Mineral structures M&N
Updated to 091806 by J V Smith

macallisterite / mcallisterite $Mg_2B_{12}O_{20}.15aq$.
Structure: **A Dal Negro C Sabelli L Ungaretti** 1969 Acc Naz Lincei Rend Cl Sci Fis Mat Nat 47 353-64 (D172) = MA 72-1852.
Occurrence: MM 35 1142.
macaulayite $Fe_{22}Al_2Si_4O_{43}(OH)_2$.
Proposed layer structure with silica/double hematite/silica layer separated by water layer.
Structure determination not found; Mössbauer, **DE Sawcer & 3 others** 1988 PCM 16 73-7.
Occurrence: **MJ Wilson & 4 others** 1984 MM 48 127-9.
macdonaldite $BaCa_4Si_{16}O_{36}(OH)_2.10aq$. *Delhayelite* structure group of layer silicates.
Structure: **E Cannillo G Rossi L Ungaretti** 1968 Accad Naz Lincei 45 399-414 (C201).
Occurrence: MM 35 1142.
macedonite $PbTiO_3$. *Perovskite* structure group.
Structure: **HD Megaw** 1946 Proc Roy Soc 58 133-52;
G Shirane R Pepinsky BC Frazer 1956 AC 9 131-40 (S1408).
XRPD, synthetic: PDF 6-0452.
Occurrence: **D Radusinovic C Markov** 1971 AM 56 387-94.
macfallite $Ca_2Mn_3(SiO_4)(Si_2O_7)(OH)_3$.
Structure: **PB Moore J Shen T Araki** 1985 AM 70 171-81.
Occurrence: MM 43 1063.
machatschkiite $Ca_{6-x}Na_x(AsO_4)(AsO_3OH)(PO_4)_{1-x}(SO_4)_x.15aq$, x ~0.3.
Review: **Sabelli** p. 41.
Structure: **H Effenberger & 3 others** 1982 TMPM 30 145-55 (E332).
mackayite $FeTe_2O_5OH$.
Structure: **F Pertlik** 1969 TMPM 13 219-32 (P132);
synthetic, **F Pertlik A Gieren** 1977 NJMM 145-54.
Occurrence: MM 27 271.
mackinawite $(Fe,Ni)S_{1-x}$. PbO *litharge* structure type.
Structure: **RA Berner** 1962 S 137 669;
NPD, 2 K, no magnetic ordering, **EF Bertaut & 2 others** 1965 Solid State Comm 3 335-8 (B1342);
O Kuovo Y Vuorelainen JVP Long 1963 AM 48 511-24;
synthetic FeS, **M Uda** 1968 ZaaC 361 94-8;
LA Taylor LW Finger 1970 CIWYB 69 318-22;
synthetic, XRPD, **AR Lennie & 3 others** 1995 MM 59 677-83;
synthetic, disordered, **M Wolthers SJ Van der Gaast D Rickard** 2003 AM 88 2007-15.
Occurrence: MM 33 1142.
Adsorption & coprecipitation of divalent metals: **JW Morse T Araki** 1993 GCA 57 3635-40.
Phase relations: **RE Krupp** 1994 EJM 6 265-78.
Transformation to *greigite*, in situ XRPD and TEM: **AR Lennie & 5 others** 1997 AM 82 302-9.
Reaction of Cu & Cd with powder in water, XAS & surface-structure models: **RH Parkman & 5 others** 1999 AM 84 407-19.
U adsorption, XAS: **LN Moyes et al** 2000 EST 34 1062-8 (M1795).
Pb/Cd retention mechanisms vs pH: **CA Coles SR Rao RN Yong** 2000 EST 34 998-1000 (C1157).
Persists to 393 K when anoxic, & oxic transformation to *greigite, pyrite,* & *goethite*, time-resolved XRD: **CL Cahill & 3 others** 2000 ChG 167 53-63 (C1145).
Precursor to *pyrite*, reactions < 373 K: **LG Benning RT Wilkin HL Barnes** 2000 ChG 167 25 51 (B1997).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Synthetic FeSe, **G Hägg AL Kindstrom** 1933 Z Phys Chem 22 453-**?**.
macphersonite $Pb_4(SO_4)(CO_3)_2(OH)_2$. Trimorphic with *leadhillite* & *susannite*.
Structure: SC-XRD, **IM Steele JJ Pluth A Livingstone** 1998 MM 62 451-9.
Description: MM 48 577.
macquartite $Pb_7Cu_2(CrO_4)_4(SiO_4)_2\ (OH)_2$.

Probably isostructural with *wherryite* $Pb_7Cu_2(SO_4)_4(SiO_4)_2(OH)_2$, hence revised composition:
M Cooper FC Hawthorne 1994 CM 32 373-80.
Structure determination not found.
Occurrence: **SA Williams M Duggan** 1980 BM 103 530-2 (W673) = AM 66 638.

madocite $Pb_{17}(Sb,As)_{16}S_{41}$.
Structure determination not found.
Occurrence: **JL Jambor** 1967 CM 9 7-24.

magadiite $NaSi_7O_{13}(OH)_3.4aq$.
Structure determination not found.

2D ^{23}Na MQ MAS NMR of layered silicates: **H Minoru RK Harris** 1998 JMC 8 1073-9.
FT-IR & -Raman: **Y Huang Z Jiang W Schwieger** 1999 ChM 11 1210-7 (H1407).
Surface heterogeneity & adsorption: **C Eypert-Blaison & 6 others** 2002 ClM 37 531-42.
Occurrence: **HP Eugster** 1967 S 157 1177-80 (E303);
HP Eugster BF Jones 1968 S 161 160-3 (E78);
TP Rooney BF Jones JT Neal 1969 AM 54 1034-43;
Lake Chad, **D Sebag EP Verrecchia S Lee A Durand** 2001 SG 139 15-31 (1386).
Crystallography & *synthesis*: ED & XRPD, **JL McAtee Jr R House HP Eugster** 1968 AM 53 2061-9.
Unit cell of H-, Na-, & Ca- under dehydration & glycolation, **GW Brindley** 1969 AM 54 1583-91.
Synthetic Na- & organic derivatives, transformation to silica minerals: **G Lagaly K Beneke A Weiss** 1975 AM 60 642-9.
H- & intercalation compounds, **G Lagaly K Beneke A Weiss** 1975 AM 60 650-8.
Silhydrite/magadiite transformations & intercalation: **K Beneke G Lagaly** 1977 ClM 12 363-5.
^{29}Si NMR: **W Schwieger D Heidemann K-H Bergk** 1985 Rev Chim Mineral 22 639-50 S1527).
Synthesis in presence of various cations: **RA Fletcher DM Biddy** 1987 ClClM 35 318-20.
Hypothetical layer structure: **JM Garces SC Rocke CE Crowder DL Hasha** 1988 ClClM 36 409-18 (G706).
NMR & IR of HCl-treated magadiite: **JM Rojo E Ruiz-Hitzky J Sanz** 1988 IC 27 2785-90.
SiO_2-Y = magadiite, intermediate product silica gel to *quartz*: **H Muraishi** 1989 AM 74 1147-51.

Silica-pillared H^+-: **JS Dailey TJ Pinnavaia** 1992 ChM 4 855-63 (D587).
Keggin-ion pillared magadiite: **S Wong S Cheng** 1993 ChM 5 770-7.
Hybrid organic-inorganic nanocomposite with epoxy polymer: **Z Wang T Lan TJ Pinnavaia** 1996 ChM 8 2200-7 (W772).
Synthesis, modification & catalysis: **E Terres-Rojas & 4 others** 1997 CI 69 567-94.
Synthesis in glycerol: **S Yang AG Vlessidis NP Evmiridis** 1997 MiMa 9 273-86.
Recrystallization to MFI/MEL with TPA & TBA: **G Pal-Borbely HK Beyer Y Kiyozumi F Mizukami** 1997 MiMa 11 45-51.
Benzene sorption: **CS Kim DM Yates PJ Heaney** 1997 ClClM 45 881-5 (K1036).
Source for silica-pillared molecular sieves: **S Jeong & 4 others** 1997 Stud Surface Sci Catal 105A 53-60.
Synthesis of *ferrierite* from Al-containing wet *magadiite*: **G Pál-Borbély & 3 others** 1998 MMM 22 57-68 (P796).
Carbon nanotubes on surface covered Co(II)/Fe(III): **K Mukhopadhyay & 5 others** 1999 12th Int Zeolite Conf 917-21.
Al-containing magadiite pillared with inorganic polymer ions to generate ZSM-5 & MCM-41: **A Fudala & 6 others** 1999 12th Int Zeolite Conf 1685-92.
Synthetic layer silicate with helical morphology: **Y Akiyama & 5 others** 1999 AnCh 38 1420-2 (A884).
Synthetic mesoporous composite: **A Fudala & 8 others** 2000 MMM 35-36 631-41 (F689).
Synthetic alkyltrimethyl-ammonium-intercalated: **HO Pastore & 2 others** 2000 ClClM 48 224-9 (P891).
Synthetic silica-pillared with intercalated amine-tetraethylorthosilicate: **O Kwon H Shin S Choi** 2000 ChM 12 1273-8.
Synthetic protonated, NMR of silanol: **Y Komori & 4 others** 2000 ClClM 48 632-7 (903).
Synthetic B-, sharp-peak NMR & XRPD, & of magadiite/*kenyaite* mixtures, **CA Fyfe J Skibsted W Schwieger** 2001 IC 40 5906-12 (3511).
Interlamellar esterification of H- with aliphatic alcohols: **Y Mitamura & 4 others** 2001 ChM 13 3747-53 (3477).
Synthetic Na- & H-, IR, Raman & MAS-NMR: **C Eypert-Blaison & 5 others** 2001 ChM 13 4439-46 (3875).
H/Na/K/Mg/Ca-exchanged, hydration water & swelling behavior, XRPD, IR, Raman, MAS-NMR: **C Eypert-Blaison & 5 others** 2002 JPCB 106 730-42 (4360).
Magadiite-silica monoliths: **K Kikuta K Ohta K Takagi** 2002 ChM 14 3123-7 (7722).
MAS-NMR for H, Si & Na, 2 types of Q(3) Si and 2 Na, H bonding: **C Gardiennet P Tekely** 2002 JPCB 106 8928-36 (7943).
Eu^{3+}-intercalate, XRPD, luminescence: **N Mizukami & 3 others** 2002 ClClM 50 799-806 (8661).
Natural/*synthetic*: stability 293-373 K, **M Dietzel I Letofsky-Papst** 2002 ClClM 50 657-66 (8356).
Synthetic interlamellar silylated derivatives: **I Fujita K Kuroda M Ogawa** 2003 ChM 15 3134-41 (9306).
[**LD Rollmann & 4 others** 2002 *MCM-69, a novel layered analogue of EU-19*, MMM 53 179-93 (7351).]

magbasite $KBa(Al,Sc)(Mg,Fe)_6O_{20}F_2$.
Structure determination not found.
Occurrence: **EI Semenov AP Khomyakov AV Bykova** 1965 DAN 163 718-9 = AM 51 530-1.
maghagendorfite $NaMgMnFe_2(PO_4)_3$. *Hagendorfite* structure group.
Structure determination not found.
Occurrence: **PB Moore J Ito** 1979 MM 43 227-35.
maghemite Fe_2O_3 -gamma. Ordered Li-ferrite structure type. Dimorphic with *hematite*.
Entropy/heat capacity *goethite, lepidocrocite &*: **J Majzlan & 5 others** 2003 AM 88 846-54.
Structure: **PPK Smith** 1979 CMP 69 249-54;
Mössbauer, *synthetic* & Al-substituted-: **GM Da Costa & 4 others** 1994 ClClM 42 628-33, 1995 43 562-8, 1995 PCM 22 178-85;
IR, **C Pecharroman T Gonzalez-Carrreno JE Inglesias** 1995 PCM 22 21-9.
Ferrihydrite to nanocrystal maghemite at 423 K on way to *hematite*: **V Barron J Torrent** 2002 GCA 66 2801-6 (7795).
Hypogene Ti,V-, Portugal: **AP Jesus & 5 others** 2003 CM 41 1105-24.
Occurrence: MM 22 624.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
[Magnéli phases Ti_5O_9 & Ti_8O_{15}.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.]
magnesio-alumino-katophorite *Amphibole* structure group; possible endmember.
magnesio-arfvedsonite $Na_3(Mg,Fe)_4FeSi_8O_{22}(OH)_2$.
Amphibole structure group; endmember.
Review: **BE Leake** 1978 AM 63 1023-52.
magnesio-astrophyllite $(K,Na)_3(Mg,Fe,Mn)_7Ti_2Si_8O_{24}(O,OH)_7$. See *astrophyllite.*
magnesioaubertite $(Mg,Cu)Al(SO_4)_2Cl.14aq$.
Isostructural with *aubertite* $CuAl(SO_4)_2Cl.14aq$.
Occurrence: **G Gebhard O Medenbach W Gebert** 1988 Aufschluss 39 97 = MM 54 667.
magnesioaxinite / magnesio-axinite $Ca_2MgAl_2BSi_4O_{15}OH$. *Axinite* structure group.
Structure: SC-XRD, **GB Andreozzi S Lucchesi G Graziani** 2000 EJM 12 1185-94 (299).
Occurrence: **EA Jobbins AE Tresham BR Young** 1975 J Gemmol 14 368-75 = AM 61 503.
magnesiocarpholite $\sim MgAl_2Si_2O_6(OH)_4$. *Carpholite* structure type.
Structure: **K Viswanathan** 1981 AM 66 1080-5;
SC-XRD, Raman, FTIR, **Y Fuchs M Mellini I Memmi** 2001 EJM 13 533-43 (2069).
magnesiochloritoid $Mg_2Al_4Si_2O_{10}(OH)_4$. *Chloritoid* structure type.
Structure: monoclinic at 298 & 973 K, **G Ivaldi M Catti G Ferraris** 1988 AM 73 358-64;
P Comodi M Mellini PF Zanazzi 1992 PCM 483-90.
Transition to tetragonal modification at 10 K: **H Ehrenberg & 3 others** 2002 PD 17 230-2 (7958).
Occurrence: MM 50 751.
Compression to 7 GPa: **KD Grevel DW Fasshauer S Erzner** 1997 EJM Suppl 9-1 138 (G944).
Thermodynamics: **KD Grevel & 5 others** 2005 EJM 17 587-98.
magnesiochromite $(Mg,Fe)(Cr,Al)_2O_4$. *Spinel* structure group.
Becomes antiferromagnetic at 12 K.
Structure: ND, **R Plumier** 1968 CRASP 267 B 98-101;
RJ Hill JR Craig GV Gibbs 1979 PCM 4 317-39;
XRPD, **HSC O'Neill WA Dollase** 1994 PCM 20 541-55.
Heat capacity (antiferromagnetic anomaly) & thermodynamics 1.5-340 K: **S Klemme & 3 others** 2000 AM 85 1686-93.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
magnesio-clinoholmquistite $Li_2(Mg,Fe)_3Al_2Si_8O_{22}(OH)_2$.
Amphibole structure group; endmember.
Review: **BE Leake** 1978 AM 63 1023-52.
magnesiocolumbite $(Mg,Fe,Mn)(Nb,Ta)_2O_6$. *Columbite* structure group.
Structure determination not found. XRPD matches *synthetic*.
Occurrence: **VV Mathias & 3 others** 1963 DAN 148 420-3 = AM 48 1182-3.

magnesiocopiapite $Mg_4(SO_4)_6(OH)_2.20aq$.
Copiapite structure group. Review: **Sabelli** p.20.
Structure: **P Süsse** 1972 ZK 135 34-55.
magnesiocoulsonite MgV_2O_4. *Spinel* type from XRD.
Occurrence: **LZ Reznitskii EV Sklyarov ZF Ushchapovskaya** 1995 ZVMO 124 91-8.
magnesiocummingtonite *Amphibole* structure type.
magnesiodumortierite Variable composition. Isostructural with *dumortierite*.
Structure: **G Ferraris G Ivaldi C Chopin** 1995 EJM 71 161-74.
Occurrence: **C Chopin & 7 others** 1995 EJM 7 525-35 (C765).
magnesio-ferrifluor-katophorite *Amphibole*. MM 60 675.
magnesio-ferrifluor-oxy-katophorite *Amphibole*. MM 60 675.
magnesio-ferri-katophorite $Na_2Ca(Mg,Fe)_4Fe(Si_7Al)O_{22}(OH)_2$.
Amphibole structure group; endmember.
Structure: **DYu Pushcharovskii & 5 others** 2003 CrR 48 16-23 (8791).
Review: **BE Leake** 1978 AM 63 1023-52.
magnesio-ferri-taramite. *Amphibole*. MM 42 526.
magnesioferrite $MgFe_2O_4$. *Spinel* structure group.
Structure: **RJ Hill JR Craig GV Gibbs** 1979 PCM 4 317-39;
HSC O'Neill H Annersten D Virgo 1992 AM 77 725-40.
High-P transition: to *magnetite* type: **HK Mao PM Bell** 1975 CIWYB 74 555-6;
to $CaMn_2O_4$ type, then *stishovite* + *spinel*, & finally *perovskite* type: **D Andrault N Bolfan-Casanova** 2001 PCM 28 211-7 (1636).
Cation ordering to 1430 K & 6 GPa, XRPD: **SM Antao & 4 others** 205 AM 90 1500-5..
Mechanism of cation ordering during isothermal annealing, magnetic susceptibility: **RJ Harrison A Putnis** 1999 PCM 26 322-32 (H1410).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
magnesiofoitite $(Mg_2Al)Al_6(Si_6O_{18})(BO_3)_3(OH)_4$. *Tourmaline* structure.
Occurrence & XRPD: **FC Hawthorne & 6 others** 1999 CM 37 1439-43.
magnesiohastingsite $NaCa_2(Mg,Fe)_4Fe(Si_6Al_2)O_{22}(OH)_2$.
Amphibole structure group; endmember. Review: **BE Leake** 1978 AM 63 1023-52.
Structure: **EM Walitzi F Walter** 1981 ZK 156 197-208.
magnesiohögbomite $Mg(Al,Fe,Ti)_4O_7$. *Högbomite* structure group.
Structure: polytypes, **D McKie** 1963 MM 33 563-80;
8H, **BM Gatehouse IE Grey** 1982 AM 67 373-82;
24R, **K Schmetzer A Berger** 1990 NJMM 401-22;
10T, 12H, 14T & 24R, **C Hjeny T Armbruster** 200 AM 87 277-92.
Occurrence: AM 89 819-31.
magnesioholmquistite *Amphibole* family.
magnesio-hornblende $Ca_2(Mg,Fe)_4Al(Si_7Al)O_{22}(OH,F)_2$.
Amphibole structure group; endmember. Review: **BE Leake** 1978 AM 63 1023-52.
magnesiohulsite $(Mg,Fe)_2(Fe,Sn,Mg)(BO_3)O_2$. Fe analog is *hulsite*.
6 Å Zigzag Borate: **MA Cooper FC Hawthorne** 1998 CM 36 1171-93.
Structure: **G Yang Z Peng Z Pan** 1985 Acta Miner Sinica 5 97-101 = AM 73 929.
magnesionigerite-2N1S & -6N6S $(Mg,Zn,Fe,Al)_4(Sn,Fe)_2(Al,void)_{10}O_{22}(OH)_2$.
Structure: **J Chen G Yang Z Pan N Shi Z Peng** 1989 Acta Mineral Sinica 9 20-4.
magnesioriebeckite $Na_2(Mg,Fe)_3Fe_2Si_8O_{22}(OH)_2$.
Amphibole structure group; endmember. Review: **BE Leake** 1978 AM 63 1023-52.
magnesiosadanagaite $NaCa_2[Mg_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$.
Amphibole structure group; endmember. Review: **BE Leake** 1978 AM 63 1023-52.
Occurrence: Japan, & SC-XRD, **Y Banno & 6 others** 2004 EJM 16 177-83 (10140).
magnesiostaurolite *Staurolite* analog.
Occurrence & SC-XRD: **C Chopin & 3 others** 2003 EJM 15 167-76 (8909).
magnesiotaaffeite-2N'2S $Mg_3BeAl_8O_{16}$ *Taaffeeite* group. *Taaffeite* renamed

Structure: **CC Peng KJ Wang** 1963 Scientia Sinica 12 276-8;
new polytype, **DR Hudson AF Wilson IM Threadgold** 1967 MM 36 305-10;
-8H, **B Nuber K Schmetzer** 1983 NJMM 393-402.
Purple Cr-: **K Schmetzer L Kiefert H Bernhardt** 2000 Gems Gemology Spring 50-9 (S2192).
magnesiotaaffeite-6N'3S $(Mg,Fe,Zn)_2Al_6BeO_{12}$. *Taaffeeite* group. *Musgravite* renamed
Structure: **B Nuber K Schmetzer** 1983 NJMM 393-402.
[jvs: note that described as both 9R & 18R; use the latter.]
Compare with *hogbomite*, *nigerite* & *taaffeite*.
Occurrence: & nomenclature, **K Schmetzer** 1983 NJMA 146 15-28;
& crystallography: **B Chadwick & 3 others** 1993 MM 57 121-9.
magnesiotantalite $(Mg,Fe)(Ta,Nb)_2O_6$. *Columbite* group.
Occurrence & XRPD: **IV Pekov & 3 others** 2003 ZVMO 132 49-59.
magnesiotaramite $Na_2Ca(Mg,Fe)_3Al_2(Si_6Al_2)O_{22}(OH)_2$.
Amphibole structure group; endmember. Review: **BE Leake** 1978 AM 63 1023-52.
magnesiowüstite Defined originally as MgO to $Mg_{0.22}Fe_{0.78}O$.
Compare with *periclase* MgO &*wüstite* $Fe_{1-x}O$.
Definition: MM 24 616.
jvs: probably too late to persuade geophysicists to accept redefinition, but should really be called *ferrous periclase* up to Mg = Fe.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Reaction with Fe-Ni alloy 1-40 GPa simulating lower mantle/core: **S Kesson & 4 others** 1997 AM 82 526-33.
Thermoelasticity: **J Hama K Suito OL Anderson** 2000 AM 85 321-8.
Pressure-induced instability: **SD Jacobsen & 3 others** 2004 PNAS 101 5867-71 (10219).
magnesite $(Mg,Fe)CO_3$. *Calcite* structure group.
Structure: **KD Oh H Morikawa S Iwai H Aoki** 1973 AM 58 1029-33;
H Effenberger K Mereiter J Zemann 1981 ZK 156 238-43;
SA Markgraf RJ Reeder 1985 AM 70 590-600;
G Göttlicher A Vegas 1988 AC B44 362-7;
EN Maslen VA Streltsov NR Streltsova 1993 AC B49 980-4;
G Fiquet F Guyot J-P Itié 1994 AM 79 15-23;
EN Maslen VA Streltsov NR Streltsova 1993 AC B49 636-41;
XRD & electron density, **EN Maslen & 3 others** 1995 AC B51 929-39;
theoretical factors & electron density, **M Catti A Pavese** 1996 AC A52 413-8 (C831).
Anisotropic thermal expansion to 1 GPa & 763 K: **T Wu & 4 others** 1995 AM 80 941-6.
XRD in DIA cell to 9 GPA & 1300K: **J Zhang & 4 others** 1997 PCM 24 122-30 (Z129).
Equation of state at high-P, **NL Ross** 1997 AM 82 682-8;
new data & reappraisal, **G Fiquet B Reynard** 1999 AM 84 856-60;
structure at 80 GPa: **G Fiquet & 5 others** 2002 AM 87 1261-5;
IR of C-O bonding to 60 GPa, **J Santilann & 2 others** 2005 AM 90 1669-73.
Dissolution kinetics, (104) surface morphology, AFM: **SR Higgins & 5 others** 2002 JPCB 106 6696-95 (7450).
Occurrence in *diamond*: MA 96M/4551.
In meteorites: **AE Rubin** 1997 MPS 32 231-47;
Mars dust, **JL Banfield TD Glotch PR Christensen** 2003 S 301 1084-7 (9276).
Siderite-magnesite ss, FTIR: **ME Böttcher P-L Gehlken** 1995 NJMA 169 81-95.
magnesium Mg. Synthetic metal has hexagonal closest packing of spheres: **Wells**.
Occurrence: Tien Shan glimmerite & Yakutia alluvium: **MI Novgorodova** 1996 Geokh (1) 41-50 (N399).
magnesium astrophyllite $K_2Na[Na(Fe,Mn)_4Mg_2]Ti_2Si_8O_{26}(OH)_4$void
Astrophyllite structure group.
Occurrence & crystal chemistry: **C Peng C Ma** 1963 Sci Sinica 12 272-6 = AM 60 737;
X-ray Lab Hubei Geologic College 1974 Sci Geol Sinica 1 18-33 = AM 60 737.
magnesium-chlorophoenicite $(Mg,Mn)_3Zn_2(AsO_4)(OH,O)_6$.
Chlorophoenicite structure group.
Structure determination not found.
Occurrence: MM 24 616; **Dana**.
magnesium-pennantite Analog of *pennantite*. MM 39 918-9.

magnesium-zippeite $Mg(UO_2)_2(SO_4)O_2.3.5aq$. *Zippeite* structure group.
Review: **Sabelli**, no structure.
Redefined: **J Brugger PC Burns N Meisser** 2003 AM 88 676-85.
Structure determination not found, but XRPD matches *synthetic*: **V Spitsyn & 4 others** 1982 Izv Akad Nauk SSSR Ser Khim 807-12.
Occurrence: **C Frondel et al** 1976 CM 14 429-36.

magnetite $Fe^{2+}Fe^{3+}{}_2O_4$. *Spinel* structure type.
Structure: low-T transition, **SC Abrahams BA Caldoun** 1953 AC 6 105-6;
WC Hamilton 1955 PR 110 1050-7;
W O'Reilly 1968 AC B24 422-4 (O56);
G Kullerud G Donnay JGH Donnay 1969 ZK 128 1-17 (K161);
RJ Hill JR Craig GV Gibbs 1979 PCM 4 317-39;
ME Fleet 1981 AC B37 917-20 (F435);
defect, **ME Fleet** 1982 AC B38 1711-23;
10K below Verwey transition temperature, **M Iizumi & 5 others** 1982 AC B38 2121-33;
ME Fleet 1984 AC C40 1491-3;
A Della Giusta F Princivalle S Carbonin 1987 MP 37 315-21 (D530);
SC-XRD 126-773 K, **H Okudera K Kihara T Matsumoto** 1996 AC B52 450-7 (O319);
cation-deficient, SC-XRD 295 K, **H Okudera** 1997 ZK 212 458-61 (O336);
radial electron density, SC-XRD, **S Sasaki** 1997 AC B53 762-6 (S1809);
2- & 3-beam XRD of domains, **C Medrano et al** 1998 JACr 31 726-32 (416);
charge ordering from XAS, **T Toyoda S Sasaki M Tanaka** 1999 AM 84 294-8;
ferri- & paramagnetic, multiple ND, **VL Mazzocchi CBR Parente** 1998 JACr 31 718-25 (M1739);
resonant "forbidden" reflexions & magnetism, **J Garcia & 8 others** 2000 PRL 85 578-81 (G1210);
Raman, **ON Shebanova P Lazor** 2003 JSSC 174 424-30 (9316).
Biogenic: marine magnetotactic bacterium & nonmagnetotactic Fe-reducing bacterium, HRTEM, XRD & Mössbauer, **NHC Sparks & 5 others** 1990 EPSL 98 14-22;
anaerobic biooxidation of Fe(II) & denitrification, **SK Chaudhuri JG Lack JD Coates** 2001 Appl Environ Microbiology 67 2844-8 (2118).
High-P: **LW Finger RM Hazen AM Hofmeister** 1986 PCM 13 215-20;
N Nakagiri MH Manghnani S Kimura 1986 PCM 13 238-44;
structure, **Y Fei & 4 others** 1999 AM 84 203-6;
structure to 43 GPa, transition to orthorhombic, **C Haavik et al** 2000 AM 85 514-23
9 GPa, SC-XRD, elasticity, **HJ Reichmann SD Jacobsen** 2004 AM 89 1061-6;
demagnetization, **G Kletetschka & 3 others** 2004 MPS 39 1839-48..
Curie temperature, magnetic susceptibility & cation ordering of $(Fe_3O_4)_x(MgAl_2O_4)_{1-x}$: **RJ Harrison A Putnis** 1996 AM 81 375-84;
exsolution microstructure & magnetism, **RJ Harrison A Putnis** 1997 AM 82 131-42.
Structure of 001 surface from STM: **G Tarrach & 4 others** 1993 SuS 285 1-14 (412).
Structure of 111 surface: LEED, **A Barbieri & 3 others** 1994 SuS 302 259-79;
STM, **AR Lennie & 5 others** 1996 PRB 53 10244-53 (L860);
biphase ordering, **NG Condon & 5 others** 1997 PRB 55 15885-94 (C938).
Electrical resistivity to 48 GPa: **ER Morris Q Williams** 1997 JGR 102B 18139-48 (M1527).
Surface passivation by reaction with aqueous Cr(VI), XAFS/TEM: **ML Peterson & 3 others** 1997 EST 31 1573-6 (420).
Spinodal decomposition in hercynite-, TEM & susceptibility: **U Golla-Schindler & 2 others** 2005 AM 90 1278-83.
In meteorites: **AE Rubin** 1997 MPS 32 231-47;
Martian ALHA84001, **KL Thomas-Keprta & 9 others** 2001 PNAS 98 2164-9 (1329), **EI Friedmann & 3 others** 2176-81 (1331);
elongated prisms, Mars: **KL Thomas-Keprta & 8 others** 2000 GCA 64 4049-81 (326);
TEM, inorganic not biogenic, **DJ Barber ERD Scott** 2002 PNAS 99 6556-61 (8622);
inorganic, **DC Golden & 10 others** 2004 AM 89 681-95;
Martian ALH84001, magnetics, **BP Weiss & 6 others** 2004 PNAS 101 8281-4 (10397).
Proton-induced surface charge: **DJ Wesolowski & 3 others** 2000 CG 167 193-229 (W1005).
Microbial reduction of Fe (III), XRD/Mössbauer, SEM/TEM: **H Dong & 5 others** 2000 CG 169 299-316 (418).
High-Ti from carbonatites: **DK Bailey S Kearns** 2002 AM 66 379-84.
See *titanomagnetite*.

MAGNETOPLUMBITE STRUCTURE GROUP Includes:

batiferrite	$BaTi_2Fe_{10}O_{19}$
beta-alumina	$CaAl_{12}O_{19}$
diaoyudaoite	$NaAl_{11}O_{17}$
haggertyite	~$BaMgFe_2Ti_5Fe_4O_{19}$
hawthorneite	$BaTi_3Cr_4Fe_4Mg\ O_{19}$
hibonite	$(Ca,Ce)(Al,Ti,Mg)_{12}O_{19}$
magnetoplumbite	$Pb(Fe^{3+},Mn^{3+})_{12}O_{19}$
nezilovite	$PbZn_2(Mn^{4+},Ti)_2Fe_8O_{19}$
plumboferrite	$Pb[PbFe_{11}]O_{19-x}$
yimengite	$K(Cr,Ti,Fe,Mg,Al)_{12}O_{19}$

Synthetic $SrFe_{12}O_{19}$: Mössbauer, **PM Rao A Geerard F Granjean** 1979 MRB 23 685-92.

Synthetic $BaFe_{12}O_{19}$: structure, **X Obradors & 4 others** 1985 JSSC 56 171-81;
Mössbauer, **E Kreber U Fonser** 1976 Appl Phys 10 175-80.

Synthetic $LaNiAl_{11}O_{19}$: structure, **F Laville & 5 others** 1986 JSSC 65 301-8.

Synthetic $SrAl_xFe_{12-x}O_{19}$: **F Sandiumenge S Gali J Rodriguez** 1988 MRB 23 685-92.

Synthetic $BaMg_6Ti_6O_{19}$: 1989 Izv Akad Nauk SSSR Neorg Mater 25 1932-3 = SR 56A 134.

Synthetic $Sr(Al,Cr)_{12}O_{19}$: 1989 JSSC 81 109 = SR 56A 272.

Synthetic $BaMg_6Ti_6O_{19}$: 1989 MRB 24 475 = SR 56A 272.

Synthetic $PbAl_{12}O_{19}$: structure, **N Iyi S Tatekawa S Kimura** 1990 JSSC 85 318-20.

Synthetic $Ba(Fe/Co+Ti)_{12}O_{19}$: ND, **MV Cabanas & 3 others** 1994 JSSC 111 229-37.

Synthetic $SrGa_{12}O_{19}$: **H Graetsch W Gebert** 1994 ZK 209 338-42.

Synthetic $SrCo_6Ti_6O_{19}$: **do** 1995 ZK 210 9-18.

Synthetic $CaMgAl_{14}O_{23}/CaMg_2Al_{16}O_{27}$, structure: **N Iyi M Göbbels Y Matsui** 1995 JSSC 120 364-71 (I139).

Synthetic $Sr_2MgAl_{22}O_{36}$, mixed-layer beta-alumina/magnetoplumbite: **N Iyi M Göbbels** 1996 JSSC 122 46-52 (I141).

Synthetic $SrCr_9Ga_3O_{19}$: **H Graetsch W Gebert** 1996 ZK 211 25-30 (G832).

Synthetic $Ba(Al,Ga)_{12}O_{19}$: **T Yamaguchi & 3 others** 2001 JACeS 84 1433-8 (3148).

magnetoplumbite $Pb(Fe^{3+},Mn^{3+})_{12}O_{19}$. Magnetoplumbite structure group.

Structure: **V Adelsköld** 1938 Ark Kem Mineral Geol 12A-29 1-9;
ND, **OP Aleshko-Ozhevskii MK Faek Il Yamzin** 1969 SPC 14 367-0 (A554) – also $Ba/SrFe_{12}O_{19}$;
IE Grey IC Madsen SE Haggerty 1987 AM 72 633-6;
PB Moore PK Sen Gupta Y Le Page 1989 AM 74 86-94;
Zn-rich, **V Bermanec S Scavnicar** 1993 NJMM 481-6;
V Bermanec & 5 others 1996 CM 34 1297-97.

Occurrence: MM 21 570.

Plumboferrite has defect magnetoplumbite structure type with double *a* & *c*.

Synthetic, with composition transitional to *plumboferrite*: **D Holtsam** 2003 NJMM 55-73.

Mixed layer polytypes: AM 50 1371-80.

See *hibonite* for Al-rich synthetics.

magniotriplite = Mg-triplite $(Mg,Fe,Mn)_2(PO_4)F$. *Triplite/triploidite* structure group.

Structure: **C Tadini** 1981 BM 104 677-80.

magnolite Hg_2TeO_3.

Structure: **JD Grice** 1989 CM 27 133-6.

magnussonite $Mn_5As_3O_9(OH,Cl)$.

Structure: cubic, **PB Moore T Araki** 1979 AM 64 390-401.

Optical absorption/Mössbauer, Fe-substituted ?non-cubic: **U Hålenius B Lindqvist** 1996 EJM 8 25-34.

Occurrence: MM 31 966;
P Nysten 2003 CM 41 201-6.

[magursilite $Mg_4[(UO_2)_4(Si_2O_5)_5(OH)_6].15aq$. *Weeksite* mineral group.

