

Mineral structures I-L

Updated to 091806 by jvs

ianthinite $[U^{4+}_2(VO_2)_4O_6(OH)_4aq].5aq$. Must distinguish carefully from *wyartite*.

Structure: **PC Burns & 4 others** 1997 J Nucl Mater 249 199-206.

Occurrence: MM 21 566;

C Guillemin J Protas 1959 BSFMC 82 80-6 (G737) = AM 44 1103-4.

ice H₂O. Twelve equilibrium polymorphs & several amorphous & metastable types.

Summary: **D Hall MK Wood** 1985 AC B41 169-72.

Two types of hydrogen bond: **J Li DK Ross** 1993 N 365 327-9 (L562).

Water-ice transition in restricted geometry, small-angle neutron scattering: **J Li DK Ross RK**

Heenan 1993 PR B 48 6716-9 (386).

High-resolution NMR: **DR Kinney I Chuang GE Maciel** 1993 JChS 115 6786-94 (387).

Critical nucleus size under alcohol, grazing incidence XRD: **J Majewski & 5 others** 1994 JPC 98 4087-93 (M1087).

Ice/snow accretion on structures: 9 papers in Phil Trans R Soc London A 358 2799-3033.

Nucleation of ice & management in ecosystems: **F Franks** 2003 Phil Trans R Soc London A 361 557-74.

Morphology of snow crystals: **A Janner** 2002 AC A58 334-45 (7660).

Classification using charge density: **S Jenkins I Morrison** 1999 JPCB 103 11041-9 (J362).

Recrystallization HAD to IV/V/VI/VII/XII 0.3-3.9 GPa, ND: **S Klotz & 4 others** 2003 ZK 218 117-22 (8981).

Ice-I. Proton-disordered *tridymite* structure type: **SW Peterson H Levy** 1957 AC 10 70-6;

PG Owston 1958 Adv Physics 7 171-88 = MA 14-176.

Ice Ih. At 120K: **CG van Beek** 1995 ACA Mtg Montreal p. 66.

Methane dihydrate clathrate with similar structure, 6 GPa, N&XR-PD structure:

JS Loveday & 4 others 2001 PRL 87 215501-4 (3639).

Ice-II. Proton-ordered *tridymite* structure type: **B Kamb** 1964 AC 17 1437-49;

B Kamb & 3 others 1971 JCP 55 1934-45 (K783).

Ice-III. *Keatite* structure type: **B Kamb SK Datta** 1960 N 187 140-1 (K15);

B Kamb A Prakash 1968 AC B24 1317;

at P, **C Lobban JL Finney WF Kuhs** 1996 AC A52 Suppl C-535.

Ice-IV. Structure: **H Engelhardt B Kamb** 1981 JCP 75 5887-99;

from high-density amorphous, **CG Salzmann & 4 others** JPCB 106 (7359).

Ice-V. Structure: **B Kamb A Prakash C Knobler** 1967 AC 22 706-15;

at P, **C Lobban JL Finney WF Kuhs** 1996 AC A52 Suppl C-535.

Ice-VI. Structure: interpenetrating *edingtonite* type: **B Kamb** 1965 S 150 205-9 (K784);

proton NMR of molecular rotation, **SP Garuda** 1996 AC A52 Suppl C-535;

possible inclusion in *diamond*, IR, **H Kagi & 5 others** 2000 MM 64 1089-97.

Ice-VII. Structure related to *VIII* by order-disorder antiferro-paraelectric transition:

B Kamb A Prakash 1968 PNAS 52 1433-9;

compression to 50 GPa, **L Liu** 1982 PRL 61 359-64;

thermal expansion, bulk modulus & melting <20 GPa, **Y Fei H Mao RJ Hemley** 1993 JCP 99 5369-73 (F565);

Raman & XRD, **E Wolanin & 6 others** 1996 AC A52 Suppl C-535;

neutron diffraction of VII & VIII, **JS Loveday & 5 others** 1996 AC A52 Suppl C-533;

compression to 210 GPa, IR evidence for symmetric H-bonding: **AF Goncharov & 4**

others 1996 S 273 218-20 (G866);

modulated phases & proton centering 170 GPa: **P Loubeyre & 4 others** 1999 N 397 503-6 (L973);

? present in cold subducting slabs: **CR Bina A Navrotsky** 2000 N 408 845-7 (652).

Ice VIII. Deuterated, high-P ND to 10 GPa: **RJ Nelmes & 7 others** 1993 PRL 71 1192-5;

XRD, **E Wolanin & 6 others** 1996 AC A52 Suppl C-535;

transition to high-density amorphous (*had*) then to *cubic Ic* & *hexagonal Ih*, also *ice-VI*,

ND: **AI Kolesnikov & 8 others** 1995 High Pressure Res 14 101-9 (K790).

Ice IX. Structure: **SJ Laplaca & 3 others** 1973 JCP 58 567-80 (L694);

SC-ND, transformed KOH-doped *Ih*, **SM Jackson & 4 others** 1997 JPCB 101 6142-5 (J278).

Ice XI. Structure: 1989 J Chem Phys 90 4450-3.
Ice XII. Occurs metastable in field of V.
Structure: **C Lobban JL Finney WF Kuhs** 1998 N 391 268-70 (L935);
topology, **M O'Keeffe** 1998 N 392 879 (O379);
formation under various conditions, **M Koza & 3 others** 1999 N 397 680-1 (K1138);
Raman, **C Salzmänn & 4 others** 2002 JPC B106 ?-? (4003).
Preparation & structures of H-ordered ice phases: **CG Salzmänn & 4 others** 2006 S 311 1758-61. [V to XIII
and XII to XIV.]
High-density amorphous ice & very-high-density amorphous ice, XRD & Raman: **T Loerting & 4
others** 2001 PCCP 3 5355-7 (4308).
Ammonia-IV, D₂S & methane ices, ND: **JS Loveday & 5 others** 1996 AC A52 Suppl C-533.
ND & inelastic scattering of various types at T & P, including "defective ice VI": **AI Kolesnikov &
5 others** 1997 JPC B 101 6082-6 (K939).
Kinetics of HCl uptake, 190 & 203 K: **T Huthwelker & 4 others** 2004 JPC 108 6302-18 (10505).
WW Dickinson MR Rosen 2003 *Antarctic permafrost: An analogue for water and diagenetic minerals on Mars*, GSAB 31
199-202 (87290).
DT Vaniman & 5 others 2004 *Magnesium sulphate salts and the history of water on Mars*, N 431 663-5 (10720).
JC Comiso CL Parkinson 2004 *Satellite-observed changes in the Arctic*, PT Aug 38-44 (10507).
L Kalesche & 10 others 2004 *Frost flowers on sea ice as a source of sea salt and their influence on tropospheric
halogen chemistry*, GRL 31 L16114 (10754).
WA Cassidy 2003 *Meteorites, Ice, and Antarctica*, Cambridge Univ Press.
DC Jewitt J Luu 2004 *Crystalline water ice on the Kuiper belt object (50000) Quaoar*, N 432 731-3 (10906).
B Hanson ed 2005 *First of many returns*, S 308 968-95. [Titan.]
JD Anderson & 11 others 2005 *Amalthea's density is less than that of water*, S 308 1291-3 (11041). [5th
satellite of Jupiter probably has porous ice.]
M Gosnell 2005 *Ice. The Nature, the History, and the Uses of an Astonishing Substance*, Knopf.
J Baker et al 2006 *Cassini at Enceladus*, S 311 1388-14 428. [Papers on ice properties on Saturn satellite.]
HY McSween Jr ed 2006 *Water on Mars*, Elements 2(3)135-73 [6 articles.]
Science 2006 311 3/24/ issue has articles on ice.
idaite Cu₅FeS₆ or Cu₃FeS₄ Listed in *covellite* group in **Povarennykh**.
See *nukunbamite* for paper questioning validity of *idaite*.
Cell data of *synthetic*: Cu_{5.5}FeS_{6.5}, **RA Yund** 1963 AM 48 672-6;
polemic, **G Frenzel** 1963 AM 48 676-8.
Occurrence: MM 32 962.
See **Wells** p. 908.
Possible analog in Chile, Cu₃ZnS₄: **AH Clark RH Sillitoe** 1970 AM 55 1021-5.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
[idrialite ~C₂₂H₁₄.
Complex mixture of polycyclic aromatic hydrocarbons: **M Blumer** 1975 ChG 16 245-56;
H Strunz B Contag 1965 NJMM 1 19-25.
Different compounds occur in *curtisite* & *pendletonite*.]
[igumnovite Ca₃Al₂[SiO₄]₂.Cl₄.
Not allowed as mineral name because occurs in burnt coal waste: AM 82 1038-41.]
iimoriite-Y Y₂(SiO₄)(CO₃).
Structure: **JM Hughes & 3 others** 1996 CM 34 817-20;
DY Pushcharovsky & 4 others 1999 CrR 44 418-24 (P848).
Occurrence: **A Kato K Nagashima** 1970 *An Introduction to Japanese Minerals*, = AM 58 140;
EE Foord MH Staatz NM Conklin 1969 AM 69 196-9;
in *talch-chlorite*, Trimouns, French Pyrenees: **P de Parseval F Fontan T Aigouy** 1997
CRASP 324 IIa 625-30 (D639).
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
ikaite CaCO₃.6aq.
Structure: *synthetic*, **B Dickens WE Brown** 1970 IC 9 480-6;
KF Hesse H Küppers E Suess 1983 ZK 163 227-37;
D-exchanged, NPD, 4-270 K, H bond, **IP Swainson RP Hammond** 2003 MM 67 555-62;
& thermal expansion, **AR Lennie & 2 others** 2004 MM 68 135-46

compressibility at high aq pressure, XRPD: **AR Lennie** 2005 MM 69n 325-36..

Stability: **G Marland** 1975 GCA 39 83-91.

Occurrence: MM 33 1138.

Submarine columns of ikaite tufa, Ikka Fjord, Greenland: **B Buchardt & 10 others** 1997 N 390 129-30 (B1737).

Growth in Arctic spring: **CR Omelon WH Pollard GM Marion** 2001 GCA 65 1429-37 (1617).

Precursor of *glendonite* & *thinolite*: **IP Swainson RP Hammond** 2001 AM 86 1530-3.

ikranite $(\text{Na}, \text{H}_3\text{O})_{15}(\text{Ca}, \text{Mn}, \text{REE})_6\text{Fe}_2\text{Zr}_3(\text{I}, \text{Zr})(\text{I}, \text{Si})\text{Si}_{24}\text{O}_{66}(\text{O}, \text{OH})_6\text{Cl}_{2-3\text{aq}}$. *Eudialyte* group.

Occurrence: Lovozero, **NV Chukanov & 5 others** 2003 ZVMO 82 22-33 (10514);
& structure: **RK Rastsvetaeva & 5 others** 2003 CrR 48 717-20.

ikunolite $\text{Bi}_4(\text{S}, \text{Se})_3$. *Tetradymite* mineral/structuregroup, *josëite* subgroup.

Isostructural with *josëite* Bi_4TeS_2 & *laitakarite* $\text{Bi}_4(\text{Se}, \text{S})_3$.

Structure: **P Bayliss** 1991 AM 76 257-65.

Occurrence: MM 32 962.

ilerite Old name for *hilairite*.

Synthetic silica-pillared material prepared from the layered silicic acid of ilerite using octylamine & ethyl silicate: **K Kosuge A Tsunashima** 1995 JCSOC 2427-8 = CA 124:104495k.

Synthetic $\text{NaSi}_4\text{O}_8\text{OH}_{.4\text{aq}}$, layer structure, maybe of *ilerite*: **S Vortmann J Ruis S Siegmann H Gies** 1997 JPCB 101 1292-7 (V319).

Synthetic $\text{Na}_2\text{OSi}_8\text{O}_{16.4}10.2\text{aq}$, XRD, NMR: **U Brenn & 12 others** 2000 MMM 40 43-52 (223).

Synthetic pillared: **K Kosuge PS Singh** 2000 ChM 12 421-7 (K1253).]

ilesite $(\text{Mn}, \text{Zn}, \text{Fe})\text{SO}_4.4\text{aq}$. *Rozenite* structure group. Review: **Sabelli** p. 12.

Structure: **WH Baur** 1962 AC 15 815-26.

ilimaussite-Ce $\text{K}_3\text{Na}_{4.5}(\text{Ba}, \text{Na})_{10}\text{Ce}_5(\text{Nb}, \text{Ti})_6[\text{Si}_{12}\text{O}_{36}][\text{Si}_9\text{O}_{18}(\text{O}, \text{OH})_{24}]\text{O}_6$.

Similar to *diversilite-Ce*.

Structure: **RK Rastvetsaeva & 5 others** 2003 Dokl Chem 388 9-13;
K, Ti-analog, $(\text{Ba}, \text{K}, \text{Na}, \text{Ca})_{11-12}(\text{REE}, \text{Fe}, \text{Th})_4(\text{Ti}, \text{Nb})_6(\text{Si}_6\text{O}_{18})_4(\text{OH})_{12.4.5\text{aq}}$, SC-XRD,
SV Krivovichev & 4 others 2003 ZK 218 392-6 (9166)'
refinement, **G Ferraris & 5 others** 2004 CM 42 787-95.

Occurrence: **EI Semenov ME Kazakova VJ Bukin** 1968 Medd Grønland 181-7 3-7 = AM 54 992-3.

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

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

ilinskite $\text{NaCu}_5\text{O}_2(\text{SeO}_3)_2\text{Cl}$.

Occurrence & SC-XRD structure: **LP Vergasova & 4 others** 1997 DAN 353 641-4.

illite $\sim(\text{K}, \text{H}_3\text{O})(\text{Al}, \text{Mg}, \text{Fe})_2(\text{Si}, \text{Al})_4\text{O}_{10}[(\text{OH})_2, \text{aq}]$.

Monograph: **A Meunier B Velde** 2004 QE389.625.M48.

Mica/clay group of minerals with many subtle structural variations.

1M & 2M₁ varieties, separate minerals not polytypes: **M Zöller O Brockamp** 1997 EJM 9 821-7.

Illite/smectite: interlayer order, **SP Altaner CM Bethke** 1988 AM 73 766-74;
structural models & reaction mechanisms, **SP Altaner RF Ylagan** 1997 CICIM 45 517-33 (A782);
TEM, **J Oliver M Amouric R Perbost** 2000 CICIM 48 282-9 (O428)
cis- & trans-vacancy, modeling, **CI Sainz-Diaz & 2 others** 2001 PCM 28 322-31 (2112);
FTIR of ammonium, **J Pironon & 3 others** CIM 38 201-12;
cation redistribution, octahedral sheet, diagenesis in oil shales, **LG Dainyak & 3 others** 2006 AM 91 589-603.

In Paleozoic K-bentonites, XRPD, rotational disorder, **DK McCarty RC Reynolds Jr** 1995 CICIM 43 271-84 (M1320).

Structural transformations in hydrothermal, **VA Drits AL Salyn V Sucha** 1996 CICIM 44 181-90 (D588).

McEwan crystallites & dominance of 2M₁ polytypes, **H Dong DR Peacor** 1996 CICIM 44 257-75.

Interpretation of interstratified trans- & cis-vacant, **VA Drits DK McCarty** 1996 AM 81 852-63.

Name: MM 25 632.

Crystallite size/lattice strain vs. crystallinity, pelitic rocks: **W Jiang & 4 others** 1997 JMG 15 267-81 (J150).

Phase relations among *smectite*/R1 illite-*smectite*/illite: **H Dong DR Peacor RL Freed** 1997 AM 82 379-91.

Preference of illite vs. *kaolinite* for brine, & *kaolinite* over illite for oil: **J Bantignies C Moulin H Dexpert** 1997 CICIM 45 184-93 (B1677).

Vacancy characterization by thermal analysis & XRD, **VA Drits & 4 others** 1998 AM 83 1188-98.

Nature, formation & stability of end-member: **PE Rosenberg** 2002 AM 87 103-7.

Detrital: identification, **L Aldega DD Eberl** 2005 AM 90 1587-96.
Synthetic ammonium: AM 83 58-67.
Synthetic neoformed, HR-TEM/AEM: **DM Yates PE Rosenberg** 1998 AM 83 1199-208.
NMR of ^{133}Cs & ^{23}Na : **Y Kim RJ Kirkpatrick** 1998 AM 83 661-5.
TEM/XRD-description of mixed-layer illite/*smectite*: **GD Guthrie Jr RC Reynolds Jr** 1998 CM 36 1421-34.
n-alkylammonium exchange in 2:1 clay minerals: **SK Sears R Hesse H Vali** 1998 CM 36 1485-506.
Si MAS NMR of illite & illite-smectite from shale: **SK Lausen & 3 others** 1999 AM 84 1433-8.
Smectite illitization in shales: **T Dudek J Srodon** 2003 CICIM 51 529-42.
Structure change, dehydroxylation/rehydration, XRPD: **F Muller & 3 others** 2000 CICIM 48 572-85 (M1861).
Fibrous growth & structure: **N Guven** 2001 CICIM 49 189-96.
Dissolution kinetics vs pH & T: **SJ Köhler F Dufaud EH Oelkers** 2003 GCA 67 3583-94 (9539).
Particle size from small angle XR scattering: **C Shang & 3 others** 2003 CICIM 51 293-300.
Pottery stone, Japan, AFM: **Y Kuwahara S Uehara Y Aoki** 2001 CICIM 49 300-9.
Occurrence: hydrothermal, Colorado, **DJ Bove & 3 others** 2002 AM 87 1546-56;
-*smectite*, Greenland, **V Drits & 4 others** 2002 AM 87 1590-606;
hydrothermal, Japan, **A Inoue & 2 others** 2004 CICIM 52 66-84 (10078).
DR Peacor & 4 others 2002 *Transmission and analytical microscopy evidence for high Mg contents of 1M illite: Absence of 1M polytypism in normal prograde diagenetic sequences of pelitic rocks*, CICIM 50 757-65 (8658).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
ilmajokite $(\text{Na,Ce,Ba})_2\text{TiSi}_3\text{O}_5(\text{OH})_{10.n}\text{aq}$.
Structure determination not found.
Poor X-ray diffraction.
Occurrence: **IV Bussen & 4 others** 1972 ZVMO 101 75-9 = AM 58 139-40.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
ILMENITE STRUCTURE GROUP Includes:

<i>akimotoite</i>	(Mg,Fe)SiO ₃
<i>brizziite</i>	NaSbO ₃
<i>ecandrewsite</i>	ZnTiO ₃
<i>geikielite</i>	MgTiO ₃
<i>Ilmenite</i>	FeTiO ₃
<i>melanostibite</i>	Mn(Sb,Fe)O ₃
<i>pyrophanite</i>	MnTiO ₃

Ordered superstructure of *corundum* structure type.
Thermodynamic model: **RG Berman LYa Aranovich** 1996 CMP 126 1-24 (B1572).
Synthetic high-P MgSiO₃: **H Horiuchi & 3 others** 1982 AM 67 788-99;
Raman at 7 GPa & 1030 K, **B Reynard DC Rubie** 1996 AM 81 1092-6.
Raman of ilmenite phases on MgSiO₃-Mg₃Al₂Si₃O₁₂ join: **B Reynard A Kubo M Akaogi**
2002 EJM 14 745-8.
Synthetic high-P MgGeO₃: **A Kirfel E Hinze G Will** 1978 ZK 148 305-17.
Synthetic high-P MnGeO₃ -III: **NL Ross B Reynard F Guyot** 1991 AC C47 1794-6 (R575).
Synthetic high-P ZnGeO₃: **NL Ross K Leinenweber** 1990 ZK 191 93-104.
Synthetic NiTiO₃: **M Ohgaki & 3 others** 1988 MJ 14 133-44;
NPD of ilmenite(ordered)/*corundum*(disordered), **H Boysen & 3 others** 1995 ZK 210 328-37.
Synthetic MgTiO₃, neutron PD: **BA Wechsler RB Von Dreele** 1989 AC 542-9 (W698).
Synthetic high-P LiAsO₃: 1989 JSSC 78 126-9.
Crystal chemistry, Table 1 lists 35 compositions with ilmenite connectivity, some disordered &
some triclinic: **IL Botto EJ Baran** 1981 NJMA 142 320-30 (B1367).
Ferric substitution, EPMA, Mössbauer, XRPD: **HG Cho JB Choi** 1998 NJMM 481-94 (C1108).
High-P transition from -I (ilmenite type) to -II (Li niobate type) for Mg/FeTiO₃ series: **JA Linton Y
Fei A Navrotsky** 1999 AM 84 1595-603.
Weathering: impurity elements behavior: **I Grey & 3 others** 2005 MM 69 437-46.
ilmenite FeTiO₃. *Ilmenite* structure type.

Structure: ND, magnetic: **G Shirane & 3 others** 1962 J Phys Soc Japan 17 1598;
KN Raymond HR Wenk 1971 CMP 30 135-40 (R233);
EL Belokoneva & 4 others 1979 SPD 23 626-30;
BA Wechsler CT Prewitt 1984 AM 69 176-85;
K Ohgaki & 4 others 1989 MJJ 14 179-90.

Synthetic with excess Ti: **B Reuter G Buxbaum** 1970 Nw 57 355-6.

High P: transforms to *perovskite* structure type: **A Mehta & 3 others** 1994 PCM 21 207-12.
<15 GPa, anisotropic compression: **B Reynard & 3 others** 1996 AM 81 45-50;
molecular dynamics model: **BB Karki & 2 others** 2000 AM 85 317-20;
synchrotron-XRD of *perovskite* transition using large-volume press, **LC Ming & 4 others** 2006 AM 91 120-6.

Oxidation: Mössbauer & SC-XRD, **JC Waerenborgh & 3 others** 2002 MM 66 421-30;
Nigeria, to *hematite* & *rutile* via "*ferropseudobrookite*": **EM Sakoma RF Martin** 2002 MM 66 597-604;
weathered, Georgia Piedmont: **PA Schroeder & 2 others** 2002 AM 87 1616-25.

STM, (0001): **RA Fellows & 4 others** 1999 AM 84 1384-91.

Zn-bearing: **DL Whitney M Hirschmann MG Miller** 1993 CM 31 425-36.

Inclusions in Alpe Arami peridotite massif along with 3 other variants indicative of inversion from
high-P *perovskite*: **L Dobrzhinetskaya HW Green II S Wang** 1996 S 271 1841-59.

Ti-oxide inclusions in diamonds: **NV Sobolev ES Yefimova** 2000 IGR 42 758-67 (389).

Zircon geochronology, ilmenite as source for Zr, Norway Caledonides: **B Bingen H Austrheim
M Whitehouse** 2001 JP 12 355-75 (1369).

Exsolution in *olivine* of serpentinite: EBSD, **H Massone RD Neuser** 2005 MM 119-24..
In shocked Acfer L5-6 chondrite with inferred MgSiO₃ *perovskite*: **TG Sharp & 3 others** 1997 S 277 352-5 (S1707).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

Synthetic MnGeO₃: structure to 5 GPa, **NL Ross B Reynard F Guyot** 1993 ZK 204 43-55.
Synthetic Mn₂FeSbO₆, 3 GPa 1173K, transition *perovskite* at 50 kb: **GV Bazuev & 3 others** 1997 DAN 353 622-4.

ilmenorutile (Ti,Nb,Fe)O₂.

Should be *rutile* structure type from crystallography. Series with *strüverite*.
Structure determination not found.

Occurrence: **Dana**. [jvs: is name needed ?; consider rutile-(niobian,ferrian).]
ilsemannite Mo₃O₈.n aq?. Inadequate. Occurrence: Dana.

iltisite HgSAg(Cl,Br).

Description & SC-XRD: Archs Sci Geneve 50 1-5 = AM 83 401.

ilvaite CaFe²⁺₂Fe³⁺(SiO₄)₂ OH.

Isostructural with *manganilvaite* CaFe²⁺Fe³⁺(Mn,Fe²⁺)(Si₂O₇)O(OH).

Structure: **S Ghose PK Sen Gupta EO Schlemper** 1985 AM 70 1248-52;
A Beran H Bittner 1974 TMPM 21 11-29;
N Haga 1976 ZK 144 161-74;
Y Takéuchi N Haga M Dunno 1983 ZK 163 267-83 (T441);
LW Finger RM Hazen 1987 ZK 179 415-30 (F326);
B Ghazi-Bayat & 4 others 1992 PCM 18 491-6;
B Carrozini 1994 EJM 6 465-79 (C722);
Y Takéuchi & 4 others 1994 ZK 209 861-9 (T410);
monoclinic, MA 83M/4215;
phase transition, MA 89M/1614;
673-973 K, oxidation-dehydrogenation, **P Bonazzi L Bindi** 1999 AM 84 1604-12;
Mn-rich, 673-963 K, **P Bonazzi L Bindi** 2002 AM 87 845-52.

Monoclinic to orthorhombic, 2.2 GPa: **B Ghazi-Bayat G Amthauer H Ahsbahs** 1993 PCM 20 402-6.
EMPA reference sample: **C Bertoldi & 9 others** 2006 AM 91 187.

Occurrence: **T Agata M Adachi** 1995 MM 59 489-96
AO Larsen S Dahlgren 2002 NJMM 169-81 (7088).

imandrite Na₁₂Ca₃Fe₂(Si₆O₁₈)₂. *Lovozerite* structure group.

Structure: **NM Chernitsova & 4 others** 1980 SPD 25 337-9(C704).
Occurrence: MM 46 519;
in hyperagpaitic alkaline rocks: **Khomyakov** (1995).

imhofite $Tl_6CuAs_{16}S_{40}$.
 Structure: **V Divjakovic W Nowacki** 1976 ZK 144 323-33;
 order-disorder, **T Balic-Zunic E Makovicky** 1993 NJMA 165 317-30 (B1103).
 Occurrence: MM 35 1137-8.

imiterite / imitérite Ag_2HgS_2 .
 Structure: **J-J Guillou & 5 others** 1985 BM 108 457-64 = SR 52A 65.
 Occurrence: MM 50 747.

imogolite Similar to, but distinct from, *allophane*.
 Suggested structure for $Al_8Si_8O_{14}(OH)_{14}$.8aq, **K Wada N Yoshinaga** 1969 AM 54 50-71.
 Ideal formula $Al_2SiO_3(OH)_4$ & 2D tabular structure: **P Bayliss** 1987 MM 51 327.
 Trial structures, orthosilicate groups/*gibbsite* sheets: **PDG Crawford & 5 others** 1972 Nature Phys Sci 40 187-9.
 NMR & thermal transformations: **KJD MacKenzie & 3 others** 1989 CICIM 37 317-24.
 Modulated curved structures: **ST Hyde** 1993 PCM 20 190-200.
 Molecular dynamics model with tubes: **K Tamura K Kawamura** 2002 JPCB 106 271-8(4343).
 Pore structure, model: **PI Pohl J-L Faulon DM Smith** 1996 La 12 4463-8 (P636).
 Surface chemistry, model: **JP Gustafsson** 2001 CICIM 49 73-80 (1330).
 Benzene adsorption: **MA Wilson GSH Lee RC Taylor** 2002 CICIM 50 348-51 (7466).
 Occurrence: MM 33 1138;
 with *protoimogolite*, new species during synthesis, **MA Wilson GSH Lee RC Taylor**
 JNCS 296 172-81 (4344).
 References to early syntheses, shape-selective Cu-loaded catalyst, **S Imamura & 5 others** 1996 JCa 160 137-9 (I142).

inaglyite $PbCu_3(Ir,Pt)_8S_{16}$.
 Should be isostructural with *konderite* $PbCu_3(Rh,Pt,Ir)_8S_{16}$ based on crystallography.
 Structure determination not found.
 Occurrence: **NS Rudashevskii & 4 others** 1984 ZVMO 113 712-7 = AM 71 228.

incaite $(Pb,Ag)_4Sn_4Sb_2FeS_{15}$. *Cylindrite* structure group. Complex layer structure.
 Structure: **E Makovicky** 1974 NJMM 235-56; 1976 NJMA 126 304-26.

inderborite $CaMg[B_3O_3(OH)_5]_2aq_4.2aq$.
 Layer structure; isolated 3-ring of 1 triangle & 2 tetrahedra.
 Structure: **EN Kurkutova IM Rumanova NV Belov** 1966 SPD 10 808-10 (K643);
PC Burns FC Hawthorne 1994 CM 32 553-9 (B1607).
 Occurrence: MM 26 338.

inderite $MgB_3O_3(OH)_5.5aq$. Isolated 3-ring of one triangle & two tetrahedra.
 Dimorphic with *kurnakovite*.
 Structure: **A Ashirov IM Rumanova NV Belov** 1962 SPD 7 173-5 (A558);
IM Rumanova A Ashirov 1963 SPC 8 414-28;
EN Kurkutova IM Rumanova NV Belov 1966 SPD 10 808-10 (K643);
E Corazza 1976 AC B32 1329-33.
 Occurrence: MM 25 632.

indialite $(Mg,Fe)_2Al_4Si_5O_{18}$. Disordered relative of *cordierite*.
 Structure: **EP Meagher GV Gibbs** 1977 CM 15 43-9.
 Synthetic: MM 30 735.
 Synthetic Be-, SC-XRD structure: **YI Smolin & 4 others** 1999 Cryst Rep 44 414-7 (S2112).
 Occurrence: Somma-Vesuvius, & crystal chemistry, **G Balassone & 3 others** 2004 AM 89 1-6.

indigirite $Mg_2Al_2(CO_3)_4(OH)_2.15aq$.
 Structure determination not found.
 Occurrence: **LN Indolev & 4 others** 1971 ZVMO 100 178-83 = AM 57 326-7.

indite $FeIn_2S_4$. *Spinel* structure type; *linnaeite* mineral group.
 Structure: *synthetic*, **H Hahn W Klinger** 1950 ZaaC 263 177-90;
 cation ordering, **RJ Kill JR Craig GV Gibbs** 1978 JPCS 39 1105-1(H130).
 Occurrence: **AD Genkin IV Murav'eva** 1963 ZVMO 92 445-57 = AM 49 439-40.

indium In.
 Tetragonal distortion of cubic closest packing of spheres: *synthetic*, **Pearson** p.310.
 Occurrence: **VV Ivanov** 1964 *Geochemistry, Mineralogy, and Genetic Types of Deposits of Rare*

Elements 2 568-69 Izdatelstvo "Nauka" Moscow = AM 52 299.

inesite $\text{Ca}_2\text{Mn}_7\text{Si}_{10}\text{O}_{28}(\text{OH})_{2.5}\text{aq}$. Five-repeat double chain.
 Structure: **C Wan S Ghose** 1978 AM 63 563-71;
LP Otroshchenko VI Simonov NV Belov 1978 SPD 23 110-2 (O250).
 Occurrence: (D782).

ingersonite $\text{Ca}_3\text{MnSb}_4\text{O}_{14}$. Should be isostructural with *pyrochlore* from crystallography.
 Occurrence: **PJ Dunn & 3 others** 1988 AM 73 405-12.

ingodite Bi_2TeS . *Tetradymite* mineral/structure group, *tsumoite* subgroup.
 Structure: **P Bayliss** 1991 AM 76 257-65.
 Occurrence: MM 48 574.

innelite $\text{Na}_2(\text{Ba},\text{K})_4(\text{Ca},\text{Mg},\text{Fe})\text{Ti}_3\text{Si}_4\text{O}_{18}(\text{OH},\text{F})_{1.5}(\text{SO}_4)$.
 Structure: **AN Chernov & 3 others** 1971 SPC 16 65-9 (C711).
 XRPD: **G Raade H Berg** 2000 PD 15 62-4 (R932).
 Occurrence: MM 32 962.

insizwaite $\text{Pt}(\text{Bi},\text{Sb})_2$. *Pyrite* structure group.
 Structure: **P Bayliss** 1986 CM 24 27-33.
 Occurrence: MM 38 993.

intersilite $\text{Na}_6\text{MnTiSi}_{10}\text{O}_{24}\text{OH}(\text{OH})_{3.4}\text{aq}$.
 Structure: **NA Yamnova YuK Egorov-Tismenko AP Khomyakov** 1996 CrR 41 239-44 (Y194);
 relation to *amphibole*, *palygorskite*, *tuperssuatsiaite*, *yofortierite* & *sepiolite* structures, **YuK Egorov-Tismenko NA Yamnova AP Khomyakov** 1996 CrR 41 784-8 (E398).
 Occurrence & crystal structure drawing: **AP Khomyakov & 4 others** 1996 ZVMO 2 79-85 (K888).

inoite $\text{CaB}_3\text{O}_3(\text{OH})_{5.4}\text{aq}$.
 Structure: **JR Clark** 1959 AC 12 162-70.
 Dehydrated to $\text{CaB}_3\text{O}_5(\text{OH})$: MA 16-247.

iodargyrite AgI. *Wurtzite* structure type.
 Structure: **LW Stroock** 1934 Z phys Chem B25 441-54.

iodolaurionite PbIOH . Isostructural with *laurionite*.
 Structure: 1960 SR 24 298.

iowaite $\text{Mg}_4\text{Fe}(\text{OH})_8\text{OCl}_{2.4}\text{aq}$. *Hydrotalcite/pyroaurite* structure group.
Pyroaurite is carbonate analog of iowaite; but different cell repeats.
 Review: **HFW Taylor** 1973 MM 39 377-89 (T186).
 Structure: **R Allmann JDH Donnay** 1969 AM 54 296-9;
RSW Braithwaite & 3 others 1994 MM 58 79-85.
 Occurrence: MM 36 1152.

iquiqueite $\text{K}_3\text{Na}_4\text{Mg}(\text{CrO}_4)\text{B}_{24}\text{O}_{39}(\text{OH})_{12}\text{aq}$.
 Structure determination not found.
 Occurrence: **GE Ericksen & 3 others** 1986 AM 71 830-6.

iranite $?\text{Pb}_{10}\text{Cu}(\text{CrO}_4)_6(\text{SiO}_4)_2(\text{F},\text{OH})_2$.
 Should form isostructural series with Zn analog *hemihedrite* based on crystallography.
 Structure determination not found.
 Occurrence: **P Bariand P Herpin** 1963 BSFMC 86 133-5 = AM 48 1417;
SA Williams 1974 Bull British Museum Natural History Mineral 2 377-419 = AM 61 1054.

iraqite $\text{K}(\text{La},\text{Ce},\text{Th})_2(\text{Ca},\text{Na})_4\text{Si}_{16}\text{O}_{40}$.
 Should be member of *ekanite* structure group based on crystallography.
 Structure determination not found.
 Occurrence: **A Livingstone & 3 others** 1976 MM 40 441-5.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

irarsite $(\text{Ir},\text{Ru},\text{Rh},\text{Pt})\text{AsS}$. *Pyrite* structure group; pyrite subtype.
 Structure: *synthetic* IrAsS , **F Hulliger** 1963 N 198 382-3;
E Mooser 1965 JPCS 26 429-33;
P Bayliss 1986 CM 24 27-33.
 Occurrence: MM 36 1152-3.
 Occurrence in meteorites: **AE Rubin** 1997 MPS 32 733-4.

