

Mineral structures E & F

Updated 092006 by J V Smith

eakerite $\text{Ca}_2\text{SnAl}_2\text{Si}_6\text{O}_{18}(\text{OH})_2 \cdot 2\text{aq}$. Interrupted 1,2-vertex-connected octahedral-tetrahedral net composed of crankshaft chains linked into $\text{AlSi}_3\text{O}_6(\text{OH})$ sheets further linked via SnO_6 octahedra. Consortium for Theoretical Frameworks net 1124.

Structure: **AA Kossiakoff PB Leavens** 1976 AM 61 956-62. MM 38 990.

eardleyite $\sim\text{Ni}_5\text{Al}_3(\text{CO}_3)_2(\text{OH})_{14} \cdot 5\text{aq}$.

Hydrotalcite/pyroaurite structure group: review, **HFW Taylor** 1973 MM 39 377-89.

Occurrence: MM 32 989; **EH Nickel & 5 others** 1977 AM 62 449-57.

earlandite $\text{Ca}_3(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 4\text{aq}$. Hydrated calcium citrate.

Structure determination not found, but may be in non-mineralogic literature.

Occurrence: MM 24 608; **Dana**.

earlshannonite $\text{MnFe}^{3+}_2(\text{PO}_4)_2(\text{OH})_2 \cdot 4\text{aq}$. *Arthurite* structure group.

Structure determination not found.

Occurrence: **DR Peacor PJ Dunn WB Simmons** 1984 CM 22 471-4.

ecandrewsite ZnTiO_3 . *Ilmenite* structure type; matches *synthetic*.

-*geikelite solid solution*: synthesis & XRPD structure, **RP Liferovich RH Mitchell** 2004 ACB 60 496-501 (10762).

-*pyrophanite solid solution*: synthesis & XRPD structure, **RH Mitchell RP Liferovich** 2004 CM 42 1871-80.

Occurrence: **WD Birch LA Pautov & 3 others** 1988 MM 52 237-40;

-*zincian pyrophanite*, Lujavrite, Pilansberg alkaline complex, **RH Mitchell RP Liferovich** 2004 CM 42 169-78.

ecdemite $\text{Pb}_6\text{As}_2\text{O}_7\text{Cl}_4$.

Structure determination not found.

Occurrence: **LG Sillén L Melander** 1941 ZK 103 420-30 (S1253).

eckermannite $\text{Na}_3(\text{Mg,Fe})_4(\text{Al,Fe})\text{Si}_8\text{O}_{22}(\text{OH})_2$.

Amphibole structure group; monoclinic subtype.

Occurrence: MM 27 268.

Li-ferri-, structure: **FC Hawthorne & 4 others** 1994 AM 79 443-51.

Synthetic F-(Al/Sc/Ti/V/Cr/Ga), SC-XRD: **R Oberti & 3 others** 1999 AM 84 102-11.

eclarite $(\text{Cu,Fe})\text{Pb}_9\text{Bi}_{12}\text{S}_{28}$.

Structure: **V Kupcik** 1964 TMPM 32 259-69 (K733);

anomalous scattering, **R Wulf** 1995 MP 52 187-96 (W674).

Occurrence: MM 48 572.

edenharterite $\text{TlPb}(\text{As,Sb})_3\text{S}_6$. Homeotypic with *jentschite*.

Structure: *synthetic*, **T Balic-Zunic P Engel** 1983 ZK 165 261-9;

natural, **P Berlepsch** 1995 SMPM 75 277-81 (B1420) = AM 81 520;

P Berlepsch 1996 SMPM 76 147-57 (B1528).

edenite $\text{NaCa}_2(\text{Mg,Fe})_5\text{Si}_7\text{AlO}_{22}(\text{OH})_2$. *Amphibole* structure type, monoclinic subtype.

Structure: K,F-, **RK Rastvetsaeva D Yu Pushcharovskii BE Borutski** 1995 CrR 40 27-30 (R540).

Occurrence: garnet lherzolite, China, **J Yang** 2003 AM 88 180-8.

Synthetic F-: **KF Boschmann & 4 others** 1994 CM 32 21-30.

edgarbaileyite $\text{Hg}_6\text{Si}_2\text{O}_7$.

Structure: **RJ Angel G Cressey A Criddle** 1990 AM 75 1192-6.

Occurrence: MM 54 664.

edgarite FeNb_3S_6 .

Structure determination not found.

Occurrence, Kola, matches *synthetic* XRPD: **AY Barkov & 5 others** 2000 CMP 138 229-36 (B2003).

CM 35 875-85. AM 83 1119.

edingtonite $\text{BaAl}_2\text{Si}_3\text{O}_{10} \cdot 4\text{aq}$. *Zeolite* mineral group. IZA-SC structure code EDI.

Consortium for Theoretical Frameworks net 258.

Kalborsite has the net-258 topology.

Structure: **WH Taylor R Jackson** 1933 ZK 86 53;

WH Taylor 1935 MM 24 208-20;
E Galli 1976 AC B32 1623-7 (G816);
 neutron, **A Kvick JV Smith** 1983 JCP 79 2356-62 (K786);
F Mazzi E Galli G Gottardi 1984 NJMM 373-82 (M779);
 tetragonal variety (*tetraedingtonite*), **TN Nadezhina EA Pobedimskaya AP Khomyakov** 1984 MZh 6 55-63;
 ND/proton NMR, **IA Belitsky & 3 others** 1986 NJMM 541-51 (B798);
 Al-Si order-disorder & twinning, **M Akizuki** 1986 AM 71 1510-4;
 transformation at elevated P & T, **LA Belitsky & 4 others** 1992 PCM 18 497-505;
 dehydration, synchrotron XRPD, **K Ståhl JC Hanson** 1998 EJM 10 221-8 (S1908);
 growth sectors, SC-XRD, **T Tanaka R Kimura M Akizuki Y Kudoh** 2002 MM 66 409-20;
 orthorhombic, split Ba, SC-XRD, **GD Gatta TB Ballaran** 2004 MM 68 162-75.
 High-P: <6 GPa, anisotropic compression, no phase change, **Y Lee & 3 others** 2004 PCM 31 22-7 (10015);
 <7 GPa, orthorhombic & tetragonal, **GD Gatta & 3 others** 2004 PCM 31 228-98 (10541).
 Isothermal equation-of-state & compression: **GD Gatta & 3 others** 2004 AM 89 647-53.
 In situ XRPD of dehydration: **K Ståhl** 1998 Mater Sci Forum 278-81.
 Occurrence, Strathclyde: MA 96M/4914.
 Synthetic Na- & Rb-exchanged zeolite K-F, (K/Rb)₁₃(OH)₃Si₁₀Al₁₀O₄₀~13aq:
C Baerlocher RM Barrer 1974 ZK 140 10-26;
E Tambuyzer HJ Bosmans 1976 AC B32 1714-9 (T445).
 Synthetic zeolite LiF, LiAlSiO₄.1.6aq: **YuF Shepelev LK Butikova Yul Smolin** 1989 Krist 34 1302-4 (S1040).
 Synthetic K₂Al₂Si₃O₁₀.KCl: **S Ghose Y Hexiong JR Weidner** 1990 AM 75 947-50.
 Synthetic Na₂Ga₂Si₃O₁₀.2aq: **YuA Malinovskii MS Dadashov OS Bondareva KhM Minachev** 1991 Krist 36 577-83.
 Synthetic, hydrothermal & morphology: **H Ghobarkar O Schaf** 1997 Cryst Res Technol 32 653-7.
 Synthetic N: XRPD structure, **AN Christensen H Fjellvag** 1997 Acta Chem Scand 51 969-73;
 NPd of dehydration, **do** 1999 Acta Chem Scand 53 85-9.
 Synthetic I/GaCoP, SC-XRD: **X Bu TE Gier P Feng GD Stucky** 1998 ChM 10 2546-51 (B1862).
 Synthetic ZP-4, KZnPO₄.0.8aq, SC-XRD structure: **RW Broach & 6 others** 1999 ChM 11 2076-80 (B1935).
 Synthetic K₂Ga₂Si₃O₁₀.1.5aq & Rb₇NaGa₈Si₁₂O₄₀.3aq, SC-XRD structure: **Y Lee SJ Kim JB
 Parise** 2000 MMM 34 255-71 (L1052).
edoylerite Hg₃CrO₄S₂.
 Structure: **P Burns** 1999 CM 37 113-8.
 Occurrence: **RC Erd & 5 others** 1993 MR 24 471-5 = MM 60 529.
effenbergite BaCuSi₄O₁₀. *Gillespite* structure group.
 Structure: **G Giester B Rieck** 1994 MM 58 663-70;
 synthetic, **HC Lin FL Liao SL Wang** 1992 AC C48 1297-9;
 NPd, **BC Chakoumakos JA Fernandez-Baca LA Boatner** 1993 JSSC 103 105-13 (also *Sr analog*).
 Synthetic (Ca/Sr/Ba)Si₄O₁₀, "Egyptian blue": **A Pabst** 1959 AC 12 733-9.
 Synthetic BaCuSi₄O₁₀, structure: **J Janczak R Kubiak** 1992 AC C48 1299-301;
HC Lin FL Liao SL Wang 1992 AC C48 1297-9.
 [Synthetic BaCuSi₂O₆, related phase, but not isostructural: 1989 AM 74 952-5.]
efremovite (NH₄)₂Mg₂(SO₄)₃. Isostructural with *langbeinite* & *manganolangbeinite*.
 Structure: **EP Shcherbakova LF Bazhenova** 1989 ZVMO 68 84-7 (S1353) = AM 76 299.
 [Name used earlier: MM 29 980.]
eggletonite (Na,K,Ca)₂(Mn,Fe)₈(Si,Al)₁₂O₂₉(OH)₇.11aq.
 Compare with *bannisterite*, *ekmanite* & *ganophyllite*.
 Structure determination not found.
 Occurrence: **DR Peacor PJ Dunn WB Simmons** 1984 MM 48 93-6.
eglestonite Hg₆Cl₃O₂H. Should be isostructural with Br-rich analog *kadyrelite*.
 Structure: [**A Hedlik** 1948 Experientia 4 66 = MA 11-534; **do** 1950 TMPM 1 378];
K Mereiter J Zemann 1976 TMPM 23 105-15 (M1261);
K Mereiter J Zemann AW Hewat 1992 AM 77 839-42.
ehrleite Ca₂ZnBe(PO₄)₂(PO₃OH).4aq. Sheet structure.
 Structure: **FC Hawthorne JD Grice** 1987 CM 25 767-74;
AR Kampf 1992 AM 77 848-56.

Occurrence: MM 50 745.
eifelite $\sim\text{KNa}_3\text{Mg}_4\text{Si}_{12}\text{O}_{30}$. *Osumilite* structure type.
Structure: **K Abraham & 4 others** CMP 1983 82 252-8 (A445).
Occurrence: MM 46 518; 50 745.
[eisenkalkancylite Carbonate of REE, Fe & Ca.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.]
eitelite $\text{Na}_2(\text{Mg,Fe})(\text{CO}_3)_2$. Isostructural with *buetschlite*.
Structure: **A Pabst** 1973 AM 58 211-7;
D Knobloch F Pertlik J Zemann 1980 NJMM 230-6.
Occurrence: MM 30 732.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
ekanite $(\text{Th,U})(\text{Ca,Fe,Pb})\text{Si}_4\text{O}_{10}$.
Metamict, recrystallizes to tetragonal phase: MM 32 954; AM 46 1516.
Compare with *iraqite* & *steaceyite*.
Structure: **VI Mokeeva NI Golovastikov** 1966 DAN USSR ES 167 106-8;
P Richard G Perrault 1972 AC B28 1994-9 = MA 73-1298;
JT Szymanski & 4 others 1982 CM 20 65-75;
U-rich: **V Diella G Mannucci** 1986 RSIMP 41 3-6.
[kanaekanite Contains K & Na; recognized as separate species from *ekanite*, MM 39 916.]
ekaterinite $\text{Ca}_2\text{B}_4\text{O}_7(\text{Cl,OH})_2.2\text{aq}$.
Structure determination not found.
Occurrence: **SV Malinko et al** 1981 AM 66 437 [Mike Fleischer questioned cell dimensions].
ekatite $(\text{Fe}[\text{III}],\text{Fe}[\text{II}],\text{Zn})_6(\text{OH})_3(\text{AsO}_3)_3(\text{AsO}_3,\text{SiO}_3\text{OH})$.
Occurrence & structure: **P Keller** 2001 EJM 13 769-7 (3462).
[ekdemite See *ecdemite*.]
ekmanite $(\text{K}_{0.35}\text{Ca}_{0.24}\text{Na}_{0.08})(\text{Fe}_{7.76}\text{Mn}_{1.46}\text{Mg}_{2.02})(\text{Si}_{15.2}\text{Al}_{2.6}\text{O}_{42})(\text{OH})_{8.n}\text{aq}$.
2:1 modulated layer silicate related to *bannisterite* & *ganophyllite*.
Structure: **EA Ferrow LR Wallenberg D Holtstam** 1999 EJM 11 299-308 (F657).
elbaite $\text{Na}(\text{Li,Al})_3\text{Al}_6(\text{BO}_3)_3\text{Si}_6\text{O}_{18}(\text{OH})_4$. *Tourmaline* structure group.
Structure: **G Donnay R Barton Jr** 1972 TMPM 18 273-86 (D531);
Al-rich, **MG Gorskaya & 3 others** 1982 SPC 27 63-6;
GR Rossman E Fritsch JE Shigley 1991 AM 76 1479-84;
boron K-edge XANES, **ME Fleet S Muthupari** 2000 AM 85 1009-21.
Manganoan, **B Nuber K Schmetzer** 1984 NJMM 301-4;
PC Burns DJ MacDonald FC Hawthorne 1994 CM 32 31-41 (B1604).
[electrum Ag,Au. Solid solution between *silver* & *gold*.
Occurrence, San Bernardino Co CA: **RW Sheets JR Craig RJ Bodnar** 1995 CM 33 137-51.]
ellenbergite $(\text{Mg}_{1/3}\text{Ti}_{1/3}\text{void}_{1/3})_2\text{Mg}_6\text{Al}_6\text{Si}_8\text{O}_{28}(\text{OH})_{10}$.
Structure: **P Comodi PF Zanazzi** 1993 EJM 5 819-29, 831-8.
IR & NMR of protons: **F Brunet T Schaller** 1996 AM 81 385-94.
Occurrence: **C Chopin LA Pautov & 3 others** 1986 CMP 92 316-21 = AM 73 190-1.
Synthetic phosphoellenbergite $(\text{Mg, void})_2\text{Mg}_{12}\text{P}_6\text{P}_2\text{O}_{38}\text{H}_9$ & natural solid solution: **C Chopin et al** 1994 IMA Pisa p. 74.
ellestadite General name for *chlorellestadite*, *fluorellestadite* & *hydroxyellestadite*.
Name: MM 25 627.
IR & Raman, natural hydroxyl-rich: **DK Arkhipenko TN Moroz** 1997 CrR 42 651-6 (A765).
ellisite Ti_3AsS_3 .
Structure: *synthetic*, **M Gostojic** 1980 ZK 151 249-54 (E339).
Occurrence: MM 43 1060.
elpasolite K_2NaAlF_6 . Isostructural with cubic high-T variety of *cryolite*.
Based on *perovskite* topology - atomic ordering.
Natural: **C Sabelli** 1987 NJMM 481-7 (S1481).
Synthetic $\text{K}_2\text{Na}(\text{Cr/Fe/Ga})\text{F}_6$: **K Knox DW Mitchell** 1961 J Inorg Nucl Chem 21 253-8.
Synthetic NaMoF_6 : **AJ Edwards RD Peacock** 1961 J Chem Soc 4253-4.
Synthetic $\text{Cs}_2\text{LiCo}(\text{CN})_6$: **A Wolberg** 1969 AC B25 161-2.

Synthetic $K_2NaH^{+}1.5Fe^{3+}0.5F_6$: **OV Yakubovich & 3 others** 1986 SPD 31 192-4 (Y123).
Synthetic K_2NaScF_6 , Cs_2NaYCl_6 , Cs_2LiYCl_6 & Cs_2NaYBr_6 : 1986 IC 28 3249-58 = SR 56A 80.
Synthetic Cs_2KTiF_6 & Rb_2KTiF_6 : 1989 ZaaC 568 126-35 = SR 56A 81.
Synthetic $CsCo[N(CH_3)_4]_2(CN)_6$ & $NaFe[H_3NCH_3]_2(CN)_6$: **S Peschel D Babel** 1994 ZN 49b 1373-80 (P586).
Synthetic $Rb_2K(Y/In)F_6$ & Tl_2KInF_6 , NMR of F motion: **H Faget-Guengard & 4 others** 1996 JAICo 238 49-53 (F503).
Synthetic $Cs_2NaCeCl_6$, XRPD: **R Acevedo V Poblete** 1995 PD 10 241-2 (A813).
Synthetic Mo(III)-doped Cl/Br, excited states & photon yield, upconversion: **DR Gamelin HU Gudel** 2000 JPCB 104 10222-34 (234).
Synthetic $K_3MoO_3F_3$, ED & XRPD: **FJ Brink & 4 others** 2002 JSSC 163 267-74 (5914).
Synthetic $Cs_2NaTbCl_6$, XRPD structure: **V Poblete & 3 others** 2002 PD 17 10-2.
Synthetic Na_2LiAlF_6 , XRPD structure: **SD Kirik & 3 others** 2002 ACC 58 i159-60 (8383).
Synthetic $Tl_3MoO_3F_3$, ED/XRPD: **FJ Brink L Noren RL Withers** 2003 JSSC 174 44-51 (9819).
Synthetic $Rb_2K(In/Lu/Sc)F_6$, phase change, model: **VI Zinenko NG Zamkova** 2004 CrR 49 34-44 (10028).

elpidite $Na_2ZrSi_6O_{15} \cdot 3aq$. 2-vertex-connected octahedral-tetrahedral net CTF 1093.
Structure: **NN Neronova NV Belov** 1965 SPC 9 700-5 (N347);
NN Neronova NV Belov 1965 DAN USSR ES 150 115-8;
E Cannillo G Rossi L Ungaretti 1973 AM 58 106-9 (C302);
Ca-containing, **AN Sapozhnikov AA Kashaev** 1978 SPC 23 24-7;
calcined, **do** 1980 SPC 25 357-69 (S1405).
Titano-elpidite has $Ti > Zr$: MM 21 578-9.
Synthetic, XRPD: **SR Jale A Ojo FR Fitch** 1999 ChCo 411-2 (J335).

elsmoreite $WO_3 \cdot 0.5aq$. Defect *pyrochlore* structure type.
Structure: XRPD analogy with *synthetic*, **JR Günter & 2 others** 1989 MRB 24 289-92.
Occurrence: **PA Williams & 3 others** 2005 CM 43 1061-4.

elyite $Pb_4Cu(SO_4)O_2(OH)_4 \cdot aq$.
Structure: SC-XRD, **U Kolitsch G Giester** 2000 AM 85 1816-21.
Occurrence: **SA Williams** 1972 AM 57 364-7.

embreyite $Pb_5(CrO_4)_2(PO_4)_2 \cdot aq$. Analog of *cassedanneite* $Pb_5(VO_4)_2(CrO_4)_2 \cdot aq$.
Structure determination not found.
Occurrence: **SA Williams** 1972 MM 38 790-3.

emeleusite $Li_2Na_4Fe_2Si_{12}O_{30}$. *Osumilite* structure type with orthorhombic distortion.
Isostructural with *zektzerite*.
Structure: **O Johnsen K Nielsen I Sotofte** 1978 ZK 147 297-306 (J253).
Occurrence: MM 42 523.

Synthetic $Na_2LiYSi_6O_{15}$: **RP Gunawardane RA Howie FP Glasser** 1982 ACB 38 1405-8.
Synthetic $Na_2Mg_2Si_6O_{15}$: **ME Cradwick HFW Taylor** 1972 ACB 28 3583-7.

emilite $Cu_{10.7}Pb_{10.7}Bi_{21.3}S_{48}$. 4-fold superstructure of *bismuthinite-alkinite* series.
SC-XRD structure: **T Balic-Zunic D Topa E Makovicky** 2002 CM 40 239-45.

emmonsite $Fe_2(TeO_3)_3 \cdot 2aq$.
Structure: **F Pertlik** 1972 TMPM 18 157-68 (P166).

emplectite $CuBiS_2$. Isostructural with *chalcostibite*.
Structure: **W Hoffman** 1933 ZK 84 177-203;
JC Portheine W Nowacki 1975 ZK 141 387-402 (P233);
XRPD & EXAFS of *chalcostibite*-emplectite series, **MF Razmara & 4 others** 1997 MM 61 79-88
SC-XRD refinement, **A Kyono M Kimata** 2005 AM 90 162-5.

empresseite $AgTe$. Contrast *stutzite*.
Structure: SC-XRD, **L Bindi PGSpry C Cipriani** 2004 AM 89 1043-7.
Occurrence: **RM Honea** 1964 AM 49 325-38.
System Ag-Te: **EF Stumpfl J Rucklidge** AM 53 1513-22.

enargite Cu_3AsS_4 . Dimorphic with *luzonite*.
Similar structure to *lithiophosphate* Li_3PO_4 -gamma.
Structure: **G Adiwidjaja J Löhn** 1970 AC B26 1878-9;

JA Henao et al 1994 MRB 29 1121-7 (H903);
synthetic, **J Rosnstingl** 1994 Ost Akad Wiss Math-natur KI Anz 130 27-30;
 absolute, SC-XRD, **L Karanovic & 4 others** 2002 NJMM 241-53 (7550).
 Stacking disorder, HRTEM & SAED: **M Pósfai M Sundberg** 1998 AM 83 365-72.
 Oxidation of natural & *synthetic*: **D Fullston D Fornasiero J Ralston** 1999a,b La 15 4524-9, 4530-6 (F661,662).
 Point-contact diode component: **ET Wherry** 1925 AM 10 28.
 IR microthermometry, Bulgaria, **K Kouzmanov & 3 others** 2004 CM 42 1501-21.
Synthetic Cu₃PS₄ & Cu₃PSe₄: **J Garin E Parthé** 1972 ACB 28 3672.
Synthetic LiGaS₂: **J Leal-Gonzalez SS Melibary AJ Smith** 1990 AC C46 2017-9 (L662).
Synthetic LiGaO₂: **M Marezio** 1965 AC 18 481-4.
Synthetic NaFeO₂-beta: **F Bertaut P Blum** 1954 CRASP 239 429-31.
Synthetic NaAlO₂: see nonmineral.
endellite Al₂Si₂O₅(OH)₄.2aq. *Kaolinite-serpentine* group.
 Structure determination not found.
 Occurrence: MM 26 336.
englishite K₃Na₂Ca₁₀Al₁₅(PO₄)₂₁(OH)₇.26aq.
 Structure determination not found.
 Structure speculation: **PB Moore** 1976 MM 40 863-6.
 Occurrence: **PJ Dunn RC Rouse J Nelen** 1984 CM 22 469-70;
TJ Campbell WL Roberts 1986 MR 17 237-54.
 Occurrence: MM 22 619.
enstatite MgSiO₃. *Pyroxene* structure type, *orthorhombic* subtype.
 Transforms to *perovskite* type at high P.
 Structure: **N Morimoto K Kato** 1969 ZK 129 65-83;
S Sasaki LA Pautov & 3 others 1982 ZK 158 279-97;
Y Ohashi 1984 PCM 10 217-29;
 ND, **S Ghose V Schomaker RK McMullan** 1986 ZK 176 159-75
Synthesis & chemistry, excess-Si aluminous-: **T Fockenberg W Schreyer** 1997 EJM 9 509-18 (F535).
High-P: 0-8.5 GPa, **DA Hugh-Jones RJ Angel** 1994 AM 79 405-10;
 to 9 GPa, **RJ Angel DA Hugh-Jones** 1994 JGR 99 19777-83;
 to 4.5 GPa & 1000 K, **Y Zhao D Schiferl TJ Shankland** 1995 PCM 22 387-92;
 to 12 GPa & 1473 K, **T Shinmei et al** 1999 AM 84 1588-94;
 molecular-dynamics modeling, **SL Chaplot N Choudhury** 2001 AM 86 752-61;
 1-14 GPa, 790-1900 K, phase changes, Raman of quenched, **P Ulmer R Stalder** 2001 AM 86 1267-74;
 to 8 GPa, IR, H incorporation, **GD Bromley FA Bromley** 2006 AM 91 1094-101.
 (Mg,Fe)(Si,Al)O₃: Mössbauer & ELNES spectroscopy of *synthetic* perovskite, **S
 Lauterbach & 4 others** 2000 CMP 138 17-26 (L1039).
 XRPD structure & thermoelasticity of MgSiO₃ *perovskite*: to 94 GPa & 2500 K, **G Fiquet & 4
 others** 2000 GRL 27 21-4 (F681).
 XANES: Fe, **F Farges** 1995 PCM 22 318-22 (F540);
 Fe in Bamble: **C Closmann E Knittle F Bridges** 1996 AM 81 1321-31;
 Mg: **D Cabaret LA Pautov & 3 others** 1998 AM 83 300-4;
 Mg & Fe, & XRPD structure, *synthetic* En-Fs series: **G Giuli & 4 others** 2002 EJM 14 429-36 (7134).
 Dissolution vs. pH, T, etc: **EH Oelkers J Schott** 2001 GCA 65 1219-31 (1667).
 Water solubility vs T 973-1373 K at 1.5 GPa: **K Mierdel H Keppler** 2004 CoMP 148 305-11 (10832).
 From LL chondrites: **G Artioli G Davoli** 1994 EPSL 128 469-78.
 Lunar: MA 91M/2598.
 In meteorites: **AE Rubin** 1997 MPS 32 231-47.
 Biopyribole polysomes: **BH Grobéty** 1996 AM 81 404-17.
Synthetic Mn,Co-substituted: **FC Hawthorne J Ito** 1977 CM 15 321-38.
Synthetic Mg_{0.75}Fe_{0.25} up to 1300 K: **H Yang S Ghose** 1995 AM 80 9-20;
 high-T to 1400K, **H Yang S Ghose** 1995 PCM 22 300-10 (Y156).
Synthetic Cu_{0.2-0.5}Mg_{1.8-1.5}Si₂O₆: (T422).
Synthetic with <1000 ppmw Al, FTIR of OH: **R Stalder H Skogby** 2002 EJM 14 1139-44 (8682).
eosphorite (Mn,Fe)Al(PO₄)(OH)₂.aq. Related to *ernstite*, its oxidation product.