Occurrence: ?; **Povarennyk** p. 457.]

mahlmoodite $FeZr(PO_4)_2.4aq$. XRPD match with *synthetic* $(Mn/Co/Ni/Cu/Zn)Zr(PO_4)_2.4aq$.
Structure determination not found, but layer is related to that in various *synthetic* phases.
Occurrence & crystallography: **C Milton JJ McGee HT Evans Jr** 1993 AM 78 437-40;
NJ Elton JJ Hooper 1995 MM 59 166-8.

mahnertite $(Na,Ca)Cu_{2.75}(AsO_4)_2Cl_{0.6}.3.6aq$. Related to *zdenekite.*
Structure: SC-XRD, **DY Puscharovsky & 4 others** 2004 EJM 16 687-92 (10619).
Occurrence & XRD: **H Sarp** 1996 Archs Sci Genéve 49 119-24 = AM 82 1262.

maikainite $Cu_{10}(Fe,Cu)_3MoGe_3S_{16}$. *Germanite* group.
XRPD matches *germanite & colusite.*
Occurrence: **EM Spiridonov** 2003 DES 393A 9 1329-32.

majakite PdNiAs.
Structure determination not found. XRPD matches *synthetic*.
Occurrence: **AD Genkin & 3 others** 1976 ZVMO 105 698-703.

majorite $Mg_3(Fe,Al,Si)_2(SiO_4)_3$. *Garnet* structure type.
Structure: **RJ Angel & 6 others** 1989 AM 74 509-12;
phase transition, **DM Hatch S Ghose** 1989 AM 74 1221-4;
Y Wang T Gasparik RC Liebermann 1993 AM 78 1165-73;
Ca-bearing, **RM Hazen & 4 others** 1994 AM 79 581-4;
RM Hazen & 3 others 1994 PCM 21 344-9 (H904);
crystal field & charge transfer $(Mg,Fe)SiO_3$: **H Keppler CA McCammon** 1996 PCM 23 94-8 (K829);
phase transition, Raman, **M Rauch & 4 others** 1996 AM 81 1289-92
birefringent tetragonal Cr-substituted, **A Nakatsuka & 3 others** 1999 AM 84 199-202.
Cubic/tetragonal change, *-pyrope* series: **JB Parise & 7 others** 1996 GRL 23 3799-802 (P563);
S Heinemann TG Sharp F Seifert DC Rubie 1997 PCM 24 206-21 (H1172)
TEM of quenched specimens, **N Tomioka & 5 others** 2002 EJM 14 7-14 (6133).
$En_{50}Py_{50}$, $En_{80}Py_{20}$ & En_{100}, adiabatic elastic moduli: **SV Sinogeiken & 3 others** 1997 PCM 24 115-21 (S1703).
Synthetic Mg- solid solutions, 20 GPa 2273 K, SC-XRD RT: **A Nahatsuka & 5 others** 1999 AM 84 1135-43.
Synthetic 20% *pyrope* s s, equation of state to 23 GPa & 773 K, XRPD: **H Morishima et al** 1999 PCM 27 3-10 (M1790).
Immiscibility at 13-15 GPa: **T Gasparik** 2000 GCA 64 1641-50 (G1191).
-pyrope s s: Brillouin scatter/elasticity to high T, **SV Sinogeikin JD Bass** 2002 EPSL 203 549-55 (8330).
Equation of state & strength: **A Kavner & 3 others** 2000 JGR 105 5963-71 (K1222).
Occurrence: **JV Smith B Mason** 1970 S 168 832.
In mantle xenoliths, Malaita: **KD Collerson & 3 others** 2000 S 288 1215-23 (C1142).
Relics, Norway garnet peridotite: **HLM van Roermund MR Drury** 1998 Terra Nova 10 295-301 (1746).
In meteorites: **AE Rubin** 1997 MPS 32 231-47;
Suizhou, **M Chen X Xie A El Goresy** 2004 MPS 39 1797-808.
Compositional change in MORB 7-17 GPa 1673-1873 K: **S Ono A Yasuda** 1996 PEPI 96 171-9 (O322).

makarochkinite $Ca_2Fe^{2+}{}_4Fe^{3+}TiSi_4BeAlO_{20}$. *Aenigmatite* structure group.
Structure: **OV Yakubovich OV Malinovskii OV Polyakov** 1990 SPC 35 818-22 = AM 77 448;
SC-XRD, & occurrence, **ES Grew & 7 others** 2005 AM 90 1402-12.

makatite $NaSi_2O_4OH.2aq$.
Structure: **N Annehed L Fälth FJ Lincoln** 1982 ZK 159 203-10 (A389).
^{29}Si NMR: **W Schwieger D Heidemann K-H Bergk** 1985 Rev Chim Miner 22 639-50 (S1527).
IR & Raman: **Y Huang Z Jiang W Schwieger** 1999 Can J Chem 77 495-501.
2D ^{23}Na MQ-MAS-NMR of layered silicates: **H Minoru RK Harris** 1998 JMC 8 1073-9.
Occurrence: MM 37 960; in hyperagpaitic alkaline rocks: **Khomyakov** 1995.
Synthetic, NMR:**W Schwieger & 4 others** 1991 ZK 197 1-12 (S1066).
See *grumantite* $NaSi_2O_4OH.aq$, *kanemite* $NaHSi_2O_4(OH)_2.2aq$, *natrosilite* $Na_2Si_2O_5$ &
revdite $Na_{16}[Si_4O_6(OH)_5]_2[Si_8O_{15}(OH)_6](OH)_{10}.28aq$.
in hyperagpaitic alkaline rocks: **Khomyakov** 1995.

mäkinenite NiSe-gamma. Isostructural with S analog *millerite* from crystallography.
Structure determination not found.
Occurrence: **Y Vuorelainen A Huhma A Häkli** 1964 Compt Rend Soc Geol Finlande 1964 36 113-25 = AM 50 519.

makovickyite $Ag_{1.5}Bi_{5.5}S_9$.

Structure: **WG Mumme** 1990 NJMM 193-204.
Occurrence & structure: **L Zak & 3 others** 1994 NJMA 168 147-69 (Z82).

[MALACHITE STRUCTURE GROUP (tentative) Includes

malachite	$Cu_2CO_3(OH)_2$
pokrovskite	$Mg_2CO_3(OH)_2.0.5aq$

jvs: may include *rosasite* group which may have 1:1 cation ordering. Entire group will need sorting out when crystal structures are determined. Note the distinct values of the monoclinic beta angle.

ROSASITE STRUCTURE GROUP Includes

glaukosphaerite	$CuNi(CO_3)(OH)_2$	
kolwezite	$CuCo(CO_3)(OH)_2$	
mcguinnessite	$MgCu(CO_3)(OH)_2$	
nullaginite	$Ni_2(CO_3)(OH)_2$	
rosasite	$CuZn(CO_3)(OH)_2$	
[zincrosasite	$(Zn,Cu)_2(CO_3)(OH)_2$	may be merely rosasite.**]**

malachite $Cu_2CO_3(OH)_2$. Isostructural with Mg analog *pokrovskite*.
Georgeite is amorphous analog. Review: (E289).
Structure: **AF Wells** 1951 AC 4 200-4;
P Süsse 1967 AC 22 146-51;
ND, **F Zigan W Joswig HD Schuster** 1977 ZK 145 412-26;
PH Ribbe SC Eriksson 1991 MR 22 65-6;
IR/Raman & H bonding: **M Schmidt HD Lutz** 1993 PCM 20 27-32 (S1862).
[**malakhovite** see *aenigmatite* group.]
malanite $Cu(Pt,Ir)_2S_4$. Analog of *cuprorhodsite, cuproiridsite & ferrorhodsite* .
Structure determination not found.
Occurrence: **T Yu & 4 others** 1974 Acta Geol Sinica = AM 61 185;
G Garuti M Gazzoni J Torres-Ruiz 1995 CM 33 509-20;
revised, **Z Yu** 1996 Acta Geol Sinica 70 309-14.
Nickeloan, Imandra Complex, nw Russia: **AY Barkov & 4 others** 1997 CM 35 887-97.
Dayingite is Co-rich malanite.
Synthesis: **RA Munson** 1966 IC 5 1296-7 (M1329).
malayaite $CaSnSiO_5$. *Titanite* structure type.
Structure: **JB Higgins PH Ribbe** 1976 AM 62 801-6 (H911);
XRPD, HRTEM & Raman: **LA Groat & 7 others** 1996 AM 81 595-602;
SC-XRD & Mössbauer, **NN Eremin & 3 others** 2002 CrR 47 759-67 (8240).
High-P, <7 GPa, polymorphic transition, SC-XRD structure: **S Rath M Kunze R Miletich** 2003 AM 88 293-300.
Occurrence: MM 35 1144.
maldonite Au_2Bi.
Structure given in **Povarennykh** p 204 without reference; not found in **Pearson** or **Wells**.
Occurrence: **Dana**.
maleevite $BaB_2Si_2O_8$. Analog of *danburite* & *pekovite*.
Occurrence & SC-XRD structure: **LA Pautov & 3 others** 2004 CM 42 107-19.
malinkoite $NaBSi_2O_6$.
Similar structure units to *beryllonite*, but different connectivity.
Occurrence: & SC-XRD structure, **EV Sokolova FC Hawthorne AP Khomyakov** 2001 CM 39 159-69;
APK GN Nechelyustov EVS FCH 2001 ZVMO 129 35-42.
malladrite Na_2SiF_6.
Structure: **A Zalkin JD Forrester DH Templeton** 1964 AC 17 1408-12 (Z85).
Occurrence: MM 21 570-1. Further description: AM 82 1041.
mallardite $MnSO_4.7aq$. *Melanterite* structure group. Review: **Sabelli** p.9.
Compare with *chvaleticeite* with 6aq.
Structure determination not found.
Occurrence: **Dana**.

mallestigite $Pb_3Sb(SO_4)(AsO_4)(OH)_6.aq$. Analog of *fleischerite*.
Occurrence/crystallography: **I Sima** 1998 Mitt Österreich Mineral Ges 143 225-7 = MA 50 2002.
mammothite $Pb_6Cu_4AlSbO_2(SO_4)_2Cl_4(OH)_{16}$. Review: (E289).
Structure: **H Effenberger** 1985 TMPM 34 279-88 (E329).
Occurrence: MM 50 751-2.
manaksite $KNaMnSi_4O_{10}$. ?structural analog of *fenaksite*.
Occurrence: **AP Khomyakov TA Kurova GN Nechelyustov** 1992 ZVMO 121 112-5.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.

manandonite-2H$_2$ $Li_2Al_5Si_2BO_{10}(OH)_8$. *Chlorite* structure group.
Al,Li,B-rich analog of *amesite*.
Structure: **N Ronorosa F Fontan A Fransolet** 1989 EJM 1 633-8;
-$2H_2$, **H Zheng SW Bailey** 1995 AM 80 387-93.

MANASSEITE STRUCTURE GROUP Includes

barbertonite	$Mg_6Cr_2CO_3(OH)_{16}.4aq$
charmarite-2H	$Mn_4Al_2(OH)_{12}CO_3.3aq$
chlormagaluminite	$(Mg,Fe)_4Al_2(OH)_{12}(Cl_2,CO_3)_2.2aq$
iowaite	$Mg_4Fe(OH)_8OCl.2\text{-}4aq$
manasseite	$Mg_6Al_2CO_3(OH)_{16}.4aq$
quintinite-2H	$Mg_4Al_2(OH)_{12}CO_3.3aq$
sjögrenite	$Mg_6Fe_2CO_3(OH)_{16}.4aq$
zaccagnaite	$Zn_4Al_2(OH)_{12}(CO_3)_{0.5}.3aq$. .

Essentially 2-layer hexagonal analog of 3R *hydrotalcite* structure group.
Review: **HFW Taylor** 1973 MM 39 377-89 (T186).
manasseite $Mg_6Al_2CO_3(OH)_{16}.4aq$. Manasseite structure group.
Synthetic: incomplete, **GJ Ross H Kodarma** 1967 AM 52 1036-47.
Occurrence: MM 26 338.
mandarinoite $Fe_2Se_3O_9.6aq$.
Structure: **FC Hawthorne** 1984 CM 22 475-80.
Occurrence: MM 43 1063.
manganarsite $Mn_3As_2O_4(OH)_4$. *Friedelite* structure group.
Occurrence & crystallography: **DR Peacor & 3 others** 1986 AM 71 1517-21.
manganaxinite $Ca_2(Mn,Fe)Al_2BSi_4O_{15}(OH)$. *Axinite* structure group from crystallography.
Occurrence: **BM French JJ Fahey** 1972 AM 57 989-92;
nomenclature, **E Sanero G Gottardi** 1968 AM 53 1407-11.
manganbabingtonite $Ca_2(Mn,Fe)FeSi_5O_{14}(OH)$. *Pyroxenoid* mineral group.
Isostructural series with Fe analog *babingtonite* from crystallography.
Occurrence: **RA Vinogradova VA Sychkova YuK Kabalov** 1966 DAN 169 434-7;
RA Vinogradova IN Plyusinna 1967 Vestn Moskov Univ Ser IV Geol 54-67 = AM 53 1064-5;
MA 97M/1914.
[**manganbelyankinite** amorphous.]
manganberzeliite $(Ca,Na)_3(Mn,Mg)_2(AsO_4)_3$. *Garnet* structure type.
Occurrence: **C Frondel J Ito** 1963 AM 48 663-4.
manganese Mn.
Occurrence & XRPD matching beta-Mn: **AA Kim NV Zayakina** 2001 = AM 88 933.
Chemical constituent of steel.
manganese-hörnesite $(Mn,Mg)_3(AsO_4)_2.8aq$. *Vivianite* structure type.
Detailed structure determination not found.
Occurrence: **O Gabrielson** 1951 Ark Mineral Geol 1 333-7 = AM 39 159.
manganese-shadlunite $(Mn,Pb,Cd)(Cu,Fe)_8S_8$.
Pentlandite structure group from XRPD.
Series with *shadlunite* $(Pb_{0.7}Cd_{0.2})Fe,Cu)_8S_8$.

Occurrence: **TL Evstigneeva & 4 others** 1973 ZVMO 102 63-74.

mangangordonite $(Mn,Fe,Al)Al_2(PO_4)_2(OH)_2.8aq$. *Paravauxite* structure group.

Structural analog of *gordonite*. Polymorph of *kastningite*.

Structure: **PB Leavens & 3 others** 1991 NJMM 169-76 (L653).

manganhumite $(Mn,Mg)_7(SiO_4)_3(OH)_2$. *Humite* structure group.

Structure: **CA Francis PH Ribbe** 1978 AM 63 874-7.

Occurrence: MM 42 526.

manganilvaite $CaFe^{2+}Fe^{3+}(Mn,Fe^{2+})(Si_2O_7)O(OH)$. *Ilvaite* structure type.

Structure: SC&P-XRD & NPD, Mössbauer, **N Zotov & 6 others** 2005 CM 43 1043-52.

Occurrence & XRPD: **IK Bonev & 3 others** 2005 CM 43 1027-42 = AM 91 712.

manganite MnOOH. Superstructure of *marcasite.* Trimorphic with *feitknecktite* & *groutite.*

Structure: **H Dachs** 1963 ZK 118 303-26 (D505).

XRPD pattern: **KW Mandernack J Post BM Tebo** 1995 GCA 59 4393-408.

Spectral reflectance, implication for Mars: **EA Cloutis JF Bell III** 2000 JGR 105 7053-70 (C1141).

Cd/Mn(II) coordination, water interface, EXAFS: **L Bochatay P Persson S Sjoberg** 2000 JCIS 229 584-92 (420), **LB PP** 593-9 (421).

Synthetic manganite $La_{1.4}Sr_{1.6}Mn_2O_7$, interplane tunneling magnetoresistance: **T Kimura & 5 others** 1996 S 274 1698-701 (K884).

[jvs: note physicists use the name manganite in a different way from mineralogists].

manganlotharmeyerite $Ca(Mn^{3+},void,Mg)_2\{(AsO_4,[(AsO_2(OH)_2]_2(OH,aq)_2$.

Lotharmeyerite subgroup of *tsumcorite* group.

Occurrence & SC-XRD structure: **J Brugger & 6 others** 2002 CM 40 1597-608.

mangan-neptunite $KNa_2Li(Mn,Fe)_2Ti_2Si_8O_{24}$.

Isostructural series with Fe analog *neptunite*.

Occurrence: AM 12 96.

manganochromite $(Mn,Fe)(Cr,V)_2O_4$. *Spinel* structure group.

Occurrence: **J Graham** 1978 AM 63 1166-74.

manganocolumbite $(Mn,Fe)(Nb,Ta)_2O_6$. *Columbite* structure group.

Occurrence: Powder Diffraction File 33-899.

manganokhomyakovite $Na_{12}Sr_3Ca_6Fe_3Zr_3W(Si_{25}O_{73})(O,OH,aq)_3(Cl,OH)_2$.

Eudialyte group.

Description and structure: **O Johnsen RA Gault JD Grice TS Ercit** 1999 CM 37 893-9.

manganolangbeinite $K_2Mn_2(SO_4)_3$. Isostructural with *efremovite* & *langbeinite*.

Review: **Sabelli** p.35.

Structure: **A Bellanca** 1947 Atti Rend Accad Naz Lincei 2 451-?.

MANGANOMELANE MINERAL GROUP Includes:

coronadite	$\sim PbMn_8O_{16}.0\text{-}1.5aq$
cryptomelane	$\sim K_{1\text{-}2}Mn^{4+}{}_8O_{16}.n\ aq$
manjiroite	$\sim (Na,K)(Mn^{4+},Mn^{2+})_8O_{16}.naq$
romanéchite	$\sim BaMn^{2+}Mn^{4+}{}_8O_{16}(OH)_4$

The term *manganomelane* is used for intermediate compositions $\sim (Na,K,Ba)_{1\text{-}2}Mn^{4+}{}_8O_{16}.n\ aq$:

J Gutzmer NF Beukes 1997 MM 313-31.

manganonaujaksite $Na_6(Mn,Fe)Al_4Si_8O_{26}$. Isotype with *naujaksite.*

Occurrence/SC-XRD structure: **AP Khomyakov & 3 others** 2000 ZVMO 129 48-53.

manganonordite-Ce $CeNa_3SrMnSi_6O_{17}$. *Nordite* group.

Occurrence & XRD: **IV Pekov & 5 others** 1998 ZVMO 127 32-40 (P842).

Structure & geochemistry: **DY Pushcharovskii & 8 others** 1999 CrR 44 565-74 (P847).

manganophyllite Variety of *phlogopite-1M*.

Structure: **RA Knurr SW Bailey** 1986 ClClM 34 7-16 (K408).

manganosegelerite $(Mn,Ca)(Mn,Fe,Mg)Fe(PO_4)_2(OH).4aq$.

Overite structure group from crystallography.

Occurrence: **AV Voloshin YaA Pakhomovskii FN Tyusheva** 1992 ZVMO 95-103 (V205).
manganosite MnO. *Periclase* mineral group. *Halite* structure type: **Wells** p 458.
Structure: **S Sasaki & 3 others** 1980 AC 36 904-15.
[**manganosteenstrupine** (La,Th,Ca)$MnSiO_3$.2aq.
Amorphous.
Occurrence: AM 45 1132; MM 32 968.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.]
manganostibite $Mn_7Sb(As,Si)O_{12}$.
Structure: **PB Moore** 1970 AM 55 1489-99 (M1163).
New chemical data: **PJ Dunn** 1986 Geol Før Stockholm Förh 109 101-2 = AM 73 667.
Synthetic Ni_7AlSiO_{12}, structure: **C Ma E Tillmanns** 1975 AC B31 2139-41
Synthetic Ni_7GaSiO_{12}, structure: **R Hammond J Barbier** 1993 AC B49 204-13.
Synthetic $Co_7As_2O_{12}$, structure: **J Barbier** 1997 ZK 212 445-9 (B1642).
manganotapiolite $(Mn,Fe)(Ta,Nb)_2O_6$. *Tapiolite* structure group.
Trirutile superstructure of *rutile*.
Occurrence: **Sl Lahti B Johanson M Virkkunen** 1963 BGSF 55 101-9 = AM 70 217.
Occurrence: MM 50 752.
manganotantalite $Mn(Ta_{0.6}Nb_{0.4})_2O_6$. Mn-rich end of Mn,Fe tantalite series.
Alpha-PbO_2 (*scrutinyite*) structure type.
Structure: **JD Grice RB Ferguson FC Hawthorne** 1976 CM 14 540-9.
Summary: **NA Yamnova DYu Pushcharovskii AV Volshin** 1995 CrR 40 428-33 (Y158).
manganotychite $Na_6Mn_2(SO_4)(CO_3)_4$. *Tychite* structure group.
Occurrence & crystallography: **AP Khomyakhov & 3 others** 1990 ZVMO 46-9 (K665).
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.
manganous sulphide/ manganous sulfide MnS.
Beta phase occurring in Baltic Sea sediment.
Occurrence: MM 32 968.
manganpyrosmalite $(Mn,Fe)_8Si_6O_{15}(OH,Cl)_{10}$.
Friedelite structure group; trigonal subtype. See *pyrosmalite.*
Mn-rich half of series with *ferropyrosmalite*.
Structure: **Y Takéuchi & 3 others** 1969 MJJ 5 450-67 (T142);
T Kato Y Takéuchi 1983 CM 21 1-6.
Occurrence & nomenclature: MM 30 740;
JP Vaughan 1986 MM 50 527-31, 1987 51 174.
manganvesuvianite $Ca_{19}Mn^{3+}(Al,Mn^{3+},Fe^{3+})_{10}(Mg,Mn^{2+})_2Si_{18}O_{69}(OH)_9$.
Vesuvianite structure.
Occurrence & SC-XRD structure: **T Armbruster & 6 others** 2002 MM 66 137-50.
manjiroite $(Na,K)(Mn^{4+},Mn^{2+})_8O_{16}$.naq.
Manganomelane mineral group. *Cryptomelane* structure group.
Occurrence: **M Nabu K Tanida** 1967 JJAMPEG 58 39-54.
asbestiform, **J Gutzmer NJ Beukes** 2000 South African J Geol 103 163-74 (2004).
mannardite $BaTi_6V_2O_{16}$.aq. *Cryptomelane* structure group.
Structure: **JT Szymanski** 1986 CM 24 67-78.
Occurrence, central Asia: **LA Pautov** 1994 ZVMO 123 72-6.
Occurrence: MM 50 752.
mansfieldite $AlAsO_4$.2aq. *Variscite* structure group from crystallography.
Occurrence: **VT Allen JJ Fahey JM Axelrod** 1948 AM 33 122-34.
mantiennite / mantiennéite $KMg_2Al_2Ti(PO_4)_4(OH)_3$.15aq.
Essentially isostructural with *benyacarite* $(aq,K)_2(Mn,Fe)_2(Fe,Ti,Al)_2Ti(PO_4)_4(O,F)_2$.14aq &
paulkerrite $K(Mg,Mn)_2(Fe,Al,Ti,Mg)_2(PO_4)_4(OH)_3$.15aq.
Structure: **F Demartin T Pilati HD ?**. Occurrence: MM 50 752.
mapimite $Zn_2Fe^{3+}{}_3(AsO_4)_3(OH)_4$10aq.

Structure: **D Ginderow F Cesbron** 1981 AC B37 1040-3 (G782).
Occurrence & description: MM 43 1064; MM 48 577. .
MARCASITE STRUCTURE SUPERGROUP Includes *marcasite* subgroup with uncompressed *c*-axis & *löllingite* subgroup with compressed *c*.

		subgroup	
anduoite	$(Ru,Os)As_2$		löllingite
clinosafflorite	$(Co,Fe,Ni)As_2$		löllingite
costibite	$CoSb_2$	marcasite	
ferroselite	$FeSe_2$	marcasite	
frohbergite	$FeTe_2$	marcasite	
hastite	$CoSe_2$	marcasite	
kullerudite	$NiSe_2$	marcasite	
löllingite	$FeAs_2$		löllingite
marcasite	FeS_2	marcasite	
mattagamite	$CoTe_2$	marcasite	
nisbite	$NiSb_2$	marcasite	
omeiite	$(Os,Ru)As_2$		löllingite
rammelsbergite	$NiAs_2$	marcasite	
safflorite	$(Co,Fe)As_2$		löllingite
seinäjokite	$(Fe,Ni)(Sb,As)_2$		löllingite
[*oenite*	CoSbAs]		

List: **WB Pearson** 1965 ZK 121 449-62 (P567).
Structural chemistry of marcasite & *pyrite* type structures: **ME Fleet** 1975 ZK 142 332-46 (F459).
Synthetic $CuSe_2$: **G Gattow** 1965 Nw 52 258.
Synthetic $(Ru/Os)Se_2$ & $(Pt/alpha\ Ni)As_2$: **WN Stassen RD Heyding** 1968 Canad J Chem 46 2159-63.
Synthetic $(Cr/Fe)Sb_2$, ND: **H Holseth A Kjekshus AF Andresen** 1970 Acta Chem Scand 24 3309-16.
Synthetic $Fe(As/Se)_2$, $NiAs_2$ & $CuSe_2$: **A Kjekshus T Rakke AF Andresen** 1974 Acta Chem Scand A 28 996-1000.
Synthetic $(Fe,Cr/Ni)(As/Sb)_2$: **A Kjekshus & 3 others** 1979 Acta Chem Scand A33 469-80 (K717).
Synthetic $RuTe_2$, alpha-, structure: **J Köhler** 1997 ZaaC 623 1657-60 (H981).

marcasite FeS_2. Marcasite structure group. Dimorph of *pyrite*.
Structure: **MJ Buerger** 1931 AM 16 361-95;
G Brostigen A Kjekshus C Rømming 1973 Acta Chem Scand 27 2791-6.
Trace elements in *pyrite* &, East Midlands coals, SXRF: **RN White & 4 others** 1989 F 68 1480-6 (422).
In meteorites: **AE Rubin** 1997 MPS32 231-47.
XAS of *pyrite*/marcasite, Co/Ni/Cu-disulfides/FeAsS/CoAsS: **JFW Mosselsmans & 6 others** 1995 PCM 22 311-7.
XPS/Auger Electron Spectroscopy, oxidized/acid-treated surfaces: **MJ Rinker HW Nesbitt AR Pratt** 1997 AM 82 900-12.
marecottite $Mg_3aq_{18}[(UO_2)_4O_3(OH)(SO_4)_2]_2.10aq$. Related to *zippeite.*
Occurrence & SC-XRD: **J Brugger PC Burns N Meisser** 2003 AM 88 675-85.
margaritasite $(Cs,K,H_3O)_2(UO_2)_2V_2O_8$. Related to K analog anhydrous *carnotite*.
Structure: *synthetic*, **DE Appleman HT Evans Jr** 1965 AM 50 825-42.
Occurrence: MM 48 577.
margarite $CaAl_2Al_2Si_2O_{10}(OH)_2$. *Mica* structure group; $2M_1$ - dioctahedral subtype.
Structure: **S Guggenheim SW Bailey** 1975 AM 60 1023-9 (G530); 1978 63 186-7 (G375);
W Joswig Y Takéuchi H Fuess 1983 ZK165 295-303.
Surface diffraction & angle-resolved XPS: **GS Biino & 4 others** 1999 AM 84 629-38.
Synthesis & properties margarite/*beidellite* 34Å phase: **T Matsuda M Kurosaki** 1998 CM 36 1569-76.
Occurrence: eclogites, **G Godard D Smith** 1999 CMP 136 20-32 (G1168);
ultramafic alteration zone, Egypt, **MA Takla & 3 others** 2003 EJM 15 991-9 (10080).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
margarosanite $Pb(Ca,Mn)_2Si_3O_9$. Isostructural with *wahlstromite* $BaCa_2Si_3O_9$.

Structure: **RL Freed DR Peacor** 1969 ZK 128 213-28 (F119).
Synthesis: **J Ito** 1968 AM 53 231-40.

marialite $Na_4Al_3Si_9O_{24}Cl$. *Scapolite* structure series; species name for endmember.

Structure: **JJ Papike T Zoltai** 1965 AM 50 641-55 (P71);
SB Lin BJ Burley 1973 AC B29 1272-8;
XRPD, **YuK Kabalov EV Sokolova VS Urusov** 1995 CrR 40 766-9 (K791);
Pamir, 6, 8 & 15% Me, XRPD, **YuK Kabalov EV Sokolova** 1996 CrR 41 436-44 (K848);
XRPD & MAS-NMR, **EV Sokolova & 7 others** 1996 CM 34 1039-50;
YuK Kabalov & 3 others 1998 CrR 43 578-83 (K1100)
heating, **YK Kabalov & 3 others** 1999 CrR 44 979-83 (K1214);
SC-XRD refinement, **EV Sokolova & 3 others** 2000 CrR 45 934-8 (1747).
See *scapolite* for further references to mineral series.
Occurrence in meteorites: **AE Rubin** 1997 MPS 32 733-4.

maricite $Na(Fe,Mn)PO_4$. Isostructural with $Na(Co/Fe/Fe,Zn)PO_4$-alpha.

Compare with *natrophilite* $NaMnPO_4$ which has *olivine* type of structure.

Structure: **Y LePage G Donnay** 1977 CM 15 518-21 (L776);
& *synthesis*, **JN Bridson SE Quinlan PR Tremaine** 1998 ChM 10 763-8 (B1803).
Occurrence: MM 42 526; **BD Sturman JA Mandarino MI Corlett** 1977 CM 15 396-8.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Occurs as corrosion product of boilers in fossil-fired electrical power stations.
Synthetic $NaCoPO_4$-alpha: **R Hammond J Barbier** 1996 AC B52 440-9 (H1116);
high-T beta dimorph is stuffed *hexagonal*-UDUDUD,UUUDDD type with triple-*c* superstructure.

maricopaite $Pb_7Ca_2Al_{12}Si_{36}(O,OH)_{100}.n(aq,OH)$.

Interrupted vertex-connected tetrahedral net derivative of *mordenite*.
Structure: **RC Rouse DR Peacor** 1994 AM 79 175-84.

marinellite $(Na,K)_7CaSi_6Al_6O_{24}.(SO_4)_{1.3}Cl_{0.3}.aq.$

ABCBCBACBCBC-6 stacking in *cancrinite* group.
Occurrence & SC-XRD: **E Bonaccorsi P Orlandi** 2003 EJM 15 1019-27 (10062).

marokite $CaMn_2O_4$.

Structure: **M-M Couffon G Rocher J Protas** 1964 CRASP 258 1847-9;
G Lepicard J Protas 1966 BSFMC 89 318-24.
Antiferromagnetism: **CD Ling JJ Neumeier DN Argyriou** 2001 JSSC 160 167-73 (2946).
Occurrence: MM 33 1143.
Synthetic: **PV Ribaud A Muan** 1963 JACeS 46 33-6.
High-P Mn_3O_4, marokite structure: XRPD, **CR Ross II DC Rubie E Paris** 1990 AM 75 799-809.

marrite $PbAgAsS_3$. Isostructural with Sb analog *frieslebenite*.

Structural relations between *diaphorite, freieslebenite, marrite & sicherite*, SC-XRD structure of *marrite*: **P Berlepsch E Makovicky T Armbruster** 2002 NJMA 178 75-91 (8796).
Structure: **BJ Wuensch W Nowacki** 1967 ZK 125 459-88 (W672).

marshite CuI. Polytypic. Cubic 3-layer polytype has *sphalerite* structure: **Wells** p 349.
Synthetic 12-layer rhombohedral: **R Batchelor T Birchall** 1982 AC B38 1260-3.
Solid solution with *miersite*: **PW Millsteed** 1998 MM 62 471-5.

marsturite $\sim NaCaMn_3Si_5O_{14}OH$.

5-repeat pyroxenoid: *rhodonite* structure type from crystallography.
Iso with *lithiomarsturite*.
Occurrence: **DR Peacor PJ Dunn BD Sturman** 1978 AM 63 1187-9;
epitaxial on rhodonite, **PJ Dunn PB Leavens** 1986 MR 17 123-5.
Occurrence: 2 specimens Japan with composition $Na_2Ca_3Mn_5Si_{10}O_{28}(OH)_2$: MA 97M/1908;
Urals, **NR Ayupova** 2003 ZVMO 132-4 58-61 (10510).

martensite $(Fe,Ni)\text{-alpha}_2$. (name first used in iron/steel industry).

Structure: **NJ Petch** 1943, *The positions of the carbon atoms in martensite*. J Iron Steel Inst 147 221-31= MA 9-41;
KH Jack 1951 *The iron-nitrogen system: the preparation and the crystal structure of nitrogen-austenite and nitrogen-martensite.* Proc Roy Soc A208 200-15 = MA 11-367.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

marthozite $Cu(UO_2)_3(SeO_3)_2O_2.8aq$. Same sheet as *guilleminite,* different interlayer.
Structure: SC-XRD, **MA Cooper FC Hawthorne** 2001 CM 39 797-807.
Occurrence: **F Cesbron R Oosterbosch R Pierrot** 1970 BSFMC 92 278-83.
mascagnite $(NH_4)_2SO_4$. Review: **Sabelli** p. 32.
Structure: **EO Schlemper WC Hamilton** 1966 J Chem Phys 44 4498-509.
maslovite PtBiTe. *Pyrite* structure group.
Structure: **P Bayliss** 1968 CM 24 27-33, 1989 AM 74 1168-76;
Occurrence: MM 43 1064.
massicot PbO-beta (yellow).
High-T beta polymorph, corrugated layers; alpha (red) *litharge,* flat layers stable at low-T.
Complex transitions & modulated structures.
Structure: **A Byström** 1944 Ark Kemi Min Geol 17B no. 8 (B1411) = MA 9-98;
NPD: **MI Kay** 1961 AC 14 80-1;
J Leciejewicz 1961 AC 14 66;
RJ Hill 1985 AC C41 1281-4 (H1009).
Synthetic $Pb_{1-x}Ti_xO_{1+x}$, x 0-0.8, alpha & beta-PbO types: 1990 MRB 25 979-86 = SR 57A 160.
masutomilite $K(Li,Al,Mn)_3(Si,Al)_4O_{10}(F,OH)_2$.
Mica structure group; 1-layer monoclinic trioctahedral subtype.
Structure: **T Mizota T Kato K Harada** 1986 MJJ 13 13-21.
Occurrence: MM 42 526-7.
masuyite $Pb_3U_8O_{27}.10aq$. Related to *protasite*, but extra cation in interlayer.
Structure: **P Burns** 1999 CM 37 1483-91 (B2002).
Occurrence: **JF Vaes** 1947 Soc geol Belgique Annales 70 B212-29;
crystallography, **CL Christ JR Clark** 1960 AM 45 1026-61
mathewrogersite $Pb_7(Fe,Cu)GeAl_3Si_{12}O_{36}(OH,aq,void)_6$.
Structure determination not found.
Occurrence: **P Keller PJ Dunn** 1986 NJMM 203-8 (K760).
mathiasite $(K,Ca,Sr)(Ti,Cr,Fe,Mg)_{21}O_{38}$. *Crichtonite* structure group.
Structure: **BM Gatehouse IE Grey JR Smyth** 1983 AC C39 421-2.
Occurrence: MM 48 577.
matildite $AgBiS_2$. *Tetradymite* mineral/structure group, *tsumoite* subgroup.
Isostructural with Se analog *bohdanowczite*.
Structure: **P Bayliss** 1991 AM 76 257-65.
MATLOCKITE STRUCTURE GROUP Includes:

bismoclite	BiOCl
daubréeite	BiO(OH,Cl)
matlockite	PbFCl
rorisite	CaFCl
zavaritskite	BiOF

Synthetic PbFBr: **W Nieuwenkamp JM Bijvoet** 1932 ZK 82 157-60.
Synthetic SrFCl & BaFCl: **M Sauvage** 1974 AC B30 2786-7.
Synthetic PbFI: **A Rulmont** 1973 CRASP C 276 775-8.
Synthetic BaFI & BaFBr: **BW Liebich D Nicollin** 1977 AC B33 2790-4.
Synthetic BiOBr: **J Kettere V Krämer** 1986 AC C42 1098-9.
Synthetic NaLiTe, KNaTe, KLi(Se/Te): 1989 ZN 44B 1602-4 & 1607-9 = SR 56A 56.
Synthetic ThOTe: 1989 ZaaC 1989 571 162-4 = SR 56A 187.
matlockite PbFCl Matlockite structure group.
Structure: *synthetic*, **W Nieuwenkamp JM Bijvoet** 1932 ZK 81 469-74;
FA Bannister 1934 MM 23 587-97;
N Kodamo & 4 others 1984 J Mineral Soc Japan 16 309-16 = MA 86M/4315;
M Pasero N Perchiazzi 1996 MM 60 833-6.
Occurrence: **RP Greg** 1851 Phil Mag ser 4 2 120-1.
matraite ZnS.
[jvs Appears to be rhombohedral distortion of *sphalerite*, but needs detailed check.]

Structure: *synthetic gamma*, **DC Buck LW Strock** 1955 AM 40 199-200.
Occurrence: beta-prime, AM 45 1131 = MM 32 968.

matsubaraite $Sr_4Ti_5(Si_2O_7)_2O_8$. *Perrierite-chevnikite* group.

Occurrence & structure: **H Miyajima R Miyawaki K Ito** 2002 EJM 14 1119-28 (8680).

mattagamite $CoTe_2$. *Marcasite* structure subgroup in marcasite supergroup.

XRPD matches *synthetic*.
Occurrence & crystallography: **RI Thorpe DC Harris** 1973 CM 12 55-60;
3d transition metal L-edge XAS, **JM Charnock & 3 others** 1996 PCM 23 403-8 (C878).

matteuccite $NaH(SO_4)$.aq. Review: **Sabelli** p.31.

Structure: **GE Pringle TA Broadbent** 1965 AC 19 426-32;
M Catti G Ferraris M Franchini-Angela 1975 Atti Accad Sci Torino 109 531-45;
M Catti G Ferraris G Ivaldi 1979 AC B35 525-9.
Occurrence: MM 28 988.

mattheddleite $Pb_5(SiO_4)_{1.5}(SO_4)_{1.5}Cl_{0.6}(OH)_{0.4}$ *Apatite* structure group.

Structure: SC-XRD, **IM Steele JJ Pluth A Livingstone** 2000 MM 64 915-21 (97).
Occurrence: **A Livingstone & 3 others** 1987 SJG 23 1-8.
See *kegelite* $Pb_8Al_4Si_8(SO_4)_2(CO_3)_4(OH)_8O_{20}$ & unnamed mineral
$Pb_{27}(Al_{1.6}Mn_{0.4})(Si_6O_{15})_2(SO_4)_2O_{10}(OH)_{24}$.

matulaite $CaAl_{18}(PO_4)_{12}(OH)_{12}(OH)_{20}$.28aq.