Unnamed (Ir,Os)(S,As,Te)₂, in Western Sayan: **N Tolstykh A Krivenko L Pospelova** 1997 EJM 9 457-65 (T517).

irhtemite Ca₄MgH₂(AsO₄)₄aq. Dehydration product of *picroparmacolite*.

Structure determination not found.

Occurrence: **R Pierrot H-J Schubnel** 1972 BSFMC 95 365-70 = AM 59 209.

iridarsenite (Ir,Rh)As₂. [jvs: ?monoclinic distortion of *pyrite* structure.]

XRPD matches *synthetic*: **JC Quensel RD Heyding** 1962 Can J Chem 40 814-8.

Structure determination not found.

Occurrence: **DC Harris** 1974 CM 12 280-4 (H1036).

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

Unnamed Ir(As,Se,S)₂, in Western Sayan: **N Tolstykh A Krivenko L Pospelova** 1997 EJM 9 457-65 (T517).

iridium Pt. Cubic closest packing = face-centered cubic.

Isostructural with *copper, gold, iron-gamma, palladium, platinum & silver*.

Brittle cleavage: **MJ Cawkwell & 4 others** 2005 S 309 1058-62.

Nomenclature: **DC Harris LJ Cabri** 1973 CM 12 104-12.

iridrhorthenium Description: **S Mao X Zhu** 1989 Acta Mineral Sinica 9 136-40.

iriginite UO₂Mo₂O₇.3aq.

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

Structure: *synthetic*, wrong space group, 1973 DAN SSSR Chem 210 873-6;

corrected, SC-XRD, **SV Krivovichev P Burns** 2000 CM 38 847-51;

Raman, **RL Frost L Duong M Weier** 2004 NJMA 180 145-80 (10963).

Occurrence: MM 31 962.

Synthetic UO₂Mo₂O₇.2aq: SC-XRD structure, **SV Krivovichev** 2002 CM 40 1571-7.

[irinite (Na,Ce,Th)_{1-x}(Ti,Nb)(O,OH)₃.

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

iron Fe, commonly as alloy.

Polymorphic: *alpha* = *native* body-centered cubic close packing
[beta] ?double-hexagonal closest packing; probably orthorhombic Pbnm;
probably occurs only when sample is stressed. [Also used for gamma
from 1039-1179 K above its Curie point.]
gamma face-centered cubic closest packing
[delta] = *alpha* body-centered cubic close packing
epsilon = *hexaferrum* hexagonal closest packed
epsilon-prime double-hexagonal closest-packed

The stability is still debated, but probably *alpha* is stable at low P,T; with triple point with *gamma* (zero to high P, medium to high T) & *epsilon* (high P, low T); *delta* is stable at low P & T > 1700K and actually is *alpha*.

In meteorites: *kamacite*, a Fe,Ni alloy, is a solid solution of *alpha*;

taenite, a Fe,Ni alloy, has the fcc structure of *gamma*, but a superstructure for high Ni;

plessite, is a mixture of *kamacite, taenite & tetrataenite* (**Jl Goldstein JR Michael** 2006 MPS 41 553-70).

In industry: *steel* is an alloy of iron with various substituents, including C, Si, P, V, Cr, Mn, Ni, Co, Mo & W. *Pig-* or *cast-iron* is quenched liquid from near the eutectic with ~ 4 wt % C, 2 % Si, etc. It purifies to *wrought* iron. Currently, high-strength steel carries ~ 0.5 % C & ~ 2 % Mn. Various heat/cool treatments cause C to precipitate as small particles which enhance the strength. Many names are used including *austenite (gamma), ferrite (alpha)*, & various terms for intergrowths – *cementite, pearlite, martensite & sorbite*. *Case-hardening* involves reaction of surface with C, and N. P substitution inhibits rusting.

iron [-alpha] [native] Fe. Body-centered cubic close packing. Isostructural with *chromium*. *Kamacite*, a Fe,Ni alloy in meteorites, is a solid solution.

Structure: **DE Thomas** 1948 J Sci Instruments 25 440-4;

high-P, **T Takahashi WA Bassett** 1964 S 145 483-6;

high-P to 30 GPa, **HK Mao WA Bassett T Takahashi** 1967 JAP 38 272-6.

Shock compression to 78 GPa: **AP Jephcoat HK Mao PM Bell** 1986 JGR 91 4677-84 (J261).

Occurrence: carbonado, **AN Gorshkov & 4 others** 1996 GI 33 59-63 (G850);

diamond, Kimberlite Pipe 50, Liaoning, China: **AI Gorshkov & 5 others** 1997 GI 35 695-703 (G929).

Thermal equation iron & Fe,Si alloy <8.9 GPa & 773 K: **J Zhang F Guyot** 1999 PCM 26 206-11 (Z193).

Equation of state 10-45 Mbar, laser-driven shock: **D Batani & 18 others** 2002 PRL 88 235502-1-4 (7754).

Cu/Ni partition in iron meteorites, SXRF: **SR Sutton & 3 others** 1987 GCA 51 2653-62 (390).
Fe/Ni/Ga/Ge in Canyon Diablo meteorite, SXRF: **RG Cavell & 6 others** 2004 AM 89 519-26.
Fe-Ni-S, solid-liquid partition of Tc/Mo/Ru/Re: **C Lazar D Walker RJ Walker** 2004 GCA 68 643-51 (9898).
PGEs/RE/Mo/W in Fe-Ni metal of meteorites: **MI Petaev SB Jacobsen** 2004 MPS 39 2685-97.
Zoned/unzoned in CBb chondrites, Ni/Cu/Ga/Ru/Pd/Ir/Au: **AJ Campbell & 2 others** 2005 MPS 40 1131-48.
[iron-beta] Fe. ?double-hexagonal closest packing; probably orthorhombic Pbnm.

Occurrence in diamond pressure cell: **R Boehler** 1993 N 363 534-6;

SK Saxena G Shen P Lazor 1993 S 260 1312-4;

SK Saxena & 5 others 1995 S 269 1703-4 (S1512);

SK Saxena LS Dubrovinsky P Häggkvist 1996 GRL 23 2441-4 (S1627);

D Andraut & 4 others 1997 S 278 831-41;

reversible transitions to hcp, fcc & dhcp, 35-68 GPa, **LS Dubrovinsky SK Saxena P Lazor** 1998 EJM 10 43-7 (D715).

Phase diagram & implications for Earth's core: **CS Yoo & 4 others** 1995 S 270 1473-5 (Y167).

Structure & stability at high P and T, phase relations with gamma and epsilon:

D Andraut & 3 others 2000 AM 85 364-71;

SK Saxena LS Dubrovinsky 2000 AM 85 372-5.

Not observed in multi-anvil cell: **A Kubo & 6 others** 2003 GRL 30 16394 (8981).

[iron-gamma] Fe. Cubic closest packing ABC = face-centered cubic.

Stable at high-T (1183-1663K). *Copper* structure group.

Taenite, a Fe,Ni alloy in meteorites, has the fcc structure, but a superstructure occurs for high Ni. To 0.9 GPa & 5-110K, NPD: **A Onodera & 4 others** 1994 PRB 50 3532-4.

Synthesis in MA8 high-P device with sintered diamond anvils: **N Funamori T Yagi T Uchida** 1996 GRL 23 953-6 (F494).

[iron-epsilon] = [hexaferrum end-member] Fe. Hexagonal closest packing AB.

Presence in Earth's inner core?: **A Jephcoat P Olson** 1987 N 325 332-5 (J262).

Phase diagram & implications for Earth's core, **CS Yoo & 4 others** 1995 S 270 1473-5 (Y167).

Synthesis in MA8 high-P device with sintered diamond anvils: **N Funamori T Yagi T Uchida** 1996 GRL 23 953-6 (F494).

Vibrational Grüneisen ratio to 330 GPa at 300 K: **OL Anderson & 3 others** 2001 GRL 28 399-402 (850).

Stability & thermal equation-of-state, XRPD, multi-anvil apparatus: **T Uchida & 3 others** 2001 JGRB 106 21799-810 (3117).

[iron-epsilon-prime] Fe. Double-hexagonal closest packing ABAC.

Phase diagram & implications for Earth's core, **CS Yoo & 4 others** 1995 S 270 1473-5 (Y167).

Grüneisen parameter to 300 GPa, XRPD: **LS Dubrovinsky et al** 2000 AM 85 386-9.

High P

WA Bassett MS Weathers 1994 *Thermodynamic significance of a high pressure/temperature bcc iron phase*, Am Inst Physics Proc 309 915-8 (B1451).

R Boehler 1994 *The phase diagram of iron to 2 Mbar: new static measurements*, Am Inst Physics Conf Proc 309 919-22 (B1450).

GQ Chen TJ Ahrens 1996 *High-pressure melting of iron: new experiments & calculations*, Phil Trans R Soc London A354 1251-63.

R Boehler 1996 *Melting of mantle & core materials at very high pressures*, Phil Trans R Soc London A354 1265-78.

Density of phonon states: **R Lubbers et al** 2000 S 287 1250-3 (L1038);

phonon density to 153 GPa, **HK Mao & 18 others** 2001 S 292 914-6 (1741).

Phase transition epsilon to beta, **LS Dubrovinsky et al** 2000 PRL 84 1720-3 (D790);

Sound velocity to 110 GPa, **G Fiquet & 4 others** 2001 S 291 468-71 (827).

Superconductivity <2 K & 15 to 30 GPa, **K Shimizu & 6 others** 2001 N 412 316-8 (2113).

P instability, **H Ma SL Qiu PM Marcus** 2002 PRB 66 024113 (8068).

Sound velocity of hcp up to 773 GPa 1700 K: **J Lin & 5 others** 2005 S 308 1892-4.

Earth's core

Iron solid solution occurs as solid inner core and liquid outer core; much speculation on substituting elements including Si, and on P and T.

Diamond-cell crystallogr: phase diagram & implications for, **CS Yoo & 4 others** 1995 S 270 1473-5 (Y167).

Modeling of iron at core conditions: **A Laio & 4 others** 2000 S 287 1027-30 (1285).
Si solubility: **CK Gessmann BJ Wood DC Rubie MR Kilburn** 2001 EPSL 184 367-76 (936).
Light element partitioning constraints on substitution: **J Li CB Agee** 2001 GRL 28 81-4 (914).
Synchrotron XRPD, window on core: **RJ Hemley H Mao** 2001 IGR 43 1-30 (1598).
Iron-silicon alloy, phase topology: **J Lin & 4 others** 2002 S 295 313-5 (3914).
Molecular dynamics simulation indicates bcc stable high P&T: **AB Belonoshko & 2 others** 2003 N 424 1032-4 (9277).

Meteorites

Cu & Ni partition, iron/troilite in irons: **SR Sutton & 3 others** 1987 GCA 51 2653-62 (S2164).
Ru in meteoritic irons, synchrotron XRF: **J Saito & 4 others** 1993 MJ 16 258-67 (1388).
Si, Cr & P in metal of chondrites: **B Zanda et al** 1994 S 265 1846-0 (Z218).
Fe,Ni metal grains in primitive meteorites: **A Meibom & 6 others** 2000 S 288 839-41 (M1801);
A Meibom & 4 others 2001 JGR 106 32,797-801 (8624).
As/Co/Cr/Cu/Ga/Ge/Ir/Os/Pd/Pt/Re/W partitioning with Fe/Ni/P/S liquid: **NL Chabot & 4 others**
2003 MPS 38 181-96.

Formation of Widmanstätten structure: **J Yang JI Goldstein** 2005 MPS 40 239-53.

[iron carbide Fe_{2.5}C.

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

irtyshite Na₂(Ti,Nb)(Ta,Nb)₄O₁₁ or Na₂Ta₄O₁₁. Compare with *natrotantite*.

Structure determination not found.

Occurrence: **AV Voloshin & 3 others** 1985 AM 71 1545.

[iscorite Fe₇SiO₁₀.

Synthetic: structure, **J Smuts JGD Steyn JCA Breyens** 1969 AC B25 1251-5.]

ishikawaite ?(U,Fe,Y,Ce)(Nb,Ta)O₄. *Samarskite* group.

Structure determination not found.

Occurrence: **KA Vlasov** 1966 *Mineralogy of Rare Elements* II 533-44.

New data & suggested nomenclature: **SL Hanson & 4 others** 1999 MM 63 27-36.

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

isoclasite Ca₂PO₄OH.2aq.

Structure determination not found.

Occurrence: **Dana** II 933-4.

isocubanite CuFe₂S₃. Cubic high-T polymorph of *cubanite*.

Near-*sphalerite* structure with two cation sites. Matches *synthetic* intermediate solid solution:

Structure: heated natural, **JT Szymanski** 1974 ZK 140 240-8.

New definition: **R Caye & 5 others** 1988 MM 52 509-14.

Composition range & isomorphism: **NN Mosgova & 3 others** 1996 GI 33 1-21.

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

isoferroplatinum (Pt,Pd)₃(Fe,Cu). Isostructural with *awaruite* & *chengdeite* Ir,Fe.

Composition range: **LJ Cabri CE Feather** 1975 CM 13 117-26.

Phase relations & magnetic properties: **JFW Bowles** 1990 MP 43 37-47 (B1345).

Gold & Pt-group minerals, Aldan Shield, Russia: **IYA Nekrasov & 6 others** 2005 CM 43 737-54.

isokite CaMgPO₄F. *Titanite* structure type.

Structure not refined: **HW Jaffe LM Hall HT Evans Jr** 1992 MM 56 227-33.

Occurrence: MM 30 736.

See AM 91 1208 for data on further specimen.

isolueshite ~(Na,La,Ca)(Nb,Ti)O₃. *Perovskite* structure group.

Structure: **SV Krivovichev et al** 2000 EJM 12 597-607 (K1262).

Occurrence: **A Chakhmouradian & 3 others** 1997 EJM 9 483-90 (C911).

Compare with orthorhombic *lueshite*.

isomertieite (Pd,Cu)₅(Sb,As)₂ or Pd₁₁Sb₂As₂. ?Dimorph of *mertieite-I*.

Structure: Chinese paper listed in AM 65 408, [jvs: some scepticism by LJ Cabri about identity with *fengluanite* & *guanglinite*; need restudy.]

Occurrence: **AM Clark AJ Criddle EE Fejer** 1974 MM 39 528-43;

GR Olivo M Gauthier 1995 MM 59 455-63;

AR Cabral B Lehmann 2003 MM 67 453-63.

isostannite Cubic high-temperature polymorph of *stannite*: MM 31 962.

isovite $(\text{Cr,Fe})_{23}\text{C}_6$. Matches *synthetic*. Analog of *haxonite*.
Occurrence, ED, XRPD: **ME Generalov & 3 others** 1998 ZVMO 127 26-37 (G1209).

istisuite $(\text{Ca,Na})_7(\text{Si,Al})_8(\text{O,OH})_{24}$. Occurrence: MM 31 962.

itoigawaite $\text{SrAl}_2\text{Si}_2\text{O}_7(\text{OH})_2$.aq. *Lawsonite* structure type.
Occurrence & XRPD: **H Miyajima & 3 others** 1999 MM 63 909-16.

itoite $\text{Pb}_3\text{Ge}(\text{SO}_4)_2\text{O}_2(\text{OH})_2$. Alteration of *fleischerite*. Cell dimensions similar to *anglesite*.
Structure determination not found.
Occurrence: **C Frondel H Strunz** 1960 NJMM 132-62 = AM 45 1313.

ivanovite Ca,?K hydrous chloroborate.
Occurrence: AM 40 552.

iwakiite $\text{Mn}^{2+}(\text{Fe}^{3+},\text{Mn}^{3+})_2\text{O}_4$. Tetragonal dimorph of cubic *jacobsite*.
Spinel structure type; tetragonal distortion.
Structure: **D Jarosch** 1988 ZK 185 605 (J264).
Occurrence: **S Matsubara A Kato K Nagashima** 1979 MJJ 9 383-91 = AM 65 406.

ixiolite $(\text{Ta}_{0.4}\text{Mn}_{0.3}\text{Nb}_{0.2},\text{Ti,Sn,Fe})\text{O}_2$. Alpha- PbO_2 (*scrutinyite*) structure type.
Summary: **NA Yamnova DYu Pushcharovskii AV Volshin** 1995 CrR 40 428-33 (Y158).
Structure: **JD Grice RB Ferguson FC Hawthorne** 1976 CM 14 540-49;
RBF FCH JDG 550-60.
[jvs: compare with *wolframite*.]
Synthetic FeNbO_4 : trimorphic, **RS Roth JL Waring** 1964 AM 49 242-6.

izoklakeite $(\text{Cu,Fe})_2\text{Pb}_{27}(\text{Sb,Bi})_{19}\text{S}_{57}$.
Orthorhombic Sb-rich analog of monoclinic Bi-rich *giessenite*.
Member of *kobellite* homologous series, $n = 4$.
Structure: **E Makovicky WG Mumme** 1986 NJMA 153 121-45 (M1282);
MA Zakzewski E Makovicky 1986 CM 24 7-18;
T Armbruster W Hummel 1987 AM 72 821-31.
Occurrence: MM 50 748.

jáchymovite $(\text{UO}_2)_8(\text{SO}_4)(\text{OH})_{14}$.13aq.
Crystallography, IR & occurrence: **J Céjka & 3 others** 1996 NJMA 170 155-70 (C850).
Compare with *uranopilite*.

jacobsite $(\text{Mn,etc})(\text{Fe,Mn})_2\text{O}_4$.
Spinel structure type. Cubic dimorph of tetragonal *iwakiite*.
Structure: **RJ Hill JR Craig GV Gibbs** 1979 PCM 4 317-39.
From reductive dissolution of MnO_2 by Fe(II), XAS: **JE Vilinski & 3 others** 2001 EST 1157-60.

jacquesdietrichite $\text{Cu}_2[\text{BO}(\text{OH})_2](\text{OH})_3$.
Occurrence & structure: **AR Kampf G Favreau** 2004 EJM 16 361-6 10315).

jadeite $\text{Na}(\text{Al,Fe})\text{Si}_2\text{O}_6$. *Pyroxene* structure group; monoclinic subtype.
Structure: **CT Prewitt CW Burnham** 1966 AM 51 956-75;
high temperature, **M Cameron & 3 others** 1973 AM 58 594-618;
thermoelastic equation of state, XRPD, **Y Zhao & 6 others** 1997 GRL 24 5-8 (Z123)
magnetization/susceptibility, **JA Bartkowska & 5 others** 2004 EJM 16 671-5 (10618).
Trace elements vs. color: **H Harder** 1995 J Gemmology 24 508-11.

High-P transformation to *stishovite* & CaFe_2O_4 type of NaAlSiO_4 :
L Liu 1978 EPSL 438-44 (L892);
F Tutti LS Dubrovinsky SK Saxena 2000 GRL 27 2025-8 (T652).

Augite-jadeite, cation ordering: **TB Ballaran & 3 others** AM 83 419-33, 434-43.
OH solubility: **GD Bromiley H Keppler** 2004 CMP 147 189-200.
Dabie, China, high-P transformation to *omphacite*, HRTEM: **X Wu Y Han D Meng D Li** 2002 EPSL 197 165-9 (7199).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Synthetic $\text{NaFeSi}_2\text{O}_6$: **JR Clark DE Appleman JJ Papike** 1969 MSA Spec Paper 2 31-50.

Synthetic NaScSi₂O₆: **FC Hawthorne HD Grundy** 1973 AC B29 2615-6.
Synthetic NaInSi₂O₆: **do** 1974 AC B30 1882-4.
Synthetic NaTiSi₂O₆: **H Ohashi T Fujita T Osawa** 1982 JJAMPEG 77 305-9.
Synthetic NaGaSi₂O₆: **do** 1983 JJAMPEG 78 159-63;
H Ohashi T Osawa A Sato 1995 AC C51 2476-7 (O303).
Synthetic NaMnSi₂O₆: **H Ohashi T Osawa K Tsukimura** 1987 AC C43 605-7.
Synthetic NaVSi₂O₆: **H Ohashi T Osawa A Sato** 1994 AC C50 1652-5 (O261).
Synthetic -diopside, Na K-edge XANES: **A Mottana & 4 others** 1997 PCM 24 500-9 (M1551).
jaffeite Ca₆Si₂O₇(OH)₆. Natural analog of C₃SH_{1.5} cement mineral.
Occurrence: **H Sarp DR Peacor** 1989 AM 74 1203-6.
Isotypic with *fluoborite*, *jeremejevite* & *painite*
Structure: *synthetic*, **VF Kazak VV Blinov NV Belov** 1974 DAN 219 340-3.
Product of *quartz-portlandite* reaction: **J Wang A Tomita** 1997 Ind Eng Chem Res 36 1464-9 =
CA 126:240543t.
jagoite (Pb,Ca)₃FeSi₃O₁₀(Cl,OH).
Related to *reyerite* group of layer structures.
Structure: **M Mellini S Merlino** 1981 AM 66 352-8.
Occurrence: MM 31 962.
jagowerite BaAl₂(PO₄)₂(OH)₂.
Vertex-edge-shared octahedral-tetrahedral net; two octahedra share OH-OH edge.
Similar topology to *paganoite*.
Structure: **EP Meagher CS Gibbons J Trotter** 1974 AM 59 291-5.
Occurrence: MM 39 916.
jaguéite Cu₂Pd₃Se₄. Analog of *chrisstanleyite*.
Occurrence: & structure, SC-XRD: **WH Paar & 6 others** 2004 CM 42 1745-5.
JAHSITE-WHITEITE STRUCTURE GROUP Includes:

<i>jahnsite-CaMnFe</i>	CaMnFe ₂ Fe ³⁺ ₂ (PO ₄) ₄ (OH) ₂ .8aq
<i>jahnsite-CaMnMg</i>	CaMn(Mg,Fe) ₂ Fe ³⁺ ₂ (PO ₄) ₄ (OH) ₂ .8aq
<i>jahnsite-CaMnMn</i>	CaMnMn ₂ Fe ³⁺ ₂ (PO ₄) ₄ (OH) ₂ .8aq
<i>keckite</i>	(Ca,Mg)(Mn,Zn) ₂ Fe ³⁺ ₃ (PO ₄) ₄ (OH) ₃ .2aq
<i>rittmannite</i>	(Mn,Ca) ²⁺ Mn ² Al ₂ (PO ₄) ₂ (OH) ₂ .8aq
<i>whiteite-CaFeMg</i>	Ca(Fe,Mn)Mg ₂ Al ₂ (PO ₄) ₄ (OH) ₂ .8aq
<i>whiteite-CaMnMg</i>	CaMnMg ₂ Al ₂ (PO ₄) ₄ (OH) ₂ .8aq
<i>whiteite-MnFeMg</i>	MnFeMg ₂ Al ₂ (PO ₄) ₄ (OH) ₂ .8aq

Nomenclature: **JD Grice PJ Dunn RA Frank** 1989 CM 27 699-702.
jahnsite-CaMnFe CaMnFe₂Fe³⁺₂(PO₄)₄(OH)₂.8aq. Jahnsite-whiteite structure group.
Structure: **PB Moore T Araki** 1974 AM 59 964-73.
jahnsite-CaMnMg CaMn(Mg,Fe)₂Fe³⁺₂(PO₄)₄(OH)₂.8aq.
Jahnsite-whiteite structure group.
Structure: **PB Moore T Araki** 1974 AM 59 964-73.
jahnsite-CaMnMn CaMnMn₂Fe³⁺₂(PO₄)₄(OH)₂.8aq. Jahnsite-whiteite structure group.
Occurrence: **JD Grice PJ Dunn RA Ramik** 1990 AM 75 401-4.
jaipurite Co_{1-x}S. *Niccolite* structure type.
Structure determination & occurrence not found.
Decomposition of *synthetic* to *linnaeite/Co-pentlandite*: **K Bente & 4 others** 1994 JAC 27 1068-9 (B1182).
jalpaite Ag₃CuS₂. XRPD matches synthetic.
Structure determination not found.
Occurrence: **Z Johan** 1967 Acta Univ Carolinae Geol no. 2 113-22 = AM 53 1778;
D Grybeck JJ Finney 1968 AM 53 1530-42.
jamborite?(Ni,Fe)(OH)₂(OH,S,aq).

XRPD similar *synthetic* Ni(OH)₂ (= *theophrastite*) indicating layer structure, probably with polytypic relation.

Occurrence: **N Morandi G Dalrio** 1973 AM 58 835-9;
MR 28 369-84.

jamesite Pb₂Zn₂Fe₅(AsO₄)₅O₄.

Structure: **MA Cooper FC Hawthorne** 1999 CM 37 53-60.

Occurrence: **P Keller H Hess PJ Dunn** 1981 ChE 40 105-9 (K705) = AM 66 1275.

jamesonite Pb₄FeSb₆S₁₄.

Should be isostructural with Mn analog *benavidesite* from crystallography.

Dimorphic with *parajamesonite*.

Structure: **N Niizeki MJ Buerger** 1957 ZK 109 161-83 (N360)

Synthetic, SC-XRD, **Y Matsushita Y Ueda** 2003 IC 42 7830-8 (9527).

[jäneckeite Ca₈Al₂Si₂O₁₅. In Portland cement clinker: MM 23 631.]

janggunit Mn⁴⁺_{5-x}(Mn²⁺,Fe³⁺)_{1+x}O₈(OH)₆.

Structure determination not found.

Occurrence: **SJ Kim** 1977 MM 41 519-23.

janhaugite (Na,Ca)₃(Mn,Fe)₃(Ti,Zr,Nb)₂(Si₂O₇)₂O₂(F,OH).

Wöhlerite/låvenite supergroup, *låvenite* structure group, but with double c.

Structure: **H Annehed L Fälth G Raade** 1985 NJMM 7-18 (A629).

Occurrence: MM 48 574.

jankovicite Ti₅Sb₉(As,Sb)₄S₂₂.

Occurrence & structure: **L Cvetkovic & 7 others** 1995 MP 53 125-31 = AM 81 250.

Modular description: **E Makovicky T Balic-Zunic** 1998 NJMA 174 181-210 (M1684).

jarandolite CaB₃O₄(OH)₃. Similar structure to *colemanite* CaB₃O₄(OH)₃.aq.

Structure: AM 91 217-8.

Occurrence and SC-XRD/IR structure: **SV Malinko & 9 others** 2006 AM 91 216-2.

jarlite Na(Sr,Na,void)₇Al₆(Mg,void)₃F₃₂(OH,aq)₂.

Isostructural with *calcjarlite* & *jørgensenite* Na₂(Sr,Ba)₁₄Na₂Al₁₂F₆₄(OH,F)₄.

Structure: **FC Hawthorne** 1983 CM 21 553-60 (H720).

Extended composition range: **H Pauly RN Nielsen** 1992 CM 30 449-55.

Occurrence: MM 23 631.

Synthetic Ba₇CuFe₆F₃₄, defective-jarlite type: **J Renaudin & 3 others** 1987 Rev Chim Miner 24 295-?

Synthetic Ba₇Fe₆F₃₂.2aq, defective-jarlite type: **MP Crosnier-Lope & 3 others** 1995 ZaaC 621 1025-32 (C773).

Synthetic Pb₈Fe²⁺Fe³⁺₂F₂₄: **A Pierrard A & 3** ₃AsO₄(OH)₆. **others** 1995 ZaaC 621 1053.

Synthetic Pb₇Fe²⁺Fe³⁺₆F₃₄: **A Pierrard A de Kozak P Gredin** 1996 ZaaC 622 1200-4 (P628).

jarosewichite Mn³⁺Mn²⁺

Structure determination not found.

Occurrence: **PJ Dunn & 3 others** 1982 AM 67 1043-7;

[Unnamed mineral also described.]

jarosite KFe₃(SO₄)₂(OH)₆. *Alunite* structure group. Review: *Sabelli* p. 25.

Structure: magnetism, IR, **DA Powers & 3 others** 1975 JSSC 13 1-13;

S Menchetti C Sabelli 1976 NJMM 9 406-17;

T Kato Y Miura 1977 MJ 8 419-30;

Raman, **K Sasaki O Tanaike H Konno** 1998 CM 36 1225-35.

Visible & IR spectra: **JL Bishop E Murad** 2005 AM 90 1100-7.

Occurrence: MM 25 633.

Secondary mineral in very acid mine drainage, contrasting with *goethite* & *schwertmannite* in weakly acid to neutral; bacteria may be involved.

In acidic groundwater, XRPD, Mössbauer/SEM: **RB Herbert Jr** 1997 CICIM 45 261-73 (H1210).

Morphology of jarosites from *Thiobacillus ferrooxidans*: **K Sasaki** 1997 = MA 00M/3036.

Growth, evaluation using SEM, AFM: **U Becker B Gasharova** 2001 PCM 28 545-56 (3638).

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

Synthetic KFe₃(CrO₄)₂(OH)₆: synthesis, **A Bonnin A Lecerf** 1966 CRASP C262 1782-4;

crystallography & IR, **Y Cudennec & 3 others** 1980 Rev Chim Mineral 17 158-67;

solubility, **D Baron CD Palmer** 1996 GCA 60 3815-24;
 with jarosite, solution, **D Baron CD Palmer** 2002 GCA 66 2841-53 (7830);
 do, thermochemistry, **C Drouet D Baron A Navrotsky** 2003 AM 88 1949-54.
Synthetic (Ag/K/NH₄)Fe₃(SO₄)₂(OH)₆, using biological and chemical oxidation of Fe,
 morphology: **K Sasaki H Konno** 2000 CM 38 45-56.
Synthetic (K/Na/ H₂O): **C Drouet A Navrotsky** 2003 67 2063-76 (9142).
Synthetic 0-15 wt % AsO₄-subst: XRPD/EXAFS/XANES, **D Paktunc JE Dutrizac** 2003 CM 41 905-19.

jaskolskiite ~Pb_{2+x}Cu_x(Sb,Bi)_{2-x}S; x = 0.2. Matches *synthetic*.
 Homologue of *meneghinite* CuPb₁₃Sb₇S₂₄.
 Structure: **E Makovicky R Nørrestam** 1985 ZK 171 179-94.
 Description: MM 50 748.

jasmundite Ca₂₂Si₈O₃₆S₂. See *alinite* with Cl for S.
 Structure: **LS Dent Glasser CK Lee** 1981 AC B37 803-6 (D539) = MM 46 519;
AM Il'inets & 3 others 1989 SPC 34 40-3 (I94).
 Occurrence: MM 48 574.

jeanbandyite (Fe,Mn)Sn(OH)₆. Distorted ReO₃ structure type.
Schoenfliesite-stottite structure group; XRPD cubic, morphology & optics indicate tetragonal.
 Occurrence: **AR Kampf** 1982 MR 13 235 = MM 48 574;
J Betterton & 4 others 1998 MM 62 707-12.
Natanite FeMn(OH)₆ is cubic.

jedwabite / jedvabite Fe₇(Ta,Nb)₃.
 Occurrence, XRPD & match with *synthetic* (PDF 12-604).
 Occurrence: **MI Novgorodova MR Generalov NV Trubkin** 1997 ZVMO 126 100-3 (N48).

jeffreyite (Ca,Na)₂(Be,Al)Si₂(O,OH)₇. *Melilite* structure group;
 [jvs: presumably a distorted ordered superstructure of dimorph *gugiaite*].
 Occurrence & discussion of members of melilite group: **JD Grice GW Robinson** 1984 CM 22 443-6.

jennite Ca₉H₂Si₆O₁₈(OH)₈.6aq.
 Structure determination not found, but related to *tobermorite*.
 TEM of disordered layering along a-axis: **D Viehland & 4 others** 1997 JACeS 80 3021-8 (V296).
 Occurrence: **AB Carpenter & 4 others** 1966 AM 51 56-74.
 New composition & *metajennite*, **JA Gard & 3 others** 1977 AM 62 365-8.
Tobermorite, jennite and cement gel: **HFW Taylor** 1992 ZK 202 41-50 (T387).
 Mesostructure of C-S-H gels in Portland cement paste:
D Viehland J Li L Yuan Z Xu 1996 JACeS 79 1731-44 (V255);
Z Xu D Viehland 1996 PRL 77 952-5 (X15).
 IR: **P Yu & 4 others** 1999 JACeS 82 742-8 (Y240).
 Ca-EXAFS & Si NMR: **N Lequex & 3 others** 1999 JACeS 82 1299-306 (L987).
 Transformation from Si-S-C-containing *apatite*: **NI Organova et al** 1999 ZVMO 88-90 (O427).

jensenite Cu₃TeO₆.2aq.
 Structure: **JD Grice LA Groat AC Roberts** 1996 CM 34 55-9.
 Occurrence: **AC Roberts & 6 others** 1996 CM 34 49-54.

jentschite TIPbAs₂SbS₆. Homeotypic with *edenharterite*.
 Structure: **P Berlepsch** 1996 SMPM 76 147-57 (B1528) = AM 82 431-2.
 Occurrence: **S Graeser A Edenharter** 1997 MM 61 131-7.

jeppelite (K,Ba)₂(Ti,Fe)₆O₁₃.
 Structure: **AN Bagshaw & 3 others** 1977 Austr J Chem 30 1195-200;
synthetic, *Ilyushin* 2003 IMA 39 951-8 (9580).
 Occurrence: **MW Pryce LC Hodge AJ Criddle** 1984 MM 48 263-6.

jeremejevitte Al₆B₅O₁₅(F,OH)₃. Isostructural with *fluoborite*, *jaffeite* & *painite*.
 Structure: **NI Golovastikov EN Belova NV Belov** 1955 DAN SSSR 104 78-81(G756);
C Rodellas S García- Blanco A Vegas 1983 ZK 165 255-60 (R535).
 New data: **EE Foord RC Erd GR Hunt** 1981 CM 19 303-10.
 Gem update: **K Scarratt D Beaton G DuToit** 2001 Gems Gemology Fall 206-11 (3440).