Structural series with *childrenite*.

Structure: **AW Hanson** 1960 AC 13 384-7;

MA Hoyos LA Pautov & 3 others 1993 MM 57 329-36.

ephesite $\text{NaLiAl}_2\text{Al}_2\text{Si}_2\text{O}_{10}(\text{OH})_2$. *Mica* structure group; 2M₁ polytype.

Structure: polytype 2M₁ in Cc, **PG Slade EW Radoslovich** 1985 NJMM 337-52;

PG Slade PK Schultz C Dean 1987 NJMM 6 275-87.

Al XANES: **A Mottana & 6 others** 1997 AM 82 497-502.

epididymite $\text{NaBeSi}_3\text{O}_7(\text{OH})$. Dimorphic with *eudidymite*.

Structure: **YeA Pobedinskaya NV Belov** 1960 DES 129 1172-5 = MA 16-26;

PD Robinson JH Fang 1970 AM 55 1541-9.

Synthetic K-: **IS Naumova & 4 others** 1977 SPD 21 422-4 (N335).

Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).

EPIDOTE STRUCTURE GROUP

Includes

<i>androsite-La</i>	$(\text{La}, \text{Mn}, \text{Ca})_2\text{AlMn}^{3+}\text{Mn}^{2+}(\text{SiO}_4)(\text{Si}_2\text{O}_7)\text{OOH}$
<i>allanite-Ce</i>	$(\text{Ce}, \text{Ca}, \text{Fe})_2(\text{Al}, \text{Fe})_3\text{Si}_3\text{O}_{12}\text{OH}$
<i>allanite-Y</i>	$(\text{Y}, \text{Ce}, \text{Ca})_2(\text{Al}, \text{Fe})_3\text{Si}_3\text{O}_{12}(\text{OH})$
<i>clinozoisite</i>	$\text{Ca}_2\text{Al}_3\text{Si}_3\text{O}_{12}\text{OH}$
<i>dissakisite-Ce</i>	$\text{Ca}_{1.0}(\text{Ce}_{0.6}\text{La}_{0.3}\text{Nd}_{0.1})\text{Mg}_{0.9}\text{Ti}_{0.1}\text{Al}_{1.9}\text{Si}_{2.9}\text{O}_{12}$
<i>dissakisite-La</i>	$\text{CaLaMgAl}_2\text{Si}_3\text{O}_{12}(\text{OH})$.
<i>dollaseite-Ce</i>	$\text{CaCeMg}_2\text{AlSi}_3\text{O}_{11}(\text{OH}, \text{F})$
<i>epidote</i>	$\text{Ca}_2(\text{Al}, \text{Fe})_3\text{Si}_3\text{O}_{12}\text{OH}$
<i>ferrillanite-Ce</i>	$\text{CaCeFe}^{2+}\text{AlFe}^{3+}(\text{SiO}_4)(\text{Si}_2\text{O}_7)\text{O}(\text{OH})$
<i>hancockite</i>	$(\text{Pb}, \text{Ca}, \text{Sr})_2(\text{Al}, \text{Fe})_3\text{Si}_3\text{O}_{12}\text{OH}$
<i>khristovite-Ce</i>	$(\text{Ca}, \text{RE})\text{RE}(\text{Mg}, \text{Fe})\text{AlMnSi}_3\text{O}_{11}(\text{OH})(\text{F}, \text{O})$
<i>mukhinite</i>	$\text{Ca}_2\text{Al}_2\text{VSi}_3\text{O}_{12}\text{OH}$
<i>niigataite</i>	$\text{CaSrAl}_3(\text{Si}_2\text{O}_7)(\text{SiO}_4\text{O}(\text{OH}))$
<i>piemontite</i>	$\text{Ca}_2(\text{Al}, \text{Fe}, \text{Mn})_3\text{Si}_3\text{O}_{12}\text{OH}$
<i>strontio Piemontite</i>	$\text{CaSr}(\text{Al}, \text{Mn}, \text{Fe})_3\text{Si}_3\text{O}_{11}\text{O}(\text{OH})$
<i>tweddillite</i>	$\text{CaSr}(\text{Mn}^{3+}, \text{Fe}^{3+})_2\text{AlSi}_3\text{O}_{12}(\text{OH})$
<i>zoisite</i>	$\text{Ca}_2\text{Al}_3\text{Si}_3\text{O}_{12}\text{OH}$

epidote $\text{Ca}_2(\text{Al}, \text{Fe})_3\text{Si}_3\text{O}_{12}\text{OH}$.

A Liebscher G Franz ed 2004 Epidotes, RMG 56.

Structure: **NV Belov JM Rumanova** 1953 DAN SSSR 89 853-6;

T Ito N Morimoto R Sadanaga 1954 AC 7 53-9;

WA Dollase 1971 AM 56 447-64 (D164);

EJ Gabe JC Portheine SH Whitlow 1973 AM 58 218-23 (S942);

neutron, **YuZ Novik LA Pautov & 3 others** 1979 GI 66-9;

S Carbonin G Molin 1980 NJMA 139 205-15;

neutron, **Å Kvik LA Pautov & 3 others** 1988 AC B44 351-5;

Mn-, **EV Sokolova TN Nadezhina LA Pautov** 1991 SPC 36 172-4;

Fe-, **AC Stergiou PJ Rentzeperis S Sklavounos** 1987 ZK 178 297-305;

22 clinozoisites & allanites, **P Bonazzi S Menchetti** 1995 MP 53 133-53 (B1333);

synthetic, Al-Fe disorder, SC-XRD, **G Giuli P Bonazzi S Menchetti** 1999 AM 84 933-6.

Polarized XAS: **GA Waychunas GE Brown Jr** 1990 PCM 17 420-30 (W590).

Phase stability & magmatic evolution: **MW Schmidt AB Thompson** 1996 AM 81 462-74.

Dissolution vs speed of granite magma: **AD Brandon RA Creaser T Chacko** 1996 S 271 1845-8.

FTIR: **G Della Ventura A Mottana GC Parodi WL Griffin** 1996 EJM 8 655-65 (D595).

Sr-bearing, eclogites/paraschists, Su-Lu province: **A Nagasaki M Enami** 1998 AM 83 240-7.

Talc-kyanite-phengite eclogites, Sulu, China: **CG Mattinson & 3 others** 2004 AM 89 1772-83.

Electronic absorption Fe(III), 300-750 K, P <10 GPa: **MN Taran K Langer** 2000 EJM 12 7-15 (T645).

Mössbauer/molecular orbital calculations: **M Grodzicki S Heuss-Assbichler G Amthauer** 2001 PCM 28 675-81 (3463).

epistilbite $\text{CaAl}_2\text{Si}_6\text{O}_{16}\cdot 5\text{aq}$. Zeolite group. IZA-SC code EPI. CTF net 250.

Structure: **IS Kerr** 1964 N 202 589;

S Merlino 1965 Atti Soc Toscana Sci Nat A72 480-3;

AJ Perrotta 1967 MM 36 480-90 (P81);

disordered, **M Slaughter WT Kane** 1969 ZK 130 68-87 (S366);

A Alberti E Galli G Vezzalini 1985 ZK 173 257-65;

symmetry & twinning, **M Akizuki H Nishido** 1988 AM 73 1434-7;

(010) disorder, partial Si,Al order & Ca distribution in triclinic-, SC-XRD, **P Yang T**

Armbruster 1996 EJM 8 263-71 (Y177).

Crystal chemistry: **E Galli R Rinaldi** 1974 AM 59 1055-61.

Dehydration dynamics, XRPD: **G Cruciani A Martucci C Meneghini** 2003 EJM 15 257-66.

Synthesis: **S Khodabandeh ME Davis** 1997 MiMa 9 149-60 = CA 127:12475n.

epistolite $\sim\text{Na}_4\text{TiNb}_2(\text{Si}_2\text{O}_7)_2\text{O}_2(\text{OH})_2\cdot 4\text{aq}$. *Murmanite-lomonosovite* mineral group.

Not isostructural with *murmanite*, but forms syntactic intergrowths.

Structure: general description, **AD Khalikov LA Pautov & 3 others** 1965 DES 162 138-40 (K774)

SC-XRD & crystal chemistry, **E Sokolova FC Hawthorne** 2004 CM 42 797-806.

Intergrowth with unknown phase: **S Karup-Møller** 1986 NJMA 155 289-304 (K743).

TEM/XRD, syntactic intergrowth with *murmanite* & *shkatulkalite*, new formula: **P Nemeth & 3 others** 2005 CM 43 973-87.

Occurrence: **OB Bøggild** 1901 Medd Grønland 24 183-90.

[**epsilon-alumina** See *alumina-epsilon*.]

EPSOMITE STRUCTURE GROUP. Includes:

epsomite $\text{MgSO}_4\cdot 7\text{aq}$

fauserite? $\text{MnSO}_4\cdot 7\text{aq}$ (? = manganoan epsomite)

goslarite $\text{ZnSO}_4\cdot 7\text{aq}$

morenosite $\text{NiSO}_4\cdot 7\text{aq}$

tauriscite $\text{FeSO}_4\cdot 7\text{aq}$

epsomite $\text{MgSO}_4\cdot 7\text{aq}$. Epsomite structure type.

Structure: **WH Baur** 1964 AC 17 1361-9 (B224);

G Ferraris DW Jones J Yerkes 1973 JCS D 816-21;

absolute configuration, **M Calleri & 3 others** 1984 AC B40 218-22.

Synthesis with urea: **S Ramalingom & 3 others** 2003 JCG 247 523-9 (8743).

In meteorites: **AE Rubin** 1997 MPS 32 231-47.

ercitite $\text{NaMnPO}_4\text{OH}\cdot 2\text{aq}$. Structural relative of *bermanite*.

Structure: done, but published?

Occurrence & XRPD: **A Fransolet & 4 others** 2000 CM 38 893-8.

erdite $\text{NaFeS}_2\cdot 2\text{aq}$. Matches *synthetic*.

Structure: **JA Konnert HT Evans Jr** 1980 AM 65 516-21.

Occurrence: MM 46 518.

erdmannite Aluminosilicate of REE, Fe & Ca.

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

ericaite $(\text{Fe},\text{Mg},\text{Mn})_3\text{B}_7\text{O}_{13}\text{Cl}$. Iron analog of *boracite*.

Orthorhombic, dimorphic with trigonal *congolite*.

Structure determination not found.

Occurrence: MM 31 957;

F Heide R Kühn I Schaacke 1956 AM 41 372.

2 cm crystals, Boulby Mine, at Manchester Museums: **DI Green MD Freir** 1996 MR 27 163-70.

ericssonite $\text{BaMn}_2\text{FeOSi}_2\text{O}_7\text{OH}$.

Seidozerite structure group [jvs: may be subtle structural variations].

Monoclinic, dimorphic with *orthoericssonite*.

Structure determination not found.

Occurrence: **PB Moore** 1971 Li 4 137-45 (M1158) = AM 56 2157.

eriochalcite $\text{CuCl}_2\cdot 2\text{aq}$. Chain structure. Review: (E289).

Structure: **D Harker** 1936 ZK 93 136-45 (H942);

Raman, implication copper corrosion, **RL Frost & 3 others** 2003 NJMM 433-45 (9622).

erikite Pseudomorph after *vitusite*.
History, occurrence: **IV Pekov & 3 others** 1997 NJMM 97-112 (P677).]

erionite $(K_2, Ca, Na_2)_2 Al_4 Si_{14} O_{36} \cdot 15aq$. *Zeolite* group. IZA-SC code ERI.
Consortium for Theoretical Frameworks net 119.
Structure: **LW Staples JA Gard** 1959 MM 32 261-81 (S42);
A Kawahara H Curien 1969 BSFMC 92 250-6 = MA 70-222;
dehydrated, **JL Schlenker JJ Pluth JV Smith** 1977 AC B33 3265-8;
reexamination, SC-XRD, **A Alberti E Galli G Vezzalini** 1997 Z 19 349-52;
stacking faults: **GT Kokotailo S Sawruk SL Lawton** 1972 AM 57 439-44;
crystal chemistry, **E Passaglia G Artioli A Gualtieri** 1998 AM 83 577-89, 590-606.
From Faedo, Italy: **E Passaglia A Tagliavini** 1995 NJMM 185-91.
Epitaxial overgrowth on *levyne*: **E Passaglia E Marchi AF Gualtieri** 1999 NJMM 568-76 (P858).
Adsorption propylene/propane, natural/K/Ag-exch: **G Aguilar-Armenta ME Patino-Iglesias** 2002 La 18 7456-61 (8105).
Synthetic $Ga_9P_9O_{36}OH \cdot HNEt_3$: **G Yang S Feng R Xu** 1987 JCSCC 1254-5 (G861).
Synthetic SAPO-17, Cu(II)-exchanged: **AM Prakash L Kevan** 1997 La 13 5341-8.

erlianite $(Fe, Mg)_4(Fe, V)_2Si_6O_{15}(OH, O)_8$.
Structure determination not found.
Occurrence: **X Feng R Yang** 1986 MM 50 285-9.

erlichmanite OsS_2 . *Pyrite* structure type.
Series with *aurite*, & Ir, Os & As varieties, Urals: **VV Murzin SG Sustavov** 2000 DES 370 160-2 = DAN 380-2 (M1804).
Structure, synthetic: **OK Sutarno KIG Reid** 1967 Canad J Chem 54 1391-400.
Occurrence: MM 38 991.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
[Unnamed (Ir, Os)(S, As, Te)₂, Western Sayan: **N Tolstykh A Krivenko L Pospelova** 1997 EJM 9 457-65 (T517).]

ernienickelite $NiMn_3O_7 \cdot 3aq$. *Chalcophanite* structure type.
Isostructural with *aurorite*, *chalcophanite* & *jianshuiite*.
Structure: XRPD, **JD Grice LA Pautov & 3 others** 1994 CM 32 333-7.

ernigllite $Tl_2SnAs_2S_6$.
Structure: **S Graeser LA Pautov & 3 others** 1992 SMPM 72 293-305 (G734).

ernstite $(Mn, Fe)Al(PO_4)(OH)_{2-x}O_x$. Oxidation product of *eosphorite*: structural relation?
Occurrence: **E Seeliger A Mücke** 1970 NJMM 289-98 (S1400) = AM 56 637.

ershovite $K_3Na_4(Fe, Mn, Ti)_2Si_8O_{20}(OH)_4 \cdot 4aq$.
Structure: **RK Rastsvetaeva OYu Rekhlova AP Khomyakov** 1991 SPC 36 500-3 (R516).
Occurrence: **AP Khomyakov & 3 others** 1993 ZVMO 122 116-20 (K658) = MM 60 530.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).

ertixiite $Na_2Si_4O_9$.
Structure determination not found.
Cubic polymorph with $a = 5.97 \text{ \AA}$, Pa3: see nonmineral file for monoclinic high-P and metastable orthorhombic varieties (F548).
Occurrence: **R Zhang F Han C Du** 1985 Geochemistry 4 192-5 = 1986 AM 71 1544.
Occurrence: MM 52 724.

erythrite $Co_3(AsO_4)_2 \cdot 8aq$. *Vivianite* structure type.
Structure: **M Wildner CL Lengauer G Giester** 1994 IMA Pisa 439 (also synthetic Mg, Co, Ni);
& Mössbauer, **M Wildner & 3 others** 1996 EJM 8 187-93.
Annabergite-erythrite-hörnesite synthetic system: **JL Jambor JE Dutrizac** 1995 CM 33 1063-71.
Synthetic $Co_3(PO_4)_2 \cdot 8aq$: **A Riou Y Cudennec Y Gerault** 1989 AC C45 1412-3.

erythrosiderite $K_2FeCl_5 \cdot aq$. Series with isostructural ammonium *kremersite*.
Structure: **A Bellanca** 1947 PMR 17 59-72 (B1297).
[Synthetic $RbCl_2(NH_3)_5Cl$: MA 6-173.]

eskebornite $CuFeSe_2$. *Chalcopyrite* structure type.
Structure: **Z Johan** 1988 NJMM 337-43 (J252);
JM Delgado & 4 others 1992 MRB 27 367-73 (D626).
XRPD: **JA Henao JM Delgado** 1994 PD 9 108-14.
Occurrence: MM 29 980.

Synthetic (Cu,Fe)_{1.1}Se: **G Tischendorf** 1960 NJMA 94 1169-82.

eskimoite ~Ag₇Pb₁₀Bi₁₅S₃₆. *Lillianite* homologous series, 5,9 subtype.

No detailed structure determination seen.

Quadruple *b*: **A Ertl E Libowitzky F Pertlik** 1994 Mitt Osterreich Mineral Ges 139 135-42 = MA 95M/2053.

Occurrence: **E Makovicky S Karup-Møller** 1977 NJMA 131 56-82 (M1210) = AM 64 243-4.

eskolaite Cr₂O₃. *Hematite* structure type.

Antiferromagnetic transition at 305 K.

Structure: **RE Newnham YM De Haan** 1962 ZK 117 235-7;

LW Finger RM Hazen 1980 J Appl Phys 51 5362-7 (F224);

FTIR of water on surface: **S Kittaka & 3 others** 1993 SuS 282 255-61 (K933).

Heat capacity (magnetic anomaly)/thermodynamics 1.5-340 K: **S Klemme LA Pautov & 3 others** 2000 AM 85 1686-93.

No phase transition to 32 GPa: **S Rekhii & 4 others** 2000 JAICo 302 16-20 (R935).

Occurrence: MM 32 954.

Orthorhombic Cr₂O₃: MA 11-421.

In meteorites: **AE Rubin** 1997 MPS 32 231-47.

esperanzaite NaCa₂Al₂(AsO₄)₂F₄(OH)₂aq.

Structure & occurrence: **EE Foord & 6 others** 1999 CM 37 67-72.

esperite (Ca,Pb)ZnSiO₄.

Structure determination not found. [jvs: ?superstructure of *beryllonite*.]

Compare with *trimerite*.

X-ray data: **PB Moore PH Ribbe** 1965 AM 50 1170-8.

Synthesis: AM 53 231-4.

esseneite CaFeAlSiO₆. *Pyroxene* structure group; *monoclinic* subtype.

Structure: **MA Cosca DR Peacor** 1987 AM 72 148-56.

ETTRINGITE STRUCTURE GROUP OF HEXAGONAL HYDRATED SULFATES Includes:

bentorite Ca₆(Cr,Al)₂(SO₄)₃(OH)₁₂.26aq

[birunite ? AM 44 907.]

buryatite Ca₃(Si,Fe,Al)(SO₄)B(OH)₉O.12aq

carraraite Ca₃Ge(OH)₆(SO₄)_{1.1}(CO₃)_{0.9}.12aq

charlesite Ca₆(Al,Si)₂(SO₄)₂B(OH)₄(OH,O)₁₂.26aq

ettringite Ca₆Al₂(SO₄)₃(OH)₁₂.26aq

jouravskite Ca₃Mn(SO₄)(CO₃)(OH)₆.13aq

micheelsenite (Ca,Y)₃Al(PO₃OH,CO₃)(CO₃)(OH)₆.12aq

strurmanite Ca₆(Fe,Al,Mn)₂(SO₄)₂B(OH)₄(OH)₁₂.25aq

thaumasite Ca₃Si(CO₃)(SO₄)(OH)₆.12aq

ettringite Ca₆Al₂(SO₄)₃(OH)₁₂.26aq. *Ettringite* structure group.

Structure: **AE Moore HFW Taylor** 1968 N 218 1048-9;

AE Moore HFW Taylor AC B26 386-93 (M315).

Review: **HFW Taylor** 1973 MM 39 377-89.

Synthesis of 7 analogs: **H Pöllmann H-J Kuzel R Wenda** 1989 NJMA 160 133-58 (P555).

Synthesis of other Ca-Al-sulfate-hydrates: **H Pöllmann** 1989 NJMA 27-40 (P554).

Formation, stability & microstructure of Ca sulfo aluminates in hydrated cement paste, XRPD:

E Henderson X Turrillas P Barnes 1995 JMS 30 3856-62 (H1188).

Thermal decomposition; XRD & FTIR, **C Hall & 4 others** 1996 JCSF 92 125-9 (H1103).

DTA, TG & XRPD: **SM Antao MJ Duane I Hassan** 2002 CM 40 1403-9.