Structure determination not found.
Occurrence: **PB Moore J Ito** 1980 Aufschluss 31 55-61 = MM 46 521; MM 43 1064.

maucherite $Ni_{11}As_8$.

Matches *synthetic*; local features match *millerite*, but not isostructural.
Structure: **ME Fleet** 1973 AM 58 203-10.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
[maufite= *lizardite/chlorite*, MR 30 175. AM 15 275.]

mawbyite $Pb(Fe_{2-x}Zn_x)(AsO_4)_2(OH)_{2-x}aq_x$.

Essentially isostructural with ZnFe analog *tsumcorite* from crystallography.
Dimorphic with *carminite*.
Occurrence & crystallography: **A Pring EM McBriar WD Birch** 1989 AM 74 1377-8.
Structure: **Kharisun & 4 others** 1997 MM 61 685-91.

mawsonite $Cu_6SnFe_2S_8$. *Germanite* structure group.

Compare with *chatkalite* $Cu_6FeSn_2S_8$ with similar XRPD.

Structure: **JT Szymanski** 1976 CM 14 529-35.
Occurrence: MM 35 1144.

maxwellite $NaFe(AsO_4)F$. *Titanite* structure type. Isostructural with *durangite* & *tilasite*.

Structure: **MA Cooper FC Hawthorne** 1995 NJMM (3) 97-104 (C758).
Occurrence: MM 60 676.

[mayenite ~$Ca_{12}Al_{14}O_{33}$. See *grossite & hibonite*.

Occurs in Portland cement clinker.
Not = *brownmillerite*.
Occurrence: **G Hentschel** 1964 NJMM 1 229 (H512) = AM 50 2106-7.
Structure: **H Bartl T Scheller** 1970 NJMM 35 547-?;
PP Williams 1973 ACB 29 1550-?;
H Hosono Y Abe 1987 IC 26 1192-?;
M Lacerda & 3 others 1988 N 32 525-.

Chlormayenite $Ca_{13}Al_{14}(SiO_4)_{0.5}O_{32}Cl_2$ - *silicochlormayenite* $Ca_{13}Al_{14}(SiO_4)O_{32}Cl_4$ *chlorhibschite* $Ca_3Al_2(SiO_4)_{3-x}$ (x 0.3-0.4) series, occurrence in waste combustion products of coal mines: **BV Chesnokov** 1997 DAN 356 1064-5 (C965).]

Synthetic $Ca_{12}Al_{10}Si_4O_{33}$: **S Fujita & 7 others** 20003 ChM 15 255-63.
[Calcined product of *hydrogarnet*. Potential catalyst for oxidizing hydrocarbons.]
Synthetic $Ca_5Al_6O_{14}$: XRPD, **W Büssem A Eitel** 1936 ZK 95 175-88 (B1339), *garnet*-like.

mayingite IrBiTe.

Occurrence: **Z Yu** 1995 Acta Mineralogica Sinica 15 5-8 = AM 81 251.
Matches *synthetic*: **jvs search**.
XRPD of *changchengite* IrBiS matches *synthetic* and mayingite
[telluromayingite $Ir(Te,Bi)_2$.
Analog of *mayingite* which would become $Ir(Bi,Te)_2$: AM 84 687.
Description: **Z Yu** 1998 Acta Mineralogica Sinica 18 134-7.]
mazzetteite $Ag_3HgPbSbTe_5$.
Occurrence: & similarity to *petrovicite*, **L Bindi C Cipriani** 2004 CM 42 1739-43.
mazzite-Mg $K_2CaMg_2(Si,Al)_{36}O_{72}.28aq$. *Zeolite* mineral group.
IZA-SC structure code MAZ. Consortium for Theoretical Frameworks net 632.
Synthetic phases: LZ-202, Omega & ZSM-4.
Structure: **E Galli** 1974 Cryst Struct Comm 3 339-44;
dehydrated at 873K, **R Rinaldi JJ Pluth JV Smith** 1975 AC B31 1603-8;
dehydrated, **A Alberti G Vezzalini** 1981 BM 104 5-9;
^{27}Al NMR, Omega, **J Klinowski MW Anderson JM Thomas** 1983 JCSCC 525-6 (9383);
synthesis & thermal behavior, XRPD, **A Araya & 4 others** 1984 Z 4 263-9 (A451);
^{29}Si NMR, *synthetic*, **RH Jarman AJ Jacobson MT Melchior** 1984 JPC 88 5748-52 (9385);
synthetic dehydrated Ga-, NPD, **JM Newsam RH Jarman AJ Jacobson** 1985 MRB 20 125-36;
$^{29}Si/^{27}Al$ NMR, Omega, **P Massiani & 3 others** 1988 Z 8 332-7 (M909);
MQ-MAS-NMR, Al distribution, **BH Wouters & 4 others** 1999 JPC B 103 8093-6.
Occurrence: MM 39 919.
Synthetic, using p-dioxane: **B De Witte & 3 others** 1997 MiMa 10 247-57.
Synthetic Na-Omega gallosilicate, Cu(II)-exchanged, ESR & electron spin echo modulation spectroscopy: **J Yu & 5 others** 1997 JCSF 93 4211-9.
Synthetic, MQ-MAS-NMR, Al in T1/T2: **BH Wouters & 4 others** 1999 JPCB 103 8093-6.
Synthetic with tetramethylammonium, Na & n-hexane derivatives as agents: **AM Goossens & 6 others** 2000 MMM 35-36 555-72 (G1194).
CO adsorption on superacid sites of dealuminated, IR: **RA Shigeishi BH Chiche F Fajula** 2001 MMM 43 211-26 (1500).
mazzite-Na $Na_8Al_8Si_{28}O_{72}.30aq$. *Zeolite* mineral group.
IZA-SC structure code MAZ. Consortium for Theoretical Frameworks net 632.
Occurrence & SC-XRD structure: **R Arletti & 3 others** 2005 AM 90 1186-91.
mbobomkulite $(Ni,Cu)Al_4[(NO_3)_{1.5}(SO_4)_{0.25}](OH)_{12}.3aq$.
Essentially isostructural with *chalcoalumite* $CuAl_4(SO_4)(OH)_{12}.6aq$ & *nickelalumite* $(Ni,Cu)Al_4[(SO_4),(NO_3)_2](OH)_{12}.3aq$.
Structure determination not found.
Occurrence: **JEJ Martini** 1980 Annals Geol Survey S Africa 14 1-110 = AM 67 415-6.
mboziite $Na_2CaFe_3Fe_2Al_2Si_6O_{22}(OH)_2$. *Amphibole*.
Occurrence: MM 33 1143.
mcallisterite / macallisterite $Mg_2B_{12}O_{14}(OH)_{12}.9aq$. Dimorphic with *admontite*.
Structure: **A Dal Negro C Sabelli L Ungaretti** 1969 Acc Naz Lincei Rend Cl Sci Fis Mat Nat 47 353-64 (D172) = MA 72-1852.
mcalpineite $Cu_3TeO_6.aq$.
XRPD almost matches *synthetic* Cu_3TeO_6, PDF 22-251.
Structure, **L Falck O Lindqvist J Moret** 1978 AC B34 896-7 (F418).
Occurrence: **AC Roberts & 6 others** 1994 MM 58 417-24.
mcauslanite $HFe_3Al_2(PO_4)_4F.18aq$.
Structure determination not found.
Occurrence: **JM Richardson & 3 others** 1988 CM 26 917-21.
mcbirneyite $Cu_3(VO_4)_2$. Review: (E289).
Synthetic: **RD Shannon C Calvo** 1972 Canad J Chem 50 3944-9 (S1426).
Occurrence & crystallography: **JM Hughes & 3 others** 1987 JVGR 33 183-90 = AM 73 1495.
Synthetic $Ni_3V_2O_8$: **A Durif EF Bertaut** 1959 J Phys Radium 20 455;
& $Co_3V_2O_8$, **H Fuess & 3 others** 1970 AC B26 2036.

Synthetic $Zn_3V_2O_8$: **R Gopal C Calvo** 1971 Canad J Chem 49 3056.

Synthetic $Mg_3V_2O_8$: **N Krishnamachari C Calvo** 1971 Canad J Chem 49 1629.

mcconnellite / macconnellite $CuCrO_4$. Isostructural with Fe analog *delafossite*.

Structure: *synthetic*, **W Dannhauser PA Vaughan** 1955 JAChS 77 896-7 (D511).

mccrillisite $CsNa(Be,Li)Zr_2(PO_4)_4.1\text{-}2aq$.

Isostructural with *gainesite* NaCa & *selwynite* KNa.

Structure: **EE Foord & 4 others** 1994 CM 32 839-42.

mcgillite $Mn_8Si_6O_{15}(OH)_8Cl_2$. *Friedelite* structure group; monoclinic subtype.

Occurrence & crystallography: **T Ozawa & 4 others** 1983 CM 21 7-17.

HRTEM: **S Iijima** 1982 AC A38 685-94.

Occurrence: MM 43 1063.

MCGOVERNITE POLYSOMATIC GROUP

arakiite	$ZnMn_{12}Fe_2(AsO_3)(AsO_4)_2(OH)_{23}$
dixenite	$CuMn_{14}Fe(As^{3+}O_3)_5(SiO_4)_2(As^{5+}O_4)(OH)_6$
franciscanite	$Mn_6[V,void]_2Si_2(O,OH)_{14}$
hematolite	$(Mn,Mg,Al)_{15}(AsO_3)(AsO_4)_2(OH)_{23}$
kraisslite	$Mg_2Mn_{22}Zn_3Fe(AsO_3)_2(AsO_4)_3(SiO_4)_6(OH)_{18}$
mcgovernite	$(Mn,Mg)_{19}Zn_3(AsO_3)(AsO_4)_3(SiO_4)_3(OH)_{21}$
örebroite	$Mn_6(Sb,Fe)_2Si_2(O,OH)_{14}$
turtmannite	$(Mn,Mg)_{22.5}Mg_{3-3x}[(V,As)O_4]_3(SiO_4)_3(AsO_3)_xO_{5-5x}(OH)_{20+x}$
welinite	$Mn_6[W,Mg]_2Si_2(O,OH)_{\sim 14}$

Complex polysomatic relations: **J Brugger & 4 others** 2001 AM 86 1494-505.

mcgovernite / macgovernite $(Mn,Mg)_{19}Zn_3(AsO_3)(AsO_4)_3(SiO_4)_3(OH)_{21}$.

Structure: **BJ Wuensch** 1960 AM 45 937-45.

Occurrence: MM 21 570.

mcguinessite $(Mg,Cu)_2(CO_3)(OH)_2$. *Rosasite* structure group from crystallography.

Structure determination not found.

Occurrence: **RC Erd FP Cesbron FE Goff JR Clark** 1981 MR 12 143-7.

MCKELVEYITE STRUCTURE GROUP Includes:

donnayite	$NaCaSr_3Y(CO_3)_6.3aq$	triclinic, pseudo-trigonal
M5		polymorph of donnayite
mckelveyite	$NaBa_3(Ca,U)Y(CO_3)_6.3aq$	trigonal
[*mckelveyite-Nd*	Question about adequacy of mineralogical description.	
mckelveyite-Y	Question about adequacy of mineralogical description.]	
weloganite	$Na_2Sr_3Zr(CO_3)_6.3aq$	triclinic, pseudo-trigonal

[jvs Mckelveyite is supposed to be dimorphic with *ewaldite*, but ewaldite is anhydrous $Ba(Ca,Y,Na,K)(CO_3)_2$.]

mckelveyite-Y $NaBa_3(Ca,U)Y(CO_3)_6.3aq$.

Structure deterrmination not found.

Occurrence: MM 35 1142;

PE Desautels 1967 AM 52 860-4;

intergrowth with supposed dimorph *ewaldite,* **G Donnay JDH Donnay** 1971 TMPM 1185-200.

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

mckinstryite / mackinstryite $(Ag,Cu)_2S$.

Structure determination not found.

Occurrence: **BJ Skinner JL Jambor M Ross** 1966 EG 61 1383-9.

mcnearite $NaCa_5H_4(AsO_4)_5.4aq$.

Structure determination not found.

Occurrence: **H Sarp J Deferne BW Lieblich** 1981 SMPM 61 1-6 (S1411) = AM 67 856.

medaite $(Mn,Ca)_6(V,As)Si_5O_{18}OH$. Heteropoly $VSi_5O_{18}OH$ complex.

Compare with *tiragalloite*.

Structure: **CM Gramaccioli G Liborio T Pilati** 1981 AC B37 1972-8 (G741).

Occurrence: MM 46 521.
medenbachite $Bi_2Fe(Cu,Fe)(O,OH)_2(OH)_2(AsO_4)_2$.
Isostructural with *cobaltneustädtelite & neustädtelite*.
Structure & mineralogy: **W Krause & 5 others** AM 81 505-12;
W Krause & 3 others 2002 AM 87 726-38.
megacyclite $KNa_8Si_9O_{18}(OH)_9.19aq$. Layer structure with elliptical 18-rings.
Structure: **NA Yamnova & 5 others** 1992 SPC 37 167-74 (Y132).
Occurrence: MM 60 676.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.
megakalsilite $KAlSiO_4$. $(UDUDUD)_1(UUUDDD)_3$-hex net.
Occurrence & structure: **AP Khomyakov** 2002 CM 40 961-70.
meionite $Ca_4Al_6(SiO_4)_6CO_3$. *Scapolite* structure group, species name for endmember.
Structure: *mizzonite* variety, **JJ Papike NC Stephenson** 1966 AM 51 1014-27;
SB Lin BJ Burley 1973 AC B29 2024-6;
BG Aitken HT Evans Jr JA Konnert 1984 NJMA 149 309-24 (A382);
NMR & XRPD, **BL Sherriff & 7 others** 2000 CM 38 1201-13.
See *scapolite* for further references to mineral series.
meixnerite $Mg_6Al_2(OH)_{18}.4aq$.
[jvs Possibly related to *hydrotalcite* but does not contain CO_3.]
Structure determination not found.
Occurrence: **S Koritnig P Süsse** 1976 TMPM 22 79-87 (K730) = AM 61 176.
melanocerite-Ce $(Ce,Ca)_5(Si,B)_3O_{12}(OH,F).naq$. *Apatite* structure group.
Structure determination not found.
Occurrence: **KA Vlasov** 1966 Mineralogy of Rare Elements 301-2 Israel Program for Scientific Translations.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
melanophlogite SiO_2.(encapsulated species). Many polymorphs.
IZA-SC code MEP. Consortium for Theoretical Frameworks net 595.
Structure: **B Kamb** 1965 S 148 232-4 (K84);
L Zak 1972 AM 57 779-96;
H Gies F Liebau 1981 AC A37 C187-8;
synthesis, **H Gies H Gerke F Liebau** 1982 NJMM 119-24 (G508);
H Gies 1983 ZK 164 247-57 (G470);
^{29}Si MAS NMR, two transitions in empty silica: **S Liu MD Welch J Klinowski** 1997 JPC 101 2811-4 (L830);
low-tetragonal, SC-XRD, **T Nakagawa K Kihara K Harada** 2001 AM 86 1506-12;
Raman, $N_2/CO_2/CH_4$, **BA Kolesov CA Geiger** 2003 AM 88 1364-8.
Guest-free, thermochemistry: **A Navrotsky & 3 others** 2003 AM 88 1612-4.
Occurrence & *quartz* pseudomorphs: **GE Dunning JF Cooper Jr** 2002 MR 33 237-42.
melanostibite $Mn(Sb,Fe)O_3$. Ordered superstructure of *corundum* structure type.
Isostructural *ecandrewsite* $ZnTiO_3$, *geikielite* $MgTiO_3$, *ilmenite* $FeTiO_3$ & *pyrophanite* $MnTiO_3$.
Structure: **PB Moore** 1968 AM 53 1104-9.
melanotekite $Pb_2Fe_2Si_2O_9$. Isostructural series with Mn analog *kentrolite*.
Structure: **PB Moore & 3 others** 1991 AM 76 1389-99.
Synthetic $Pb_2In_2Si_2O_9$: **J Ito** 1968 AM 53 1663-73;
J Werner H Müller-Buschbaum 1997 ZN 52 b 1213-8 (W860).
Synthetic $Pb_2Fe_2Ge_2O_9$, structure: **J Barbier D Lévy** 1998 AC C54 2-5 (B1790).
melanothallite Cu_2OCl_2.
Synthetic, SCXRD: **SV Krivovichev SK Filatov PC Burns** 2002 CM 40 1185-90.
Occurrence: **LP Bergasova SK Filatov** 1982 ZVMO 111 562-5.
melanovanadite $CaV_4O_{10}.5aq$. Vanadium bronze structure group; *other* subgroup.
Review: **HT Evans Jr JM Hughes** 1990 AM 75 508-21.
Structure: **JA Konnert HT Evans Jr** 1987 AM 72 637-44.
MELANTERITE STRUCTURE GROUP Includes:
bieberite $CoSO_4.7aq$

boothite	$CuSO_4.7aq$
mallardite	$MnSO_4.7aq$
melanterite	$FeSO_4.7aq$
zinc-melanterite	$ZnSO_4.7aq$.

Important for acid mine waste.
Cu,Zn-bearing *melanterites*: *synthetic*/natural vs color & XRD structure, **RC Peterson** 2003 CM 41 937-49;
cuprian- to rozenite in mine waste , **RC Peterson AH Grant** 2005 CM 43 171-81.
RC Peterson AH Grant 2005 CM 43 171-81.
melanterite $FeSO_4.7aq$. Review: **Sabelli** p. 8-9.
Structure: **WH Baur** 1964 AC 17 1167-74 (B225);
FR Fronczek SN Collins J Chan 2003 ACE 57 i26-7.
Melanterite-*rozenite* equilibria: **I Chou RR Seal II BS Hemingway** 2001 AM 87 108-14.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Rapid formation from *pyrite* in mine waste, Sardinia, Italy: **F Frau** 2000 MM 64 995-1006.

MELILITE STRUCTURE GROUP Includes:

åkermanite	$Ca_2MgSi_2O_7$	
gehlenite	$Ca_2Al(SiAl)O_7$	
gugiaite	$Ca_2BeSi_2O_7$	
jeffreyite	$(Ca,Na)(Be,Al)Si_2(O,OH)_7$	?superstructure
hardystonite	$Ca_2ZnSi_2O_7$	
leucophanite	$(Na,Ca)_2BeSi_2(O,F,OH)_7$	ordered, distorted
melilite	åkermanite-gehlenite series	
meliphanite	$(Ca,Na)_2Be(Si,Al)_2(O,OH,F)_7$	double *c*
Na-melilite	non-mineral name for *synthetic* $NaCaAlSi_2O_7$ (**SJ Louisnathan** 1970)	
okamayalite	$Ca_2B_2SiO_7$	
strontian-soda melilite	[Cameroon, SC-XRD structure: **L Bindi P Bonazzi G Fitton** 2001 EJM 13 121-5 (1675).]	

Review: **M Kimata** 1980 NJMA 181-97.
Review of incommensurate modulations: **F Seifert F Röthlisberger** 1993 MP 48 179-92.
Low-T XRD, towards commensurate value of q vector: **L Bindi P Bonazzi** 2003 PCM 30 5523-8.
Occurrence, hyperagpaitic alkaline rocks, Na,Sr-rich variety: **Khomyakov** 1995.
In meteorites: **AE Rubin** 1997 MPS 32 231-47;
K diffusion vs planetesimal size for CAI inclusions: **M Ito J Ganguly** 2004 MPS 39 191-20.
Synthetic $Ca_2B_2SiO_7$ '*boron-melilite*': **J Tarney AW Nicol GF Marriner** 1973 MM 39 158; see *boron-gehlenite.*
Synthetic $Ba_2CdSi_2O_7$: **F Seifert** 1986 NJMM 8-12.
Synthetic $Ca_2CoSi_2O_7$: **M Kimata** 1983 NJMA 146 221-41;
commensurate, **K Hagiya & 3 others** 2001 AC B 57271-7 (2003)..
Synthetic $(Na,Ca)(Al/Ga)Si_2O_7$: **H Schichl F Raaz** 1968 Anz Osterr Akad Wiss Math-Naturw Kl 361-4 = MA 69-2894.
Synthetic $Sr_2MnSi_2O_7$: **M Kimata** 1985 NJMM 83-96.
CaZnGeSi system: **TF Armbruster F Röthlisberger F Seifert** 1990 AM 75 847-58.
Synthetic $Ca_2ZnGe_2O_7$: **C Van Heurck G Van Tendeloo S Amelinckx** 1992 PCM 18 441-52.
Synthetic $Y_2Be_2SiO_7$: **SF Bartram** 1969 AC B25 791-5.
Synthetic $Y_2Si_3O_3N_4$: **KS Chee Y-B Chung ME Smith** 1995 ChM 7 982-8 (C760);
O,N ordering from ^{15}N NMR, **A Koroglu & 3 others** 1996 JMC 6 1031-4 (K842);
do, & in $Nd_2Si_{2.5}Al_{0.5}O_{3.5}N_4$: **P Wang & 4 others** 1997 JMC 7 2127-30 (W842).
Synthetic sulfide family: **AM Lozac'h M Guittard K Flahaut** 1972 CRASP C275 809.
Synthetic $CaLaGa_3S_7$: **A Mazurier S Jaulmes M Guitard** 1987 AC C43 1859-61.
Synthetic oxysulfides $(Ca/Sr)LaGa_3S_6O$, $(La/Sr)_2ZnGa_2S_6O$: **CL Teske** 1985 ZaaC 531 52-60.
Synthetic $Ba_2MgSi_2O_7$: **M Shimizu M Kimata I Iida** 1995 NJMM 39-47 (S1423).
Synthetic $Ca_2Al(AlSi)O_7$ & $Ca_2MgSi_2O_7$ with Cr substitution for luminescence, structure:
GM Kuz'micheva EV Zharikov AL Denisov 1995 Russian J Inorg Chem 40 1368-74 (K793).
Synthetic $CaYAl_3O_7$ with Cr substitution for luminescence, structure, also of Cr,B-substituted:

GM Kuz'micheva & 5 others 1995 Russian J Inorg Chem 40 548-56 (K792).

Synthetic $(Ca,Sr)_2(Mg,Co,Zn)Si_2O_7$, EXAFS of local structure in incommensurate modulated structure: **T Tamura & 6 others** 1996 PCM 23 81-8 (T476).

Synthetic $RE_2Si_3O_3N_4$, phase relations/cell dimensions: **Z Huang I Chen** 1996 JACeS 79 2091-7 (H1112).

Synthetic Cr-doped *akermanite, gehlenite, Ga-gehlenite & GaGe-gehlenite*, optical spectroscopy: **A Sugimoto & 6 others** 1997 PCM 24 326-32 (S1752).

Synthetic $Ca_2MgSi_2O_7$, $Ca_2CoSi_2O_7$ & $Ca_2(Mg, Fe)Si_2O_7$, SC-XRD structures to 773 K, incommensurate, diffuse streaks: **K Kusaka & 6 others** 2001 PCM 28 150-66 (1631).

Synthetic akermanite-gehlenite, interdiffusion of Al + Al vs Mg + Si: **H Nagasawa & 3 others** 2001 PCM 28 706-10 (3826).

Synthetic La-Sr-Ga-O ceramic: **M Rosurnek & 3 others** 2004 JACeS 87 662-9 (10233).

melilite see above.

Structure: **JV Smit**h 1953 AM 38 643-61;
incommensurate theory, **JDC McConnell** 1999 ZK 214 457-64 (M1768);
incommensurate in 5-D superspace, **L Bindi & 4 others** 2001 AC B57 739-46 (3789);
twin with 5-fold supercell, **L Bindi LH Rees P Bonazzi** 203 ACB 59 156-8 (8759).

Hartman-Perdok growth theory: **MF Nicolov** 2004 ZK 219 630-6 (10966).

Occurrence in kimberlite: **EMW Skinner IL Makotkin HS Grutter** 1999 Proc VII Int Kimberlite Conf 788-794.

meliphanite $(Ca)_4(Na,Ca)_4Be_4AlSi_7O_{24}(F,O)_4$. *Melilite* structure type with double *c*.

Structure: **A Dal Negro G Rossi L Ungaretti** 1967 AC 23 260-4 (N78)'
JD Grice FC Hawthorne 2002 CM 40 971-80.

melkovite $CaFeH_6(MoO_4)_4(PO_4).6aq$.

Possible derivative structure of *mitridatite*: **PB Moore T Araki** 1977 IC 16 1096-106 (M581).

Crystallography: **KV Skvortsova & 5 others** 1972 IGR 14 473.

Occurrence: **BL Egorov AD Dara VM Senderova** 1969 ZVMO 98 207-12.

mellite $Al_2[C_6(COO)_6].18aq$.

Structure; **C Giacovazzo S Menchetti F Scordari** 1973 AC B29 26-331.

MELONITE STRUCTURE GROUP Includes:

berndtite	SnS_2
kitkaite	NiTeSe
melonite	$NiTe_2$
merenskyite	$PdTe_2$
moncheite	$(Pt,Pd)(Te,Bi)_2$

CdI_2 topology, ~= *brucite*, except for hydrogen.

melonite $NiTe_2$. Melonite structure type.

Occurrence, synthesis & crystallography: **MA Peacock RM Thompson** 1946 Univ Toronto Studies Geol Series 50 63-73 = MA 10-4;
3d transition metal L-edge X-ray absorption, **JM Charnock & 3 others** 1996 PCM 23 403-8 (C878).

melonjosephite $Ca(Fe,Mg)Fe(PO_4)_2OH$.

Structure: **AR Kampf PB Moore** 1977 AM 62 60-6.

Occurrence: MM 39 919.

mendipite $Pb_3Cl_2O_2$.

Structure: **O Gabrielson** 1957 Arkiv Mineral Geol Stockholm 2 299-304 (G758).

Synthetic SC-XRD structure: **SV Krivovichev PC Burns** 2001 EJM 13 801-9 (3463).

mendozavilite $Na(Ca,Mg)_2[Fe_6(PO_4)_2(PMo_{11}O_{39})(OH,Cl)_{10}].33aq$.

Related to *paramendozavilite*.

Occurrence: **SA Williams** 1986 Boletin de Mineralogia 2 13-9 = AM 73 193
& XRPD like *betpakdalite*, **WD Birch A Pring K Wallwork** 2002 Austral J Mineral 8 11-5 = 2003 AM 478-9.

mendozite $NaAl(SO_4)_2.11aq$. Compare with *kalinite*. Review: **Sabelli** p. 16.

Structure: **JH Fang PD Robinson** 1972 AM 57 1081-8.

meneghinite $CuPb_{13}Sb_7S_{24}$. Defect/deformed *galena* structure.

Homolog of *jaskolskiite* $\sim Pb_{2+x}Cu_x(Sb,Bi)_{2-x}S$; x = 0.2.

Crystal chem, homologs/related sulfosalts: **P Berlepsch & 2 others** 2001 NJMM 115-35 (1748).
Structure: **R Euler E Hellner** 1960 ZK 113 345-72 (E321);
Cu-poor, SC-XRD, **Y Moelo & 3 others** 2002 CRG 334 529-36 (8132).
Structural differences between specimens: **WD Hicks EW Nuffield** 1978 CM 16 393-5.
Solid solution, *zinckenite*, *robinsonite* & *meneghinite*: **KL Pryseth B Mishra HJ Bernhardt** 1998 CM 36 207-13.
Occurrence: (W786).
Synthetic boulangerite, falkmanite & Cu-free *meneghinite*, XRPD & stability: **KL Pruseth B Mishra H Bernhardt** 2001 EJM 13 411-9 (1996).

menshikovite $Pd_3Ni_2As_3$. Composition matches *synthetic*.
Occurrence: **AY Barkov & 3 others** 2000 MM 64 847-51; 2002 CM 40 679-92.

mercallite $KHSO_4$. Review: **Sabelli** p.32.
Structure: **LH Loopstra CH MacGillavry** 1958 AC 11 349-54;
DWJ Cruickshank 1964 AC 17 682-3;
FA Cotton BA Frenz DL Hunter 1975 AC B31 302-4;
F Payan R Haser 1976 AC B32 1875-9;
300 & 468 K, **GY Lenz & 4 others** 2001 Ber Deut Mineral Ges 13 111 (2941).
Occurrence: MM 24 618.
Synthetic $K/RbSO_4$: **WG Mumme** 1973 AC B29 1076-83.
Synthetic $KHSeO_4$: **J Baran T Lis** 1986 AC C42 270-2.

mercury Hg. Rhombohedral distortion of cubic close packing.
Structure: **N Alsén G Aminoff** 1922 Geol Foren Forh 44 124-8.
Occurrence, submarine vents: **P Stoffers & 5 others** 1999 G 27 931-4 (S2093).
Beta-Hg: **M Atoji JE Schirber CA Swennson** 1959 J Chem Phys 31 1628-9.

mereheadite $Pb_2O(OH)Cl$. *Nadorite* family of Pb sheet structures.
Related to *litharge* & *synthetic* Pb oxyhalides.
Occurrence, partial structure: **MD Welch AJ Criddle RF Symes** 1998 MM 62 387-93.

mereiterite $K_2Fe[SO_4]_2.4aq$. Isostructural with Mg analog *leonite*.
Structure: **G Giester B Rieck** 1995 EJM 7 559-66 (G764).

merenskyite $(Pd,Pt)(Te,Bi)_2$. *Melonite* structure family.
Similar to *synthetic* $PdTe_2$.
[*biteplapalladite* & *biteplatinite* are unnecessary names for merenskyite-*moncheite* solid solutions: AM 61 174; MA 76-2362.]
Occurrence: **GA Kingston** 1966 MM 35 815-34.

merlinoite $(K,Ca,Na,Ba)_7Al_9Si_{25}O_{64}.23aq$. Zeolite mineral group. IZA-SC code MER.
Consortium for Theoretical Frameworks net 17.
Structure: **E Galli G Gottardi D Pongiluppi** 1979 NJMM 1-9 (G761);
Si-poor from Kola Peninsula, **SV Baturin YuA Malinovskii IB Bunova** 1985 Mineral Zhurnal 7 67-74;
Na,K-rich, SC-XRD, **OV Yakubovich & 3 others** 1999 CrR 44 776-82 (Y258);
ordered Al, MAS-NMR, **GJ Kennedy M Afeworki SB Hong** 2002 MMM 52 55-9.
Occurrence: MM 42 527.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.
Synthesis & crystallography: **C Colella R Ailello V Di Ludovico** 1977 Rend Soc Italiana Min Petr 33 511-8.
Synthetic $BaAlSi_2O_6(Cl,OH)$: **LP Solov'eva SV Borisov VV Bakakin** 1972 SPC 16 1035-8 (S1337).
Synthetic zeolite W like merlinoite, structure: **A Bienok & 3 others** 1996 JMC 6 271-5 (B1494).
Synthetic Sr-: **AA Belhekar AJ Chandwadkar SG Hegde** 1995 Z 15 535-**?**

Synthetic $AlCo_2P_4O_{16}$, structure: **P Feng X Bu GD Stucky** 1997 N 388 735-40 (F556).
Synthesis with/without organocations: **JC Quirin LT Yuen SI Zones** 1997 JMC 7 2489-94 (Q20).

Synthetic NH_4 Be phosphate, structure: **X Bu TE Gier GD Stucky** 1998 MMM 26 61-6 (B1894).
Synthetic Ga-, XRPD, NMR & IR: **SH Kim & 4 others** 2000 MMM 42 121-9 (780).
Synthetic K-, structural & thermal properties: **BM Skofteland OH Ellestad KP Lillerud** 2001 MMM 43 61-71 (1191).

merrihueite $(K,Na)_2(Fe,Mg)_5Si_{12}O_{30}$. *Osumilite* structure type.
Occurrence: MM 35 1144-5.
Synthetic Mg-: **AA Khan WH Baur WC Forbes** 1972 AC B28 267-72.

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

merrillite $NaCa_9Mg(PO_4)_7$. Beta-$Ca_3(PO_4)_2$ structure type Stable at ambient.

Transforms to gamma-$Ca_3(PO_4)_2$ at high P.

In Suizhou L6 chondrite: **X Xie & 6 others** 2002 GCA 66 2439-44 (7763).

Occurrence in meteorites: **AE Rubin** 1997 MPS 32 733-4.

mertieite-I $(Pd,Cu)_{5+x}(Sb,As)_{2-x}$.

Related to *isomertieite*, *mertieite-II* & *stibiopalladinite*. Matches *synthetic*.

Structure related *niccolite*: *synthetic* Pd_5Sb_2, **M El-Boragy S Bhan K Schubert** 1970 J Less Common Metals 22 445-58.

Occurrence & crystallography: **GA Desborough JJ Finney BF Leonard** 1973 AM 58 1-10;
LJ Cabri TT Chen 1976 AM 61 1249-54.

Phase relations in Pd-Pt-Sb: **W Kim GY Chao** 1996 NJMM 351-64 (K886).

mertieite-II $Pd_8(Sb,As)_3$. Related to *isomertieite*, *mertieite-I* & *stibiopalladinite*.

Occurrence & crystallography: **GA Desborough JJ Finney BF Leonard** 1973 AM 58 1-10;
LJ Cabri TT Chen 1976 AM 61 1249-54.

Occurrence & alteration to *palladium hydroxide compound* & *Pd-Mn-Au-Cu-Cl-bearing Fe oxyhydroxide*: **A Raphael Cabral & 6 others** 2001 MM 65 169-79.

Phase relations in Pd-Pt-Sb: **W Kim GY Chao** 1996 NJMM 351-64 (K886).

merwinite $Ca_3Mg(SiO_4)_2$. Isostructural with *brianite* $Na_2CaMg(PO_4)_2$.

Structure: **PB Moore T Araki** 1972 AM 57 1355-74 (M399).

manganese-merwinite $Ca_3MnSi_2O_8$. Slag mineral. MM 27 272.]

mesolite $Na_2Ca_2Al_6Si_9O_{30}.8aq$. *Natrolite* structure type with cation ordering.

Structure: **G Artioli JV Smith JJ Pluth** 1986 AC C42 937-42 (A656);
K Stähl 1994 Z 14 12-7 (S1238));

Al & Si, MAS-NMR, **PS Neuhof & 4 others** 2002 AM 87 1307-20.

Real-time XRPD of dehydration: **K Ståhl J Hanson** 1994 JACr 27 543-50.

Phase changes & amorphization at high P: **P Gillet J Malézieux J Itié** 1996 AM 81 651-7.

messelite $Ca_2(Fe,Mn)(PO_4)_2.2aq$. *Fairfieldite* structure group from crystallography.

Structure determination not found.

Occurrence: **C Frondel** AM 40 828-33;
F Cech K Padera 1958 CEr 19 436-49 = AM 44 469.

meta-aluminite $Al_2SO_4(OH)_4$ .5aq. Review: **Sabelli**, no structure.

Compare with *aluminite* 8aq.

Indexed XRPD: **L Farkas P-E Werner** 1980 ZK 151 141-52 (F434).

[jvs; may have chosen different monoclinic cell than one analogous to aluminite.]

Occurrence: **C Frondel** 1968 AM 53 717-21.

meta-alunogen $Al_4(SO_4)_6.27aq$. Review: **Sabelli**, doubtful species.

Occurrence, steam condensate, Taupo, New Zealand: **KA Rodgers & 4 others** 2000 MM 64 125-42.

Occurrence: MM 26 339.

meta-ankoleite $K_2(UO_2)_2(PO_4)_2.6aq$.

Meta-autunite structure group from crystallography.

Occurrence: **MJ Gallather D Atkin** 1966 Bull Geol Surv Great Britain 25 49 = AM 52 560.

Synthesis, XRPD & IR: **L Van Havebeke R Vochten K Van Springel** 1996 MM 60 759-66.

PDF 29-1061.

EXAFS: **HA Thompson GE Brown Jr GA Parks** 1997 AM 82 483-96.

META-AUTUNITE STRUCTURE GROUP Includes:

abernathyite	$KUO_2AsO_4.4aq$
autunite	$Ca(UO_2)_2(PO_4)_2.10\text{-}12aq$
bassetite	$Fe(UO_2)_2(PO_4)_2.8aq$
chernikovite	$(H_3O)(UO_2)(PO_4).3aq$
lehnerite	$Mn[VO_2/PO_4]_2.8aq$
meta-ankoleite	$K(UO_2)(PO_4).3aq$
meta-autunite	$Ca(UO_2)_2(PO_4)_2.6\text{-}8aq$
meta-heinrichite	$Ba(UO_2)_2(AsO_4)_2.8aq$

meta-kahlerite	$Fe(UO_2)_2(AsO_4)_2.8aq$
meta-kirchheimerite	$Co(UO_2)_2(AsO_4)_2.8aq$
meta-lodevite	$Zn(UO_2)_2(AsO_4)_2.10aq$
meta-natroautunite	$Na(UO_2)(PO_4).3aq$
meta-novacekite	$Mg(UO_2)_2(AsO_4)_2.4\text{-}8aq$
meta-torbernite	$Cu(UO_2)_2(PO_4)_2.8aq$
meta-uranocircite	$Ba(UO_2)_2(PO_4)_2.8aq$
meta-uranospinite	$Ca(UO_2)_2(AsO_4)_2.8aq$
meta-zeunerite	$Cu(UO_2)_2(AsO_4)_2.8aq$
natroautunite	$Na(UO_2)(PO_4).3aq$
sodium uranospinite	$(Na_2,Ca)(UO_2)_2(AsO_4)_2.5aq$
trögerite	$(H_3O)(UO_2)(AsO_4).3aq$
uramphite	$(NH_4)(UO_2)(PO_4).3aq$

WARNING: I am not certain about the exact status of the water content of some of the above, or about hyphenation.