Occurrence, Namibia: **WE Wilson CL Johnston ER Swoboda** 2002 MR 33 289-301.
Synthetic hydroxyl-: **A Stachowiak W Schreyer** 1998 EJM 10 875-88 (S1992).
Synthetic $Al_6[BO_3]_5F_3$: **YeV Sokolova & 4 others** 1987 Vest Mosk Univ Ser 4 Geol 3 82-4 = MA 88M/3508.

jerrygibbsite (Mn,etc) $9(SiO_4)_4(OH)_2$. *Humite* structure group. Dimorphic with *sonolite*.
 Zn-bearing, **T Kato Y Ito N Hashimoto** 1989 NJMM 410-30 (K740).
 Occurrence: MM 50 748.

jervisite (Na,Ca,Fe)(Sc,Mg,Fe) Si_2O_6 . *Pyroxene* structure group; monoclinic subtype.
 Occurrence: **M Mellini & 3 others** 1982 AM 67 599-603.
Synthetic $NaScSi_2O_6$: **FC Hawthorne HD Grundy** 1973 AC B29 2615-6.

jianshuiite (Mg,Mn) $Mn^{4+}_3O_7 \cdot 3aq$. *Chalcophanite* structure group.
 Occurrence: **G Yan S Zhang M Zhao J Ding D Li** 1992 Acta Min Sinica 12 69 = MM 60 533.

jinboite $Mn_3B_2O_6$. Isostructural with Mg analog *kotoite*.
 Structure: **R Sadanaga T Nishimura T Watanabe** 1965 MJJ 4 380-8;
OS Bondareva MA Simonov NV Belov 1979 SPC 23 272-3.
 Occurrence: MM 33 1139.

jimthompsonite (Mg,Fe) $5Si_6O_{16}(OH)_2$. Dimorphic with *clinojimthompsonite*.
 Structure: **DR Veblen CW Burnham** 1978 AM 63 1000-9.
 Occurrence: MM 42 525.
 Biopyribole polysomes: **BH Grobéty** 1996 AM 81 404-17.
 In meteorites: **AE Rubin** 1997 MPS 32 231-47.
 Replacement of: **BH Grobéty** 1997 CMP 127 2337-47 (G908).

jinshajiangite (Na,Ca) $5(Ba,K)_4(Fe,Mn)_{15}(Ti,Fe,Nb,Zr)_8(SiO_4)_{15}(F,O,OH)_{10}$.
 Structure determination not found.
 Occurrence: **W Hong P Fu** 1982 Geochemistry (China) 1 458-64 = AM 69 567.

jiixianite $Pb(W,Fe)_2(O,OH)_7$. *Pyrochlore* structure group.
 Structure determination not found.
 Occurrence, China: **J Liu** 1979 Acta Geol Sinica 53 46-9 = AM 64 1330.
 Occurrence & XRD, Sweden: **D Holtstam** 1998 GFF 120 373-4 (H1383).

JOAQUINITE STRUCTURE GROUP Includes:
bario-orthojoaquinite (Ba,Sr) $4Fe_2Ti_2Si_8O_{26} \cdot aq$
belorussite-Ce $NaBa_2Ce_2MnTi_2Si_8O_{26}(F,OH) \cdot aq$
joaquinite-Ce $NaBa_2Ce_2Fe(Ti,Nb)_2Si_8O_{26}(OH,F) \cdot aq$
orthojoaquinite-Ca $NaBa_2Ce_2FeTi_2Si_8O_{26}(OH,F) \cdot aq$
orthojoaquinite-La $Na(Ba,Sr)_2La_2FeTi_2Si_8O_{26}(OH,F) \cdot aq$
strontiojoaquinite $Sr_2Ba_2(Na,Fe)_2Ti_2Si_8O_{24}(O,OH)_2 \cdot aq$
strontio-orthojoaquinite $Na(Ba,Sr)_4FeTi_2Si_8O_{24}(OH)_4$
[nanekeveite (Na,K)(Ba,Sr,Na,Re,Fe) $4(Fe,Nb,Ti)Ti(Si,Al)_8O_{25}(OH)_3$
 not approved by IMA, but possible member.]

Orthorhombic & monoclinic subtypes related by twin-type polytypism.
 Cyclosilicates with Ti octahedra.
 Optical spectra for ferrous Fe: **GR Rossman MN Taran** 2001 AM 86 896-903.

joaquinite-Ce $NaBa_2Ce_2Fe(Ti,Nb)_2Si_8O_{26}(OH,F) \cdot aq$.
Joaquinite structure group; monoclinic subtype. Dimorphic with *orthojoaquinite*.
 Structure: **E Cannillo F Mazzi G Rossi** 1972 Tmpm 17 233-46 (C300) = MA 73-1291;
E Dowty 1975 AM 60 872-8.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

joesmithite (Ca,Pb) $Ca_2(Mg,Fe)_5Si_6Be_2O_{22}(OH)_2$. *Clinoamphibole* structure type.
 Structure: **PB Moore** 1968 MM 36 876-8, 1988 AM 73 843-4;
PB Moore DG Van Derveer PK Sen Gupta 1993 MP 48 97-113.
 Occurrence: MM 36 1153.

johachidolite $CaAlB_3O_7$.
 Structure: **PB Moore T Araki** 1972 Nature Phys Sci 240 63-5 (M1149) = MA 74-3006.

Occurrence: MM 28 731; incorrect composition.

johannite $\text{Cu}(\text{UO}_2)_2(\text{SO}_4)_2(\text{OH})_2 \cdot 8\text{aq}$. Cf. with *pseudojohannite*

Review: **Sabelli** p. 26-7; **PC Burns ML Miller RC Ewing** 1996 CM 34 845-80.

Structure: **DE Appleman** 1957 BGSA 68 1696;

K Mereiter 1982 TMPM 30 47-57 (M1256) = AM 68 851.

Thermal analysis & crystal chemistry: 1988 NJMA 159 297-309.

johannsenite $\text{Ca}(\text{Mn,Fe})\text{Si}_2\text{O}_6$. *Pyroxene* structure group; monoclinic subtype.

Structure: **RL Freed DR Peacor** 1967 AM 52 709-20.

Occurrence: MM 23 631.

johillerite $(\text{Na,K})(\text{Mg,Zn,Fe})_3\text{Cu}(\text{AsO}_4)_3$. *Alluardite* group. Close relation to *o'danielite* & *nickenichite*.

Structure: Tsumeh, **P Keller H Hess** 1988 NJMM 395-404 = MM 48 575;

Kamchatka, **KT Tait FC Hawthorne** 2004 CM 42 717-22.

Synthetic $\text{KCo}_3\text{Cu}(\text{As}_{2.6}\text{V}_{0.4})\text{O}_{12}$: **D Frerichs H Müller-Buschbaum** 1994 ZN 49b 1463-6 (F474).

Synthetic $(\text{Rb/Tl})\text{Cd}_4\text{V}_3\text{O}_{12}$, structures & long list of other synthetic phases: **B Mertens H**

Müller-Buschbaum 1997 ZN 49b 663-7.

johnbaumite $\text{Ca}_5(\text{AsO}_4)_3\text{OH}$. *Apatite* structure type.

Structure determination not found.

Occurrence: **PJ Dunn DR Peacor N Newberry** 1980 AM 65 1143-5;

I Kusachi C Henmi S Kobayashi 1996 MJ 18 60-6 (K891).

johnnnesite $\text{Na}_2\text{Mn}(\text{Mg,Mn})_7(\text{AsO}_4)_2(\text{Si}_6\text{O}_{17})_2(\text{OH})_8$.

Layer structure somewhat resembling *howieite*.

Structure: **JD Grice PJ Dunn** 1994 AM 79 991-5.

Occurrence: (D592).

johnsenite-Ce $\text{Na}_{12}(\text{Ce,La,Sr,Ca})_3\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{W}(\text{Si}_{25}\text{O}_{73})\text{CO}_3(\text{OH,Cl})_2$.

Eudialyte group.

Occurrence & SC-XRD structure: **JD Grice RA Gault** 2006 CM 44 105-15.

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

Isostructural with *fillowite* from crystallography.

Occurrence: **A Livingstone** 1980 MM 43 833-6.

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

13 phosphates in IIIAB irons, **EJ Olsen & 5 others** 1999 MPS 34 285-300 (210).

johnstomaite $\text{BaFe}_2\text{Fe}_2(\text{PO}_4)_3(\text{OH})_3$. *Bjarebyite* structure type.

Occurrence, SC-XRD structure: **U Kolitsch A Pring ERT Tiekink** 2000 MP 70 1-14.

johnwalkite $\text{K}_2(\text{Mn,Fe})_4(\text{Nb,Ta})_2(\text{PO}_4)_4\text{O}_4(\text{aq,OH})_4$.

Essentially isostructural with Fe analog *olmsteadite* from crystallography.

Structure determination not found.

Occurrence: **PJ Dunn & 5 others** 1986 NJMM 115-20 (D504).

jokokuite $\text{MnSO}_4 \cdot 5\text{aq}$. *Chalcanthite* structure group.

Review: **Sabelli** p. 17.

Structure determination not found.

Occurrence: **M Nambu K Tanida T Kitamura** 1978 MJJ 9 28-38 (N359) = AM 64 655.

Synthesis: MM 29 987.

joliffeite NiAsSe . Analog of *gersdorffite* NiAsS .

Structure: & occurrence, **H Forster D Rhede G Tischendorf** 2004 CM 42 841-9.

Occurrence & crystallography: **LJ Cabri & 4 others** 1991 CM 29 411-8.

Unnamed CoAsSe with unindexed XRPD differing from quenched synthetic: **do**.

joliotite $(\text{UO}_2)(\text{CO}_3) \cdot 1-2 \text{aq}$.

Structure determination not found.

Occurrence: **K Walenta** 1976 SMPM 56 167-85 (W671) = MM 42 525.

jonesite $\text{Ba}_2(\text{K,Na})\text{Ti}_2[\text{AlSi}_5\text{O}_{18}\text{aq}] \cdot n \text{aq}$.

Structure: SC-XRD, **SV Krivovichev T Armbruster** 2004 AM 89 314-8.

Occurrence: **WS Wise A Pabst JR Hinthorne** 1977 MR 8 453-6 = MM 42 525.

jordanite $Pb_{14}(As,Sb)_6S_{23}$. Deformed *galena* structure type.
 Isostructural series with Sb-rich analog *geocronite*.
 Structure: **BJ Wuensch W Nowacki** 1966 SMPM 46 89-96.
T Ito W Nowacki 1974 ZK 139 161-85 (I60).

jordisite MoS_2 . Trimorphic with *molybdenite-2H* & *-3R*. Poorly crystalline.
 Mechanism of Mo removal from the sea and concentration into black shale: **GR Helz & 6 others** 1996 GCA 60 3631-42 (H1205).
 Occurs in metalliferous black shales, s. China & Germany, SEM, TEM, SAED, EXAFS, XRPD; coexists with new unnamed mineral *MoSC* similar to *synthetic* hydrodesulfurization catalysts in petrochemical industry: **L Kao & 6 others** 2001 AM 86 852-61.

jørgensenite $Na(Sr,Ba)_7NaAl_6F_{32}(OH,F)_2$.
 Iso with *jarlite* $Na(Sr,Na,void)_7Al_6(Mg,void)F_{32}(OH,aq)_2$ & *calcjarlite*.
 Occurrence & structure: **H Pauly & 3 others** 1997 CM 35 175-9 (P666);
FC Hawthorne PC Burns 1998 CM 35 1509-13.

joseite / joseite-A Bi_4TeS_2 . *Tetradymite* mineral/structuregroup, *josëite* subgroup.
 Isostructural with *ikunolite* $Bi_4(S,Se)_3$ & *laitakarite* $Bi_4(Se,S)_3$.
 Structure: **P Bayliss** 1991 AM 76 257-65.
 Occurrence: MM 39 916.

joseite-B $Bi_4(Te,S,Se)_{3-x}$. *Tetradymite* mineral/structuregroup, *josëite* subgroup.
 Structure: **P Bayliss** 1991 AM 76 257-65.

joseite-C $Bi_{16}(TeS_3)_3$.
 Occurrence & XRPD: **AA Godovikov KV Kochetkova YuG Lavrent'ev** 1970 Geol Geofiz 11 123-7 = AM 56 1839-40 [jvs: sceptical comment on need for more study of joseite].

joseite-D
 Occurrence: MM 39 916.

jouravskite $Ca_3Mn^{4+}(SO_4)(CO_3)(OH)_6.13aq$. *Ettringite* structure group.
 Review: **Sabelli** p.18.
 Structure: **MM Granger J Protas** 1969 AC B25 1943-51 (G738).
 General: **HFW Taylor** 1973 MM 39 377-89 (T186).
 Occurrence: **C Gaudefroy F Permingeat** 1965 BSFMC 88 254-62 (G739).

juabite $Cu_5(TeO_4)_2(AsO_4)_2.3aq$.
 Structure: **PC Burns CMC McCracken RA Gault** 1999 submitted MM (B1888).
 Occurrence & crystallography: **AC Roberts & 4 others** 1997 MM 61 139-44.

juangodoyite $Na_2Cu(CO_3)_2$.
 Occurrence & crystallography (matchessynthetic for which structure is known): **J Schlüter D Pohl** 2005 NJMA 182 11-4 = AM 91 1204.

juanitaite $(Cu,Ca,Fe)_{10}Bi(AsO_4)_4(OH)_{11}.2aq$.
 Structure not known, but some relation to *mixite*.
 Occurrence: **AR Kampf WS Wise GR Rossman** 2000 MR 31 301-5.

[juanite ignore.
 Occurrence: MM 23 632.]

julgoldite $Ca_2Fe(Fe,Al)_2(SiO_4)(Si_2O_7)(OH)_2.aq$. *Pumpellyite* structure group.
 Structure: **R Allmann G Donnay** 1973 MM 39 271-81;
 ferric, XRPD & Mössbauer, **G Artioli CA Geiger M Dapiaggi** 2003 AM 88 1084-90.
 Occurrence: MM 37 959.

juliënite $Na_2Co(SCN)_4.8aq$.
 Structure: *synthetic*, **A Preisinger** 1953 TMPM 3 376-80 (P519).
 Occurrence: MM 21 567.

jungite $Ca_2Zn_4Fe_8(PO_4)_9.16aq$.
 Structure determination not found.
 Occurrence: **PB Moore J Ito** 1980 Aufschluss 31 55-61 = AM 65 1067.

junitoite $CaZn_2Si_2O_7.aq$. 3,2-vertex-connected tetrahedral net.
 Structure: **RD Hamilton JJ Finney** 1985 MM 49 91-5.

junoite $\text{Cu}_2\text{Pb}_3\text{Bi}_8(\text{S},\text{Se})_{16}$. Compare with *nordstromite*.
 Structure and classification of bismuth sulfosalts: **WG Mumme** 1975 AM 60 548-58.

juonniite $\text{CaMgSc}(\text{PO}_4)\text{OH}\cdot 4\text{aq}$. Cell dimensions match *overite* & *segelerite*.
 Occurrence, XRPD & IR: **RP Liferovich & 4 others** 1997 ZVMO 4 80-7 (L939) = AM 83 908.

jurbanite $\text{Al}(\text{SO}_4)(\text{OH})\cdot 5\text{aq}$. Dimorphic with *rostite*.
 Review: **Sabelli** p.13.
 Structure: **R Bachet F Cesbron R Chevalier** 1981 BM 104 19-22;
C Sabelli 1985 ZK 173 33-9.
 Occurrence: MM 40 908.

kaatialite $\text{Fe}(\text{H}_2\text{AsO}_4)_3\cdot 5\text{aq}$.
 Structure: *synthetic*, **A Boudjada JC Guitel** 1981 AC B37 1402-5.
 Occurrence: MM 48 575;
K Schmetzer 1986 NJMM 337-42 (S1482).

kadyrelite $?\text{[Hg}_2\text{]}_3(\text{Br},\text{Cl})_3\text{O}_2\text{H}$. Should be isostructural with Cl-rich analog *eglestonite*.
 Structure determination not found.
 Occurrence: **VI Vasil'ev** 1987 ZVMO 116 733-7 = AM 74 503;
 revised composition, **K Mereiter J Zemann AW Hewat** 1992 AM 77 839-42.

kaersutite $\text{NaCa}_2(\text{Mg},\text{Fe})_4\text{Ti}(\text{Si}_6\text{Al}_2)\text{O}_{22}(\text{OH})_2$.
Amphibole structure group; *monoclinic* subtype.
 Structure: **M Kitamura M Tokonami** 1971 Sci Rept Tohoku Univ III XI-2 125-41 (K206);
 oxykaersutite, **M Kitamura M Tokonami N Morimoto** 1975 CMP 51 167-72 (K288);
 ND, **F Pechar H Fuess W Joswig** 1989 NJMM 137-43.
 In meteorites: **AE Rubin** 1997 MPS 32 231-47.

kafehydrocyanite $\text{K}_4\text{Fe}(\text{CN})_6$.
 Occurrence: MM 39 916.

kahlerite $\text{Fe}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 10\text{-}12\text{aq}$. *Autunite* structure group from crystallography.
 Compare with *metakahlerite* with 8aq.
 Structure determination not found.
 Occurrence: **H Meixner** 1953 Der Karinthin 23 277-80 = AM 39 1038;
C Frondel 1958 US Geol Survey Bull 1064 204-5.

kainite $\text{KMg}(\text{SO}_4)\text{Cl}\cdot 3\text{aq}$. Review: **Sabelli** p. 34.
 Structure: **PD Robinson JH Fang Y Ohya** 1972 AM 57 1325-32.

kainosite-Y $\text{Ca}_2(\text{Y}_{1.5}\text{REE}_{0.5})(\text{Si}_3.9\text{Al}_{0.1})\text{O}_{12}\text{CO}_3\cdot \text{aq}$.
 Isostructural with *cenosite*(Y).
 Structure: **IM Rumanova GF Volodina NV Belov** 1967 SPC 11 485-91 (R502);
GF Volodina IM Rumanova NV Belov 1965 DAN USSR ES 149 109-11 = MA 18-224.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

kalborsite $\text{K}_6\text{BaAl}_4\text{Si}_6\text{O}_{20}[\text{B}(\text{OH})_4]\text{Cl}$. *Edingtonite* type of framework.
 Structure: **YuA Malinovskii NV Belov** 1980 SPD 25 331-4 (M1120) = MM 46 520;
AP Khomyakov SM Sandomirskaya YuA Malinovskii 1980 DAN 252 1465-8 (K611).
 Occurrence: (P657).
 New data on Kola specimens: MA 97M/1957.
 Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).

kaliborite $\text{KHMg}_2\text{B}_{12}\text{O}_{16}(\text{OH})_{10}\cdot 4\text{aq}$.
 Structure: **E Corazza C Sabelli** 1966 Accad Naz Lincei 41 527-52 = MA 70-188;
PC Burns FC Hawthorne 1994 CM 32 885-94 (B1601).

kalicinite KHCO_3 .
 Structure: **P Herpin** 1952 CRASP 234 2205-7 = MA 12-94;
I Nitta Y Tomie CH Koo 1952 AC 5 292;
JO Thomas R Tellgren I Olovsson 1974 AC B30 1155-66.
 High-P phase transition: **H Kagi & 4 others** 2003 AM 88 1446-51.

kalifersite $(\text{K},\text{Na})\text{Fe}[\text{SiO}(\text{OH})]\cdot 12\text{aq}$.
 Structure model of alternating ribbons resembling *palygorskite* & *sepiolite*.

XRPD/ED: **G Ferraris & 3 others** 1996 Acta Mineralogica Petrographica Szeged XXXVII Supplementum (F547).
Occurrence: **G Ferraris & 3 others** 1998 EJM 10 865-74.
kalininite $ZnCr_2S_4$. *Spinel* structure type; *linnaeite* mineral group.
Structure determination not found.
Occurrence: **LZ Reznickij EV Skl'arov ZF Ustschapovskaya** 1987 ZVMO 114 622-7.
kalinite $KAl(SO_4)_2 \cdot 11aq$. Potash alum. Compare with Na analog *mendozite*.
Review: **Sabelli** p.15.
Structure determination not found.
Raman: **RL Frost JT Kloprogge** 2001 NJMA 27-40 (951).
Occurrence: **Dana**;
steam condensate, Taupo, New Zealand: **KA Rodgers & 4 others** 2000 MM 64 125-42.
kaliophilite $KAlSiO_4$.
Possible stuffed derivative of *tridymite* structure type, but may be new topology based on up-down linkages of hexagonal 2D net.
Polymorphic with *kalsilite*, *tetrakalsilite* & *trikalsilite*.
Structure determination not found.
Phase transitions in natural: **D Cellai MA Carpenter PJ Heaney** 1992 EJM 4 1209-20.
Occurrence: **Dana**.
Synthetic heated K-exchanged LTA zeolite: **R Dimitrijevic V Dondur** 1995 JSSC 115 214-24.
kalipyrochlore $(K,Sr)_{2-x}Nb_2O_6(O,OH).naq$. *Pyrochlore* structure type.
Structure: **TS Ercit FC Hawthorne P Cerny** 1994 CM 32 415-20 (E377).
Occurrence: MM 42 525.
kalistrontite $K_2Sr(SO_4)_2$. Isostructural with *palmierite* based on crystallography.
Review: **Sabelli** p.34.
Structure determination not found.
Occurrence: **ML Voronova** 1962 ZVMO 91 712-7 = AM 48 708-9.
kalsilite $KAlSiO_4$. Stuffed tridymite structure type.
Polymorphic with *kaliophilite*, *tetrakalsilite* & *trikalsilite*; also *synthetic* orthorhombic polymorph.
Structure: **GF Claringbull FA Bannister** 1948 AC 1 42-3;
JV Smith 1957 AM 42 287-8;
AJ Perrotta JV Smith 1965 MM 35 588-93;
high-low transition, **Y Andou A Kawahara** 1982 MJ 11 72-7;
synthetic, **Y Andou A Kawahara** 1984 MJ 12 153-61;
high-T, **A Kawahara Y Andou F Marumo M Okumo** 1987 MJ 13 260-70;
unquenchable superstructure, 1123-1193 K, **C Capobianco M Carpenter** 1989 AM 74 797-811;
H Xu DR Veblen 1994 GSAAP 26 A112;
XRPD, MAS-NMR, *nepheline*- solid solutions, **GL Hovis & 4 others** 1992 AM 77 19-29;
superstructures & domains, natural & *synthetic*, **H Xu DR Veblen** 1996 AM 81 1360-70;
microstructures & high-T phase transitions, **MA Carpenter D Cellai** 1996 AM 81 561-84;
twinning, **D Cellai P Bonazzi MA Carpenter** 1997 AM 82 276-9;
trigonal/hexagonal transition, high-T XRPD, **D Cellai & 3 others** 1999 AM 84 1950-5.
Immiscibility with *nepheline*, effect of excess Si: **GL Hovis JA Crelling** 2000 AJG 300 238-49.
High P decomposition to *hollandite* $KAlSi_3O_8$ & $KAlO_2$: **L Liu** 1978 Geochem J 12 275-7 (L450).
Thermodynamics of excess Si in Ks-Ne s. s.: **GL Hovis J Roux** 1999 EJM 11 815-27 (H1445).
Occurrence: MM 26 338.
Synthetic on $CaAl_2O_4-SiO_2$: **T Yoskioka** 1970 Bull Chem Soc Japan 43 2317-21 = MA 73-442.
K-exchanged nepheline: **WA Dollase WP Freeborn** 1977 AM 62 336-40.
Synthetic H_3OZnPO_4 : **PA Sandomirskii & 3 others** 1977 Sov Phys Dokl 22 466-8 (S1273).
Synthetic $KLiSO_4$: **S Bhakay-Tanhane A Sequeira R Chidambaram** 1984 AC C40 1648-51.
Synthetic $(Na/K)GaSiO_4/(Na/K)AlGeO_4/(Na/K)GaGeO_4$: **J Barbier ME Fleet** 1987 JSSC 71 361-70.
Synthetic *kalsilite* from heating K-LTA zeolite: **R Dimitrijevic V Dondur** 1995 JSSC 115 214-24.
Synthetic orthorhombic $KAlSiO_4$, thermal expansion to 1273K: **T Ota & 3 others** 1996 JMS 31 1431-3 (O308).
Ion-exchange nepheline- s s with molten $(Li/Na/K/Ag)(NO_3/Cl)$: **I Gregorkiewitz M Gregorkiewitz** 1993 PCM 20 433-41.
Synthetic $KFeSiO_4/RbFeSiO_4/CsFeSiO_4$, XRPD/Mössbauer: **AM Bychkov & 3 others** 1996 G 33 17-32 (B1524).

kaluginite (Mn,Ca)(Mg,Fe³⁺)(PO₄)₂OH.4aq.
 Occurrence: **VI Kydryashova IV Rozhdestvenskaya** ZVMO 120 100 = MM 60 533.
 Not approved by IMA.

kalungaite PdAsSe.
 Occurrence & XRPD: **NF Botelho and 4 others** 2006 MM 70 123-30 = AM 91 1454-5.

kamacite Fe_{1-x}Ni_x. Alloy found in iron meteorites. Isostructural with *iron-alpha*.
 Superstructure?, tetragonal 7.1 x 5.7Å: **AR Ramsden EN Cameron** 1966 AM 51 37-55.
 In meteorites: **AE Rubin** 1997 MPS 32 231-47.

kamaishilite Ca₂Al₂SiO₆(OH)₂. Tetragonal pseudo-cubic; dimorphic with cubic *bicchulite*.
 [jvs: presumably distorted *sodalite* structure type.]
 Structure determination not found.
 Occurrence: **E Uchida JT Iiyama** 1981 Proc Japan Acad 57B 239-43 = MM 48 575.

kambaldaite NaNi₃(CO₃)₃(OH)₃.3aq.
 Edge-shared octahedral framework; cf. *buttgembachite-connellite*, *cacoxenite* & *szymanskiite*.
 Structure: **LM Engelhardt SR Hall AH White** 1985 AM 70 423-7.
 Occurrence: MM 54 666.
 Synthetic Co-analog: **NE Johnson BH Howard** 1995 GSAAP 27 A440.

kamchatkite KCu₃OCl(SO₄)₂.
 Structure: **TV Varaksina & 3 others** 1990 MM 54 613-6.
 Occurrence: MM 54 666.

kamiokite Fe₂Mo₃O₈.
 Structure: **A Sasaki S Yui M Yamaguchi** 1985 MJJ 12 393-9 = AM 62 726;
Y Kanazawa A Sasaki 1986 AC C42 9-11 (K771).
 Synthetic (Mg/Mn/Fe/Co/Ni/Zn/Cd)₂Mo₃O₈: **WH McCarroll L Katz R Ward** 1957 JChS 79 5410-4.
 Synthetic Zn₂Mo₃O₈: **GB Ansell L Katz** 1966 AC 21 482-5.

kamitugaite PbAl(UO₂)₅[(P,As)O₄]₂(OH)₉.9.5aq.
 Structure determination not found.
 Occurrence: **M Deliens P Piret** 1984 BM 107 15-9 (D500).

kamotöite-Y / kamotoite-Y 4UO₃.(Y,Nd,Gd,Sm,Dy)₂O₃.3CO₂.14.5aq.
 XRPD has principal lines similar to *bijvoetite* but weak diffractions and cell dimensions differ.
 Occurrence: **M Deliens P Piret** 1986 BM 109 643-7 (D499).
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

kampfite Ba₆[Si,Al]O₂]₈(CO₃)₂Cl₂ (Cl,aq)₂. *Montregianite-wickenburgite* series.
 Occurrence & SC-XRD structure: **AC Roberts & 3 others** 2001 CM 39 1059-64.

kamphaugite-Y Ca₂(Y,REE)₂(CO₃)₄(OH)₂.3aq.
 Compare with *kimuraite*, *lokkaite*, *schomiokite-Y* & *tengerite*.
 Structure: **C Rømming AK Kocharian G Raade** 1993 EJM 5 685-90 (R539).
 Occurrence: **AV Voloshin & 5 others** 1996 ZVMO 1 109-19 (V262).

kanaekanite Contains K & Na; recognized as separate species from *ekanite*, MM 39 916.
[kaneite MnAs ? *niccolite* structure group. Dubious species: Dana I 208.]

kanemite NaHSi₂O₄(OH)₂.2aq.
 Based on 3-connected boat-shaped hexagonal net and distorted Na-aqua octahedra.
 Precursor to industrial ion-exchanger SKS-6.
 Structure: XRPD Rietveld: **H Gies & 8 others** 1998 MMM 21 183-97 (G1117);
 high-order *synthetic*, **S Vortmann J Rius B Marler H Gies** 1999 EJM 11 125-34 (V322);
 SC-XRD, **LAJ Garvie & 4 others** 1999 AM 84 1170-5.
 Should have similar silicate layer to K-exchanged *synthetic* KHSi₂O₅ & isotypic H₂Si₂O₅, but the
 Na & aq cannot match the K: **MT Le Bihan A Kalt R Wey** 1971 BSFMC 94 15-23 (L650).
 Speculation on layer structure, no atomic coordinates: **K Beneke G Lagaly** 1977 AM 62 763-71.
 Ion exchange/NMR, single-sheet structure: **DC Apperley & 3 others** 1995 JMC 5 577-82 (A592).
 Surface heterogeneity & adsorption: **C Eypert-Blaison & 6 others** 2002 CIM 37 531-42.
 Occurrence: MM 39 916-7.
 2D ²³Na MQ MAS NMR of layer silicates: H Minoru RK Harris 1998 JMC 8 1073-5.

IR & Raman: **Y Huang Z Jiang W Schwieger** 1998 MMM 26 215-9 (H1385).
 Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
Synthesis H-exch $\text{Na}_2\text{Si}_2\text{O}_5$ -delta, part-dehydration, MAS-NMR: **W Wieker & 3 others** 1995 ZaaC 621 1779-84 (W725).
Synthetic pillared kanemite: **S Inagaki Y Fukushima K Kuroda** 1993 JCSCC 680-2 (I97).
Synthetic from delta- $\text{Na}_2\text{Si}_2\text{O}_5$, MAS-NMR: **W Wieker & 3 others** 1995 ZaaC 621 1779-84.
Mesophase molecular sieve derived from: **S Inagaki & 3 others** 1996 ChM 3 2089-95 (I145).
Transformation to silicalite-1 & silicalite-2 by intercalation with tetrapropyl- and tetrabutyl-ammonium cations: **S Shimizu & 6 others** 1996 AdM 8 759-62 (S1651).
Synthesis, modification & catalysis: **E Terres-Rojas** 1997 CI 69 567-94.
Synthesis, solid-state NMR of ^1H , ^{23}Na & ^{29}Si using 1D, 2D cross-polarization, nutation & triple-quantum: **S Hayashi** 1997 JMC 7 1043-8 (H1176).
Synthetic AIPO-nu prepared with n-alkylamines, NMR, FT-IR & ion exchange, speculation on layer structure: **S Cheng J Tzeng B Hsu** 1997 ChM 9 1788-96 (C935).
Synthetic FSM-16-meso phase from: **Y Sakamoto & 6 others** 1998 MMM 21 589-96 (S1967).
Porous materials based on pillaring of: **U Brenn W Schweiger HG Karge** 1999 12th IZC 847-55.
 Recrystallization of Al-bearing to *ferrierite*: **G Pal-Borbely A Szegedi HK Beyer** 2000 MMM 35-36 575-84 (3607).
Synthetic silylated derivative: **A Shimojima D Mochizuki K Kuroda** 2001 ChM 13 3603-9 (3473).
 Hydrothermal transformation to zeolite Beta = *tschermichite*: **T Selvam & 4 others** 2003 MMM 64 41-50 (10006).
 ^2H NMR of surface water: **AJ Benesi & 3 others** 2004 JPCB 108 17783-90 (10850).
 See *grumantite* $\text{NaSi}_2\text{O}_4\text{OH}$.aq, *makatite* $\text{Na}_2\text{Si}_4\text{O}_6(\text{OH})_5$.2aq, *natrosilite* $\text{Na}_2\text{Si}_2\text{O}_5$ & *revdite* $\text{Na}_{16}[\text{SO}_{15}(\text{OH})_6](\text{OH})_{10}$.28aq.

kanonerovite $\text{Na}_3\text{MnP}_3\text{O}_{10}$.12aq.

