A
SYSTEM
OF
MINERALOGY.

DESCRIPTIVE MINERALOGY,

COMPRISING THE

MOST RECENT DISCOVERIES.

BY

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"*Hæc studia nobiscum peregrinantur....rusticantur.*"

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492. APATITE. *Crystallized from Spain.* Chrysolite ordinaire *de Lisle* (with figs.), Crist., 1772, ii. 271, 1783;=Spargelgrüne Steinkrystalle aus Spanien nähern Apatit *Wern.*, Bergm. J., 74, 1790;=Spargelstein *Wern.;* Asparagus Stone; Pierre d'Asperge *Fr.;* Asparagolithe *Abildgaard*, Ann. Ch., xxxii. 195, 1800. Chaux phosphatée *Vauq.*, Ann. Ch., xxvi. 123, 1798. Phosphate of Lime.

Cryst. fr. Saxony. Aquamarin (celandine-green, fr. Schneckenstein) *Brunnich*, his Cronst., 1770. Améthiste basaltine (mostly violet, fr. Mines d'etain de Saxe) *Sage*, Min. i., 281, 1777; *de Lisle*, Crist., ii. 254, 1783;=Apatit *Wern.*, Gerhard's Grundr., 281, 1786, Bergm. J., 576, 1788, 378, 1789. Phosphorsaurer-Kalk *Klapr.*, ib., 294, 1788. Sachsischer Beryll, Agustit (with announcem. of supposed new earth, Agusterde), *Trommsdorf*, Trommsd. J. d. Pharm., 1800.

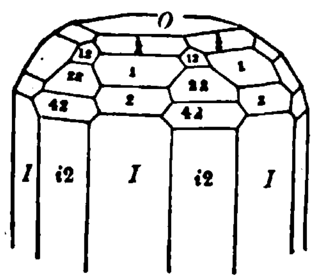
Cryst. fr. Norway, etc. Moroxit (fr. Arendal) *Abildgaard*, Moll's Jahrb. B. H., ii. 432, 1798. Francolite (fr. Devonshire) *Brooke; T. H. Henry*, Phil. Mag., III. xxxvi. 1850. Lazur-Apatit *N. Nordensk.*, Bull. Nat. Moscou, xxx. 224, 1857.

Massive. La Pierre Phosphorique (fr. Lagrosan, Estremadura) *Davila*, p. 60, Madrid;=Phosphate calcaire *Proust*, J. de Phys., xxxii. 241, 1788; *Pelletier*, Ann. Ch., vii. 1790;=Phosphorite *Kirw.*, Min., i. 129, 1794; id. *Karst.*, Tab., 52, 1808. Eupyrchroite (fr. N. Y.) *Emmons*, Rep. G. N. Y., 1838. Osteolith *Bromeis*, Ann. Ch. Pharm., lxxix. 1851=Bone-phosphate.

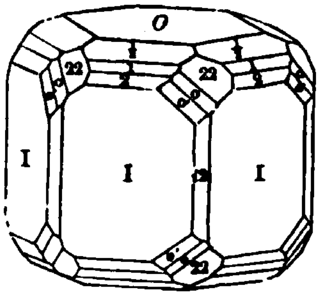
Apatite (incl. the Saxon and the Spanish crystallized (Spargelstein) and massive Phosphorite, excl. Moroxite) *Karst.*, Tab., 36, 1800; id. (incl. the same and also Moroxite) *H.*, Tr., ii. 1801.

Hexagonal; often hemihedral. $O \wedge 1=139° 41' 38''$, Kokscharof; $a=0{\cdot}734603$. Observed planes: O; prismatic, I, i-2, i-$\frac{3}{2}$, i-$\frac{5}{4}$; pyramidal, $\frac{1}{2}$, 1, 2: 1-2, 2-2, 4-2; 3-$\frac{3}{2}$, 4-$\frac{4}{3}$; 2-$\frac{4}{3}$. Figs. 440, 441, 442; f. 441, hemihedral in the planes, 3-$\frac{3}{2}$, 4-$\frac{4}{3}$; f. 442, actual form of a crystal of which f. 441 is the normal form; o=3-$\frac{3}{2}$, o'=4-$\frac{4}{3}$.

440



441

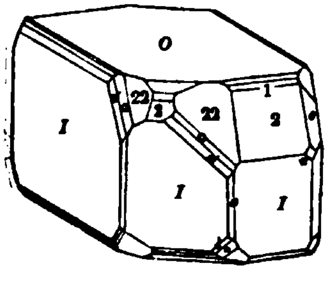


St. Gothard.