Structures of *synthetic* phases & review of compositions: **AJ Locock & 3 others** 2004 CM 42 973-96.

Review: **PC Burns ML Miller RC Ewing** 1996 CM 34 845-80.

Natural *hydrogen-autunite*: occurrence, **WGR de Camargo** 1971 Minerais uraniferous de Perus, S. P. Bull Instituto Geosciencas Astronomica, Universidade de Sao Paulo 2 85-201, quoted in **CRM Butt J Graham** 1981 AM 66 1068-72.

Natural *sodian potassian hydroxonian meta-autunite*: Type I meta-autunite structure.

Occurrence & crystallography: **CRM Butt J Graham** 1981 AM 66 1068-72.

Layer structure: review (E289).

Dissolution kinetics: **DM Wellman & 3 others** 2006 AM 91143-58.

Natroautunite & *metanatroautunite*, XRPD: **AA Chernikov NI Organova** 1994 DES 338 368-71(C832).

meta-autunite $Ca(UO_2)_2(PO_4)_2.2\text{-}6aq$. Meta-autunite structure group.

Structure: **ES Makarov VI Ivanov** 1962 DES 132 601-3 = MA 16-27; **M Ross** 1963 AM 48 1389-93.

Sr-containing; **A Volborth** 1959 AM 44 702-11.

EXAFS: **HA Thompson GE Brown Jr GA Parks** 1997 AM 82 483-96.

metaberyllite $Be_2SiO_5.2aq$. Lower hydrate of *beryllite*.

Occurrence: **EI Semenov** 1972 ZVMO 102 75.

[*beryllite* $Be_3SiO_4(OH)_2.aq$. Structure determination not found.

Occurrence: **MV Kuzmenko** 1954 DAN 99 451-4 = AM 40 787-8.] [jvs: check hydration levels!]

metaborite (alpha / beta) HBO_2.

Consortium for Theoretical Frameworks tetrahedral net 1043.

Structure: synthetic, **WH Zachariasen** 1963 AC 16 380-4.

Occurrence: MM 33 1143.

metacalciouranoite / metacaltsuranoite $(Ca,Na,Ba)U_2O_7.1.7aq$.

Compare *bauranoite* $BaU_2O_7.4\text{-}5aq$ & *wölsendorfite* $(Pb,Ca)U_2O_7.2aq$; may relate structurally justifying membership in proposed wölsendorfite group: **LN Belova & 3 others** 1985 Izv Akad Nauk SSSR Ser Geol 2 65-72 = AM 75 246.

Occurrence: **VP Rogova & 3 others** 1973 ZVMO 102 75-81.

metacinnabar HgS. Trimorphic with *cinnabar* & *hypercinnabar*. *Sphalerite* structure type. Continuous series with Se analog *tiemannite*.

Structure: **PM Bethke** 1956 GSAB 67 1671.

metadelrioite $CaSrV_2O_6(OH)_2$.

Intergrown fibrous *delrioite* $CaSrV_2O_6(OH)_2.3aq$: SC-XRD, **ML Smith** 1970 AM 55 185-200.

metahaiweeite $Ca(UO_2)_2Si_6O_{15}.<5aq$.

Partly dehydrated *haiweeite* 5aq: **TC McBurney J Murdoch** 1959 AM44 839-43.

Synthetic: MM 32 969.

[metahalloysite Dehydrated at 323 K; distinct structure from *kaolin*: MM 24 618.]

metaheinrichite $Ba(UO_2)_2(AsO_4)_2.8aq$. *Meta-autunite* structure group.

Electron diffraction: **MEJ de Abeledo EE Galloni MAR de Benyacar** 1968 AM 53 1028-33.
Occurrence: **EB Gross & 3 others** 1958 AM 43 1134-43.

metahewettite $CaV_6O_{16}.\sim 3aq$.

Vanadium bronze structure group; *hewettite* subgroup.

Hewettite with 9aq may dehydrate to 6aq and certainly to 3aq, of which latter is metahewettite or *dehydrated hewettite*: **M Ross** 1959 AM 44 322-41;
HT Evans Jr JM Hughes 1990 AM 75 508-21.

Structure: $NaCa_{0.5}V_6O_{16}.2aq$ & anhydrous, **HG Bachmann WH Barnes** 1962 CM 7 219-35;

XRPD of 7 specimens: **P Bayliss SSJ Warne** 1979 MM 43 550.

metahohmannite $Fe_2[O(SO_4)_2].4aq$. Related to *amarantite & hohmannite*.

Structure: dehydrated *hohmannite*, XRPD, **F Scordari G Ventruti AF Gualtieri** 2003 AM 89 365-70;
order-disorder of $FeOHSO_4$ obtained by thermal decomposition, **G Ventruti & 4 others** 2005 AM 90 679-86.

metajennite see *jennite*. Artificial: MM 35 1145.

metakahlerite $Fe(UO_2)_2(AsO_4)_2.8aq$. *Meta-autunite* structure group.

Occurrence: **K Walenta** 1958 Jahresheft geol Land Baden-Württemberg 3 17-51 = AM 45 254.

metakingite Artificial derivative of *kingite*: MM 31 966.

metakirchheimerite $Co(UO_2)_2(AsO_4)_2.8aq$. *Meta-autunite* structure group.

Occurrence: **K Walenta** 1959 BSFMC 81 67-8 = AM 44 466.

metaköttigite / metakoettigite $(Zn,Fe^{3+})(Zn,Fe)_2(AsO_4)_2.8(aq,OH)$.

Metavivianite structure group?.
Analog of *symplesite*.
Occurrence: **K Schmetzer G Amthauer V Stähle O Medenbach** 1982 NJMM 506-18.

metalodevite / meta-lodevite $Zn(UO_2)_2(AsO_4)_2.10aq$. *Meta-autunite* structure group.

Occurrence: **H Agrinier & 5 others** 1972 BSFMC 95 360-4 (A585).

metamunirite $NaVO_3$-beta.

Structure: *synthetic*, **K Kato E Takayama** 1984 AC B40 102-5;
HT Evans Jr MM 55 509-13.

metanovacekite $Mg(UO_2)_2(AsO_4)_2.4-8aq$. *Meta-autunite* structure group.

Reversible dehydration *novacekite I* to *II* to *metanovacekite*: **K Walenta** 1964 TMPM 9 111-74.
Electron diffraction: **MEJ de Abeledo EE Galloni MAR de Benyacar** 1968 AM 53 1028-33.
Monoclinic polymorph?: **B Bachet C Brassy A Cousson** 1991 AC C47 2013-5.
Occurrence: MM 31 966-7;
NJ Elton JJ Hooper AE Jeal 1994 MM 58 513-4.

metarossite $CaV_2O_6.2aq$.

Structure: **CH Kelsey WH Barnes** 1960 CM 6 448-66 & 697 (K707).
Occurrence: MM 21 571.

metaschoderite $Al_2(PO_4)(VO_4).6aq$. Structure determination not found.

Occurrence: **DM Hausen** 1962 AM 47 637-48.

[metaschoepite $UO_3.1-2aq$. ? = *schoepite-II*.

Crystallographic relationships among *schoepite*, metaschoepite & dehydrated schoepite: **RJ Finch FC Hawthorne RC Ewing** 1996 GAC/MAC Mtg P-25.
Structure: *synthetic*, SC-XRD: **MT Weller ME Light T Gelbrich** 2000 AC B56 577-83 (W1015).
Occurrence: MM 32 970.]

metasideronatrite $Na_4Fe_2(SO_4)_4(OH)_2.3aq$. Review: **Sabelli** p. 16.

Contains $M(TO_4)_2$ chain also in *labuntsovite*,*nenadkevichite*, *sideronatrite*, *tancoite* & *yftisite*.

Structure: **JJ Phinney** 1973 AM 58 1080-1;
F Scordari F Stasi G Milella 1982 NJMM 341-7;
synthetic, **F Cesbron** 1964 BSFMC 87 125-43.

meta-sodium-uranospinite $(Na_2,Ca)(UO_2)_2(AsO_4)_2.5aq$.

Meta-autunite structure group from crystallography.
Structure determination not found.
Occurrence: **EV Kopchenova KV Skvortsova** 1957 DAN SSSR 114 634-6;

renamed MM 35 1144.

[metastibnite Amorphous. Ignore.]

metastrengite $FePO_4.2aq$. Monoclinic dimorph of *strengite*: MM 29 978.

Occurrence in fertilizers: **JR Lehr & 4 others** 1966 *Crystallographic Properties of Fertilizer Compounds*, Tenn Valley Auth Chem Eng Bull 6, 163p (L758).

Hydrothermal *synthesis* with urea: **C Trobajo et al** 2000 JCSDT 767-90 (T638).

[*clinostrengite & phosphosiderite* = metastrengite?]

metastudtite $UO_4.2aq$.

Structure determination not found.

XRPD matches *synthetic* & heated *studtite*.

Occurrence: **M Deliens P Piret** 1983 AM 68 456-8.

Synthetic, XRPD: **PC Debets** 1963 J Inorg Nuclear Chem 25 727-30.

metaswitzerite $Mn_3(PO_4)_2.4aq$.

Structure: **L Fanfani PF Zanazzi** 1979 TMPM 26 255-69;
PF Zanazzi PB Leavens JS White Jr 1986 AM 71 1224-8.

[metathenardite Na_2SO_4.

High-temperature type III related to *thenardite* type V by topotactic transformation.
jvs: unnecessary name?]

metatorbernite $Cu(UO_2)_2(PO_4)_2.8aq$. *Meta-autunite* structure group.

Review: **PC Burns ML Miller RC Ewing** 1996 CM 34 845-80.

Structure: **ES Makarov KI Tobelko** 1960 SPD 5 221-3 (M1136) = MA 16-25;
M Ross HT Evans Jr DE Appleman 1964 AM 49 1603-21;
AC Stergiou PJ Rentzeperis S Sklavounos 1993 ZK 205 1;

beta designation for this natural mineral from Sonora, Mexico because of different site symmetry from supposed *alpha* type of Stergiou and Ross, **NJ Calos CHL Kennard** 1996 ZK 211 701-2 (C877).

Electron diffraction: **MEJ & 3 others** 1968 AM 53 1028-33.

metatyuyamunite $Ca(UO_2)_2(VO_4)_2.3\text{-}5aq$. Dehydration product of *tyuyamunite*.

Structure determination not found.

Occurrence: MM 30 740;
TW Stern & 3 others 1956 AM 41 187-201;
C Frondel 1958 USGS Bull 1064 254-7;
BP Onac G Veni WB White 2001 EJM 13 135-43 (1674)..

meta-uranocircite $Ba(UO_2)_2(PO_4)_2.8aq$. *Meta-autunite* structure group.

Review: **PC Burns ML Miller RC Ewing** 1996 CM 34 845-80.

Structure: *synthetic*, **F Khosrawan-Sazedj** 1982 TMPM 29 193-204 (K736).

Synthetic *metauranocircite-II* with 6aq, ion-exchanged from *chernikovite*: **RF Vochten L Van Haverbeke K Van Springel** 1992 AM 56 367-72.

meta-uranopilite $(UO_2)_6SO_4(OH)_{10}.5aq$. Review: **Sabelli**, no structure.

Structure determination not found.

Occurrence: **C Frondel** 1952 AM 37 950-9.

metauranospinite $Ca(UO_2)_2(AsO_4)_2.8aq$. *Meta-autunite* structure group.

Occurrence: **K Walenta** 1958 Jahr geol Landesamt Baden-Württemberg 3 17-51 = AM 45 254.

metavandendriesscheite $PbU_7O_{22}.<12aq$. See *vandendriesscheite*. MM 32 970.

metavanmeersscheite / metavan-meersscheite $U(UO_2)_3(PO_4)_2(OH)_6.2aq$.

Structure determination not found.

Occurrence: **P Piret M Deliens** 1982 BM 105 125-8.

metavanuralite / metavanuralite $Al(UO_2)_2(VO_4)_2OH.8aq$.

Structure determination not found.

Occurrence: **F Cesbron** 1970 BSFMC 93 242-8.

metavariscite $AlPO_4.2aq$. Polymorph of *variscite*, CTF net 5.

Based on CTF net 3: **JM Bennett & 4 others** 1986 Z 6 349-63.

Structure: **J Borensztajn** 1966 BSFMC 89 428-38;
R Kniep D Mootz 1973 AC B29 2292-4 (9293).

Synthetic $InPO_4.2aq$, SC-XRD: **K Sugiyama J Yu K Hiraga O Terasaki** 1999 AC C55 279-81 (S2048).

metavauxite $FeAl_2(PO_4)_2\ (OH)_2\ 8aq$. Dimorphic with *paravauxite*.

Structure: **WH Baur B Rama Rao** 1967 Nw 21 1-2;
PB Moore 1975 NJMA 123 148-59.

Occurrence: MM 21 571.

METAVIVIANITE STRUCTURE GROUP Includes:

metaköttigite	$(Zn,Fe)_3(AsO_4)_2.8(aq,OH)$
metavivianite	$Fe^{2+}_{1.1}Fe^{3+}_{1.9}(PO_4)_2.(OH)_{1.9}.6.1aq$
symplesite	$Fe_3(AsO_4)_2.8aq$

jvs: no structure determination found of any member of this triclinic group; isostructural nature deduced from crystallography; major questions about chemistry. See *vivianite* structure group of monoclinic members [?near-polytypism or dimorphism].

metavivianite $\sim Fe^{2+}_{3-x}Fe^{3+}_x(PO_4)_2(OH)_x.(8-x)aq.$

Occurrence: **C Ritz EJ Essene DR Peacor** 1974 AM 59 896-9;
Mössbauer & speculation that not dimorphic with *vivianite*, **J Dormann J Poullen** 1980 BM 103 633-9;
KA Rodgers 1986 MM 50 687-91 (R667);
XRPD & structural ideas for transition from *vivianite*, **T Sameshita & 3 others** 1985 MM 49 81-5;
KA Rodgers JH Johnston 1985 NJMM 539-42.

Metavivianite intermediate *vivianite & ferro/ferristrunzite*: **RL Frost M Weier WG Lyon** 2004 NJMM 225-40 (10364).

metavoltine $K_2Na_6Fe^{2+}Fe^{3+}_6(SO_4)_{12}.18aq$. Review: **Sabelli** p. 13.

Structure: **G Giacovazzo & 3 others** 1976 TMPM 23 155-65 (G765);
F Scordari 1980 MM 43 669-73, 1981 TMPM 28 207-22.

Maus' salt is not isostructural: **G Giacovazzo F Scordari S Menchetti** 1975 AC B31 2171-3.

Synthetic $K_2(K_{0.4}aq_{0.6})_6Na_4(H_3O)_{0.8}X_{0.7}Fe_6O_2(SO_4)_{12}.12aq$, related to *metavoltine* & alpha-Maus' salt: **F Scordari** 1980 AC B36 1733-8 & 2858;
transformation product, **do** 1981 AC B37 312-7.

metazellerite $Ca(UO_2)(CO_3)_2\ .3aq.$

Structure determination not found.

Occurrence: **RG Coleman DR Ross R Meyrowitz** 1966 AM 51 1567-78.

metazeunerite / meta-zeunerite $Cu(UO_2)_2(AsO_4)_2.8aq$. *Meta-autunite* structure group.

Review: **PC Burns ML Miller RC Ewing** 1996 CM 34 845-80.

Structure: wrong SG, **F Hanic** 1960 Czech J Phys 10 169-81;
correct SG, **P Burns** 1999.

Electron diffraction: **MEJ de Abeledo EE Galloni MAR de Benyacar** 1968 AM 53 1028-33.

Occurrence: **C Frondel** 1958 USGS Bull 1064 215-20.

[methane clathrate hydrate

XRD of solid-state unmixing under shearing stress: **LA Stern SH Kirby WB Durham** 1995 Eos Suppl 11/16 F632.]

meurigite $\sim KFe_7(PO_4)_5(OH)_7.8aq.$

Compare with 5 Å phosphate minerals.

Occurrence, XRPD & ED: **WD Birch & 6 others** 1996 MM 60 787-93.

meyerhofferite $CaB_3O_3(OH)_5.aq.$ 3-ring: triangle & 2 tetrahedra.

Structure: **CL Christ JR Clark** 1960 ZK 114 321-42;
JR Clark DE Appleman CL Christ 1964 J Inorg Nucl Chem 26 73-95;
PC Burns FC Hawthorne 1993 CM 31 305-12 (B1605);
boron K-edge XANES, **ME Fleet S Muthupari** 2000 AM 85 1009-21.

[**meymacite** $WO_3.2aq$. Amorphous. MM 39 920.]

[**'Mg-blatterite'** see *blatterite*.]

[**Mg-perovskite** $MgSiO_3$.

Presumed major component of lower mantle.

Pipe DO-27, Slave Craton, Canada, many inclusions of *sanidine, ferropericlase, nickel & interpreted Mg -perovskite*: **RM Davies & 5 others** 1999 Proc VII Int Kimberlite Conf 148-55.]

mgriite $(Se_{0.42}Cu_{0.42}As_{0.14}Fe_{0.02})$.

Possibly isostructural with *diamond* & *silicon*, but might be a superstructure.

Crystal data indicating diamond structure type: **P Bayliss** 1990 CM 28 751-5.
XRPD data indicating match with *synthetic* Cu_3AsS_3: **YuM Dymkov & 6 others** 1991 Novye Dannye Mineral 37 81-101 = AM 80 849.
Occurrence: **YuM Dymkov & 4 others** 1982 ZVMO 111 215-9.
[Mg-wollastonite *Synthetic*. MM 39 920.]

miargyrite $AgSbS_2$-alpha.
Structure: **W Hoffmann** 1938 Sitz Preus Akad Wiss 111-9;
CR Knowles 1964 AC 17 847-51 (K65);
revised in C121, **JV Smith JJ Pluth S Han** 1997 MM 61 671-75 (S1815);
refined in C2/c, SC-XRD, **H Effenberger & 4 others** 2002 AM 87 753-64.
High-T beta polymorph is cubic with complete solid solution to cubic $AgSbSe_2$.
Synthetic $AgSb(Se/Te)_2$/$AgBi(S/Se)_2$, XRD, high/low-T forms: **S Geller JH Wernich** 1959 AC 12 46-64.
Selenium mineral analog; up to $AgSbS_{0.7}Se_{1.3}$, also *synthetic* S,Se, **IYa Nekrasov S Ye Lunin** 1987 Mineral Zhurnal 9 25-39 = AM 74 950.
Synthetic $Ag(As/Bi/Sb)S_2$, Cd substitution: **I Kelleher SAT Redfern RAD Pattrick** 1996 MM 60 393-401.

miassite $Rh_{17}S_{15}$
Occurrence: **SN Britvin & 3 others** 2001 ZVMO 2 41-5.

MICA STRUCTURE GROUP Includes:

		Polytypes/polymorphs
aluminoceladonite		
anandite		
annite	$KFe_3AlSi_3O_{10}(OH)_2$.	1M
aspidolite	$NaMg_3AlSi_3O_{10}(OH)_2$	
biotite	$K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH,F)_2$	1M, $2M_1$, $5M_1$ & 6A
bityite	$CaLiAl_2(BeAlSi_2)O_{10}(OH)_2$	
boromuscovite	$KAl_2BSi_3O_{10}(OH,F)_2$	1M & $2M_1$
brammalite	$(Na,H_3O)(Al,Mg,Fe)_2(Si,Al)_4[(OH)_2,aq]$.	
celadonite	$K(Mg,Fe)(Fe,Al)Si_4O_{10}(OH)_2$	1M
chernykhite		
chromphyllite	$KCr_2[AlSi_3O_{10}](OH,F)_2$	
clintonite	$Ca(Mg,Al)_3(Al_3Si)O_{10}(OH)_2$	1M
eastonite		
ephesite	$NaLiAl_2Al_2Si_2O_{10}(OH)_2$	$2M_1$
[tetra-]ferri-annite	$K(Fe,Mg)_3(Fe,Al)Si_3O_{10}(OH)_2$	1M
ferro-aluminoceladonite	$K_2Fe^{2+}{}_2Al_2Si_8O_{20}(OH)_4$	1M
ferroceladonite	$K_2Fe^{2+}{}_2Fe^{3+}{}_2Si_8O_{20}(OH)_4$	1M
ferrokinoshitalite	$BaFe_3Si_2Al_2O_{10}(OH)_2$	
[fluor-polylithionite	$KAlLi_2Si_4O_{10}F_2$. *Synthetic* mica. MM 38 992.]	
fluoroannite	$KFe_3AlSi_3O_{10}F_2$	1M
ganterite	$Ba_{0.5}(Na,K)_{0.5}Al_2(Si_{2.5}Al_{1.5})O_{10}(OH)_2$	$2M_1$
glauconite	$(K,Na)(Fe,Al,Mg)_2(Si,Al)_4O_{10}(OH)_2$	1M
hendricksite	$K(Zn,Mg,Mn)_3(Si_3Al)O_{10}(OH)_2$	1M
illite	$\sim(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,aq]$	1M & $2M_1$
kinoshitalite	$(Ba,K)(Mg,Mn,Al)_3Si_2Al_2O_{10}(OH)_2$	1M
lepidolite	$K(Li,Al)_3(Si,Al)_4O_{10}(F,OH)_2$	various
margarite	$CaAl_2Al_2Si_2O_{10}(OH)_2$	$2M_1$
masutomilite	$K(Li,Al,Mn)_3(Si,Al)_4O_{10}(F,OH)_2$	1M
monfdorite	$(K,Na)_2(Fe,Mn,Mg)_5Si_8O_{20}(F,OH)_2$	?
muscovite	$\sim KAl_2(Si_3Al)O_{10}(OH,F)_2$	$2M_1$

nanpingite	$CsAl_2(AlSi_3O_{10})(OH)_2$	$2M_2$
^[norrishite	oxymica]	
oxykinoshitalite	$Ba(Mg_2Ti)(Si_2Al_2)O_{10}O_2$	1M
paragonite	$NaAl_2AlSi_3O_{10}(OH)_2$	1M & 3T
phlogopite	$KMg_3AlSi_3O_{10}(OH,F)_2$	various
polylithionite	$KLi_2AlSi_4O_{10}(F,OH)_2$	1M & $2M_2$
preiswerkite	$NaMg_2Al_3Si_2O_{10}(OH)_2$	
roscoelite	$NaMg_2Al_3Si_2O_{10}(OH)_2$	1M
shirokshinite	$K(NaMg_2)Si_4O_{10}F_2$	1M
siderophyllite	$KFe_2AlAl_2Si_2O_{10}(F,OH)$	
sodium phlogopite	$(Na,K)Mg_3AlSi_3O_{10}(OH)_2$	
tainiolite	$KLiMg_2Si_4O_{10}F_2$	1M
tobelite	$(NH_4,K)Al_2(Si_3Al)O_{10}(OH)_2$	
trilithionite	series with *polylithionite*	1M & $2M_2$
wonesite	$(Na,K)(Mg,Fe,Al)_6(Si,Al)_8(OH,F)_4$	1M
zinnwaldite	$KLiFeAl(AlSi_3)O_{10}(F,OH)_2$	1 & 2M

ME Fleet 2004 Rock-Forming Minerals, Vol 3A 2nd ed: Geol Soc London.

Nomenclature, international committee, not yet checked with above list:
M Rieder & 14 others 1998 CM 36 905-12; 1999 MM 63 267-79;
M Rieder 2001 EJM 13 1009-12 (3796);
K-micas **G Tischendorf & 4 others** 2004 MM 68 649-67.

Crystal chemistry & metamorphic petrology: **A Mottana & 3 others** 2002 ReMG 46 1-499.

Oriented SC-Mössbauer: **TJ Evans & 2 others** 2005 AM 90 1540-55.

Occurrence of Rb- & Cs-rich analogs of *polylithionite & annite & Cs analog of phlogopite in REE-pegmatites, Manitoba*: **P Cerny & 3 others** 2003 AM 88 1832-5.

Polytypism: **JV Smith HS Yoder** 1956 MM 31 209-35;
role of M2 layer in inhomogeneous, **M Nespolo** 2001 ClClM 49 1-23 (1332);
geometric structure models, **PHJ Mercier & 2 others** 2005 AM 90 382-98.

Crystal chemistry of 1M polytype: **MF Brigatti S Guggenheim M Poppi** 2003 AM 88 667-75;
cell dimensions for 250 synthetic & natural, **PHJ Mercier & 2 others & 4 others 2005** AM 90 399-410;
octahedral flattening & rotation angle, *synthetic*. & natural, **PHK Mercier & 6 others** 2006 AM 91 431-499.

OD analysis re twin identification: **M Nespolo** 1999 MJJ 21 53-85 (N528).

1M dioctahedral, ED, Si/Al order: **OV Sidorenko BB Zvyagin SV Soboleva** 1975 SPC 20 332-5.

Layer geometry & OH orientation, IR & ND of 43 specimens: **IV Rozhdestvenskaya TF Semenova VA Frank-Kamenetsky** 1979 Mineral Zhurnal 1 41-58.

Review of refined structures: **Z Weiss M Rieder M Chimielová J Krajicek** 1985 AM 70 747-57.

Polytypism, identification & origin: **H Takeda M Ross** 1995 AM 80 715-24.

XPS of Al & model: **T Ebina & 4 others** 1997 JPC B 1011125-9 (E395).

XPS of surface charge: **WD Johns S Gier** 2001 ClM 36 355-67 (3067).

Model of water on surface: **S Park G Sposito** 2002 PRL 89 085501-1 (7903.

Bityite-margarite intermediate $2M_1$: **J Lin S Guggenheim** 1983 AM 68 130-42.

Octahedral Fe, trioct: **A Manceau D Bonnin WEE Stone J Sanz** 1990 PCM 17 363-70 (423).

Ba-rich 1M, 10 from igneous & metamorphic rocks: **MF Brigatti L Poppi** 1993 EJM 5 857-71.

IR & OH stretch vs. chemical composition of dioctahedral: **G Besson VA Drits** 1997a,b ClClM 45 158-69, 170-83 (B1676,7).

Far-IR of *synthetic* ND_4*-phlogopite/tobelite*: **M Mookherjee & 2 others** 2004 NJMM 1-9 (10081).

TEM of long-period polytypes: **T Kogure M Nespolo** 1999 AC B55 507-16 (K1175).

8-layer polytype of $2M_1$, XRD: **M Nespolo H Takeda** 1999 MJ 21 103-18 (N522).

Tri-octahedral, review of minor & trace elements: **G Tischendorf H Forster B Gottesmann** 2001MM 65 249-76.

Structure vs OH/F substitution in K-Fe(II,III)-Al-Si-O-HF-aq: **B Boukili & 3 others** 2001 SMPM 81 55-67 (2120).

AFM: **Y Kuwahara** 2001 PCM 28 1-8 (1403).

MDO-2O polytype associated with 1M polytype, SC-XRD structure: **G Ferraris & 6 others** 2001 EJM 13 1013-23 (3797).

Trioctahedral 1M-, structural disorder/crystal chem: **E Schingaro F Scordari G Ventruti** 2001 EJM 13 1057-69 (3801).

Fe-XANES of Fe-rich: **MD Dyar JS Delaney SR Sutton** 2001 EJM 13 1079-98 (3803).

Experimental/theoretical XANES/EXAFS of tetra-ferriphlogopite: **G Giuli & 6 others** 2001 EJM 13 1099-108 (3804).
Coexisting K- & ammonium micas in low-grade metapelites: **F Nieto** 2002 AM 87 205-16.
KSDB-3 deep bore-hole:
structural state, in amphibolites, **NO Ovchinnikov & 6 others** 2002 MM 66 491-512;
in ultramafics & mafics, **LP Nikitina & 6 others** 2002 ZVN+MO 81 23-7 (8774).
Monte Carlo simulation of adsorbed water: **S Park G Sposito** 2002 PRL 89 85501-(3) (8010).
Thermodynamic model for K, Fe-Mg dioctahedral white micas, experiments & natural pelites: **T Parra O Vidal P Agard** 2002 CMP 143 706-32 (8049).
Garnet-phengite thermobarometer: **R Coggon TJB Holland** 2002 JMG 20 683-96 (8051).
Li-bearing 3T: crystal structure & chemistry, **MF Brigatti DE Kile L Poppi** 2003 EJM 15 349-56.
Mössbauer/IR, computer model, Fe, dioctahedral trans-vacant: **LG Dainyak & 2 others** 2004 EJM 16 451-68 (10472).
Intermediate Na-K- mica, hydrothermal alteration, Waterloo, Australia, SEM/EMP/XRD/TEM: **G Giorgetti & 3 others** 2003 CMP 146 159-73.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Synthetic 4-layer LiF-phlogopite & XRPD vs polytypism: **H Takeda** 1967 AC 22 845-53 (T141).
Synthetic $BaLiMg_2AlSi_3O_{10}F_2$: **JW McCauley RE Newnham** 1973 ZK 137 360-7.
Synthetic $(K_{1.9}Na_{0.1})Mg_{5.7}(Si_{7.3}Mg_{0.6}Fe_{0.1}Al_{0.1})O_{20}(OH)_4$: **H Tateyama S Shimoda T Sudo** 1974 ZK 139 196-206.
Synthetic $KMg_{2.5}Ge_4O_{10}F_2/KLiMg_2Ge_4O_{10}F_2$ 1M: **H Toraya S Iwai F Marumo** 1978 ZK 148 65-81.
Synthetic $K\ Mg_{2.7}Si_{3.5}Al_{0.5}O_{10}F_2$: **H Toraya & 4 others** 1978 MJJ 9 210-20.
Synthetic $K\ Mg_3Ge_3AlO_{10}F_2$: **H Toraya S Iwai F Marumo** 1978 MJJ 9 221-30.
Synthetic $KMg_{3-x}Mn_xGe_3AlO_{10}F_2$: **H Toraya F Marumo** 1981 M JJ 10 396-407.
Synthetic $KMg_{2.4}Ge_{3.7}Al_{0.3}O_{10}F_2$: **H Toraya F Marumo** 1983 MJJ 11 222-31.
Synthetic $K(Mg_{2.4}Mn_{0.2})(Si_{3.8}Mn_{0.2})O_{10}F_2$: **H Toraya F Marumo M Hirao** 1983 MJJ 11 240-7.
Synthetic phyllosiloxides, $KMg_2AlSi_4O_{12}$ & $KMgAl_2Si_3BO_{12}$: **P Reig & 2 others** 1995 CRASP 321 IIb 199-203 (R600).
Cu(II) adsorbed on muscovite, REFLEXAFS & XPS: **ML Farquhar & 3 others** 1996 JCIS 177 561-7 (409).
Ice-like monolayer adsorbed mica, IR/AFM: **PB Miranda & 3 others** 1998 PRL 81 5876-9 (410).
Synthetic Na-rich, NMR: **S Komarneni & 3 others** 1999 ClClM 47 410-6 (K1200).
Dehydroxylation of Fe(III),Mg dioctahedral:
structure change, **F Muller & 3 others** 2000 ClM 35 491-504 (M1823);
cation migration, **FM VAD Sl Tsipursky AP** 505-14 (M1824).
Synthetic annite-siderophyllite, XRPD structure, IR/Mössbauer: **GJ Redhammer et al** 2000 85 449-65.
Synthetic muscovite-aluminoceladonite, XRPD: **MW Schmidt M Dugnani G Artioli** 2001 AM 86 555-65.
1.8 nm pillared phlogopite: **F del Rey-Perez-Cabellero G Poncelet** 2000 MMM 41 169-81 (462).
9 (Fe/Ti)-phlogopites, Brazil, SC-XRD structure: **MF Brigatti & 3 others** 2001 CM 39 1333-45.
Muscovite-paragonite, XRD, thermal equation of state: **P Comodi & 4 others** 2002 PCM 29 538-44 (8211).
Synthetic, nuclear waste cleanup: **S Komarneni N Kozai WJ Paulus** 2001 N 410 771(1463).
Synthetic NaF-mica: **M Park & 5 others** 2002 ChM 14 2582-9 (7718).
Synthetic phlogopitic, IR & interlayer vacancy: **B Wunder S Melzer** 2002 EJM 14 1129-38 (8681).
Pyridinium compounds, orientation & electronic struct: **M Zwahlen D Brovelli W Caseri G Hähner** 2002 JCIS 256 262-7.
Synthetic Rb-tatraferri-annite, SC-XRD to 7 GPa, phase change: **P Comodi & 5 others** 2003 PCM 30 198-205 (9235).

micheelsenite $(Ca,Y)_3Al(PO_3OH,CO_3)(CO_3)(OH)_6.12aq$. *Ettringite* group.
Occurrence & XRPD: **AM McDonald & 6 others** 2001 NJMM 337-51 (3645).

michenerite $PdBi_2$ / (Pd,Pt)BiTe. *Pyrite* structure group.
Structure: **JG Childs SR Hall** 1973 CM 12 61-5;
P Bayliss 1986 CM 24 27-33.
Occurrence: MM 32 971.
[jvs: not clear what is composition range of natural specimens.]

microcline $KAlSi_3O_8$. *Feldspar* structure group.
Low-temperature triclinic polymorph with ordered Si & Al.
Partly and strongly disordered polymorphs with monoclinic symmetry are denoted *orthoclase (sanidine-low) & sanidine (high)*.

microlite $(Na,Ca)_2Ta_2O_6$. *Pyrochlore* structure group.
Structure determination not found but may be recorded in pyrochlore group references.
Occurrence: **C Frondel** 1958 USGS Bull 1064 326-33.

microsommite $\sim(Na,Ca,K)_{7-8}(Al,Si)_{12}O_{24}(Cl,SO_4,CO_3)_{2-3}$.