Occurrence: **VI Popova & 4 others** 2002 NJMM 117-27 (6628).
Synthetic $\text{Na}_3\text{MnP}_3\text{O}_{10}$.12aq: SC-XRD structure, **P Lightfoot AK Cheetham** 1987 AC C43 4-7.
Synthetic $\text{Na}_3(\text{Ni}/\text{Co}/\text{Mn}/\text{Mg}/\text{Zn}/\text{Cd})\text{P}_3\text{O}_{10}$.12aq: **E Rakotomahanina et al** 1972 BSFMC 95 516-20.

kankite FeAsO_4 .3.5aq.

Structure determination not found.
 Occurrence, chemically related arsenates: **F Cech J Jansa F Novak** 1976 NJMM 426-36 (C746).

kanoite $(\text{Mn},\text{Mg})_2\text{Si}_2\text{O}_6$. *Pyroxene* structure group; *monoclinic* subtype.

Structure: **WA Gordon & 4 others** 1981 AM 66 127-44;
 & refs to Mn-bearing pyroxenes, **E Gnos T Armbruster D Nyfeler** 1996 EJM 8 251-61;
 P₂₁/c-C₂/c transition: **T Arlt T Armbruster** 1997 EJM 9 953-64 (A793).
 P-T-X, & displacive phase transitions: **T Arlt et al** 2000 CMP 138 35-45 (A915).
 Occurrence: **H Kobayashi** 1977 J Geol Soc Japan 83 537-42 = AM 63 598.
 Occurrence in meteorites: **AE Rubin** 1997 MPS 32 733-4.

kanonaite $(\text{Mn},\text{Al})\text{AlSiO}_5$. Isostructural with Al analog *andalusite*.

Structure: **Z Weiss SW Bailey M Rieder** 1981 AM 66 561-7.
Ferrian, 1 Al replaced (Mn,Fe): occur, Belgium & XRD structure, **W Schreyer & 3 others** 2004 CMP 147 276-87 (10335).
 Occurrence: MM 43 1062;

hollandite-strontiomelane with k & *braunite*, **W Schreyer A Fransolet H Bernhardt** 2001 CMP 141 560-71;
 Oman opholite, **Y Kugimiya & 3 others** 2004 CM 42 143-53.

Manganian andalusite: **KS Acharyya S Mukherjee A Basu** 1990 MM 54 75-80.

KAOLINITE-SERPENTINE STRUCTURE GROUP Includes

<i>amesite</i>	$\text{Mg}_2\text{Al}(\text{Si},\text{Al})\text{O}_5(\text{OH})_4$
<i>antigorite</i>	$(\text{Mg},\text{Fe})_3\text{Si}_2\text{O}_5(\text{OH})_4$
[<i>baumite</i>	discredited]
<i>berthierine</i>	$(\text{Fe}^{2+}, \text{Fe}^{3+}, \text{Mg})_{2-3}(\text{Si},\text{Al})_2\text{O}_5(\text{OH})_4$
<i>brindleyite</i>	$(\text{Ni},\text{Mg},\text{Fe})_3\text{Al}(\text{Si},\text{Al})\text{O}_5(\text{OH})_4$
<i>clinochrysotile</i>	$\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$
<i>cronstedtite</i>	$\text{Fe}^{2+}_2\text{Fe}^{3+}(\text{Si},\text{Fe})\text{O}_5(\text{OH})_4$
<i>dickite</i>	$\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$
<i>endellite</i>	$\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$.2aq
[<i>ferrikaolinite</i>	synthetic]

<i>fraipontite</i>	$(\text{Zn,Al})_3(\text{Si,Al})_2\text{O}_5(\text{OH})_4$
<i>greenalite</i>	$(\text{Fe}^{2+}, \text{Fe}^{3+})_2\text{-}_3\text{Si}_2\text{O}_5(\text{OH})_4$
<i>halloysite</i>	$\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$
<i>kaolinite</i>	$\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$
<i>kellyite</i>	$(\text{Mn, Mg, Al})_3(\text{Si, Al})_2\text{O}_5(\text{OH})_4$
<i>lizardite</i>	$\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$
<i>nacrite</i>	$\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$
<i>nepouite</i>	$\text{Ni}_3\text{Si}_2\text{O}_5(\text{OH})_4$
<i>orthochrysotile</i>	$\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$
<i>parachrysotile</i>	$\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$
<i>pecoraite</i>	$\text{Ni}_3\text{Si}_2\text{O}_5(\text{OH})_4$

FT Raman spectroscopy: **RL Frost** 1997 CIM 32 65-77 (F527).

Defect structures in kaolin minerals, HRTEM: **T Kogure A Inoue** 2005 AM 90 85-9.

Heterogeneous Ni distribution, hydrous silicates Caledonia: **A Manceau G Calas** AM 70 549- 58.

Ni/Mg substitution, XAS: **A Manceau G Calas** 1986 CIM 21 341-60 (421).

Kaolinite-to-*mullite* transition, DTA, TG, DTG: **JL Holm** 2001 PCCP 3 1362-5 (1442).

Cm(III) on *smectite* & kaolinite, laser fluorescence: **T Stumpf & 3 others** 2001 EST 35 3691-4 (3018).

Kaolin polytype vs hot-fluid pulse, European Margin thrust: **J Parnell & 8 others** 2003 MM 68 419-32.

kaolinite $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$. Kaolinite-*serpentine* mineral group.

Polymorphic with *dickite*, *halloysite* & *nacrite*.

Structure: **GW Brindley K Robinson** 1945 N 156 661-3;

GW Brindley K Robinson 1946 MM 27 242-53;

GW Brindley M Nakahira 1958 MM 31 781-6;

BB Zvyagin 1960 Kristallografiya 5 32-42;

PR Suitch RA Young 1983 CICIM 31 357-66;

JM Adams 1983 CICIM 31 352-6;

A Hewat RA Young 1987 CICIM 32 233-4;

RA Young AW Hewat 1988 CICIM 36 225-32;

DL Bish RB Von Dreele 1989 CICIM 37 289-96 (B953);

ED, C-centering, non-H atoms, **JG Thompson JD Fitzgerald RL Withers** 1989 CICIM 37 563-5;

XRPD, 1.5 K, **DL Bish** 1993 CICIM 41 738-44;

XRPD, **L Smrcok** 1995 ZK 210 177-83;

submicrometer synchrotron XRD, **RB Neder & 6 others** 1996 ZK 211 763-5 (N433);

RB Neder & 5 others 1999 CICIM 47 487-94 (N525);

ab initio energy minimization, **JD Hobbs & 4 others** 1997 AM 82 657-62;

deuterated, neutron time-of-flight, **E Akiba & 8 others** 1997 CICIM 45 781-8 (A812);

Fe XANES, natural/calcined, **AF Gualtieri A Moen DG Nicholson** 2000 EJM 12 17-23;

vibration spectra & model, **D Bougeard KS Smirnov E Geidel** 2000 JPC B 104 9210-7;

molecular dynamics of OH, **L Benco & 3 others** 2001 AM 86 1057-65;

IR & modeling, **E Balan & 3 others** 2001 AM 86 1321-30;

¹⁷O MAS & 3QMAS, **SK Lee JF Stebbins** 2003 AM 88 493-500;

disorder broadening of EPR lines vs Fe, **JM Gaitte F Muller S Jemai** 2003 PCM 36 366-72 (9244)

morphology vs order, **J Kameda & 2 others** 2005 AM 90 1462-5.

Stacking faults: **A Plancon & 4 others** 1989 CICIM 37 203-10;

AS Bookin & 3 others 1989 CICIM 37 297-307.

Fourier transform Raman, **RL Frost** 1995 CICIM 43 191-5;

do 1997 CIM 32 65-77;

do SJ van der Gaast 1997 CIM 32 471-84 (F576);

do et al 1998 Analyst 123 611-6.

Structure models based on energy minimization: **RF Giese** 1973 CICIM 21 145-9;

RF Giese P Datta 1973 AM 58 471-9;

DC Collins CRA Catlow 1991 AC B47 678-82 (C770);

G Artioli & 3 others 1995 CICIM 43 438-45 (A670).

Crystal chemistry of kaolinite & Fe-Mn oxides, XAS & EPR: **J Muller & 5 others** 1995 AJS 295 1115-55 (M1498).

Fe ordering, ^{29}Si & ^{27}Al MAS NMR: **PA Schroeder RJ Pruet** 1996 AM 81 26-38.

Fe^{3+} EPR spectra: **JM Gaité P Ermakoff JP Muller** 1993 PCM 20 242-7;
E Balan & 3 others 1999 CICIM 47 605-16 (B1961);
E Balan et al 2000 CICIM 48 439-45 (B2023).

Molecular dynamics modeling: **BJ Teppen & 4 others** 1997 JPC B 101 1579-87 (T504).

Hydroxyl deformation in kaolins: **RL Frost** 1998 CICIM 46 280-9 (F617).

Preference of *illite* vs. kaolinite for brine, and of kaolinite over *illite* for oil: **J Bantignies C Moulin H Dexpert** 1997 CICIM 45 184-93 (B1677).

Adsorption of neutral polysaccharides: **C Chenu CH Pons M Robert** 1985 Proc Int Clay Conf Denver 375-81 (C988).

P effect on intercalation: **RL Frost & 3 others** 1998 AM 83 1182.

Single-/triple-quantum ^{27}Al MAS-NMR of thermal transformation: **J Rocha** 1999 JPCB 103 9801-4 (R923).

Alkali halide complexes, Raman: **KH Michaelian & 3 others** 1998 Appl Clay Science 13 233-43.

Pb/Cu/Zn/Co/Mn(II), adsorption isotherms: **J Ikhsan BB Johnson JD Wells** 1999 JCIS 217 403-20 (425).

Intercalated K acetate, XRPD/Raman, 298-573 K: **RL Frost & 3 others** 2000 La 16 7421-8.

Multiple-quantum & cross-polarized ^{27}Al MAS-NMR of mechanical mixtures of *gibbsite* and kaolinite that produce *mullite* ceramic: **SE Ashbrook et al** 2000 JPCB 104 6408-16.

Sr adsorption, EXAFS: **N Sahai & 3 others** 2000 JCSI 222 198-212.

Thermal transformation, paramagnet Fe, XRD/EPR: **A Djemai & 5 others** 2001 JACeS 84 1017-24 (2114).

Laterite weathering, IR: **A Beauvais F Bertaux** 2002 CICIM 50 314-30 (7462).

Grinding, XRPD: **RC Reynolds Jr DL Bish** 2002 AM 87 1626-30.

Dissolution rate: effect of acid pH & T, **J Cama V Metz J Ganor** 2002 GCA 66 3913-26 (8007).

Hydrothermal transformation to *illite* at 473 & 573 K: **M Bentabol & 3 others** 2002 CIM 38 161-72.

Synthetic order/disorder organic intercalates 8.4Å: **PM Costanzo RF Giese Jr** 1990 CICIM 38 160-70.

Synthetic Cu-substituted: **S Petit & 4 others** 1995 CICIM 43 482-94 (P584).

Synthetic polyethylene glycol intercalate: **JJ Tunney C Detellier** 1996 ChM 8 927-35 (T469).

Synthetic CsF intercalate: **I Lapides S Yariv N Lahav** 1995 CIM 30 287-94.

Synthetic methoxy/interlamellar aluminol surface: **JJ Tunney C Detellier** 1996 JMC 6 1679-85 (T489).

Conversion to LTA zeolite: **A Gualtieri & 3 others** 1997 PCM 24 191-9 (G910).

Deuteration of hydroxyl, diffuse reflectance FTIR: **U Johansson et al** 1998 Analyst 123 641-5.

Synthetic 10 Å: & 8.4 Å, XRD & IR, **S Jemal & 3 others** 1999 JAC 32 968-76 (J356);
dehydration, XRD & SAXS, **S Naamen & 3 others** 2003 JAC 36 898-905 (9064).

Synthetic intercalated formamide, NMR: **X Xie S Hayashi** 1999 JPCB 103 5949-55.

Synthetic, Co(II) sorption/precipitation in pure water: **HA Thompson GA Parks GE Brown** 2000 JCIS 222 241-53 (T637).

Synthetic K(Cl/Br/I) intercalates, IR: **S Yariv et al** 2000 CICIM 48 10-8 (Y264).

Synthetic p-nitroaniline intercalate, XRPD/NMR: **K Kuroda et al** 1999 ChC 2253-4 (K1221).

Synthetic amino acid intercalates, XRPD, DTA-TG, IR: **M Sato** 1999 CICIM 47 793-802 (S2131).

Synthetic, crystal properties/energetics: **C Fialips A Navrotsky S Petit** 2001 AM 86 304-11.

Synthesis, high Fe(III): **I Iriarte & 6 others** 2005 CICIM 53 1-10.

Adsorption Cs 137 & Sr 90 : **CH Jeong** 2001 JESH A36 1089-99 (2940).

Adsorption of silane coupling agents: **U Johansson & 3 others** 1999 CIM 34 239-46 (2710).

Sorption of lanthanides: **F Coppin & 4 others** 2002 ChG 183 57-68 (4328).

Adsorption benzamide on waste from fertilizer industry: **BP Kelleher TF O'Dwyer** 2002 50 331-5 (7463).

Adsorption of hydrazine: **RL Frost & 4 others** 2002 JCIS 251 350-9 (7521).

Radio-frequency plasma-induced H-bonding: **H Ming KM Spark** 2003 JPCB 107 694-702 (8639).

Siderophore adsorption/dissolution pH 3-7 296 K: **DR Rosenberg PA Maurice** 2003 GCA 67 223-9 (8651).

Chemical activation with acid & alkali: **C Belver MAB Munoz MA Vicente** 2002 ChM 14 2033-43 (7304).

Adsorption AuCl $_4$ vs pH/T/crystallinity: **H Hong Z Sun Z Fu X Min** 2003 CICIM 51 502-12.

Interstratified -smectite: mechanism of smectite kaolinization, **T Dudek & 2 others** 2002 AM 91 259-70.

kapitsaite-Y (Ba,K,Pb,Na) $_4$ (Y,Ca,REE) $_2$ Si $_8$ B $_2$ (B,Si) $_2$ O $_28$ F. Isotypic with *hyalotekite*.

Occurrence & SC-XRD structure: **EV Sokolova et al** 2000 NJMM 74-84 (S2162).

kappa alumina Al $_2$ O $_3$. Superstructure of kappa-prime.

Synthetic: **P Liu J Skogsmo** 1991 AC B47 425-33 (L656).

kappa-prime alumina Al $_2$ O $_3$. ABAC-hexagonal stacking of oxygens.

Synthetic: **M Okumiya & 3 others** 1971 Bull Chem Soc Japan 44 418-23.

kapustinitite Na $_{5.5}$ Mn $_{0.25}$ ZrSi $_6$ O $_{16}$ (OH) $_2$. *Lovozerite* group.

Occurrence & structure: **IV Pekov & 4 others** 2003 ZVMO 132-6 1-14 (10518);
 SC-XRD, **NA Yamnova & 3 others** 2004 DES 397 5 658-62 (10664).

karasugite $\text{SrCaAl}[\text{F},\text{OH}]_7$.
 Structure determination not found.
 Occurrence: **OV Petersen & 4 others** 1994 NJMM 209-16 (P487).

karelianite V_2O_3 . *Hematite* structure type.
 Structure: **RE Newnham YM de Haan** 1962 ZK 117 235-7;
synthetic 300-873K, **WR Robinson** 1975 AC B31 1153-60;
LW Finger RM Hazen 1980 J Appl Phys 51 5362-7 (F224);
MG Vincent K Yvon J Ashkenazi 1980 AC A36 808-13.
 Occurrence: MM 33 1140.

karibibite $\text{Fe}_2\text{As}_4(\text{O},\text{OH})_9$.
 Structure determination not found.
 Occurrence: **O Von Knorring TG Sahama P Rehtijärvi** 1973 Li 6 265-72 = AM 59 382.

karlite $(\text{Mg},\text{Al})_7(\text{BO}_3)_3(\text{OH},\text{Cl})_5$.
 Structure: **P Bonazzi & 3 others** 1986 NJMM 253-62 (B1146).
 Occurrence: MM 46 520.

karnasurtite-Ce $(\text{Ce},\text{La},\text{Th})(\text{Ti},\text{Nb})(\text{Al},\text{Fe})(\text{Si},\text{P})_2\text{O}_7(\text{OH})_4.3\text{aq}$. *Metamict*.
 Composition near *hydrocerite*.
 Occurrence: MM 32 963.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

karpatite $\text{C}_{24}\text{H}_{12}$. *Coronene* structure.
 Structure: **M Blumer** 1975 CG 16 245-56 = AM 61 1055.

karpinskite $?(Mg,Ni)_2\text{Si}_2\text{O}_5(\text{OH})_2$.
 Structure determination not found.
 Occurrence: **IA Rukavishnikova** 1956 Kora Vyvetrivaniya 2 124-78 = AM 42 584.

karpinskyite $\text{Na}_2(\text{Be},\text{Zn},\text{Mg})\text{Al}_2\text{Si}_6\text{O}_{16}(\text{OH})_2$.
 Occurrence: MM 31 963.

[karrooite MgTi_2O_5 . *Pseudobrookite* structure group; problem of nomenclature with respect to *armalcolite*, **JFW Bowles** 1988 AM 73 1377-83.
 Structure: **L Pauling** 1930 ZK 73 97-112;
 structural/thermodynamic/kinetic aspects of disorder, **NE Brown A Navrotsky** 1989 AM 74 902-12;
 neutron powder diffraction, **BA Wechsler RB Von Dreele** 1989 AC B45 542-9;
 high-P crystal chemistry, **H Yang RM Hazen** 1999 AM 84 130-7;
 Raman of oriented SC, site disorder, **H-P Liermann & 2 others** 2006 AM 91 790-3.
 Thermodynamics of cation ordering: **MS Ghiorso H Yang RM Hazen** 1999 AM 84 1370-4.
 Thermodynamics & stability: **D Xirouchakis & 4 others** 2002 AM 87 658-67.
Synthetic: MM 32 963-4.
Synthetic $(\text{Li}_{0.5}\text{Mg}_{0.25}\text{Ti}_{0.25})\text{Ti}_2\text{O}_5$: **DP Romanov & 4 others** 1986 SPD 31 94-6 (R495).]

karupmøllerite-Ca $(\text{Na},\text{Ca},\text{K})_2\text{Ca}(\text{Nb},\text{Ti})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.7\text{aq}$. *Labuntsovite* group.
 Structure: **NA Yamnova & 4 others** 2000 Doklady RAN 375 487-90.
 Occurrence & XRPD: **IV Pekov & 6 others** 2002 NJMM 433-44 (8336).

kashinite $(\text{Ir},\text{Rh})_2\text{S}_3$. Isostructural series with Rh-rich analog *bowieite*.
 Structure: *synthetic*, **E Parthé D Hohnke F Hulliger** 1967 AC 23 932-40.
 Occurrence: MM 50 749.

kasolite $\text{Pb}(\text{UO}_2)_2\text{SiO}_4.\text{aq}$.
 Review: **PC Burns ML Miller RC Ewing** 1996 CM 34 845-80.
 Structure: **A-M Huynen & 2 others** 1963 Bull acad roy Belgique Cl-Sci 5 ser 49 192-201 = MA 17-258;
VI Mokeeva 1965 SPC 9 621-2 (M1134);
A Rosenzweig RR Ryan 1977 Cryst Str Comm 6 617-21.

[kasparite Supposed to equal *cobaltoan pickeringite*. jvs: XRPD do not match well.]

kassite $\text{CaTi}_2\text{O}_4(\text{OH})_2$.
 Closely isostructural with Ce analog *lucasite-Ce*, may be subtle differences involving distortion.
 Structure: **LS Rudashevskii IB Firfarova DI Tsekhobal'skaya** 1977 ZVMO 106 114-20;

model of Ca/PbSb₂O₆ type based on electron & X-ray diffraction of natural & Al
smelting by-product: **PG Self PR Buseck** 1991 AM 76 283-7
chromian, Urals, SC-XRD, **IE Grey & 3 others** 2003 AM 88 1331-5.
Occurrence: MM 36 1153.
[*Synthetic* PbSb₂O₆: **A Magneli** 1941 Ark Kemi Mineral Geol 15B no.3 6p.]
See *cafetite* CaTi₂O₅.aq.

kastningite (Mn,Fe,Mg)Al₂(PO₄)₂(OH)₂.8aq.
Analog of *stewartite* & polymorph of *mangangordonite*.
Structure: **G Adiwidjaja & 3 others** 1999 ZK 214 465-8 (A903).
Occurrence & SC-XRD structure: **J Schlüter & 3 others** 1999 NJMM 1999 40-8.

katayamalite (K,Na)Li₃Ca₇(Ti,Fe,Mn)₂(Si₆O₁₈)₂(OH,F)₂. Ring structure.
Isostructural with F-rich analog *baratovite*, except for details.
Structure: **T Kato N Murakami** 1985 MJJ 12 206-17;
WH Baur D Kassner 1992 EJM 4 839-41.
Occurrence: MM 50 749.

katoite Ca₃Al₂(SiO₄)(OH)₈. *Hydrogrossular* structure group.
Structure: **M Sacerdoti E Passaglia** 1985 BM 108 1-8 (S1517);
NPD <9 GPa, **GA Lager RB Von Dreele** 1996 AM 81 1097-104;
SC-XRD <5 GPa, symmetry change, **GA Lager & 3 others** 2002 AM 87 643-7;
low-T IR & Raman, **BA Kolesov CA Geiger** 2005 AM 90 1335-41.
Occurrence & nomenclature: **E Passaglia R Rinaldi** 1984 BM 107 605-18 (P312);
O Ferro & 5 others 2003 EJM 15 419-26.

katoptrite (Mn₅Sb₂)(Mn₈Al₄Sb₂Si₂)O₂₈.
Structure: **PB Moore T Araki GD Brunton** 1976 NJMA 127 47-61 (M565).

kawazulite Bi₂Te₂Se. *Tetradymite* mineral/structure type; tetradymite subgroup.
Structure: **P Bayliss** 1991 AM 76 257-65.
Occurrence: MM 38 993-4;
M Shimizu & 3 others 1995 NJMA 169 305-8 (S1524).

kazakhstanite Fe³⁺₅V⁴⁺₃V⁵⁺₁₂O₃₉(OH)₉.8.5aq.
Structure determination not found.
Occurrence: **EA Ankinovich GK Bekenova NI Podlipaeva** 1989 ZVMO 118 95-100 (A560).

kazakovite Na₆(Mn,H₂)TiSi₆O₁₈. *Lovozerite* structure group.
Structure: **AA Voronkov & 4 others** 1979 SPD 24 132-4 (V178) = MA 80-2849.
Occurrence: MM 39 917.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).

[keatite SiO₂. *Synthetic* polymorph: MM 30 736.
Structure: **J Shropshire PP Keat PA Vaughan** 1959 ZK 112 409-13 (S58).
Synthesis from silica glass: **B Martin** 1995 EJM 7 1389-97 (M1352).
Synthetic BeP₂O₆-III: **E Schultz F Liebau** 1981 ZK 154 115-26 (S1224).
Synthetic HAlSi₂O₆: **T Vogt H Paulus H Fuess G Müller** 1990 ZK 190 7-18 (V172).
Synthetic (Na/K)AlSi₂O₆: **B Baumgarten G Müller** 1990 EJM 2 155-62 (B969).
Synthesis/crystallography, (H/Li/Cu/Na/K)AlSi₂O₆: **M Sternitzke G Müller** 1991 EJM 3 769-76.]

keckite (Ca,Mg)(Mn,Zn)₂Fe³⁺₃(PO₄)₄(OH)₃.2aq. *Jahnsite-whiteite* structure group.
Structure determination not found.
Occurrence: **A Mücke** 1979 NJMA 134 183-91 (M1213).

kegelite Pb₈Al₄Si₈(SO₄)₂(CO₃)₄(OH)₈O₂₀.
Review: **Sabelli** no structure.
Redefined: **PJ Dunn & 3 others** 1990 AM 75 702-4.
See *mattheddleite* Pb₂₀(SiO₄)₇(SO₄)₄Cl₄ & unnamed mineral
Pb₂₇(Al_{1.6}Mn_{0.4})(Si₆O₁₅)₂(SO₄)₂O₁₀(OH)₂₄.

[kehoite not valid: MM 56 256-8.]
keilite (Fe,Mg)S. Analog of *niningerite*.

Occurrence & XRPD structure: **M Shimizu H Yoshida JA Mandarino** 2002 CM 40 1687-92.
keithconnite Pd₂₀Te₇.
Structure: **P Bayliss** 1990 CM 28 751-5.
Occurrence: MM 43 1062;
Sierra Leone, **JFW Bowles** 2000 MP 68 75-84 (B2018).
keiviite-Y (Y,Yb)₂Si₂O₇. See below.
keiviite-Yb (Yb,Y)₂Si₂O₇. Isostructural with *thortveitite*.
Synthetic: **OV Yakubovich & 4 others** 1986 SPD 31 930-2.
Occurrence: MM 48 575.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
keldyshite NaZrSi₂O₆OH. Structure similar to *hibinskite*.
Vertex-shared octahedral-tetrahedral net: Consortium for Theoretical Frameworks net 1081.
Structure: **AD Khalikov AP Khomiakov SA Makhmudov** 1978 SPD 23 8-10 (K621).
Occurrence: MM 33 1140.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
Synthetic K₂ZrSi₂O₇: **AN Chernov & 3 others** 1971 SPD 15 711-3.
kellyite (Mn,Mg,Al)₃(Si,Al)₂O₅(OH)₄. *Kaolinite-serpentine* structure group.
Two polytypes recognized, 6-rhombohedral & 2-hexagonal, others expected, crystallography &
XRPD but no atomic coordinates: **DR Peacor & 3 others** 1974 AM 59 1153-6.
Relation to *grovesite* is unclear.
kelyanite Hg₃₆Sb₃(Cl,Br)₉O₂₈.
Structure determination not found.
Occurrence: **VI Vasil'ev YuG Lavrent'ev NA Pal'chik** 1982 ZVMO 111 330-4.
kemmlitzite (Sr,Ce,La)Al₃(AsO₄)(P/S)O₄(OH)₆.
Isostructural with P analog *svanbergite* based on crystallography. Review: **Sabelli** p.25.
Cell dimensions: **J Hak & 3 others** 1969 NJMM 201-12 (H945).
Review: (different formula) **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
kempite Mn₂Cl(OH)₃. Isostructural with Cu analog *atacamite* based on crystallography.
Isostructural series with *hibbingite*.
Structure determination not found.
Occurrence: **Dana**.
kenhsuite Hg₃S₂Cl₂-gamma.
Structure: *synthetic*, **S Durovic** 1968 AC B24 1661-70.
Occurrence/XRPD (like *synthetic* except for O/D details): **JK McCormack FW Dickson** 1998 CM 36 201-6.
[kennedyite Pseudobrookite group; name abandoned. MM 32 964.]
kentbrooksites Na₁₅Ca₆Mn₃Zr₃NbSi₂₅O₇₃(O,OH,aq)₂(F,Cl)₂.
Mn-REE-Nb-F endmember of *eudialyte* mineral group.
Description & structure: **O Johnsen JD Grice RA Gault** 1997 EJM 10 207-19 (J234).
Sr-Fe analog, structure: **IA Ekimenkova RK Rastsvetaeva AP Khomyakov** 2000 CrR 45 930-3.
K-analog, structure: **RK Rastsvetayeva & 2 others** 2005 DAN 403 636-9 = AM 91 1205.
kentrolite Pb₂Mn₂Si₂O₉. Isostructural with Fe analog *melanotekite*.
Structure: **O Gabrielson** 1963 Arch Mineral Geol Sverige 3 141-51 = MA 16-133;
PB Moore & 3 others 1991 AM 76 1389-99.
Synthetic Pb₂In₂Si₂O₉: **J Werner H Müller-Buschbaum** 1997 ZN 52 b 1213-8 (W860).
kenyaite Na₂Si₂₂O₄₁(OH)_{8.6aq}.
Structure determination not found.
²⁹Si NMR: **W Schwieger D Heidemann K-H Bergk** 1985 Rev Chim Mineral 22 639-50 (S1527).
2D ²³Na MQ MAS NMR of layered silicates: **H Minoru RK Harris** 1998 JMC 8 1073-9.
Surface heterogeneity & adsorption: **C Eypert-Blaison & 6 others** 2002 CIM 37 531-42.
Occurrence: **HP Eugster** 1967 S 157 1177-80 (E303) = AM 53 510.
XRPD: **JL McAtee Jr R House HP Eugster** 1968 AM 53 2061-9.
Synthesis & pillaring: **EW Valyocsik** 1990 PCT Int Appl WO 91 12204 = CA 115:186362r.
Synthetic Fe analog, XRPD: **RB Borade A Clearfield** 1997 ChC 277-8 (B1563).

Synthesis, kenyaite/MCM-22 zeolite, Al effect: **M Cheng & 4 others** 2001 MMM 42 307-16 (986).
Synthetic B-, sharp-peaked NMR & XRPD, and of *magadiite*/kenyaite mixtures, **CA Fyfe J Skibsted W Schwieger** 2001 IC 40 5906-12 (3511).

kermesite Sb_2S_2O .

Structure: **V Kupcik** 1967 Nw 54 114;

P Bonazzi S Menchetti C Sabelli 1987 NJMM 557-67 (B1387).

Gudmundite-antimony mineralization, Quebec ophiolite, late hypogene *kermesite*, *senarmontite* & *valentinite*: **C Normand M Gauthier M Jebrak** 1996 EG 91 149-63 (N408).

kernite $Na_2B_4O_6(OH)_2 \cdot 3aq$.

Structure: **RF Giese** 1966 S 154 1453-4;

G Cialdi E Corazza C Sabelli 1967 Accad Naz Lincei Rend Cl Sci Fis Mat Nat 42 236-51 = MA 69-2921;

P Coppens WF Cooper FK Larsen 1972 S 176 165-6;

WF Cooper & 3 others 1973 AM 58 21-31;

boron K-edge XANES, **ME Fleet S Muthupari** 2000 AM 85 1009-21.

Occurrence: MM 21 560.

kerstenite $PbSeO_4$. Problem because original specimen has not been studied by X-rays.

New occurrences of minerals with above composition: **J Goni C Guillemin** 1953 BSFMC 76 422-9 (G736) = AM 39 850.

Synthetic $PbSeO_4$: **CWFT Pistorius MC Pistorius** 1962 ZK 117 259-71 (P518).

kësterite / kesterite $Cu_2(Zn,Fe)SnS_4$. *Stannite* structure type.

Structure: **SR Hall JT Szymanski JM Stewart** 1978 CM 16 131-7.

Occurrence: MM 31 963.

Solid solution with *cernyite*: **AV Chicagov EuG Osadchii ZV Usyakovskaya** 1986 NJMA 15-22.

EPR & SQUID magnetometry: **GP Bernardini et al** 2000 PCM 27 453-61 (B2022).

Cu_2SnS_3 -ZnS-MnS phase relations at 1093 & 973 K: **EG Osadchii** 1996 NJMM 201-11 (O320).

kettnerite $CaBi(CO_3)OF$.

Structure: partly correct, **V Synecek L Zak** 1960 Czech J Phys 10 195-207;

revised, **JD Grice MA Cooper FC Hawthorne** 1999 CM 37 923-7.

Compare with *bismutite* & *beyerite*.

Occurrence: MM 31 963.

keyite $Cu^{2+}_3(Zn,Cu^{2+})_4Cd_2(AsO_4)_6 \cdot 2aq$.

Structure & redefinition: **MA Cooper FC Hawthorne** 1996 CM 34 623-30.

Occurrence: **PG Embrey EE Fejer AM Clark** 1977 MR 8 87-90 (E310) = AM 62 1259.

keystoneite $(Mg_{0.8}Hf_{0.7}Na_{0.1})(Ni_{1.3}Fe_{0.5}Mn_{0.1})(TeO_3)_3 \cdot 4.7aq$.

Isostructural with *kinichilite* & *zemannite*.

Structure: **ME Back & 3 others** 1988 Geol Mineral Assoc Canada Mtg 13 Abstr A4 = MM 60 534.

khademite $Al(SO_4)(F,OH) \cdot 5aq$.

Confused literature on relation to supposed OH-rich analog *rostite*, [jvs: here assumed to be mineral species for future accreditation].

Structure: **B Bachet F Cesbron R Chevalier** 1981 BM 104 19-22 (B1303);

FP Cesbron P Bayliss 1988 MM 52 133-4.

khaidarkanite $Cu_4Al_3(OH)_{14}F_3 \cdot 2aq$.

Occurrence & structure: **NV Chukanov & 4 others** 1999 ZVMO 78 58-60 (C1157).

khamrabaevite $(Ti,V,Fe)C$. *Halite* structure type. MM 50 749.

khanneshite $(Na,Ca)_3(Ba,Sr,Ln,Ca)_3(CO_3)_5$. *Burbankite* structure type.

Structure: **YuV Beovitskaya & 4 others** 2002 Krist 47-1 46-9;

Raman, **AN Zaitsev AR Chakhmouradian** 2002 CM 40 103-20.