Raman & XRD of thermal breakdown: **SK Deb & 4 others** 2003 PCM 30 31-8.

Sorption/desorption of arsenate (V): **SCB Myneni & 3 others** 1997 EST 31 1761-8 (M1480).

Characterization/fixation, heavy metals, review: **WA Klemm** 1998 R&D Bull RD116W Portland Cement Assoc Skokie.

eucairite AgCuSe.

Structure: **AJ Frueh GK Czamanske C Knight** 1957 ZK 108 389-96 (F414).

euchlorine (Na,K)Cu₃O(SO₄)₃. Series with K-endmember *fedotovite*.

Structure, Vesuvius: **F Scordari F Stasi** 1990 NJMA 161 241-53 (S1466).

New data, Kamchatka specimen: **YY Bykova & 4 others** 1994 DAN 335 118-22 (B1452).

euchroite $\text{Cu}_2(\text{AsO}_4)\text{OH}\cdot 3\text{aq}$. Review: (E289).
 Structure: **G Giuseppetti** 1963 PMR 32 131-56;
JJ Finney 1966 AC 21 437-40 = MA 18-14;
RK Eby FC Hawthorne 1989 AC C45 1479-82 (E350) = SR 56A 235.

euclase $\text{BeAlSiO}_4(\text{OH})$. *Datolite-gadolinite-herderite* mineral group.
 Structure: **ME Mrose DE Appleman** 1962 ZK 117 16-36 (M58);
RM Hazen AY Au LW Finger 1986 AM 71 977-84;
F Demartin CM Gramaccioli T Pilati 1992 SMPM 72 159-65.

[eucrasite Silicate of Th, Ca, Na & REE.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.]

eucryptite LiAlSiO_4 -alpha. Isostructural with *phenakite* & *willemite*.
 Structure: **HGF Winkler** 1948 AC 1 27-34;
K-F Hesse 1985 ZK 172 147-51 (H609);
 NMR & SC-XRD, **P Daniels CA Fyfe** 2001 AM 86 279-83.
 Beta- isostructural with *quartz*: average structure, **V Tscherry H Schulz F Laves** 1972 ZK 135 161-74 (T179);
 superstructure, **do** 175-98 (T178);
WW Pillars DR Peacor 1973 AM 58 681-90;
 low, MA 73-1309;
 mechanisms for near-zero thermal expansion, N&XRPD, **H Xu PJ Heaney DM Yates** 1999 JMR 14 3138 (X31);
 MAS-NMR, **BL Phillips & 3 others** 2000 AM 85 181-8;
 IR/Raman, phonons/phase transitions, **M Zhang EKH Salje PJ Heaney** 2003 PCM 30 47-62.

Gamma-, synthesis, XRD/MAS-NMR/IR/DTA/DSC: **R Dimitrijevic V Dondur N Petranovic** 1995
 J Serbian Chem Soc 60 1057-64 = CA 124:44020q.

Epsilon-, high-P transition: **J Zhang & 4 others** 2002 AM 87 566-71.
 Synthesis from zeolite Li-A(BW), in-situ XRPD: **P Norby & 4 others** 2000 ChM 12 1473-9 (N528).

EUODIALYTE MINERAL GROUP. Includes:

<i>alluaivite</i>	$\text{Na}_{19}(\text{Ca}, \text{Mn})_6(\text{Ti}, \text{Nb})_5\text{Si}_{26}\text{O}_{74}\text{Cl}\cdot 2\text{aq}$
<i>aqualite</i>	$(\text{H}_3\text{O})_8(\text{Na}, \text{K}, \text{Sr})_5\text{Ca}_6\text{Zr}_3\text{Si}_{26}\text{O}_{66}(\text{OH})_9\text{Cl}$
<i>carbokentbrooksitesite</i>	$(\text{Na}, \text{I})_{12}(\text{Na}, \text{REE})_3\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{NbSi}_{25}\text{O}_{73}(\text{OH})_3(\text{CO}_3)\cdot \text{aq}$
<i>eudialyte</i>	$\text{Na}_{15}\text{Ca}_6\text{Fe}_3\text{Zr}_3\text{Si}(\text{Si}_{25}\text{O}_{73})(\text{O}, \text{OH}, \text{aq})_3(\text{Cl}, \text{OH})_2$
[<i>eucolite</i>	meaningless, should be abandoned]
<i>feklichevite</i>	$\text{Na}_{12}\text{Ca}_9\text{Fe}_2\text{Zr}_3\text{NbSi}_{25}\text{O}_{73}(\text{OH}, \text{aq}, \text{Cl}, \text{O})_5$
<i>ferrokentbrooksitesite</i>	$\text{Na}_{15}\text{Ca}_6(\text{Fe}, \text{Mn})_3\text{Zr}_3\text{NbSi}_{25}\text{O}_{73}(\text{O}, \text{OH}, \text{aq})_3(\text{Cl}, \text{F}, \text{OH})_2$
<i>georgbarsanovite</i>	$\text{Na}_{12}(\text{Mn}, \text{Sr}, \text{REE})_3\text{Ca}_6\text{Fe}_3\text{Zr}_3\text{NbSi}_{25}\text{O}_{76}\text{Cl}_2\cdot \text{aq}$
<i>ikranite</i>	$(\text{Na}, \text{H}_3\text{O})_{15}(\text{Ca}, \text{Mn}, \text{REE})_6\text{Fe}_2\text{Zr}_3(\text{I}, \text{Zr})(\text{I}, \text{Si})\text{Si}_{24}\text{O}_{66}(\text{O}, \text{OH})_6\text{Cl}\cdot 2\text{-}3\text{aq}$
<i>johnsenite-Ce</i>	$\text{Na}_{12}(\text{Ce}, \text{La}, \text{Sr}, \text{Ca}, \text{I})_3\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{W}(\text{Si}_{25}\text{O}_{73})\text{CO}_3(\text{OH}, \text{Cl})_2$
<i>kentbrooksitesite</i>	$\text{Na}_{12}\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{NbSi}_{25}\text{O}_{73}(\text{O}, \text{OH}, \text{aq})_2(\text{F}, \text{Cl})_2$
<i>khomyakovite</i>	$\text{Na}_{12}\text{Sr}_3\text{Ca}_6\text{Fe}_3\text{Zr}_3\text{W}(\text{Si}_{25}\text{O}_{73})(\text{O}, \text{OH}, \text{aq})_3(\text{Cl}, \text{OH})_2$
<i>labyrinthite</i>	$(\text{Na}, \text{K}, \text{Sr})_{35}\text{Ca}_{12}\text{Fe}_3\text{Zr}_6\text{TiSi}_{51}\text{O}_{144}\text{Cl}_3(\text{O}, \text{OH}, \text{aq})_9$
<i>mangankhomyakovite</i>	$\text{Na}_{12}\text{Sr}_3\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{WSi}_{25}\text{O}_{73}(\text{O}, \text{OH}, \text{aq})_3(\text{Cl}, \text{OH})_2$
<i>oneillite</i>	$\text{Na}_{15}\text{Ca}_3\text{Mn}_3\text{Fe}_3\text{Zr}_3\text{NbSi}_{25}\text{O}_{73}(\text{O}, \text{OH}, \text{aq})_3(\text{OH}, \text{Cl})_2$
<i>raslakite</i>	$\text{Na}_{15}\text{Ca}_3\text{Fe}_3(\text{Na}, \text{Zr})_3(\text{Si}, \text{Nb})\text{Si}_{25}\text{O}_{73}(\text{OH}, \text{aq})_3(\text{Cl}, \text{OH})_2$
<i>rasvetaevite</i>	$\text{Na}_{27}\text{K}_8\text{Ca}_{12}\text{Fe}_3\text{Zr}_6\text{Si}_{52}\text{O}_{144}(\text{O}, \text{OH}, \text{aq})_6\text{Cl}_2$
<i>taseqite</i>	$\text{Na}_{12}\text{Sr}_3\text{Ca}_6\text{Fe}_3\text{Zr}_3\text{NbSi}_{25}\text{O}_{73}(\text{O}, \text{OH}, \text{aq})_3\text{Cl}_2$
<i>zirsilite-Ce</i>	$(\text{Na}, \text{I})_{12}(\text{REE}, \text{Na})_3\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{Nb}(\text{Si}_{25}\text{O}_{73})(\text{OH})_3(\text{CO}_3)\cdot \text{aq}$

Discussion of terminology: **O Johnsen OV Petersen RA Gault** 1997 NJMM 371-83 (J302).
 Nomenclature, final report of CNMMN committee: **O Johnsen & 5 others** 2003 CM 41 785-94.
 Crystal chemistry based on 17 structures: **O Johnsen JD Grice** 1999 CM 37 865-91.
 Analog of eudialyte, R3 space group, structure: **RK Rastsvetaeva & 2 others** 1999 CrR 44 765-9 (R918).
 Mn, Na-ordered analog, R3 symmetry: **RK Rastsvetaeva AP Khomyakov** 2000 CrR 45 591-4 (1732).
 K-rich analog, double c, SC-XRD structure: **RK Rastsvetaeva AP Khomyakov** 2001 CrR 46 647-53 (2926).
 Review: **O Johnsen JD Grice RA Gault** 2001 GGSB 190 65-72 (8685).
 Chemical variability & sorting: **AG Bulakh TG Petrov** 2004 NJMM 127-44 (10215);

do 2003 ZVMO 132-4 1 (10509).

eudialyte $\text{Na}_{15}\text{Ca}_6\text{Fe}_3\text{Zr}_3\text{Si}(\text{Si}_{25}\text{O}_{73})(\text{O},\text{OH},\text{aq})_3(\text{Cl},\text{OH})_2$.
 Many unnamed varieties: AM 86 941.
 Structure: **G Giuseppetti F Mazzi C Tadini** 1971 TMPM 16 105-27 (G234);
VM Golyshev VI Simonov NV Belov 1971 SPC 16 70-4 (G705);
 do 1973 SPC 17 993-6 (G703);
RK Rastsvetaeva VI Andrianov 1987 SPD 32 252-4 (R496);
RK Rastsvetaeva BE Borutskii AI Gusev 1988 SPC 33 207-10;
 K-oxonium, **RK Rastsvetaeva MN Sokolova BE Borutskii** 1990 SPC 35 814-7;
 low-Fe, SC-XRD structure, **RK Rastsvetaeva AP Khomyakov** 1998 DAN 362 784-8
 Ti-rich, SC-XRD structure, **RK Rastsvetaeva AP Khomyakov G Chapuis** 1999 ZK 214 271-8 (R896);
 hyper-Zr, **RK Rastsvetaeva AP Khomyakov** 2000 CR 45 219-2 (1731) = AM 86 941;
 oxonium, SC-XRD, **IA Ekimenkova RK Rastsvetaeva IV Chukanov** 2000 DAN 371 625-8;
 Fe,Sr, SC-XRD, **IA Ekimenkova RK Rastsvetaeva AP Khomyakov** 2000 CrR 45 930-3;
 Na,Fe-depleted, SC-XRD, **RK Rastsvetaeva AP Khomyakov** 2002 CrR 47 232-6 (7086)
 Ta-rich, SC-XRD, **RK Rastsvetaeva NV Chukanov S Möckel** 2003 CrR 48 216-21 (8934).
 Optical & Mössbauer, minerals in eudialyte group: **EV Pol'shin & 4 others** 1991 PCM 18 117-25.
 Optical spectra for Fe (II): **GR Rossman MN Taran** 2001 AM 86 896-903.
 Chemical range, 36 EMP analyses, XRPD: **O Johnsen RA Gault** 1997 NJMA 171 215-37 (J274).
 $(\text{Na},\text{K})_5(\text{H}_3\text{O})_7\text{Ca}_6\text{Fe}_3\text{Zr}_3(\text{Si}_3\text{O}_9)_2[\text{Si}_9\text{O}_{24}(\text{OH})_3]_2\text{Cl}_{1.5}(\text{O},\text{OH})_6$: 1990 SPC 35 814-7.
 Hydrothermal RE-rich, S. Africa: **GR Olivo AE Williams-Jones** 1999 CM 37 653-63.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
 Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
eudidymite $\text{Na}_2\text{Be}_2\text{Si}_6\text{O}_{15}\cdot\text{aq}$.
 Vertex-connected Si_6O_{15} layer connected by edge-sharing B_2O_6 tetrahedra.
 Dimorphic with *epididymite*.
 Structure: [early determination wrong, not listed];
JH Fang PD Robinson Y Ohya 1972 AM 57 1345-54.
eugenite $\text{Ag}_{11}\text{Hg}_2$. [Check for structure of synthetic amalgams.]
 Occurrence: **H Kucha** 1986 Mineral Polonica 17 3-10;
A Piastczynski W Tylka 1992 Mineral Polonica 23 17-24 = AM 80 845-6.
eugsterite $\text{Na}_4\text{Ca}(\text{SO}_4)_3\cdot 2\text{aq}$. XRPD matches synthetic.
 Structure determination not found: review, **Sabelli**.
 Occurrence: **L Vergouwen** 1981 MM 66 632-6.
eulytite $\text{Bi}_4(\text{SiO}_4)_3$. Prototype of *langbeinite* structure, but no polymorphism.
 Structure: ignore 1931 proposal;
DR Segal RP Santoro RE Newnham 1966 ZK 123 73-6 = MA 18-160;
 XPS, **R Gopalakrishnan CS Gopinath P Ramasamy** 1996 Cryst Res Technol 31 249-54;
synthetic, XRPD, **H Liu C Kuo** 1997 ZK 212 48 (L808).
 Crystal chemistry of 140 isostructural compounds: **A Wetzel W Eysel** 1998 EJM 316 (W938).
Synthetic $\text{Pb}_4(\text{PO}_4)_2\text{CrO}_4$, structure of high-T cubic eulytite type & low-T rhombohedral
 subtype: **J Barbier D Maxin** 1995 JSSC 116 179-84 (B1325).
Synthetic $\text{Pb}_4(\text{PO}_4)_2\text{SO}_4$: **J Barbier & 3 others** 1990 Eur J Solid State Inorg Chem 27 855;
J Barbier 1992 JSSC 101 249;
 do 1994 Eur J Solid State Inorg Chem 31 163.
Synthetic $\text{Sr}_4(\text{PO}_4)_2\text{CrO}_4$: **K Hartl R Braumgart** 1978 Z Naturforschung B33 954.
Synthetic Ge-: 1990 SPC 35 204-6; CA 124 355386v.
Synthetic $(\text{Sr}/\text{Ba}/\text{Pb})\text{K}(\text{PO}_4)(\text{SO}_4)_2$: MA 18-160.
Synthetic $\text{Sr}_3\text{La}(\text{PO}_4)_3$: 1990 Eur J Solid State Inorg Chem 27 855-67 = SR 57A 263.
Synthetic $\text{Ba}_3\text{Bi}(\text{PO}_4)_3$: SC-XRD structure, **EH Arbib & 3 others** 2000 MRB 35 761-73 (A931).
euxenite-Y (Y, etc.) $(\text{Nb},\text{Ta},\text{Ti})_2\text{O}_6$. *Columbite* structure type.
 Crystal chemistry of complex Nb & Ta oxides: **J Graham MR Thornber** 1974 AM 59 1026-39.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
lytrocraosite (Y,Th,Ca,U)(Ti,Fe) $_2(\text{O},\text{OH})_6$. Cell data match *euxenite* structure type.

New occurrence & SCXRD: **WW Crook III** 1977 AM 62 1009-11.]
Synthetic Y(Nb_{0.5}Ti_{0.5})₂O₆: neutron, **H Weitzel H Schröcke** 1980 ZK 152 69-82 (W694).
evansite Al₃PO₄(OH)₆.6aq? Compare with *bolivarite* & *vashegyite*.
Amorphous.
Occurrence: **Dana**;
J Garcia-Guinea AM Chagoyen EH Nickel 1995 CM 33 59-65.
eveite Mn₂(AsO₄)(OH). *Andalusite* topology.
Adamite structure group.
Dimorph of *sarkinite*.
Structure: **PB Moore JR Smyth** 1968 AM 53 1841-5.
Occurrence: MM 37 957.
evenkite [C₂₃H₄₈ dominant in C 19 to 28].
Paraffin wax; matches monoclinic *n*-tetracosane C₂₄H₅₀.
Symmetry/chemistry/identification/thermal behavior: **EN Kotelnikova & 2 others** 2004 ZVMO 133 80-92 = AM 90 1468-9.
Occurrence: MM 30 732;
H Strunz B Contag 1965 NJMM 19-25 = AM 50 2109.
eveslogite (Ca,K,Na,Sr,Ba)₂₄[(Ti,Nb,Fe,Mn)₆(OH)₆Si₂₄O₇₂](F,OH,Cl)₇.
Occurrence: **YuP Menshikov & 5 others** 2003 ZVMO 132 59-66.
ewaldite Ba(Ca,Y,Na,K,Sr,REE)(CO₃)₂.
Composition varies between publications.
Supposed to be dimorphic with *mckelveyite*, but latter is hydrous.
[jvs Check relation with *barytoalcite*.]
Structure: **G Donnay H Preston** 1971 TMPM 15 201-12 (D496).
Occurrence: MM 38 991.
Occurrence: hyperagpaitic alkaline rocks: **Khomyakov** (1995);
Khibina carbonatite, **AN Zaitsev et al** 1998 MM 62 225-50.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
(Ca,Na,RE)(Ba,Sr)(CO₃)₂.n aq, structure: **AV Voloshin & 4 others** 1992 ZVMO 121(1) 56-67 =
AM 80 634.
eyletterite ?(Th,Pb)_{1-x}Al₃[(P/Si)O₄]₂(OH)₆?. *Crandallite* structure type.
Structure determination not found.
Occurrence: **L Van Wambeke** 1974 BSFMC 95 98-105 = AM 59 208.
eyeselite FeGe₃O₇(OH).
Occurrence & crystallography: **AC Roberts & 6 others** 2004 CM 42 1771-6.
ezcurrite Na₄B₁₀O₁₇.7aq. Polyanion type.
Occurrence: **S Muessig RD Allen** 1957 EG 52 426-37 = AM 42 919;
CS Hurlbut Jr LF Aristian 1967 AM 52 1048-59.
[Na₂B₅O₇(OH)₃.2aq, tri-tetrahedra cluster: **E Cannillo A Dal Negro L Ungaretti** 1973 AM 58 110-5.
eztlite Fe₆Pb₂(TeO₃)₃TeO₆(OH)₁₀.8aq.
Structure determination not found.
Occurrence: **SA Williams** 1982 MM 46 257-9.

fabianite CaB₃O₅OH. Triangle-two-tetrahedra rings in sheet structure.
Structure: **JA Konnert JR Clark CL Christ** 1970 ZK 132 241-54.
Occurrence: MM 33 1132.
faheyite (Mn,Mg)Be₂Fe₂(PO₄)₄.6aq.
Structure determination not found.
Occurrence: **ML Lindberg KJ Murata** 1953 AM 38 263-70;
ML Lindberg 1964 AM 49 395-8;
MM 30 732.
fahleite Zn₅CaFe₂(AsO₄)₆.14aq. ?analog of *osmolianinovite*.
Very diffuse X-ray pattern.

Occurrence: **O Medenbach K Schmetzer K Abraham** 1988 NJMM 167 (M1270).

fairbankite PbTeO_3 . Dimorphic with *plumbotellurite*.

Structure determination not found.

Occurrence: **SA Williams** 1979 MM 43 453-7.

fairchildite $\text{K}_2\text{Ca}(\text{CO}_3)_2$. Dimorphic with *buetschliite*. See *natrofairchildite*.

Structure: *synthetic*, **F Pertlik** 1981 ZK 157 199-205.

Occurrence: MM 28 728.

Thermochemistry: **A Navrotsky & 3 others** 1997 AM 82 546-8.

FAIRFIELDITE STRUCTURE GROUP Includes:

cassidyite $\text{Ca}_2(\text{Mg,Ni})(\text{PO}_4)_2 \cdot 2\text{aq}$

collinsite $\text{Ca}_2(\text{Mg,Fe})(\text{PO}_4)_2 \cdot 2\text{aq}$

fairfieldite $\text{Ca}_2(\text{Mn,Fe})(\text{PO}_4)_2 \cdot 2\text{aq}$

gaitite $\text{Ca}_2\text{Zn}(\text{AsO}_4)_2 \cdot 2\text{aq}$

hillite $\text{Ca}_2(\text{Zn,Mg})(\text{PO}_4)_2 \cdot 2\text{aq}$

messelite $\text{Ca}_2(\text{Fe,Mn})(\text{PO}_4)_2 \cdot 2\text{aq}$

parabrandtite $\text{Ca}_2\text{Mn}(\text{AsO}_4)_2 \cdot 2\text{aq}$

roselite-beta $\text{Ca}_2(\text{Co,Mg})(\text{AsO}_4)_2 \cdot 2\text{aq}$

talmessite $\text{Ca}_2\text{Mg}(\text{AsO}_4)_2 \cdot 2\text{aq}$

Natural $(\text{Ca,Sr})_2\text{Mg}(\text{PO}_4)_2 \cdot 2\text{aq}$, 21 wt % SrO: XRPD structure, **OV Yakubovich & 4 others** 2003 CrR 48 226-32 (8932).

Synthetic $\text{Na}_2(\text{Mn/Co/Ni})(\text{SeO}_4)_2 \cdot 2\text{aq}$ & $\text{K}_2(\text{Mn/Co})(\text{SeO}_4)_2 \cdot 2\text{aq}$:

SC-XRD structures, **M Wildner D Stoilova** 2003 ZK 218 201-9 (9128).

Fairfieldite group is polymorphic with *roselite* group.

fairfieldite $\text{Ca}_2(\text{Mn,Fe})(\text{PO}_4)_2 \cdot 2\text{aq}$. Fairfieldite structure group.

Structure: **L Fanfani A Nunzi PF Zanazzi** 1970 AC B26 640-5.

falcondoite $(\text{Ni,Mg})_4\text{Si}_6\text{O}_{15}(\text{OH})_2 \cdot 6\text{aq}$. Analog of Mg *sepiolite*.

Structure determination not found.

Occurrence: **G Springer** 1976 CM 14 407-9 (S1402).

falkmanite $\text{Pb}_3\text{Sb}_2\text{S}_6$. [jvs. Is it really equal to *boulangerite*?]

MA 12-525; AM 69 411; AM 73 667 (M1280); MM 25 627.

Synthetic boulangerite, falkmanite & Cu-free meneghinite, XRPD & stability: **KL Pruseth B**

Mishra H Bernhardt 2001 EJM 13 411-9 (1996).

famatinite Cu_3SbS_4 . *Stannite* structure group.

Isostructural with *permingeatite* $\text{Cu}_3(\text{Sb,As})\text{Se}_4$.

Structure: **J Garin E Parthé** 1972 AC B28 3672-4.

Point-contact diode component: **ET Wherry** 1925 AM 10 28-?.

Synthetic Cu_3SnSe_4 : **J Garin E Parthé** 1972 AC B28 3672-4.

fangite Ti_3AsS_4 .

Structure: **JR Wilson & 3 others** 1993 AM 78 1096-103.

farallonite $?2\text{MgO} \cdot \text{W}_2\text{O}_5 \cdot \text{SiO}_2 \cdot n \text{aq}$. Alteration product of wolframite.

?Characterization & structure.