Cancrinite structure group. Review: **Sabelli** p. 41.
Crystal chemistry, phase transitions/SC-XRD structure: **E Bonaccorsi & 3 others** 2001 PCM 28 509-22 (3643).
Occurrence & crystallography: **P Bariand F Cesbron R Giraud** 1968 BM 91 34-42 (B1437).
miersite (Ag,Cu)I. *Sphalerite* 3-layer cubic structure type from crystallography.
Synthetic AgI, 4-layer hexagonal polytype: **Q Johnson RN Schock** 1975 AC B31 1482-3.
Solid solution with *marshite*: **PW Millsteed** 1998 MM 62 471-5.
miharaite $Cu_4FePbBiS_6$.
Structure: **IV Petrova EA Pobedimskaya IA Bryzgalov** 1988 SPD 33 157-9 (P465).
Occurrence: MM 46 521.
mikasaite $(Fe,Al)_2(SO_4)_3$. Isostructural with *millosevichite* $(Al,Fe)_2(SO_4)_3$.
Occurrence: **H Miura K Niida T Hirama** 1994 MM 58 649-53.
Synthetic $Fe_2(SO_4)_3$: **R Masse JC Guitel R Perret** 1973 BSFMC 96 346-9.
[mikheevite $K_2Ca_4(SO_4)_5$. Occurrence: MM 30 740. jvs: not listed in later compilations.]
milarite $KCa_2AlBe_2(Si_{12}O_{30}).aq$. *Osumilite* structure type.
Analog of **almarudite** $K(void,Na)_2(Mn,Fe,Mg)_2(Be,Al)_3Si_{12}O_{60}$.
Consortium for Theoretical Frameworks tetrahedral net 279.
Review, **WC Forbes WH Baur AA Khan** 1972 AM 57 463-72.
Structure: **VV Bakakin VP Balkin LP Solov'eva** 1975 SPC 460-2 (B1140);
SC-XRD, crystal chemistry, **P Cerny FC Hawthorne E Jarosewich** 1980 CM 18 41-57;
natural/dehydrated, 100K, **T Armbruster V Bermanec R Oberhansli** 1989 EJM 1 352-62;
natural $K(K_{0.6}Na_{0.4})_2Zn_3Mn1.5[Si_{12}O_{30}]$, **TN Nadezhina & 2 others** 1990 SPD 35 701-3 (N345);
FC Hawthorne & 5 others 1991 AM 76 1836-56.
Other compositions: (P48); (S1305); MA 72-1813; AM 77 451.
Occurrence: Alpine, **TP Moore** 2004 35 405-18.
Synthetic $K_2Mn_5Si_{12}O_{30}.aq$: **PA Sandomirskii MA Simonov NV Belov** 1977 SPD 22 181-3.
12 *synthetic phases* $(Na/K/Rb)_x$(tetrahedral Mg/Zn/Fe/Cu/Li)$_3$(octahedral Mg/Cu/Fe)$_2Si_{12}O_{30}$:
N Nguyen J Choisnet B Raveau 1980 JSSC 34 1-9 (N377).
16 s*ynthetic* phases K/Rb/Na/K-Mg/Mg,Co-Cr/Fe/Li: **A Wohlfart W Eysel** 1998 EJM 324 (W937).
millerite NiS. Beta.
Beta form transforms to alpha at 670 K: **G Kullerud RA Yund** 1962 JP 3 126-75.
Kinetics of alpha-beta in *synthetic*: **H Wang & 3 others** 2006 AM 91 171-81.
Structure: ND, **JT Sparks J Komoto** 1963 J Appl Phys 34 1191-22;
SC-XRD, **V Rajamani CT Prewitt** 1974 CM 12 253-7;
SC-XRD, **JD Grice RB Ferguson** CM 12 248-52;
electronic, **SR Krishakumar & 2 others** 2002 PRB 66 115015.
High-P: equation of state & phase change, **AJ Campbell DL Heinz** JPCS 54 5-7;
structure to 27 GPa: **H Sowa H Ahsbahs W Schmitz** 2004 PCM 31 321-7 (10506).
Mechanism & kinetics of oxidation at 943-973K to NiO & *heazlewoodite*: **H Wang & 3 others** 2006 AM 91 537-43.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
millisite $(Na,K)CaAl_6(PO_4)_4(OH)_9.3aq$.
Isostructural *cyrilovite* $NaFe_3(PO_4)_2(OH)_4.2aq$ & *wardite* $NaAl_3(PO_4)_2(OH)_4.2aq$ from crystallography.
Structure determination not found.
[jvs: might well be a broad family of phases, check *synthetic* literature].
Occurrence: MM 22 625;
in phosphorite, XRPD, **JP Owens ZS Altschuler R Berman** 1960 AM 45 547-61
millosevichite $(Al,Fe)_2(SO_4)_3$. Isostructural with $(Fe,Al)_2(SO_4)_3$ *mikasaite*.
Structure determination not found.
Synthetic solid solution series: **H Miura H Suzaki T Kikuchi** 1994 MJ 17 42-5 (M1141).
milotaite PdSbSe. *Ullmanite* subgroup of *gersdorffite group*.
Synthetic: structure, **AJ Foecker W Jeitschko** 2001 JSSC 162 69-78.
mimetite $Pb_5(AsO_4)_3Cl$. *Apatite* structure type.
Structure: **NJ Calos CHL Kennard RL Davis** 1990 ZK 191 125-9;
Y Dai JM Hughes PB Moore 1991 CM 29 369-76.
Clinomimetite above 371-393K.

minamiite $(Na,K,Ca)Al_3(SO_4)_2(OH)_6$. *Alunite* structure group.
Has double *c* compared to *natroalunite*; superstructure with cation ordering.
Review: **Sabelli** p.25.
Structure: **J Ossaka & 3 others** 1982 AM 67 114-9.
Synthesis: **K Okada & 3 others** 1987 NJMM 64-70.
minasgeraisite-Y $CaY_2Be_2Si_2O_{10}$. *Gadolinite* structure group.
Structure determination not found.
Occurrence: **EE Foord & 4 others** 1986 AM 71 603-7.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
minasragrite $VO(SO_4).5aq$. Monoclinic analog of *orthominasragrite & anorthominasragrite*.
Structure: *synthetic*, **CJ Ballhausen BF Djurinskij KJ Watson** 1968 JACeS 90 3305-9.
2 other *synthetic* polymorphs are metastable.
Occurrence & crystallography: **ML Smith J Marinenko** 1973 AM 58 531-4.
[mindigite $9Co_2O_3$ 2CuO.16aq. Colloid. Occurrence: MM 24 619.]
mineevite-Y $Na_{25}Ba(Y,Gd,Dy)_2(CO_3)_{11}(HCO_3)_4(SO_4)_2F_2Cl$.
Structure: **AP Khomyakov & 3 others** 1992 ZVMO 138-43 (K670);
NA Yamnova & 3 others 1992 Kr 37 1394-402.
Occurrence in hyperagpaitic alkaline rocks**: Khomyakov** 1995.
minehillite $(K,Na)_{2-3}Ca_{28}Zn_4Al_4Si_{40}O_{112}(OH)_{16}$.
Structurally related to *gyrolite*, *reyerite* & *truscottite*:
Structure: **Y Dai JE Post DE Appleman** 1995 AM 80 173-8.
Occurrence & crystallography: **PJ Dunn & 3 others** 1984 AM 69 1150-5.
minguzzite $K_3Fe^{3+}(C_2O_4)_3.3aq$.
XRPD matches *synthetic*. [jvs: check for structure of synthetic.]
Occurrence & crystallography: **CL Garavelli** 1955 Atti Accad Naz Lincei Rend Classe Sci Fis Mat Nat 18 392-402 = AM 41 370.
minium Pb_3O_4. *Trippkeite* structure group. "*Red lead*" pigment.
Structure: **A Byström A Westgren** 1943 Arkiv Kemi Mineral Geol 16B no. 14 (B1412);
ST Gross 1943 JAChS 65 1107-10 (G745);
ND, **MK Fayek J Leciejewitz** 1965 ZaaC 336 104;
NPD, **J Gavarri D Weigel** 1975 JSSC 13 252-7 (G948).
Review ferroelastic/ferroelectric phase transitions at low T, calculated electronic structure, **HJ Terpstra RA De Groot C Haas** 1997 JPCS 58 561-6 (T544).
High-P phase transitions I/II/III: XRPD structures to 40 GPa, **RE Dinnebier & 3 others** 2003 AM 88 996-1002.
Historical usage of minium for both *cinnabar* & red lead, Raman identification: **HGM Edwards et al** 2000 Analyst 124 1323-6 = MA 00M/1134.
minnesotaite $(Fe,Mg)_3Si_4O_{10}(OH)_2$.
Essentially isostructural Mg analog *talc* & Ni *willemseite*, but complications from polytypism.
Structure: **S Guggenheim SW Bailey** 1982 CM 20 579-84 (G447);
S Guggenheim RA Eggleton 1986 CM 24 479-97;
do 1987 AM 72 724-38;
J Ahn PR Buseck 1989 AM 1989 AM 74 384-93.
Occurrence: MM 27 272.
minrecordite $CaZn(CO_3)_2$. *Dolomite* structure group.
Occurrence & crystallography: **CG Garavelli F Vurro GC Fioravanti** 1982 MR 13 131-6.
minyulite $KAl_2(PO_4)_2(OH,F).4aq$.
Structure: **AR Kampf** 1977 AM 62 256-62.
Occurrence: MM 23 634; MR 32 297-302.
Synthetic OH-, SC-XRD, ND of OD-, ^{31}P NMR, **S Dick & 3 others** 1997 ZN 52b 1439-46 (D712).
Occurrence: **JR Lehr EH & 4 others** 1966 *Crystallographic Properties of Fertilizer Compounds*, Tenn Valley Auth Chem Eng Bull 6, 163p (L758).
mirabilite $Na_2SO_4.10aq$. = *Glauber's salt*. Review: **Sabelli** p. 14.
Structure: **HW Ruben & 3 others** 1961 JAChS 83 820-4;

ND, **HA Levy GC Lisensky** 1978 AC B34 3502-10.
Occurrence: steam condensate, Taupo, New Zealand, **KA Rodgers & 4 others** 2000 MM 64 125-42;
Turkey, **F Orti I Gundogan C Helvaci** 2002 SG 146 305-33 (4323).
[misenite ?$KHSO_4$. Review: **Sabelli** - doubtful species. Occurrence: **Dana**.]
miserite ~$K(Ca,Ce)_4Si_5O_{13}(OH)_3$.
Structure: **JD Scott** 1976 CM 14 515-28 (S1252);
refinement, **IV Rozhdestvenskaya MD Evdokimov** 2006 DES 406 74-8 = AM 91 1457.
Occurrence: MM 29 990.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
MITRIDATITE STRUCTURE GROUP Includes:

arseniosiderite	$Ca_3Fe_4(AsO_4)_4(OH)_6.3aq$
mitridatite	$Ca_3Fe_4(PO_4)_4(OH)_6.3aq$
robertsite	$Ca_{5.6}Mn_9O_6(PO_4)_9aq_6.3aq$

See *kolfanite* which is close to arseniosiderite.
See *melkovite* $CaFeH_6(MoO_4)_4(PO_4).6aq$, a possible derivative structure.
See *sailaufite* $(Ca,Na,void)_2Mn_3O_2(AsO_4)_2(CO_3).3aq$.
mitridatite $Ca_3Fe^{3+}_4(PO_4)_4(OH)_6.3aq$. Mitridatite structure group.
Structure: **PB Moore T Araki** 1977 IC 16 1091-106 (M581);
do 1977 MM 41 527-8 & M8-9.
Occurrence: MM 25 638.
mitryaevaite $Al_5[(PO_4)_2[(P,S)O_3(OH,O)]_2F_2(OH)_28aq.6.5aq$.
Structure: SC-XRD, **CL Cahill & 4 others** 2001 CM 39 179-86.
Occurrence & XRPD: **EA Ankinovich & 4 others** 1998 CM 35 1415-9.
mitscherlichite $K_2CuCl_4.2aq$. Strukturbericht I 193. Occurrence: MM 21 571-2.
MIXITE STRUCTURE GROUP Includes:

[agardite-Ce	$Cu_6(Ce,Ca)(AsO_4)_3(OH)_6.3aq]$
agardite-La	$Cu_6(La,Ca)(AsO_4)_3(OH)_6.3aq$
agardite-Y	$Cu_6(Y,Ca)(AsO_4)_3(OH)_6.3aq$
calciopetersite	$CaCu_6(PO_4)_2(PO_3OH)(OH)_6.3aq.$
goudeyite	$Cu_6(Al,Y)(AsO_4)_3(OH)_6.3aq$
mixite	$Cu_6Bi(AsO_4)_3(OH)_6.3aq$
petersite-Y	$Cu_6Y(PO_4)_3(OH)_6.3aq$
plumboagardite	$Cu_6(Pb,REE,Ca)(AsO_4)_3(OH)_6.3aq$
zalesiite	$CaCu_6(AsO_4)_2(AsO_3OH)(OH)_6.3aq$

Consortium for Theoretical Frameworks net 1152.
mixite $Cu_6Bi(AsO_4)_3(OH)_6.3aq$. Review: framework, (E289).
Structure: **K Mereiter A Preisinger** 1986 Osterreich Akad Wiss Math-nat Kl Anz 123 79-81;
SC-XRD & IR of fully hydrated & partly dehydrated, hydration kinetics & crystal chemistry, **R Miletich J Zemann M Nowak** 1997 PCM 24 411-22 (M1519).
SEM/Raman identification: **RL Frost & 3 others** 2005 MM 69 169-78.
Synthesis: **R Miletich J Zemann** 1993 Aufschluss 44 17-21.
[mizzonite Intermediate member of *scapolite* group; not a mineral species.
Structure: **JJ Papike NC Stephenson** 1966 AM 51 1014-27 (P72).]
[Mn-palygorskite = yofortierite $NaMgMnFe_2AlSi_7O_{20}(OH)_2.10aq$.
Palygorskite type. Occurrence: MM 39 920.]
Mn-sepiolite ~$Mn_4Fe_4Si_{12}O_{30}(OH)_6.8aq$. *Sepiolite* type. Occurrence: MM 39 921.
Mn-shadlunite Mn replaces Pb in *shadlunite*. Occurrence: MM 39 921.
moctezumite $Pb(UO_2)(TeO_3)_2$.
Review: **PC Burns ML Miller RC Ewing** 1996 CM 34 845-80.
Structure: **GW Swihart & 4 others** 1993 AM 78 835-9.
Occurrence: MM 35 1146.
modderite (Co,Fe)As. Deformed *niccolite* structure type.

Structure: *synthetic* CoAs, StrukturBericht III 273.
Occurrence: MM 21 572.

moeloite $Pb_6Sb_6S_{14}S_3$.

Occurrence & structure: **P Orlandi & 3 others** 2002 EJM 14 599-606 (7676).

moganite SiO_2. Twin-type polytype of *quartz*.

Consortium for Theoretical Frameworks net 292.
Phase transition at 570 K: **PJ Heaney JE Post** 2001 AM 86 1358-66.
Structure: **G Miehe & 3 others** 1988 ZK 182 183-4;
G Miehe H Graetsch 1992 EJM 4 693-706 (M1026).
Occurrence: MM 50 753;
Gran Canaria, **OW Floerke JB Jones H Schmincke** 1976 ZK 143 156-65;
do, **OW Floerke U Floerke U Giese** 1984 NJMA 149 325-36;
in agate/chalcedony, Raman, XRPD, **J Götze & 3 others** 1998 CMP 133 96-105 (G1133);
in volcanic sinters with *quartz* after recrystallization of opal, **KA Rodgers G Cressey** 2001 MM 65 157-67;
in agate vs age, **T Moxon S Rios** 2004 EJM 16 269-78 (10318).
Thermochemistry: **I Petrovic PJ Heaney A Navrotsky** 1996 PCM 23 119-26 (P614).
Pressure-induced amorphization, DAC-XRPD: **J Leger J Haines C Chateau** 2001 EJM 13 351-9.
Synthetic PON, XRPD structure: **C Chateau & 4 others** 1999 AM 84 207-10.

mohite Cu_2SnS_3. Matches *synthetic*.

Structure determination not found [jvs: look for synthetic.]
Occurrence & crystallography: **VA Kovalenker & 3 others** 1982 ZVMO 111 110-4.
Cu_2SnS_3-ZnS-MnS phase relations at 1093 & 973 K: **EG Osadchii** 1996 NJMM 201-11 (O320).

mohrite $(NH_4)_2Fe(SO_4)_2.6aq$. *Synthetic* is *Mohr's salt*. Review: **Sabelli** p 31.

Structure: **H Montgomery & 3 others** AC 22 775-80.

moissanite = *carborundum* (trade name). SiC. Vast literature on polytypism.

Occurrence:
Yakutia kimberlites with *silicon*/*Fe-Ti silicides/sinoite*: **EA Mathez & 3 others** 1995 GCA 59 781-91;
diamond/kimberlite: **IS Leung & 3 others** 1996 IGR 38 595-606 (L810);
beach pebble, Turkey, **S Di Pierro & 5 others** 2003 AM 88 1817-21;
cubic SiC as inclusions in moissanite: **VK Marshinsev & 2 others** 1983 DES 262 163-6.
Anvils for high P; reached 52 GPa, fill absorption gap in diamond: **J Xu H Mao** 2000 S 290 783-5.
Yied strength to 18 GPa & 1473 K: **J Zhang & 4 others** 2002 AM 87 1005-8.
In meteorites: **AE Rubin** 1997 MPS 32 231-47;
presolar, GCA 67 4679-92 & 4823-48;
supernovae, 4693-704;
circumstellar, 4743-68;
stardust, extinct Tc, **MR Savina & 6 others** 2004 S 303 649-52 (9914).

[**moluranite** $H_4U^{4+}(UO_2)_3(MoO_4)_7.18aq$. Amorphous.]

molybdenite-(2H & 3R) MoS_2.

Hexagonal & rhombohedral polytypes. Isotypic with *tungstenite*.
Also amorphous polymorph *jordisite*.
Drysdallite is hexagonal Se analog.
Castaingite $CuMo_2S_5$ has XRPD similar to molybdenite, but atomic ratios differ [jvs: perhaps because of incorrect analysis].
Structure: 3R, **Y Takéuchi W Nowacki** 1944 SMPM 44 105-20 (T86);
polytypism, **F Wickman DK Smith** 1970 AM 1843-56 & 1857-75;
2H & 3R, **RB Schönfeld JJ Huang SC Moss** 1983 AC B39 404-7;
polarized XANES & electronic structure, **D Li & 5 others** 1995 PCM 22 123-8.
Synthetic molybdenite-*tungstenite* series: **GH Moh G Udubasa** 1976 CEr 35 327-35.
Tungstenoan, to 6 wt % W, Kola, Russia: CM 38 1377-85.
Single-wall nanotubes: **M Remskar & 8 others** 2001 S 292 479-81 (1692).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Synthetic $LaBr_2$: 1989 ZaaC 575 61-70 = SR 56A 96.

molybdenum Mo.

In meteorites: **AE Rubin** 1997 MPS 32 231-47.
In lunar regolith: **OA Bogatikov & 4 others** 2001 GI 39 604-8 (2948).
molybdenum carbide MoC.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
molybdite MoO_3.
Structure: *synthetic*, **H Bräkken** 1931 ZK 78 485-7 (B1338), also CrO_3 & WO_3;
N Wooster 1931 ZK 80 504-12 (W683).
molydofornacite $Pb_2Cu[(As,P)O_4][(Mo,Cr)O_4]OH]$. Review: (E289).
Isostructural with *fornacite* .
Structure determination not found.
Occurrence/crystallography: **O Medenbach K Abraham W Gebert** 1983 NJMM 289-95 (M1091).
molybdomenite $PbSeO_3$. Isostructural with *scotlandite* $PbSO_3$.
Structure: isostructural $KClO_3$, **R Fischer J Zemann** 1970 Osterr Akad Wiss Math Naturw Kl 107 185-6 = MA 72-194;
R Fischer 1972 TMPM 17 196-207 (F426) = MA 73-239;
M Koskenlinna J Valkonen 1977 Cryst Struct Comm 6 813-6;
M Pasero N Rotiroti 2003 NJMM 145-52 (9062).
molybdophyllite $Pb_2Mg_2Si_2O_7(OH)_2$.
Structure determination not found.
Occurrence: **Dana**.
Two analyses of Längban specimens, cell dimensions from SC-XRD: **G Charalampides** 1994 Mineral Wealth 91 33-46 = AM 81 520.
molysite $FeCl_3$.
Structure: **N Wooster** 1932 ZK 83 35-41.
Occurrence, Mt St Augustine volcano fumarole: **A Getahun MH Reed R Symonds** 1996 JVGR 71 73-107 (G858).

MONAZITE STRUCTURE GROUP	Includes:
brabantite	$CaTh(PO_4)_2$
cheralite-Ce	$(Ce,Ca,Th)(P,Si)O_4$
crocoite	$PbCrO_4$
gasparite-Ce	$(Ce,\text{other RE})AsO_4$
huttonite	$ThSiO_4$
monazite-Ce	$(Ce,La,Nd,Th)PO_4$
monazite-La	$(La,Ce,Nd)PO_4$
monazite-Nd	$(Nd,La,Ce)PO_4$
monazite-Sm	$(Sm,Gd,Th,Ca,Nd,\text{ etc})PO_4$
rooseveltite	$BiAsO_4$ -alpha
?tombarthite	$Y_4(Si,H)_4O_{12-x}(OH)_{4+2x}$

General: **MW Molloy** 1959 AM 44 510-32.
Crystal chemistry of monazite & *xenotime* structure groups, structure of natural monazite and $(La/Ce/Pr/Nd/Sm/Eu/Gd)PO_4$ *synthetic*: **Y Ni JM Hughes AN Mariano** 1995 AM 80 21-6.
Review of $REEXO_4$ compounds & stability fields: **U Kolitsch D Holtstam** 2004 EJM 16 117-26 (10133).
Monazite-*cheralite-Ce-brabantite* solid solution series, occurrence Erzgebirge Fichtelgeburge, Germany: **H Förster** 1998 AM 83 259-72.
Genesis & transformations during medium grade metamorphism of monazite/*florencite/ rhabdophane*: **G Nagy & 4 others** 2002 ChG 191 25-46.
Monazite-*apatite* relations in iron ore, Sweden: **DE Harlov & 5 others** 2002 ChG 191 47-72.
Experimental dissolution of natural monazite 323-503 K 1.5-10 pH: **EH Oelkers F Poitrasson** 2002 ChG 191 73-88.
Microprobe geochronology: 8 papers: 2005 AM 90 525-638.
Brabantite-monazite series, XRPD: **J Montel J Devidal D Avignant** 2002 ChG 191 89-104.
U-Pb-Th in monazite, resetting: **A Seydoux-Guillaume & 4 others** 2002 ChG 191 165-82.
Raman spectra of actinide-bearing: **R Podor** 1995 EJM 7 1353-60 (P592).
Polyphase & discordant: TEM, **A Seydoux-Guillaume & 3 others** 2003 G 31 973-6 (9604).
Synthetic $SrSeO_4$: **H Prévost-Czeskleba H Endres** 1984 AC C40 18-20 (P556).
Synthetic $SrCrO_4$, $SrSeO_4$, $PbCrO_4$ & $PbSeO_4$: **H Effenberger F Pertlik** 1986 ZK 176 75-83.

Synthetic $Ce_{0.9}U_{0.1}PO_4$: 1989 Lanthanide Actinide Research 3 51-61 = SR 56A 218-9.
Synthesis, cell dimensions (La/Ce/Pr/Nd/Sm/Gd)PO_4: **JM Montel F Lhote JM Claude** 1989 MM 53 120-3.
Synthesis $CeVO_4$-I (*wakefieldite* structure) ambient P, & -II (monazite) & -III (*scheelite*) high P, structure of -I & -II: **K-J Range H Meister U Klement** 1990 ZN 45b 598-602 (R617).
Synthetic $LaPO_4$-$(Ca_{0.5}Th_{0.5})PO_4$ series: **R Podor M Cuney** 1997 AM 82 765-71.

monazite-Ce $(Ce,La,Nd,Th)PO_4$. Monazite structure group.

Structure: early papers ignored because of low accuracy;
natural monazite & *synthetic* $CePO_4$, **Y Ni JM Hughes AN Mariano** 1995 AM 80 21-6.
Immiscibility monazite/*xenotime*, *synthetic* $(Ce/Y)PO_4$, XRPD: **R Gratz W Heinrich** 1997 AM 82 772-80.
Occurrence in *talc-chlorite*, Trimouns, French Pyrenees: **P de Parseval F Fontan T Aigouy** 1997 CRASP 324 IIa 625-30 (D639).
Annealing of radiation damage, XRD/TEM/Raman: **AM Seydoux-Guillaume & 5 others** 2002 PCM 29 240-53 (7756).
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

monazite-La $(La,Ce,Nd)PO_4$. Monazite structure group.

Structure: *synthetic* $LaPO_4$: **Y Ni JM Hughes AN Mariano** 1995 AM 80 21-6.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

monazite-Nd $(Nd,La,Ce)PO_4$. Monazite structure group.

Structure: *synthetic* $NdPO_4$: **Y Ni JM Hughes AN Mariano** 1995 AM 80 21-6.
Occurrence: MM 48 578;
S Graeser H Schwander 1987 SMPM 67 103-13 = AM 73 1495.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

monazite-Sm (Sm,Gd,Th,Ca,Nd, etc)PO_4. Monazite structure group.

Occurrence: **M Masau & 4 others** 2001 Mitt Österreich Mineral Gesell 146 189-90;
MM & 3 others 2002 CM 40 1649-55.

moncheïte $(Pt,Pd)(Te,Bi)_2$.

Melonite structure family. CdI_2, ~= *brucite*, topology, except for hydrogen.
Similar *synthetic* $PtTe_2$: **F Grønvold H Haraldsen H Kjekshus** 1960 ACSc 14 1879-93 (G753).
Isostructural with PtS_2 & $PtSe_2$.
Occurrence: MM 33 1144.
[*biteplapalladite* & *biteplatinite*, unnecessary names for *merenskyite*-moncheite solid solutions: AM 61 174; MA 76-2362.]

monetite $CaHPO_4$. Isostructural with *weilite* $CaHAsO_4$.

Structure: **G McLennan CA Beevers** 1955 AC 8 579-83;
B Dickens JS Bowen WE Brown 1972 AC B28 797-806 (D548);
ND, **M Catti G Ferraris A Filhol** 1977 AC B33 1223-9;
M Catti G Ferraris SA Mason 1980 AC B36 254-9.
Proton mobility, IR/quasi-elastic neutron scattering: **L Tortet JR Gavarri G Nihoul** 1997 JSSC 132 6-16 (T540).
Occurrence in fertilizers: **JR Lehr & 4 others** 1966 *Crystallographic Properties of Fertilizer Compounds*, Tenn Valley Auth Chem Eng Bull 6, 163p (L758).

mongolite $Ca_4Nb_6Si_5O_{24}(OH)_{10}$.5-6aq.

Structure determination not found.
Occurrence: **NV Vladykin & 5 others** 1985 ZVMO 114 374-7 (V224).

monimolite $(Pb,Ca)_3(SbO_4)_2$.

Structure determination not found.
Occurrence: **Dana**.

monohydrocalcite $CaCO_3$.aq.

XRPD matches *synthetic* [jvs: search for structure of synthetic.]
Occurrence: lake sediments, **EI Semenov** 1964 Kr 9 109-10 = AM 49 1151;
guinea pig bladder stone, **HCW Skinner GW Osbaldiston AN Wilner** 1977 AM 62 273-7.

monsmedite $H_8K_2Tl_2(SO_4)_8$.11aq. Structure determination not found.

Occurrence: MM 36 1155;
A Götz S Mihalka I Ionita Z Toth 1968 Rev Mineral Bucharest = AM 54 1496.

[montanite Bi_2TeO_6. Inadequate description. Occurrence: **Dana**.]

montbrayite $(Au,Ag,Sb,Bi)_2(Te,Sb,Bi)_3$.
Structure: atomic coordinates only, **F Bachechi** 1971 Nature Phys Sci 231 67-8 (B1341); R = 0.23 without absorption correction; see PhD thesis, 1970 Univ of Toronto for full data.
Occurrence: MM 27 272;
Sb-rich, Australia, **JM Shackleton PG Spry** 2002 NJMM 113-25 (8776).
Synthesis: **F Bachechi** 1972 AM 57 146-54.
montdorite $(K,Na)_2(Fe,Mn,Mg)_5Si_8O_{20}(F,OH)_2$. Mica structure group.
Structure determination not found.
Occurrence: **J Robert RC Maury** 1979 CMP 68 117-23 = MA 64 1331.
montebrasite $(Li,Na)Al(PO_4)(OH,F)$. *Amblygonite* is F-rich analog.
Structure determination not found.
Occurrence: **EW Heinrich AS Corey** 1955 AM 40 1141-5.
monteponite CdO. *Periclase* mineral group. *Halite* structure type.
Structure determination not found [jvs: but should be one for *synthetic*].
Occurrence: MM 28 734.
monteregianite $KNa_2YSi_8O_{19}.5aq$.
Structure: **S Ghose PK Sen Gupta CF Campana** 1987 AM 72 365-74.
Occurrence: MM 43 1064.
Review: (different formula) **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
Synthetic $KNa_2Y_2Si_8O_{19}.5aq$, XRPD, MAS-NMR, FTIR & Raman, TGA & DSC:
J Rocha & 5 others 1997 ChC 2103-4 (R789), JPCB 102 4739-44 (R828).
Synthetic Ce analog, XRPD, NMR, optical emission, potential use in optoelectronics with variable oxidation of Ce: **J Rocha P Ferreira LD Carlos A Ferreira** 2000 ACIE 39 3276-9 (R964).
[*kampfite* $Ba_6[Si,Al)O_2]_8(CO_3)_2Cl_2$ $(Cl,aq)_2$. Montregianite-*wickenburgite* series.]
montesommaite $(K,Na)_9Al_9Si_{23}O_{64}.10aq$.
Structure: **RC Rouse & 4 others** 1990 AM 75 1415-20.
MONTGOMERYITE STRUCTURE GROUP Includes

calcioferrite	$Ca_4MgFe_4(PO_4)_6(OH)_4.12aq$
kingsmountite	$Ca_4FeAl_4(PO_4)_6(OH)_4.12aq$
montgomeryite	$Ca_4MgAl_4(PO_4)_6(OH)_4.12aq$
zodacite	$Ca_4MnAl_4(PO_4)_6(OH)_4.12aq$

Review: **PF Dunn JD Grice WC Metropolis** 1988 AM 73 1179-81.
Contains same vertex-linked octahedral chain as *johnwalkite* & *olmsteadite*.
montgomeryite $Ca_4Al_4Mg(PO_4)_6(OH)_4.12aq$.
Structure & relation to *vauxite*, **PB Moore T Araki** 1974 AM 59 843-50;
L Fanfani & 3 others 1976 AM 61 12-4.
Occurrence: MM 25 639;
red, **PJ Dunn & 3 others** 1983 MR 14 195-7.
monticellite $CaMgSiO_4$. *Olivine* structure type with cation ordering.
Structure: **GB Brown J West** 1927 ZK 66 154-61;
H Onken 1965 TMPM 10 34-44 (O33);
high-T, **GA Lager EP Meagher** 1978 AM 63 365-77;
ZD Sharp RM Hazen LW Finger 1987 AM 72 748-55.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Fe,Mn-rich, Oka carbonatite: **SV Sokolov GA Sidorenko** 1997 GI 35 810-5 (S1755).
Synthetic $Ca_{1.25}Co_{0.75}SiO_4$: **M Kimata N Nishida** 1987 NJMM 160-70 (K759).
Synthetic $NaYSiO_4$: **BA Maksimov VV Ilyukhin NV Belov** 1967 SPC 11 583-4.
montmorillonite $(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2$. n aq. *Smectite* structure group.
Infrared: OH stretching, **J Madejova P Komadel B Cicel** 1994 CIM 29 319-26;
Fe/Mg/Al in octahedral sheet, **D Vantelon & 4 others** 2001 CIM 36 369-79 (3068).
MQ-MAS-NMR, 2 Al-tetrahedra: **T Ohkubo & 3 others** 2003 ClClM 51 513-8.
Stability, rehydration hysteresis, effect of interlayer cations, hydrothermal diamond cell to 1 GPa & 600 K: **T Wu & 4 others** 1997 AM 82 69-78.

K-exchanged, ED of wet & dry: **G Besson C Tchoubar** 1980 BM 103 429-33.
XANES/Mössbauer octahedral Fe(III) + minor Fe(II): **E Paris A Mottana P Mattias** 1991 MP 45 105-17 (412).
Adsorption of neutral polysaccharides: **C Chenu CH Pons M Robert** 1985 Proc Int Clay Conf Denver 375-81 (C988).
Citric acid interaction with OH-Al-, XRPD: **P Cambier G Sposito** 1991 ClClM 39 158-66 (C668).
La-Al pillared: **J Sterte** 1991 ClClM 39 167-73 (414).
Pillared, AFM: **ML Occelli B Drake SAC Gould** 1993 JCa 142 337-48.
Fourier-transform Raman: **RL Frost L Rintoul** 1996 Appl Clay Sci 11 171-83.
Li-exch, ND, H/D/Li isotopes: **DH Powell HE Fischer NT Skipper** 1998 JPCB 102 10899-905.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
In situ XRPD of dehydration: **HJ Bray SAT Redfern SM Clark** 1998 MM 62 647-56.
XAS, Cu adsorption: **JD Morton JD Semrau KF Hayes** 2001 GCA 65 2709-22 (2947).
Oriented mesostructure/gel, XRF microscopy: **I Bihannic & 8 others** 2001 La 17 4144-7 (2949).
Disorder, simulated XRPD: **A Viani AF Gualtieri G Artioli** 2002 AM 87 966-75.
Synthesis of Mg/Zn types using F, XRPD/MAS-NMR/EXAFS: **M Reinholdt & 6 others** 2001 EJIC 2831-41 (3478).
*[*cupromontmorillonite Occurrence: MM 30 731, correction of 19th list.]
Cu adsorption: XAS, **JD Morton JD Semrau KF Hayes** 2001 GCA 65 2709-22 (3153);
on Ca-, relevance to grape growing with Cu-pesticide, **T Undabeytia & 5 others** 2002 EST 2677-83 (7395).
Ni(II) sorption on edges, polarized XAS: **R Dähn & 6 others** 2002 GCA 67 1-15 (8714).
Molecular simulation of hydration: **S Karaborni & 4 others** 1996 S 271 1102-4 (K415).
Reduction of Fe, NMR: **WP Gates JW Stucki RJ Kirkpatrick** 1996 PCM 23 535-41 (G886).
Heat reactions, Mossbauer: **E Murad & 3 others** 2002 ClM 37 583-90.
Synthetic Ca- & natural: MM 26 335.
Synthetic fluoro-: **A-M Hecht E Geissler** 1972 BSFMC 95 291.
Synthetic alumina-pillared: **LJ Michot TJ Pinnavaia** 1992 ChM 4 1433-7 (M1384).
Synthetic Mn (II) trapped in single-layer hydrate: **AU Gehring & 3 others** 1993 ClClM 41 565-9.
Synthetic Al-Fe & Fe-pillared, extraction/reduction of Fe: **P Komadel DH Doff JW Stucki** 1994 JCSCC 1243-4 (K838).
Synthetic Al-intercalated: **G Fetter & 3 others** 1996 JMC 6 1857-8 (F519).
Synthetic Mn(III) & acid-activated pillared: **T Mishra K Parida** 1997 JMC 7 147-52 (M1444).
Synthetic Ti-pillared: **F Kooli J Bovey W Jones** 1997 JMater JMC 1996 ClCLM 44 132-41.
TMA & TMPA, FTIR: **JJ Stevens SJ Anderson** 1996 ClClM 44 142-50.
Ni-saturated, Camp-Bertaux, model for octahedral cations: **F Muller & 3 others** 1997 PCM 24 159-66 (M1481).
Heated Li/Cs-, IR reflectance: **MA Karakassides D Petridis D Gournis** 1997 ClClM 45 649-58.
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Al-pillared, ammonium interaction, IR: **S Bodoardo & 4 others** 1998 MMM 20 187-96 (B1836).
Molecular simulations, intercalation by Al-complex cations: **P Capkova & 5 others** 1998 ClClM 46 232-9, 240-4 (C1060).
Modeling Cd adsorption/desorption: **T Undabeytia & 4 others** 1998 ClClM 46 423-8 (U56).
Synthetic silica-chromia pillared: **Y Han S Yamanaka J Choy** 1998 Appl Catal A 174 83-90.
Cu-doped Al-pillared: **K Bahranowski et al** 1998 Mineral Polonica 29 55-65.
Transition-metal-exchanged, sorption: **K Dyrek et al** 1998 Mineral Polonica 29 71-85.
Na-, hydrothermal transformation to *smectites* etc: **H Yamada et al** 1998 Clay Sci 10 385-94.
Hydroxylaluminosilicate complexes, retention of phosphate: **UK Saha S Hiradate K Inoue** 1998 SSSAJ 62 922-9 (1387).
Pb adsorption, XAFS: **DG Strawn DL Sparks** 1999 JCIS 216 257-69 (413).
Li-exchanged, tetramethylammonium Wyoming Volclay, XRPD: **LP Meier R Nüesch** 1999 JCIS 217 77-85 (M1792).
Ca- exchanged Mn/Cu/TNA/hexadecyltrimethylammonium vs pore structure/surface fractality: **J Lee C Lee L Juang** 1999 JCIS 217 172-6 (L1022).
pH vs surface area/pore size distribution/density/porosity: **O Altin Ö Özbelge T Dogu** 1999 JCIS 217 19-27 (A901).
Kinetics of dehydration of Ca-: **HJ Bray SAT Redfern** 1999 PCM 26 591-600 (B1941).
Location of Li/Cu/Cd(II) in heated, IR/ESR: **MA Karakassides & 5 others** 1999 JMC 9 1553-8 (K1180).
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Dehydroxylation heated/steamed- Li/Na/Ca/Sr/Cu/Zn: **K Emmerich FT Madsen G Kahr** 1999 ClClM 47 591-604 (E468).
Immobilization Zn/Cd, vs aging/acidification: **B Lothenbach & 3 others** 1999 EST 33 2945-52 (L1032).
Trinuclear Fe(III) acetato complex intercalated, thermal transformation: **KM Parida et al** 1999 Appl Clay Sci 15 463-75.
Li migration, XPS: **T Abina T Iwasaki A Chatterjee** 1999 Clay Sci 10 569-81 = MA 00M/2405.
Al speciation in intercalated Al-OH & Al,Si-OH ions, NMR: **S Taniguchi S Hiradate K Sakurai** 1999 S 10 443-55.
Permanganate-mediated dissolution of hydroxy-Cr interlayers: **WE Dubbin TB Goh** 1999 Appl Clay Sci 15 325-36.
Pillared, adsorption & wetting vs time: **I Dekany V Seefeld G Lagaly** 2000 ClM 35 763-9 (449).
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Cr(VI), reduction & sorption by Fe(II)-*chlorite, corrensite* and montmorillonite for waste-water

clean-up: **MF Brigatti & 7 others** 2000 ClClM 48 272-81 (B2013).
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Binding of hydrophobic herbicides *alachlor & metolochlor* with montmorillonite pretreated with phenyltrimethylammonium, FTIR: **Y El-Nahhal & 4** 2000 JAgFC 48 4791-801 (E477).
Structural transformation, dehydroxylation/rehydration, XRPD: **F Muller & 3 others** 2000 ClClM 48 572-85 (M1861).
Ca-rich in bentonite, heating vs physical properties: **Y Sarikaya & 3 others** 2000 ClClM 48 557-62 (S2226).
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Uranium (VI) sorption & solution chemistry: **CJ Chisholm-Brause & 3 others** 2001 JCIS 233 38-49 (766).
Water self-diffusion, pulsed field gradient NMR: **Y Nakashima** 2001 AM 86 132-8.
Intercalation with cetylpyridinium etc, XRPD/modeling: **M Pospisil & 4 others** 2001 JCIS 236 127-31 (1680).
Surface hydrophobic modification by organosilane, XRPD/TGA/NEXAFS: **K Song G Sandi** 2001 ClClM 49 19-25 (1605).
Synthetic OH-Al-/-AlSi-complexes, Cd/Zn/Pb adsorption: **UK Saha & 2 others** 2001 SSSAJ 65 694-703 (2122).
Synthetic Al-intercalated, structural collapse by Na-salicylate solution: **E Molis & 3 others** 2001 ClM 36 335-44 (3065).
Synthetic alkyl quaternary ammonium, thermal degradation: **W Xie & 5 others** 2001 ChM 13 2979-90 (3160).
Synthetic Cr/Ti-pillared, adsorption benzene/water: **M Sychev & 5 others** 2001 MMM 47 311-21 (3136).
Reversible collapse & Mg release, de- & rehydrated Na/Ca/Sr/Li/Cu/Zn cis-vacant: **K Emmerich M Plotze G Kahr** 2001 ACS 19 143-54.
Sorption of lanthanides: **F Coppin & 4 others** 2002 ChG 183 57-68 (4328).
Ni-pillared, hydration structure, NPD: **C Pitteloud DH Powell HE Fischer** 2001 PCCP 3 5567-74 (4309).
Sr adsorption on Al-pillared with carboxylate groups: **CA Papachristodoulou & 2 others** 2002 JCIS 245 32-9 (4347).
Cd/Zn/Pb adsorption on OH-Al-Si complexes: **UK Saha S Taniguchi K Sakurai** 2002 SSSAJ 66 117-28 (4352).
Sorption of hexadecyltrimethylammonium, small-angle XRD: **C Shang JA Rice JS Lin** 2002 SSSAJ 66 1225-30 (7581).
Ni adsorption, phyllosilicate growth, EXAFS: **R Dahn & 6 others** 2002 GCA 66 2335-47 (7433).
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Cs adsorption, EXAFS: **BC Bostick & 3 others** 2002 EST 36 2670-6 (7394).
Hydration of reduced-charge: **P Komadel & 3 others** 2002 ClM 37 43-50.
Synthetic Al-OH-pillared, Cs/Ca/Ba/Fe/Cu/Ce-exchanged vs thermal stability **AS Reis Jr JD Ardisson** 2003 ClClM 51 33-40 (8607).
Acid dissolution, reduced-charge Li- /Ni-: **H Pálková J Madejová D Righi** 2003 ClClM 51 133-42.
Adsorptionof quinolinecarboxylic acid pesticides: **A Pucino & 3 others** 2003 ClClM 51 143-9.
Synthetic methane hydrate intercalate, low-T stability: **S Guggenheim AF Koster van Groos** 2003 G 31 653-6 (9258).
Desorption of Cd/Pb/Zn sorbed on OH-Al & OH-Al-Si-: **UK Saha K Iwasaki K Sakurai** 2003 ClClM 51 481-92.
Time-resolved XRPD of Na- dehydration: **J Wilson J Cuadros G Cressey** 2004 ClClM 52 180-91 (10234).
Selenite adsorption, OH-Al- &OH-Al-Si-complexes: **UK Saha & 3 others** 2004 SSSAJ 68 1197-209 (10473).
Structure by Convergent-Beam-ED: **T Beermann O Brockamp** 2005 ClM 40 1-14.
Hydration: model of XRPD, **E Ferrage & 3 others** 2005 AM 90 1358-74.

montroseite (V,Fe)O(OH). *Diaspore* structure group.
Loses hydrogen during transformation to *paramontroseite*, also based on diaspore structure type.
Structure: **HT Evans Jr S Block** 1953 AM 38 1242-50;
HT Evans Jr ME Mrose 1955 AM 40 861-75.
Occurrence: MM 29 990.

montroyalite $Sr_4Al_8(CO_3)_3(OH,F)_{26}.10\text{-}11aq$.
Occurrence & TEM of twins: **AC Roberts & 6 others** 1986 CM 24 455-9.

montroydite HgO.
Structure: **K Aurivilius** 1956 AC 9 685-6 (A585A).

mooihoekite $Cu_9Fe_9S_{16}$.
Structure: **SR Hall JF Rowland** 1973 AC B29 2365-72 (H389).
Occurrence: MM 338 995.

moolooite $Cu(C_2O_4).0.4aq$.
XRPD matches *synthetic*, but diffuse diffractions indicate complexities.
Partial structure information, EXAFS: **A Michalowicz JJ Girerd J Goulon** 1979 IC 18 3004-10.
Occurrence: **RM Clarke IR Williams** 1986 MM 50 295-8;
in lichens, MM 51 715-8.

mooreite $(Mg,Zn,Mn)_{15}(SO_4)_2(OH)_{26}.8aq$. Review: **Sabelli** p. 24.
Structure: **RJ Hill** 1980 AC B36 1304-11.
Occurrence: MM 22 624.

moorhouseite $(Co,Ni,Mn)SO_4.6aq$. *Hexahydrite* structure group. Review: **Sabelli** p. 9.
Structure, *synthetic*: **A Zalkin H Ruben DH Templeton** 1962 AC 15 1219-24;
Y Elerman 1988 AC C44 599-601.