Occurrence: MM 46 520. [jvs: also listed with Ce instead of Ln.]

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

kharaelakhite $(Pt,Cu,Pb,Fe,Ni)_9S_8$. Possibly related to *pentlandite*.

XRPD: **AD Genkin & 3 others** 1985 MZh 7 78-88 = MA 74 1215.

khatyrkite $(Cu,Zn)Al_2$.

Matches *synthetic* $CuAl_2$: **AJ Bradley P Jones** 1933 J Inst Metals 51 131-?.

Occurrence: **LV Razin NS Rudashevskij LN Vyalsov** 1985 ZVMO 114 90-100 = AM 71 1278.

khibinskite $K_2ZrSi_2O_7$. Structure similar to *parakeldyshite*.
Vertex-connected octahedral-tetrahedral net 1127 of Consortium for Theoretical Frameworks.
Monoclinic distortion of rhombohedral prototype. Types I & II.

Structure: **AN Chernov & 3 others** 1970 DAN SSSR 193 1293-6;

synthetic, **NA Nosyrev & 5 others** 1976 DAN SSSR 231 1351-3.

Occurrence: **AP Khomyakov & 4 others** 1974 ZVMO 103 110-6 = AM 60 340.

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

Type II: *synthetic*, **NA Nosyrev & 5 others** 1977 SPD 21 696-7 (N334) = MA 78-2696.

khinite $PbCu_3TeO_4(OH)_6$. Dimorphic with *parakhinite*.

Structure determination not found.

Occurrence: **SA Williams** 1978 AM 63 1016-9.

[khlopinite $\sim Fe_2Nb_2TiO_9.aq$ with Th & U. Occurrence: MM 24 615.]

khmaralite $\sim Mg_{5.5}Al_{14.3}Fe_2Si_{4.8}Be_{1.5}O_{40}$. Related to *sapphirine*.

Structure: TEM & SC-XRD, **J Barbier & 3 others** 1999 AM 84 1650-60.

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

Eudialyte group.

Description and structure: **O Johnsen & 3 others** 1999 CM 37 893-9.

khristovite-Ce $(Ca,RE)RE(Mg,Fe)AlMnSi_3O_{11}(OH)(F,O)$.

Epidote structure group from crystallography.

Occurrence: **LA Pautov & 4 others** 1993 ZVMO 122 103-11 (P484) = AM 80 405.

kiddcreekite Cu_6SnWS_8 . *Stannite* structure group.

Should be isostructural with Mo analog *hemusite*, & have *sphalerite* superstructure.

No structural determination found.

Occurrence: **DC Harris & 4 others** 1984 CM 22 227-32.

kidwellite $NaFe_9(OH)_{10}(PO_4)_6.5aq$. Member of 5 Å phosphate group.

Similar to *laubmannite*.

Structure: SC-XRD, **U Kolitsch** 2004 MM 68 147-65.

Occurrence: **PB Moore J Ito** 1978 MM 42 137-40; MM 42 526.

kieftite $CoSb_3$. Isostructural with *skutterudite*.

Structure: **RTM Dobbe & 5 others** 1994 CM 32 179-83.

Synthetic: **A Kjekhus T Rakke** 1974 Acta Chem Scand A28 99-103 = MA 77-1488;

T Schmidt G Kliche HD Lutz 1987 AC C43 1678-9 (S1499).

KIESERITE STRUCTURE GROUP OF SULFATES & PHOSPHATE Includes

dwornikite $(Ni,Fe)SO_4.aq$

cobaltkieserite $CoSO_4.aq$

gunningite $(Zn,Mn)SO_4.aq$

kieserite $MgSO_4.aq$

[poitevinite] $(Cu,Fe,Mn)SO_4.aq$ delete MR 28 438]

serrabrancaite $MnPO_4.aq$

szmikite $MnSO_4.aq$

szomolnokite $FeSO_4.aq$

Titanite topology, Consortium for Theoretical Frameworks net 1092;

graphic relation to *amblygonite*: **WH Baur** 1959 Beitr Mineral Petrogr 6 399-404;

J Zemann 1990 Aufschuss 41 7-11.

Review: **Sabelli** p.32.

Chemical modeling: **S Aleksovskaja VM Petrusevski B Soptrajanov** 1998 AC B54 564-7 (A859).

Synthetic $CoSO_4.aq$: **HR Oswald** 1965 Helv Chim Acta 48 590-608.

Synthetic (Mn/Fe/Co/Ni/Zn): **Y Le Fur J Coing-Boyat G Bassi** 1966 CRASP 262C 632-5.

Synthetic $CdSO_4.aq$: **JM Brégeault P Herpin** 1970 BSFMC 93 37-42.

Synthetic $MnSeO_4.aq$: **A Kirfel G Nover G Will** 1974 JACr 7 311.

Synthetic $HgSO_4.aq$: **C Sålhandske** 1978 AC B34 1408-11.

Synthetic $CdSeO_4.aq$: **C Sålhandske** 1978 AC B37 2055-7.

Synthetic (Mn/Fe/Co/Ni/Zn)SO₄.aq: **M Wildner G Giester** 1991 NJMM 296-306 (W692).
Synthetic (Mg/Mn/Co/Ni/Zn)SeO₄.aq: **G Giester M Wildner** 1992 NJMM 135-44 (G777).
Synthetic (Cu/Ni)SeO₄.aq: **LD Iskhakova NP Kozlova** 1995 CrR 40 583-6 (I133).
Synthetic Co(S/Se)O₄.aq, polarized electronic absorption: **M Wildner** 1996 PCM 23 489-96.
Synthetic MnPO₄.aq: **MAG Aranda** 1993 PD 8 155-9.

kieserite MgSO₄.aq. *Kieserite* structure type.
 Structure: **J Leonardt R Weiss** 1957 Nw 44 338-9;
JM Brégeault & 3 others 1970 Bull Soc Chim France 12 4243-8;
 neutron, **JM Brégeault P Herpin J Coing-Boyat** 1972 Bull Soc Chim France 6 2247-51;
FC Hawthorne & 3 others 1987 NJMA 157 121-32 (H977).
 Series with *poitevinite*, XRPD: **CL Lengauer G Giester** 1995 PD 10 189-94.
 Occurrence in meteorites: **AE Rubin** 1997 MPS 32 733-4.
Sanderite is dihydrate.

kilchoanite Ca₃Si₂O₇. Dimorphic with *rankinite*.
 Structure: **HFW Taylor** 1971 MM 38 26-31; also structure model for Ca₈Si₅O₁₈.
 Occurrence: MM 32 964.
Synthetic Ca_{2.3}Mn_{0.7}Si₂O₇: **M Kimata** 1989 MM 53 625-31.
 Polysomatism & structure models of Ca silicates: **MI Chiragov DYu Pushcharovskii** 1992 SPC 36 679-83 (C697).
Synthetic Ba₄Si₂O₇, SC-XRD structure like *kilchoanite*: **V Kahlenberg** 2001 MM 65 533-41.

killalaite ~Ca_{3.2}(H_{0.6}Si₂O₇)(OH).
 Structure: pseudo-cell, **HFW Taylor** 1977 MM 41 363-9.
 Occurrence: MM 39 917.
Synthetic phase F: probably isostructural, **A Aitken HFW Taylor** 1960 J Appl Chem 10 7-15.

kimrobinsonite (Ta,Nb)(OH)_{5-2x}(O,CO₃)_x.
 XRPD indicates primitive cubic *perovskite*.
 Occurrence and crystallography: **EH Nickel BW Robinson** 1985 CM 23 573-6.

kimuraite-Y CaY₂(CO₃)_{4.6}aq.
 Compare with *kamphaugite*-(Y), *lokkaite*, *schomiokite*-(Y) & *tengerite*.
 Occurrence: **K Nagashima & 7 others** 1986 AM 71 1028-33.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

kimzeyite Ca₃(Zr,Ti)₂(Si,Al,Fe)₃O₁₂. *Garnet* structure type.
 Structure: **R Munro G Rossi C Tadini** 1980 AM 65 188-91
 SC-XRD & Raman: **E Schingaro & 5 others** 2001 EJM 13 749-59 (3474).
 Occurrence: MM 32 964.

kingite Al₃(PO₄)₂(F,OH)_{3.7}aq.
 Structure: [incorrect suggestion of relation to *kaolinite*, **D McConnell** 1974 MM 39 802-6];
 XRPD, **KS Wallwork & 3 others** 2003 AM 88 235-9;
 NPD of D-analog, **do** 2004 CM 42 135-41.
 Occurrence, also *metakingite*: **K Norrish LER Rogers RE Shapter** 1957 MM 31 351-7;
 cell dimensions, **T Kato** 1970 AM 55 515-7.

kingsmountite (Ca,Mn)₄(Fe,Mn)Al₄(PO₄)₆(OH)_{4.12}aq.
Montgomeryite structure group.
 Occurrence: **PJ Dunn & 3 others** 1979 CM 17 579-82.

kingstonite (Rh,Ir,Pt)₃S₄.
 Occurrence & SC-XRD structure: **CJ Stanley & 5 others** 2005 MM 69 447-54 = AM 91711.
Synthetic: structure, **J Beck T Hilbert** 2000 ZaaC 626 772-9.

kinichilite Mg_{0.5}[(Mn,Zn)Fe³⁺(TeO₃)₃].4.5aq.
 Isostructural with Ni analog *keystoneite* & Zn,etc analog *zemannite*.
 Structure: **R Miletich** 1995 EJM 7 509-23 (M1258).
 Occurrence: MM 46 520.

kinoite Ca₂Cu₂Si₃O₈(OH)₂. Review: (E289).
 Structure: **RB Laughon** 1971 AM 56 193-200;

reinterpretation, **WH Baur** 1971 AM 56 1573-99.
 Occurrence: MM 38 994.
kinoshitalite (Ba,K)(Mg,Mn,Al)₃Si₂Al₂O₁₀(OH)₂. *Mica* structure family; 1M polytype.
 Structure: **T Kato & 3 others** 1979 MJJ 9 392-408;
 SC-XRD, **E Gnos T Armbruster** 2000 AM 85 242-50.
 Mn-: **S Guggenheim T Kato** 1984 MJJ 12 1-5.
 Occurrence: MM 40 909; AM 88 740-7.
 Fe-: **HE Frimmel & 3 others** 1995 AM 80 833-40.
kintoreite PbFe₃(PO₄)₂(OH,aq)₆. *Jarosite-alunite* family. Analog of arsenate *segnitite*.
 Structure: **Kharisun & 3 others** 1997 MM 61 123-9.
 XRPD: **A Pring & 5 others** 1995 MM 59 143-8.
kipushite (Zn,Cu)₆(PO₄)₂(OH)₆.aq. Review: (E289).
 Structure: **P Piret M Deliens J Piret-Meunier** 1985 CM 23 35-42.
 Occurrence: MM 21 568.
kirkiite Pb₁₀Bi₃As₃S₁₉. Homologous with *jordanite*.
 See *vurroite* Pb₁₀Sn(Bi,As)₁₁S₂₇Cl₃.
 Structure: Pb₁₀Bi₂.₂As₃.₈S₁₉, SC-XRD, **E Makovicky & 3 others** 2006 CM 44 177-88.
 Occurrence: **Y Moélo & 6 others** 1985 BM 108 667-77 = AM 1278-9; MM 50 750.
 Se-bearing, XRPD, *synthetic* analog: **YS Borodaev & 6 others** 1998 CM 36 1105-14.
kirschsteinite CaFeSiO₄. *Olivine* structure group.
 Structure: **GE Brown** 1970 PhD thesis, Virginia Polytechnic Institute.
 Occurrence: **TG Sahama K Hytönen** 1957 = AM 37 790.
Larnite-rich: **NVC Rao & 3 others** 1996 MM 60 513-6.
 In meteorites: **AE Rubin** 1997 MPS 32 231-47;
 crystal chemistry, **L Folco M Mellini** 1997 EJM 9 969-73 (F575).
[kitaibelite 15Bi₂S₃.5Ag₂S.PbS. MM 52 726. Not approved by MA.]
kitkaite NiTeSe. *Melonite* structure family.
 CdI₂, topology, (~ = *brucite* except for hydrogen).
 Structure determination not found.
 Occurrence: **TA Häkli Y Vourelainen TG Sahama** 1965 AM 50 581-6.
kittatinnyite Ca₂Mn²⁺₂Mn³⁺Si₂O₈(OH)₄.₉aq.
 Isostructural with As analog *walkkilldellite* from crystallography.
 Structure determination not found.
 Occurrence: **PJ Dunn DR Peacor** 1983 AM 68 1029-32.
kivuite ?(Th,Ca,Pb)H₂(UO₂)(PO₄)₂(OH)₈.₇aq. *Phosphuranylite* mineral group.
 Structure determination not found.
 Occurrence: **L Van Wambeke** 1958 Bull Soc Belg Geo Paleo Hydro 67 383-403 = AM 44 1326-7.
kladnoite C₆H₄(CO₂)NH. Phthalimide structure.
 Structure: **E Matzat** 1972 AC B28 415-8.
 Occurrence: MM 27 270.
klebelsbergite SbO₄(OH)₂SO₄. Review: **Sabelli** p. 28.
 Structure: **I Nakai DE Appleman** 1980 AM 65 489-505;
S Menchetti C Sabelli 1980 AM 65 931-5.
[kleberite ?FeTi₆O₁₃.₄aq.
 = *hydroxylite pseudorutile*: **IE Grey JA Watts P Bayliss** 1994 MM 58 597-600.
 Original description: MM 43 1062.]
kleemanite ZnAl₂(PO₄)₂(OH)₂.₃aq.
 Structure determination not found.
 Occurrence: **ES Pilkington & 3 others** 1979 MM 43 93-5.
kleinite (Hg₂N)(Cl,OH,SO₄,aq). High-*tridymite* type of connectivity.
 Polytypic with *mosesite* = high-*crystalite* connectivity.
 Both minerals are related to the salts of Millon's base.
 Review: **Sabelli** p.3.

Structure: **H Heritsch** 1949 TMPM 1 301-12 (H948);
 SC-XRD & vibrational spectroscopy, **G Giester W Mikenda F Pertlik** 1996 NJMM 49-56 (G839).

klockmannite CuSe. Isostructural with S analog *covellite*. Polytypism.
 Structure: 12H polytype, **LG Berry** 1954 AM 39 504-9;
CA Taylor FA Underwood 1960 AC 13 361-2 (T451);
synthetic 2H & 12H, **SON Arunsingh B Dayal** 1972 AC B28 635-8;
H Effenberger F Pertlik 1981 NJMM 197-205.

Occurrence: MM 21 568.
 Hexagonal-orthorhombic transition Cu(S,Se): **H Nozaki K & 3 others** 1995 JSSC 118 176-9 (N388).

klyuchevskite $K_3Cu_3(Fe,Al)O_2(SO_4)_4$.
 Structural analog of *piypite*, with cation ordering.
 Structure: **MG Gorskaya & 3 others** 1992 MM 56 411-6.
 Structure modeling: **V Milman** 2002 AC B58 437-47 (7453).
 Occurrence: MM 54 666-7.

[knopite $?(Ca,Ti,Ce)_2O_3$.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.]

knorringite $Mg_3Cr_2Si_3O_{12}$. *Garnet* structure type.
 Structure determination not found.
 Occurrence: **PH Nixon G Hornung** AM 53 1833-40.

koashvite $Na_6(Ca,Mn)(Ti,Fe)Si_6O_{18} \cdot aq$. *Lovozerite* structure group.
 Structure: **NM Chernitsova & 3 others** 1980 Min Zh 2 40-4 = MA 81-2386.
 Occurrence: MM 40 909;
 in hyperagpaitic alkaline rocks: **Khomyakov** (1995).

[kochelite = fergusonite + altered zircon NJMM 2004 193-207 (10362).

kobeite-Y $(Y,Fe,U)(Ti,Nb,Ta)_2(O,OH)_6$. Metamict.
 Occurrence: MM 29 985-6;
CO Hutton 1957 AM 42 342-53.

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

KOBELLITE HOMOLOGOUS SERIES Includes:

<i>giessenite</i>	$Cu_2Pb_{26}(Bi,Sb)_{20}S_{57}$	N = 4
<i>izoklakeite</i>	$Cu_2Pb_{26}(Sb,Bi)_{20}S_{57}$	N = 4
<i>kobellite</i>	$Pb_{22}Cu_4(Bi,Sb)_{30}S_{69}$	N = 2
<i>tintinaite</i>	$Pb_{22}Cu_4(Sb,Bi)_{30}S_{69}$	N = 2

Review of Bi-Pb sulfosalts: **E Makovicky** 1981 Fortschr Mineral 59 137-90.

kobellite $Pb_{22}Cu_4(Bi,Sb)_{30}S_{69}$.
 Kobellite homologous series, N = 2: **E Makovicky WG Mumme** 1986 NJMA 153 121-45.
 Structure: **G Mieke** 1971 Nature Phys Sci 231 133-4 = MA 72-1842.

kochite $Na(Na,Ca)_2Ca_2(Mn,Ca)ZrTi(Si_2O_7)_2(O,F)_2F_2$. *Rosenbuschite* group.
 Occurrence & XRPD: **CC Christiansen & 3 others** 2003 EJM 15 551-4 (9175).

kochkarite $PbBi_4Te_7$.
 Structure determination not found.
 Occurrence: **EM Spirodonov & 2 others** 1989 Geol Rudnykh Mestorozhdenii 31 98-102 = AM 76 1434-40.

koechlinite Bi_2MoO_6 . Gamma polymorph. Isostructural with W analog *russellite*.
 Polymorphism: **G Blasse** 1966 J Inorg Nucl Chem 28 1124-5.
 Neutron PD of *synthetic*: **RG Teller & 3 others** 1984 AC C40 2001-5 (T458);
F Theobald A Laarif AW Hewat 1984 Ferroelectrics 56 219-37;
 earlier papers have serious deficiencies.

Raman: **RL Frost L Duong M Weier** 2004 NJMA 180 145-80 (10963).
Synthetic Bi_2NbO_5F : **B Aurivillius** 1952 Ark Kemi 5 39-47.

koeninite $Na_4Mg_9Al_4Cl_{12}(OH)_{22}$.
 Structure: **R Allmann H-H Lohse E Hellner** 1968 ZK 126 7-22.

kogarkoite $Na_3(SO_4)F$. Review: **Sabelli** p. 31.
 Matches *synthetic*.

Structure: **L Fanfani & 3 others** 1980 MM 43 753-9.

Occurrence: MM 39 917.

[koivinite] $YAl_5(PO_4)_4(OH)_4 \cdot 2aq.$

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

kokchetavite $KAlSi_3O_8$. Polymorph of K-feldspar.

Occurrence: Kazakstan, eclogite, inclusions in *clinopyroxene* & *garnet*. **S Hwang & 8 others** 2004 CoMP 148 380-9 (10833).

koktaite $(NH_4)_2Ca(SO_4)_2 \cdot aq.$ Isostructural with K analog *syngenite*.

Review: **Sabelli** p. 29.

Structure (papers in Sabelli review, not seen by jvs):

J Sekanina Acta Acad Sci Nat Moravo-Silesiaca 20 1 = AM 34 618;

GB Bokij NA Pal'cik MYu Antipin 1981 Tr Inst Geol Geofiz Novosibirsk 487 4-8.

Synthetic: MM 28 723.

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

kolarite $PbTeCl_2$.

Structure determination not found.

Occurrence: **AD Genkin & 7 others** 1985 CM 23 501-6.

kolbeckite $ScPO_4 \cdot 2aq.$ *Clinovariscite* structure group from crystallography.

Structure determination not found.

Occurrence: MM 21 568-9;

ME Mrose B Wappner 1959 Bull Geol Soc Am 70 1648-9.

kolfanite $Ca_2Fe_3O_2(AsO_4)_3 \cdot 2aq.$

Has similar cell data to *arseniosiderite* and similar but different composition.

[jvs: is *kolfanite* just a variety or a different hydrate?]

Occurrence: **AV Voloshin & 3 others** 1982 Mineral Zh 4 90-5 = MA 68 280.

kolicite $Mn_7Zn_4(AsO_4)_2(SiO_4)_2(OH)_8$. Compare *gerstmannite* & *holdenite*.

Structure: **DR Peacor** 1980 AM 65 483-7.

Occurrence: MM 43 1062.

kolovratite Composition uncertain.

Restudy of type material: **JL Jambor GR Lachance** 1962 CM 7 311-4.

kolwezite $(Cu_{0.67}Co_{0.33})_2(CO_3)(OH)_2$. *Rosasite* structure group.

Structure determination not found.

Occurrence: **M Deliens P Piret** 1980 BM 103 179-84.

kolymite Cu_7Hg_6 . *Beta-brass* structure type from XRPD.

Structure: **F Schoszberger** 1935 ZPC 29 1-3.

Compare with rhombohedral *belendorffite* Hg_6Cu_7 , *goldamalgam* $(Au,Ag)Hg$ & *moschellandsbergite* Ag_2Hg_3 .

Occurrence: **EA Markova NM & 4 others** 1980 ZVMO 109 206-11 = AM 66 218.

komarovite $(H,Na,Ca)(Nb,Ti)_2Si_2O_{10}(OH,F)_2$.

Compare with *labuntsovite* & *nenadkevichite*.

Na-komarovite has a different unit cell.

Structure: & occurrence, **T Balić-Žunić & 3 others** 2002 NJMM 497-514 (8334).

Occurrence: **AM Portnov & 2 others** 1971 ZVMO 100 599-602 = AM 5 1315-6;

GK Krivokoneva & 3 others 1979 DAN SSSR 248 443-7.

Unnamed '*white-Nb-silicate*' $Na_2Nb_2Si_2O_{10} \cdot aq.$ & M53, $Na_4CaTiNb_3Si_3O_{18}F \cdot 3aq.$, perhaps to be named '*Na-komarovite*': 2001 GGSB 190 124-5.

Unnamed Mn- analog, from Lovozero, SC-XRD structure: **NI Golovina & 3 others** 1998 DAN 362 350-2 = AM 84 1197-8.

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

kombatite $Pb_{14}(VO_4)_2O_9Cl_4$. Isostructural with *sahlinite*.

Layers of PbO *litharge* type interleaved with V-O-Cl layers.

Structure: **M Cooper FC Hawthorne** 1994 AM 79 550-4.

Occurrence: (R578).

komkovite BaZr[Si₃O₉].3aq. *Hilairite* structure group.
 Structure: **EK Sokolova AV Arakcheeva AV Voloshin** 1991 Sov Phys Dokl 36 666-8 (S1276).
 Occurrence: MM 54 667.

konderite / kondërite PbCu₃(Rh,Pt,Ir)₈S₁₆.
 Should be isostructural with *inaglyite* based on crystallography.
 Structure determination not found.
 Occurrence: **NS Rudashevskii & 5 others** 1984 ZVMO 113 703-12 = AM 71 229.
 Potential new, like Fe-Pb-Cu-Rh-Pd-Ir sulfide: **AY Barkov & 3 others** 2004 CM 42 499-513.

koninckite FePO₄.3aq.
 [jvs: if composition and tetragonal symmetry are correct, this is different from *strengite* & *metastrengite* (*phosphosiderite*).]
 Occurrence: **Dana**;
 Japan, MA 97M/2009.

konyaite Na₂Mg(SO₄)₂.5aq.
 Matches *synthetic*; both transform rapidly to *bloedite* with 4aq.
 Structure determination not found.
 Occurrence: **JDJ van Doesburg L Vergouwen L van der Plas** 1982 AM 67 1035-8;
 cave in Romania, **BP Onac WB White I Viehmann** 2001 MM 65 103-10.

koragoite
 (Mn²⁺_{1.8}Mn³⁺_{1.0}Fe²⁺_{0.1})(Nb_{0.8}Mn²⁺_{0.2})₂(Nb_{2.0}Ta_{0.7}W_{0.1})(W_{1.7}Ti_{0.1})O₂₀.
 Occurrence & structure: **NA Yamnova DYu Pushcharovsky AV Voloshin** 1995 Krist 40 469-75;
 AM 83 186.

koritnigite Zn(AsO₃)OH.aq.
 Structure: **P Keller H Hess H Riffel** 1980 NJMA 138 316-22.
 Occurrence: MM 43 1063.

kornelite Fe₂(SO₄)₃.7aq. Review: **Sabelli** p.26.
 Structure: **PD Robinson JH Fang** 1973 AM 58 535-9.

kornerupine ~(Mg,Al,Fe)₅(Si,Al,B)₅O₂₁OH. Considerable range in composition.
 Structure: **PB Moore JM Bennett** 1968 S 159 524-6 (M213);
PB Moore T Araki 1979 NJMA 134 317-36 (M648);
 Fe-rich, **LW Finger RM Hazen** 1981 CIWYB 80 370-3;
PB Moore PK Sen Gupta EO Schlemper 1989 AM 74 642-55;
 B-free, **R Klaska ES Grew** 1991 AM 76 1824-35;
 Fe Mössbauer, **ES Grew & 5 others** 1999 AM 84 536-49.
 Raman spectra of B-free & B-rich: **B Wopenka JJ Freeman E Grew** 1999 AM 84 550-4.
Prismatine is B-rich endmember of kornerupine series.
 Occurrence: **DA Young** 1995 CM 33 1255-62.]

kornite (K,Na)(Na,Li)₂(Mg,etc)₅Si₈O₂₂(OH)₂. *Amphibole* structure group.
 Occurrence: **T Armbruster & 3 others** 1993 SMPM 73 349.

korobitsynite Na_{4-x}Ti₂(Si₄O₁₂)(O,OH)₂.4aq. *Labuntsovite* group.
 Occurrence and structure: **IV Pekov et al** 1999 ZVMO 72-5 (P892).
 Occurrence: **G Niedermayr & 3 others** 2002 NJMM 41-8 (5957).

korshunovskite Mg₂Cl(OH)₃.4 aq.
Synthetic phase has n = 4: structure, **PM de Wolff L Walter-Levy** 1953 AC 6 40-4 (D502).
 Occurrence: MM 46 520.

[nepskoite Mg₄Cl(OH)₇.6aq. XRPD similar to *korshunovskite* & *synthetics*.
 Occurrence & XRD: **VN Apollonov** 1998 ZVMO 127 41-6.]

korzhinskite CaB₂O₄.0.5aq. Compare with *sibirskite* Ca₂B₂O₅.aq.
 No structure listed in **CL Christ JR Clark** 1977 PCM 2 59-87 (C381).
 Occurrence: **SV Malinko** 1963 ZVMO 92 555-9 = AM 49 441.
 Occurrence, crystallography, XRPD, ED, = *synthetic*: **SV Malinko VT Dubinchuk** 1996 ZVMO 4 60-71 (M1446).
Synthesis from pandermite: **OV Dimitrova & 3 others** ZVMO 133 96-101 (10873_).

kosmochlor NaCrSi₂O₆. *Pyroxene* structure group; monoclinic subtype.

Structure: **M Cameron & 3 others** 1973 AM 58 594-618;
H Ohashi T Fujita 1979 JJAMPEG 74 16-26 = MA 82M/3908;
 2 to 9 GPa, SC-XRD, **MJ Origlieri & 5 others** 2003 AM 88 1025-34.
 Metasomatic –diopside in peridotite, New Zealand: **K Ikehata S Arai** 2004 AM 89 1396-404.
 In meteorites: **AE Rubin** 1997 MPS 32 231-47.

kosnarite $KZr_2(PO_4)_3$.
 Structure: *synthetic*, **M Slijkic 3 others** 1969 ZK 130 148-61.
 Occurrence: **ME Brownfield 3 others** 1993 AM 78 653-6.

kostovite $AuCuTe_4$. *Calaverite* structure group.
 Structure: modulation, relation to idealized *calaverite* structure: **G van Tendeloo S Amelinckx** 1986 AC B42 121-30.
 Occurrence: MM 35 1140.

kostylevite $K_2ZrSi_3O_9$.aq. Dimorphic with *umbite*. Octahedral-tetrahedral net. CTF ?.
 Structure: **GD Ilyushin & 5 others** 1981 DAN SSSR 256 860-3.
 Occurrence: MM 48 575-6;
AA Voronkov NG Shumyatskaya YuA Pyatenko 1978, *Krystallkimiya mineralov tsirkoniya i ikh iskusstvennykh analogov*, Nauka, Moscow.
 Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
Synthetic $K_2PbSi_3O_9$.aq, SC-XRD structure: **P Pertierra & 6 others** 2001 MRB 36 717-23.
Synthetic $K_{1.8}Na_2ZrSi_3O_9$.aq, XRPD structure: **P Ferreira & 3 others** 2001 ChM 13 355-63 (2002).
Synthetic $K_2SnSi_3O_9$.aq, XRPD structure: **Z Lin J Rocha & 2 others** 2000 JMC 10 1353-6 (3715).

kotoite $Mg_3(BO_3)_2$. Isostructural with Mn analog *jimboite*. Isolated BO_3 triangles.
 Structure: **SV Berger** 1949 Acta Chem Scand 3 660-75 = MA 11-537;
J Zemann H Effenberger F Pertlik 1982 Österr Akad Wiss Math-Anz 61-2 = MA 84M/2549;
 Mg/Co/Ni-, **H Effenberger F Pertlik** 1984 ZK 166 129-40;
AA Brovkin LN Nikishova 1975 SPC 20 252-4 (B1143).
 Occurrence: MM 25 634.
Synthetic $Ni_3(BO_3)_2$: **J Pardo M Martinez-Ripoli S Garcia-Blanco** 1974 AC B30 37-40.
Synthetic $Co_3(BO_3)_2$: MA 11-537; 17-459;
JLC Rowsell NJ Taylor LF Nazar 2003 JSSC 174 189-97 (9820).

köttigite / koettigite $Zn_3(AsO_4)_2 \cdot 8aq$. *Vivianite* structure type.
 Structure: **RJ Hill** 1979 AM 64 376-82.
 Compare with *warikahnite* with 2aq & *synthetic* 1.33 aq: **P Feng X Bu GD Stucky** 1997 ACC 53 997-1000 (F549).

kotulskite $Pd(Te,Bi)$. *Niccolite* structure type.
 Structure determination not found.
 Occurrence: **AD Genkin NN Zhuravlev EM Smirnova** 1963 ZVMO 92 33-50 = AM 48 1181;
GA Kingston 1966 MM 35 815-34.
Synthetic PdTe: **ML Gimpl CE Nelson N Fuschillo** 1963 AM 48 689-90.

koutekite Cu_2As . XRPD matches *synthetic*. Distinct from *domeykite-beta*.
 Structure determination not found.
 Occurrence: **Z Johan** 1958 N 181 1553-4;
Z Johan 1960 CEr 20 217-26 (J237).

kovdorskite $Mg_5(PO_4)_2(CO_3)(OH)_2 \cdot 4.5aq$. Octahedral cluster.
 Structure: **VE Ovchinnikov & 4 others** 1980 Sov Phys Dokl 876-7 (O251) = MA 82M/1161.
 Occurrence: MM 43 1063.

kozoite-La $La(CO_3)OH$. *Ancylite* structure.
 Occurrence: **R Miyawaki & 5 others** 2003 J Miner Petrol Sci 98n 137-41.

kozoite-Nd $Nd(CO_3)OH$. *Ancylite* structure.
 Occurrence & XRPD structure: **R Miyawaki & 5 others** 2000 AM 85 1076-81.

kozulite $Na_3Mn_4(Fe,Al)Si_8O_{22}(OH,F)_2$. *Amphibole* structure group, monoclinic subtype.
 Structure determination not found.
 Occurrence: **M Nambu K Tanida T Kitamura** 1969 JJAMPEG 62 311-28 = AM 55 1815-6.

K-priderite Endmember of *priderite*.
kraisslite $Mg_2Mn_{22}Zn_3Fe(AsO_3)_2(AsO_4)_3(SiO_4)_6(OH)_{18}$. *Mcgovernite* group.
 May be related homologously to *hematolite*.

Structure determination not found.

Occurrence: **PB Moore J Ito** 1978 AM 63 938-40;
revised composition, **PJ Dunn JA Nelen** 1980 AM 65 957-60.

[krasnogorite] WO_3 . Pseudomorph of drill alloy.

Occurrence: **BV Krasnoselskite & 4 others** 1988 *Mineralogy, Technogenesis and Mineral-Resource Complexes of the Urals* p. 5 = MM 60 535.

Not submitted to IMA.]

[krasnoselskite] CoWO_4 . Pseudomorph of drill alloy.

Occurrence: **BV Krasnoselskite & 4 others** 1988 *Mineralogy, Technogenesis and Mineral-Resource Complexes of the Urals* p. 5 = MM 60 535.

Not submitted to IMA.]

krasnovite $\text{Ba}(\text{Al,Mg})(\text{PO}_4,\text{CO}_3)(\text{OH})_2.\text{aq}$.

Occurrence: **SN Britvin YaA Pakhomovskii AN Bogdanova** 1996 ZVMO125 110-2 (B1556).

kratochvilite $\text{C}_{13}\text{H}_{10}$. Possible analog of anthracene: AM 84 688.

Structure determination not found.

Occurrence: AM 23 667; MM 25 635.

krausite $\text{KFe}(\text{SO}_4)_2.\text{aq}$. Review: **Sabelli** p.17.

Structure: **EJ Graeber B Morosin A Rosenzweig** 1965 AM 50 1929-36;
H Effenberger F Pertlik J Zemann 1986 AM 71 202-5.

Occurrence: MM 22 622.

Synthetic $\text{KFe}(\text{CrO}_4)_2.\text{aq}$: **V Debelle P Gravereau A Hardy** 1974 AC B30 2185-91.

krauskopfite $\text{BaSi}_2\text{O}_4(\text{OH})_2.2\text{aq}$. Chain silicate.