Occurrence: MM 30 732.

farneseite $(\text{Na,K})_{46}\text{Ca}_{10}\text{Al}_{42}\text{Si}_{42}\text{O}_{168}(\text{SO}_4)_{11} \cdot 3\text{aq}$.

Cancrinite mineral group: ABCABABACBACAC-14-layer type.

Occurrence & SC-XRD structure: **F Camara & 3 others** 2005 EJM 17 839-46 = AM 91 1454.

farringtonite $\text{Mg}_3(\text{PO}_4)_2 \cdot \text{l}$. *Graftonite* structure group.

Structure: **LH Fuchs E Olsen E Gebert** 1973 AM 58 949-51;

AG Nord T Ericsson 1985 AM 70 624-9.

Occurrence: MM 33 1132.

High-P transition to *phase II sarcopside* structure: **F Brunet D Vielzeuf** 1996 EJM 8 349-54 (B1508);

& *synthetic phase III*: **S Jaulmes Elfakir & 3 others** 1997 JSSC 129 341-5 (J268).

In meteorites: **AE Rubin** 1997 MPS 32 231-47.

[*Synthetic* $\gamma\text{-Zn}_2\text{Co}(\text{PO}_4)_2$ & $\text{Zn}_{1.5}\text{Co}_{1.5}(\text{PO}_4)_2$: **AG Nord** 1984 AC B40 191-4.

(Mg,metals)₃(PO₄)₂: cations vs 5- & 6-coordinated sites, **AG Nord T Stefanidis** 1980 MRB 15 1183-91.

Synthetic (Co,Fe)₃(PO₄)₂: MA 87M/3986.]

[fassaite (renamed *diopside* or *augite*, MR 30 175) Ca(Mg,Ti,Al)(Al,Si)₂O₆.

Ferrian aluminian diopside-augite member of pyroxene group.

MA 73-3460; AM 58 230-42.

In meteorites: **AE Rubin** 1997 MPS 32 231-47; includes *Sc-fassaite*

V-, 2003 MPS 38 407-17.]

faujasite ~ $(\text{Na}_2, \text{Ca}, \text{etc.})_{30}\text{Al}_{60}\text{Si}_{132}\text{O}_{384}\text{.aq}$. *Zeolite* mineral group. Type FAU.

The natural mineral has a narrow range of Al/Si near above value.

Wide range of synthetic and ion-exchanged analogs including Linde X & Y zeolites that dominate the petroleum catalysis/adsorption industry. As-synthesized materials display a complete solid solution from

Al-rich synthetic Linde X (Na₉₆₋₇₇Al₉₆₋₇₇Si₉₆₋₁₁₅O_{384.n} aq) to

Si-rich synthetic Linde Y (Na₇₆₋₄₈Al₇₆₋₄₈Si₁₁₆₋₁₄₄O_{384.n} aq).

Dealumination techniques have generated *ultra-silicic* material with negative thermal expansion from 25 to 573 K: **MP Attfield AW Sleight** 1998 ChC 601-2 (A816).

The faujasite structure can be obtained from the *diamond* structure (ABC type of stacking) by replacing each C atom by a truncated octahedron (*toc*) of linked tetrahedra, and joining them by hexagonal prisms.

The *synthetic* zeolite *EMT* (AB stacking) is similarly related to *lonsdaleite*; the {111} twin of faujasite has an AB interface.

Synthetic ZSM-3 is faulted ABC/AB: **GT Kokotailo J Ciric** 1971 Adv Chem Ser 101 109-21.

In the AlPO₄ family, type 37 has the FAU structure type.

The huge literature on structure characterization is organized under three headings:

- *reviews & general matters including crystal-chemical theories & de-alumination*
- *natural mineral*
- *synthetic & ion-exchanged materials.*

The third heading is subheaded in order of atomic number of the exchangeable cation or tetrahedral substituent or sorbed metal complex. In addition to diffraction methods, various other structure-revealing techniques are referenced. Entries are in chronologic order in each section. The filing code in jvs files is given in brackets. See *Zeolite* for further information.

Reviews & general matters, including crystal-chemical theories & dealumination:

Divalent cation distribution vs residual water in faujasite-type zeolites: **E Dempsey DH Olson** 1970 JPC 74 305-7.

Ultrastable heated ammonium-exchanged Y, XRPD: **PK Maher FD Hunter J Scherzer** 1971 Adv Chem Ser 101 266-78.

Review of positions of cations & sorbed molecules in structures published up to 1970: **JV Smith** 1971 Adv Chem Ser 101 171-200 (S1520).

CNDO, electronic structure of faujasite-type framework: **WJ Mortier P Geerlings** 1980 JPC 84 1982-6;

Nature of disorder in supercages of hydrated Na-X: **B Beagley J Dwyer** 1981 Z 1 69-71 (B763).

²⁹Si MAS NMR: faujasite zeolites, **G Engelhardt & 4 others** 1981 ZaaC 482 49-64 (E227);

synthetic Y-X series & Si/Al ordering, **S Ramdas & 4 others** 1981 N 292 228-30 (R399);

dealuminated & ultrastable Y, **G Engelhardt & 5 others** 1982 Z 2 59-62 (E232);

dealuminated, tetrahedral & octahedral Al, **J Klinowski & 3 others** 1982 N 533-6 (9388).

Dependence of ²⁹Si NMR: of dealuminated Y upon degree of NH₄ exchange, temperature &

water vapor pressure of thermochemical treatment, **G Engelhardt V Patzelova**

M Magi E Lippmaa 1983 Z 3 233-8 (E230);

on Si/Al (2.5 to 5.8) & type of dealumination, **G Engelhardt & 4 others** 1983 Z 3 239-43 (E231).

Twinning in Na- & La-Y: **M Audier & 4 others** 1982 JPC 86 581-4.

Non-framework structural disorder/variability, hydrated Na-X: **B Beagley & 4 others** 1982 Z 2 167-7 (B764).

Quantum-mechanical calculations for Li-, Na- & K-faujasites: **S Beran** 1982 JPCS 43 221-5.

Compilation of Extra Framework Sites in Zeolites, **WJ Mortier** 1982 Butterworth Scientific, 19-31.

Theoretical Al distribution & acidity: **B Beagley & 4 others** 1984 JPC 88 1744-51 (B775).

NPD, calcined dealuminated Y (Al₅₂₋₁₉Si₁₄₀₋₁₇₃): **JB Parise & 3 others** 1984 AC C40 1493-7 (P578).

Industrial consequences of chemical effects dependent on cation locations in faujasite-type zeolites: **JB Uytterhoeven** 1984 Proc 6th Intern Zeolite Conf, Butterworths, 49-55 (U26).
Far-IR: **MD Baker J Godber GA Ozin** 1985 JChS 107 3033-43.
Radial distribution functions, H-Y & H-Y dehydroxylated in vacuo 923K & in steam 1163K: **RD Shannon & 5 others** 1985 JPC 89 4778-88.
NMR & IR of Na-Y dealuminated with SiCl₄: **PJ Grobet PA Jacobs HK Beyer** 1986 Z 6 47-50.
²⁹Si & ²⁷Al NMR/XRPD, steamed ultrastable Y: **GJ Ray BL Meyers CL Marshall** 1987 Z 7 307-10 (R378).
Laser-induced fluorescence, far-IR/luminescence quenching: **MD Baker GA Ozin MM Olken** 1988 JChS 110 5709-14.
XRPD/MAS-NMR, structural evolution, dealumination of Y: **L Aouali & 4 others** 1988 Z 8 517-22.
IR & ²⁹Si NMR (Bloch decay/cross-polarization), dealuminated Na-Y: **GJ Ray & 2 others** 1988 Z 8 458-63 (R400).
Position of saturated hydrocarbons in Y: **S Yashonath JM Thomas AK Nowak AK Cheetham** 1988 N 331 601-4 (Y84).
Review of cell dimension vs. Si/Al: **GT Kerr** 1989 Z 9 350-1.
²⁹Si NMR, alkali-/alkaline earth/RE-exchanged Y, **K-J Chao J-Y Chern** 1989 JPC 93 1401-4 (C588).
Molecular dynamics, position/mobility benzene Na-Y: **P Demontis S Yashonath ML Klein** 1989 JPC 93 5016-9 (D406).
²⁹Si & ²⁷Al MAS NMR of hydrothermally dealuminated Y, **PJ Grobet H Geerts M Tielen JA Martens PA Jacobs** 1989 in HG Karge J Weitkamp ed *Zeolites as Catalysts, Sorbents & Detergent Builders*, 721-34 (G593).
²⁷Al quadrupole nutation, 4 kinds of Al, dealuminated Y: **H Hamdan J Klinowski** 1989 JCSOC 240-2 (H752).
²⁹Si MAS NMR/IR/XRPD, de- & re-aluminated Y: **H Hamdan B Sulikowski J Klinowski** 1989 JPC 93 350-6 (H749).
XRPD/FT-IR, Si/Al 1.1 to 1000: **F Ficht-Schmittler & 3 others** 1990 ZPC 271 69-79.
Dealuminate Na-Y, EDTA 293/373 K, IR framework vibrations: **LS Kosheleva TI Titova** 1993 Izv Akad Nauk Khim 655-9.
Hydrothermal dealumination NH₄Na-Y, IR: **SP Zhdanov & 3 others** 1993 Izv Akad Nauk Khim 660-4.
XPS methylene blue inside SAPO-37: **R Hoppe & 4 others** 1993 Z 13 222-8 (206).
Thermal stability TPA/TMA inside SAPO-37: **M Briend & 4 others** 1993 Z 13 201-11 (217).
Si/Al ordering, XRPD/IR/²⁹Si, ²⁷Al & ²³Na MAS-NMR, as-synthesized X & EMT & dealuminated materials: **K Chao & 3 others** 1994 MiMo 2 91-104.
Speculation on Si/Al order & chiral Y: **T Takaishi** 1995 JPC 99 10982-7 (T441).
Faujasites/EMT, synthesis/dealumination: **U Lhose & 4 others** 1995 Appl Catal A 129 189-202.
Simulated annealing of Al/Si distribution: **D Ding B Li P Sun Q Jin J Wang** 1995 Z 15 569-73.
FT Raman of framework vibrations of Na-Y vs. exchangeable cations, hydration, & adsorbed molecules incl. pyridine, **R Ferwerda JH van der Maas** 1995 Spectr Acta A51 2147-59.
Model for Al/Si distribution based on local Al avoidance: **AJ Vega** 1996 JPC 100 833-6 (V242).
Al/Si order, FAU & EMT crystallized with crown ethers: **EJP Feijen & 5 others** 1996 JPC 100 4970-5 (F486).
Perdeuterated Na-X & -Y, ²H NMR & molecular mechanics: **SM Auerbach & 4 others** 1996 JPC 100 5923-30 (A685).
2 new tetrahedral Al sites in NH₃-treated steamed Y, ²⁷Al MASNMR: **X Yang RE Truitt** 1996 Z 16 249-53.
Accelerated nucleation & growth by chelators, no Si/Al influence: **T Lindner H Lechert** 1996 Z 16 196-206.
Cu-histidine complexes in Na-Y mimicking Cu enzymes: **BM Weckhuysen & 6 others** 1995 AnCh 34 2652-4 (W732).
Crown ether template vs. FAU/EMT growth: **T Ohsuna & 6 others** 1996 PRSL A452 715-40.
Al distribution from molecular dynamics, NMR simulation/ND/graphics: **H Hiroaki & 7 others** 1996 MiMa 7 235-42.
High-resolution ¹⁷O NMR study of siliceous: **LM Bull & 11 others** 1998 JChS 120 3510-1.
²⁷Al/¹H TRAPDOR NMR on dealuminated: **F Deng Y Yue C Ye** 1998 Solid State Nucl Magn Reson 10 151-60.
Heterogeneous Brønsted acid sites vs. Al: **M Sierka & 3 others** 1998 JPCB 102 6397-404 (S1970).
Mesopores 20 nm in dealuminated Y, TEM: **Y Sasaki & 4 others** 1998 JCa 178 94-100 (S1964).
Reversible tetrahedral/octahedral transform in Y: **BH Wouters T Chen PJ Grobet** 1998 JChS 120 11419-25 (W935).
Oriented FAU films on micrometer EMT: **AM Goossens & 3 others** 1999 AdM 11 561-4 (G1163).
H & Al multiple-quantum MAS-NMR, SAPO-37: **T Chen BH Wouters PJ Grobet** 1999 JPC B103 6179-84.
Al K-edge NEXAFS of minerals, including Y: **JA van Bokhoven & 3 others** 1999 JPC B103 7557-64 (V350).
REAPDOR NMR of Si cluster in Y: **Y Ba J He I Ratcliffe JA Ripmeester** 1999 JChS 8387-8 (B1950).
Dielectric properties, X & Y during dehydration: **A Abdoulaye & 5 others** 2000 MMM 34 317-25 (A921).
H NMR, rehydrated dealuminated H-faujasites: **V Semmer-Herledan & 6 others** 2000 MMM 34 157-69 (S2158).
Fabrication of ordered porous structures, self-assembly of nanocrystals: **L Huang & 6 others** 2000 JChS 122 3530-1.
Energetics of formation/hydration, ion-exchanged Y: **S Yang A Navrotsky** 2000 MMM 37 175-86 (Y266).
Epitaxy, X on LTA, & twinning: **F Porcher Y Dusausoy M Souhassou C Lecomte** 2000 MM64 1-8.
Effect of stirring, synthesis FAU-Y & EMT polymorph: **N Hanif & 3 others** 2000 PCCP 2 3349-57 (H1479).
Steamed H-Y = USY, MQMAS-NMR 4 Al sites: **CA Fye JL Bretherton LY Lam** 2000 ChC 1575-6 (F708).
Growth/characterization, X in low earth orbit: **J Warzywoda & 3 others** 2000 JCG 220 140-9 (323); **J Warzywoda et al** 150-60 (324).
Dealuminated stabilized Y, effects of leaching agent, XRPD/MAS-NMR: **A Gola & 7 others** 2000 MMM 40 73-83 (224).
Biphenyl sorption on nonacidic Y, spectroscopy/models: **I Gener & 3 others** 2000 JPCB 104 11656-66 (678).

Microporous carbon synthesized with Y template: **Z Ma T Kyotani A Tomita** 2000 ChC 2365-6.
 Benzene adsorption (111) surface, theory: **L Whitmore B Slater CRA Catlow** 2000 PCCP 2 5354-6.
 UV Raman, synthesis mechanism of X: **G Xiong & 5 others** 2000 MMM 42 317-23 (987).
 Loss of long-range order by chemical treatments, 46 SC-XRD structures: **D Bae K Seff** 2001MMM 42 299-306 (985).
 Transient Al species during steaming, NMR: **BH Wouters T Chen PJ Grobet** 2001 JPC B 1135-9 (1269).
 Xylene dynamics, X, effect of cations, quasi-elastic neutron scattering: **H Jobic & 3 others** 2001 MMM 42 135-55 (980).
 Mesopores in dealuminated Y, TEM: **AH Jansen AJ Koster KP de Jong** 2001 AnCh 40 1102-6.
 Proton mobility, modeling: **M Sierka J Sauer** 2001 JPC B 105 1603-13 (1729).
 OH in steamed HNa-Y, FTIR: **O Cairon K Thomas T Chevreau** 2001 MMM 46 327-40 (2311).
 Calorimetry of synthesis: **S Yang A Navrotsky BL Phillips** 2001 MMM 46 137-51 (2310).
 Acid-base characterization, cation-exchanged X/Y by methylamine, IR: **F Docquir H Toufar BL Su** 2001 La 17 6282-8.
 Type V adsorption isotherm, methanol/hydrophobic dealuminate Y: **I Halasz S Kim B Marcus** 2001 JPCB 105 10788-96.
 Pyrrole/(LiNa/Na/KNa/CsNa), IR /NMR: **M Sanchez-Sanchez T Blasco** 2002 JChS 124 3443-56 (7047).
 Ultrastable Y, ²⁹Si & ²⁷Al NMR: **KU Gore & 5 others** 2002 JPCB 106 6115-20 (7382).
 Na-X, synthesis 20-800 nm crystals, XRD/SEM/FT-IR/NMR: **B Zhan & 6 others** 2002 ChM 14 3636-42 (7921).
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NPD: Yb-Y isomerization catalyst, p-perdeuterioxylylene, **M Czjzek T Vogt H Fuess** 1989 AnCh 101 786-7;

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Structure: **GV Sokolova & 3 others** 1983 SPC 28 95-6 (S1328);

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Occurrence: MM 36 1150.

fedorovskite $\text{Ca}_2(\text{Mg,Mn})_2\text{B}_4\text{O}_7(\text{OH})_6$. Series with Mn analog *roweite*.

Structure determination not found.

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fedotovite $\text{K}_2\text{Cu}_3\text{O}(\text{SO}_4)_3$. Compare with *euchlorine*.

Structure: **GL Starova & 3 others** 1991 MM 55 613-6.

Occurrence: MM 52 724.

feinglosite $\text{Pb}_2(\text{Zn,Fe})(\text{AsO}_4)$.aq. *Brackebuschite* structure group from XRPD.

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feitknechtite MnOOH -beta. Trimorphic with *groutite* (alpha) & *manganite* (gamma).

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Occurrence: **O Bricker** 1965 AM 50 1296-354.

[*hydrohausmannite* is mixture with *pyrochroite*.]

feklischevite $\text{Na}_{12}\text{Ca}_9\text{Fe}_2\text{Zr}_3\text{NbSi}_{25}\text{O}_{73}(\text{OH},\text{aq},\text{Cl},\text{O})_5$. *Eudialyte* group.

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FELDSPAR MINERAL / STRUCTURE GROUP Includes

<i>albite</i>	$\text{NaAlSi}_3\text{O}_8$
<i>alkali feldspar series</i>	
<i>anorthite</i>	$\text{CaAl}_2\text{Si}_2\text{O}_8$
<i>anorthoclase</i>	$(\text{Na},\text{K},\text{Ca})\text{AlSi}_3\text{O}_8$
<i>buddingtonite</i>	$\text{NH}_4\text{AlSi}_3\text{O}_8$
<i>celsian</i>	$\text{BaAl}_2\text{Si}_2\text{O}_8$
<i>dmisteinbergite</i>	$\text{CaAl}_2\text{Si}_2\text{O}_8$
<i>filatovite</i>	$\text{K}(\text{Al},\text{Zn})_2(\text{As},\text{Si})_2\text{O}_8$
<i>hyalophane</i>	
<i>kokchetavite</i>	KAlSi_3O_8
<i>microcline</i>	KAlSi_3O_8
<i>orthoclase</i>	KAlSi_3O_8
<i>plagioclase series: includes oligoclase, andesine, labradorite, bytownite</i>	
<i>reedmergnerite</i>	NaBSi_3O_8
<i>sanidine</i>	$(\text{K},\text{Na})\text{AlSi}_3\text{O}_8$
<i>svyatoslavite</i>	$\text{CaAl}_2\text{Si}_2\text{O}_8$.

There are many complex phase transitions and types of domain and microscopic intergrowths.

In meteorites: **AE Rubin** 1997 MPS 32 231-47.

Two synthetic polymorphs of anorthite were later found as minerals:

hexagonal- $\text{CaAl}_2\text{Si}_2\text{O}_8$ *dmisteinbergite* & orthorhombic- $\text{CaAl}_2\text{Si}_2\text{O}_8$ *svyatoslavite*.

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Part 6 Occurrence

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felsöbanyaite $\text{Al}_4(\text{SO}_4)(\text{OH})_{10.4}\text{aq.} = \text{basaluminite}$.

Structure: **L Farkas F Pertlik** 1997 Acta Mineral Petrogr Szeged 38 5-15 = AM 83 1350.

Occurrence: 1950 MM 29 1-17;

S Koch I Sarudi 1965 AM 50 812.

fenaksite $\text{KNaFeSi}_4\text{O}_{10}$. Near-isostructural with *litidionite* $\text{KNaCu}(\text{Si}_4\text{O}_{10})$.

Manaksite is Mn analog.

Structure: **VP Golovachev & 3 others** 1971 SPD 15 902-4 (G693);

SC-XRD, **IV Rozhdestvenskaya & 3 others** 2004 DES 398 1029-33 (10825).

Occurrence: MM 32 955;

isomorphic series with *manaksite*, **OA Ageeva** 2000 DES 373 A 927-9 (292).

fencooperite $\text{Ba}_6\text{Fe}_3\text{Si}_8\text{O}_{23}(\text{CO}_3)_2\text{Cl}_3\text{aq.}$

Structure: SC-XRD, **JD Grice** 2001 CM 39 1065-71.

Occurrence: **AC Roberts & 3 others** 2001 CM 39 1059-64.

fengluanite $\text{Pd}_5(\text{As,Sb})$.

Might be a variant of *isomertierite*: **Z Peng C Chang L Ximen** 1978 Acta Geol Sinica 4 326-36 =

AM 65 408 (commentary: XRPD will index on cubic cell except for 4 lines).

MM 40 907.

[fenhuanglite $(\text{Na,Ca,Ce,Th})_9(\text{P,Si})\text{O}_4$.

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.]

[Fe-pennantite MM 39 972.]

ferberite FeWO_4 . *Wolframite* structure group.

Based on $\alpha\text{-PbO}_2$ (*scrutinyite*) connectivity.

Isostructural series with *huebnerite* MnWO_4 .

Structure: **F Laves G Bayer A Panagos** 1963 SMPM 43 217-34;

XR&ND, **D Ülkü** 1967 ZK 124 192-219;

H Cid-Dresdner C Escobar 1968 ZK 127 61-72.

Synthetic CoWO_4 & NiWO_4 : **C Wilkinson MJ Sprague** 1977 ZK 145 96-107.

ferchromide / ferchromite $\text{Cr}_{1.5}\text{Fe}_{0.2}\text{void}_{0.3}$. Defect *halite* structure type.

Occurrence: AM 73 191; also FeCo analog.

ferdisilicite FeSi_2 . Matches *synthetic*.

Occurrence: **VKh Gevork'yan AL Litvin AS Povarennyk** 1969 AM 54 1737.

See *fersilicite*.

fergusonite-Ce $(\text{Ce,L a,Nd})\text{NbO}_4$. Deformed *scheelite* structure type.

Dimorphic with *fergusonite-beta-Ce*.

Crystal chemistry of complex Nb/Ta oxides: **J Graham MR Thornber** 1974 AM 59 1026-39.

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

fergusonite-Nd $(\text{Nd,Ce})\text{NbO}_4$. Deformed *scheelite* structure type.

Dimorphic with *fergusonite-beta-Nd*.

Crystal chemistry of complex Nb/Ta oxides: **J Graham MR Thornber** 1974 AM 59 1026-39.

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

fergusonite-Y $(\text{Y,Er,Ce,Fe})(\text{Nb,Ta,Ti})\text{O}_4$. Deformed *scheelite* structure type.