Occurrence: MM 35 1146.

mopungite $NaSb(OH)_6$. Distorted ReO_3 structure type.

Schoenfliesite/stottite structure group. Matches *synthetic*.

Occurrence & crystallography: **SA Williams** 1985 MR 16 73-4.

moraesite $Be_2PO_4(OH).4aq$.

Isostructural with As analog *bearsite* based on crystallography.

Compare with *uralolite*.

Structure: **S Merlino M Pasero** 1992 ZK 201 253-62 (M1027).

Occurrence: MM 30 741.

mordenite ~$(Ca, Na, K)Al_2Si_{10}O_{24}.7aq$. *Zeolite* mineral family. IZA-SC code MOR.

Consortium for Theoretical Frameworks net 594.

Structure:

WM Meier 1961 ZK 115 439-50 (M735);
redescription of Meier structure, **EA Pobedimskaya NV Belov** 1964 SPC 8 736-8;
cell dimensions for 35 natural, **E Passaglia** 1975 CMP 50 65-77;
rehydrated Ca-exchanged, **WJ Mortier JJ Pluth JV Smith**1976 MRB 1115-22;
Ca-exchanged at 278, 623 & 818 K, **WJ Mortier** 1977 JPC 81 1334-8 (M720);
simulated, **WM Meier R Meier V Gramlich** 1978 ZK 147 329;
HCl-treated natural: **M Ito Y Saito** 1985 Bull Chem Soc Japan 58 3035-6;
natural $(Na_{1.5}K_{2.8}Ca_{2.1})(Al_9Si_{139})$, **A Alberti P Davoli G Vezzalini** 1986 ZK 175 249-56 (A323);
crystallographic faults, **JV Sanders** 1985 Z 5 81-90 (S1444);
water/OH interaction in H-, neutron inelastic, **H Jobic M Czjzek van Santen RA** 1992 JPC 96 1540-2;
K-rich, altered rhyolites, XRPD, **E Passaglia & 3 others** 1995 EJM 7 429-38 (P524);
defects, HREM, **SG Song** 1999 JMR 14 2616-20;
linear defects, **BJ Campbell AK Cheetham** 2002 JPCB 106 57-62 (4005);
Fe bonding, XAS, **H Aritani & 5 others** 2002 ChM 14 562-7 (6213);
dehydrated to 1103 K, XRPD, **A Martucci & 3 others** 2003 EJM 15 485-93 (9173)
natural vs *synthetic*, defects, SC-XRD: **P Simoncic T Armbruster** 2004 AM 89 421-31;
SC-XRD, thionin blue-exchanged, **P Simoncic & 2 others** 2004 JPCB 108 172352-60 (10807);

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surface structure of *synthetic*: **S Sugiyama & 7 others** 1997 SuS 377-9.

Heterogeneity of OH in H-: **J Datka B Gil A Kubacka** 1996 Z 17 428-33.

Interaction CD_3OH & H-mordenite, ^1H-NMR, **L Heeribout & 4 others** 1997 Catal Lett 43 143-7.

Active sites in Cu-, **Y Kuroda & 4 others** 1997 JPCB 101 1312-6.

Model & defects: **AA Sokol CRA Catlow** 1997 NATO ASI Ser 3 22 125-35 = CA 126:334706a.

Imperfect overgrowth on 110, TEM: **S Yoshida & 4 others** 1997 Chem Lett 371-2 (Y212).

Location of Brønsted sites from IR and modeling: **A. Alberti** 1997 Z 19 411-5 (A799).

Vibrational spectroscopy, ammonium-: **A Zecchina & 4 others** 1997 JPCB 101 10128-35 (Z156).

OH heterogeneity, IR/NMR/CO sorption: **J Datka B Gil J Weglarski** 1998 MMM 21 75-9 (D734).

H locations & NMR: **S Ganapathy & 3 others** 2003 ChC 2076-7 (9881).

Synthetic in F- media, ordered Al, NMR: **M Kato & 3 others** 2003 JPCB 107 1788-97 (9093).

Solubility & stability, aqueous solution: **LG Benning RT Wilkin HL Barnes** 2000 AM 85 495-508.

Synthetic high-Si using seeds: **B Lu & 4 others** 2004 MMM 76 1-7 (10942).

Na,Ca- & K- types in Greece: **KP Kitsopoulos AC Dunham** 1998 EJM 10 569-77 (K1088).

Occurrence: Sardinia pyroclastics (G1165).

Clinoptilolite-Na/mordenite/*clinoptilolite-Ca/epistilbite/stilbite/barrerite* sequences at Morden attributed to cooling: **G Pe-Piper** 2000 CM 38 1215-32.

Ion-exchanged natural ptilolite(mordenite), structure:

I, *dehydrated Ca-exchanged*, **WJ Mortier JJ Pluth JV Smith** 1975 MRB 10 1037-46;
II, *dehydrated H-*, **do** 1975 MRB10, 1319-26;
III *rehydrated Ca-exchanged*, **do** 1976 MRB 1115-22;
IV *dehydrated & rehydrated K-exchanged*, **do** 1978 in Natural Zeolites, Occurrence, Properties, ed. **LB Sand & F Mumpton** p. 53-76;
V *dehydrated Rb-exchanged*, **JL Schlenker JJ Pluth JV Smith** 1978 MRB 13 77-82;
VI *dehydrated Ba-exchanged*, **do** 1978 MRB 13 169-74;

VII *dehydrated Cs-exchanged*, **do** 1978 MRB 13 901-5;
VIII *dehydrated Na-exchanged*, **do** 1979 MRB 14 751-8;
IX *dehydrated H- via acid exchange*, **do** 1979 MRB 14 849-56;
X *dehydrated Ca,H-*, **do** 1979 MRB 14 961-9.
Synthetic dealuminated, NMR: **GR Hays & 5 others** 1984 Z 4 377-83 (220).
Acidity, ^{1}H NMR at 4K & MAS 300K: **L Heeribout & 4 others** 1995 Stud Surf Sci Catal 98 97-8.
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XAS, **AV Kolobov & 3 others** 1999 J Synchrotron Radiat 6 362-3.
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Synthetics Si/Al 6 to 9.*5*: XRPD refinement, **PR Rudolf JM Garces** 1994 Z 14 137-46.
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Synthetic Ca-: structure, 293-723 K: **J Elsen GSD King WJ Mortier** 1987 JPC 91 5800-5 (E239).
Synthetic K,Fe(III)-: cell dimensions & Mössbauer: **AM Bychkov & 4 others** 1992 Gk (6) 813-20.
Synthetic Ga-: XRD & spectroscopy:
MJ Espen & 3 others 1992 J Inclusion Phenomena Mol Recognit Chem 14(2) 119-29;
AJ Chandwadkar & 3 others 1993 Z 13 470-7.
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Cu clusters, position from computer modeling: **DC Sayle & 3 others** 1997 JMC 7 1917-23;
heat reduction/reoxidation, **FX Llabres I Xamena & 8 others** 2003 JPCB 107 7036-44.
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Synthetic Cu-exchanged: FTIR & ESR, **C Oliva & 7 others** 1997 JCSF 93 2603-8;
siting, EPR & diffuse reflectance spectr, **A Delabie & 4 others** 2002 PCCP 4 134-45.
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RCT Slade GB Hix B Ducourant 1997 Solid State Ionics 99 233-9..
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Synthetic, lower Al causes hydrophobic adsorption: **IV Mishin TR Brueva GI Kapustin** 1997 Kinet Catal 38 574-80.
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Ammonia removal by natural: **S Noda** 1997 Stud Surf Sci Catal 105B 1641-6 = CA 128:184155v.
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Synthetic Fe(III)-, XRPD/UV-visible/IR: **P Wu T Komatsu T Yashima** 1998 MMM 20 139-47;
A Nakahira & 4 others 2001 JMS 36 1885-9 (2125).
Synthetic Ag-, redox vs Bronsted acidity: **H Berndt M Richter T Gerlcah M Baerns** 1998 JCSF 94 2043-6.
Synthetic, nitrile-hydroxyl in side pockets: **O Marie F Thibault-Starzyk J Lavalley** 2000 PCCP 2 5341-9.
Synthetic Ni(I)-, ESR: **H Choo SB Hong L Kevan** 2001 JPC B 105 1995-2002 (1429).
Synthetic ZnSi-, XRPD, FTIR, XAFS: **M Dong J Wang Y Sun** 2001 MMM 43 237-43 (1499).
Synthetic Na- & H-, adsorption: **CE Webster A Cottone RS Drago** 1999 JAChS 121 12127-39.
Synthetic Li/Ag/Na-F- vs N_2/O_2 adsorption: **I Salla & 4 others** 2004 JPCB 108 5359-64 (10217).
Synthetic Na,Se, SC-XRd structure: **P Simoncic T Armbruster** 2004 MMM 71 185-98 (10373).
Synthetic proton, high-Al: **N Katada T Kanai M Niwa** 2004 MMM 75 61-7 (10765).
Synthetic B-modified, 11B NMR: **L Chen & 4 others** 2004 MMM 76 151-6 (10946).

moreauite $UO_2Al_3(PO_4)_3(OH)_2.13aq$. Structure determination not found.
Occurrence: **M Deliens P Piret** 1985 BM 108 9-13 (D507).

morelandite $(Ba,Pb,Ca)_5[(As,P)O_4]_3Cl$. *Apatite* structure type.
Structure determination not seen.
Occurrence: **PJ Dunn RC Rouse** 1978 CM 16 601-4.

morenosite $NiSO_4.7aq$. *Epsomite* structure type.
Isostructural with orthorhombic $MgSO_4.7aq$ (*epsomite*), $MgCrO_4.7aq$ & $ZnSO_4.7aq$ (*goslarite*).
Review: **Sabelli** p.8.
Structure: **CA Beevers CM Schwartz** 1935 ZK 91 157-69 (B1337);
charge density RT & 25 K, **H Ptasiewicz-Bak & 2 others** 1997 ACB 53 325-36 (P679).
-*retgersite* equilibria at 0.1 MPa: **I Chou RR Seal II** 2003 AM 88 1943-8.

morimotoite $Ca_3TiFe^{2+}Si_3O_{12}$. *Garnet* structure type.

Structure: **C Henmi I Kusachi K Henmi** 1995 MM 59 115-20.
Discussion: **IT Rass** 1997 MM 61 728-30.
Synthesis of Ti-garnets: **KT Fehr G Amthauer** 1996 MM 60 842-5.

morinite $NaCa_2Al_2(PO_4)_2(F,OH)_5.2aq$.

Structure: **FC Hawthorne** 1979 CM 17 93-102 (H717).

morozeviczite / morozewiczite $\sim(Pb,Fe)_6Ge_{\sim 2}S_8$. *Germanit*e structure group.

Structure determination not found.
Occurrence: **C Haranczyk** 1975 Rudy Metalla 20 288-93 = AM 66 437.

mosandrite $(Na,Ca,Ce)_3TiSi_2O_7(F,OH,O)$.

Perhaps there is a mosandrite group distinct from *rinkite* structure group: **OV Petersen JG Rønsbo ES Leonardsen** 1989 NJMM 84-96 = AM 75 708.

[jvs: probably needs further study because may be subtle effects for element substitution; also compare with following:

giannetite	$Na_2Ca[Ti(O,OH)_2(Si_2O_7)_2]Ca_3(Ca_{0.7}Mn_{0.1}Fe0.1Ce_{0.1})F_2$
götzenite	$(Ca,Na)_7(Ti,Al)_2Si_4O_{15}(F,OH)_3$
hainite	$Na_2Ca_4[(Ti,Zr,Mn,Fe,Nb,Ta)_{1.5}](Si_2O_7)_2F_4$
johnstrupite	
lovchorrite	
nacareniobsite	$Na_3Ca_3RE(Nb,Ti)(Si_2O_7)_2\ (F,O)_3$
rinkite	
rinkolite.]	

Octahedral-tetrahedral sheet structure.
Structure: **MB Kheirov KS Mamedov NV Belov** 1965 DAN SSR ES 150 103-6;
T Li VI Simonov NV Belov 1965 SPD 10 496-8 = MA 17-736;
VI Simonov NV Belov 1968 SPD 12 740-4 (S1309) = MA 69-1993;
rinkite (old name), **E Galli A Alberti** 1971 AC B27 1277-84 (G632);
RK Rastsvetaeva BE Borutskii ZV Shlyukova 1991 SPC 36 349-51.
Occurrence in hyperagpaitic alkaline rocks, $Na_2Ca_6REETiSi_4O_{17}(F,OH)_3$: **Khomyakov** 1995.
Review: (different formula) **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

moschelite HgI. Analog of *calomel*. HgCl.
Occurrence: **ER Krupp G Nottes U Heidtke** 1989 NJMM 524.

moschellandsbergite Ag_2Hg_3. ~beta-brass type with defects & lower symmetry.

Other materials related to beta-brass:*belendorffite* Hg_6Cu_7, *goldamalgam* (Au,Ag)Hg & *kolymite* Cu_7Hg_6.
Structure of *synthetic* used in dental cement: **CW Fairhurst JB Cohen** 1972 AC B28 371-8.
Occurrence: MM 25 639.

mosesite $(Hg_2N)(Cl,SO_4,MoO_4,CO_3,aq)$. *Cristobalite* type of connectivity.

Isotropic above 460K.
Polytypic with *kleinite* with *tridymite* connectivity.
Both minerals related to salts of Millon's base $Hg_2NOH.2aq$: **WN Lipscomb** 1951 AC 4 156-8.
Review: **Sabelli** p.30.
Similar to *gianellaite*.
Structure: **G Switzer & 3 others** 1953 AM 38 1225-34 (S1403);
G Giester F Pertlik 1995 ACA Mtg Montreal p. 137.

moskvinite-V $Na_2K(Y,REE)Si_6O_{15}$.

Occurrence & SC-XRD structure: **AA Agakhanov & 4 others** 22003 ZVMO 15 (10802).

mottanaite-Ce $Ca_4(CeCa)AlBe_2(B_4Si_4O_{22})O_2$. *Hellandite* group.

Occurrence & SC-XRD structure: **G Della Ventura & 3 others** 2002 AM 87 739-44.

moskvinite-Y $Na_4K(Y,RE)(Si_6O_{15})$.

Occurrence & SC-XRD structure: **E Sokolova & 3 others** 2003 CM 41 513-20;
AA Agakhanov & 4 others 2003 132-6 15-20 (10519).

mottramite $Pb(Cu,Zn)VO_4OH$. *Conichalcite/descloizite* structure group.

Isostructural series with *descloizite*.
Structure: **MA Cooper FC Hawthorne** 1995 CM 33 1119-24.

motukoreaite $Na_2Mg_{38}Al_{24}(CO_3)_{13}(SO_4)_8(OH)_{108}.56aq$.
Analog of *nikischerite* & *shigaite*.
Layer structure similar to *hydrotalcite* & *manasseite*.
Structure: **GW Brindley** 1979 MM 43 337-40;
DL Bish 1980 BM 103 120-5;
J Rius F Plana 1986 NJMM 263-72;
I Zamarreno & 3 others 1989 AM 74 1054-8.
Occurrence: MM 42 527.
mounanaite $PbFe_2(VO_4)_2(OH)_2$. Matches *synthetic*.
Structure determination not found.
Occurrence & crystallography: **F Cesbron J Fritsche** 1969 BSFMC 92 196-202.
mountainite $(Ca,Na_2,K_2)_2Si_4O_{10}.3aq$ & $KNa_3Ca_2Si_8O_{20}.8aq$. *Delhayelite* mineral group.
Structure determination not found.
Occurrence: **JA Gard HFW Taylor RA Chalmers** 1957 MM 31 611-23;
IV Bussen & 5 others 1973 DAN 210 674-7.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.
mountkeithite $(Mg,Ni)_9(Fe,Cr,Al)_3(OH)_{24}][(CO_3,SO_4)_{1.5}(Mg,Ni)_2(SO_4)_2.11aq$.
Review: **Sabelli** p. 21.
Structure determination not found.
Occurrence & relation to *pyroaurite* group: **DR Hudson M Bussell** 1981 MM 44 345-50.
mourite $UMo_5O_{12}(OH)_{10}$.
Structure determination not found.
Occurrence & crystallography: MM 33 1144;
ML Smith J Marinenko AD Weeks 1971 AM 56 163-73.
moydite $(Y,Ca,Gd,Dy)B(OH)_4(CO_3)$.
Structure: **JD Grice TC Ercit** 1986 CM 24 675-8.
Review: (different formula) **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
mozartite $CaMn^{3+}OSiO_3OH$. *Conichalcite/descloizite* structure type.
Adelite mineral group.
Structure: **R Basso & 3 others** 1993 CM 31 331-6;
SC-XRD 100K, FTIR & structure model, **D Nyfeler & 4 others** 1996 AM 82 841-8.
mozgovaite $PbBi_4(S,Se)_7$.
Occurrence & XRPD: **F Vurro & 4 others** 1999 CM 37 1499-506.
Natural analog of *synthetic* phase V: structure, **W Coe S Lee P O'Connel A Covey** 1997 ChM 9 2025-30.
mpororoite $WAlO_3(OH)_3.2aq$.
Occurrence & crystallography: **O Von Knorring TG Sahama M Lehtinen** 1981 MR 12 83;
S Matsubara A Kato K Nagashima 1984 MM 48 397-400.
Occurrence: MM 39 921.
mrázekite $Bi_2Cu_3(OH)_2O_2(PO_4)_2.2aq$.
Structure: **T Ridkosil & 4 others** 1992 CM 30 215-24;
revision, **H Effenberger & 6 others** 1994 CM 32 365-72.
mroseite $CaTeO_2(CO_3)$.
Structure: **R Fischer F Pertlik J Zemann** 1975 CM 13 383-7.
Occurrence: MM 40 910.
mückeite $CuNi(Bi,Sb)S_3$.
Structure: **K Bente & 5 others** 1990 ACC 46 127-8.
muirite $Ba_5(Ca,Mn,Ti)_2Si_4O_{12}(Cl,OH,O)_6.2aq$.
Complex edge-sharing trigonal prisms of (Ca,Mn,Ti) vertex-connected to 8-rings of Si tetrahedra.
Structure: **AA Khan WH Baur** 1971 S 173 916-8 (K777);
YuA Malinowskii EA Pobedimskaya NV Belov 1975 SPD 20 163-4 (M1123).
Occurrence: MM 35 1146.
mukhinite **~**$Ca_2Al_2V(SiO_4)_3OH$. *Epidote* structure group.
Structure determination not found.

Occurrence: **AB Shepel MV Karpenko** 1969 DAN SSSR 185 1342-5 = AM 55 321-2.
mullite ~$Al_6Si_2O_{13}$. Complex defect structures based on *sillimanite* topology.
Structure: **R Sadanaga M Tokonami Y Takéuchi** 1962 AC 15 65-8 (S61);
M Tokonami Y Nakajima N Morimoto 1980 AC A36 270-6 (T269);
RJ Angel CT Prewitt 1986 AM 71 1476-82; 1987 AC B43 116-26 (A728);
3:2 & 2:1 types, HR-TEM, **SH Rahman H-T Weichert** 1990 AC B46 139-49;
RJ Angel RK McMillan CT Prewitt 1991 AM 76 332-42;
S Padlewski V Heine GD Price 1992 PCM 18 373-8; 1992 19 196-202;
MA 91M/0176;
MA 92M/1387;
incommensurate ordering of O vacancies, **BD Butler TR Welberry RL Withers** 1993 PCM 20 323-32;
Al-rich, **RX Fischer H Schneider M Schmücker** 1994 AM 79 983-90;
EPR of Cr^{3+} in 2:1 type: **K Dräger W Guse H Saalfeld** 1995 NJMA 169 227-45;
HR-TEM images, **C Paulmann SH Rahman S Strothenk** 1994 PCM 21 546-54;
NMR of Al coordination, **P Rehak & 5 others** 1998 AM 83 1266-76.
3:2 type: **H Saalfeld W Guse** 1981 NJMM 145-50;
D Balzar H Leadbetter 1993 AM 78 1192-6;
high-T neutron, **G Brunauer & 4 others** 2001 ZK 216 284-90 (2127);
2:1 type, **H Saalfeld** 1979 NJMA 134 305-16;
SC-XRD & IR, Al-Si, Al-Ge, Ga-Ge, **D Voll & 3 others** 2001 EJM 13 591-604 (2067).
Al,Ge,Si: **S Durovic P Fejdi** 1976 Silikaty 20 97-112 = MA 77-525.
Cr^{3+}-: electron spin resonance: **K Dräger W Guse H Saalfeld** 1995 NJMA 169 227-45;
incoherent X-ray channeling patterns, **CJ Rossouw PR Miller** 1999 AM 84 965-9;
XRPD structure: **RX Fischer H Schneider** 2000 AM 85 1175-9.
Multiple-quantum & cross-polarized Al MAS-NMR of mechanical mixture of *gibbsite* & *kaolinite* that produce mullite ceramic: **SE Ashbrook et al** 2000 JPC B 104 6408-16.
Color vs structural Fe(III) & Fe oxide nanophases, **A Djemai G Calas JP Muller** 2001 JACeS 84 1627-31 (2126).
Defects, computer model: **L Wondraczek & 5 others** 2002 PCM 29 341-5 (7680).
2:1 to 3:2 transformation 1923 K: **M Schmucker B Hildmann H Schneider** 2002 AM 87 1190-3.
Heat capacity 148-1673 K vs high-T phase change: **B Hildmann H Schneider** 2004 JACeS 87 227-34 (10024).
-*magnetite-quartz* pseudotachylyte: Colorado, **DP Moecher AJ Brearley** 2004 AM 89 1486-95.
Synthetic Mn/Fe/Cr/Ti-doped, EPR/Mössbauer: **SP Chaudhuri SK Patra** 2000 JMS 35 4735-41 (C1175).
Synthetic Al-B-P-O, N & XRD structures: **D Mazza & 4 others** 2001 ChM 13 103-8 (1010).
Synthetic $(K_yNa_{1-y})_{0.7}Al_6O_{9.3}$, XRPD structure: **RX Fischer & 3 others** 2001 AM 86 1513-8.
Synthetic Sn-doped, XAS: **A Caballero M Ocana** 2002 JACeS 85 1910-4 (7822).
Synthetic $Al_{10}Si_2O_{19}$, fibers, elastic tensor: **JW Palko & 5 others** 2002 JACeS 85 2005-12 (7825).
Synthetic rectangular microtubes: **XY Kong ZL Wang J Wu** 2003 AdM 15 1445-9.
Needles in vitrified *kaolin*: **H Lu W Wang W Tuan M Lin** 2004 JACeS 87 1843-7 (10761).
Synthetic Fe-: high-T Mössbauer, **DE Mack KD Becker H Schneider** 2005 AM 90 1078-83.
mummeite $Ag_{2.5-2.8}Cu_{1.2-1.0}Pb_{1.6-1.3}Bi_{6.3-6.4}S_{13}$. *Pavonite* homolog with n = 8.
Structure: **S Karup-Møller E Makovicky** 1992 NJMM 555-76 (M1276) = MM 60 677.
mundite $Al(UO_2)_3(PO_4)_2(OH)_3.{\sim}5aq$.
Phosphuranylite mineral group, beware of problems.
Occurrence: **M Deliens P Piret** 1981 BM 104 669-71 (D527).
mundrabillaite $(NH_4)_2Ca(HPO_4)_2.aq$. Dimorphic with orthorhombic *swaknoite*.
XRPD = *synthetic* form-A = PDF 20-0203: **AW Frazier JR Hehr JP Smith** 1964 JAgFC 12 198.
Structure determination not found [jvs: check synthetic literature.]
Occurrence & crystallography: **PJ Bridge RM Clarke** 1983 MM 47 80-1.
munirite $NaVO_3.2aq$. Matches *synthetic*.
Structure: **A Björnberg B Hedman** 1977 Acta Chem Scand A31 579-84;
HT Evans Jr 1988 MM 52 716-7;
HT Evans Jr JM Hughes 1990 AM 75 508-21.
Occurrence: MM 48 578.
Relation to *metamunirite*: **HT Evans Jr** 1991 MM 55 509-13.
murataite $(Y,Na)_6(Zn,Fe)_5Ti_{12}O_{29}(O,F)_{10}F_4$. Modulation of *fluorite* structure.

Structure: **TS Ercit FC Hawthorne** 1995 CM 33 1223-9;
Fe valence, **VS Urusov VS Rusakov SV Yudintsev** 2002 DES 384 461-5 (7363).
Modulation: **OV Karimova NI Organova VG Balakirev** 2002 CrR 47 957-60 (8725).
Occurrence: **JW Adams & 3 others** 1974 AM 59 172-6.
Synthetic, ? use for actinide waste: **NP Laverov & 5 others** 1998 DES 363 1104-6 (L993).
Synthetic, new species: **NP Laverov & 4 others** 1999 DES 363A 1272-4 (L994).
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

murdochite $PbCu_6(O,Cl,Br)_8$. Defect *halite* structure type.
Structure: **CL Christ JR Clark** 1955 AM 40 907-16;
revision, **E Dubler A Vedani HR Oswald** 1983 AC C39 1143-6.
Occurrence: MM 30 741.
Synthetic Mg_6MnO_8: **P Porta M Valigi** 1973 JSSC 6 344.
Synthetic Ni_6MnO_8: **P Porta & 3 others** 1991 JSSC 92 202.
Synthetic $(Ni_{1-x}Mg_x)_6MnO_8$: **H Taguchi & 4 others** 1995 JSSC 118 112-6 (T444).
Synthetic $Mg_{6-x}Li_x)MnO_8$: **H Taguchi et al** 1996 JSSC 124 220-3 (T484).

MURMANITE-LOMONOSOVITE STRUCTURE GROUP Complex relations. Includes:

betalomonosovite	$Na_7Ti_4Si_4P_2O_{23}(OH)_3$
epistolite	$Na_5TiNb_2(Si_2O_7)_2O_3F.5aq$
lomonosovite	$Na_2Ti_2Si_2O_9.Na_3PO_4$
murmanite	$Na_2(Ti,Nb)_2Si_2O_9.naq$
polyphite	$Na_5(Na_4Ca_2)Ti_2[Si_2O_7][PO_4]_3O_2F_2$Structure:
quadruphite	$Na_{14}CaMgTi_4[Si_2O_7]_2[PO_4]_6O_4F_2$
shkatulkalite	$Na_{10}(Mn,Ca,Sr)Ti_3Nb_3(Si_2O_7)_6(OH)_2F.12aq$
sobolevite	$Na_5(Na_4Ca_2)Ti_2[Si_2O_7][PO_4]_3O_2F_2$.
vuonnemite	$Na_5TiNb_2(Si_2O_7)_2.2Na_3PO_4F.1.5O_2$

[jvs Needs detailed study to ensure that minerals are fully described. May be other members.
Note that the members are not isostructural, but are related by modules.]
See CM 43 974 for listing of members of *mero-plesiotype bafertisite* series.

murmanite $Na_2(Ti,Nb)_2Si_2O_9.naq$. Murmanite-*lomonosovite* structure group.
Forms easily from lomonosovite by loss of phosphate. Related to *epistolite*.
Structure: **AD Khalilov& 3 others** 1965 DES 161 150-2;
RK Rastsvetaeva VI Andrianov 1986 SPC 31 44-8 (R477);
superstructure in Ilimaussaq, **S Karup-Møller** 1986 NJMA 67-88 (K742).
[muromontite ~$Be_2FeY_2Si_3O_{12}$. = *beryllium orthite*: MM 27 266.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.]

murunskite $K_2Cu_3FeS_4$.
Essentially isostructural with *bukovite* $Cu_3FeTl_2Se_4$ & *thalcusite* $Tl_2(Cu,Fe)_4S_4$ from cell data.
Structure determination not found; stated to be isostructural with *synthetic* $KCuFeS_2$/$KCuFeSe_2$ with $ThCr_2Si_2$ topology, **C Majica J Páez J Ilanos** 1994 MRB 29 263-8 (M1460).
Occurrence: **MG Dobrovolskaya & 4 others** 1981 ZVMO 110 468-73.
Synthetic $KCo_{2-x}Cu_xS_2$, x 0.5-1.5 & (K/Rb/Cs)$CoCuS_2$: **M Oledskaya & 3 others** 1996 JSSC 127 151-60 (O329).
Synthetic $NaCuFeS_2$: Li_2FeS_2 type: **J Llanos & 5 others** 1993 MRB 28 39-44 (L811).

muscovite ~$KAl_2(Si_3Al)O_{10}(OH,F)_2$. *Mica* structure group. Dioctahedral subtype.
Structure: $2M_1$ polytype: **SM Richardson JW Richardson Jr** 1982 AM 67 69-72;
Cbar1; **PK Schultz PG Slade ERT Tiekink** 1989 NJMM 121-9.
NPD, 0 & 2 GPa, **M Catti G Ferraris S Hull A Pavese** 1994 EJM 6 171-8;
MA 19-178;
XRPD, **J Liang FC Hawthorne** 1996 CM 34 115-22;
NPD, RT & 12 K, FTIR, evidence for triclinic symmetry: **J Liang FC Hawthorne IP Swainson** 1998 CM 36 1017-27;
Raman & vibration analysis, **DA McKeown MI Bell ES Etz** 1999 AM 84 1041-8;
Li-bearing, SC-XRD, **MF Brigatti DE Kile M Poppi** 2001 CM 39 1171-80.

Al XANES: **A Mottana & 6 others** 1997 AM 82 497-502;
^{17}O MAS & 3Q-MAS, **SK Lee JF Stebbins** 2003 AM 88 493-500.
Mn-substituted, **RA Knurr SW Bailey** 1986 ClClM 34 7-16;
high-T, 973K, **CM Catti G Ferraris G Ivaldi** 1989 EJM 1 625-32.
Cr-substituted, SC-XRD & XANES: **MF Brigatti & 6 others** 2001 EJM 13 377-89 (2128).
3T polytype: **N Güven CW Burnham** 1967 ZK 125 163-83 (G148).
Phengite is high-silica type.
Phengitic: **A Amisano-Canesi & 4 others** 1994 EJM 6 489-96.
High-Si (phengite): 1989 SPC 34 369-73 = SR 56A 261-2.
High-P to 3.5 GPa: **P Comodi PF Zanazzi** 1993 PCM 22 170-7 (C787).
Predicted enthalpy of formation, error from structure determination: **P Vieillard** 1995 PCM 22 428-36.
Crystal chemistry of Mg,Fe-2M$_1$: **MF Brigatti P Frigieri L Poppi** 1998 AM 83 775- 85.
AFM of surface: **Y Kuwahara** 1999 PCM 26 198-205.
Compositional range in granites: **A Zane G Rizzo** 1999 CM 37 1229-38.
U adsorption, XAS: **LN Moyes et al** 2000 EST 34 1062-8 (M1795).
Sorbed organics, conformation/aggregate structure, AFM: **K Namjesnik-Dejanovic PA Maurice** 2000 GCA 65 1047-57.
Al-Si order, theory: **EJ Palin & 5 others** 2001 PCM 28 534-44 (3644).
Cr substitution, XANES: **A Cardelli & 5 others** 2003 PCM 30 54-8.
Barian-, Switzerland: SC-XRD structure, **T Armbruster & 3 others** 2002 SMPM 82 537-47 (8718).
Recrystallization or cooling ages in mylonites: **A Mulch MA Cosca** 2004 JGSL 161 572-82 (10448).
Unusual ditrigonal optics: **AF Golovachev** 2005 ZVMO 134 90-6.

museumite $Pb_5AuSbTe_2S_{12}$.
Occurrence: **L Bindi C Cipriani** 2004 EJM 16 835-8 (10837).

mushistonite $(Cu,Zn,Fe)Sn(OH)_6$. ReO_3 structure type.
Schoenfliesite/stottite structure group.
Occurrence: **NK Marshukova AB Pavlovskii GA Sidorenko** 1984 ZVMO 113 612-7;
PJ Dunn WL Roberts 1986 MR 17 383;
MR 26 143 = MM 50 753.

muskoxite $Mg_7Fe_4O_{13}$.10aq.
Occurrence: **JL Jambor** 1969 AM 54 684-96.

muthmannite $AuAgTe_2$. NiAs type.
Structure: SC-XRD, **L Bindi C Cipriani** 2004 AM 80 1505-9.
Occurrence: **F Zambonini** 1911 ZK 49 249-53.

mutinaite $Na_{2.8}K_{0.1}Mg_{0.2}Ca_{3.8}Al_{11.2}Si_{84.9}O_{192}$.60aq. *Zeolite* mineral group.
Analog of *synthetic* zeolite ZSM-5. IZA-SC code MFI.
Silicalite is *synthetic* pure silica endmember of the MFI structural series.
Synthetic stacking variant ZSM-11 has the IZA-SC code MEL.
Structure: mutinaite, **G Vezzalini & 5 others** 1997 Z 19 323-5 (V291);
synthetic TPA-ZSM-5, Si/Al 23, SC-XRD, Pn2$_1$a: **Y Yokomori S Idake** 1999 MMM 28 405-13 (Y251);
deuterated monoclinic & orthorhombic silicalite, NPD, **G Artioli C Lamberti GL Marra** 2000 AC B56 2-10 (408);
Na-Fe-silicalite, SC-XRD, **M Milanesio & 5 others** 2000 JPCB 104 9951-3 (71);
F site, TPA-F silicalite, SC-XRD, **E Aubert & 4 others** 2002 JPCB 106 1110-7 (7055);
B/Ga silicalites vs pure Si, SC-XRD structure, **L Palin & 6 others** 2003 JPCB 107 4034-42 (9097).