Structure: **A Coda A Dal Negro G Rossi** 1967 *Accad Naz Lincei* 859-73 (C149) = MA 70-220.

Occurrence: MM 35 1140.

krautite $\text{MnAsO}_3\text{OH}.\text{aq}$. Pseudopolytypic with *fluckite*.

Structure: **M Catti M Franchini-Angela** 1979 AM 64 1248-54;
alkylamine expansion, **K Beneke G Lagaly** 1981 AM 66 432-5.

Occurrence: MM 40 909.

kremersite $(\text{NH}_4,\text{K})_2\text{FeCl}_5.\text{aq}$. Isostructural series with K analog *erythrosiderite*.

Structure determination not found.

Occurrence: **Dana**.

krennerite AuTe_2 . Dimorphic with *calaverite*.

Structure: **G Tunell L Pauling** 1952 AC 5 375-81;
F Pertlik 1984 *TMPM* 33 253-62 (P540).

krettnichite $\text{PbMn}_2(\text{VO}_4)_2(\text{OH})_2$. *Tsumcorite* group.

Occurrence & SC-XRD structure: **J Brugger & 5 others** 2001 *EJM* 13 145-58 (1673).

kribergite $\sim\text{Al}_5(\text{PO}_4)_3\text{SO}_4(\text{OH})_4.2\text{aq}$. Review: **Sabelli**: no structure.

XRPD: **H de Bruijn 3 others** 1989 *MM* 53 385-6.

Occurrence: **Dana**; MM 27 270.

krinovite $\text{NaMg}_2\text{CrSi}_3\text{O}_{10}$. *Aenigmatite* structure type.

Structure: **E Bonaccorsi S Merlino M Pasero** 1989 *ZK* 187 133-8 (B1099).

Occurrence: MM 37 959.

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

kristiansenite $\text{Ca}_2\text{ScSn}(\text{Si}_2\text{O}_7)\text{Si}_2\text{O}_6\text{OH}$.

Structure: SC-XRD, **G Ferraris & 4 others** 2001 *ZK* 216 442-8 (3475).

Occurrence: **G Raade & 4 others** 2002 *MP* 75 89-99 (7280).

kröhnkite / kröhnkite $\text{Na}_2\text{Cu}(\text{SO}_4)_2.2\text{aq}$. *Roselite* structure group. Chain structure.

Review: **Sabelli** p.17; (E289).

Structure: **B Dahlman** 1952 *Ark Mineral Geol* 1 339-66 = MA 12-95;

M Leone F Sgarlata 1954 *PM* 23 224-34;

FC Hawthorne RB Ferguson 1975 *AC B31* 1753-5.

krupkaite $\text{CuPbBi}_3\text{S}_6$.

Complex series with *bismuthinite* (B) & *aikinite* (A), with *gladite* (2B + 2K), *hammarite* (4K +

2A), *lindstromite* (8K + 2A), *freidrichite* (2K + 4A) & *pekoite* (4B + 2K) as intermediates:
C Danti & 4 others 2001 NJMM 221-34 (1994).
Structure review: **WGME Welin BJ Wuensch** 1976 AM 61 15-20.
Structure: **WG Mumme** 1975 AM 60 300-8;
A Pring 1989 AM 74 250-5;
excess Cu & Pb, SC-XRD, **D Topa E Makovicky T Balic-Zunic** 2002 CM 40 1147-59.
Occurrence: **V Synecek J Hybler** 1974 NJMM 541-60.
Occurrence: MM 40 909.
krutaite CuSe_2 . *Pyrite* structure group.
Structure determination not found.
Occurrence: **Z Johan & 3 others** 1972 BSFMC 99 475-81.
krutovite NiAs_2 . *Pyrite* structure type from XRPD.
Boundary with *gersdorffite* NiAsS : **EM Spiridonov TN Chvileva** 1995 DAN 341 785-7.
Trimorphic with *rammelsbergite* & *pararammelsbergite*.
Structure determination not found.
Occurrence: **RA Vinogradova & 5 others** 1976 ZVMO 195 59-71 (V219) = AM 62 173-4.
kryzhanovskite $\text{MnFe}(\text{PO}_4)_2(\text{OH})_2$.aq.
Structure: **PB Moore T Araki** 1976 IC 15 316-21 (M1058);
PB Moore T Araki AR Kampf 1980 MM 43 789-95.
Occurrence: MM 29 986;
E Roda Robles et al 1998 EJM 10 155-67 (R816).
ktenasite $(\text{Cu,Zn})_5(\text{SO}_4)_2(\text{OH})_6$.6aq.
Layer structure with different connectivity than *serpierite* & *devillite*; also relation to *langite*.
Similar sheets to *christelite* $\text{Zn}_3\text{Cu}_2(\text{SO}_4)_2(\text{OH})_6$.4aq, but different H-bonding.
Review: **Sabelli** p. 24; (E289).
Structure: **M Mellini S Merlino** 1978 ZK 147 129-40 (M1278);
synthetic, TEM, **M Xue & 6 others** 2004 JSSC 177 1624-30 (10281).
Raman vs OH: **RL Frost & 4 others** 2004 AM 89 1130-7.
Synthesis & intercalation: **M Xue & 6 others** 2004 JSSC 177 1624-30 (10232).
Occurrence: MM 29 986.
Zn analog, unnamed mineral: **E Olsen CF Lewis** 1979 AM 64 446-8;
A Livingstone 1991 J Russell Soc 4 13-5 = AM 78 674.
kuannersuite-Ce $\text{Ba}_6\text{Na}_2\text{REE}_2(\text{PO}_4)_6\text{FCl}$. Apatite group.
Occurrence & SC-XRD structure: **H Friis & 3 others** 2004 CM 42 95-106.
kudriavite $(\text{Cd,Pb})\text{Bi}_2\text{S}_4$. *Pavonite* homologue N = 3.
Occurrence & P- & SC-XRD structure: **IV Chaplygin & 4 others** 2005 CM 43 695-701.
kukharenkoite-Ce $\text{Ba}_2\text{Ce}(\text{CO}_3)_3\text{F}$.
Structure: **SV Krivovichev SK Filatov AN Zaitsev** 1998 CM 36 809-15.
Occurrence, IR/crystallography, relation other minerals: **AN Zaitsev & 6 others** 1996 EJM 8 1327-36 (Z125).
Synthetic, structure: **N Mercier M Leblanc** 1993 Eur J Solid State Inorg Chem 207-16.
kukharenkoite-La $\text{Ba}_2(\text{La,Ce})(\text{CO}_3)_3\text{F}$.
Structure: cation framework, **SV Krivovichev & 3 others** 2003 ZVMO 3 65-72.
Occurrence: **IV Pekov & 4 others** 2003 ZVMO 3 55-64.
kukisvumite $\text{Na}_6\text{ZnTi}_4\text{Si}_8\text{O}_{28}$.4aq. Polysomatic relation to *lintisite*.
Structure: **S Merlino M Pasero O Ferro** 2000 ZK 215 352-6 (M1825).
Occurrence: **VN Yakovenchuk & 2 others** 1991 MZh 13 63-7 = AM 77 1116-21.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
kuksite $\text{Pb}_3\text{Zn}_3\text{TeO}_6(\text{PO}_4)_2$.
Compare with As analog *dugganite* & V analog *remnykhite*.
Structure determination not found.
Occurrence: **AA Kim NV Zayakina VF Makhotko** 1990 ZVMO 119 50-7 (K666) = AM 77 446.
kulanite $\text{Ba}(\text{Fe,Mn,Mg})_2(\text{Al,Fe})_2(\text{PO}_4)_3(\text{OH})_3$. Isostructural with *bjarebyite*.
Structure: **M Cooper FC Hawthorne** 1994 CM 32 15-9.
Occurrence: MM 40 909

kuliokite-Y $(Y,RE)_4Al(SiO_4)_2(OH)_2F_5$.
Structure determination not found.
Occurrence: **AV Voloshin & 5 others** 1984 MZh 8 94-9 (S1291) = AM 73 192.

kulkeite $Mg_8Al(AlSi_7)O_{20}(OH)_{10}$. 1:1 *clinochlore/talc* layer structure.
Structure determination not found.
Occurrence: **K Abraham & 3 others** 1980 Fortschr Mineral Beih 58 4-5 = AM 66 218.

kullerudite $NiSe_2$. *Marcasite* structure subgroup in *marcasite* supergroup.
Dimorphic with *penroseite*; *pyrite* structure group.
Structure determination not found.
Occurrence: **Y Vuorelainen A Huhma A Häkli** 1965 Comptes Rend Soc geol Finlande 36 113-25 = AM 50 520.

kupčikite $Cu_{3.4}Fe_{0.6}Bi_5S_{10}$. *Cuprobismutite* homologous series, N = 1.
Occurrence: & SC-XRD structure, **D Topa et al** 2003 CM 41 1155-66;
Pb,Fe-bearing, with *cuprobismutite* & *hodrushite*, **A Prešek & 3 others** 2005 EJM 17 155-62 (11027).

kupletskite $K_2Na(Mn,Fe)_7(Ti,Nb)_2Si_8O_{26}(OH)_4F$. *Astrophyllite* structure group.
Structure: **PC Pilonen AM McDonald AE Lalonde** 2003 CM 41 27-54.
Occurrence: **El Semenov** 1956 DAN 108 933-6 = AM 42 118-9.

kuramite Cu_3SnS_4 . *Stannite* structure group.
Structure determination not found.
Occurrence: **VA Kovalenker & 3 others** 1979 ZVMO 108 564-9 = AM 65 1067.

kuranakhite $PbMnTeO_6$.
Structure determination not found.
Occurrence: **SV Yablokova & 3 others** 1975 ZVMO 104 310-3 = AM 61 339.

kurchatovite $Ca(Mg,Mn,Fe)B_2O_5$. Dimorphic/OD relation with *clinokurchatovite*.
Structure: Mg-, **OV Yakubovich & 4 others** 1976 SPD 21 294-6;
Ca,Mg-, **do** 1976 SPD 2 542-4 (Y116);
clino, **MA Simonov & 4 others** 1980 SPD 25 228-30 (S1281);
OD relation, **EL Belokoneva** 2003 CrR 48 222-5 (8933);
modular aspects, **A Callegari F Mazzi C Tadini** 2003 EJM 15 277-82.
Occurrence: MM 35 1141.
Synthetic Mn-: **OV Yakubovich MA Simonov NV Belov** 1978 SPD 23 4-5 (Y115).

kurgantaite $SrCaB_5O_9Cl_{1aq}$. Sr analog of *hilgardite*.
Occurrence: MM 30 737;
revalidation, **DYa Pushcharovskii** 2000 CrR 45 1150 (1744);
revalidation, **IV Pekov & 7 others** 2001 ZVMO 3 71-9.
Synthetic $CaSrB_5O_9Cl_{1aq}$, SC-XRD structure: **O Ferro & 5 others** 2000 CrR 45 410-5.

kurnakite Mn_2O_3 . Beta- = cubic; alpha = tetragonal.
Usually confused with *braunite* & *bixbyite*.
Occurrence: MM 31 964.

kurnakovite $MgB_3O_3(OH)_{5.5aq}$. Dimorphic with *inderite*.
Structure: **ZP Razmanova IM Rumanova NV Belov** 1970 SPD 14 1139-42 (R507);
E Corazza 1974 AC B30 2194-9;
boron K-edge XANES, **ME Fleet S Muthupari** 2000 AM 85 1009-21.
Occurrence: MM 26 338.

kurumsakite $?(Zn,Ni,Cu)_8Al_8V_2Si_5O_{35.27aq}$.
Structure determination not found.
Occurrence: MM 31 964;
EN Bohnstedt-Kupletskaia 1955 ZVMO 84 343-4 (abstr) = AM 42 583-4.

kusachiite $CuBi_2O_4$.
Synthetic, structure: **R von Arpe HK Müller-Buschbaum** 1976 ZaaC 426 1-6;
J-C Boivin J Trehoux D Thomas 1976 BSFMC 99 193-6;
JL Garcia-Munoz & 5 others 1990 J Phys Condensed Matter 2 2205-14;

J Konstantinovic & 3 others 1991 J Phys Condensed Matter 3 381-4.
 Occurrence: **C Henmi** 1995 MM 59 545-8.

kusuite $(\text{Ce}^{3+}, \text{Pb}^{2+}, \text{Pb}^{4+})\text{VO}_4$.
 Occurrence: **M Deliens P Piret** 1977 BSFMC 100 39 = MM 42 526.

kutinaite Cu_2AgAs .
 Structure: *synthetic*, XRPD, **L Karanovic & 4 others** 2002 CM 40 1437-49.
 Occurrence: **J Hak Z Johan BJ Skinner** 1970 AM 55 1083-7.

kutnohorite / kutnahorite $\text{Ca}(\text{Mn}, \text{Mg}, \text{Fe})(\text{CO}_3)_2$. *Dolomite* structure type.
 Structure: **DR Peacor EJ Essene AM Gaines** 1987 AM 72 319-28;
 X-ray & neutron PD, **L Farkas & 3 others** 1988 NJMM 539-46 (F432).
 In sediments adjacent orebody, Ghana: **FK Nyame & 3 others** 2002 SG 154 159-75 (8447).
 In meteorites: **AE Rubin** 1997 MPS 32 231-47.

kuzelite $\text{Ca}_4\text{Al}_2(\text{OH})_{12}(\text{SO}_4) \cdot 6\text{aq}$. *Hydrocalumite* group.
 Structure: *synthetic*, **R Allmann** 1977 NJMM 136-44.
 Occurrence, XRD & IR: **H Pöllmann T Witzke H Kohler** 1997 NJMM 423-32 (P752).

kuzmenkoite-Mn $\text{Na}_2\text{K}_2\text{MnTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O}, \text{OH})_4 \cdot 5-6\text{aq}$. *Labuntsovite* group.
kuzmenkoite-Zn $\text{K}_2\text{Zn}(\text{Ti}, \text{Nb})_4(\text{Si}_4\text{O}_{12})_2(\text{O}, \text{OH})_4 \cdot 6-8\text{aq}$. *Labuntsovite* group.
 Structure: **NA Yamnova AP Khomyakov IV Zlykhenskaya** 2000 Kryst 45 830-2;
 SC-XRD refined, **RK Rastsvetaeva NV Chukanov IV Pekov** 2000 CrR 45 759-61.
 Occurrence & SC-XRD structure: **NV Chukanov & 4 others** 1999 ZVMO 128 45-50 (8770).

kuzminite $\text{Hg}_2(\text{Br}, \text{Cl})_2$. Occurrence: MM 62 726-7.

kuznetsovite $\text{Hg}_3\text{Cl}(\text{AsO}_4)$.
 Structure: **LP Solovyeva & 3 others** 1991 SPC 36 731-2.
 Crystal-chemical review: **SV Borisov SA Magaril NV Pervukhina** 2004 J Struct Chem 44 441-7 (10206).
 Occurrence: MM 46 520.

kvanefjeldite $\text{Na}_4(\text{Ca}, \text{Mn})\text{Si}_6\text{O}_{14}(\text{OH})_2$.
 Structure: **O Johnsen & 3 others** 1983 NJMM 505-12.

kyanite Al_2SiO_5 . Trimorphic with *andalusite* & *sillimanite*.
 Structure: **CW Burnham** 1963 ZK 118 337-60 (B184);
F Scarlatta 1965 PM 34 241-56 = MA 18-158;
C de Rango & 3 others 1966 BSFMC 89 419-24;
JK Winter S Ghose 1979 AM 64 573-86;
 stacking faults & twins, **A Lefebvre D Ménard** 1981 AC A37 80-4;
 stacking faults & polytypism, HRTEM, **BH Grobéty D Veblen** 1995 EJM 7 807-18;
 OH vs IR, **DR Bell & 4 others** 2004 AM 89 998-1003.
 High-pressure synthesis of Cr-substituted: **K Langer F Seifert** 1971 ZaaC 383 29-39.
 Cr substitution & interpretation of spectroscopy: MA 96M/1531.
 FeTi charge transfer & Cr^{3+} dd transitions: **AN Platonov & 5 others** 1998 PCM 25 203-12.
 Compression moduli to 8 GPa, **K Langer MN Taran AN Platonov** 1997 PCM 24 109-14 (L842).
 Lattice-dynamics model: **T Pilati F Demartin CM Gramaccioli** 1997 AC B53 82-94 (P662).
 Compressibility & structural deformation to 6 GPa: **P Comodi & 3 others** 1997 AM 82 452-9;
 compressibility <4.6 GPa, H Yang & 4 others **RT Downs & 4 others** 1997 AM 82 467-74.
 Decomposition to stishovite & corundum: **MW Schmidt & 3 others** 1997 AM 82 460-6.
 Evidence for Al-rich exsolution, Yakutia eclogite, TEM: **R Wirth K Langer AN Platonov** 2001 EJM 13 311-8 (2115).
 Shock-induced, Ries crater, Germany: **V Ståle & 3 others** 2004 CMP 148 150-9 (10777).
Synthetic Al_2GeO_5 : 1989 ZK 186 85 = SR 56A 276.

kyzylkumite $\text{V}_2\text{Ti}_3\text{O}_9$. Dimorphic with *schreyerite*.
 Structure determination not found.
 Occurrence: **IG Smyslova & 3 others** 1981 ZVMO 110 607-12.

labradorite Intermediate member of *plagioclase feldspar* series.

LABUNTSOVITE MINERAL GROUP
 Contains $\text{M}(\text{TO}_4)_2$ chain also in *metasideronatrite*, *nenadkevichite*, *sideronatrite*, *tancoite* & *yftsite*.

Recommended nomenclature: **NV Chukanov IV Pekov AP Khomyakov** 2002 EJM 14 165-73 (6145).

NENADKEVICHITE SUBGROUP

nenadkevichite $\text{Na}_{4-x}\text{Nb}_2(\text{Si}_4\text{O}_{12})(\text{O},\text{OH})_2.4\text{aq}$

korobitsynite $\text{Na}_{4-x}\text{Ti}_2(\text{Si}_4\text{O}_{12})(\text{O},\text{OH})_2.4\text{aq}$

VUORIYARVITE SUBGROUP

?*tsepinite-K* $(\text{K},\text{Ba},\text{Na})_2(\text{Ti},\text{Nb})_2(\text{Si}_4\text{O}_{12})(\text{OH},\text{O})_2.3\text{aq}$

?*paratsepinite-Ba* $(\text{Ba},\text{Na},\text{K})_{2-x}(\text{Ti},\text{Nb})_2(\text{Si}_4\text{O}_{12})(\text{OH},\text{O})_2.4\text{aq}$

?*paratsepinite-Na* $(\text{Na},\text{K},\text{Ba},\text{Sr})_{2-x}(\text{Ti},\text{Nb})_2(\text{Si}_4\text{O}_{12})(\text{OH},\text{O})_2.4\text{aq}$

tsepinite-Ca $(\text{Ca},\text{K},\text{Na},\square)_2(\text{Ti},\text{Nb})_2(\text{Si}_4\text{O}_{12})(\text{OH},\text{O})_2.4\text{aq}$

tsepinite-Na $(\text{Na},\text{H}_3\text{O},\text{K},\text{Sr},\text{Ba})_{6\text{to}3}\text{Ti}_4(\text{Si}_4\text{O}_{12})_2(\text{OH},\text{O})_4.6-8\text{aq}$

tsepinite-Sr $(\sim\text{Na},\text{Ca})\text{KSr}(\text{Ti},\text{Nb})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.4\text{aq}$

vuoriyarvite-K $(\text{K},\text{Na})_{6\text{to}3}\text{Nb}_4(\text{Si}_4\text{O}_{12})_2\text{O}_4.6-8\text{aq}$

KUZMENKOITE SUBGROUP

gjerdingenite-Fe $\text{K}_2(\text{Fe},\text{Mn})(\text{Nb},\text{Ti})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.6\text{aq}$

gjerdingenite-Mn $(\text{K},\text{Na})_2(\text{Mn},\text{Fe})(\text{Nb},\text{Ti})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.6\text{aq}$

karupmøllerite-Ca $(\text{Na},\text{Ca},\text{K})_2\text{Ca}(\text{Nb},\text{Ti})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.7\text{aq}$

kuzmenkoite-Mn $\text{Na}_2\text{K}_2\text{MnTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.5-6\text{aq}$

kuzmenkoite-Zn $\text{K}_2\text{Zn}(\text{Ti},\text{Nb})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.6-8\text{aq}$

lepkhenelmitite-Zn $\text{Ba}_2\text{Zn}(\text{Ti},\text{Nb})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.7\text{aq}$

LEMMLEINITE SUBGROUP

lemmleinite-Ba $\text{Na}_2\text{K}_2\text{Ba}_{1+x}\text{Ti}_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.4\text{aq}$

lemmleinite-K $\text{Na}_2\text{K}_2\text{KTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.4\text{aq}$

LABUNTISOVITE SUBGROUP

labuntsovite-Fe $\text{Na}_2\text{K}_2\text{FeTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.5-6\text{aq}$

labuntsovite-Mg $\text{Na}_2\text{K}_2\text{MgTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.5-6\text{aq}$

labuntsovite-Mn $\text{Na}_2\text{K}_2\text{MnTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.5-6\text{aq}$

labuntsovite-Nb $\text{NaK}_3\text{Fe}(\text{Ti},\text{Nb})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.6\text{aq}$

neskevaaraite-Fe $\text{K}_3\text{NaFe}(\text{Ti},\text{Nb})_4\text{Si}_8\text{O}_{24}(\text{O},\text{OH})_4.6\text{aq}$

PARALABUNTISOVITE SUBGROUP

paralabuntsovite-Mg $\text{Na}_2\text{K}_2\text{MgTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.5-6\text{aq}$

ORGANOVAITE SUBGROUP

organovaite-Fe $(\text{K},\text{Ba})_2\text{Fe}(\text{Nb},\text{Ti})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.5-7\text{aq}$

organovaite-Mn $\text{K}_2\text{Mn}(\text{Nb},\text{Ti})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.5-7\text{aq}$

organovaite-Zn $\text{K}_2\text{Zn}(\text{Nb},\text{Ti})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.6\text{aq}$

GUTKOVAITE SUBGROUP

gutkovaite-Mn $\text{CaK}_2\text{MnTi}_4(\text{Si}_4\text{O}_{12})_2\text{O}_4.\sim 5\text{aq}$

alsakharovite-Zn $\text{NaSrKZn}(\text{Ti},\text{Nb}_4)(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.7\text{aq}$

Labuntsovite group: XRD & IR, **RK Rastsvetaeva NV Chukanov** 2002 CrR 47 939-45.

Cation-deficient $\text{Na}_{4.1}\text{K}_{3.9}\text{Ba}_{1.5}\text{Fe}_{0.2}\text{Mn}_{0.6}\text{Ti}_{6.3}\text{Nb}_{1.8}(\text{Si}_4\text{O}_{12})_4(\text{O},\text{OH})_8.13\text{aq}$.

Structure: **KA Rozenberg & 3 others** 2002 CrR 47 229-31 (7085).

labuntsovite-Fe $\text{Na}_2\text{K}_2\text{FeTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.5-6\text{aq}$

labuntsovite-Mg $\text{Na}_2\text{K}_2\text{MgTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.5-6\text{aq}$

labuntsovite-Mn $\text{Na}_2\text{K}_2\text{MnTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4.5-6\text{aq}$

Occurrence & crystallography: **VV Subbotin & 5 others** 1998 DAN 358 517-9.

Structure: **NI Golovastikov** 1974 SPC18 596-9 (G683);

Ba-rich, **RK Rastsvetaeva NB Chukanov IV Pekov** 1997 DAN 357 64-7;

RK Rastsvetaeva & 4 others 1998 CrR 43 820-7 (R584);

44 analyses & 3 structures, **NV Chukanov & 3 others** 1999 CM 37 901-10;

Ca-rich, SC-XRD, **RK Rastsvetaeva IV Pekov YuV Nekrasov** 2001 Kryst 46 415-7;

Ca-Nb-, XRPD, **NA Yamnova & 4 others** 2000 Dokl Chem 375 263-6 = AM 86 1114 (distinct mineral).

Occurrence: MM 31 964;

AP Khomyakov & 4 others 2001 ZVMO 4 36-45.

labuntsovite-Nb $\text{NaK}_3\text{Fe}(\text{Ti,Nb})_4(\text{Si}_4\text{O}_{12})_2(\text{O,OH})_4.6\text{aq}$.

Structure: CrR 47 408-11 = AM 89 1829.

labyrinthite $(\text{Na,K,Sr})_{35}\text{Ca}_{12}\text{Fe}_3\text{Zr}_6\text{TiSi}_{51}\text{O}_{144}\text{Cl}_3(\text{O,OH,aq})_9$. *Eudialyte* group.

See AM 90 1466-9 for centrosymmetric analog.

lacroixite $\text{NaAl}(\text{PO}_4)(\text{F,OH})$. *Titanite* structure type.

Isostructural with As analog *durangite*.

Structure: **A Pajunen SI Lahti** 1985 AM 70 852-5.

laffittite AgHgAsS_3 . PbS superstructure.

Structure: **I Nakai DE Appleman** 1983 AM 68 235-44.

Occurrence: MM 39 917.

laflammeite $\text{Pd}_3\text{Pb}_2\text{S}_2$. Structural relation to *parkerite*.

Occurrence & XRPD: **AY Barkov & 3 others** 2002 CM 40 671-8.

laforéteite AgInS . *Chalcopyrite* group.

Occurrence & structure: **N Meisserr P Thelin PJ Chiappero** 1999 EJM 11 891-7 (M1797).

lafossaite TlCl . Isostructural with *salammoniac*.

Occurrence & XRPD: **AC Roberts & 4 others** 2006 MR 37 165-8 = AM 91 1455.

[laihunite $\text{Fe}^{2+}\text{Fe}^{3+}_2(\text{SiO}_4)_2$. Defect *olivine* structure; = *ferrifayalite*.

Structure: **O Tamada B Shen N Morimoto** 1983 MJ 11 382-91 (T294);

P Fu Y Kong L Zhang 1979 Geochimica 103-19 = MA 80-1284;

MW Schaefer 1985 AM 70 729-36;

HREM, **BS Zou KH Kuo** 1986 AC B42 17-21;

B Shen & 3 others 1986 AM 71 1455-60;

B Shen 1995 Sci Geol Sinica 30 373-83 = MA 96M/2706;

HRTEM, **DE Janney JF Banfield** 1998 AM 83 799-810.

laitakarite $\text{Bi}_4(\text{Se,S})_3$. *Tetradymite* mineral/structure group, *joséite* subgroup.

Isostructural with *ikunolite* $\text{Bi}_4(\text{S,Se})_3$ & *joséite* Bi_4TeS_2 .

Structure: **P Bayliss** 1991 AM 76 257-65.

Occurrence: MM 32 965-6.

New unnamed mineral, ?cuprian S-poor *laitakarite*: **A Piestrzynski** 1992 Mineral Polonica 23 35-42 = AM 80 186.

lammerite $\text{Cu}_3[(\text{As,P})\text{O}_4]_2$. Review: (E289).

Structure: **FC Hawthorne** 1986 AM 71 206-9.

Occurrence: MM 46 520.

Synthetic polymorph: **SJ Poulsen C Calvo** 1968 Can J Chem 46 917-?;

Synthetic $\text{Cu}_4(\text{AsO}_4)_2\text{O}$: (A662).

lamprophyllite $\text{Na}_2(\text{Sr,Ba})_2\text{Ti}_3(\text{SiO}_4)_4(\text{OH,F})_2$. *Seidozerite* structure group.

Variable composition: see *barytolamprophyllite* & *nabalamprophyllite*.

Composition for world-wide alkaline massifs: **VA Zaitsev LN Kogarko** 2002 GI 40 313-22 (7234).

Polytypes -2M & -2O, TEM & XRPD: **O Johnsen** 1996 NJMM 407-17 (J148).

Structure: **YuN Saf'yanov & 4 others** 1983 SPD 28 207-9 (S1299);

-2M & -2O, SC-XRD, **SV Krivovichev & 4 others** 2003 EJM 15 711-8 (9317).

Sr-rich: **RK Rastsetaeva MN Sokolova AI Gusev** 1990 Mineral Zh 12(5) 25.

Sr-free, in Aldan shield, SC-XRD: **KA Lazebnik NV Zayakina GP Patskevich** 1998 DES 361A 817-20 (L995).

lanarkite $\text{Pb}_2(\text{SO}_4)\text{O}$. Isostructural with Cr analog *phoenicochroite*.

Layer structure. Review: **Sabelli** p. 29.

Structure: **WP Binnie** 1951 AC 4 471-2 (B1344);

K Sahi 1970 ZK 132 99-117 (S1406).

landauite $\text{NaMnZn}_2(\text{Ti,Fe})_6\text{Ti}_{12}\text{O}_{38}$. *Crichtonite* structure group.

Structure: **LE Nikolaeva NV Belov** 1970 SPD 15 91-3 (N34) = MA 73-1320;

IE Grey BM Gatehouse 1978 CM 16 63-8.

Occurrence: MM 36 1153.

landesite $(\text{Mn,Mg})_9\text{Fe}^{3+}_3(\text{PO}_4)_8(\text{OH})_3 \cdot 9\text{aq}$. *Phosphoferrite* structure group.
 Structure: **PB Moore T Araki AR Kampf** 1980 MM 43 789-95.
 Occurrence: MM 22 622.

[**langasite** trade name for $\text{La}_3\text{Ga}_5\text{SiO}_{14}$ piezoelectric materials with $\text{Ca}_3\text{Ga}_2\text{Ge}_4\text{O}_{14}$ structure (140 known types): **BV Mill & 6 others** 2004 CrR 49 60-9 (10029). Ta & Ga analogs: **GM Kuz'micheva & 4 others** 2005 IMA 41 412-9 (11033).]

långbanite $\text{Mn}^{2+}_4\text{Mn}^{3+}_9\text{SbSi}_2\text{O}_{24}$. ABAC-cubic-closest-packing of oxygen spheres.
 Structure: **VG Rau EN Kurkutova** 1973 SPC 18 320-2 (R512);
 monoclinic type, **G Giuseppetti F Mazzi C Tadini** 1991 NJMM 193-211 (G777);
PB Moore PK Sen Gupta Y Le Page 1991 AM 76 1408-25.
 Fe-rich monoclinic: **P Nysten T Ericsson** 1994 NJMM 557-66 (N362).

langbeinite $\text{K}_2\text{Mg}_2(\text{SO}_4)_3$. Derivative of *eulytite* structure. Review: **Sabelli** p. 35.
 Isostructural with *efremovite* $(\text{NH}_4)_2\text{Mg}_2(\text{SO}_4)_3$ & *manganolangbeinite* $\text{K}_2\text{Mn}_2(\text{SO}_4)_3$.
 Structure: **A Zemann J Zemann** 1957 AC 10 409-13;
K Mereiter 1979 NJMM 182-8 (M1085);
 magnetic, **H Oelkrug & 3 others** 1988 PCM 16 246-9;
 TGA/DTA & ^1H MAS-NMR, **J Zhang & 4 others** 1997 JMS 32 5113-22 (Z147).
 Crystal chemistry of 110 isostructural compounds: **A Wetzel W Eysel** 1998 EJM 316 (W938).
 Occurrence in fertilizers: **JR Lehr & 4 others** 1966 *Crystallographic Properties of Fertilizer Compounds*, Tenn Valley Auth Chem Eng Bull 6, 163p (L758).
Synthetic $\text{K}_2\text{Ca}_2(\text{SO}_4)_3$ 'calcium-langbeinite': **GW Morey 2 others** 1964 J Inorg Nucl Chem 26 53 = MM 39 909.
Synthetic $\text{K}_{1.75}\text{Ti}_2(\text{PO}_4)_3$: 1989 JSSC 227-31.
Synthetic $\text{K}_2\text{Ti}_2(\text{PO}_4)_3$: 1989 SPC 34 363-5 ; 1989 SPC 34 674-6.
Synthetic $\text{K}_2\text{Cd}_2(\text{SO}_4)_3$: MA 91M/1376.
Synthetic Co-doped, 1989 PCM 16 569-75.
Synthetic monoclinic 121 K & orthorhombic 85 K phases of $\text{Ti}_2\text{Cd}_2(\text{SO}_4)_3$: **A Guelylah et al** 2000 ACB 56 921-35 (906).
Synthetic $\text{K}_2\text{Mn}_2(\text{BeF}_4)_3$: monoclinic phase <213 K, **A Guelylah & 5 others** 2001 ACB 57 221-30 (2116).
Synthetic $(\text{Na/K/Cs})\text{BaIn}_2(\text{PO}_4)_3$: XRPD structure, **D Louer & 3 others** 2002 PD 17 1-7 (6629).
Synthetic $\text{K}_2(\text{Er/Yb/Y})\text{Ti}_2(\text{PO}_4)_3$: SC-XRD structure, **ST Norberg** 2002 ACB 58 743-9 (8165).
Synthetic $\text{Rb}_2\text{Cd}_2(\text{SO}_4)_3$: SC-XRD struct, **A Guelylah G Madariaga** 2003 ACC 59 i32-4 (9145).
Synthetic $\text{K}_2\text{FeZr}(\text{PO}_4)_3$: XRPD structure, **AI Orlova & 7 others** 2003 JSSC 173 314-8 (9614).
Synthetic $\text{Rb}_2\text{FeZr}(\text{PO}_4)_3$: NPD structure, **AI Orlova & 7 others** 2003 JSSC 173 314-8 (10964).
Synthetic $\text{K}_2(\text{Ce-Yb})\text{Zr}(\text{PO}_4)_3$: XRPD structure, **IG Trubach & 3 others** 2004 CrR 49 614-8 (10586).
Synthetic $\text{Rb}_2\text{YbTi}(\text{PO}_4)_3$ & $\text{Rb}_2\text{Yb}_{0.3}\text{Ti}_{1.7}(\text{PO}_4)_3$: XRD struct 273/150 K: **JCM Gustafsson & 3 others** 2005 ACC 61 i?.

langisite $(\text{Co,Ni})\text{As}$. *Niccolite* structure group from XRPD.
 Structure determination not found.
 Occurrence: **W Petruk DC Harris JM Stewart** 1969 CM 9 597-616.

langite $\text{Cu}_4(\text{SO}_4)(\text{OH})_6 \cdot 2\text{aq}$. Polymorphic with *posnjakite* & *wroewolfeite*.
 Corrugated layer structure; different from that in *ktenasite*. Review: **Sabelli** p. 24; (E289).
 Structure: **J Galy & 3 others** 1984 BM 107 641-8;
M Gentsch K Weber 1984 AC C40 1309-11 (G796).
 Raman vs OH: **RL Frost & 4 others** 2004 AM 89 1130-7.

lanmuchangite $\text{TlAl}(\text{SO}_4) \cdot 12\text{aq}$. *Alum* group.
 Occurrence, XRPD structure: **D Chen G Wang** 2001 Acta Mineral Sinica 21 271-7 = AM 87 996.

lannonite $\text{HCa}_4\text{Mg}_2\text{Al}_4(\text{SO}_4)_8\text{F}_9 \cdot 32\text{aq}$.
 Structure determination not found.
 Occurrence: **SA Williams FP Cesbron** 1983 MM 47 37-40.