Dimorphic with *fergusonite-beta-Y*

Crystal chemistry of complex niobium & tantalum oxides: **J Graham MR Thornber** 1974 AM 59

Three polymorphs M, M' & T: review, **J Graham** 1974 AM 59 1045-6.
 General: **HP Rooksby AD White** 1963 AC 16 888-90 (R53).
 Natural & polymorph: **AI Komkov** 1960 SPC 4 796-800 (K640).
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
Synthetic M'-YT₂O₇: **GM Wolten** 1967 AC 23 939-44.
Synthetic M, T, M': **J Graham** 1974 AM 59 1045-6;
LN Kinzhibalo & 3 others 1982 SPC 27 22-5 (K647).
Synthesis & second polymorph: **GM Wolten AB Chase** 1967 AM 52 1536-41.
fergusonite-beta-Ce (Ce,La,Nd)NbO₄. Deformed *scheelite* structure.
 Matches *synthetic*: XRPD 14-501,596,597.
 Occurrence: **C-T Kuo et al** 1975 AM 60 485;
 alkaline pegmatites, western Mongolia: **GV Andreev GS Ripp EA Dambura** 1994 ZVMO
 123 68-72.

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
fergusonite-beta-Nd (Nd,Ce)NbO₄. Deformed *scheelite* structure.
 Occurrence: **W Sun F Ma S Zhuang** 1983 Sci Geol Sinica 78 = AM 69 406.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
fergusonite-beta-Y YNbO₄. Deformed *scheelite* structure.
 Dimorphic with *fergusonite*.
 Structure: **RB Ferguson** 1957 CM 6 72-?.
 Occurrence: MM 33 1132.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
Synthetic M-fergusonite YNbO₄: **H Weitzel H Schröcke** 1980 ZK 152 69-82 (W694).
Synthetic YNbO₄ = monoclinic-beta: **VK Trunov & 3 others** 1981 SPC 26 35-7.
Synthetic (La/Sm/Gd/Ho/Yb)NbO₄: **LN Kinzhibalo & 3 others** 1982 SPC 27 22-5.

fermorite (Ca,Sr)₅(As,PO₄)₃OH. *Apatite* structure type.
 Structure: **JM Hughes JW Drexler** 1991 NJMM 327-36 (H976).

fernandinite CaV⁴⁺₂V⁵⁺₁₀.14aq. *Vanadium bronze* structure type; *straczekite* subtype.
 Review: **HT Evans Jr JM Hughes** 1990 AM 75 508-21.
 Structure: **HT Evans Jr & 3 others** 1994 CM 32 339-51.

feroxyhyte FeOOH-delta'.
 Distinction made between disordered nonmagnetic and ordered magnetic: literature citations,
CB Koch & 5 others 1995 PCM 22 333-41(K766).
 Definition: MM 42 523-4.
 Polymorphic with *akaganeite-beta*, *goethite-alpha* & *lepidocrocite-gamma*.
 Structure: **MH Francombe HP Rooksby** 1959 Clay Minerals Bulletin 4 1-14;
S Okamoto 1968 JACeS 51 594-9;
W Krakow H Colijn O Muller 1980 JMS 15 119-26;
G Patrat & 3 others 1983 AC B39 165-70;
VA Drits BA Sakharov A Manceau 1993a,b CIM 28 185-208, 209-22 (D688).
 Occurrence in meteorites: **AE Rubin** 1997 MPS 32 733-4.

ferrarisite Ca₅H₂(AsO₄)₄.9aq. Dimorphic with *guerinite*.
 Compare with *picroparmacolite*.
 Structure: **M Catti G Chiari G Ferraris** 2980 BM 103 541-6 (C749).
 Occurrence: MM 46 518.

ferriallanite-Ce CaCeFe²⁺AlFe³⁺(SiO₄)(Si₂O₇)O(OH). *Epidote* group.
 Occurrence, SC-XRD structure, Mössbauer: **PM Kartashov & 4 others** 2002 CM 40 1641-8.
 Occurrence: Sweden, **D Holtstam UB Andersson J Mansfield** 2003 CM 41 1233-40.

ferri-annite K(Fe,Mg)₃(Fe,Al)Si₃O₁₀(OH)₂. *Mica* structure group; trioctahedral 1M subtype.
 Structure: *synthetic*, SC-XRD, 100/270 K, **GJ Redhammer G Roth** 2004 ACC 60 i33-6 (10257).
 Occurrence: MM 37 957;
T Miyano S Miyano 1982 AM 67 1179-94.
Synthetic all-ferric: MM 37 957.

ferri-barroisite *Amphibole*. MM 42 524.

ferri-clinoferroholmquistite $\text{Li}_2\text{Fe}^{2+}_3\text{Fe}^{3+}_2\text{Si}_8\text{O}_{22}(\text{OH})_2$
Occurrence & structure: **R Oberti & 3 others** 2003 CM 41 1345-54.

ferri-clinoholmquistite $\text{Li}_2(\text{Fe}^{2+}, \text{Mg})_3 \text{Fe}^{3+}_2\text{Si}_8\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; monoclinic subtype.
Occurrence & structure: **JM Caballero & 3 others** 1998 AM 83 167-71.
Synthesis & characterization: **G lezzi & 3 others** 2003 EJM 15 321-8.

ferricopiapite $\text{Fe}^{3+}\text{Fe}^{3+}_4(\text{SO}_4)_6\text{O}(\text{OH})_{20}\text{aq}$. *Copiapite structure group*.
Review: **Sabelli** p. 20.
Structure: **L Fanfani & 3 others** 1973 AM 58 314-22;
P Bayliss D Atencio 1985 CM 23 53-6.

[**ferridravite** (renamed *povondraite*, MR 30 175) $(\text{Na}, \text{K})(\text{Mg}, \text{Fe})_3\text{Fe}_6(\text{BO}_3)_3\text{Si}_6\text{O}_{18}(\text{O}, \text{OH})_4$.
Tourmaline structure type.
Equals *povondraite*: **JD Grice TS Ercit FC Hawthorne** 1993 AM 78 433-6.
Occurrence: **K Walenta PJ Dunn** 1979 AM 64 945-8.]

ferrierite $\sim(\text{Na}, \text{K})_2\text{MgAl}_3\text{Si}_{15}\text{O}_{36}(\text{OH})_{9\text{aq}}$. *Zeolite mineral group*. IZA-SC code FER.
Consortium for Theoretical Frameworks net 600.
Structure: **PA Vaughan** 1966 AC 21 983-90;
IS Kerr 1966 N 210 294-5;
faults, **R Gramlich-Meier WM Meier BK Smith** 1984 ZK 169 201-10 (G815);
monoclinic variety, possibly related to Mg content, **R Gramlich-Meier V Gramlich WM Meier** 1985 AM 70 619-23 (G484);
faults, **BK Smith** 1986 AM 71 989-98;
statistical & true symmetry, **A Alberti C Sabelli** 1987 ZK 178 249-56 (A449);
TEM of planar defects, **SB Rice** 1995 AM 80 930-6;
modeling & defects, **AA Sokol CRA Catlow** 1997 NATO ASI Ser 3 22 125-35;
oxygen tetramers, **T Takaishi T Okada K Nonaka** 1997 JCSF 93 1251-5;
sorption & ^{13}C NMR, linear alkanes, **WJM van Well & 7 others** 1998 JPCB 102 3945-51;
molecular simulations of absorption of linear alkanes, effect of chain length, **do & 4 others** 1998 JPCB 102 3952-8 (V306), 1998 AnCh 37 1081-3 (V308);
FTIR of acid sites, **VL Zholobenko DB Lukyanov J Dwyer** 1998 JPCB 102 2715-21;
synthesis, structure and absorption, **M Ma H Jiang Y Long Y Sun** 1998 Huaxue Xuebao 56 405-16 = CA 128:275630n;
synthetic low-Si, neutron PD, location of Brønsted sites, **A Martucci & 5 others** 1999 MMM 30 95-101 (M1752);
FTIR of water in H-, **B Lee & 3 others** 1999 J Mol Catal A Chem 137 269-72;
VIS diffuse reflectance spectroscopy of Co-exchanged, **D Kaucky J Dedecek B Wichterlova** 1999 MMM 31 75-87 (K1195);
synthetic ferrierite & TON, sorption & ordering of dibranched alkanes, IR etc, **JAZ Pieterse & 3 others** 2000 JPCB 104 5715-23 (P887);
Si-rich ferrierite, O & Si NMR, **LM Bull & 7 others** 2000 JChS 122 4948-58 (B2015);
do, thermal expansion, SC-P-XRD, MAS-NMR, **do & 6 others** 2003 JChS 125 4342-9;
synthetic with anion surfactant, to ~1273 K, **RK Ahedi & 4 others** 2001 JCIS 236 47-51;
do nonionic surfactants, **RK Khomane BD Kulkarni RK Ahedi** 2001 JCIS 236 208-13;
Kamloops Lake, SC-XRD, I222, **Y Yokomori & 2 others** 2001 MMM 50 137-43 (3976);
synthetic B-, SC-XRD, **G Perego & 4 others** 2002 MMM 56 193-202 (8273);
divalent metal cations, density functional theory: **SA McMillan & 3 others** 2004 MMM 68 45-53 (10045).

From drillhole KR-1, Slovakia: **E Samajova P Fejdi** 1994 Geol Carpathica-Clays 45 93-8 = MA 95M/4675.

From Hokkaido: **S Matsubara & 3 others** 1996 MJJ 18 147-53 (M1449).
Synthetic zeolite Sr-D: **RM Barrer DJ Marshall** 1965 AM 50 484-9.
Synthetic Na/K- : **WE Cormier LB Sand** 1976 AM 61 1259-66.
Synthetic Al,Fe-: **S Ueda M Itagaki M Koizumi** 1988 Clay Science 7 185-92.
Synthetic Na, tetra-methyl-ammonium-: **H Fjellvaag KP Lillerud K Soerby** 1989 Z 9 152-8.

Synthetic Ga-: **B Sulikowski J Klinowski** 1989 JCSOC 1289-90 (S1018).
Synthetic K-exchanged, NPD: **LJ Pickering & 3 others** 1989 JCa 119 261-5 (P388).
Synthetic Al-free: **H Gies RP Gunarwardane** 1987 Z 7 442-5 (G551).
Synthetic Si-, XR & NPD: **RE Morris & 6 others** 1994 JChS 116 11849-55 (M1206).
Synthetic Kr-sorbed: **RH Jones P Lightfoot RM Ormerod** 1995 JCSOC 783-4.
Synthetic layered aluminosilicate precursor to FER: **L Schreyeck & 3 others** 1995 ChC 2187-8.
 Structure-directing effects in *synthesis* of ferrierite & dodecasil-3C in presence of HF/pyridine & propylamine: **SJ Weigel & 6 others** 1996 JChS 118 2427-35 (W743).
Synthetic with HF/pyridine & 1-amino-n-propane plus calcined: **JE Lewis Jr CC Freyhardt M Davis** 1996 JPC 100 5039-49 (L729).
Synthetic with Si/Fe = 11: **RB Borade A Clearfield** 1996 ChC 2267-8 (B1523).
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Synthetic as synthesized & dealuminated, XRPD & IR: **K Vinje & 3 others** 1997 CI 69 315-24.
Synthetic /para-xylene, XRPD/computation: **ZA Kaszkur & 4 others** 1996 Mol Phys 89 1345-57.
Synthetic Si/Al 18, 50 & 80 with propylamine & pyridine, near-IR FT Raman & multinuclear NMR:
A Davidson & 3 others 1997 JPCB 101 3065-71 (D637).
Synthesis in glycerol: **S Yang AG Vlessidis NP Evmiridis** 1997 MiMa 9 273-86.
Synthetic high-silica: **H Jongkind & 4 others** 1997MiMa 10 149-61.
Synthetic Cu_{0.02}Al_{0.065}Si_{0.935}O₂, XRPD/ESR: **MP Atfield SJ Weigel AK Cheetham** 1997 JCa 172 274-80 (A807).
Synthetic membrane: **N Nishiyama & 3 others** 1997 MiMa 12 293-303.
Synthetic ferri-: **S Shevade RK Ahedi AN Kotasthane** 1997 Catal Lett 49 69-75.
Synthetic Mn/Mg/Ni/Co-exchanged Na-, FTIR: **Z Sobalik Z & 2 others** 1998 JPCB 102 1077-85.
Synthetic NH₄/Na, MQ-MAS-NMR: **P Srav B Wichterlová J Cejka** 1998 JPCB 102 1372-3.
Synthetic, FTIR character of acid sites: **VL Zholobenko & 3 others** 1998 JPCB 102 2715-21.
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Synthetic Na- & Mn-, Co/Cu to elucidate bonding: **Z Sobalik & 3 others** 1998 MMM 21 525-32.
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Synthetic Ni-exchanged, hydrated & dehydrated, XRPD structure: **MC Dalconi & 4 others** 2000 MMM 39 423-30 (216).
 Modeling of Cu(I): **P Nachtigall M Davidova D Nachtgallova** 2001 JPCB 105 3510-7 (1661).
 [MCM-47 has ferrierite layers linked differently, XRPD structure & NMR: ChM 12 2936-42 (360).]
Synthetic ammonium, with Co(II), ESCA: **I Jirka** 2001 JPCB 1140-8 (1282).
Synthetic Ni(I)-, ESR: **H Choo SB Hong L Kevan** 2001 JPCB 105 1995-2002 (1429).
 [Synthetic ITQ-6 made from delaminated precursor to FER, electrostatic/covalent immobilization of enzymes: **A Corma & 6 others** 2001 CC 419-20 (1734).]
Synthesis from delaminated PREFER: **A Corma & 3 others** 2000 JChS 122 2804-9 (3605).
 Solid-state recrystallization of Al-bearing *kanemite* to ferrierite: **G Pál-Borbély A Szegedi HK Beyer** 2000 MMM 35-36 575-84 (3607).
 Co-exchanged ZSM-5, ferrierite & *mordenite*, XAS, UV-Vis & IR: **L Drozdova & 4 others** 2002 JPCB 106 2240-8 (7052).
Synthetic Fe-, decomposition of N₂O vs dehydration: **J Nováková & 3 others** 2004 Catal Lett 98 123-6 (10834).
GBF Seijger & 5 others 2002 *In situ preparation of ferrierite coatings on structured metal supports*, MMM 56 33-45 (8139).
MC Dalconi & 4 others 2003 *Siting and coordination of cobalt in ferrierite: XRD and EXAFS studies at different loadings*, MMM 62 191-200 (9229).
SA McMillan RQ Snurr LJ Broadbelt 2003 *Origin and characteristics of preferential adsorption on different sites in cobalt-exchanged ferrierite*, JPCB 107 13329-35 (9606).
MC Dalconi A Alberti G Cruciani 2003 *Cation migration and structural modification of Co-exchanged ferrierite upon heating: a time-resolved powder diffraction study*, JPCB 107 12973-80 (9525).
ferrihydrite Fe₁₀O_{15.9aq}.
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 superparamagnetic relaxation in nanoscale particles, **J Zhao** 1996 PRB 54 3403-7.

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 do., **J O Nriagu** ed 1994 Wiley NY;
 As in marine environment, **W Maher E Butler** 1988 Appl Organometallic Chem 2 191-4;
 As removal from geothermal fluids by adsorptive bubble flotation on ferric hydroxide
 colloid, **EH De Carlo DM Thomas** 1985 EST 19 538-44;
 drinking water, **JG Hering & 3 others** 1997 J Environmental Engineering Aug 800-7;
 arsenite & arsenate adsorption, **KP Raven A Jain RH Loeppert** 1998 EST 32 244-9.
 Occurrence & constitution, natural & *synthetic*: **JL Jambor JF Dutrizac** 1998 ChR 98 2549-85.
 Occurrence in soils, review: **CW Childs** 1992 Z Pflanzenernahrung u. Bodenkunde 155 441-8.
 Structure: **RA Eggleton RW Fitzpatrick** 1988 CICIM 36 111-24;
A Manceau J-M Combes G Calas 1990 CICIM 38 331-4 (M1185);
A Manceau VA Drits 1993 CIM 28 165-84;
VA Drits BA Sakharov AL Salyn A Manceau 1993 CIM 28 185-207 (D687).
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 XAFS, various precipitation & drying, **J Zhao & 3 others** 1994 CICIM 42 737-46 (Z88);
 arsenate sorbed on ferrihydrite & crystalline FeOOH, reevaluation of EXAFS, **GA
 Waychunas JA Davis CC Fuller** 1995 GCA 59 3655-61;
 WAXS, **GA Waychunas & 3 others** 1996 GCA 60 1765-81;
 surface structure model, **A Manceau WP Gates** 1997 CICIM 45 448-60 (M1562);
 aqueous Zn sorption, EXAFS: **GA Waychunas CC Fuller JA Davis** 2002 GCA 66 1119-
 37 (6990).
 XPS for Si: **M Soma & 4 others** 1996 Clay Science 9 385-91.
 Arsenate adsorption: kinetics/coprecipitation, **CC Fuller & 2 others** 1993 GCA 57 2271-82;
 arsenite (low pH) & arsenate (high pH), surface charge reduction, application to soil: **A
 Jain KP Raven RH Loeppert** 1999 EST 33 1179-84 (381).
 Mössbauer & Fe isotopic exchange: **BA Rea JA Davis GA Waychunas** 1994 CICIM 42 23-34.
Synthetic 2- & 6-line, TEM: **DE Janney JM Cowley PR Buseck** 2000 CICIM 48 111-9 (J368);
 2-line, electron nanodiffraction, do. 2000 AM 85 1180-7;
 6-line, electron nanodiffraction, **DE Janney JM Cowley PR Buseck** 2001 AM 86 327-35;
 2-line, HRTEM freeze-dried/ untreated, **C Greffie & 2 others** 2001 CIM 36 381-7 (3069);
 Mössbauer 4 K, **U Schwertmann J Friedl A Kyek** 2004 CICIM 52 221-6 (10227);
 magnetometry, **DG Rancourt & 2 others** 2004 AM 89 987-97.
 Changes in transition and heavy metal partitioning during aging, TGA & XRPD: **RG Ford PM
 Bertsch KJ Farley** 1997 EST 31 2028-33 (F592).
 Al-hematite from, 293 K pH 4-7: **U Schwertmann & 3 others** 2000 CICIM 48 159-72 (S2181).
 Adsorption of 3 imidazolinone herbicides: **P Leone & 3 others** 2001 JAFC 49 1315-20 (1402).
 Pb- & Cu- sorption, with fulvic acid, XAS, XR microscopy: **AC Scheinost & 3 others** 2001 EST 35 109-6.
 Kinetics of dissolution: **O Larsen D Postma** 2001 GCA 65 1367-79 (1619).
 As-rich hydrous ferric oxide, island off Papua New Guinea, surface complexation in color-banded ferrihydrite, XRPD,
 TEM, XRF, visible-IR, Mössbauer, SQUID: **DG Rancourt & 6 others** 2001 AM 86 834-51.
 Green rust to ferrihydrite, effect of orthophosphate on oxidation products of Fe(II)-Fe(III)
 hydroxycarbonate: **O Benali & 2 others** 2001 GCA 65 1715-26.
 Solubility: **J Yu M Park J Kim** 2002 GJ 36 119-32 (7277).
 Sulfide oxidation/Fe dissolution, reaction with dissolved sulfide: **SW Poulton** 2003 ChG 202 79-94 (9863).
 Formation of *goethite* & *hematite* in presence of ZnS: **M Loan & 2 others** 2005 AM 90 258-61.
 Fe isotope exchange on nanoparticle: **RL Poulson & 2 others** 2005 AM 90 758-63.
 2-line to *goethite/hematite* at 277 to 298 K: **U Schwertmann & 2 others** 2004 CIM 39 433-8 (10918).
 Transformation rate to *goethite* via Fe(II): **NYee & 3 others** 2006 AM 91 92-6.
 Occurrence: MM 39 913;
 Clark Ford River Superfund Complex, **MF Hochella & 4 others** 2005 AM 90 718-24.
 In meteorites: **AE Rubin** 1997 MPS 32 231-47.
ferrikataphorite $\text{Na}_2\text{Ca}(\text{Mg},\text{Fe})_4\text{FeSi}_7\text{AlO}_{22}(\text{OH})_2$. *Amphibole* structure group.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52.
ferrilotharmeyerite $\text{Ca}(\text{Zn},\text{Cu})(\text{Fe},\text{Zn})(\text{AsO}_3\text{OH})_2(\text{OH})_3$. Ferric analog of *lotharmeyerite*.

Occurrence: **HG Ansell & 5 others** 1992 CM 30 225-7.
ferrimolybdate $?Fe_2Mo_3O_{12}.8aq.$
 XRPD: **E Horn & 3 others** 1995 PD 10 101-3.
 Occurrence: **PF Kerr AW Thomas AM Langer** 1963 AM 48 14-32.
 Synthesis: 1965 AM 50 223-6.
ferrinatrite $Na_3Fe(SO_4)_3.3aq.$ Review: **Sabelli** p.17.
 Structure: **K Mereiter** 1976 TMPM 23 317-27 (M1262);
F Scordari 1977 MM 41 375-83 (S1095A).
 Breakdown of Na,K- Maus' salt to ferrinatrite & *goldichite*: **F Scordari E Scandale** 1980 ZK 151 325-30 (S1458).
ferrilotolinite $NaLi(Mg_3Fe_2)Si_8O_{22}(OH)_2.$ *Amphibole* structure group.
 Occurrence & structure: **R Oberti & 2 others** 2004 AM 89 888-93.
ferripedrizite $NaLi_2(Fe_2Mg_2Li)Si_8O_{22}(OH)_2.$ *Amphibole* structure group.
 Occurrence & structure: **JM Caballero R Oberti L Ottolini** 2002 AM 87 976-82.
[ferriphlogopite $\sim K(Mg_{2.7}Fe_{0.3})[FeSi_3]O_{10}(OH)_{1.8}F_{0.1}.$
Mica structure group; name not approved.
 Structure: **MF Brigatti L Medici L Poppi** 1996 CICIM 44 540-5 (F512) = AM 82 430-1.]
ferripumpellyite MM 38 991.
ferripyrophyllite $Fe^{3+}_2Si_4O_{10}(OH)_2.$ Ferric analog of *pyrophyllite*.
 Structure determination not found.
 Occurrence: **FW Chukhrov et al** 1979 Chem Erde 38 324 = MM 46 518.
ferrisicklerite $Li(Fe^{3+},Mn^{2+})PO_4.$ Oxidized *sicklerite*.
Triphylite structure subgroup in *olivine* structure group.
 Structure: **A Alberti** 1976 AC B32 2761-4.
ferristrunzite $Fe^{3+}Fe^{3+}_2(PO_4)_2(OH)_2[aq_5(OH)_6].$ Oxidized *strunzite*.
 Occurrence: **DR Peacor PJ Dunn WB Simmons RA Ramik** 1987 NJMM 453-7.
ferrisurite $\sim (Pb,Ca)_2-3(CO_3)_{0.5-1}(Fe,Al)_2(Si,Al)_4O_{10}(OH)_2.$
Smectite/hydrocerussite interlayer structure. Ferric analog of *surite*.
 Occurrence: **AR Kampf & 4 others** 1992 AM 77 1107-11.
ferrisymplesite $Fe_3(AsO_4)_2(OH)_3.5aq.$ Amorphous
ferritaramite *Amphibole*. MM 42 524.
ferrilotolinite $NaLi(Mg_3Fe_2)Si_8O_{22}(OH)_2.$ *Amphibole* structure group.
ferritwhittakerite $Na(NaLi)(Mg_2Fe_2Li)Si_8O_{22}(OH)_2.$ *Amphibole* structure group.
 Occurrence & structure: **R Oberti & 2 others** 2004 AM 89 888-93.
ferritwinchite $NaCaMg_4FeSi_8O_{22}(OH,F)_2.$ *Amphibole*. MM 42 524.
 Occurrence: **AG Bazhenov & 3 others** 2005 ZVMO 134-3 74-7 = AM 91 1203.
ferritungstite $Ca_2Fe^{2+}_2Fe^{3+}_2(WO_4)_7.9aq$ or $(W,Fe)(O,OH)_6.n$ aq.
Pyrochlore structure type.
 Structure: **TS Ercit GW Robinson** 1994 CM 32 567-94.
 Raman: MA 96M/1557.
 Occurrence: Japan, different formula, MA 97M/2012.
ferroactinolite $Ca_2(Fe,Mg)_5Si_8O_{22}(OH)_2.$
Amphibole structure group; *monoclinic* subtype.
 Fe-Mg order-disorder *tremolite-actinolite-ferroactinolite* ambient & high T: **BW Evans H Yang** 1998 AM 83 458-75.
 Stability & thermodynamics: **DM Jenkins KN Bozhilov** 2003 AJS 303 723-52 (9523).
 Occurrence: **BE Leake** 1978 AM 63 1023-52.
ferroalluardite $(Na,Ca)Fe^{2+}(Fe^{2+},Mn,Fe^{3+},Mg)_2(PO_4)_3.$
 Structure determination not found.
 Occurrence: **PB Moore J Ito** 1979 MM 43 227-35.
 Might have been named *headdenite*: MM 24 611.
ferroaluminobarroisite *Amphibole*. MM 42 524.
ferroaluminoceladonite $K_2Fe^{2+}_2Al_2Si_8O_{20}(OH)_4.$
Mica structure group, 1M polytype.