Natural: occurrence
Occurrence, XRPD & IR: **E Galli & 4 others** 1997 Z 19 318-22 (G980).

Synthetics
There is a huge literature on industrial zeolites with the MFI/MEL structure type.

General: synthesis, structure, applications
Synthetic ZSM-5 & silicalite, MAS-NMR: **CA Fyfe & 4 others** 1982 N 296 530-3 (9537).
Synthetic ZSM-5, IR demonstrating 5-rings: **JC Jansen FJ van der Gaag H van Bekkum** 1984 Z 4 369-72 (222).
Dealumination of ZSM-5 to silicalite, NMR: **CA Fyfe GC Gobbi GJ K ennedy** 1984 JPC 88 3248-53 (9386).
Vibrational spectroscopy, ammonium-: **A Zecchina & 4 others** 1997 JPCB 101 10128-35 (Z156).
Density theory/divalent cations ZSM-5: **MJ Rice AK Chakraborty AT Bell** 2000 JPCB 104 9987-92.
Recrystallization, *magadiite* to MFI/MEL with TPA & TBA: **G Pal-Borbely & 3 others** 1997 MiMa 11 45-51.
Synthetic MFI/MEL, EM: **T Ohsuna & 4 others** 1997 JPC B101 9881-5.

Al site distribution, model: **G Ricchiardi JM Newsam** 1997 JPC B101 9943-50 (R799).
Synthetic TPA-silicalite, crystallization kinetics/mechanism: **JN Watson & 5 others** 1997 JPCB 101 10094-104 (W864).
Synthetic H-ZSM-5, proton affinity/defects, model: **NO Gonzales AT Bell AK Chakaborty** 1997 JPCB 101 10058-64.
Synthetic Na-/H-, adsorption of methanol: **B Hunger & 3 others** 1997 La 13 6249-54 (H1284).
Synthetic ZSM-5, TPAD, NMR, XRD, FTIR, nature of framework Al: **GL Woolery & 4 others** 1997 Z 19 288-96.
Synthetic silicalite/CH_3CN-HCl adducts, IR: **C Pazé & 4 others** 1998 JCSF 94 309-14 (P758).
Synthetic Na- & Mn-, use of Co & Cu substitution to elucidate bonding: **Z Sobalik & 3 others** 1998 MMM 21 525-32.
Synthetic H-ZSM-5 & Cs-, p-xylene complex, XRPD structure: **BF Mentzen P Gelin** 1998 MRB 33 109-16.
Synthetic silicalite: adsorption n-alkanes, T-program desorption, **B Millot A Methivier H Jobic** 1998 JPCB 102 3210-5;
diffusion cyclohexane/alkyl-: **FD Magalhaes RL Lawrence WC Conner** 1998 JPCB 102 2317-24;
IR of methylcyanide HCl adduct: **C Paze & 4 others** 1998 JCSF 94 309-14;
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Synthetic Fe-ZSM-5 catalyst, preparation, characterization: **R Joyner M Stockenhuber** 1999 JPC B 103 5963-76 (J348).

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Synthetic Ga-ZSM-5, role alkali cations & F medium: **E Nigro & 5 others** 1999 MMM 30 199-211.
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Tantalum
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mutnovskite $Pb_2AsS_3(I,Cl,Br)$.
Occurrence & SC-XRD structure: **M Zelenski & 6 others** 2006 AM 91 21-8.

nabalamprophyllite $(Na,Ba)Na_3Ba\{Ti[Ti_2O_2Si_4O_{14}](OH,F)_2$.
Seidozerite structure group.
Occurrence: **NV Chukanov & 7 others** 2004 ZVMO 133 59-69 (10872).

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Structure: **SV Baturin YuA Malinovskii NV Belov** 1982 SPD 27 690-2 (B1123).

nabiasite $BaMn_9[(V,As)O_4]_6(OH)_2$.
Occurrence & structure: **J Brugger & 5 others** 1999 EJM 11 879-90 (B1968).

nabokoite $Cu_7TeO_4(SO_4)_5KCl$. Isotypic series with *atlasovite* $Cu_6FeBiO_4(SO_4)_5KCl$.
Structure: **F Pertlik J Zemann** 1988 MP 38 291-8 (P537).
Occurrence: MM 52 728.

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Structure: **EK Sokolova YuK Egorov-Tismenko AP Khomyakov** 1989 SPD 34 9-11 (S1293); SC-XRD, **E Sokolova FC Hawthorne** 2001 CM 39 1275-94.
Synthetic dimorph, structure: **EV Sokolova & 4 others** 1999 CM 37 83-90.
Occurrence: MM 43 1064.

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Should belong to ill-defined *mosandrite* & *rinkite* structure groups: undetermined structural details.
Structure/discussion nomenclature: **OV Petersen JG Rønsbo ES Leonardsen** 1989 NJMM 84-96 (P547).
Occurrence: MM 54 667.
Review: (different formula) **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

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Structure: **AM Blount IM Threadgold SW Bailey** 1969 ClClM 17 185-94 (B398);
BB Zvyagin SV Soboleva AF Fedotov 1972 SPC 17 448-52 (Z73);
H Zheng SW Bailey 1994 ClClM 42 46-52;
2M stacking for Tunisian, **A Ben Haj Amara & 4 others** 1997 JACr 30 338-44 (B1643), **do** 1998 31 654-62 (A889).
Intercalated: MA 96M/2659.

NADORITE FAMILY OF LEAD SHEET MINERALS

mereheadite	$Pb_2O(OH)Cl$
nadorite	$PbSbO_2Cl$
symesite	$Pb_{10}(SO_4)O_7Cl_4.aq$
thorikosite	$(Pb_3Sb_{0.6}As_{0.4})O_2(OH)Cl_2$

See AM 85 526-33 for other members.

nadorite $PbSbO_2Cl$. Isostructural with Bi analog *perite* from cell data.

Structure: **LG Sillén L Melander** 1941 ZK 103 420-3 (S1253);
G Giuseppetti C Tadini 1973 PMR 42 335-45 (G742).

nafertisite $(Na,K)_3(Fe^{2+},Fe^{3+},void)_{10}[Ti_2(Si,Fe^{3+},Al)_{12}O_{37}](OH,O)_6$.

Structure model involving heterophyllosilicate polysomatic relation to *bafertisite* & *astrophyllite*, & test with poor XRD: **G Ferraris & 5 others** 1996 EJM 8 241-9 (F500).

Occurrence: **AP Khomyakov & 4 others** 1995 ZVMO 124 101-7;
in Greenland, crystallography: **OV Petersen & 4 others** 1999 NJMM 303-10 (P843).

nagashimalite $Ba_4(V,Ti)_4Si_8B_2O_{27}Cl(O,OH)_2$.

Isostructural with Fe analog *taramellite*.

Structure: **S Matsubara** 1980 MJ 10 131-42 (M1219).

nagelschmidtite $\sim Ca_7(SiO_4)_2(PO_4)_2$.

Review of silicophosphates, including *silicocarnotite* & *nagelschmidtite*, & importance for fertilizers: **BI Lazoryak VN Golubev RG Aziev** 1989 SPC 33 659-64 (L585).

Occurrence: MM 26 339;
mixture of two polymorphs, assigned composition $(Ca_{3.78}Na_{0.06}K_{0.06})(Si_{1.58}P_{0.40})O_8$, **S Gross** 1977 Geol Survey Israel Bull 70 80p = AM 63 425-6.

[jvs: obviously needs thorough study of both natural & *synthetic* materials.].

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Chemical & crystallographic data but no structure: **CJ Stanley AC Roberts DC Harris** 1994 MM 58 479-82.
Synthetic, average structure, SC-XRD: **H Effenbeger & 4 others** 1999 AM 84 669-76.
Arsenian-, possible new species: **G Simon DHM Alderton T Bleser** 1994 MM 58 473-8.
Occurrence with *buckhornite*, new formula $\sim Pb_5Au(Sb,Bi)Te_2S_6$: **Z Johan & 3 others** 1994 CRASP II 318 1225-31.

nahcolite $NaHCO_3$.

Structure: **WH Zachariasen** 1933 J Chem Phys 1 634-9 (Z91);
RL Sass RF Scheuerman 1962 AC 15 77-81 (S1410).

Occurrence: MM 22 624.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.

nahpoite $Na_2H(PO_4)$.

Matches *synthetic*: PDF 10-184.
Structure determination not found.
Occurrence: **LC Coleman BT Robertson** 1981 CM 19 373-6.

nakauriite $Cu_8(SO_4)_4(CO_3)(OH)_6.48aq$. Review: **Sabelli** no structure.

Structure determination not found.
Occurrence: intergrowth with *chrysotile*, **J Suzuki M Ito T Sugiura** 1976 JJAMPEG 71 183-92;
RSW Braithwaite R Pritchard 1983 MM 47 84-5.

Na-komarovite $(Na,Ca,H)_2Nb_2Si_2O_{10}(OH,F)_2.aq$.

Komarovite has a different unit cell. Reference: PDF 33-608.

naldrettite Pb_2Sb. See *ungavaite*.

Occurrence & crystallography, relation to *synthetics*: **LJ Cabri & 7 others** 2005 MM 69 89-97.

nalipolite $NaLi_2PO_4$.

Structure: **TS Ercit** 1991 CM 29 569-73.
Occurrence: **GY Chao TS Ercit** 1991 CM 29 565-8.

namansilite $\sim NaMnSi_2O_6$. *Pyroxene* structure type.

Mineralogy: **VV Kalinin & 4 others** 1992 ZVMO 121 89-9 (K669);
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Y Kawachi DS Coombs 1993 MM 57 533-8.
Synthetic, structure refinement: **H Ohashi T Osawa K Tsukimura** 1987 AC C43 605-7 (O288).
nambulite $LiNaMn_8Si_{10}O_{28}(OH)_2$. *Rhodonite* structure type in *pyroxenoid* mineral family.
Structure: **H Narita K Koto N Morimoto** 1975 AC B31 2422-6 (N192).
Occurrence: MM 39 921.
namibite $Cu(BiO)_2VO_4OH$. Slightly distorted ordered relative of *brendelite*.
Redefined: **Z Mrazek & 4 others** 1994 NJMM 481-8.
Structure: SC-XRD, **U Kolitsch G Giester** 2000 AM 85 1298-301.
Occurrence: **EE Foord** 1996 MM 387-8; MM 48 578; MA 96M/2490.
Summary of world occurrences: **GE Dunning JF Cooper Jr** 1998 MR 29 163-6.
namuwite $(Zn,Cu)_4SO_4(OH)_6.4aq$.
Structure: **LA Groat** 1996 AM 81 238-43.
Occurrence: MM 46 522.
Synthetic $(Zn,Cu)_4SO_4(OH)_6.3$ & 5aq, structures: **IJ Bear & 4 others** 1986 AC B42 32-9.
[nanekeveite $(Na,K)(Ba,Sr,Na,Re,Fe)_4(Fe,Nb,Ti)Ti(Si,Al)_8O_{25}(OH)_3$. Similar to *joaquinite*.
Not approved by IMA.
Occurrence: MM 50 753.]
nanlingite $\sim CaMg_4(AsO_3)_2F_4$.
Structure determination not found.
Occurrence & crystallography: **X Gu K Ding Y Xu** 1976 Geochimia 2 107-12 = AM 62 1058-9.
nanpingite $CsAl_2(AlSi_3O_{10})(OH)_2$. $2M_2$ dioctahedral *mica*.
Structure: SC-XRD, **NY Ni JM Hughes** 1996 AM 81 105-10.
Occurrence: MM 54 667-8.
nantokite CuCl. *Sphalerite* 3-layer cubic structure type.
Above 708 K, disordered *wurtzite* type: **Wells** p 376.
Structure: **M Sakata S Hoshino J Harada** 1974 AC A30 655-61;
Raman, implication copper corrosion, **RL Frost & 3 others** 2003 NJMM 433-45 (9622).
narsarsukite $Na_2(Ti,Fe)Si_4(O,F)_{11}$. Vertex-connected octahedral-tetrahedral net.
Consortium for Theoretical Frameworks net 1126. Compare with *vlasovite*, net 1123.
Structure: **YuA Pyatenko ZV Pudovkina** 1960 SPC 4 885-6, 1961 5 540-8;
DR Peacor MJ Buerger 1962 AM 47 539-56 (P25).
MAS-NMR, ^{29}Si: **ML Balmer & 4 others** 1997 JPCB 101 9170-9 (B1738);
A Labouriau TG Higley WL Earl 1998 JPCB 102 2897-904.
Occurrence: **PM Kartashov** 1994 ZVMO 123 58-66.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.
Synthetic ETS-4 (~ *zorite* structure type) transforms to *narsarsukite*: **M Naderi MW Anderson** 1996 Z 17 437-43 (N416).
Synthetic ETS-10 can be calcined into narsarsukite: see *zeolite*.
Synthetic $K_2ScFSi_4O_{10}$: similar topology, **U Kolitsch E Tillmanns** 2004 EJM 16 143-9 (10136).
nasinite $Na_2B_5O_8(OH).2aq$.
Structure: **E Corrazza S Menchetti C Sabelli** 1975 AC B31 2405-10.
Occurrence: MM 33 1145.
Identical with *Auger's borate*.
nasledovite $PbMn_3Al_4(CO_3)_4(SO_4)O_5.5aq$. Review: **Sabelli** no structure.
Structure determination not found.
Occurrence: **MR Enikeev** 1958 Dokl Akad Nauk Uzbek SSSR no. 5 13-6 = AM 44 1325.
nasonite $Ca_4Pb_6Si_6O_{21}Cl_2$.
Related *apatite* structure by 60° rotation of building block.
Structure: **G Giuseppetti G Rossi C Tadini** 1971 AM 56 1174-9 (G241);
HRTEM, 1987 AC B43 171-4.
nastrophite $Na(Sr,Ba)PO_4.9aq$. Isostructural with Ba analog *nabaphite*.
Structure: **SV Baturin YuA Malinovskii NV Belov** 1981 SPD 26 1023-6 (B1122).
natalyite $Na(V,Cr)Si_2O_6$. *Pyroxene* structure group, monoclinic subtype.
Structure determination not found.

Occurrence: **LZ Reznitskii EV Skliarov ZF Ushchapovskaia** 1985 ZVMO 114 630-5;
EV Rumjantseva 1994 ZVMO 123 55-7.

natanite $FeSn(OH)_6$. ReO_3 structure type. *Schoenfliesite/stottite* structure group.

[jvs: ?cubic polymorph of pseudocubic *jeanbandyite*?]

Matches *synthetic* cubic $FeSn(OH)_6$: **H Strunz B Contag** 1960 AC 13 601-**?**

Occurrence: **NK Marshukova & 3 others** 1981ZVMO 110 492-500;
J Betterton & 4 others 1998 MM 62 707-12. MM 46 522.

Synthetic $MnSn(OH)_6$, structure: **AN Christensen RG Hazell** 1969 ACSc 23 1219-24 (C804);
also Ca/Fe/Co/Zn varieties.

natisite $Na_2TiOSiO_4$. Tetragonal, polymorphic with orthorhombic *paranatisite*.

Derivative of *sulfohalite* type: **OV Yakubovich OK Mel'nikov** 1995 Phys-Dokl 40 279-84 (Y164).

Structure: **H Nyman M O'Keeffe J Bovin** 1978 AC B34 905-6;
YuK Egorov-Tismenko MA Simonov NV Belov 1978 SPD 23 289-90;
XRPD, *synthetic*, **S Ferdov V Kostov-Kytin O Petrov** 2002 PD 17 234-7 (7959).

Occurrence: MM 40 910.

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

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

Synthetic $Na_2TiOGeO_4$: **VYa Verkhovskii & 3 others** 1970 SPD 15 7-8;
SC-XRD, **OV Yakubovich VV Kireev OK Mel'nikov** 2000 CrR 45 578-84 (1750).

Synthetic $Li_2TiOSiO_4$: **A Ziadi G Thiele B Elouardi** 1994 JSSC 109 112-5.

Synthetic analogs, & structural changes during phase transitions: **A Ziadi & 3 others** 1996 JSSC 123 324-30 (Z114).

Synthetic Li_2VOSiO_4, structure SC-XRD: **KK Rangan & 3 others** 1998 AC C54 176-7 (R817).

natrite Na_2CO_3-gamma.

Structure: SC-XRD, **NV Zubkova & 5 others** 2002 NJMM 85-96 (6131);
SC-XRD at room T, & -delta at 110 K, **M Dusek & 3 others** 2003 ACB 59 337-52 (9063).

Low-T variety, to -beta ~620K & alpha- 684K: **PM de Wolff F Tuinstra** 1987 ZK 179 241-8 (D498).

N&XRPD, anharmonic motion & multipolar expansion of electron density, literature review: **W Gonschorek & 4 others** 1995 ZK 210 843-9 (G822) .

Matches *synthetic*: PDF 19-1130.

Occurrence: **AP Khomyakov** 1982 ZVMO 111 220-5.

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

natroalunite $NaAl_3(SO_4)_2(OH)_6$. *Alunite* structure group. Review: **Sabelli** p. 25.

Minamiite is superstructure with double *c* and cation ordering.

Structure: **K Okada J Hirabayashi J Ossaka** 1982 NJMM 534-40.

P-rich: AM 86 200.

natroapophyllite $NaCa_4Si_8O_{20}F.8aq$. *Apophyllite* mineral group.

Structure: **Y Miura & 3 others** 1981 AM 66 416-23.

Occurrence: MM 46 522.

natrobistantite $(Na,Cs)Bi(Ta,Nb,Sb)_4O_{12}$. *Pyrochlore* structure group.

Structure determination not found.

Occurrence: **AV Voloshin & 3 others** 1983 Mineral Zhurnal 5 82-6 = AM 69 407-8.

natrochalcite $NaCu_2(SO_4)_2OH.aq$. Review: **Sabelli** p. 27.

Structure: **IM Rumanova GF Volodina** 1958 SPD 3 1093-6 (R509);
G Chevrier G Giester J Zemann 1993 ZK 206 7-14.

Hydrogen bonding, FTIR: **A Beran G Giester E Libowitzky** 1997 MP 61 223-5 (B1791).

Synthetic (Na/K/Rb)(S/Se): **G Giester J Zemann** 1987 ZK 179 431-42.

Synthetic $AgCu_2(SO_4)_2OH.aq$ & $(Ag/NH_4/Tl)(SeO_4)_2OH.aq$: **G Giester** 1989 ZK 187 239-47 G674).

Synthetic $KCu_2(H_3O)_2(SO_4)_2$: ND, **G Chevrier & 3 others** 1990 AC C46 175-7.

Synthetic $Me^+Cu_2(SO_4)_2(H_3O_2)$: variation H-bonding, **G Giester J Zemann** 1988 ZK 185 500.

natrodufrenite $Na(Fe^{2+},Fe^{3+})(Fe,Al)_5(PO_4)_4(OH)_6.2aq$.

Isostructural with *burangaite* & *dufrenite* from XRPD & crystallography.

Occurrence: **F Fontan F Pillard F Permingeat** 1982 BM 105 321-6.

[**natrofairchildite** $Na_2Ca(CO_3)_2$.

Should match *nyerereite*, but might be different inversion product.
XRPD matches *fairchildite* $K_2Ca(CO_3)_2$.
Occurrence: **YuL Kapustin** 1971 *Mineralogy of carbonatites*, Izdat "Nauka" Moscow 181-3 = AM 60 488.]

natrojarosite $NaFe(SO_4)_2(OH)_6$. *Alunite* structure group.
Structure: **S Menchetti C Sabelli** 1976 NJMM 406-17.
Raman spectrum, **K Sasaki O Tanaike H Konno** 1998 CM 36 1225-35.
Produced in zinc smelters, and commonly mixed with mine waste. Unfortunately, mixing accentuates acidity & increases release of toxic elements Pb/Cd/Ni: **J Jurjovec & 3 others** 2003 EST 37 158-64 (8662).

natrolemoynite $Na_4Zr_2Si_{10}O_{26}.9aq$. *Lemoynite* structure.
Occurrence & SC-XRD structure: **AM McDonald GY Chao** 2001 CM 39 1295-306.
Consortium for Theoretical Frameworks net 1089.

natrolite $Na_2Al_2Si_3O_{10}.2aq$. *Zeolite* mineral family. IZA-SC structure code NAT.
Consortium for Theoretical Frameworks net 260.
Natrolite (orthorhombic) has ordered Al and Si; *gonnardite* & *tetranatrolite* (tetragonal) have disordered tetrahedral atoms; *paranatrolite* is pseudo-orthorhombic, monoclinic or tetragonal, but structural details unclear: review, **TN Kol'tsova** 2005 Inorg Mat 41 750-6.
Scolecite is Ca analog, and *mesolite* is ordered Na,Ca intermediate.
Structure: **WH Taylor CA Meek WW Jackson** 1933 ZK 84 373;
WM Meier 1960 ZK 113 430-44 (M742);
inelastic neutron scattering, **H Boutin GJ Safford HR Danner** 1963 JCP 39 488-9;
ND, **BH Torrie ID Brown HE Petch** 1964 Canad J Phys 42 229-40 (T74);
high-T to 520K, **DR Peacor** 1973 AM 58 676-80;
partially disordered, **A Alberti G Vezzalini** 1981 AC B37 781-8;
A Alberti G Vezzalini 1983 NJMM 135-44 (A379);
F Pechar W Schäfer G Will 1983 ZK 164 19-24 (P499);
partly disordered, **K Hesse** 1983 ZK 163 69-74 (H1024);
SC-ND, **G Artioli JV Smith Å Kvick** 1984 AC C40 1658-62;
A Kirfel M Orthen G Will 1984 Z 4 140-6 (K785);
inelastic neutron scattering of aq, **H Fuess E Stuckenschmidt BP Schweiss** 1986 Ber Bunsen-Ges Phys Chem 90 417-21;
proton NMR, **AV Sapiga & 4 others** 1986 Zh Strukt Khim 27 181-2 = CA 105:211952m;
proton NMR, **VA Detinnich BN Grechushnikov VYu Galitskii** 1989 Kr 34 494-7;
high-P to 7 GPa, **IA Belitsky & 4 others** 1992 PCM 18 497-505 (B1011);
E Stuckenschmidt W Joswig WH Baur 1993 PCM 19 562-70 (S1107);
deformation density, **do** 1994 PCM 21 309-16;
order-disorder, **A Alberti G Cruciani I Dauru** 1995 EJM 7 501-8 (A609);
dehydrated (meta-), **W Joswig WH Baur** 1995 NJMM 26-38;
XRPD, **AA Finch & 3 others** 1995 PD 10 243-7;
dehydration/rehydration to 923 K, **WH Baur W Joswig** 1996 NJMM 171-87 (B1462);
static deformation density, XRD, **NE Ghermani C Lecomte Y Dusausoy** 1996 PRB 53 5231-9 (G846);
anomalous mobility & transformation tetra- to para-, **SP Gabuda SG Kozlova** 1997 J Struct Chem 38 562-9 (G1000)
librational & vibrational spectra of aq, inelastic neutron scattering vs model, **CMB Line GJ Kearley** 1998 Chem Phys 234 207-22;
K-rich, SC-XRD, **E Meneghinello & 3 others** 1999 MMM 30 89-94 (M1793);
Raman & lattice-dynamics, **SV Goryainov MB Smirnov** 2001 EJM 13 507-19 (2132);
Al & Si, MAS-NMR, **PS Neuhof & 4 others** 2002 AM 87 1307-20;
Raman & IR of water in channels, **BA Koselov CA Geiger** 2006 AM 91 1039-48.
P-induced expansion: **Y Lee & 4 others** 2002 JAChS 124 5466-75 (7183).
P-induced hydration, *synthetic* Na-GaSi-NAT: **Y Lee & 4 others** 2003 JAChS 125 6036-7 (9003).
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.
3 disordered & 1 Li-exchanged: **E Krogh Andersen & 2 others** 1991 EJM 2 799-807 (K543).
Predicted enthalpy of formation, error from structure: **P Vieillard** 1995 PCM 22 428-36.
Thermochemistry of natural fibrous: **IA Kiseleva & 4 others** 1997 EJM 9 327-332 (K913).
Low-T thermodynamics of disordered zeolites of natrolite group: **IE Paukov & 3 others** 2002 PCM 29 300-6 (7761).

Ion-exchanged, Li-: **NHW Sieber C-H Kim** 1988 ZK 185 615 (S1511).
Ion-exchanged, $Li_{1.6}Na_{0.4}$-, $(Na/K)_2$ - simulation: **WH Baur & 3 others** 1990 EJM 2 761-9.
Ion-exchanged, Tl-: **AM Panich & 5 others** 1990 Strukt Khim 31 67-73 = CA 113:15140w.
Ion-exchanged, NH_4-: **E Stuckenschmidt D Kassner W Joswig WH Baur** 1992 EJM 4 1229-40;
converted to H_3O, **E Stuckenschmidt W Joswig WH Baur** 1996 EJM 8 85-92 (S1557).
Synthetic Ge-: MM 32 958.
Synthetic $Rb_2Ga_2Ge_3O_{10}$: **KH Klaska O Jarchow** 1985 ZK 172 167-74 (K488).
Synthetic gallosilicate: **D Xie & 3 others** 1988 Mater Res Soc Symp Proc111 147-54 (X2).
Synthetic gallosilicates made with NaOH, KOH & BTMAOH: **ML Occelli E Goldish H Eckert**
1994 Stud Surface Sci Catalysis 84 597-604.
Synthetic Ga, TNU-2, XRPD/NMR/SEM: **HH Cho & 5 others** 2000 ChM 12 2292-300 (C1156).
Heteroionic exchange types, diffusion of water, **A Dyer H Faghihian** 1998 MMM 21 27-38.
Dealuminated Na-/ammonium-, IR/XRD: **R Joshi SP Banerjee** 1998 J Indian Chem Soc 75 335-40.
New *synthesis* procedure, **GM Johnson A Tripathi JB Parise** 1999 ChM 11 10-2 (J330).
natromontebrasite $(Na,Li)Al(PO_4)(OH,F)$. *Amblygonit*e structure group.
Structure determination not found.
Occurrence: **Dana**.
natron = washing soda $Na_2CO_3.10aq$.
Structure: **T Taga** 1969 AC B25 2656-8;
synthetic, SC-XRD, IR & Raman, **E Litowitsky G Giester** 2003 MP 77 177-95 (8921).
Occurrence: in hyperagpaitic alkaline rocks, **Khomyakov** 1995;
Beypazari lacustrine basin, Turkey, **F Suner & 3 others** NJMM 31-48 (8627)..
natronambulite $(Na,Li)(Mn,Ca)_4Si_5O_{14}OH$.
Rhodonite structure type from crystallography. *Pyroxenoid* mineral family.
Occurrence: **S Matsubara A Kato T Tiba** 1985 MJJ 12 332-40 = AM 72 224.
[natroniobite $NaNbO_3$. Monoclinic dimorph of orthorhombic *lueshite*.
[jvs: should have *perovskite* topology; may difffer from *lueshite* in its phase inversion history.]
Compare with cubic *isolueshite* $(Na,La,Ca)(Nb,Ti)O_3$.
Occurrence: **AG Bulakh et al**, abstr in ZVMO 92 190 = AM 47 1483.]
natrophilite $NaMnPO_4$. *Olivine* structure type.
Compare with *maricite* $Na(Fe,Mn)PO_4$.
Structure: **A Byström** 1943 Ark Kemi Mineral Geol 17B no.4 = MA 9-101;
PB Moore 1972 AM 57 1333-44 (M580).
natrophosphate $Na_7(PO_4)_2F.19aq$.
Structure: **EA Genkina AP Khomyakov** 1992 SPC 37 844-5 (G677).
Occurrence: MM 38 995-6;
Namibia, **OV Petersen & 3 others** 1997 NJMM 511-7 (P761)
Ilimaussaq, **OV Petersen AP Khomyakov H Sorensen** 2001 GGSB 190 139-41.
natrosilite $Na_2Si_2O_5$-beta.
Synthetic: **G Donnay JDH Donnay** 1953 AM 38 163-71.
Occurrence: MM 40 910.
Alpha: **DWJ Cruikshank** 1969 AC B24 13-9.
Beta: **AK Pant** 1969 AC B24 1077-83.
Gamma & sigma: **W Hoffman H-J Scheel** 1969 ZK 129 396-404.
See *grumantite* $NaHSi_2O_5.aq$, *kanemite* $NaHSi_2O_4(OH)_2.2aq$, *makatite* $NaSi_2O_4OH.2aq$
& *revdite* $Na_{16}[Si_4O_6(OH)_5]_2[Si_8O_{15}(OH)_6](OH)_{10}.28aq$.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.
natrotantite $Na_2Ta_4O_{11}$.
Structure: **TS Ercit FC Hawthorne P Cerny** 1985 BM 108 541-9.
Occurrence: MM 46 523.
natroxalate $Na_2C_2O_4$.
Structure: jvs, look for *synthetic*.
Occurrence: **AP Khomyakov** 1996 ZVMO 125 126-32 (K890).

naujakasite $(Na,K)_6(Fe,Mn)Al_4Si_8O_{26}$. Isotype with *manganonaujaksite*.
Structure: **R Basso & 3 others** 1975 Bull Grønlands Unders 116 11-24 (B638) = MA 76-1417.
Occurrence: MM 23 635;
Ilimaussaq & Lovozero, **AP Khomyakov & 3 others** 2001 GGSB 190 95-108 (8688);
Ilimaussaq, & stability in hyperagpaitic melt, **T Andersen H Sörensen** 2005 MM 69 125-36.
naumannite Ag_2Se.
Essentially isostructural with S analog *acanthite,* orthorhombic but with similar cell repeats.
Phase II, stable low T: inverts to cubic phase I 405 K (structure: **P Rahlfs** 1936 ZPC B31 157-94).
Structure: XRPD, **GA Wiegers** 1971 AM 56 1882-8.
navajoite $Ca_{0.05}(V,Fe)_{10}O_{24}.12aq$. *Vanadium bronze* structure group; *other* subgroup.
Review & new data: **HT Evans Jr JM Hughes** 1990 AM 75 508-21 [earlier data reevaluated].
Occurrence: MM 30 741.
[navarite $BaAl_2Si_2O_8.4aq$.
[jvs: had original specimen, now with Peter Burns; can we find crystal from thin section?.]
nchwaningite $Mn_2SiO_3(OH)_2.aq$. New-topology chain structure related to *pyroxene* type.
Structure: **D Nyfeler & 3 others** 1995 AM 80 377-86.
nealite $Pb_4Fe(AsO_4)_2Cl_4.2aq$.
Structure: **G Guiseppetti F Mazzi C Tadini** 1993 NJMM 278-88;
F Pertlik G Schnorrer 1993 MP 48 193-200 (P471).
Occurrence: MM 46 523.
nefedovite $Na_5Ca_4(PO_4)_4F$.
Structure: **M Sebais & 3 others** 1984 SPD 29 700-3.
Occurrence: MM 48 579.
neighborite $NaMgF_3$. *Perovskite* structure type.
Structure: SC-XRD, **V Pischedda & 2 others** 2005 NJMA 182 23-9 = AM 91 1457.
Occurrence: MM 32 972.
High-P, 0 & 5 GPa: **Y Zhao & 8 others** 1994 AM 79 615-21 (Z92).
Elastic moduli: **Y Xhao DJ Weidner** 1993 PCM 20 419-24.
Superionicity, molecular-dynamics: **LX Zhou JR Hardy HZ Cao** 1997 GRL 24 747-50 (Z126).
Potassium neighborite, Oldoniyo Lengai natrocarbonatite: **RH Mitchell** 1997 MM 61 779-89.
nekoite $Ca_3Si_6O_{15}.7aq$. Related to *okenite*.
Structure: **XS Mamedov NV Belov** 1958 DAN SSSR 121 720-3;
A Alberti E Galli 1980 AM 65 1270-6.
nekrasovite $Cu_{13}VSn_3S_{16}$. Isostructural with As analog *colusite*.
Occurrence & crystallography: **VA Kovalenker & 5 others** 1984 MZh 6-2 88-97 = AM 70 437.
Zn-bearing: **GS Anisimova & 3 others** 2002 ZVMO 65-8.
nelenite $(Mn,Fe)_8Si_6O_{15}(OH)_7[As_{1.5}O_3(OH)_{1.5}]$.
Friedelite structure group; monoclinic subtype. Dimorphic with *schallerite*.
Structure determination not found.
Occurrence: **PJ Dunn DR Peacor** 1984 MM 48 271-5.
neltnérite / neltnerite $CaMn_6SiO_{12}$. *Braunite* structure group.
Structure: **JPR de Villiers SM Dobson PR Buseck** 1991 EJM 3 567-73.
Occurrence: MM 46 523.
nenadkevichite $\sim(Na,Ca,K)(Nb,Ti)Si_2O_6(O,OH).2aq$.
Isotypic with *korobitsynite* $Na_{3-x}(Ti,Nb)_2(Si_4O_{12})(OH,O)_2.3$-4aq.
Has $M(TO_4)_2$ chain also in *labuntsovite*, *metasideronatrite*, *sideronatrite*, *tancoite* & *yftisite*.
Related to *vuoriyarvite* $(K,Na)(Nb,Ti)Si_2O_6(O,OH).2aq$.
Occurrence: MM 30 741.
Structure: **G Perrault & 4 others** 1973 AM 58 1102-3;
do 1973 AC B29 1432-8 (P231);
K-rich, **RK Rastsvetaeva & 3 others** 1994 EJM 6 503-9 (R518);
do 1994 CrR 39 908-14 (R534).
Monoclinic analog, structure & microtwin: **RK Rastsvetaeva & 2 others** 1996 DAN 351 207-11.

Unnamed M70, ~$Na_2(Ca,Sr)(Nb,Ti)_2Si_4O_{12}(O,OH)_4.3aq$: occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.

K-dominant, Nb-rich from Narssarssuk, mineralogy & crystallography: **OV Petersen RA Gault ES Leonardsen** 1996 NJMM 103-13 (P615) = AM 81 1286.

Natural Ti-rich, SC-XRD structure: **RK Rastsvetaeva & 2 others** 1997 DAN 357 364-7.

Natural water-rich: MA 86 379.

Synthetic ETS-4: **SM Kuznicki** 1989 US Patent 4,853,202;
SM Kuznicki AK Thrush 1990 European Patent 0405978A1;
SM Kuznicki & 6 others 1992 Synth Microporous Mater 1 427-56 = CA 121:314317t;
proposal that intergrown nenadkevichite & *zorite*, **A Philippou MW Anderson** 1996 Z 16 98-107 (P590).

Synthetic Ti/Nb analogs with molar = 0.8, 2.0, 4.1 & 12.3, XRPD & ^{29}Si MASNMR: **J Rocha & 4 others** 1996 ChC 669-70 (R652);
0.8 to 17, **J Rocha & 5 others** 1996 JPC 100 14978-83 (R676).

[nenadkevite MM 31 967.]

neodymian goyazite Definition: MM 50 753-4.

neodymium bastnäsite = bastnäsite (Nd) $(Nd,Y,La,Ca)(CO_3)(OH,F).naq$.

Bastnäsite structure type.

Occurrence: **YeK Podporina VV Burkov** 1986 DAN 289 959.

[neotocite See *hisingerite*.]

nepheline $\sim(Na,K)AlSiO_4$. Natural specimens generally have Si>Al & ~ Na/K = 3.