LANSFORDITE MINERAL GROUP OF HYDRATED MG CARBONATES. Includes:

<i>artinite</i>	$\text{Mg}_2\text{CO}_3(\text{OH})_2 \cdot 3\text{aq}$
<i>barringtonite</i>	$\text{MgCO}_3 \cdot \text{aq}$
<i>dypingite</i>	$\text{Mg}_5(\text{CO}_3)_4(\text{OH})_2 \cdot 5\text{aq}$
<i>giorgiosite</i>	$\text{Mg}_5(\text{CO}_3)_4(\text{OH})_2 \cdot 4\text{aq}$

<i>hydromagnesite</i>	$Mg_5(CO_3)_4(OH)_2 \cdot 4aq$
<i>lansfordite</i>	$MgCO_3 \cdot 5aq$
<i>nesquehonite</i>	$MgCO_3 \cdot 3aq$
<i>pokrovskite</i>	$Mg_2(CO_3)(OH)_2 \cdot 0.5aq$
<i>yoshikawaite</i>	$Mg_5(CO_3)_4(OH)_2 \cdot 8aq?$
<i>protohydromagnesite</i>	$MgCO_3 \cdot 2aq$

unnamed HCMC $(Mg_{0.92}Ca_{0.08})CO_3 \cdot 3aq$: **I Querault et al** 1997 AM 82 812-9.

lansfordite $MgCO_3 \cdot 5aq$. Lansfordite mineral group of hydrous carbonates.
Structure determination not found.
Occurrence: **Dana**.

lanthanite-Ce $(Ce,La,Nd)_2(CO_3)_3 \cdot 8aq$.
Redefinition of lanthanites into 3 composition groups: **D Atencio RE & 4 others** 1989 MM 53 639-42.
Structure determination not found.
Occurrence: **RE Bevins & 4 others** 1985 AM 70 411-3.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

lanthanite-La $(La,Nd)_2(CO_3)_3 \cdot 8aq$.
Redefinition of lanthanites into 3 composition groups: **D Atencio RE & 4 others** 1989 MM 53 639-42.
Structure: **A Dal Negro G Rossi V Tazzoli** 1977 AM 62 142-6.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

lanthanite-Nd $(Nd,La)_2(CO_3)_3 \cdot 8aq$.
Redefinition of lanthanites into 3 composition groups: **D Atencio RE & 4 others** 1989 MM 53 639-42.
Structure determination not found.
Occurrence: **AC Roberts GY Chao F Cesbron** 1980 Geol Survey Canada Paper 80-1C 141-2 = AM 66 637-8.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

laphamite $(As_2(Se,S))_3$. Isostructural with S analog *orpiment*.
Structure: *synthetic* As_2Se_3 , **AL Renninger BL Aerbach** 1973 AC B29 1583-9.
Occurrence: **PJ Dunn & 3 others** 1986 MM 50 279-82.

lapieite $CuNiSbS_3$. Chemical analog of *bournonite*, but not isostructural.
Structure determination not found.
Occurrence: **DC Harris & 4 others** 1984 CM 22 561-4.

lappandite-Ce $Na_4CeTiPSi_7O_{22} \cdot 5aq$.
Structure determination not found.
Occurrence: **EM Eskova & 4 others** 1974 ZVMO 103 571-5 = AM 60 487;
RA Vinogradova et al. 1999 ZVMO 88-90 (V367).
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
Review: (different formula) **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

[lapparentite] $Al_2S_2O_9 \cdot 10aq$. Occurrence: MM 23 632.]

larderellite $(NH_4)B_5O_7(OH)_2 \cdot aq$. Compare with *ammonioborite*.
Structure: **S Merlino F Sartori** 1969 AC B25 2264-70.
Structural mechanism of thermal reactions: **I Waclawska** 1997 JAICo 257 191-5 (W815).

larisaite $Na(H_3O)(UO_2)_3(SeO_3)_2O_2 \cdot 4aq$.
Occurrence: Utah, **NK Chukanov & 8 others** 2004 EJM 16 367-74 (10317). **To here**

larnite Ca_2SiO_4 -beta.
Trimorphic with *alpha* (*bredigite*) & *gamma* (*olivine* structure type).
Structure: **CM Midgley** 1952 AC 5 307-12;
high temperature, **H Saalfeld** 1975 AM 60 824-7;
synthetic, **KH Jost B Ziemer R Seydel** 1977 AC B33 1696-700.
Beta/gamma transformation, crystallography: **G Gazzoni G Chiari** 1986 AC B42 146-51.
Occurrence: MM 22 622.
Phase transformations, Raman: **C Remy B Reynard M Madon** 1997 JACeS 80 413-23 (R707);
Raman to 24 GPa, olivine type to larnite at 2 GPa: **B Reynard C Remy F Takir** 1997 PCM 24 77-84 (R725).
Synthetic Sr_2SiO_4 , beta-alpha prime transition: **M Catti G Gazzoni** 1983 AC B39 679-84.

larosite $(Cu,Ag)_2(Pb,Bi)_2S_{13}$. [jvs: indexing of XRPD implausible.]

Structure determination not found.

Occurrence: **W Petruk** 1972 CM 11 886-91.

larsenite PbZnSiO_4 .

Structure: **CT Prewitt E Kirchner A Preisinger** 1967 ZK 124 115-30 (P91).

Synthesis: **J Ito C Frondel** 1967 AM 52 1077-84;

J Ito 1968 AM 53 231-40.

Occurrence: MM 21 569.

Synthetic BaMnSiO_4 : **DD Nihtianova 3 others** 1999 PD 12 167-70.

latiumite $(\text{Ca,K})_8(\text{Al,Mg,Fe})(\text{Si,Al})_{10}\text{O}_{25}(\text{SO}_4)$. Double-layer.

Structure: **E Cannillo A Dal Negro G Rossi** 1973 AM 58 466-70;

M Mellini S Merlino 1983 NJMM 167-74 (M774).

Occurrence: MM 29 986.

latrappite $(\text{Ca,Na})(\text{Nb,Ti,Fe})\text{O}_3$. *Perovskite* structure group.

Structure: XRPD, **RH Mitchell & 4 others** 1998 CM 36 107-16.

Occurrence: **EH Nickel** 1964 CM 8 121-2.

laubmannite $\text{Fe(III,II)}_2\text{Fe(III)}_6(\text{PO}_4)_5(\text{OH})_9 \cdot 2\text{aq}$.

XRPD matches *andrewsite* $(\text{Cu,Fe,Mn})_3(\text{Fe,Al})_6(\text{PO}_4)_4(\text{OH})_{12}$.

Occurrence: **C Frondel** 1949 AM 34 513-40.

Defined by **PB Moore** 1975 AM 55 135-69.

Discredited **PJ Dunn** 1990 AM 75 1197-9.

Resurrected with SC-XRD: **U Kolitsch** 2001 Ber Deut Mineral Ges 13 99 (2941);

do 2004 MM 68 147-65.

laueite $\text{MnFe}_2(\text{PO}_4)_2(\text{OH})_2 \cdot 8\text{aq}$. *Paravauxite* structure type.

Structure: **PB Moore** 1965 AM 50 1884-92 (M1039);

K Plieth G Ruban H-G Smolczyk 1965 AC 19 485;

PB Moore 1975 NJMA 123 148-59.

Topologic/geometric isomerism in compounds with laueite-sheets: **SV Krivovichev** 2004 NJMM 209-20 (10363).

Occurrence: MM 30 737.

Comparison with *pseudolaueite*: **WH Baur** 1969 AM 54 1312-23.

laumontite $\text{CaAl}_2\text{Si}_4\text{O}_{12} \cdot 4\text{aq}$. *Zeolite* mineral group. IZA-SC structure code LAU.

Consortium for Theoretical Frameworks net 633.

Leonhardite is partly dehydrated with $\sim 3\text{aq}$: a *primary* type occurs naturally with Na & K, & does not rehydrate to laumontite.

Structure: NMR, **IA Belitskiy & 3 others** 1964 DES 159 85-7 = MA 70-659;

ST Amirov VV Ilyukhin NV Belov 1967 DES 174 121-4;

H Bartl KF Fischer 1967 NJMM 33-42 (B767);

leonhardite, **H Bartl** 1970 NJMM 298-310 (B766);

ST Amirov VV Ilyukhin NV Belov 1971 ZVMO 100 20-30;

V Schramm KF Fischer 1971 ACS Advances in Chemistry 101 259-65 (S1228);

OV Yakubovich MA Simonov 1985 SPC 30 624-6 (Y127);

G Artioli JV Smith Å Kvik 1989 Z 9 377-91 (A526);

re- & dehydration, SC-XRD 100K, **T Armbruster T Kohler** 1992 NJMM 385-97 (A515);

G Artioli K Ståhl 1993 Z 13 249-55 (A521);

K Ståhl G Artioli 1993 EJM 5 851-6 (S1221);

water positions at 200-390K from NMR of H & Al: **SP Gabuda SG Kozlova** 1995 J

Inclusion Phenom Mol Recognit Chem 22 1-13 = CA 123:345789u;

thermochemistry/equilibria, Ca zeolites, **I Kiseleva & 3 others** 1996 AM 81 658-67;

dehydration, real-time XRPD, **K Ståhl G Artioli JC Hanson** 1996 PCM 23 328-36 (S1630);

dehydration, thermodynamics, petrogenetics, **PS Neuhoff DK Bird** 2001 MM 65 59-70;

XRPD, isothermal hydration/dehydrat, RT, **T Fridriksson DL Bish DK Bird** 2003 AM 88 277-87;

thermochemistry of hydration, **T Fridriksson & 4 others** 2003 AM 88 106-12;

P-induced hydration, **CLIM White & 2 others** 2004 AnCh 43 469-72 (9900).

Natural *KNaCa leonhardite* & cation-exchanged forms, thermochemistry:

I Kiseleva & 3 others 1996 AM 81 668-75;

structure, **J Stolz T Armbruster** 1997 NJMM 131-44 (S1702);

structure with P lattice, **WH Baur & 3 others** 1997 EJM 9 1173-82 (B1765);
thermodynamics, 6-309 K, **IE Paukov & 3 others** 2002 GI 40 621-4 (7904).
Na,K-exchanged, XRD/TGA-DTA: **A Yamazaki T Shiraki H Ishida** 1994 Stud Surf Sci Catal 98 32-3.
To *wairakite* + water, experimental transformation: **C Jové BR Hacker** 1997 AM 82 781-9 (J294).
Synthetic Ga-P: **AD Bond & 4 others** 1997 Z 19 326-33 = CA 128:56607g.

launayite $Pb_{22}Sb_{26}S_{61}$. Structure determination not found.
Occurrence: **JL Jambor** 1967 CM 9 191-213 (J235);
MM 36 1153.

laurelite $Pb_7F_{12}Cl_2$.
Structure not isotypic with *penfieldite*: contains face-sharing clusters of tricapped trigonal prisms
linked into trigonal cylinders by face sharing ; alpha-PbF₂ has edge-sharing of the face-
sharing clusters.
Structure: **S Merlino M Pasero N Perchiazzi AR Kampf** 1996 AM 81 1277-81.
Occurrence: **AR Kampf PJ Dunn EE Foord** 1989 AM 74 927-33.

laurionite $PbClOH$. Isostructural with *iodolaurionite*. Dimorphic with *paralaurionite*.
Structure: **E Cannillo G Giuseppetti C Tadini** 1969 PM 38 395-402;
CC Venetopoulos PJ Rentzeperis 1975 ZK 141 246-59.
Synthetic (Ba/Pb)O(H/D)(Cl/Br/I) & SrO(H/D)I, X-ray & neutron diffraction, IR & Raman: **HD Lutz
& 4 others** 1994 ZK 209 157.
Synthetic Ba(OD)I, Sr(OD)I & Sr(OH)I, neutron diffraction: **S Peter JK Cockcroft T Roisnel HD
Lutz** 1996 AC B52 423-7 (P634).
Synthetic PbO(H/D)(Cl/Br/I), XR & neutron diffraction: **HD Lutz K Beckenkamp T Kellersohn H
Möller S Peter** 1996 JSSC 124 155-61 (L761).

laurite RuS_2 . *Pyrite* structure type.
Synthetic, X-ray powder: **OK Sutarno O Knop KIG Reid** 1967 Canad J Chem 45 1391-9;
WN Stassen RD Heyding 1968 Canad J Chem 46 2159-63.
Synthetic, SC-XRD: **HD Lutz B Müller T Schmidt T Stingl** 1990 AC C46 2003-5 (L660).
Synthetic, high-T/S fugacity stability in Ru-Os-Ir-S: **JM Brenan D Andrews** 2001 CM 39 341-60.
Occurrence: Borneo placer, Se & As content, **KH Hattori & 3 others** 2004 MM 68 353-68.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Synthetic RuSe₂: **HD Lutz B Müller T Schmidt T Stingl** 1990 AC C46 2003-5 (L660).
Synthetic RuTe₂: **HD Lutz M Jung G Aäschenbach** 1987 ZaaC 554 87-91.
Ru-Os-Ir alloy+ laurite, phase equilibrium: **DRA Andrews JM Brenan** 2002 CM 40 1705-16.

lausenite $Fe_2(SO_4)_3 \cdot 5aq$. Compare with *kornelite* 7aq.
Structure: *synthetic*, XRPD, **J Majzlan & 2 others** 2005 AM 90 411-6.
Occurrence: MM 22 622; **Dana**.

lautarite $Ca(IO_3)_2$.
Structure: **S Ghose C Wan O Wittke** 1978 AC B34 84-8.
[*Synthetic* Ca(IO₃)₂·6aq: **B Morosin JG Bergman GR Crane** 1973 AC B29 1067-72.]

lautenthalite $PbCu_4[(OH)_6/(SO_4)_2] \cdot 3aq$. Isostructural with Ca analog *devillite/devilline*.
Structure determination not found.
Occurrence: **O Medenbach W Gebert** 1993 NJMM 401-7.

lautite $CuAsS$.
Structure: **F Marumo W Nowacki** 1964 SMPM 44 439-54;
DC Craig NC Stephenson 1965 AC 19 643-7.
Synthesis: **A Müller R Blachnik** 2003 ZaaC 629 1833-8 (9596).

lavendulan / lavendulane $NaCaCu_5(AsO_4)_4Cl \cdot 4-5aq$.
From crystallography isostructural with P analog *sampleite* $NaCaCu_5(PO_4)_5Cl \cdot 5aq$ & Pb analog
zdenekite $NaPCu_5(AsO_4)_4Cl \cdot 5aq$.
Structure determination not found.
Occurrence: **C Guillemin** 1956 BSFMC 79 7-95.
Zinc lavendulan: **H Strunz** 1959 Fortschr Mineral 37 87-90.

lâvenite $(Na,Ca)_3ZrSi_2O_7(O,OH,F)_2$.
Wöhlerite/lâvenite supergroup; *lâvenite* structure group.

Isostructural with *cuspidine* & *niocalite*.

Not isostructural with *wöhlerite*, but could be put in wöhlerite mineral family.

Structure: **VI Simonov NV Belov** 1961 DAN USSR ES 130 167-70 = MA 16-26;

M Mellini 1981 TMPM 28 99-112 (M1128A).

Titan-lâvenite, Kola Peninsula: MM 26 342.]

lavrentievite $\text{Hg}_3\text{S}_2(\text{Cl},\text{Br})_2$.

Isostructural series with Br analog *arzakite*. Dimorphic with *corderoite*.

Structure determination not found.

Occurrence: **VI Vasil'ev NA Pal'chik OK Grechishchev** 1984 Geol Geofiz 7 54-63.

lawrencite $(\text{Fe},\text{Ni})\text{Cl}_2$. CdCl_2 structure type from crystallography.

Isostructural with Mg analog *chloromagnesite* MgCl_2 & Mn analog *scacchite* MnCl_2 .

Structure determination not found.

Occurrence: **Dana**.

lawsonbauerite $\sim(\text{Mn},\text{Mg})_5\text{Zn}_2(\text{SO}_4)(\text{OH})_{12.4\text{aq}}$.

Essentially isostructural with *torreyite* $\sim(\text{Mg},\text{Mn})_5\text{Zn}_2(\text{SO}_4)(\text{OH})_{12.4\text{aq}}$. Sheet structure.

Review: **Sabelli** p.24.

Structure: **AH Treiman DR Peacor** 1982 AM 67 1029-34.

Occurrence: MM 43 1063.

lawsonite $\text{CaAl}_2\text{Si}_2\text{O}_7(\text{OH})_2.\text{aq}$.

Isostructural with *hennomartinite* $\text{SrMn}_2[\text{Si}_2\text{O}_7](\text{OH})_2.\text{aq}$, *itoigawaite* $\text{SrAl}_2\text{Si}_2\text{O}_7(\text{OH})_2.\text{aq}$ & *noélbensonite* $\text{BaMn}_2\text{Si}_2\text{O}_7(\text{OH})_2.\text{aq}$.

Crystal chemistry: **T Armbruster R Oberhänsli V Bermanec** 1992 EJM 4 17-22 (B1026).

Dimorphic with *partheite*.

Edge-sharing Al-octa chain crosslinked by Si_2O_7 .

Structure: **FE Wickman** 1947 Ark Kemi 25A no. 2 7p;

IM Rumanova TI Skipetrova 1959 Sov Phys Dokl 4 20-3 (R510);

IR & orientation of water & hydroxyl, **TC Labotka GR Rossman** 1974 AM 59 799-806;

WH Baur 1978 AM 63 311-5 (B1026);

phase transitions 155 & 273K, role of H bonds, **E Libowitzky T Armbruster** 1996 SMPM 76 118-9 (L736);

SC-XRD determination at 110-500 K, **do** 1995 AM 80 1277-85;

order across low-T phase transitions, **H Meyer & 4 others** 2000 EJM 12 1139-50 (427);

lattice defects, TEM, **F Camara JC Doukhan MA Carpenter** 2001 MM 65 33-40;

phase transitions, neutron PD, **H Meyer & 6 others** 2001 AM 86 566-77.

Thermal expansion: to 863 K, **AR Pawley SAT Redfern TJB Holland** 1996 AM 81 335-40;

to 871 K & up to 3.8 GPa, **P Comodi PF Zanazzi** 1996 AM 81 833-41.

Equation of state: to 7 GPa & 873 K, **N Chinnery AR Pawley SM Clark** 2000 AM 85 1001-8;

& high-P phase transitions, **T Boffa Ballaran RJ Angel** 2003 EJM 15 241-6.

Elasticity vs T: **FR Schiling SV Sinogeikin JD Bass** 2003 PEPI 136 107-19.

Phase transitions: calorimetry, **J Martin-Olalla & 5 others** 2001 EJM 13 5-14 (1678);

SA Hayward & 4 others 2002 EJM 14 1145-53 (8683);

spontaneous strain, NPD structure of D-, **MA Carpenter & 4 others** 2003 AM 88 534-46;

ordering/elasticity vs low-T, **P Sondergeld & 6 others** 2005 AM 90 448-56;

classical/3d-Ising critical behavior near antiferrodistortive change, **W Schranz & 7 others** 2005 ZK 220 704-11.

FTIR spectroscopy from 82 to 325 K: **E Libowitzky GR Rossman** 1996 AM 81 1080-91.

High-P: PVT equation-of-state, no phase change to 9 GPa, **I Daniel & 4 others** 1999 PCM 26 (D779);

equation-of-state to 7 GPa & 1273 K, **K Grevel et al** 2000 AM 85 206-16;

XRPD to 16 GPa, **AR Pawley DR Allan** 2001 MM 65 41-58.

Single crystal elasticity, Brillouin: **SV Sinogeikin FR Schilling JD Bass** 2000 AM 85 1834-7.

Enthalpy of formation: **K Grevel & 4 others** 2001 CMP 142 298-308 (3788).

Chrome-, oscillatory-zoned, Turkey: **SC Sherlock AI Okay** 1999 MM 63 687-92.

REE-bearing, sector-zoned: **T Ueno** 1999 EJM 11 993-8 (U363).

lazarenkoite $(\text{Ca},\text{Fe}^{2+})\text{Fe}^{3+}\text{As}_3\text{O}_7.3\text{aq}$.

Structure determination not found.

Occurrence: **LK Yakhontova II Plosina** 1981 MZh 3 92-6 = AM 67 415.

[lazarevicite Cu_3AsS_4 . Analog of Cu_3VS_4 *sulvanite*.

Arsenosulvanite $\text{Cu}_3(\text{As,V})\text{S}_4$ is probably a better name.

Occurrence: MM 32 966.]

LAZULITE STRUCTURE GROUP OF MONOCLINIC PHOSPHATES Includes:

<i>barbosalite</i>	$\text{FeFe}_2(\text{PO}_4)_2(\text{OH})_2$
<i>hentschelite</i>	$\text{CuFe}_2(\text{PO}_4)_2(\text{OH})_2$
<i>lazulite</i>	$(\text{Mg,Fe})\text{Al}_2(\text{PO}_4)_2(\text{OH})_2$
<i>[lipscombite</i>	$(\text{Fe}^{2+},\text{Mn})\text{Fe}^{3+}_2(\text{PO}_4)_2(\text{OH})_2$.
synthetic: replaces	<i>iron-lazulite</i> : MM 30 737-8.]
<i>scorzalite</i>	$(\text{Fe,Mg})\text{Al}_2(\text{PO}_4)_2(\text{OH})_2$

Structurally related are orthorhombic & triclinic $\text{CuFe}_2(\text{AsO}_4)_2(\text{OH})_2$: **H Effenberger** 1988 ACC 44 2041-3 (E353) & 1995 51 1042-5 (E342).

Synthetic 'iron-lazulite', but tetragonal: crystal structure: MM 29 985.

Synthetic lazulite-scorzalite, Mössbauer/XRPD:

P Schmid-Beurmann S Knitter L Cemič 1999 PCM 26 496-505 (S2065);
cation/valence distribution, **R Selke & 2 others** 2003 EJM 15 127-36 (8913).

Synthetic scorzalite/barbosalite, Mössbauer/diffuse reflectance spectrosc: **M Grodzicki & 6 others** 2003 AM 88 481-8.

lazulite $(\text{Mg,Fe})\text{Al}_2(\text{PO}_4)_2(\text{OH})_2$. Lazulite structure type.

Structure: **ML Lindberg CL Christ** 1959 AC 12 695;

G Giuseppetti C Tadini 1983 NJMM 410-6 (G551);

I Hassan RC Peterson HD Grundy 1985 AC C41 827-32;

Raman, **M Ostroumov & 3 others** 2002 CM 40 885-93;

RK Rastsvetaeva & 5 others 2002 CrR 47 404-7 (7370).

Heat capacity: synthetic, **F Brunet & 2 others** 2004 MM 68 123-34.

lazurite $(\text{Na,Ca})_8(\text{Al,Si})_{12}\text{O}_{24}[\text{SO}_4,\text{Cl}_2,(\text{OH})_2]$. Sodalite structure type.

Structure: **I Hassan RC Peterson HD Grundy** 1985 AC C41 827-32 (H1004);

loss of modulation upon heating, **AN Sapozhnikov & 4 others** 1994 ZVMO 123 82-8;

triclinic, **VG Evsyunin & 3 others** 1997 CrR 42 938-45 (E428);

modulated, **NR Bolotina & 5 others** 2003 CrR 48 8-11 (8787).

Industrial blue pigments are called *ultramarine*, other colors prepared by various processes: XR, neutron & NMR, **SE Tarling P Barnes J Klinowski** 1988 AC B44 128-35 (T433).

Phase stability in $\text{Al}_2\text{O}_3\text{-AlPO}_4\text{-Mg}_3(\text{PO}_4)_2\text{-aq}$: **L Cemic P Schmid-Beurmann** 1995 EJM 7 921-9 (C794).

Polymorphism, TEM & DTA: **I Hassan** 2000 AM 85 1383-9.

Color: **VL Tauson AN Sapozhnikov** 2003 132-5 102-6 (10517).

Natural & synthetic: S K-edge XANES & XPS, **ME Fleet & 3 others** 2005 CM 43 1581-8.

lead Pb. Cubic closest packing of spheres. Copper structure group.

High-P: **T Takahashi HK Mao WA Bassett** 1969 S 105 1352-3.

ND, 100-600 K: **M Merisalo MS Lehmann FK Larsen** 1984 AC A40 127-38.

leadamalgam / lead amalgam HgPb_2 .

XRPD indexed as tetragonal, $a = 3.5$, $c = 4.5\text{\AA}$: AM 70 215-6.

Compare with *altmarkite* with tetragonal cell, $a = 2.5$, $c = 4.5\text{\AA}$ [jvs: $2.5 \times \text{square root of } 2 = 3.5$.

Unless proven otherwise, one might consider that *altmarkite* = leadamalgam.]

leadhillite $\text{Pb}_4(\text{SO}_4)(\text{CO}_3)_2(\text{OH})_2$. Layer structure.

Stable at RT. Trimorphic with *macphersonite* & *susannite* (>473K).

High-T reversible transition with susannite: HT-XRPD: **L Bindi S Menchetti** 2005 AM 90 1641-7.

Structure: **G Giuseppetti F Mazzi C Tadini** 1990 NJMM 255-68 (G773);

Raman, **RL Frost JT Kloprogge PA Williams** 2003 NJMA 529-42 (10019).

leakeite $\text{NaNa}_2(\text{Mg}_2\text{Fe}_2\text{Li})\text{Si}_8\text{O}_{22}(\text{OH})_2$. Amphibole structure group, monoclinic subtype.

Structure: **FC Hawthorne & 4 others** 1994 AM 79 443-51.

Occurrence: AM 77 1112-5 (H1168).

lecontite $\text{Na}(\text{NH}_4,\text{K})\text{SO}_4 \cdot 2\text{aq}$. Review: **Sabelli** p. 15.

Structure: **E Corazza C Sabelli G Giuseppetti** 1967 AC 22 683-7.

legrandite $\text{Zn}(\text{OH})_2(\text{AsO}_3\text{OH})?$.

Complex 1,2,3-vertex-connected octahedral-tetrahedral net.
 Structure: **WJ McLean JW Anthony JJ Finney RB Laghon** AM 56 1147-54;
DY Pushcharovsky EA Pobedinskaya NV Belov 1971 SPD 16 419-21 (P469);
DYu Pushcharovskii EA Pobedinskaya NV Belov 1973 SPC 17 747-8 (P479);
 infrared, no aq, **VI Sumin de Portilla** 1976 AM 61 95-9.

Occurrence: MM 23 632.
[lehiite $5\text{CaO} \cdot (\text{Na}, \text{K})_2\text{O} \cdot 4\text{Al}_2\text{O}_3 \cdot 4\text{P}_2\text{O}_5 \cdot 12\text{aq}$. Compare *lewistonite*.
 Occurrence: MM 22 622.]

lehnerite $\text{Mn}[\text{UO}_2/\text{PO}_4]_2 \cdot 8\text{aq}$.
Meta-autunite structure group if error of V for U is assumed.
 Occurrence: **A Mücke** 1988 Der Aufschluss 39 209 = MM 62 727.

leifite $\sim \text{Na}_7\text{Be}_2\text{Al}_3\text{Si}_{15}\text{O}_{39}\text{F}_2 \cdot \text{aq}$. Isostructural with *telyushenkoite* $\text{CsNa}_6\text{Be}_2\text{Al}_3\text{Si}_{15}\text{O}_{39}\text{F}_2$.
 Consortium for Theoretical Frameworks net 978.
 Structure: **A Coda L Ungaretti A Della Giusta** 1974 AC B30 396-401;
 revised composition, SC-XRD, **E Sokolova & 5 others** 2002 CM 40 183-92.
 Occurrence: in hyperagpaitic alkaline rocks, **Khomyakov** (1995);
 Norway, MA 96M/3971.

leightonite $\text{K}_2\text{Ca}_2\text{Cu}(\text{SO}_4)_4 \cdot 2\text{aq}$. Review: **Sabelli** p. 35.
 XRPD: **PR van Loan** 1962 CM 7 272-7 (V221).
 Structure: SC-XRD, **S Menchetti L Bindi P Bonazzi F Olmi** 2002 AM 87 721-5.
 Occurrence: MM 25 635; **Dana**.

leisingite $\text{Cu}(\text{Mg}, \text{Cu}, \text{Fe}, \text{Zn})_2\text{Te}^{6+}\text{O}_6 \cdot 6\text{aq}$.
 Occurrence and crystallography: **AC Roberts & 6 others** 1996 MM 60 653-7.

leiteite ZnAs_2O_4 .
 Structure: **S Ghose PK Sen Gupta EO Schlemper** 1987 AM 72 629-32.
 Occurrence: MM 42 526.

lemleinite-Ba $\text{Na}_2\text{K}_2\text{Ba}_{1+x}\text{Ti}_4(\text{Si}_4\text{O}_{12})_2(\text{O}, \text{OH})_4 \cdot 4\text{aq}$. *Labuntsovite* group.
 Structure: SC-XRD, **T Armbruster & 6 others** 2004 AM 89 1655-66.

lemleinite-K $\text{Na}_2\text{K}_2\text{KTi}_4(\text{Si}_4\text{O}_{12})_2(\text{O}, \text{OH})_4 \cdot 4\text{aq}$. *Labuntsovite* group.
 Structure: SC-XRD, **T Armbruster & 6 others** 2004 AM 89 1655-66.
 Occurrence & structure reference: **AP Khomyakov & 3 others** 1999 ZVMO 128 54-63.
 Occurrence & new composition: **NV Chukanov & 3 others** 2001 ZVMO 3 36-42.

lemoynite $(\text{Na}, \text{K})_2\text{CaZr}_2\text{Si}_{10}\text{O}_{26} \cdot 5-6\text{aq}$. Same framework as *natrolemoynite* & *altisite*.
 CTF net 1089.
 Structure: **VA Blinov & 3 others** 1975 SPD 19 397-8 (B1120) (incorrect space group?) = MA 75-3006;
Y Le Page G Perrault 1976 CM 14 132-8 (L602).
 Occurrence: MM 37 960.

A McDonald (pers comm) proposes that the space group is C2/m not C2/c.

lenaite AgFeS_2 . *Chalcopyrite* structure group.
 Occurrence & crystallography: **VA Amuzinsky & 3 others** 1995 ZVMO 124 85-91 = AM 81 1283.
 Structure: SC-XRD, **L Bindi & 2 others** 2006 CM 44 207-12.

lengenbachite $(\text{Ag}, \text{Cu})_2\text{Pb}_6\text{As}_4\text{S}_{13}$. Incommensurate layer structure.
 Structure: **TB Williams A Pring** 1988 AM 73 1426-33;
E Makovicky E Leonardsen Y Moëlo 1994 NJMA 166 169-91 (M1108).

leningradite $\text{PbCu}_3(\text{VO}_4)_2\text{Cl}_2$.
 Structure determination not found.
 Occurrence: **LP Vergosa & 3 others** 1990 DAN SSSR 310 1434-7 = AM 76 1434-5.

lennilenapeite $\text{K}_{6-7}(\text{Mg}, \text{Mn}, \text{Fe}, \text{Zn})_{48}(\text{Si}, \text{Al})_{72}(\text{O}, \text{OH})_{216} \cdot 16\text{aq}$.
Stilpnomelane structure group.
 Essentially isostructural with Mn analog *franklinphillite* & Fe analog *stilpnomelane*.
 Structure determination not found.
 Occurrence: **PJ Dunn DR Peacor WB Simmons** 1984 CM 22 259-63.

lenoblite $\text{V}_2\text{O}_4 \cdot 2\text{aq}$. Compare with *duttonite* & *synthetic*.