$I \wedge i$-$2=150°$

$O \wedge \frac{1}{2}=157° 1'$
$O \wedge 2=120\ 31$
$O \wedge 3=111\ 27$
$O \wedge \frac{3}{2}=128\ 10$
$O \wedge 4$-$\frac{4}{3}=108\ 6$
$O \wedge 3$-$\frac{3}{2}=114\ 1$
$O \wedge 2$-$\frac{4}{3}=123\ 11$
$O \wedge 1$-$2=143\ 42$
$O \wedge 2$-$2\ \ 124\ 14\frac{1}{2}$
$I \wedge 2$-$2=135\ 35$
$I \wedge 4$-$\frac{4}{3}=157\ 19$
$I \wedge 3$-$\frac{3}{2}=149\ 40$
$1 \wedge 1$, pyr.,$=142\ 16$
$1 \wedge 1$, bas.,$=80\ 36\frac{3}{4}$

442



St. Gothard.

Cleavage: O, imperfect; I, more so. Also globular and reniform, with a fibrous or imperfectly columnar structure; also massive, structure granular.

H.=5, sometimes 4·5 when massive. G.=2·92—3·25. Lustre vitreous, inclining to subresinous. Streak white. Color usually sea-green, bluish-green; often violet-blue; sometimes white; occasionally yellow, gray, red, flesh-red, and brown; none bright. Transparent—

opaque. A bluish opalescence sometimes in the direction of the vertical axis, especially in white varieties. Cross fracture conchoidal and uneven. Brittle.

Var.—1. *Ordinary.* Crystallized, or cleavable and granular massive. (*a*) The *asparagus stone* (originally from Murcia, Spain) and *moroxite* (from Arendal) are ordinary apatite. The former was yellowish-green, as the name implies; the latter was in greenish-blue and bluish crystals; and the names have been used for apatite of the same shades from other places.

G.=3·211, fr. Ehrenfriedersdorf, in Saxony, G. Rose; emerald mine on the Tokovaia River, Urals, 3·212, Koksch.; of Pargas (anal. 14) 3·19, Arppe; of Tammela, bluish-green (anal. 15), 3·18, Arppe; of Miask, yellow (anal. 17), 3·234, v. Rath; ib., 3·215, Alexejef; of Murcia, Spain, 3·235, Rose; of Arendal, Norway, 3·194, Rose; of Snarum, 3·174, Rose; of Greiner, Tyrol, 3·175, Rose; of St. Gothard, 3·197, Rose.

The above measurements are by Kokscharof, on crystals from the emerald mine on the Tokovaia, a fluor-apatite (anal. 27). According to him, apatite from Achmatovsk, and that of L. Laach, affords $O \wedge 1 = 139° \, 54'$ and $1 \wedge 1 = 142° \, 25'$; that from Blagodat, 139° 44′ and 142° 18½′; that from Murcia, 139° 47′ and 142° 20′; that of St. Gothard, 142° 19′; that of Ehrenfriedersdorf the same as that from the Tokovaia emerald mine.

(*b*) *Lasurapatite* is a sky-blue variety; it occurs in crystals with lapis-lazuli at Bucharei in Siberia. (*c*) *Francolite*, from Wheal Franco, near Tavistock, Devonshire, occurs in small crystalline stalactitic masses, grayish-green to brown, and in minute curving crystals.

2. *Fibrous, concretionary, stalactitic.* The name *Phosphorite* was used by Kirwan for all apatite, but in his mind it especially included the fibrous concretionary and partly scaly mineral from Estremadura, Spain, and elsewhere. It has H.=4·5; G.=2·92–3, Forbes, but 2·98–3·12 after ignition. Eupyrchroite (from Crown Point, N. Y.) belongs here; it is concentric in structure, consisting of convex subfibrous layers, more or less easily separable; H.=4½; G.=3·053; ash-gray and bluish-gray in color, and gives a green phosphorescence when heated (whence the name, from εὖ, *well*, πῦρ, *fire*, and χρόα, *a color*.

3. *Earthy apatite; Osteolite.* Mostly altered apatite (see beyond). Coprolites are mainly impure phosphate of lime.

4. *Fluor-apatite.* 5. *Chlor-apatite.* Apatite also varies as to the proportion of fluorine to chlorine, one of these elements sometimes replacing nearly or wholly the other.

Pseudoapatite of Breithaupt is pseudomorphous apatite from Kurprinz, near Freiberg, and Schlackenwald in Bohemia.