Occurrence, crystallography, TEM: **G Li & 3 others** 1997 AM 82 503-11.

ferro-alumino-tschemakite *Amphibole*. MM 42 524.

ferro-alumino-winchite *Amphibole*. MM 42 524.

ferro-anthophyllite $(\text{Fe}^{2+}, \text{Mg})_7\text{Si}_8\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; *orthorhombic* subtype.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferroaxinite $\sim\text{Ca}_2\text{Fe}^{2+}\text{Al}_2\text{BSi}_4\text{O}_{15}\text{OH}$. *Axinite* structure group.
 See axinite for structure determinations.
 Boron K-edge XANES, **ME Fleet S Muthupari** 2000 AM 85 1009-21.
 Occurrence: **C Milton FA Hildebrand AM Sherwood** 1953 AM 38 1148-58.

ferro-barroisite $\text{NaCa}(\text{Fe}, \text{Mg})_3\text{Al}_2\text{Si}_7\text{AlO}_{22}(\text{OH})_2$.
Amphibole structure group; *monoclinic* subtype.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferrobustamite $\text{Ca}(\text{Fe}, \text{Ca}, \text{Mn})\text{Si}_2\text{O}_6$. *Pyroxenoid* mineral group.
 Structure: **PA Rapoport CW Burnham** 1973 ZK 138 419-38; correction 142 450-2.
 Occurrence: MM 39 913.

ferrocarpholite $(\text{Fe}_{0.76}\text{Mg}_{0.24})\text{Al}_2\text{Si}_2\text{O}_6(\text{OH})_4$. *Carpholite* structure type.
 Structure: **CH MacGillavry** 1956 AC 9 773-6;
G Ferraris G Ivaldi B Goffé 1992 NJMM 337-47 (F433).

ferroceladonite $\text{K}_2\text{Fe}^{2+}_2\text{Fe}^{3+}_2\text{Si}_8\text{O}_{20}(\text{OH})_4$. *Mica* structure group, 1M polytype.
 Occurrence, crystallography, TEM: **G Li & 3 others** 1997 AM 82 503-11.

ferroclinoholmquistite $\text{Li}_2(\text{Fe}, \text{Mg})_3\text{Al}_2\text{Si}_8\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; *monoclinic* subtype.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferrocolumbite $(\text{Fe}, \text{Mn})(\text{Nb}, \text{Ta})_2\text{O}_6$. *Columbite* mineral group.
 Structure: *synthetic* **FeNb₂O₆, F Laves G Bayer A Panagos** 1963 SMPM 43 217-34;
 Sc- & W-, XRPD, **M Okrusch & 5 others** 2003 AM 88 986-95.

ferro-eckermannite $\text{Na}_3(\text{Fe}, \text{Mg})_4\text{AlSi}_8\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; *monoclinic* subtype.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferro-edenite $\text{NaCa}_2(\text{Fe}, \text{Mg})_5\text{Si}_7\text{AlO}_{22}(\text{OH})_2$.
Amphibole structure group; *monoclinic* subtype.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferro-ferri-tschemakite $\text{Ca}_2(\text{Fe}, \text{Mg})_3\text{Fe}^{3+}_2\text{Si}_6\text{Al}_2\text{O}_{22}(\text{OH})_2$.
 Hypothetical endmember of *amphibole* structure group; *monoclinic* subtype.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferro-ferri-winchite *Amphibole*. MM 42 524.

ferrogedrite $(\text{Fe}, \text{Mg})_5\text{Al}_2(\text{Si}_6\text{Al}_2)\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; *orthorhombic* subtype.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferroglaucophane $\text{Na}_2(\text{Fe}, \text{Mg})_3\text{Al}_2\text{Si}_8\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; *monoclinic* subtype.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52. MA 80-0137.

[ferrohagendorfite Proposed endmember. MM 43 1060.]

ferrohexahydrate $\text{FeSO}_4 \cdot 6\text{aq}$. Review: **Sabelli** p.9; structure known.
Occurrence: **VV Vlasov AV Kuznetsov** 1962 ZVMO 91 490-2 = AM 48 433.

ferrohögbomite-2N2S $(\text{Fe}_3\text{ZnMgAl})\text{Al}_{14}\text{FeTi}_3\text{O}_{30}(\text{OH})_2$. Högbomite group, polysome.
Occurrence & SC-XRD structure: **C Hejny & 3 others** 2002 EJM 14 957-67 (8347).

ferroholmquistite $\text{Li}_2(\text{Fe,Mg})_3\text{Al}_2\text{Si}_8\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; *orthorhombic* subtype.
Structure determination not found.
Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferrohornblende $\text{Ca}_2(\text{Fe,Mg})_4\text{AlSi}_7\text{AlO}_{22}(\text{OH,F})_2$.
Amphibole structure group; *monoclinic* subtype.
Structure determination not found.
Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferrokaersutite $\text{NaCa}_2(\text{Fe,Mg})_4\text{TiSi}_6\text{Al}_2\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; *monoclinic* subtype.
Structure determination not found.
Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferrokentbrooksit $\text{Na}_{15}\text{Ca}_6(\text{Fe,Mn})_3\text{Zr}_3\text{NbSi}_{25}\text{O}_{73}(\text{O,OH,aq})_3(\text{Cl,F,OH})_2$.
Eudialyte structure group.
Occurrence & SC-XRD: **O Johnsen JD Grice RA Gault** 2003 CM 41 55-60.

ferrokesterite $\sim\text{Cu}_2\text{FeSnS}_4$.
Isostructural series with *kësterite* $\text{Cu}_2(\text{Zn,Fe})\text{SnS}_4$, of which *isostannite* is a member.
Polymorph of *stannite*.
Description: **SA Kissin DAR Owens** 1989 CM 27 673-85.
Occurrence: MM 54 664.

ferrokinoshitalite $\text{BaFe}_3\text{Si}_2\text{Al}_2\text{O}_{10}(\text{OH})_2$. *Mica* structure group.
Occurrence & SC-XRD structure: **S Guggenheim HE Frimmel** 1999 CM 37 1445-52.

ferronickelplatinum Pt_2FeNi . *Tetra-auricupride* structure group. Pearson structure type tP₂.
Structure: **P Bayliss** 1990 CM 28 751-5 = AM 69 1190-1.
PDF 35-702 lists smaller cell: [jvs order-disorder?].
Occurrence: MM 48 572.

ferronigerite $(\text{Zn,Mg,Fe})(\text{Sn,Zn})_2(\text{Al,Fe})_{12}\text{O}_{22}(\text{OH})_2$. *Högbomite* group.
Structure: **D McKie** 1963 MM 33 563-80;
polytypism, **DR Peacor** 1967 AM 52 864-6;
24R polytype, **IE Grey BM Gatehouse** 1979 AM 64 1255-64;
6T-polytype, **AV Arakcheeva & 4 others** 1995 CrR 40 587-92 (A651);
occurrence of 6H & 24R polysomes, **AMR Neiva PE Champness** 1997 NJMM 385-409 (N473).
Occurrence: MM 28 734; MM 30 742.

ferronordite-Ce $\text{Na}_3\text{SrCeFeSi}_6\text{O}_{17}$. *Nordite* group.
Occurrence & XRD: **V Pekov NK & 3 others** 1998 ZVMO 127 32-40 (P842).
Structure, geochemistry: **DY Pushcharovskii & 3 others** 1999 CrR 44 565-74 (P853).

ferronordite-La $\text{Na}_3\text{Sr}(\text{La,Ce})\text{FeSi}_6\text{O}_{17}$. *Nordite* group.
Occurrence & XRD: **IV Pekov & 3 others** 2001 ZVMO 253-6.

ferropargasite $\text{NaCa}_2(\text{Fe,Mg})_4\text{AlSi}_6\text{Al}_2\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; *monoclinic* subtype. Structure determination not found.
Occurrence: **BE Leake** 1978 AM 63 1023-52.

[ferropericlasite $(\text{Fe,Mg})\text{O}$. Presumed major component of lower mantle.
Pipe DO-27, Slave Craton, Canada, inclusions of *sanidine*, ferropericlasite, *nickel* interpreted *Mg-perovskite*, etc: **RM Davies & 5 others** 1999 Proc VII Int Kimberlite Conf 148-55.
Yakutia, various inclusions, **NV Sobolev ES Yefimova VI Koptil** 1999 Proc VII Int Kimberlite Conf 816-22.
XRPD, diamond cell to 1000 K & 86 GPa, possible decomposition into Mg- & Fe-rich phases:
LS Dubrovinsky & 8 others 2000 S 289 430-2 (D813).
Elasticity to 9 GPa: **J Kung & 4 others** 2002 EPSL 203 557-66 (8331).

ferropumpellyite MM 38 991.

ferropyrosmalite $(\text{Fe,Mn})_8\text{Si}_6\text{O}_{15}(\text{OH,Cl})_{10}$.
 Fe-rich half of *pyrosmalite* series with *manganpyrosmalite*.
Friedelite structure family; *trigonal* subtype.
 Structure determination of near-endmember not found.
 Occurrence & nomenclature: **JP Vaughan** 1986 MM 50 527-31; 1987 MM 51 174.
 Transformation to *clinopyroxene* in brine inclusion: **P Kodera PJ Murphy AH Rankin** 2003 AM 88 151-8.

ferrorhodsite $(\text{Fe,Cu})(\text{Rh,Pt,Ir})_2\text{S}_4$. Analog of *cuprorhodsite*, *cuproiridsite* & *malanite*.
 Occurrence & XRPD: **NS Rudashevsky & 3 others** 1998 ZVMO 127 37-41 (R945).
 Charge compensation, Cu-Fe-PGE thiospinels from Penikat: **AV Barkov & 3 others** 2000 AM 85 694-9.

ferrorichterite $\text{Na}_2\text{Ca}(\text{Fe,Mg})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$. *Amphibole* structure group; *monoclinic* subtype.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferrorosemaryite $\text{NaFe}^{2+}\text{Fe}^{3+}\text{Al}(\text{PO}_4)_3$. Fe analog in *wylleyite* group.
 Occurrence & SC-XRD structure: **F Hatert & 6 others** 2005 EJM 17 79-59 = AM 91 1263-4.

ferrosaponite $\text{Ca}_{0.3}(\text{Fe,Mg})_3(\text{Si,Al})_4\text{O}_{10}(\text{OH})_{2.4\text{aq}}$. *Smectite* group.
 Occurrence: **NV Chukanov et al** 2003 ZVMO 2 68-74.

ferroselite FeSe_2 . *Marcasite* structure subgroup in *marcasite* supergroup.
 Structure: **A Kjekshus T Rakke AF Andresen** 1974 Acta Chem Scand A28 996-1000.
 3d transition metal L-edge XAS: **JM Charnock & 3 others** 1996 PCM 23 403-8 (C878).
 Occurrence: MM 31 959.

ferrosilite = orthoferrosilite FeSiO_3 .
 Endmember of *pyroxene* group; *orthorhombic* subtype. Also *monoclinic* subtype.
 Structure: orthorhombic, **S Sueno M Cameron CT Prewitt** 1976 AM 61 38-53;
S Sasaki & 3 others 1982 ZK 158 279-97 (also Mg & Co analogs).
 Monoclinic C2/c at 1.9 GPa: **DA Hugh-Jones AB Woodland RY Angel** 1994 AM 79 1032-41.
 Reversed ortho-clino transition 5-7.5 GPa: **AB Woodland RJ Angel** 1997 EJM 9 245-54 (W796).
 In meteorites: **AE Rubin** 1997 MPS 32 231-47.

ferrosilite III FeSiO_3 . Polymorphic with *clinoferrosilite* & *ferrosilite*. *Pyroxenoid* group.
 High-T: **H-P Weber** 1983 AC C39 1-3 (W457).

ferrostrunzite $\text{Fe}^{2+}\text{Fe}^{3+}_2(\text{PO}_4)_2.6\text{aq}$. Ferrous analog of *strunzite* $\text{Mn}^{2+}\text{Fe}^{3+}_2(\text{PO}_4)_2.8\text{aq}$.
 XRD & Mössbauer of Arnsberg specimen gave ferrous/ferric 0.36/0.64 instead of ideal 0.5/0.5: **R van Tassel E de Grave** 1992 NJMA 207-12 (V228).
 Occurrence: MM 50 746.

ferrotaaffeite-6N'2S $\text{Fe}_3\text{BeAl}_8\text{O}_{16}$. *Taaffeite* group. *Pehrmanite* renamed
 Occurrence & crystallography: **EAJ Burke WJ Lustenhouwer** 1981 CM 19 311-4.

ferrotantalite $(\text{Fe,Mn})(\text{Ta,Nb})_2\text{O}_6$. Alpha-PbO₂ (*scrutinyite*) structure type. *Columbite* group.
 See tantalite for series.
 Structure determination not found for Fe-rich tantalite.

ferrotapiolite See *tapiolite*.
 Composition gap: **P Cerny TS Ercit MA Wise** 1992 CM 30 587-96.
 Pseudomorph of stibiotantalite: **M Novak & 4 others** 2004 CM 42 1117-28.

ferrotitanowodginite $\text{FeTiTa}_2\text{O}_8$. *Wodginite* structure group.
 Occurrence, XRD: **MA Gallinski & 3 others** 1999 AM 84 773-7.

ferrotschermakite $\text{Ca}_2(\text{Fe,Mg})_3\text{Al}_2\text{Si}_6\text{Al}_2\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; *monoclinic* subtype.
 Structure determination not found.
 Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferrotychite / Fe-tychite $\text{Na}_6\text{Fe}_2(\text{SO}_4)(\text{CO}_3)_4$. *Tychite* structure group.
 Structure: **YuA Malinovskii SV Baturin NV Belov** 1980 SPD 24 951-3 (M1118).
 Occurrence: MM 48 572.
 [Fe-tychite $\text{Na}_6(\text{Fe,Mn,Mg})_2\text{SO}_4(\text{CO}_3)_4$ is listed in MM 46 518.]
 Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).

ferrowinchite $\text{NaCa}(\text{Fe,Mg})_4\text{AlSi}_8\text{O}_{22}(\text{OH})_2$.

Amphibole structure group, *monoclinic* subtype.
Structure determination not found.
Occurrence: **BE Leake** 1978 AM 63 1023-52.

ferrowodginite $\text{Fe}^{2+}\text{SnTa}_2\text{O}_6$. *Wodginite* structure group.
Occurrence: **TS Ercit P Cerny FC Hawthorne** 1992 CM 30 633-8.

ferrowyllieite $(\text{Na,Ca,Mn})(\text{Fe,Mn})(\text{Fe,Mg})\text{Al}(\text{PO}_4)_3$. *Wyllieite* structure group.
Structure determination not found.
Occurrence: **PB Moore J Ito** 1973 MR 4 131-6; AM 65 810-1; MM 43 1060.

ferruccite NaBF_4 . *Anhydrite* structure type.
Structure: **A Bellanca** 1946 Rend Soc Mineral Ital 3 20-1 = MA 10-534.
Occurrence: MM 23 629.

fersilicite FeSi . Structure described as defect derivative of *pyrite* by **Pearson** 1972 p 411.
Structure: **MC Farquhar H Lipson HR Weill** 1945 J Iron Steel Inst 152 457.
Occurrence: MM 37 957. See *ferdisilicite*.

ferdisilicite FeSi_2 .
Occurrence: MM 37 957.

fersmanite $\text{Ca}_4(\text{Na,Ca})_4(\text{Ti,Nb})_4(\text{Si}_2\text{O}_7)_2\text{O}_8\text{F}_3$.
Structure: **YuN Saf'yanov RI Bochkova VV Ilyukhin** 1984 SPC 29 31-3 (S1322;
SC-XRD & revised composition, **E Sokolova & 2 others** 2002 CM 40 1421-8.
Occurrence: MM 22 620.

fersmite $(\text{Ca,Ce,Na})(\text{Nb,Ti,Fe,Al})_2(\text{O,OH,F})_6$.
Columbite structure group with $\alpha\text{-PbO}_2$ (*scrutinyite*) structure type.
Structure: **VB Aleksandrov** 1961 DAN USSR ES 132 597-600 = MA 16-26.
Occurrence: MM 28 729-30.
Review: (different formula) **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
Synthetic CaNb_2O_6 : **JP Cummings SH Simonson** 1970 AM 55 90-7.

[fersmite-Ce Structure: **OA Gurbanova & 3 others** 2001 Kr 46 234-5.]

feruvite $\text{Ca}(\text{Fe,Mg})_3(\text{Al,Mg})_6(\text{BO}_3)_3\text{Si}_6\text{O}_{18}(\text{OH})_4$. *Tourmaline* structure group.
Structure: **JD Grice GW Robinson** 1989 CM 27 199-203.
Occurrence: MM 31 958; CM 36 433-9.

fervanite $\text{Fe}_4\text{V}_4\text{O}_{16.5}\text{aq}$. *Vanadium bronze* structure group, *other* subgroup.
Structure analysis not found.
Review: **HT Evans JM Hughes** 1990 AM 75 508-21.
Occurrence: MM 22 620.

fetiasite $(\text{Fe}^{2+},\text{Fe}^{3+},\text{Ti})_3\text{O}_2[\text{As}_2\text{O}_5]$.
Structure: **S Graeser & 5 others** 1994 AM 79 996-1002.

fettelite $\text{Ag}_{24}\text{HgAs}_5\text{S}_{20}$.
Occurrence & XRPD: **N Wang A Paniagua** 1996 NJMM 313-20 (W780).

[Fe-tychite $\text{Na}_6(\text{Fe,Mn,Mg})_2\text{SO}_4(\text{CO}_3)_4$. See *ferrottychite*.]

fianelite $\text{Mn}_2\text{V}(\text{V,As})\text{O}_7.2\text{aq}$.
Occurrence & crystal structure: **J Brugger P Berlepsch** 1996 AM 81 1270-6.

fibroferrite $\text{Fe}^{3+}\text{SO}_4(\text{OH}).2\text{aq}.\sim 3\text{aq}$.
Hydroxo-bridged $\text{Fe}(\text{OH})_2\text{O}_2.2\text{aq}$ octahedral/ SO_4 tetrahedral chain; stereoisomer of chains in
butlerite & *parabutlerite*.
Structure: **F Scordari** 1981 TMPM 28 17-29 (S1449).

fichtelite $\text{C}_{19}\text{H}_{34}$.
Structure: **HA Mace RC Peterson** 1995 CM 33 7-11.

fiedlerite $\text{Pb}_3\text{Cl}_4\text{F}(\text{OH}).\text{aq}$.
Polytypic, monoclinic & triclinic structures: **S Merlino M Pasero N Perchiazzi** 1994 MM 58 69-78.

filatovite $\text{K}(\text{Al,Zn})_2(\text{As,Si})_2\text{O}_8$. Feldspar structure.
Structure: **SL Filatov & 3 others** 2004 EJM
Occurrence: **LP Vergasova & 4 others** 2004 EJM 16 533-6 (10473).

filipstadite $(\text{Mn,Mg})_2(\text{Sb}^{5+}_{0.5}\text{Fe}^{3+}_{0.5})\text{O}_4$.

? *spinel* structure: **PJ Dunn & 3 others** 1988 AM 73 413-9.

Occurrence in Sweden: **D Holtstam** 1993 Geol För Stockholm Förh 115 239-40 = MA 94M/4752; MM 62 395-407.

FILLOWITE MINERAL GROUP

chladniite $\text{Na}_2\text{CaMg}_7(\text{PO}_4)_6$

fillowite $\text{Na}_2\text{Ca}(\text{Mn,Fe})_7(\text{PO}_4)_6$

johnsomervillite $\text{Na}_{10}\text{Ca}_6\text{Mg}_{18}(\text{Fe,Mn})_{25}(\text{PO}_4)_{36}$

stornesite-Y $(\text{Y,Ca})\text{voidNa}_6(\text{Ca,Na})_8(\text{Mg,Fe})_{43}(\text{PO}_4)_{36}$

Mineral & *synthetic* members: **ES Grew & 4 others** 2006 AM 91 1412-24.

fillowite $\text{Na}_2\text{Ca}(\text{Mn,Fe})_7(\text{PO}_4)_6$.

Isostructural with Fe analog *johnsomervillite* & Mg analog *chladniite*.

Structure: **T Araki PB Moore** 1981 AM 66 827-42 (A326);

PB Moore 1989 AM 74 918-26.

Synthetic $\text{Na}_4\text{Ca}_4\text{Mg}_{21}(\text{PO}_4)_{18}$: **AI Domanskii et al** 1982 SPC 27 535-7.

Synthetic $\text{Na}_2\text{Ca}(\text{FeMg}_2\text{Mn}_4)(\text{PO}_4)_6$: **ZS Ma NC Shi H Wang** 1993 AC A49 (abstr.).

Synthetic $\text{NaCaCdMg}_2(\text{PO}_4)_3$: structure, **D Antenucci & 3 others** 1995 EJM 7 175-8;

reversible polymorph of *alluardite*, **D Antenucci & 2 others** 1996 NJMM 289-96 (A724).

fingerite $\text{Cu}_{11}\text{O}_2(\text{VO}_4)_6$. Review: (E289).

Structure: **LW Finger** 1985 AM 70 197-9.

Occurrence: MM 50 746.

finnemanite $\text{Pb}_5(\text{AsO}_3)_3\text{Cl}$.

Structure similar to *apatite*: **O Gabrielson** 1955 Ark Mineral Geol 2 1-8 = MA 14-21;

H Effenberger F Pertlik 1979 TMPM 26 95-107 (E323).

fischesserite Ag_3AuSe_2 . *Petzite* structure group. *Garnet* structure type.

Structure: XRPD, **L Bindi C Cipriani** 2004 CM 42 1733-7.

Occurrence: **Z Johan & 3 others** 1972 BSFMC 94 381-4.

fizélyite $\text{Pb}_{14}\text{Ag}_5\text{Sb}_{21}\text{S}_{48}$. *Lillianite* homologous series. *Andorite* group.