Stuffed *tridymite* structure type, as is *yoshiokaite* $Ca_{8-0.5x}Al_{16-x}Si_xO_{32}$, x = 2.8-6.0.

Dimorphic with *carnegieite* $NaAlSiO_4$ with stuffed *cristobalite* structure type.

Structure: **MJ Buerger GE Klein G Donnay** 1954 AM 39 805-18 (B90);
T Hahn MJ Buerger 1955 ZK 106 308-38 (H47);
ED of superstructure diffractions, **JDC McConnell** 1962 MM 33 114-24;
WA Dollase 1970 ZK 132 27-44 (D162);
N Foreman DR Peacor 1970 ZK 132 45-70;
different ordering in 5 specimens, **WA Dollase DR Peacor** 1971 CMP 30 129-34;
JM Parker JDC McConnell 1971 Nature Phys Sci 234 178-9;
NMR, **D Brinkmann S Ghose F Laves** 1972 ZK 135 208-18;
$NaAlSiO_4$, **M Ghélis M Gasperin** 1972 CRASP 275D 1583-4;
domain model, **JM Parker** 1972 ZK 136 255-72;
WB Simmons Jr DR Peacor 1972 AM 57 1711-9;
P-induced transition, **LH Cohen W Klement Jr** 1976 MM 40 487-92;
CMB Henderson J Roux 1977 CMP 61 279-98 (H595);
crystal chemistry Si-rich, low-alkali, **WA Dollase WM Thomas** 1978 CMP 66 311-8;
time-T relation of satellite diffractions, **JDC McConnell** 1981 AM 66 990-6;
NMR of defects & short-range order, **JF Stebbins & 3 others** 1986 PCM 13 371-81;
water content, SC-IR spectroscopy, **A Beran GR Rossman** 1989 MP 40 235-40;
transformation to *carnegieite*, **H Schneider OW Flörke R Stoeck** 1994 ZK 209 113-7;
variable water content, polarized FTIR, **G Balassone A Beran** 1995 MP 52 75-83;
SC-XRD, **KT Tait & 3 others** 2003 CM 41 61-70;
satellite diffractions, SC-XRD/TEM/thermal, **I Hassan SM Antao AAM Hersi** 2003 CM 41 759-83.

Ion migration, dielectric spectroscopy: **A Jones & 3 others** 2001 PCM 28 28-34 (1406).

Thermodynamics, excess Si in *kalsilite*- series: **GL Hovis J Roux** 1999 EJM 11 815-27 (H1445).

High-P to *jadeite* & alpha-$NaAlO_2$ type, & $CaFe_2O_4$ type: **L Liu** 1977 GRL 4 183-6 (L448);
do 1978 EPSL 37 438-44 (L892).

Fibrous, *pectolite* & *plagioclase*, Baffin Island: **DD Hogarth & 3 others** 2001 EJM 13 51-6 (1683).

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

Synthetic Ge-: MM 32 958.

Synthetic solid solutions in $Ca_3Al_6Si_2O_{16}$-$NaAlSiO_4$ & $Ca_3Al_6Si_2O_{16}$ -$KAlSiO_4$: **T Yoshioka** 1970 J Mineral Soc Japan 10 10-31 = MA 77-365.

Synthetic trinepheline: **WL Brown F Cesbron G Dupont** 1972 ZK 136 468-70;
M Ghélis M Gasperin 1972 CRASP 275 D 1583-4 = MA 73-2392.

Synthetic sub-potassic: **CMB Henderson J Roux** 1977 CMP 61 279-98;

low-T inversion, **CMB Henderson AB Thompson** 1980 AM 65 970-80.
Synthetic (Sr/Ba)Al_2O-4: **CMB Henderson D Taylor** 1982 MM 45 111-27.
Synthetic $K_{0.5}Na_{0.5}Na_3Al_4Si_4O_{16}$: **M Gregorkiewitz** 1984 BM 107 499-507.
Synthetic $Na_{2-x}Na_6Al_{8-x}Si_{8+x}O_{32}$, x = 0.8, 1.7: **B Hippler H Böhm** 1989 ZK 187 39-53.
Synthetic ~Ca_1void$_1Na_6Al_8Si_8O_{32}$: **G Rossi R Oberti DC Smith** 1989 EJM 1 59-70 (R407).
Ion-exchange -kalsilite with molten (Li/Na/K/Ag)(NO_3/Cl): **I Gregorkiewitz M Gregorkiewitz** 1993 PCM 20 433-41.
Synthesis ceramic from LTA zeolite, microwave heating: **T Ohgushi & 3 others** 2001 JACeS 84 321-7 (1254).
Heat capacity & entropy: **D de Ligny & 3 others** 2002 PCM 29 267-72 (7758).
-kalsilite series, thermal expansion: **GL Hovis & 6 others** 2003 MM 67 535-46.

nepouite $Ni_3Si_2O_5(OH)_4$. *Kaolinite-serpentine* group. Dimorphic with *pecoraite*.
Structure: **GW Brindley H-M Wan** 1975 AM M60 863-71.
Occurrence: **Y Song H-S Moon H-T Chon** 1995 CIM 30 211-24.

nepskoite $Mg_4Cl(OH)_7$.6aq.
XRPD similar to *korshunovskite* & *synthetics*.
Occurrence & XRD: **VN Apollonov** 1998 ZVMO 127 41-6 (A899).

neptunite $KNa_2Li(Fe,Mn)_2Ti_2Si_8O_{24}$. Series with *mangan-neptunite*.
Isostructural with *watatsumiite* $KNa_2LiMn_2V_2Si_8O_{24}$.
Edge-sharing octahedral chains vertex-connected to silicate framework.
Structure: **E Cannillo F Mazzi G Rossi** 1966 AC 21 200-8 (C652);
SV Borisov & 3 others 1966 SPC 10 684-9 (B1128);
M Kunz & 6 others 1991 PCM 18 199-213;
site occupancy & electrical field gradient, Mössbauer/XRPD, **W Lottermoser & 4 others** 1997 PCM 24 2-6.

neskevaaraite-Fe $K_3NaFe(Ti,Nb)_4Si_8O_{24}.(O,OH)_4$.6aq. *Labuntsovite* group.
Occurrence: Russia, **NV Chukanov & 7 others** 2003 New Data on Minerals 38 9-14 = CM 42 1249.

nesquehonite $Mg(HCO_3)OH$.2aq. *Lansfordite* mineral group of hydrated Mg carbonates.
Structure: **GW Stephan CH McGillavry** 1972 AC B28 1031-3 (S1409).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

neustädtelite ~$Bi_2Fe(Fe,Co)(OH)_{2.5}O_{1.5}(AsO_4)_2$.
Isostructural with *medenbachite & cobaltneustädtelite*.
Occurrence & SC-XRD structure: **W Krause H Bernhardt C McCammon H Effenberger** 2002 AM 87 726-38.

nevadaite $(Cu,void,Al,V)_3[Al_4(PO_4)_4F_4](OH).11aq$.
Occurrence & SC-XRD structure: **MA Cooper & 6 others** 2004 CM 42 741-52.

nevskite **~**Bi(Se,S). *Tetradymite* mineral/structure group, *tsumoite* subgroup.
Structure: **P Bayliss** 1991 AM 76 257-65.
Occurrence: MM 50 754.
Occurrence, Erzegebirge: **H Förster & 2 others** 2005 CM 43 899-908 = AM 91 224.

newberyite $MgH(PO_4)$.3aq.
Structure: **DJ Sutor** 1967 AC 23 418-22;
F Abbona R Boistelle R Haser 1979 AC B25 2514-8;
H Bartl M & 3 others 1983 TMPM 32 187-94 (B1336).
Synthetic $CaHAsO_4$.3aq: **M Catti G Ferraris** 1973 AC B29 90-6.
Synthetic $MnPO_3(OH)$.3aq: **Y Cudennec A Riou Y Gerault** 1989 AC C45 1411-2 (C771).

neyite $Ag_2Cu_6Pb_{25}Bi_{26}S_{68}$.
Structure: SC-XRD, **E Makovicky T Balic-Zunic D Topa** 2001 CM 39 1365-76.
Occurrence: **AD Drummond & 3 others** 1969 CM 10 90-6.

nezilovite $PbZn_2(Mn^{4+},Ti)_2Fe_8O_{19}$. *Magnetoplumbite* structure group.
Structure & occurrence: **V Bermanec & 5 others** 1996 CM 34 1297-97.

niahite NH_4MnPO_4.aq.
Related to fragments of *triphylite* structure: **PB Moore** 1970 AM 55 135-69;
OV Yakubovich MA Simonov NV Belov 1977 DAN 235 93-5.
Structure: related to Mg-analog in **AW Frazier JP Smith JR Lehr** 1966 JAFC14 522-9;
XRPD matches PDF 3-0027 for Mn compound & PDF 20-663 for Mg compound;
matches Fe analog listed below.

XRPD: *synthetic*, **A Gomez & 3 others** 1997 PD 12 20-1 (G1178).
Occurrence: **ME Mrose** 1971 US Geol Surv Prof Paper 750-A 115;
PJ Bridge BW Robinson 1983 MM 47 79-80.
Synthetic NH_4MgPO_4HF: **J Ando T Akiyama M Morita** 1968 Bull Chem Soc Japan 41 1716-23.
Synthetic $NH_4(Cd/Co/Fe/Mg/Mn/Ni)PO_4.aq$: **A Durif M Averbuch-Pouchot** 1968 BSFMC 91 495-6.
Synthetic $NH_4CoPO_4.aq$, structure: **D Tranqui A Durif J Guitel et al** 1968 BSFMC 91 10-2;
OV Yakubovich & 3 others 1999 AC C55 151-3.
Synthetic NH_4FePO_4HF: **OV Yakubovich & 3 others** 1995 Phys-Dokl 40 221-5 (Y163).

NICCOLITE/NICKELINE STRUCTURE GROUP Includes:

achavalite	FeSe	
breithauptite	NiSb	
freboldite	CoSe	
[*imgreite*	NiTe	rejected]
jaipurite	$Co_{1-x}S$	
[kaneite	MnAs	dubious species: **Dana** I 208]
kotulskite	Pd(Te,Bi)	
langisite	(Co,Ni)As	
modderite	CoAs	distorted
niccolite / nickeline	NiAs	
niggliite	PtSn	
[platstibite	PtSb	unnamed mineral: **EF Stumpfl** 1961 MM 32 833-47.]
sederholmite	NiSe-beta	
sobolevskite	PdBi	
sorosite	Cu(Sn,Sb)	
stumpflite	Pt(Sb,Bi)	
sudburyite	PdSb	
troilite	FeS-delta	
yuanjiangite	AuSn	
unnamed	$CuNiSb_2$	

The alloy literature contains many materials with niccolite parent structure, or a derivative thereof including complex superstructures: see *mertieite*, etc.
Compounds with the niccolite structure: **Wells** Table 29.12.
Superstructures in intermetallic NiAs-Ni_2In-type phases: **S Lidin A-K Larsson** 1995 JSSC 118 313-22 (L693).
Synthetic PdTe: **ML Gimpl CE Nelson N Fuschillo** 1963 AM 48 689-91.
Synthetic FeO & FeS at high-P & -T: **Y Fei** 1994 Eos 75(44) 606.
Synthetic nu-prime Cu_6Sn_5: **A-K Larsson L Stenberg S Lidin** 1994 AC B50 636-43.
Synthetic MgTe at 4GPa in diamond cell: **T Li & 5 others** 1995 PRL 74 5232-4.
niccolite / nickeline NiAs. Niccolite structure group.
Structure: **G Aminoff** 1923 ZK 58 204.
XPS & reaction with air & water: **HW Nesbitt M Reinke** 1999 AM 84 639-49.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
nichromite $(Ni,Co,Fe)(Cr,Fe,Al)_2O_4$. *Spinel* structure group.
Occurrence: **SA DeWaal** 1978 Bull Bur Rech Geol Minieres II Geol Gites Mineraux 225-30 = AM 65 811.
nickel Ni. Face-centered cubic closest packing of spheres. *Copper* structure group.
Structure*: synthetic*, NPD, **KJ Tilli A Tiitta H Pöyry** 1980 AC A36 252-9.
Occurrence: in *heazlewoodite*, MM 36 1155;
in carbonado**, AN Gorshkov & 5 others** 1996 GI 33 59-63 (G850);
Pipe DO-27, Slave Craton, Canada, many inclusions including *sanidine, ferropericlase, nickel* & interpreted Mg-*perovskite*: **RM Davies & 5 others** 1999 Proc VII Int Kimberlite Conf 148-55.
Substitution of K at high pressure: **LJ Parker T Atou JV Badding** 1996 S 273 95-7 (P626).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
nickelalumite $NiAl_4(SO_4)(OH)_{12}.3aq$.

Essentially isostructural with *chalcoalumite* $CuAl_4(SO_4)(OH)_{12}.6aq$ & *mbobomkulite* $(Ni,Cu)Al_4[(NO_3)_{1.5}(SO_4)_{0.25}](OH)_{12}.3aq$; and *alvanite* $(Zn,Ni)Al_4(VO_3)_2(OH)_{12}.2aq$ & *ankinovichite* $(Ni,Zn)Al_4(VO_3)_2(OH)_{12}.2aq$.

Structure: SC-XRD, **YA Uvarova & 5 others** 2005 CM 43 1511-9..
Occurrence: **JEJ Martini** 1980 Annals Geol Survey S Africa 14 1-110 = AM 67 415-6.

nickel austinite $Ca(Ni,Zn)AsO_4OH$.

Conichalcite/descloizite structure type. *Adelite* mineral group.
Occurrence: **FP Cesbron & 4 others** 1987 CM 25 401-7.

nickelbischofite $NiCl_2.6aq$.

Should be isostructural with Co analog *albrittonite* & Mg analog *bischofite*.
Occurrence: **WW Crook III JL Jambor** 1979 CM 17 107-9.

nickelbloedite / nickelblödite $Na_2(Ni,Mg)(SO_4)_2.4aq$.

Isostructural with Mg analog *bloedite* from XRPD.
Matches synthetic Ni endmember. Review: **Sabelli** p. 12.
Occurrence & crystallography: **EH Nickel PJ Bridge** 1977 MM 41 37-41.

nickel-boussingaultite / nickelboussingaultite $(NH_4)_2(Ni,Mg)(SO_4)_2.6aq$.

Picromerite structure group. Review: Sabelli p. 31.
Structure: **NW Grimes HF Kay MW Webb** 1963 AC 16 823-**?**;
H Montgomery EC Lingenfelter 1964 AC 17 1478-81.
Occurrence: MM 46 523.

nickel-hexahydrite $NiSO_4.6aq$. *Hexahydrite* structure type.

Monoclinic dimorph of tetragonal *retgersite*.
Review: **Sabelli** p 9.
Structure: **DJ Sutor A Kotoglu** 1973 ZK 137 51-66;
deuterated, **H Ptasiewicz-Bak GJ McIntyre I Olovsson** 1983 AC C39 966-8;
RE Gerkin WJ Reppart 1988 AC C44 1486-8;
synthetic, **RJ Angel LW Finger** 1988 AC C44 1869-73 (A618).

nickeline / niccolite NiAs. Niccolite structure group. See above.

nickellotharmeyerite $Ca(Ni,Fe)_2(AsO_4)_2.(aq/OH)_2$. *Tsumcorite* group.

Occurrence & structure: **W Krause H Bernhardt H Effenberger M Martin** 2001 NJMM 558-76.

nickelphosphide $(Ni,Fe)_3P$. Analog of *schreibersite*.

Structure: synthetic, XRPD profile, **R Skála M Drábek** 2002 PD 17 322-5, 2003 67 783-92.
Occurrence in meteorites: & XRPD, **SN Britvin et al** 1999 ZVMO 64-6 (B2021)
Butler, **R Skála M Drábek** 2003 67 783-92.

nickelschneebergite $BiNi_2(AsO_4)_2OH.aq$. *Tsumcorite* group.

Occurrence & structure: **W Krause & 3 others** 2002 EJM 14 115-26.

nickel-skutterudite $(Ni,Co)As_{2-3}$.

Isostructural with Co analog *skutterudite* from crystallography.
Structure determination not found.
Occurrence: **Dana** I 342-6.

nickel-zippeite $Ni_2(UO_2)_6(SO_4)_3(OH)_{10}.16aq$.

Zippeite structure group from crystallography.
Review: **Sabelli**, no structure.
Occurrence: **C Frondel et al** 1976 CM 14 429-36.

nickenichite $Na_{0.8}Ca_{0.4}Cu_{0.4}(Mg,Fe,Al)_3(AsO_4)_3$. Related to *johillerite* & *o'danielite*.

Structure: **M Auernhammer & 4 others** 1993 MP 48 153-66 (A553).

niedermayrite $Cu_4Cd(SO_4)_2(OH)_6.4aq$. Closely related to *christelite* and *campigliaite*.

Occurrence & structure: **G Giester B Rieck F Brandstätter** 1998 MP 63 19-34 (G1122).

nierite Si_3N_4-alpha. Trigonal polymorph.

Mineralogy, SAED: **MR Lee & 3 others** 1995 M 30 387-98 = AM 81 251.
The hexagonal beta polymorph was also found but not given mineral name.
Structure: **D Hardie KH Jack** 1957 N 180 332-3;
SN Ruddlesden P Popper 1958 AC 11 465-8;

PR Marchand Y Laurent J Lang 1969 AC B25 2157-60;
I Kohatsu JW McCauley 1974 MRB 9 917-20;
beta, **R Grun** 1979 AC B35 800-4.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
nifontovite $Ca_3B_6O_6(OH)_{12}.2aq$. Neso-triborate, analogous to *olshanskyite*.
Structure: **YuK Egorov-Tismenko MA Simonov NV Belov** 1973 DAN 210 140-3 (Y133);
MA Simonov & 4 others 1978 SPD 23 159-61.
Occurrence: MM 32 990.
Occurrence: Japan, & XRPD, **I Kusachi C Henmi** 1994 MM 58 279-84;
Mexico, **FC Hawthorne & 2 others** 2005 MR 36 375-6.
nigerite group See *högbomite* group.
Lithium vs polysomatism: **T Armbruster A Feenstra** 2004 EJM 16 247-54 (10319).
niggliite PtSn. *Niccolite* structure group.
Occurrence: AM 56 360;
new data & XRPD of *synthetic*, **LJ Cabri DC Harris** 1972 MM 38 794-800.
[jvs: earlier literature is confusing because of original assignment of Pt telluride, now assigned to *kotulskite*; I did not come across a clear description of the reassignment. MM 24 619.]
niigataite $CaSrAl_3(Si_2O_7(SiO_4O(OH)$. Epidote group.
Occurrence & SC-XRD structure: **H Miyajima & 3 others** 2003 Mineral Petrol Sci 98 118-29.
nikischerite $NaFe_6Al_3(SO_4)_2(OH)_{18}.12aq$. Analog of Mg *motokureaite* & Mn *shigaite.*
Structure: **DMC Huminicki FC Hawthorne** 2003 CM 41 79-82.
Occurrence & XRPD: **DMC Huminicki & 4 others** 2003 MR 155-8.
niksergievite $[Ba_{1.33}Ca_{0.67}Al(CO_3)(OH)_4][Al_2(AlSi_3O_{10})(OH)_2].naq.$
Phyllosilicate related to *surite-ferrisurite*.
Occurrence & XRPD: **SP Saburov & 6 others** 2005 AM 90 2263-6.
nimesite Ni analog of *amesite* $Mg_2Al(Si,Al)O_5(OH)_4$.
Occurrence: MM 39 922.
nimite $(Ni,Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$. *Chlorite* structure group.
Structure determination not found.
Occurrence: MM 37 961; **SA de Waal** 1970 AM 55 18-30.
ningyoite $(U,Ca,Ce)(PO_4)$~1aq. Series with *brockite*.
Rhabdophane structure group from XRPD of ningyoite & *synthetic* $CaU(PO_4)_2.1.5aq$.
Structure determination not found.
Occurrence, etc: **T Muto & 3 others** 1959 AM 44 633-50; MA 96M/2140.
Review: (different formula) **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
niningerite (Mg,Fe,Mn)S. *Galena/halite* structure group.
Electronic structure in Fe-substituted, sulfur XANES: **SP Farrell & 5 others** 2002 AM 87 1321-32.
Occurrence: ER Dufresne E Anders 1962 GCA 26 251-62;
K Keil KG Snetsinger 1967 S 155 541-543;
in meteorites, **AE Rubin** 1997 MPS 32 231-47.
niobium Nb.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
niobo-aeschynite-Ce / nioboaeschynite $(Ce,Ca,Th)(Nb,Ti)_2(O,OH)_6$.
Aeschynite structure group.
Structure determination not found.
Occurrence: **AG Zhabin GN Mukhitdinov ME Kazakova** 1960 AM 47 417.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
niobo-aeschynite-Nd $(Nd,Ce)(Nb,Ti)_2(O,OH)_6$.
Aeschynite structure group.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
niobokupletskite $K_2Na(Mn,Zn,Fe)_7(Nb,Zr,Ti)_2Si_8O_{26}OH)_4(O,F)$.
Astrophyllite structure group.
Description & SC-XRD structure: **PC Piilonen & 3 others** 2000 CM 38 627-39.
niobophyllite $K_2Na(Fe,Mn)_7(Nb,Ti)_2Si_8O_{26}(OH)_4(F,O)$.

Astrophyllite structure group.
Structure determination not found.
Occurrence: **EH Nickel JF Rowland DJ Charette** 1964 CM 8 40-52.

niocalite $Ca_7Nb(Si_2O_7)_2O_3F$. *Wöhlerite/låvenite* supergroup; *låvenite* structure group.
Isostructural with *cuspidine* & *låvenite*; topologically distinct from *wöhlerite*.
Probably ordered, but intimate twinning indicates some Ca,Nb disorder.
Structure: **T Li Vl Simonov NV Belov** 1966 SPD 11 197-9 (T399);
M Mellini 1982 TMPM 30 249-66 (M124).
Occurrence: MM 31 968;
J Keller CT Williams U Koberski 1995 MM 59 561-5;
-cuspidine s s, Oldoniyo Lengai, Tanzania, **RH Mitchell F Belton** 2004 MM 68 787-99..

niobocarbide NbC. Isostructural with *tantalcarbide*.
Occurrence: **MI Novgorodova ME Generalov NV Trubkin** 1997 ZVMO 126 76-80 (N481).

nisbite $NiSb_2$. *Löllingite* structure subgroup in *marcasite* supergroup.
Synthetic: **A Kjekshus T Rakke AF Andresen** 1974 ACSc A28 996-1000 (K726).
Occurrence: MM 38 996.

nissonite $Cu_2Mg_2(PO_4)_2\ (OH)_2.5aq$. Review: (E289).
Structure: **LA Groat FC Hawthorne** 1990 AM 75 1170-5.
Occurrence: MM 36 1155.

niter / nitre /nitrokalite KNO_3-alpha. *Aragonite* structure group.
Transforms to rhombohedral beta- at ~397K & on cooling to gamma at ~391K.
Structure: high-P, **TFW Barth** 1939 ZPC B43 448-50;
alpha-, **JK Nommo BW Lucas** 1973 J Phys C 6 201-11 = MA 77-4060;
K-NH_4 solid solution, **JR Holden CW Dickinson** 1975 JPC 79 249-56;
beta- & gamma-, **JK Nimmo BW Lucas** 1976 AC B32 1968-71;
phase transition, XRPD, **AN Christensen & 3 others** 1996 JACr 29 265-9 (C844).

nitrammite / nitramite NH_4NO_3-phase IV. Stable from 255 to 305K.
Structure: **SB Hendricks E Posnjak FC Kracek** 1932 JAChS 54 2766-**?**;
JL Amoros F Arrese M Canut 1962 ZK 117 92-107;
ND, **CS Choi JE Mapes E Prince** 1972 AC B28 1357-61.

[nitratite $NaNO_3$. See *nitronatrite*.]

nitrobarite $Ba(NO_3)_2$.
Synthetic, SC-ND: **H Nowotny G Heger** 1983 AC C39 952-6 (N369). Ignore earlier papers.
Isostructural with Pb, Sr & Ca cubic nitrates.

nitrocalcite $Ca(NO_3)_2.4aq$-alpha. *Calcite* structure group. Alpha/beta transition.
Structure: **A Leclaire J Monier** 1970 CRASP 271 C 1555-7 = MA 74-943;
B Ribar & 3 others 1973 AC B29 1546-8;
oriented transition, **A Leclaire JC Monier** 1977 AC A33 717-22;
alpha-, **do** 1977 AC B33 1861-6.

nitromagnesite $Mg(NO_3)_2.6aq$-alpha (low-temperature).
Structure: **A Braibanti & 3 others** 1969 AC B25 354- 61 (B1309);
ND 173 K, **J Schefer M Grube** 1995 MRB 30 1235-41 (S1515).

nitronatrite $NaNO_3$. *Calcite* structure type.
Structure: **RWG Wyckoff** 1920 PR 16 149-57;
RL Sass R Vidale F Donohue 1957 AC 10 567-70;
GL Paul AW Pryor 1972 AC B28 2700-2;
S Göttlicher CD Knöckel 1978 ZK 148 101-5 (G779); **do** 1980 AC B36 1271-7;
ordering transition at ~552 K, **WW Schmahl E Salje** 1989 PCM 16 790-8;
simulation of transition, **J Liu & 5 others** 2001 MMM 28 586-90 (3646).
Occurrence in fertilizers: **JR Lehr & 4 others** 1966 *Crystallographic Properties of Fertilizer Compounds*, Tenn Valley Auth Chem Eng Bull 6, 163p (L758).

nobleite $CaB_6O_9(OH)_2.3aq$. Isostructural with Sr analog *tunellite*. Matches *synthetic*.
Structure: SC-XRD, **L Karanović A Rosić D Poleti** 2004 EJM 16 825-33 (10838).
Occurrence: **RC Erd JF McAllister AC Vlisidis** 1961 AM 46 560-71;

KA Rodgers & 4 others 2002 MM 66 235-52.

noélbensonite ~$BaMn^{3+}_2Si_2O_7(OH)_2$.aq.

Lawsonite structure type from crystallography & XRPD.
Occurrence: **Y Kawachi DS Coombs H Miura** 1996 MM 60 369-74.
Ca-bearing: Woods Mine, NSW Australia, **DS Coombs & 3 others** 2004 EJM 16 185-9 (10141).

nolanite $(V,Fe^{2+},Fe^{3+},Ti)_5O_7OH$. Isostructural with *rinmanite* $ZnSbMgFe_2O_7(OH)$.

Structure: **AW Hanson** 1958 AC 11 703-9;
BM Gatehouse IE Grey EH Nickel 1983 AM 68 833-9.
Occurrence: MM 31 968-9.

nontronite $Na_{0.33}Fe_2(Si,Al)_4O_{10}(OH)_2$.n aq. *Smectite* structure group.

Structure: **LG Dainyak AS Bukin VA Drits** 1984 SPC 29 181-5.
Fe site occupancy, IR, XAS & XRD: **WP Gates & 3 others** 2002 ClClM 50 223-9 (7142).
K-exchanged: Mössbauer, **J Besson & 7 others** 1981 MZh 3 66-77 = MA 83M/0161.
Na-nontronite gel, Fe redox vs texture & structural order: **JW Stucki D Tessier** 1991 ClClM 39 137-43 (S1831).
Oxidation-reduction of Fe, polarized EXAFS: **A Manceau et al** 2000 AM 85 133-52; 153-72.
Oxidation state of Fe vs IR: **C Fialips & 4 others** 2002 AM 87 630-41.
Dissolution, AFM: **BR Bickmore & 4 others** 2001 AM 86 411-23.
Microbial polysaccharides, role in growth: **M Ueshima K Tazaki** 2001 ClClM 49 292-9 (2943).
Oxidative dissolution of *pyrite*, Spain: **JC Fernnadez-Caliani & 4 others** 2004 ClClM 52 106-14 (10082).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

noonkanbahite ~$KNaBaTi_2Si_4O_{14}$.

Compositional & probably structural relation to *batisite* & *shcherbakovite*.
Occurrence & crystallography: **RT Prider** 1965 MM 34 403-5.

norbergite $Mg_3SiO_4(F,OH)_2$. *Humite* structure group.

Structure: **GV Gibbs PH Ribbe** 1969 AM 54 376-90;
location of H, **F Cámara** 1997 CM 35 1523-30.
Occurrence: MM 21 572.
Synthetic F-: MM 28 730.
Synthetic Fe_3BO_6: **R Diehl G Brandt** 1975 AC B31 1662-5.

nordenskiöldine $CaSnB_2O_6$. *Dolomite* structure type.

Structure: **S Aleonard J Vicat** 1966 BSFMC 89 271-2;
H Effenberger J Zemann 1986 NJMM 111-4 (E302);
IR, **D Li M Peng GM Bancroft** 1994 CM 32 81-6.

NORDITE STRUCTURE GROUP includes

ferronordite-Ce	$(Ce,La)Na_3SrFeSi_6O_{17}$
manganonordite-Ce	$(Ce,La)Na_3SrFeSi_6O_{17}$
nordite-Ce	$(Ce,La)(Sr,Ca)Na_2(Na,Mn)(Zn,Mg)Si_6O_{17}$
nordite-La	$(La,Ce)(Sr,Ca)Na_2(Na,Mn)(Zn,Mg)Si_6O_{17}$

nordite-Ce $(Ce,La)(Sr,Ca)Na_2(Na,Mn)(Zn,Mg)Si_6O_{17}$.

Structure: **LP Solov'yeva SV Borisov NV Belov** 1969 DAN 183 136-9 = MA 71-2675;
VV Bakakin & 3 others 1970 AM 55 1167-81.
Occurrence: MM 26 340.
Review: (different formula) **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.

nordite-La $(La,Ce)(Sr,Ca)Na_2(Na,Mn)(Zn,Mg)Si_6O_{17}$.

Structure: **EV Sokolova & 3 others** 1992 Vest Mosk Univ Ser 4 Geologiya 2 97-102.
Review: (different formula) **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.

nordstrandite $Al(OH)_3$. Polymorphic with *bayerite*, *doyleite* & *gibbsite*.

Structure: **H Saalfeld O Jarchow** 1968 NJMA 109 185-91;
HJ Bosmans 1970 AC B26 649-52.
Occurrence: MM 33 1145.
Synthesis: **RA Van Nordstrand WP Hettinger CD Keith** 1956 N 177 713-4.

Cation array in Al oxides/hydroxides/oxyhydroxides: **A Ramos-Gallardo A Vegas** 1996 ZK 211 299-303 (R665).
Occurrence: hyperagpaitic alkaline rocks: **Khomyakov** 1995;
bauxite, **N Dani & 3 others** 2001 ClClM 49 216-26.

nordströmite $CuPb_3Bi_7(S,Se)_{14}$. Compare with *junoite*.

Structure: **WG Mumme** 1980 CM 18 343-52 (M1218).
Occurrence: MM 46 523.

normandite $Na_{1.1}Ca_{1.0}(Mn_{1.5}Fe_{0.3})(Ti_{0.8}Nb_{0.1}Zr_{0.1})Si_2O_8F_1$.
Wöhlerite/låvenite structure supergroup. CTF net 1083.
Structure: **N Perchiazzi & 4 others** 2000 CM 38 641-8.
Occurrence & XRD: **GY Chao RA Gault** 1997 CM 35 1035-9;
YuP Men'shikov et al 1998 ZVMO 86-91 (M1794);
& SC-XRD structure, **E Gnos T Armbruster IG Villa** 2003 AM 88 289-94.

norrishite $KLiMn_2Si_4O_{12}$. *Mica* structure group.

Structure: **PL Tyrna S Guggenheim** 1991 AM 76 266-71.
Occurrence: **RA Eggleton PM Ashley** 1989 AM 74 1360-7.

norsethite $BaMg(CO_3)_2$. *Dolomite* structure group.

Structure: **F Lippmann** 1968 TMPM 12 299-318;
H Effenberger J Zemann 1985 ZK 171 275-80;
FTIR, **ME Böttcher & 3 others** 1997 MM 61 249-56.
Crystal chemistry: **L Secco B Lavina** 1999 NJMM 87-96 (S2033).

northupite $Na_3Mg(CO_3)_2Cl$. *Tychite* structure group.

Northupite has the same general structure as the tychite members, but with subtle differences between the carbonate & chloride.
Structure: **A Dal Negro G Giuseppetti C Tadini** 1975 TMPM 22 158-63 (D247).
Occurrence: MM 32 973.

nosean $Na_8Al_6Si_6O_{24}SO_4$. *Sodalite* structure type.

Structure: **H Saalfeld** 1959 NJMM 38-46 (S165);
H Schulz H Saalfeld 1965 TMPM 10 225-32 (S168);
H Schulz 1970 ZK 131 114-38 (S407) = MA 70-3014;
I Hassan PR Buseck 1989 AM 74 394-410;
I Hassan JD Grundy 1989 CM 27 165-72.
Hydrothermal stability: **AR Kotel'nikov & 4 others** 2004 GI 42 867-9 (10734).
Synthetic carbonate-clathrated, XRPD structure: **TM Gesing J Buhl** 1998 EJM 10 71-7 (G1004).
Chromate-, brilliant yellow pigment: **F Hund & 3 others** 2002 ZaaC 628 1457-8 (7518).

novacekite $Mg(UO_2)_2(AsO_4)_2.12aq$. *Autunite* structure group.

Isostructural with P analog *saléeite* from crystallography.
Structure determination not found.
Occurrence: MM 29 991;
C Frondel 1958 USGS Bull 1064 177-83;
TW Stern CS Annell 1954 AM 39 675-6;
NJ Elton JJ Hooper AE Jeal 1994 MM 58 513-4.

novakite $(Cu,Ag)_4As_3$.

Structure determination not found.
Occurrence: **Z Johan J Kak** 1961 AM 46 885-91.

novgorodovaite $Ca_2C_2O_4Cl_2.2aq$.

Structure: **RK Rastsvetaeva NV Chukanov YuV Nekrasov** 2001 DAN 381 353-5.
Occurrence: **NV Chukanov & 4 others** 2001 ZVMO 4 32-5.

NOWACKIITE STRUCTURE GROUP Includes:

aktashite	$Cu_6Hg_3As_4S_{12}$
gruzdevite	$Cu_6Hg_3Sb_4S_{12}$
nowackiite	$Cu_6Zn_3As_4S_{12}$

nowackiite $Cu_6Zn_3As_4S_{12}$. Nowackiite structure group.

Structure: **F Marumo** 1967 ZK 124 352-68 (M195);

W Nowacki 1982 SPC 27 26-7 (M349).
Occurrence: MM 35 1148.

nsutite $Mn^{2+}_{x}Mn^{4+}_{1-x}O_{2-2x}(OH)_{2x}$.

Matches *synthetic* gamma-MnO_2 type, which covers a range of materials with different Mn redox state, but with a common XRPD pattern.
[jvs: caution, because early crystallographic data are uncertain & are omitted.]
XRPD & fiber XRD of 2 nsutites & heated material: **GM Faulring** 1965 AM 50 170-9.
Occurrence & relation to manganoan nsutite: **WK Zwicker & 2 others** 1962 AM 47 246-66.

nuffieldite $Pb_2Cu(Pb,Bi)Bi_2S_7$.

Structure: **I Kohatsu BJ Wuensch** 1973 ZK 138 343-65 (K706);
Sb-bearing, **Y Moëlo A Meerschaut E Makovicky** 1997 CM 35 1497-508.
Occurrence: MM 37 961-2.

nukundamite $(Cu_{0.85}Fe_{0.15})S$. Sulfur doublets in hexagonal structure.

Compare with *idaite* with which it was not clearly distinguished [jvs: needs further study].
Structure: *synthetic*, **A Sugaki & 3 others** 1981 AM 66 398-402.
Corrected Gibbs free energy: CM 39 1635-40.
Occurrence: MM 43 1064.
Occurrence: in Romanian iron ore, **M Lupulescu** 1993 Analele Universitatii Bucuresti Geol 42 13-9 = MA 95M/3333;
Bingham, Utah, **EE Inan MT Einaudi** 2002 EG 97 499-515 (7679).

nullaginite $Ni_2CO_3(OH)_2$. *Rosasite* structure group.

Structure determination not found.
Occurrence & crystallography: **EH Nickel LG Berry** 1981 CM 19 315-24 (N361).

nyböite $NaNa_2Mg_3Al_2(Si_7Al)O_{22}(OH)_2$. *Amphibole* structure group.

Structure: **L Ungaretti DC Smith G Rossi** 1981 BM 104 400-12.
Occurrence: MM 46 523.

nyerereïte $(Na_{0.8}K_{0.2})_2Ca(CO_3)_2$.

Phase transitions from *low*- (orthorhombic) to *intermediate*- & *high*- (hexagonal).
Average structure: **D McKie EJ Francis** 1977 145 73-95 (M1242).
Occurrence: MM 35 1148.
Compare with *natrofairchildite*, essentially same, or possibly slightly different inversion product.
Compare with *fairchildite* $K_2Ca(CO_3)_2$ which probably matches *high-nyerereite.*
In meteorites: **AE Rubin** 1997 MPS 32 231-47.