Comp.—Phosphate of lime, with chlorid or fluorid of lime, or both; $\dot{C}a^3\ddot{\bar{P}} + \frac{1}{3}\,Ca\,(Cl, F)$; or $(\frac{9}{10}\,\dot{C}a + \frac{1}{10}\,Ca\,(Cl, F))^{10}\,\ddot{\bar{P}}^3$=, for *chlor-apatite*, Phosphoric acid 40·92, lime 48·43 (=89·35 $\ddot{\bar{P}}$, $\dot{C}a$), chlorine 6·81, calcium 3·84 (=10·65 Cl, Ca); and for *fluor-apatite*, $\ddot{\bar{P}}$ 42·26, $\dot{C}a$ 50·00 (=92·26 $\ddot{\bar{P}}$, $\dot{C}a$), F 3·77, Ca 3·97 (=7·74 F, Ca); and the analyses should give for the former $\ddot{\bar{P}}$ 40·92, $\dot{C}a$ 53·81, Cl 6·81; for the latter $\ddot{\bar{P}}$ 42·26, $\dot{C}a$ 55·56, F 3·77 (Rammelsberg). In most kinds both fluorine and chlorine are present. The amount of fluorine has not been determined with accuracy; in the larger part of the analyses it has been deduced from the loss; and where this is the case, the amount of fluorine is not given in the table of analyses beyond. G. Rose first detected the fluorine and chlorine, and published the following as the composition of different specimens (Pogg., ix. 185):

	1. Snarum, Norway.	2. Murcia, Spain.	3. Arendal, Norway	4. Greiner, Tyrol.	5. St. Gothard, Tyrol.
Phosphate of lime	91·13	92·066	92·189	92·16	92·31
Chlorid of calcium	4·28	0·885	0·801	0·15	*tr.*
Fluorid of calcium	4·59	7·049	7·01	7·69	7·69
	G.=3·174	G.=2·235	G.=3·194	G.=3·175	G.=3·197

His determinations were, in 1, Cl 2·71, $\dot{C}a$ 54·75, $\ddot{\bar{F}}e$ 0·25; in 2, Cl 0·56, $\dot{C}a$ 55·30; in 3, Cl 0·51, $\dot{C}a$ 55·89; in 4, Cl 0·09, $\dot{C}a$ 55·57; in 5, Cl 0·03, $\dot{C}a$ 55·66.

Other analyses: 6, Weber (Pogg., lxxxiv. 306): 7, 8, Rammelsberg (Pogg., lxviii. 506, lxxxv. 297); 9, G. Rose (Pogg., lxxxiv. 303); 10, Joy (Inaug. Dissert., 45); 11–13, Völcker (J. pr. Ch., lxxv. 384); 14, 15, Arppe (An. Finska Min., 4); 16, Henry (Phil. Mag., III. xxxvi. 1850); 17, v. Rath (Pogg., xcvi. 331); 18, v. Alexejeff (Verh. Min. St. Pet., 59, 1862, Kokscharof's Min. Russl., iv.); 19, Jackson (Am. J. Sci., II. xi. 402); 20, J. D. Whitney (Am. J. Sci., II. xvii. 209); 21, Daubeny (Ann. Ch. Pharm., lv. 116): 22, Garzo & Penuelas (Bull. Soc. G., xvii. 157); 23, Mayer (Ann. Ch. Pharm., ci. 281); 24, Jackson (Am. J. Sci., II. xii. 73); 25, Petersen (Jahrb. Min. 1867, 101); 26, Foster (ib., 1866, 716); 27, 28, P. v. Pusirevski (Verh. Min. St. Pet., 1862, 59, and Kokscharof's Min. Russl., iv.):