Compare with *ramdohrite*.

Structure determination not found.

Occurrence & series including *fizélyite*, *quatrandorite*, *ramdohrite*, *senandorite* & *uchucchacuaite*: **Y Moëlo E Makovicky S Karup-Møller** 1984 NJMM 175-82.

flagstaffite $\text{C}_{10}\text{H}_{22}\text{O}_3$. Matches cis-terpin monohydrate.

Occurrence: **H Strunz B Contag** 1965 NJMM 19-25 = AM 50 2109.

fleischerite $\text{Pb}_3\text{Ge}(\text{SO}_4)_2(\text{OH})_6 \cdot 3\text{aq}$.

Isostructural with *despujolsite*, *mallestigite*, & *schaurteite*. Compare with *itoite*.

Structure: **HH Otto** 1975 NJMA 123 160-90.

Review: **HFW Taylor** 1973 MM 39 377-89 (T186).

Occurrence: MM 32 957. [Name also used for $\text{ZnS} \cdot 6\text{H}_2\text{O}$: MM 29 981.]

fletcherite $\text{Cu}(\text{Ni,Co})_2\text{S}_4$. *Spinel* structure type. *Linnaeite* mineral group.

Structure determination not found [jvs: check for synthetic].

Occurrence: **JR Craig AB Carpenter** 1977 EG 72 480-6 = AM 62 1057.

flinkite $\text{Mn}_3(\text{AsO}_4)(\text{OH})_4$.

Structure: **PB Moore** 1967 52 1603-13.

florencite-Ce $\text{CeAl}_3(\text{PO}_4)_2(\text{OH})_6$. *Crandallite* structure type.

See *arsenoflorencite-Ce*; -La; -Nd.

Structure: **T Kato 1990** NJMM 227-31.

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

Occurrence in marine sandstones: **B Rasmussen** 1996 AJS 296 601-32 (R677).

Occurrence in diamond from Kimberlite Pipe 50, Liaoning, China, complex minor element substitution: **AI Gorshkov & 5 others** 1997 GI 695-703 (G929).

florencite-La $(\text{La,Ce})\text{Al}_3(\text{PO}_4)_2(\text{OH})_6$. *Crandallite* structure type.

Structure determination not found.

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

Occurrence: **J Lefebvre C Gasparrini** 1980 CM 18 301-11;

containing fission RE from Gabon, **J Janeczek RC Ewing** 1996 AM 81 1263-9.

florencite-Nd (Nd,Ce)Al₃(PO₄)₂(OH)₆. *Crandallite* structure type.

Structure determination not found.

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

Occurrence: **DJ Milton H Bastron** 1971 MR 2 166-8.

florenskyite FeTiP. Anti-PbCl₂ type.

Occurrence: Kaidun chondrite breccia, SC-XRD structure: **AV Ivanov & 6 others** 2000 AM 85 1082-6.

Synthetic ZrFeP & analogs, structure: **S Rundqvist PC Nawapong** 1966 Acta Chem Scand 20 2250-4.

florensovite (Cu,Zn)(Cr_{1.5}Sb_{0.5})S₄. *Spinel* structure type. *Linnaeite* mineral group.

Complete solid solution with *kalininite*. [jvs: check for synthetic].

Occurrence: **LZ Reznitskii & 3 others** 1989 ZVMO 118 57-65 = MM 54 664.

fluckite CaMnH₂(AsO₄)₂.2aq. Pseudo-polytypic with *krutite*.

Structure: **M Catti G Chiari G Ferraris** 1980 BM 103 129-34.

Occurrence: MM 43 1060.

fluellite Al₂(PO₄)F₂(OH).7aq. Incomplete vertex-connected octahedral-tetrahedral net.

Structure: **BB Guy GA Jeffrey R Van Tassel** 1967 AM 52 1576-7 & 1966 AM 51 1579-92.

fluoborite Mg₃(BO₃)(F,OH)₃. Isotypic with *jaffeite*, *jeremejevite* & *painite*.

Structure: **Y Takéuchi** 1950 AC 3 208-10;

A Dal Negro C Tadini 1974 TMPM 21 94-100;

F Camara L Ottolini 2000 AM 85 103-7.

Occurrence: MM 21 564.

fluocerite Ce & fluocerite La Ce/LaF₃. *Tysonite* is merely La endmember.

Structure type: **Wells**, p 356.

Note: there are subtle features involving hexagonal vs. trigonal symmetry and intimate twinning.

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

Synthetic (Ce/La/Pr/Nd)F₃: **MI Afanasiev SP Habuda AG Lundin** 1972 AC B28 2903-5.

Synthetic Ce/LaF₃: **AK Cheetham BEF Bender H Fuess AF Wright** 1976 AC B32 94-7.

Synthetic LaF₃: **N Mansmann** 1965: ZK 122 375-8;

C De Rango G Tsoucaris C Zelwer 1966 CRASP 263C 64-6;

structure, **A Zalkin DH Templeton TE Hopkins** 1966 IC 5 1466-8;

structure, **B Maximov H Schulz** 1985 AC B41 88-91;

neutron, **D Gregson & 5** 1983 AC B39 687-91;

neutron, Pbar3c1, **A Zalkin DH Templeton** 1985 AC B41 91-3;

SC-XRD, **H Mueller-Bunz T Schleid** 1999 ZaaC 625 1377-83 (3632).

Synthetic Gd_{0.8}Ca_{0.2}F_{2.8}: **LP Ostroshchenko & 4 others** 1985 SPC 30 383-6.

Synthetic PrF₃: **BA Maksimov & 3 others** 1985 SPC 30 164-6 (M1138).

Synthetic Gd_{1-x}Sr_xF_{3-x}: **NI Sorokin & 4 others** 1995 CrR 40 517-20.

Synthetic NdH₃, XRPD structure: **G Renaudin P Fischer K Yvon** 2000 JAIC 313 L10-4 (741).

Synthetic (Sr,Yb)H₃, XRPD structure: **SN Achary AK Tyagi J Kohler** 2001 MRB 36 1109-15 (2008).

[fluorannite see fluoroannite KFe₃AlSi₃O₁₀F₂. *Mica* group.

Occurrence: **G Shen et al** 2000 Acta Petrologia Mineral China 19 356.]

fluorapatite (Ca,REE,Na)₅(PO₄)₃(F,OH). Apatite structure type.

Structure: **CA Beevers DM McIntyre** 1946 MM 27 254-7;

synthetic & natural, **K Sudarsanan PE Mackie RA Young** 1972 MRB 7 1331-8;

JM Hughes M Cameron KD Crowley 1989 AM 74 870-6;

Gd site preference, SC-XRD & EPR, **Y Pan & 4 others** 2002 CM 40 1103-12.

EPR, Gd & Mn substitution: **Y Pan & 3 others** 2002 AM 87 1333-41.

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

As-bearing, Val d'Aosta Mn deposits, Italy: **E Perseil & 2 others** 2000 CM 38 101-17.

In meteorites: **AE Rubin** 1997 MPS 32 231-47.

High-P,T metasomatism: **DE Harlov H Förster C Schmdt** 2002 MM 67 61-72.
Cd(I) in sedimentary, EPR: **G Morin & 4 others** 2002 EJM 141087-94 (8698).
Natural Mn-rich, Austria: SC-XRD structure & color, **JM Hughes & 4 others** 2004 AM 89 629-32.
Synthetic Mn²⁺: 3/8 atom/cell in Ca(1a) sites causing lower symmetry: **PR Suitch & 3 others** 1985 AC B41 173-9.
Sr_{0.6},0.3 & Na_{1.2},0.4-: **JM Hughes M Cameron KD Crowley** 1991 AM 76 1857-62.
Site preference of Nd: **ME Fleet Y Pan** 1994 JSSC 111 78-81.
Site preference of La, Gd & Dy: **ME Fleet Y Pan** 1995 AM 80 329-35; **do** 1997 82 870-7.
Fluid-induced nucleation of *monazite* inclusions: **DE Harlov H Förster** 2003 AM 88 1209-29.
Water/(100) surface, structure from XR reflectivity: **C Park & 4 others** 2004 AM 89 1647-54.
Synthetic Ca₅(BO₃)₃F: planar BO₃ substituting for tetrahedral PO₄: **JG Fletcher FP Glasser RA Howie** 1991 AC C47 12-4 (F444).

³⁺
Synthetic, Gd³⁺ at Ca₂ site, EPR: **N Chen Y Pan JA Weil** 2002 AM 87 37-46;
at Ca₁ site, **N Chen & 3 others** 2002 AM 87 47-55.

fluorapophyllite KCa₄Si₈O₂₀(F,OH).8aq. Isostructural with *hydroxylapophyllite*.

Structure: **VF Ivlev NI Zavarina SP Garuda** 1969 SPC 13 705-9;
AA Colville CP Anderson PM Black 1971 AM 56 1222-33;
G-Y Chao 1971 AM 56 1234-42;
neutron, **E Prince** 1971 AM 56 1243-51;
neutron, natural & partly dehydrated, **K Ståhl Å Kvick S Ghose** 1987 AC B43 517-23 ;
K Ståhl 1993 EJM 5 845-9 (S1219);
orthorhombic, **T Kato Y Miura** 1994 J Fac Liberal Arts, Yamaguchi Univ 25 15-22;
dehydration, DTA/XRD/IR, **R Wlodyka & 2 others** 2004 NJMM 337-56 (10645).

Occurrence: MM 42 524.

fluorarrojadite-(BaFe); -(BaNa); -(KNa): see *arrojadite*

fluorbritholite-Ce Complex composition. *Apatite* group. Compare *britholite-Ce*.

Occurrence: **J Gu GY Chao S Tang** 1996 J Wuhan Univ Technology 9 9-14 & Acta Petrol Mineral 15 40-5 = AM 81 1013-4.

fluor-cannilloite CaCa₂(Mg₄Al)(Si₅Al₃)O₂₂F₂. *Amphibole* structure type.

Occurrence & structure: **FC Hawthorne & 3 others** 1996 AM 81 995-1002.

fluorcaphite Ca(Sr,Na,Ca)(Ca,Sr,Ce)₃(PO₄)₃F. *Apatite* group.

Occurrence: & crystallography, **AP Khomyakov & 2 others** 1997 ZVMO CXXVI 3 87-97 (K945);
& SC-XRD structure, **AR Chakhmouradian & 2 others** 2005 CM 43 735-46.

fluor-chlor-hydroxyapatite Occurrence: MM 39 913.

fluoroannite KFe₃AlSi₃O₁₀F₂. *Mica* group; 1M polytype.

Occurrence & SC-XRD structure: **G Shen Q Lu J Xu** 2000 Acta Petrologica Mineral China 19 355-62 = AM 86 1534-7;

Mössbauer, **S Qin Z Li Z Wu A Lu** 2002 EJM 14 1049-52 (8677).

fluoro-edenite NaCa₂Mg₅Si₇AlO₂₂F₂. *Amphibole* structure type.

Structure: **KF Boschmann & 4 others** 1994 CM 332 21-30 (B1595);

NPD of cation ordering, **MD Welch KS Knight** 1999 EJM 11 321-31 (W963).

Occurrence: **A Gianfagna R Oberti** 2001 AM 86 1489-93.

fluorellestadite Ca₅[(Si,P,S)O₄]₃(F,OH,Cl). *Apatite* structure type.

Structure: **K Sudarsanan** 1980 AC B36 1636-9;

synthetic, XRPD, **I Pajares & 5 others** 2002 PD 17 281-6.

Mineral definition: **BV Chesnokov LF Bazhenova AF Bushmakin** 1987 ZVMO 116 743-6.

Occurs with *alite* & *belite* in F-fluxed Portland clinker.

fluor-ferro-leakite NaNa₂(Fe²⁺₂Fe³⁺₂Li)Si₈O₂₂F₂. *Amphibole* structure type.

Structure: **FC Hawthorne & 5 others** 1996 AM 81 226-8.

FLUORITE STRUCTURE GROUP Includes

baddeleyite ZrO₂ (monoclinic distortion)

cerianite (Ce,Th)O₂

fluorite CaF₂

<i>frankdicksonite</i>	BaF ₂	
<i>håleniusite-La</i>	(La,Ce)OF	
<i>tazheranite</i>	(Zr,Ca,Ti,etc) ₄ O ₇	(defect fluorite type)
<i>thorianite</i>	ThO ₂	
<i>veitite</i>	Ca ₁₃ Y ₆ F ₄₂ (O,F) ₁	(defect fluorite type)
<i>uraninite</i>	UO ₂	

Synthetic Bi₂O₄: 1989 J Less-Common Metals 146 161 = SR 56A 271.

Synthetic CmO₂ & ThO₂: 1989 J Less-Common Metals 156 273 = SR 56A 271.

Synthetic CeO₂: 1989 ZK 188 169.

Synthetic Zr₂Gd₂O₇: 1989 Solid State Ionics 31 319.

Synthetic (Ca,La)F_{2+x}: 1989 JSSC 81 271 = SR 56A 272.

Synthetic Pb₈Fe²⁺Fe³⁺₂F₂₄, defect ordered fluorite type: **A Pierrard A de Kozak P Gredin** 1995 ZaaC 621 1053-7 (P556).

Synthetic Sr_{0.8}Lu_{0.2}F_{2.2}: 1989 Koord Khim 15 1133-8 = SR 56A 72-3.

Synthetic high-P SnO₂: **L Liu** 1978 S 199 422-5.

Synthetic high-P PbO₂: **do** 1981 PCM 6 187-96.

Synthetic high-P post-fluorite phases: **L Liu** 1980 EPSL 49 166-72.

Synthetic Ca_{1-x}Pr_xF_{2+x}, difference electron density: **EA Zhurova & 3 others** 1996 CrR 41 413-8 (Z117).

fluorite CaF₂. Fluorite structure type.

Structure: early papers not listed;

atomic vibrations, ND, **BTM Willis** 1965 AC 18 75-6

6 micrometer crystal, **R Bachmann H Kohler H Schulz H Weber** 1985 AC A41 35-40;

difference electron density: **EA Zhurova & 3 others** 1996 CrR 41 413-8 (Z117).

Rare-earth dopants, EXAFS: **CRA Catlow & 3 others** 1984 N 312 601-4 (C947).

Divalent RE, CL, EPR: **U Kempe & 3 others** 2002 MP76 213-34 (8026).

Occurrence in diamond from Kimberlite Pipe 50, Liaoning, China: **AI Gorshkov & 5 others** 1997 GI 35 695-703 (G929); also probable Ce-bearing fluorite.

Microcrystals & nyerereite intergrowths, natrocabanatite, Oldoniyo Lengai, Tanzania: **RH Mitchell** 2006 70 103-14.

Fluorite is used industrially as a source of F.

Fluorite has many colors, and is used in jewellery and art panels.

Fluor-organics, in fluorite & rocks: **J Harnisch & 4 others** 2000 GRL 27 -6 (H1476).

Derbyshire Blue John: **TD Ford** 2000 Landmark Press, Ashbourne, UK, 1-873775-19-9 (2093).

Northern Pennines Orefield, England: **J Fisher** 2004 RoM 378-98 (10787); properties, 379-405.

Rare metal granites, Orlovskae Ta deposit: **OA Kukushkina VV Matias** 2004 GI 42 641-55 (10753).

fluoro-magnesio-arfvedsonite NaNa₂(Mg,Fe)₄FeSi₈O₂₂(F,OH)₂. *Amphibole* group.

Occurrence & XRPD: **AG Bazhenov & 4 others** 2000 ZVMO 129 28-35 = AM 86 1534.

fluoro-magnesiohastingsite, strontian *Amphibole* group.

Occurrence: Alban Hills, **M Gaeta C Freda** 2001 MM 65 787-95.

fluoropargasite NaCa₂Mg₄AlSi₆Al₂O₂₂F₂. *Amphibole* group.

Occurrence & SC-XRD: **MV Lupulescu & 3 others** 2005 CM 43 1423-8.

fluoro-potassic-magnesio-arfvedsonite KNa₂Mg₅Si₈O₂₂F₂. *Amphibole* group.

Occurrence: **DD Hogarth** 2006 CM 44 289.

fluoro-sodic-pedrizite NaLi₂Mg₂Al₂LiSi₈O₂F₂. *Amphibole* group.

Occurrence: Tuva, Siberia, and discreditation of *clinoholmquistite*: **R Oberti & 2 others** 2005 AM 90 732-6.

fluoronyböite NaNa₂(Al₂Mg₃)(Si₇Al)O₂₂F₂

Occurrence & SC-XRD structure: **R Oberti M Boiocchi DC Smith** 2003 MM 67 769-82.

fluoro-potassic-magnesio-arfvedsonite KNa₂Mg₅Si₈O₂₂F₂

fluorphlogopite / fluor-phlogopite Tri-octahedral *mica* structure type.

Synthetic: glass ceramic, **J Elsen & 4 others** 1989 J Chem Res 160-1 & 1253-63 = SR 56A 257.

Al XANES: **A Mottana & 6 others** 19977 AM 82 497-502.

Sr diffusion, Rutherford backscatter: **T Hammouda DJ Cherniak** 2000 EPSL 178 339-49.

[fluor-polyolithionite $KAlLi_2Si_4O_{10}F_2$.
Synthetic mica: **H Takeda CW Burnham** 1969 MJJ 6 102-9 = MM 38 992.
 Al XANES: **A Mottana & 6 others** 19977 AM 82 497-502.]

fluor-richterite $(Na,K)(Ca,Na)_2(Mg,Fe)_5Si_8O_{22}(F,OH)_2$. *Amphibole* group.
 Occurrence: **AG Bazhenov IL Nedosekova EU Petersen** 1993 ZVMO 122 98 = MM 60 530.
 In meteorites: **AE Rubin** 1997 MPS 32 231-47.

fluorthalénite-Y / fluorthalénite-Y $\sim Y_3Si_3O_{10}F$. Analog of *thalénite-Y*.
 Occurrence & XRD crystallography: **AV Voloshin & 2 others** 1985 MZh 7 79-94;
AV Voloshin YaA Pakhomovskii 1997 DES 354 4 481-2 (V272).
Synthetic, structure: **T Schleid H Müller-Bunz** 1998 ZaaC 624 1082-4 (S1957).

fluor-topaz $Al_2SiO_4F_2$.
 Occurrence: **MD Barton & 4 others** 1982 AM 67 350.
 [fluorsiderite = F-rich *chondrodite*, EJM 14 151-5.]

fluorvesuvianite $Ca_{19}(Al,Mg,Fe)_{13}(SiO_4)_{10}(Si_2O_7)_4O(F,OH)_9$. Vesuvianite group.
 Occurrence & SC-XRD structure, IR: **SN Britvin & 5 others** 2003 CM 41 1371-80.

foggite $CaAl(PO_4)(OH)_2 \cdot 2aq$.
 Structure: **AR Kampf T Araki** 1975 AM 60 965-71.
 Occurrence: MM 40 907.

foitite $Fe_2(Al,Fe)Al_6Si_6O_{18}(BO_3)_3(OH)_4$. *Tourmaline* structure type.
 Structure & occurrence: **DJ MacDonald FC Hawthorne JD Grice** 1993 AM 78 1299-303;
CA Francis & 3 others 1999 CM 37 1431-8.
 Foitite & "oxyfoitite", Baraboo quartzite, WI: **LG Medaris Jr JH Fournelle DJ Henry** 2003 CM 41 749-58.
Synthetic alkali-free, H-deficient, SC-XRD structure: **V Kahlenberg B Velickov** 2000 EJM 12 947-53 (236).
 Occurrence: fibrous, Turkey: **F Yavuz M Celik N Karakaya** 199 CM 37 155-61;
 Czech Republic & Pala CA, **M Novak MC Taylor** 2000 CM 38 1399-408;
 with *rossmanite*, China, **A Zhang & 4 others** 2004 CM 42 873-82.

fontanite $Ca(UO_2)_3(CO_3)_4 \cdot 3aq$.
 Structure: SC-XRD, **K Hughes PC Burns** 2003 AM 88 962-6.
 Occurrence: **M Deliens P Piret** 1992 EJM 4 1271-4.

foordite $SnNb_2O_6$. Isostructural series with *thoreaulite*.
 Structure: **TS Ercit P Cerny** 1988 CM 26 899-903.
 Occurrence: MM 54 664.

formanite $Y(Ta,Nb)O_4$. *Scheelite* structure type.
 Occurrence: MM 27 269.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

formicaite $Ca(HCO_2)_2$. Matches *synthetic* calcium beta-formate.
 Occurrence & description: **NV Chukanov & 5 others** 1999 ZVMO 43-8 (C1156).

fornacite $Pb_2(Cu,Fe)CrO_4(As,P)O_4OH$.
 Structure: **G Cocco L Fanfani PF Zanazzi** 1967 ZK 124 385-97 (C689);
C Sabelli PF Zanazzi 1972 AC B28 1182-9.

forsterite Mg_2SiO_4 . Mg end-member of *olivine* mineral group.
 Structure: early papers;
RM Hazen 1976 AM 61 1280-93;
RM Hazen LW Finger 1980 CIWY 79 364-7;
 electron density: **K Fujino & 3 others** 1981 AC B37 513-8.
 Electron density/bond critical point, SC-XRD: **A Kirfel & 6 others** 2005 PCM 32 301-13.
 High-P: to 15 GPa, **Y Takéuchi** 1985 ZK 171 291-302;
 elasticity to 16 GPa, **TS Duffy & 4 others** 1995 N 378 170-3 (D559);
 equation of state to 17 GPa, **RT Downs & 3 others** 1996 AM 81 51-5.
 OH defects: **E Libowitzky A Beran** 1995 PCM 22 387-92.
 Theoretical near-edge XAS: **Z Wu & 3 others** 1996 PCM 23 193-204 (W751).
 Band-structure calculations, electric-field-gradient tensors: **B Winkler & 3 others** 1996 AM 81 545-9.
 Mg site exchange, ^{25}Mg NMR spectroscopy: **JF Stebbins** 1996 AM 81 1315-20.

