate and titanate (zirconate) of the cerium metals, iron, calcium. Crystals slender prisms, vertically striated. G. = 4.77-4.85. Color black. Occurs at Frederiksvärn, Norway.

Euxenite. A niobate and titanate of yttrium, erbium, cerium and uranium. Crystals rare; commonly massive. H. = 6.5. G. = 4.7-5.0. Color brownish black. Analysis by Rammelsberg:

	G.	Nb ₂ O ₅	TiO ₂	Y ₂ O ₃	Er ₂ O ₃	Ce ₂ O ₃	UO ₂	FeO	H ₂ O
Alve	5.00	35.09	21.16	27.48	3.40	3.17	4.78	1.38	2.63 = 99.09

Occurs at Jölster in Norway; near Tvedestrand; at Alve, etc., near Arendal.

Polycrase. A niobate and titanate of yttrium, erbium, cerium, uranium, like euxenite. Crystals thin prismatic, orthorhombic. Fracture conchoidal. H. = 5-6. G. = 4.97-5.04. Luster vitreous to resinous. Color black, brownish in splinters. Analyses: 1, Mackintosh; 2, Hidden and Rammelsberg:

	Nb ₂ O ₅	Ta ₂ O ₅	TiO ₂	Y ₂ O ₃	Er ₂ O ₃	Ce ₂ O ₃	UO ₂	FeO	H ₂ O
Hitterö	20.35	4.00	26.59	23.32	7.53	2.61	7.70	2.72	4.02
	[= 98.84]								
Henderson Co.,	19.48	—	29.31	27.55 ^a	—	—	13.77	2.87	5.18 ^b
	[= 98.16]								

^a At. wght. 112.

^b UO₂.

From Hitterö, Norway, in granite with gadolinite; at Slättåkra, Småland, Sweden. In the U. States, in N. Carolina, in the gold-washings on Davis land, Henderson Co. with zircon, monazite, xenotime, magnetite; also in S. Carolina, four miles from Marietta in Greenville Co. Named from *πολυς*, *many*, and *κράσις*, *mixture*.