		$\ddot{\bar{P}}$	$\dot{F}e$	$\dot{M}g$	$\dot{C}a$	Cl	F	$\dot{H}$	
6.	Snarum	41·54	1·79	—	53·46	2·66	—	—	Weber.
7.	Schwarzenstein	—	—	—	55·31	0·07	—	—	Ramm.
8.	Schlackenwald	—	0·27	—	53·97	0·05	—	—	Ramm.
9.	Faldigl, Tyrol	—	—	—	55·87	0·06	—	—	Rose.
10.	" "	43·01	0·09	—	55·24	0·05	—	—	Joy.
11.	Krageröe, *white*	41·25	0·29	—	53·84	4·10	—	0·42,	$\ddot{\bar{A}}l$ 0·38, alk. 0·17, insol. 0·82 V.
12.	" "	42·28	0·92[a]	—	54·44	1·38	—	0·49,	insol. 0·99 Völck.
13.	" *red*	41·81	1·05[a]	—	54·59	1·03	—	0·83,	alk. 0·30, insol. 1·10 Völck.
14.	Pargas, *blue*	40·76	0·81	—	54·74	*tr.*	—	—,	$\ddot{\bar{P}}$, $\dot{F}e$, $\ddot{\bar{A}}l$ 0·99 Arppe.
15.	Tammela, *blh.-gn.*	41·39	1·72	—	55·40	—	—	—	Arppe.
16.	Wheal Franco	41·57	3·09[a]		53·10	*tr.*	—	—	Henry.
17.	Miask, *yellow*	42·08	0·17	—	55·17	*tr.*	—	0·16	v. Rath
18.	" "	42·99	—	—	55·00	*tr.*	—	—	Alexejeff.
19.	Hurdstown, *cryst.*	42·34	0·04	—	55·08	0·34	—	—	Jackson.
20.	" "	43·23	*tr.*	—	53·37	1·02	—	—	Whitney.
21.	Estremadura, *Phosph.*	37·18	3·15	—	54·08	0·20	—	—,	$\ddot{S}i$ 1·70 Daubeny.
22.	" "	40·12	0·61	—	53·50	0·06	2·16	—,	$\ddot{S}i$, $\ddot{\bar{A}}l$ 3·10, loss 0·79 G. & P.
23.	Amberg, "	43·53	0·90	0·10	53·55	—	2·09	—,	$\dot{K}$, $\dot{N}a$ 0·73 Mayer.
24.	*Eupyrchroite*, "	45·75	$\dot{F}$2·00	—	49·94	0·13	0·60	0·50,	$\ddot{C}$ 1·22 Jackson.
25.	Diez, Nassau, "	36·78	$\bar{F}$0·61[b]	0·19	53·30	—	2·46	1·65,	Cl & I 0·03, $\dot{K}$ 0·14, $\dot{N}a$ 0·31, $\ddot{C}$ 4·25, insol. 1·05=100·77 Pet.
26.	Staffel, "	34·48	6·42	0·16	45·79	—	3·45	2·45,	$\ddot{\bar{A}}l$ 1·08, $\ddot{S}i$ 4·83, $\ddot{C}$ 1·51, $\dot{N}a$ 0·42, $\dot{K}$ 0·58=101·17 Foster.
27.	Tokovaia, Ural	41·99	—	—	55·95	0·01	4·20	—	Pusirevski.
28.	Slüdianka, *Morox.*	41·98	—	—	55·91	0·11	4·02	—	Pusirevski.

[a] With some Mg O and Fe O. [b] With some alumina.

The earliest examination of apatite was that of Proust, in 1788 (l. c.), on the phosphorite of Estremadura, which led him to call it a *calcareous phosphate;* and that of Klaproth, in the same year (l. c.), on the Saxon apatite, in which he found $\ddot{\bar{P}}$ 45, $\dot{C}a$ 55. Pelletier in 1790 (l. c.) made a complete, although not entirely accurate, analysis of the phosphorite, detecting even the fluorine and chlorine, obtaining $\ddot{\bar{P}}$ 34, $\dot{C}a$ 59, fluoric acid 2·5, muriatic acid 0·5, $\ddot{\bar{F}}e$ 1, $\ddot{S}i$ 2, $\ddot{C}$ 1=100. The asparagus stone of Spain was not analyzed until 1798, by Vauquelin (l. c.); he found only phosphoric acid and lime, respectively 45·72 and 54·28 p. c. His results proved its identity with the Saxon mineral, and from this time they were united, along with phosphorite, under Werner's name of *apatite*, first given in 1786 to the Saxon mineral.

Forbes found in the eupyrchroite (Phil. Mag., IV. xxix 340) $\ddot{\bar{P}}$ 44·12. Phosphorite of different localities has afforded a trace of iodine, and that from Amberg gave H. Reinsch in addition a trace of *bromine.* Apatite from Krageröe, according to Völcker (anal. 11), contains no fluorine. That of Jumilla afforded de Luna 1·75 p. c. of cerium, lanthanum, and didymium.

Near Coquimbo, Chili, at the mines of Tambillos, occur clear turquois-blue crystals, containing, according to F. Field (Chem. Gaz., No. 400, 1860, p. 224), $\ddot{\bar{P}}$ 37·69, $\dot{C}a$ 36·64, $\dot{C}u$ 20·93 Ca Cl 2·33, $\dot{H}$ 2·32=99·91, the copper being present as phosphate.

Lechartier has shown (C. R., lxv. 172) that an arsenic acid apatite may be made by fusion together of arsenate of lime and chlorid of calcium; and that from the same at a lower temperature an arsenic acid wagnerite is obtained in crystals.

Pyr., etc.—B.B. in the forceps fuses with difficulty on the edges (F.=4·5—5), coloring the flame reddish-yellow; moistened with sulphuric acid and heated colors the flame pale bluish-green (phosphoric acid); some varieties react for chlorine with salt of phosphorus, when the bead has been previously saturated with oxyd of copper, while others give fluorine when fused with this salt in an open glass tube. Gives a phosphid with the sodium test.