^{17}O NMR, 3- & 5-quantum: **SE Ashbrook AJ Berry S Wimperis** 1999 AM 84 1191-4.
 In meteorites: **AE Rubin** 1997 MPS 32 231-47.
 Cathodoluminescence, meteoritic/*synthetic* 296 & 77 K: **EJ Benstock & 2 others** 1997 AM 82 310-5 (1415).
 Grain from beyond the solar system: **S Messenger & 4 others** 2003 S 300 105-8 (8823).
 Anharmonicity of Raman modes, 100 to 2000 K: **P Gillet I Daniel F Guyot** 1997 EJM 9 255-62.
 P-induced compression, local density approx: **RM Wentzcovitch L Stixrude** 1997 AM 82 663-71.
 Proton defects at 010 tilt boundaries: **NH de Leeuw & 3 others** 2000 AM 85 1143-54.
Synthetic 100 tilt boundaries: **S Heinemann & 3 others** 2005 PCM 32 229-40.
 Fe(III) in forsterite & *wadsleyite*: **NC Richmond JP Brodholt** 2000 AM 85 1155-8.
 Water diffusion, 0.2 & 1 GPa, 1273 K: **S Demouchy S Mackwell** 2003 PCM 30 486-94 (9573).
Synthetic vitreous, structure/thermochemistry: **JA Tangeman & 5 others** 2001 GRL 28 2517-20.
Synthetic, IR of H content vs Mg/Si: **C Lemaire SC Kohn RA Brooker** 2004 CMP 147 48-57 (10119).
Synthetic Cr- & Cr,Li-doped, optical spec.: **A Sugimoto & 6 others** 1997 PCM 24 333-9 (S1751).
Synthetic Li/Mn/Co/Ni/Zn/Fe/Cr/Cu/Ca/Cd/Al/V-doped, XRPD & UV/Vis/N-IR: **AF Gualtieri S Bagni** 2001 PMR 70 27-56 (2092).
 Ir(II), EPR: **JM Gaite H Rager** 2003 PCM 30 628-30.
Synthetic leaf-like *via* iodine vapor on *quartz* substrate: **RLD Whitby & 4 others** 2004 ChC 2396-7 (10865).
foshagite $\text{Ca}_4\text{Si}_3\text{O}_9(\text{OH})_2$.
 Structure: **JA Gard HFW Taylor** 1959 N 183 171-3;
do 1960 AC 13 785-93.
 Ca-EXAFS, Si NMR: **N Lequex & 3 others** 1999 JACeS 82 1299-306 (L987).
 Occurrence: after *vesuvianite*, Bushveld Complex, **IS Buick & 3 others** 2000 SAJG 103 249-54 (2077).
 [foshallasite $\text{Ca}_3\text{Si}_2\text{O}_7.3\text{aq}$? ?relation to *afwillite*? jvs ignore.]
fougerite $\sim [\text{Fe}^{2+}_{1-x}\text{Fe}^{3+}_x\text{Mg}_y(\text{OH})_{2+2y}][x\text{OH}.m \text{ aq.}]$.
 Unapproved mineral similar to '*green rust*', occurs hydromorphic soil: **F Trolard & 4 others** 1996
 CRASP Ila 323 1015-23;
do 1997 GCA 61 1107-11;
 solid solution model for Mg-bearing green rust/*fougerite*, Mössbauer: **G Bourrie & 3 others** 2004 CICIM 52 382-94 (10569).
 Structure: Mossbauer & XRPD, **JR Genin & 4 others** 2001 Appl Geochem 16 559-70.
fourmarierite $\text{Pb}_{1-x}(\text{UO}_2)_4\text{O}_{3-2x}(\text{OH})_{4+2x}4\text{aq}$.
 Review: **V Baran M Unzeitig** 1991 NJMM 63-75 (B1358);
PC Burns ML Miller RC Ewing 1996 CM 34 845-80.
 Structure: **P Piret** 1985 BM 108 659-65 = AM 72 229;
 12 natural & 1 *synthetic*, SC-XRD, **Y Li PC Burns** 2000 CM 38 737-49.
fraipontite $(\text{Zn},\text{Al})_3(\text{Si},\text{Al})_2\text{O}_5(\text{OH})_4$.
Kaolinite-serpentine structure group; analog of *berthierine*. See *zinalsite*.
 Occurrence: MM 21 564;
A-M Fransolet P Bourguignon 1975 BSFMC 98 235-44.
 Synthesis at low-T: MRB 36 1091-8 (1999).
Synthetic fraipontite-silica composite adsorbent: **N Takahashi & 3 others** 1997 Bull Chem Soc Japan 95 609-14.
francevillite $(\text{Ba},\text{Pb})(\text{UO}_2)_2(\text{VO}_4)_2.5\text{aq}$. Isostructural series with *curiéenite*.
 Review: **PC Burns ML Miller RC Ewing** 1996 CM 34 845-80.
 Structure: **DP Shaskin** 1975 DES 220 137-9 (S1357);
K Mereiter 1986 NJMM 552-60.
 Occurrence: MM 31 959.
franciscanite $\text{Mn}_6[\text{V},\text{void}]_2\text{Si}_2(\text{O},\text{OH})_{14}$. *Mcgovernite* group.
 Essentially isostructural Sb,Fe *örebroite* & W *welinite* : discussion, **PJ Dunn & 3 others** 1986 AM 71 1522-6.
 Structure: **F Pertlik** 1986 NJMM 493-9 (P419).
francisite $\text{Cu}_3\text{Bi}(\text{SeO}_3)_2\text{O}_2\text{Cl}$.
 Structure: **A Pring BM Gatehouse WD Birch** 1990 AM 75 1421-5.
 Thermal expansion, XRPD 293-773 K: **EV Nazarchuk & 3 others** 2000 PCM 27 440-4 (N529).
Synthetic $\text{Cu}_3\text{Er}(\text{SeO}_3)_2\text{O}_2 \text{Cl}$, structure: **R Berrigan BM Gatehouse** 1996 AC C52 496-7.
Synthetic $\text{Cu}_3\text{Bi}(\text{SeO}_3)_2\text{O}_2(\text{Cl}/\text{Br}/\text{I})$, SC-XRD structure/magnetics: **P Millet & 6 others** 2001 JMC 11 1152-7 (1684).

franckeite $\text{FePb}_5\text{Sn}_3\text{Sb}_2\text{S}_{14}$. *Cylindrite* mineral group.
 Complex modulated layer structure not easy to define in detail.
 X-ray study: **NN Mozgova NI Orgonova AI Gorshkov** 1976 DAN USSR 228 110-3.
 TEM & model images; **TB Williams BG Hyde** 1988 AC B44 467-4;
 TB Williams BG Hyde 1988 PCM 15 521-44;
 S Wang KH Kuo 1991 AC A47 381-92 (W696);
 S Wang PR Buseck J Liu 1995 AM 80 1174-8 (1416).
 STM & AFM: **RB Henricksen & 4 others** 2002 AM 87 1273-8.

francoanellite $\text{H}_6(\text{K},\text{Na})_3(\text{Al},\text{Fe})_5(\text{PO}_4)_8 \cdot 13\text{aq}?$. Matches *synthetic*.
Synthetic $\text{K}_3\text{Al}_5(\text{HPO}_4)_6(\text{PO}_4)_2 \cdot 12\text{aq}$, structure: **S Dick T Zeiske** 1998 Z Naturforsch 53b 711-9.
 Occurrence: **F Balenzano L Dell'Anna M Dipiero** 1976 NJMM 49-57.
Synthetic $\text{H}_6\text{K}_3\text{Al}_5(\text{PO}_4)_8 \cdot 18\text{aq}$: **JP Smith WE Brown** 1959 AM 44 138-42.

françoisite-Nd $(\text{Nd},\text{Ce},\text{Sm})(\text{UO}_2)_3\text{O}(\text{OH})(\text{PO}_4)_2 \cdot 6\text{aq}$.
Phosphuranylite mineral group; geometrical isomer uudduuS; beware of problems.
 Review: **PC Burns ML Miller RC Ewing** 1996 CM 34 845-80.
 Structure: **P Piret M Deliens J Piret-Meunier** 1988 BM 111 443-9.
 Occurrence: MM 54 664
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
 Ce-rich: **J Janeczek** 1996 MM 60 665-9.

franconite $(\text{Na},\text{Ca})_2(\text{Nb},\text{Ti})_4\text{O}_{11} \cdot 9\text{aq}$.
 Structure determination not found.
 XRPD like *hochelagaite* $(\text{Ca},\text{Na},\text{Sr})(\text{Nb},\text{Ti},\text{Si},\text{Al})_4\text{O}_{11} \cdot 8\text{aq}$ & *ternovite* $(\text{Mg},\text{Ca})\text{Nb}_4\text{O}_{11} \cdot \text{naq}$.
 Occurrence: **JL Jambor & 5 others** 1984 CM 22 239-43 (J267).

francolite See *carbonate-fluorapatite*.

frankamenite $\text{K}_3\text{Na}_3\text{Ca}_5\text{Si}_{12}\text{O}_{30}(\text{F},\text{OH})_4 \cdot \text{aq}$. F-rich triclinic analog of *canasite*.
 Structure: **IV Rozhdestvenskaya LV Nikishova KA Lazebnik** 1996 MM 60 897-905.
 Occurrence: **LV Nishikova & 4 others** 1996 ZVMO 125 106-8 (N422).

frankdicksonite BaF_2 . *Fluorite* structure type.
 Structure: **AS Radtke GE Brown** 1974 AM 59 885-8.
 High-P XR&ND, transition 3 GPa to *cotunnite* structure type: **JM Leger & 4 others** 1995 PRB 52 13247-56 (L701).

frankhawthorneite $\text{Cu}_2\text{TeO}_4(\text{OH})_2$.
 Infinite framework of edge-shared CuO_6 & TeO_6 octahedra, anions occupy half of positions in hexagonal closest packing: **JD Grice AC Roberts** 1995 CM 33 649-53.
 Structural hierarchy of copper oxysalt minerals: **RK Eby FC Hawthorne** 1993 AC B49 28-56.
 Occurrence: **AC Roberts & 5 others** 1995 CM 33 641-7.

franklinfurnaceite $\text{Ca}_2\text{Fe}^{3+}\text{Mn}^{2+}_2[\text{Zn}_2\text{Si}_2\text{O}_{10}](\text{OH})_8$.
 Dioctahedral intermediate between *chlorite* & *mica*.
 Structure: **DR Peacor RC Rouse SW Bailey** 1988 AM 73 876-87.

franklinite $(\text{Zn},\text{Mn},\text{Fe})(\text{Fe}^{3+},\text{Mn}^{3+})_2\text{O}_4$. *Spinel* structure type.
 Structure: SC-XRD & Mössbauer, 9 Franklin & Sterling specimens, **S Lucchesi U Russo A Della Giusta** 1999 EJM 11 501-11 (L1001);
 Mn-rich, XRD, **AC Doriguetto NG Fernandes** 1999 AC C55 1751-3 (D798).
Synthetic ZnFe_2O_4 , phase change, high-P, XRPD: **D Levy A Pavese M Hanfland** 2000 PCM 27 636-44 (320).

franklinphilite $\text{K}_2\text{Mn}_{24}(\text{Si},\text{Al})_{36}(\text{O},\text{OH})_{108} \cdot \sim 6\text{aq}$.
Stilpnomelane structure group from crystallography.
 Essentially isostructural with Mg analog *lennilenapeite* & Fe analog *stilpnomelane*.
 Structure determination not found.
 Occurrence: **PJ Dunn DR Peacor S-C Sun** 1992 MR 23 465-8.

franquenite $2(\text{Mg},\text{Fe})\text{SO}_4 \cdot 6(\text{Fe},\text{Al})\text{OH}\text{SO}_4 \cdot 41\text{aq}$.
 Occurrence: MM 27 269.

fransoletite $\text{H}_2\text{Ca}_3\text{Be}_2(\text{PO}_4)_4 \cdot 4\text{aq}$.
 Structure: **AR Kampf** 1992 AM 77 848-56.

franzinite $(\text{Na},\text{K})_{15}\text{Ca}_5\text{Si}_{15}\text{Al}_{15}\text{O}_{60}(\text{SO}_4)_5 \cdot \text{aq}$. *Cancrinite* structure group.

ABCABACABC stacking. Consortium of Theoretical Frameworks net 201.

Review: **Sabelli** p.41.

Structure: **S Merlino P Orlandi** 1977 NJMM 163-7;

R Rinaldi H-R Wenk 1979 AC A35 825-8;

IR & SC-XRD, **P Ballirano & 3 others** 2000 CM 38 657-68;

XRPD, **P Ballirano A Maras** 2002 PD 16 216-9 (8471).

freboldite CoSe. *Niccolite* structure group.

Structure determination not found.

Occurrence: AM 44 907 & 41 164-5; MM 31 959.

fredrikssonite Mg₂(Mn,Fe)(BO₃)O₂.

3 Å Zigzag Borate: **MA Cooper FC Hawthorne** 1998 CM 36 1171-93.

2t2t polytype in *ludwigite* subgroup of *pinakioilite* structure family.

Structure: **PC Burns MA Cooper FC Hawthorne** 1994 CM 32 397-403 (B1591).

freedite Pb₁₅(Cu,Fe)₃As₄O₁₉Cl₁₀.

Structure: **F Pertlik** 1987 MP 36 85-92 (P536).

Compare with *thorikosite*.

freibergite (Ag,Cu,Fe)₁₂(Sb,As)₄S₁₃. *Tetrahedrite* structure group.

Structure: **R Kalbskopf** 1972 TMPM 18 147-55 (K250);

RC Peterson I Miller 1986 MM 50 717-21 (P632).

freislebenite PbAgSbS₃. Isostructural with As analog *marrite*.

Structural relations between *diaphorite*, *freislebenite*, *marrite* & *sicherite*: **P Berlepsch E**

Makovicky T Armbruster 2002 NJMA 178 75-91 (8796).

Structure: **E Hellner** 1957 ZK 109 284-95 (H92);

T Ito W Nowacki 1974 ZK 139 85-102 (I59).

fresnoite Ba₂TiSi₂O₈.

Melilite has similar cell dimensions but subtly different up-down of octahedral-tetrahedral layer.

Transition from P4bm to lower symmetry below 433 K.

Structure: **R Masse J-C Grenier A Durif** 1967 BSFMC 90 20-3;

PB Moore J Louisnathan 1967 S 156 1361-2 (M183); 1969 ZK 130 438-48 (M304).

Occurrence: MM 35 1134.

MAS-NMR, ²⁹Si: **ML Balmer & 4 others** 1997 JPCB 101 9170-9 (B1738);

A Labouriau TG Higley WL Earl 1998 JPCB102 2897-904.

Synthetic Ba₂TiGe₂O₈, NPD, modulated structure: **T Hoche & 4 others** 2003 ACB 59 209-16.

Synthetic Ba₂Ti_{1+x}Si_{2-x}O₈ (x = 0 to 0.14): **AM Coats & 3 others** 1996 JSSC 126 105-7 (C859).

Synthetic Ti₂V₃O₈: **J Tudo G Laplace B Jolibois** 1971 CRASP C 307.

Synthetic Ba₂VSi₂O₈: **A Feltz & 3 others** 1975 ZaaC 417 125;

SC-XRD structure, **T Hoche & 3 others** 2003 ZK 218 788-94 (10108).

Synthetic K₂(VO)(V₂O₇): **J Galy A Carpy** 1975 AC B31 1794-5.

Synthetic (NH₄)₂V₃O₈: **FR Theobald & 3 others** 1984 JPCS 45 581;

K-J Range R Zintl AM Heyns 1988 ZN B 43 309.

Synthetic (NH₄)₂V^{IV}O(V^V_{2-x}P_xO₇): **C Ninclaus & 3 others** 1996 JSSC 122 139-42 (N407).

Synthetic RbV₃O₈: **M-L Ha-Eierdanz U Müller** 1992 ZaaC 613 63;

SC-XRD & ED, **RL Withers & 5 others** 2004 JSSC 177 3316-23 (10960).

Synthetic (K/Rb/NH₄)₂V₃O₈: magnetism & structure of RbV₃O₈, **G Liu JE Greedan** 1995 JSSC 114 499-505 (L631).

Synthetic Ti & Ge types, ED & rigid-unit-mode analysis of incommensurate-modulated structure:

RL Withers & 3 others 2002 PCM 29 624-32 (8454).

[*Synthetic* Na₄Ti₂Si₈O₂₂.4aq = JDF-L1 is layered material with exchangeable cations that does not have fresnoite structure: **MA Roberts & 7 others** 1996 N 381 401-4 (R660).]

Synthetic, optics at phase transition: **T Asahi & 4 others** 2001 PR B 63 094104 (1337).

Useful piezoelectric with large electromechanical coupling & small T variation.

freudenbergite ~(Na,K)(Fe,Si)(Ti,Nb)₃O₈.

[jvs: may be some range of cation/anion ratios - see below].

Na,Ti-bronze structure type.

Synthetic Na_xTi₄O₈: structure, **S Andersson AD Wadsley** 1962 AC 15 201;
 structure model of freudenbergite by analogy, **AD Wadsley** 1964 ZK 120 396-8.
Synthetic NaTi₅O₁₀: **T Ishiguro & 5 others** 1978 AC B34 255-6.
Synthetic (Na_{0.35}Fe_{0.1})(Ti_{1.5}Fe_{0.4})(Ti_{1.8}Fe_{0.2})O₈: **EL Belokoneva YuYa Smirnikskaya** 1993 CrR 38 756-8 (B1090).
 Occurrence: MM 32 957;
 low- & high-Ti, Katzunbuckel, Germany, **V Stähle & 4 others** 2002 CM 40 1609-27.
Ferrous freudenbergite, Na₂FeTi₇O₁₆, inclusions in ilmenite macrocrysts from kimberlites: **AD Patchen LA Taylor N Pokhilenko** 1997 AM 82 991-1000.
 Possible Synroc phase for Na-bearing high-level waste: **ER Vance & 5 others** 1994 JACeS 77 1576-80 (V275).

[freyalite (Th,Ce)SiO₄?

Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.]

FRIEDELITE STRUCTURE GROUP

	Includes:	
<i>caryopillite</i>	(Mn,Mg) ₈ Si ₆ O ₁₅ (OH) ₁₂ [? jvs]	monoclinic
<i>ferropyrosmalite</i>	(Fe,Mn) ₈ Si ₆ O ₁₅ (OH,Cl) ₁₀	trigonal
<i>friedelite</i>	(Mn,Fe) ₈ Si ₆ O ₁₅ (OH,Cl) ₁₀	monoclinic
[<i>arsenite equivalent of friedelite</i>	see manganarsite]	
<i>manganarsite</i>	Mn ₃ As ₂ O ₄ (OH) ₄	trigonal
<i>manganpyrosmalite</i>	(Mn,Fe) ₈ Si ₆ O ₁₅ (OH,Cl) ₁₀	trigonal
<i>mcgillite</i>	Mn ₈ Si ₆ O ₁₅ (OH) ₈ Cl ₂	monoclinic
<i>nelenite</i>	(Mn,Fe) ₈ Si ₆ O ₁₅ (OH) ₇ [As _{1.5} O ₃ (OH) _{1.5}	monoclinic
<i>pyrosmalite</i>	(Fe,Mn) ₈ Si ₆ O ₁₅ (OH,Cl) ₁₀	trigonal
<i>schallerite</i>	Mn ₈ Si ₆ O ₁₅ (OH) ₇ [As _{1.5} O ₃ (OH) _{1.5}]	trigonal

[*arsenite equivalent of schallerite* -see manganarsite]

Polytypic/superstructure/twinning relationships & minor chemical differences [jvs: need to check further.]

friedelite (Mn,Fe)₈Si₆O₁₅(OH,Cl)₁₀. Friedelite structure group; monoclinic subtype.

Structure: **T Ozawa & 4 others** 1983 CM 21 7-17;

T Kato I Watanabe 1992 J Fac Liberal Arts, Yamaguchi Univ 26 51-63 = MJJ 1995 246.

[Friedel's salt 3CaO.Al₂O₃.CaCl₂.10aq - alpha (low-temperature) & beta (high-T).

Brucite-type layers separated by Cl & aq.

Important for Portland cement sealant in chloride environment such as nuclear waste in salt bed:

C Abate DE Scheetz 1995 JACeS 78 939-44 (A659).

Structure: **S Filippakis & 3 others** 1987 ZK 181 29-34.]

friedrichite Cu₅Pb₅Bi₇S₁₈.

Two *krupkaite* & 4 *aikinite* slabs, EM lattice images complex: **A Pring** 1989 AM 74 250-5.
 MM 42 524.

Occurrence, Romania: **M Shimizu & 4 others** 1998 CM 36 861-8.

fringelite Hydrocarbon dye in crinoid: MM 29 982.

fritzscheite ?Mn(UO₂)₂[(P,V)O₄]₂.4aq.

Structure determination not found.

Occurrence: **C Frondel** 1958 US Geol Surv Bull 1064 195-6.

frohbergite FeTe₂. *Marcasite* structure subgroup in *marcasite* supergroup.

Structure determination not found.

3d transition metal L-edge XAS, **JM Charnock & 3 others** 1996 PCM 23 403-8 (C878).

Occurrence: MM 28 730;

M Nakata & 3 others 1989 MM 53 387-90.

frolovite CaB₂(OH)₈. Isolated B(OH)₄ tetrahedra.

Structure: **YuK Egorov-Tismenko & 4 others** 1972 SPD 17 1-3 (E295) = MA 73-237;

MA Simonov & 4 others 1976 SPD 21 471-3 (S1343) = MA 78-263.

Occurrence: MM 31 959.

frondelite (Mn,Fe)Fe³⁺₄(PO₄)₃(OH)₅.

Isostructural series with Fe endmember *rockbridgeite*.

Structure determination not found.

Occurrence: MM 29 982.

froodite PbBi_2 . Alpha polymorph; beta is *urvantsevite*.

Structure: *synthetic*-alpha, **J Brasier W Hume-Rothery** 1959 J Less-Common Metals 1 157-64.

Distinct from *palladium bismuthide* PdBi_3 & *michenerite*.

Occurrence: MM 32 957; 36 1156;

JE Hawley LG Berry 1958 CM 6 200-9;

ND Tolstykh & 4 others 2000 EJM 12 431-40 (T641).

fuchsite

Occurrence: ultramafic enclaves, Almaden Hg mining district, **D Morata & 5 others** 2001 CIM 36 345-54 (3066).

fuenzalidaite $\text{K}_6(\text{Na,K})_4\text{Na}_6\text{Mg}_{10}(\text{SO}_4)_{12}\cdot 12\text{aq}$.

Isostructural with Se analog *carlosruizite*.

Structure: **JA Konnert & 3 others** 1994 AM 79 1002-8.

fukalite $\text{Ca}_4\text{Si}_2\text{O}_6(\text{CO}_3)(\text{OH,F})_2$.

Structure determination not found.

Occurrence: **C Henmi & 3 others** 1977 MJJ 8 374-81 (H943).

fukuchilite $(\text{Cu,Fe})\text{S}_2$. *Pyrite* structure group.

Structure: **P Bayliss** 1989 AM 74 1168-76 [jvs: synchrotron X-ray study might settle the concern that there might be superstructure diffractions.]

Occurrence: MM 37 959.

fullerenes C.

Geologic, review & analysis: **PR Buseck** 2002 EPSL 203 781-92 (8741).

Synthetic open-cage fullerenes: **Y Murata M Murata K Komatsu** 2003 CEJ 9 1600-9 (8849).

fülöppite / füllöppite $\text{Pb}_3\text{Sb}_8\text{S}_{15}$. *Plagionite* structure group with $n = 1$.

Review: **A Skowron ID Brown** 1994 AC B50 524-39 (S1374).

Structure: **A Edenharter W Nowacki** 1974 NJMM 92-4 (E143);

A Edenharter 1975 ZK 142 196-215 (E157);

EW Nuffield 1975 AC B31 151-7.

Occurrence: MM 22 620.

Synthetic $\text{Sb}_{10}\text{S}_{15}$: **JS Swinnea AJ Tenorio H Steinfink** 1985 AM 70 1056-8.

[fulvite] TiO . Cement & slag clinkers. Occurrence: MM 21 564.]

furongite $\text{Al}_2(\text{UO}_2)(\text{PO}_4)_2(\text{OH})_2\cdot 8\text{aq}$.

Coconinoite subgroup, *phosphuranylite* mineral group: **LN Belova & 3 others** 1994 IMA Pisa 36-7.

Structure analysis not found.

Occurrence: AM 63 425; MM 42 524.

furutobeite $(\text{Cu,Ag})_6\text{PbS}_4$. Structure determination not found.

Occurrence: **A Sugaki A Kitakaze Y Odashima** 1981 BM 104 737-41 (S1399).