Dissolves in muriatic and nitric acid, yielding with sulphuric acid a copious precipitate of sulphate of lime; the dilute nitric acid solution gives with acetate of lead a white precipitate, which B.B. on charcoal fuses, giving a globule with crystalline facets on cooling. Some varieties of apatite phosphoresce on heating.

Obs.—Apatite occurs in rocks of various kinds and ages, but is most common in metamorphic crystalline rocks, especially in granular limestone, granitic and many metalliferous veins, particularly those of tin, in gneiss, syenite, hornblendic gneiss, mica schist, beds of iron ore; occasionally in serpentine, and in igneous or volcanic rocks; sometimes in ordinary stratified limestone, beds of sandstone or shale of the Silurian, Carboniferous, Jurassic, Cretaceous, or Tertiary formations. It has been observed as the petrifying material of wood.

Among its localities are Ehrenfriedersdorf in Saxony, Schwarzenstein and Pfitsch in the Tyrol; region of St. Gothard in Switzerland; Mussa-Alp in Piedmont, white or colorless, and of like form and color on the Mittaghorn in Upper Valais; Rabenstein and Amberg in Bavaria; Zinn wald and Schlackenwald in Bohemia; in England, in Cornwall, with tin ores; in Cumberland, at Carrock Fells, in celandine-green crystals in gilbertite; in Devonshire, cream-colored at Bovey Tracey, and at Wheal Franco (*francolite*); in Ireland, in a basaltic dike near Kilroot in Antrim, also in Down, Dublin, and Killiney Hill. The greenish-blue variety, called *moroxite*, occurs at Arendal, Snarum, and Krageröe in Norway, at the latter place in hornblendic gneiss, in part flesh-red, and looking much like feldspar; with magnetic iron of a greenish-yellow color at Mt. Blagodat in the Ural; with black tourmaline on the Schaitanka in Katharinenburg; on the Slüdianka (*lasurapatite*) at the emerald mine of the Takovaia, 85 versts N. E. of Katharinenburg; on the Kiräba, 70 versts S. W. of Miask, containing *no* chlorine (Pusirevsky), with G.=3·126; in Pargas, Finland. The *asparagus stone* or *spargelstein* of Jumilla, in Murcia (not C. de Gata), Spain, is pale yellowish-green in color; and a variety from Zillerthal is wine-yellow. The *phosphorite*, or massive radiated variety, is obtained abundantly near the junction of granite and argillite, in Estremadura, Spain; at Schlackenwald in Bohemia; at Krageröe, whence it has been largely exported to England; at Amberg, in Jurassic limestone, nodular and stalactitic.

In *Maine*, on Long Island, Blue-hill Bay, in veins 10 in. wide, intersecting granite. In *N. Hamp.*, crystals, often large, are abundant, 4 m. S. of the N. village meeting-house, Westmoreland, in a vein of feldspar and quartz, in mica slate, along with molybdenite; fine crystals at Piermont, in white limestone, on the land of Mr. Thomas Cross. In *Mass.*, crystals occasionally 6 in. long, at Norwich (N. E. part), in gray quartz; at Bolton abundant, the forms seldom interesting; sparingly at Chesterfield, Chester, Sturbridge, Hinsdale, and Williamsburgh. In *New York*, large crystals of apatite are found in St. Lawrence Co., in granular limestone, with scapolite, sphene, etc.; one crystal from Robinson's farm, in Hammond, was nearly a foot in length, and weighed 18 lbs.; in crystals 1 m. S. E. of Governeur and 2 m. N.; in Rossie, with sphene and pyroxene, 2 m. N. of the village of Oxbow; also on the bank of Vrooman Lake, Jefferson Co., in white limestone, green prisms ¼–5 in. long; Sanford mine, East Moriah, Essex Co., in magnetic iron ore, which is often thickly studded with six-sided prisms; also at Long Pond, Essex Co.; near Edenville, Orange Co., in prisms ⅓–12 in. long, bright asparagus-green, in white limestone; in the same region, blue, grayish-green, and grayish-white crystals; 2 m. S. of Amity, emerald- and bluish-green crystals; at Long Pond, Essex Co., with garnet and idocrase; at Greenfield, Saratoga Co., St. Anthony's Nose, and Corlaer's Hook, less interesting; fibrous mammillated (*eupyrchroite*) at Crown Point, Essex Co., about a mile south of Hammondsville, in large quantities, quarried for agricultural purposes. In *New Jersey*, on the Morris Canal, near Suckasunny, of a brown color, in massive pyrrhotite; with the magnetite of Bryam mine; Mt. Pleasant mine near Mt. Teabo, in a low hill near the junction of Rockaway R. and Burnt Meadow Cr., ¾ m. from the canal, in masses sometimes 6 in. through; at Hurdstown, Sussex Co., where a shaft has been sunk and the apatite mined; masses brought out weigh occasionally 200 lbs., and some cleavage prisms have the planes 3 in. wide. In *Penn.*, at Leiperville, Delaware Co.; in Chester Co., at New Garden; in Bucks Co., at Southampton. In *Maryland*, near Baltimore. In *Delaware*, at Dixon's quarry, Wilmington, of a rich blue color.

In *Canada*, in North Elmsley, and passing into South Burgess, in an extensive bed 10 ft. broad, 3 ft. of which are pure sea-green apatite, and outside of this mixed with limestone, and sometimes occurring in prisms a foot long and 4 in. through, with pyroxene and phlogopite—a *fluor-apatite* containing only 0·5 chlorine (Hunt); similar in Ross; at the foot of Calumet Falls, in blue crystals; also near Blaisdell's mill on the Gatineau; in crystals in doleryte; at St. Roch, on the Achigan, clear rose-red, amethystine, and colorless crystals, with augite.

Apatite was named by Werner from ἀπατάω, *to deceive*, older mineralogists having referred it to aquamarine, chrysolite, amethyst, fluor, schorl, etc.

For recent articles on cryst., Kokscharof, Min. Russl., ii. 39, 189, iii. 86; v. Rath, Pogg., cviii. 353; Pfaff, Pogg., cxi. 276; Hessenberg, Min. Not., Nos. ii. and iv.

Alt.—490A. OSTEOLITE is massive impure altered apatite, as stated by A. H. Church (Ch. News, xvi. 150, 1867), after analyses of specimens from various localities. The ordinary compact variety looks like lithographic stone of white to gray color. It also occurs earthy. H.=1—2; G.=2·8—3·1, fr. Hanau, Bromeis; 2·86, fr. Hanau, Church; lustre feeble or wanting. Excepting impurities, it has the composition of apatite, although most analyses, excepting those of Church, have not detected the fluorine or chlorine.

Analyses: 1–3, Bromeis, Rütz, and Ewald (Ann. Ch. Pharm., lxxix. 1); 4, Schröder (ib., lxxxix. 221, ci. 283); 5, Durré (Pogg., cv. 155):

	$\bar{\dot{P}}$	$\dot{C}a$	$\ddot{S}i$	$\ddot{\bar{A}}l$	$\ddot{\bar{F}}e$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	$\ddot{C}$	$\dot{H}$
1. Hanau	36·88	49·41	4·50	0·93	1·85	0·47	0·62	0·76	1·81	2·28=99·51 Bromeis.
2. "	37·41	49·24	2·75	1·25	2·78	0·79	0·46	0·81	2·34	3·45=101·28 Rütz.
3. "	37·16	48·20	2·03	*tr.*	2·31	1·85	0·43	0·73	2·55	3·63=98·80 Ewald.
4. Redwitz?	42·00	48·16	4·97	——	1·56	0·75	0·02	0·04	2·21	1·31=101·02 Schröder.
5. Schönwald	34·64	44·76	8·89	6·14	0·50	0·79	——	——	——	2·97, Cl *tr.*=98·69 D.

No. 1 was of the compact part; 2, of the earthy; 3, of the intermediate. Klaproth found in an earthy apatite from Siegeth, Hungary (Beitr., iv. 373), 2·5 p. c. of fluoric acid. A kind from a bed in the Tertiary formation of the Fichtelgebirge, white and earthy, with G.=2·82, gave Schmidt (B. H. Ztg., xx. 390) 76 p. c. $\dot{C}a^3\dddot{P}$. Church found the white, hard osteolite of Eichen, Hanau, to afford much fluorine, and more lime than would saturate the phosphoric and carbonic acids; whence he deduces from his analysis $\dot{C}a^3\dddot{P}$ 87·25, $\dot{C}a\ddot{C}$ 5·70, Ca F 4·92, $\dot{H}$ 2·34=100·21, making it true apatite.

Found in fissures or cavities in doleryte or related rocks, as if a secondary product; also in beds among stratified rocks.

Occurs at Ostheim, near Hanau (G.=2·89—3·08), and near Schönwald in Bohemia (G.=2·828), in doleryte; at Redwitz? in the Fichtelgebirge (G.=2·89, 2·82). It is named from ὀστέον, *bone*, and λίθος, bones consisting largely of the same phosphate.

490B. PHOSPHATIC NODULES. COPROLITES. Phosphatic nodules occur in many fossiliferous rocks, which are probably in all cases of organic origin. They sometimes present a spiral or other interior structure, derived from the animal organization that afforded them, and in such cases their coprolitic origin is unquestionable. In other cases there is no structure to aid in deciding whether they are true coprolites or not. The following are analyses of some coprolites:

	1. Burdiehouse.	2. Fifeshire.	3. Burdiehouse.	4. Burdiehouse.	5. Koschtitz.	6. Oberlaugenau.
Phosphate of lime	9·58	63·60	85·08	83·31	50·89	15·25
Carbonate of lime	61·00	24·25	10·78	15·11	32·22	4·57
Carbonate of magnesia	13·57	2·89	——	——	——	2·75
Sesquioxyd of iron	6·40	*tr.*	——	——	2·08	——
Alumina	——	——	——	——	6·42	——
Silica } Organic material }	4·13	*tr.*	0·34	0·29	0·14	——
Organic material		3·38	3·95	1·47	7·38	74·03
Water	5·33	3·33	——	——	——	——
Lime of organic part	——	——	——	——	——	1·44
Chlorid of sodium	——	——	——	——	——	1·96
	100·01	97·45	100·15	100·18	99·03	100·00

Nos. 1 and 2, by Gregory and Walker; 3 and 4, by Connell; 5, by Quadrat; 6, Rochleder. See other analyses by R. Hoffmann, J. pr. Ch., xc. 469.

Phosphatic nodules, from the Lower Silurian rocks of Canada, contain sometimes fragments of shells of Lingula and Orbicula, which shells, unlike most others, consist largely of phosphates. They are found in the Chazy formation at Allumette Id. (G.=2·875), Hawkesbury, R. Ouelle (G.=3·15), and elsewhere. They have afforded T. S. Hunt (Logan's Rep. Can., 1851–52, 1863, and Am. J. Sci., II. xvii. 235, 1854) the following results:

	Allumette I.	Hawkesbury.	R. Ouelle.
Phosphate lime	36·38	44·70	40·34
Carb. lime, with some fluorid	5·00	6·60	5·14
Carb. magnesia	——	4·76	9·70
Sesquiox. iron and little $\overline{\ddot{A}l}$ }	[7·02]	8·60	12·62
Magnesia }		——	——
Insol.	49·90	27·90	25·44
Volatile	1·70	5·00	2·13
	100·00	97·56	95·37

They are blackish externally, and yellowish-brown to blackish-brown or bluish-brown within. A phosphatic nodule, in brown coal beds near Roth, afforded Hassencamp (Jahrb. Min. 1856, 422) Phosph. lime 45·57, ph. magn. 2·04, ph. iron 27·71, magnesia 1·34, lime 4·20, alumina 0·63, organic acid 3·33, water 7·50, $\ddot{C}$ and loss 7·68=100. H.=2·5; G.=2·813. Color externally pitch-black; within, honey-yellow.

490C. *Staffelite* of Stein (Jahrb. Min. 1866, 716) occurs incrusting the phosphorite of Staffel, in botryoidal, reniform, or stalactitic masses, fibrous and radiating. H.=4. G.=3·1284. Color leek to dark green, greenish-yellow. Analysis afforded Forster (l. c.) $\dddot{P}$ 39·05, $\ddot{C}$ 3·19, $\overline{\ddot{A}l}$ 0·026, $\overline{\ddot{F}e}$ 0·037, $\dot{C}a$ 54·67, F 3·05, $\dot{H}$ 1·40=101·423. Stein regards it as a result of the action of carbonated waters on phosphorite.

490D. GUANO. Guano is bone-phosphate of lime, or osteolite, mixed with the hydrous phosphate, brushite, and generally with some carbonate of lime, and often a little magnesia, alumina, iron, silica, gypsum, and other impurities. It often contains 9 or 10 p. c. of water. It is often granular or oolitic; also compact through consolidation produced by infiltrating waters, in which case it is frequently lamellar in structure, and also occasionally stalagmitic and stalactitic. Its colors are usually grayish-white, yellowish and dark brown, and sometimes reddish, and the lustre of a surface of fracture earthy to resinous. Shepard's *Pyroclasite* (Am. J. Sci., II. xxii. 97) is nothing but the hard guano from Monk's Island, Caribbean sea, the mass of which he named *Pyroguanite*, under the wrong idea of its having undergone the action of heat; and Phipson's *Sombrerite* (J. Ch. Soc., xv. 277, 1862) is the same thing from Sombrero, as shown by A. A. Julien (Am. J. Sci., II. xxxvi. 423). The waters which have filtrated through the guano at Sombrero have altered the coral rock adjoining, turning it more or less completely into phosphate of lime of a yellowish or brownish color; and phosphatic stalagmites and stalactites resinous in fracture are common.

Shepard's massive *Glaubapatite*, yellowish-brown to chocolate-brown in color, and in fibrous stalactites, from Monk's Island (l. c.), is also in all probability merely the guano rock above described. He says the mineral contains 15·1 p. c. of sulphate of soda, with 74·0 of phosphate of lime, and 10·3 of water; but such a compound is hardly a possibility, and the fact of its existence needs confirmation. The name, from glauber and apatite, alludes to the composition. The mineral includes also "tabular crystals," which may possibly be *brushite*, although the composition is against it.

490E. EPIPHOSPHORITE *Breith.* (B. H. Ztg., xxv. 194). Occurs reniform, of scaly-granular structure, inclining to fibrous, vitreous lustre, leek- to celandine-green color, with H.=4·5—5, G.=3·125. According to Richter it fuses with much difficulty, and affords indications of phosphoric acid, lime, protoxyd of iron, alumina, and a very little silica; not tested for fluorine or chlorine, because of too little material. Occurs with garnets and graphite in a crystalline rock, but locality unknown.

490F. TALC-APATITE *Hermann* (J. pr. Ch., xxxi. 101). An apatite from chlorite slate in the Schischimskian mountains, near Slatoust, containing a large percentage of magnesia in place of part of the lime, and low in specific gravity. It occurs in 6-sided prisms, grouped or single; H.=5; G.=2·7—2·75; lustre dull to earthy; color milk-white, yellowish externally; feebly translucent.

Composition, according to Hermann (l. c.), excluding 9·50 of insoluble material as impurities: $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 43·11, $\dot{\mathrm{C}}\mathrm{a}$ 41·44, Mg 8·55, $\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}$ 1·10, Cl 0·92, $\dddot{\mathrm{S}}$ 2·32, fluorine undetermined; whence the formula $3\,\dot{\mathrm{C}}\mathrm{a}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}} + \mathrm{Mg}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$, with chlorid and fluorid. Berzelius suggests that the magnesia may have come from the gangue. According to Volger it is an altered impure apatite. Some magnesia is present in many apatites (Bischof.).

490G. HYDROAPATITE *Damour* (Ann. d. M., V. x. 65). In mammillary concretions, looking a little like chalcedony. H.=5·5, G.=3·10. Color milk-white. Subtransparent. Composition that of a *hydrous apatite*; $3\,\dot{\mathrm{C}}\mathrm{a}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}} + \mathrm{Ca\,F} + \dot{\mathrm{H}}$. Analysis by Damour (l. c.):

$\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 40·00 $\dot{\mathrm{C}}\mathrm{a}$ 47·31 F 3·36 Ca 3·60 $\dot{\mathrm{H}}$ 5·30.

Heated in a tube it decrepitates and gives out ammoniacal water.

Found near St. Girons in the Pyrenees, in the fissures of a brownish, ferruginous, argillaceous schist, a rock which not far distant affords wavellite.

493. PYROMORPHITE. Grön Blyspat, Minera plumbi viridis pt., *Wall.*, Min., 296, 1748. Mine de Plomb verte *Fr. Trl.* Wall., i. 536, 1853. Grünbleierz, Braunbleierz, *Schültze*, Dresden Mag., ii. 70, 1761, ii. 467, 1765 (with obs. on identity). Grün Bleyerz, PHOSPHORSAUREHALTIG (fr. Zschopau), *Klapr.*, Crell's Ann., i. 394, 1784. Green Lead Ore, Brown Lead Ore; Phosphate of Lead. Phosphorsaures Blei, Phosphorblei, Buntbleierz, *Germ.* Plomb phosphaté *Fr.* Polychrom, Pyromorphit, *Hausm.*, Handb., 1089, 1090, 1813. Traubenblei *id.*, ib., 1093. Polysphærit *Breith.*, Char., 54, 1832. Nussierite *Danhauser*, Barruel, Ann. Ch. Phys., lxii. 217, 1836. Miesit *Breith.*, Handb., 285, 1841. Cherokine *Shep.*, Rep. Canton Mine, 1856, Min., 407, 1857, Am. J. Sci., II. xxiv. 33, 1857.

Hexagonal. $O \wedge 1 = 139°\ 38'$; $a = 0{\cdot}7362$. Observed planes: O, I, i-2, 1, 2, 4, 2-2.

$O \wedge 4 = 106°\ 23'$	$O \wedge 2\text{-}2 = 124°\ 11'$	$1 \wedge 1$, pyr., $= 142°\ 12'$
$O \wedge 2 = 120\ \ 28$	$I \wedge i\text{-}2 = 150$	$I \wedge 2\text{-}2 = 135\ \ 46$