Structure determination not found.
Occurrence: **F Cesbron H Vachey** 1970 BSFMC 93 235-41 = AM 56 635-6.
leogangite $\text{Cu}_{10}(\text{AsO}_4)_4(\text{SO}_4)(\text{OH})_6 \cdot 8\text{aq}$.
Occurrence & SC-XRD structure: **CL Lengauer G Giester E Kirchner** 2004 MP 81 187-201 (10379).
leonite $\text{K}_2\text{Mg}(\text{SO}_4)_2 \cdot 4\text{aq}$. Isostructural with Fe analog *mereiterite*.
Structure: **D Jarosch** 1985 ZK 173 75-9;
SC-XRD of (Mg/Mn/Fe), low T: **B Hertweck G Giester E Libowitzky** 2001 AM 86 1282-92.
Phase transitions (Mg/Mn/Fe), IR/Raman: **B Hertweck E Libowitzky** 2002 EJM 14 1009-17 (8693).
 $(\text{NH}_4)_2\text{Mg}(\text{SO}_4)_2 \cdot 4\text{aq}$ in burned coal, denied as mineral: AM 86 1292.
Synthetic (Rb/Cs/T)(Cu/Ni/Zn/Cd): AM 86 1282.
Synthetic K-Cd: **MG Wyruboff** 1891 BSFM 8 233-45.
Synthetic $(\text{NH}_4)_2(\text{Mg/Mn/Fe/Co})(\text{SO}_4)_2 \cdot 4\text{aq}$: **K Kohler W Francke** 1964 ZaaC 331 17-34.
Synthetic Mn-: MM 29 988.
Synthetic $\text{K}_2\text{Mn}(\text{SO}_4)_2 \cdot 4\text{aq}$: **W Schneider** 1961 AC 14 784-91;
neutron, **S Srikanta A Sequeira R Chidambaram** 1965 AC B24 1176-82;
ND & IR, **B Hertweck E Libowitzky AJ Schulz** 2003 ZK 218 403-12 (9165).
Synthetic $\text{K}_2\text{Mg}(\text{SeO}_4)_2 \cdot 4\text{aq}$: AM 86 1292.
Synthetic $\text{K}_2(\text{Mg/Mn/Fe})(\text{SO}_4)_2 \cdot 4\text{aq}$, multiple phase transitions, SC-XRD: **B Hertweck T Armbruster E Libowitzky** 2002 MP 75 245-59 (7815).
Occurrence: cave in Romania, **BP Onac WB White I Viehmann** 2001 MM 65 103-10.
lepersonnite-(Gd) $\text{Ca}(\text{Gd,Dy,Y,Tb})_2(\text{UO}_2)_{24}(\text{CO}_3)_8\text{Si}_4\text{O}_{12} \cdot 60\text{aq}$.
Structure determination not found.
Occurrence: **M Deliens P Piret** 1982 CM 20 231-8 (D506).
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
lepidocrocite $\gamma\text{-FeO}(\text{OH})$. Isostructural with *boehmite*.
Entropy/heat capacity of *goethite*, *lepidocrocite* & *maghemite*: **J Majzlan & 5 others** 2003 AM 88 846-54.
Structure: **FJ Ewing** 1935 J Chem Phys 3 420-4 (E322);
ED, **AP Zhukhlistov BB Zvyagin TI Getmanskaya** 2001 Krist 1014-8;
apparent shift of cell repeat for nanocrystalline, **H Stanjek** 2002 CIM 37 629-38.
Reaction of Cu & Cd with powder in water, XAS & surface-structure models: **RH Parkman & 4 others** 1999 AM 84 407-19.
U adsorption, XAS: **LN Moyes et al** 2000 EST 34 1062-8 (M1795).
Synthetic alkali titanate hydroxides with a & c matching *lepidocrocite*, but with b 9, 18 or 23Å:
T Sasaki & 5 others 1995 ChM 7 1001-7 (S1439);
structure, **T Sasaki & 8 others** 1998 ChM 10 4123-8 (S2004).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Synthetic pillaring of titanate with alumina: **F Kooli T Sasaki M Watanabe** 1999 MMM 28 495-503 (K1155);
microporosity & acidity, **F Kooli & 4 others** 1999 La 15 1090-5.
Cd surface complexes on Fe-oxyhydroxides, AFM/EXAFS: **A Manceau & 3 others** 2000 JCIS 228 306-16 (428).
Phosphate vs growth from Fe(II) sulfate: **J Cumpido V Barron J Torrent** 2000 CICIM 48 503-10 (C1181).
Kinetics of dissolution: **O Larsen D Postma** 2001 GCA 65 1367-79 (1619).
As(V) adsorption, surface complexes from EXAFS: **SR Randall & 2 others** 2001 GCA 65 1015-23 (1644).
Heat conversion to Al-hematite: **E Van San & 6 others** 2001 PCM 28 488-97 (2932).
Bioreduction Fe(II,III) hydroxycarbonate *green rust*: **G Ona-Nguema & 6 others** 2002 EST 36 16-20 (3910).
Spatial profile in soil hydrosequence: **NE Smeck & 3 others** 2002 CIM 37 687-98.
Occurrence, hydrothermal sediments, Red Sea: **NT Goldman CB Koch A Singer** 2002 CICIM 50 186-97 (7139).
lepidolite $\text{K}(\text{Li,Al})_3(\text{Si,Al})_4\text{O}_{10}(\text{F,OH})_2$. *Mica* structure group; various polytypes.
Structure: 1M polytype, **F Sartori** 1977 TMPM 23 65-75;
2M₁ polytype, **F Sartori** 1977 TMPM 24 23-37;
TH Swanson SW Bailey 1981 CICIM 29 81-90 (S702);
2M₂ polytype, **F Sartori M Franzini S Merlino** 1973 AC B29 573-8;
S Guggenheim 1981 AM 60 1221-32;
3M polytype, **SW Bailey OHJ Christie** 1978 AM 63 203-4;
3T polytype, **BE Brown** 1978 AM 63 332-36;
polytype investigation by back-scatter ED/SEM, **T Kogure M Bunno** 2004 AM 89 1680-4.

lepkhenelmitite-Zn $\text{Ba}_2\text{Zn}(\text{Ti},\text{Nb})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4 \cdot 7\text{aq}$.
 Isomorphous series with *kuzmenkoite-Zn*. *Labuntsovite* group.
 Occurrence & structure: **IV Pekov & 4 others** 2006 ZVMO 133 49-59 (10871).

lermontovite $?(U,\text{Ca},\text{RE})_3(\text{PO}_4)_4 \cdot 6\text{aq}$.
 Structure determination not found.
 Occurrence: **MV Soboleva IA Pudovkina** 1957 *Uranium Minerals Handbook* 199-200 = AM 43 379-80;
 new data including ED patterns, **VG Melkov & 5 others** 1984 AM 69 214-5.

[lessingite $? \text{Ca}_2\text{Ce}_4\text{Si}_3\text{O}_{13}(\text{OH})_2$.
 Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
 Occurrence: MM 22 622.]

lesukite $\text{Al}_2(\text{OH})_5\text{Cl} \cdot 2\text{aq}$.
 Occurrence/XRPD/matches *synthetic*: **LP Vergasova & 3 others** 1997 ZVMO 2 104-10 (V278);
 Tolbachik, **SK Filatov & 4 others** 2004 ZVMO 133 (4) 1-11..

letovicite $(\text{NH}_4)_3\text{H}(\text{SO}_4)_2$. Review: **Sabelli**, no structure. **SK Filatov & 4 others**
 Occurrence: MM 23 633;
BL Davis LR Johnson 1984 JACr 17 331-3.
 XRPD: PDF 35-1500; MA 96M/2493.
Synthetic: structure, **S Suzuki Y Makita** 1978 AC B34 732-5.
 [jvs: need study of natural mineral to check if matches synthetic.]

leucite KAlSi_2O_6 . *Analcime/leucite zeolite/feldspathoid* family. ANA type of net.
 Isotypic with *ammonioleucite* $\text{NH}_4\text{AlSi}_2\text{O}_6$.
 Phase transition from low-tetragonal to high-cubic.
 Tetragonal: **F Mazzi E Galli G Gottardi** 1976 AM 61 108-15;
synthetic, **R Millini L Montanari G Bellusi** 1993 *Microporous Materials* 1 9-15.
 Review: **E Galli G Gottardi F Mazzi** 1978 *Miner Petrog Acta* 22 185-93.
 Structure: phase transitions: **DR Peacor** 1968 ZK 127 213-24;
AA Kosorukov LG Nadal 1986 SPC 31 148-51;
 leucite & Fe analog, **RA Lange ISE Carmichael JF Stebbins** 1986 AM 71 937-45;
DA Palmer EKH Salje WW Schmahl 1989 PCM 16 714-9;
DA Palmer U Bismayer EKH Salje 1990 PCM 17 259-65;
DA Palmer EKH Salje 1990 PCM 17 444-52;
 TEM, **PJ Heaney DR Veblen** 1990 AM 75 464-76;
Y Ito S Kuehner S Ghose 1991 ZK 197 75-84;
 Al/Si ordering: **BL Phillips RJ Kirkpatrick A Putnis** 1989 PCM 16 591-8;
MT Dove & 5 others 1993 AM 78 486-92;
 NMR, **SC Kohn CMB Henderson R Dupree** 1995 AM 80 705-14;
 Al,Si distribution from NMR of Cs-exchanged, **MT Dove V Heine** 1996 AM 81 39-44;
 SC-XRD at 973K, **Y Ito S Kuehner S Ghose** 1995 *Solid State Ionics* 79 120-3;
 Bragg-Williams model for ordering T, **MT Dove & 3 others** 1996 AM 81 349-62;
 NPD <1273 K, natural/*synthetic* Rb/CsAl & KFe, **DC Palmer & 3 others** 1997 AM 82 16-29;
 Si-Al ordering, MAS-NMR, **SC Kohn CMB Henderson R Dupree** 1997 AM 82 1133-40;
 radio/thermo-luminescence, MA 01M/4334;
 Si-Al ordering, **T Takaishi S Yamazaki A Yamazaki** 2002 PCCP 4 3078-84 (7698).
Pseudoleucite is attributed to change of leucite to *K-feldspar-mica-analcime*:
 occurrence, Bohemia, **E Pivec J Ulrych A Langrová** 2004 NJMA 179 221-38 (10084).
Synthetic Ge-: MM 32 958.
Synthetic $\text{K}_2\text{MgSi}_5\text{O}_{12}$: **AMT Bell & 6 others** 1994 AC B50 31-41 (B1094);
 monoclinic-orthorh transition 622 K, **SAT Redfern CMB Henderson** 1996 AM 81 369-74.
Synthetic boroleucite KBSi_2O_6 : **D Miklos & 4 others** 1992 AC C48 1831-2 (M1279).
Synthetic $\text{Cs}_2\text{CdSi}_5\text{O}_{12}$: **AMT Bell & 3 others** 1994 AC B50 560-6.
Synthetic $\text{Rb}_2\text{ZnSi}_5\text{O}_{12}$: **AMT Bell CMB Henderson** 1994 AC C50 984-6 (B1159);
 correction, x of O is 0.4711(2).
Synthetic (K/Rb/Cs) FeSi_2O_6 : **AMT Bell CMB Henderson** 1994 AC C50 1531-6.
Synthetic $\text{Rb}_x\text{K}_{1-x}\text{AlGe}_2\text{O}_6$ & $\text{Rb}_x\text{K}_{1-x}\text{GaSi}_2\text{O}_6$: **R Klaska** 1978 Nw 65 592-3.

Synthetic $\text{KAlGe}_2\text{O}_6/\text{KGaGe}_2\text{O}_6/\text{CsAlGe}_2\text{O}_6$, ND: **U Ohms-Bredemann H Pentinghaus G Heger** 1986 ZK 173 163-4.
Synthetic KAlSiO_4 -ANA, distorted leucite & other polymorphs: **R Dimitrijevic V Dondur** 1995 JSSC 115 214-24 (D512).
Ion-exchanged Cs-/Rb-, NMR, short-range Al,Si order: **BL Phillips RJ Kirkpatrick** 1994 AM 79 1025-31.
Synthetic $(\text{K/Rb/Cs})_2(\text{Mg/Zn/Cd})\text{Si}_5\text{O}_{12}$, NMR: **SC Kohn CMB Henderson R Dupree** 1994 PCM 21 176-90.
Synthetic KFeSi_2O_6 & $\text{RbFeSi}_2\text{O}_6$, XRPD & Mössbauer: **AM Bychkov & 3 others** 1996 GI 33 17-32 (B1524).
Synthetic $\text{Rb}_2\text{CdSi}_5\text{O}_{12}$ & $\text{Cs}_2(\text{Mn/Co/Ni})\text{Si}_5\text{O}_{12}$, XRPD: **AMT Bell CMB Henderson** 1996 ACC 52 2132-9 (B1532).
Synthetic $\text{RbFe/BSi}_2\text{O}_6$, XRPD: **D Mazza M Lucco Borlera** 1997 PD 12 87-9 (M1770).
Synthetic Tl, pseudomorph after *analcime*: **A Kyono & 5 others** 1999 MM 63 75-83.
Crystallization in F-doped glass: **MB Tosic RZ Dimitrijevic MM Mitrovic** 2002 JMS 37 2293-303 (7584).
[leucoglaucite $?\text{Fe}_2\text{S}_4\text{O}_{15.5}\text{aq}$.

Occurrence: MM 23 633.]

leucophanite $(\text{Na,Ca})_2\text{BeSi}_2(\text{O,F,OH})_7$.

Ordered *melilite* structure type with geometrical distortion.

Structure: **E Cannillo G Giuseppetti V Tazzoli** 1967 AC 23 255-9 (C148);

do (1969) AC B25 255-9;

JD Grice FC Hawthorne 1989 CM 27 193-7.

$(\text{Ca,REE})\text{CaNa}_2\text{Be}_2\text{Si}_4\text{O}_{12}(\text{F,O})_2$: **E Cannillo & 3 others** 1992 ZK 202 71-9.

Synthetic $\text{Na}_2\text{MgGd}_2\text{Si}_4\text{O}_{12}\text{F}_2$, structure & relation to leucophanite: **V Maissoneuve M Leblanc** 1998 CM 36 1039-43.

Occurrence: **H Bohse OV Petersen G Niedermayr** 2001 GGSB 190 119-21 (8690).

leucophoenicite $\text{Mn}_7(\text{SiO}_4)_3(\text{OH})_2$. *Humite* structure group.

Structure: **PB Moore** 1970 AM 55 1146-66 (M1162);

TJ White B Hyde 1983 AC B39 10-7 & AM 68 1009-21;

H sites, neutron PD, **MD Welch & 3 others** AM 87 154-9.

Mn-: **EL Belokoneva MA Simonov NV Belov** 1974 SPC 18 800-1 (B1137).

Structural relation to high-P B phase: **E Makovicky** 1995 AM 80 676-9.

LEUCOPHOSPHITE STRUCTURE GROUP Includes:

leucophosphite $\text{KFe}_2(\text{PO}_4)_2(\text{OH})_2\text{aq}$

spheniscidite $(\text{NH}_4,\text{K})(\text{Fe,Al})_2(\text{PO}_4)_2(\text{OH})_2\text{aq}$

tinsleyite $\text{KAl}_2(\text{PO}_4)_2(\text{OH})_2\text{aq}$

Synthetic $\text{GaPO}_4\cdot 2\text{aq}$: **RCL Mooney-Slater** 1966 AC 20 526-34 (M747).

Synthetic $\text{NH}_4\text{Al}_2(\text{OH})\text{aq}(\text{PO}_4)_2\text{aq}$, known industrially as *AlPO-15*:

structure, **JJ Pluth JV Smith JM Bennett JP Cohen** 1984 AC C40 2008-11;

synthesis, structure, **T Wang G Yang S Feng C Shang R Xu** 1989 JCSOC 948-9;

synthesis, **N Bilba & 3 others** 1994 Stud Surf Sci Catal 84 605-12 (B1156);

synthesis, wrong naming as *tinsleyite*, **S Oliver & 6 others** 1994 Stud Surf Sci Catal 84 219-4 (O257).

Synthetic $\text{CsMo}_2\text{P}_2\text{O}_{10}$ & $\text{K}_{1.5}\text{Mo}_2\text{P}_2\text{O}_{10}\cdot \text{aq}$: **A Guesdon & 4 others** 1993 Zaac 619 1841-9.

Synthetic $\text{NH}_4[\text{Ga}_2(\text{PO}_4)_2\text{OH}]\cdot 2\text{aq}$: structure, **T Loiseau G Ferey** 1994 Eur J Solid State Inorg Chem 31 575-81.

Synthetic $\text{NH}_4\text{Mo}_2\text{P}_2\text{O}_{10}\cdot \text{aq}$: **HE King Jr & 3 others** 1991 JSSC 92 1-7 (K507A).

Synthetic $(\text{K/Rb})_{1.5}[\text{Al}_2\text{P}_2\text{O}_8\cdot 5(\text{OH})_{0.5}\text{aq}]\cdot x\text{aq}$, SC-XRD: **RN Devi K Vidyasagar** 1999 JCSD 3841-5 (3735).

Synthetic ammonium-CoAlPO-15, XRPD structure: **RP Bontchev SC Sevov** 1999 JMC 9 2679-82 (3722).

Synthetic $\text{Rb}(\text{GaPO}_4)_2(\text{OH})\text{aq}\cdot \text{aq}$, SC-XRD structure: **L Beitone T Loiseau G Ferey** 2002 ACC 58 103-5 (8058).

leucophosphite $\text{KFe}_2(\text{PO}_4)_2(\text{OH})_2\text{aq}$. Leucophosphite structure group.

Structure: **PB Moore** 1972 AM 57 397-410 (M746).

Occurrence: MM 23 633.

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

[leucorhönite see *aenigmatite* group.]

leucosphenite $\text{Na}_4\text{BaB}_2\text{Ti}_2\text{Si}_{10}\text{O}_{30}$.

Structure: **NG Shumyatskaya AA Voronkov YuA Pyatenko** 1968 SPC 13 130-1 (S1308);

do 1971 SPC 16 416-22 (S1338);

YuA Malinovskii NA Yamnova NV Belov 1981 SPD 26 372-5 (M1129).

Description of structure family: **TJ White BG Hyde** 1983 AC B39 10-7.

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

levinsonite-Y $(\text{Y,Nd,Ce})\text{Al}(\text{SO}_4)_2(\text{C}_2\text{O}_4)\cdot 12\text{aq}$.

Related composition but different structure to *zugshunstite-Ce*.
 Occurrence & SC-XRD structure: **RC Rouse & 4 others** 2001 GCA 65 1101-15 (1642).
lévyclaudite / levyclaudite $\text{Pb}_8\text{Sn}_7\text{Cu}_3(\text{Bi},\text{Sb})_3\text{S}_{28}$.
 Non-commensurate *cylindrite* structure type.
 Structure determination not found.
 Occurrence: **Y Moëlo & 4 others** 1990 EJM 2 711-23.
levyne / levynite $(\text{Ca},\text{Na}/\text{K}_2)\text{Al}_6\text{Si}_{12}\text{O}_{36}$.18aq. *Zeolite* mineral group.
 IZA-SC code LEV. Consortium for Theoretical Frameworks net 189.
 Structure: **RM Barrer IS Kerr** 1959 JCSF 55 1915-23;
S Merlino E Galli A Alberti 1975 TMPM 22 117-29 (M564);
 crystal chemistry, **E Galli R Rinaldi C Modena** 1981 Z 1 157-60;
 twinned crystals from Nagasaki, Antrim & Iceland, **M Sacerdoti** 1996 NJMM 114-24;
 high-P to 5 GPa, anomalous elasticity, **GD Gatta & 3 others** 2005 AM 90 645-52.
 Occurrence: **E Passaglia E Galli R Rinaldi** 1974 CMP 43 253-9;
T Tiba S Matsubara 1977 CM 15 536-39.
Synthetic high-silica NU-3: **LB McCusker** 1989 *Zeolites for the Nineties* ed **JC Jansen L Moscou MFM Post** 281-2.
Synthetic borosilicate: **R Millini A Carati G Bellussi** 1992 Z 12 265-8.
Synthetic CoAlPO-35 , ordered P and Al,Co: **PA Barrett RH Jones** 1996 AC A52 Suppl C-401.
Synthesis in presence of F: **G Zhu & 6 others** 1997 MiM 11 269-73;
AN Christensen RG Hazell 1999 Acta Chem Scand 53 403-9.
Synthetic SAPO-35, XRPD/MAS-NMR/FTIR/TG/DTA/SEM: **AM Prakash M Hartmann L Kevan** 1998 ChM 10 932-41.
Synthetic $\text{Co}_{1.6}\text{Al}_{7.4}\text{P}_9\text{O}_{36}$.organic.aq, SC&P-XRD structure: **PA Barrett RH Jones** 2000 PCCP 2 407-12 (8900).
Synthetic B-, Al- & B,Al- with methyl-quinuclinium, **P DeLuca & 5 others** 2004 MMM 71 39-49 (10366).
lewisite $(\text{Ca},\text{Mn},\text{Na})_{1.1}\text{Sb}_{0.6}(\text{Sb},\text{Ti},\text{Fe},\text{Al})_2\text{O}_6(\text{OH})_{0.9}$. *Pyrochlore* structure.
 Structure: **RC Rouse & 3 others** 1998 JSSC 141 562-69 (R869).
[lewistonite $\sim 15\text{CaO} \cdot (\text{K},\text{Na})_2\text{O} \cdot 4\text{P}_2\text{O}_5 \cdot 8\text{aq}$. Compare *lehiite*. Occurrence: MM 22 623.]
liandratite $\text{U}(\text{Nb},\text{Ta})_2\text{O}_8$. UU_2O_8 structure type.
 Occurs with *petscheckite* $\text{UFe}(\text{Nb},\text{Ta})_2\text{O}_8$, from which it forms by loss of Fe.
 Structure: *synthetic* UTa_2O_8 , **M Gasparin** 1960 BSFMC 83 1-21(G740).
 [Compounds with the alpha- U_3O_8 structure: **WT Holser** 1956 AC 9 196 (H1037).]
 Occurrence: MM 43 1063
liberite $\text{Li}_2\text{BeSiO}_4$. *Cristobalite* topology with Be/Si ordering & Li "stuffing".
 Review of some tetrahedral oxides: **AR West** 1975 ZK 141 422-36 (W711).
 Structure: **H-C Chang** 1966 Acta Geol Sinica 46 76-86;
AR West 1975 BSFMC 98 6-10, also Ge analog.
 Occurrence: MM 35 1141-2
 CM 43 769-93.
libethenite $\text{Cu}_2(\text{PO}_4)(\text{OH})$. *Andalusite* topology.
 Solid solution with *zincolibethenite* CuZnPO_4OH .
 Compare *adamite* structure group of arsenates. Review: (E289).
 Structure: **EM Walitzi** 1963 TMPM 8 614-24;
A Cordsen 1978 CM 16 153-7;
P Keller H Hess F Zettler 1979 NJMA 134 147-56, also $\text{Co}_2(\text{PO}_4)(\text{OH})$;
 slightly monoclinic like *olivenite*: **PC Burns FC Hawthorne** 1995 CM 33 889-905.
 IR & Raman: **W Martens RL Frost** 2003 AM 88 37-46.
Synthetic $\text{Co}_2(\text{PO}_4)(\text{OH})$ & $\text{Zn}_2(\text{PO}_4)(\text{OH})$: **WTA Harrison & 5 others** 1995 JSSC 114 151-8.
liddicoatite $\text{Ca}(\text{Li},\text{Al})_3\text{Al}_6(\text{BO}_3)_3\text{Si}_6\text{O}_{18}(\text{O},\text{OH},\text{F})_4$. *Tourmaline* structure group.
 Structure: **B Nuber K Schmetzer** 1981 NJMM 215-9.
 Occurrence: MM 42 526.
[lidinite Organic cholesterine compound from human waste.
 Occurrence: **NP Tschirvinskij LV Savina ES Golovanova** 1990 Mineral sbornik Lvov 44 84 = MM 60 536.]
liebautite $\text{Ca}_3\text{Cu}_5\text{Si}_9\text{O}_{26}$. 14-repeat loop-branched single-chain.
 Structure: **MH Zöller E Tillmans G Hentschel** 1992 ZK 200 115 = MM 60 536.

liebenbergite (Ni,Mg)₂SiO₄. *Olivine* structure group.

Structure: **GA Lager EP Meagher** 1978 AM 63 365-77;

DL Bish 1981 AM 66 770-6.

Synthetic Ni₂SiO₄: **O Tamada K Fujino S Sasaki** 1983 AC B39 692-7.

Synthetic (Ni,Mg)₂SiO₄, NPD structure/EXAFS: **CMB Henderson & 3 others** 2001 AM 86 1170-87.

Synthesis from gel: **K Ikeda & 3 others** 2001 JACeS 84 1715-20.

Occurrence: MM 39 918.

P-induced ordering of (Ni,Mg): **J Chen R Li JB Parise DJ Weidner** 1996 AM 81 1519-22.

liebigite Ca₂(UO₂)(CO₃)₃.11aq.

Layer structure in contrast to framework of synthetic Sr₂[UO₂(CO₃)₃].8aq & island structure of *bayleyite* Mg₂[UO₂(CO₃)₃].18aq.

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

Structure: **K Mereiter** 1982 TMPM 30 277-88 (M1240).

Synthesis, morphology: **K Mereiter** 1986 NJMM 325-8.

Synthesis, thermal behavior: **R Vochten L Van Haverbeke K Van Springel** 1993 CM 31 161-71.

Synthetic Ca_{1.5}Na_{0.6}[UO₂(CO₃)₃].5.4aq, not isostr.: **R Vochten & 4others** 1994 CM 32 553-61.

Synthetic Sr₂[UO₂(CO₃)₃]: structure: **K Mereiter** 1986 AC C42 1678-81 (M1312).

See *andersonite*, *grimselite* & related materials.

likasite Cu₃(OH)₅(NO₃)₂aq. Incorrect early studies ignored.

Review: sheet structure, cf with *gerhardite*, **RK Eby FC Hawthorne** 1993 AC B49 28-56 (E289).

Structure: **H Effenberger** 1986 NJMM 101-10 (E362).

LILLIANITE HOMOLOGOUS SERIES Includes:

4,4	<i>bursaite</i>	Pb ₅ Bi ₄ S ₁₁
4,4	<i>gustavite</i>	PbAgBi ₃ S ₆
4,4	<i>lillianite</i>	Pb ₃ Bi ₂ S ₆
4,4	<i>ramdohrite</i>	Pb ₆ Sb ₁₁ Ag ₃ S ₂₄
4,4	<i>andorite-IV</i> = <i>quatrandorite</i>	Pb ₁₈ Ag ₁₅ Sb ₄₇ S ₉₆
4,4	<i>andorite-VI</i> = <i>senandorite</i>	Pb ₂₄ Ag ₂₄ Sb ₇₂ S ₁₄₄
4,7	<i>vikingite</i>	Pb ₈ Ag ₅ Bi ₁₃ S ₃₀
4,7r	<i>schirmerite</i>	Ag ₃ Pb ₆ Bi ₇ S ₁₈ (r = random)
4,8	<i>treasurite</i>	Ag ₇ Pb ₆ Bi ₁₅ S ₃₀
5,9	<i>eskimoite</i>	Ag ₇ Pb ₁₀ Bi ₁₅ S ₃₆
7,7	<i>heyrovskyite</i>	Pb ₆ Bi ₂ S ₉
7,7	<i>heyrovskyite-(Ag,Bi)</i>	Pb _{3.4} Ag _{1.3} Bi _{3.3} S ₉
11,11	<i>ourayite</i>	Pb ₄ Ag ₃ Bi ₅ S ₁₃
?	<i>fizélyite</i>	Pb ₁₄ Ag ₅ Sb ₂₁ S ₄₈

Structural review of selected homologues:

E Makovicky S Karup-Møller 1977 NJMA 130 264-87 & 1977-8 131 56-82;

E Makovicky T Balic-Zunic 1993 NJMA 331-44 (M1109).

Structural review of related phases including *pavonite* homologous series & *cosalite*: **E**

Makovicky 1977-8 NJMA 131 187-208

Order & compositional variation: **A Pring M Jercher E Makovicky** 1999 MM 63 917-26.

Synthetic members:

1,1 *homologue*, NdYbS₃, **D Carré P Laruelle** 1974 AC B30 952-4;

UF₆S₃, **H Noël J Padiou** 1976 AC B32 1593-5;

CuEu₂S₃, **P Lemoine D Carré M Guittard** 1986 AC C42 390-1;

1,2 *homologue*, FeHo₄S₇, **C Adolphe P Laruelle** 1968 BSFMC 91 219-32,

MnEr₄S₇, **AR Landa-Canovas LC Otero-Diaz** 1992 Australian J Chem 45 1473-87;

2,2 *homologue*, MnEr₂S₄. **AR Landa-Canovas LC Otero-Diaz** 1992 Australian J Chem 45 1473-87;

CrEr₂S₄, **A Tomas M Guittard** 1980 MRB 15 1547-56;

3,3 *homologue*, TlSb₃S₅, **M Gostojic W Nowacki P Engel** 1982 ZK 159 217-24;

E Makovicky T Balic-Zunic 1993 NJMA 165 331-44 (M1109).
Synthetic $\text{Sm}_{2/3}\text{Cr}_2\text{S}_4$: **A Lafond L Cario A van der Lee A Meerschaut** 1996 JSSC 127 295-301 (L807).
 [jvs: caution, this series is very complex & I may have missed some details.]
lillianite $\text{Pb}_3\text{Bi}_2\text{S}_6$. Lillianite homologous series; 4,4 subtype.
 Structure: **J Takagi Y Takéuchi** 1972 AC B28 649-51;
 XRPD, **K Ohsumi & 3 others** 1984 AC C40 Suppl C255-6;
 Ag-free, cf. *galenobismutite*, **D Pinto & 5 others** 2006 CM 44 159-75.
 Phase equilibria: **H Liu LLY Chang** 1994 AM 79 1159-66.
 Occurrence & crystallographic details: **YS Borodaev & 6 others** 2001 CM 39 1383-96.
lime CaO. *Halite* structure type.
 Structure: early papers, **Wyckoff**;
 charge density, **G Vidal-Valat JP Vidal K Kurki-Suonio** 1975 AC A34 594-602.
 High pressure: B1 to B2 transition.
 Thermal expansion, 300-3000 K: **G Fiquet P Richet G Montagnac** 1999 PCM 27 103-11 (F683).
 Occurrence: carbonaceous chondrites: **A Greshake & 3 others** 1996 S 272 1316-8 (G853);
 meteorites: **AE Rubin** 1997 MPS 32 231-47.
linarite $\text{PbCu}(\text{SO}_4)(\text{OH})_2$. Structure closely related to Se mineral *schmiederite*.
 Review: (E289); **Sabelli** p.19.
 Structure: **HG Bachman J Zemann** 1961 AC 14 747-53 (B1360);
T Araki 1962 MJJ 3 282-95 (A31);
H Effenberger 1987 MP 36 3-12 (E328).
 Occurrence: MA 96M/2128
lindackerite $(\text{Cu,Co,Ni})\text{Cu}_4(\text{AsO}_4)_2(\text{AsO}_3\text{OH})_2$.9aq. Similar to *chudobaite* & *geigerite*.
 Structure: SC-XRD, **J Hybler & 4 others** 2003 EJM 15 1035-42 (10079).
 Occurrence: **C Guillemin** 1956 BSFMC 79 7-95 = AM 42 124.
 Redefinition/crystallography: **H Sarp B Dominik** 1995 Arch Sci Geneve 48 239-50 = AM 81 1517.
lindbergite $\text{Mn}(\text{C}_2\text{O}_4)$.2aq. Analog of *glushkinite* & *humboltinite*.
 Occurrence & XRPD: **D Atencio & 4 others** 2004 AM 89 1087-91.
Synthetic: **R Deyrieux C Berro C Péneloux** 1973 Bull Soc Chim France 1 25-34.
lindgrenite $\text{Cu}_3(\text{MoO}_4)_2(\text{OH})_2$. Review: (E289).
 Structure: **LD Calvert WH Barnes** 1957 CM 6 31-51;
FC Hawthorne RK Eby 1985 NJMM 234-40.
 Raman: **RL Frost L Duong M Weier** 2004 NJMA 180 145-80 (10963).
 Occurrence: MM 24 615.
lindqvistite $\text{Pb}_2(\text{Mn,Mg})\text{Fe}_{16}\text{O}_{27}$. W-type hexagonal ferrite with superstructure.
 Structure: substructure, **D Holtstam R Norrestam** 1993 AM 78 1304-12.
lindsleyite $(\text{Ba,Sr})(\text{Ti,Cr,Fe,Mg,Zr})_{21}\text{O}_{38}$. *Crichtonite* structure group.
 Occurrence: MM 48 576.
 Synthesis & structure of $\text{BaMn}_3\text{Ti}_{18}\text{O}_{38}$: **RC Peterson IE Grey** 1995 CM 33 1083-9.
lindströmite $\text{Pb}_3\text{Cu}_3\text{Bi}_7\text{S}_{15}$. Structure contains 8 *krupkaite* & 2 *aikinite* units.
 Structure review: **WG Mumme E Welin BJ Wuensch** 1976 AM 61 15-20.
 Structure: $\text{PbCuBi}_3\text{S}_6$, **LN Kaplunnik EA Pobedinskaya NV Belov** 1975 SPC 20 634-6;
H Horiuchi BJ Wuensch 1976 CM 15 527-39;
A Pring BG Hyde 1987 CM 25 393-9;
A Pring 1989 AM 74 250-5;
 Cobalt, Ont, XRPD & ED, **A Pring BA Grguric AJ Criddle** 1998 CM 36 1139-48.

LINNAEITE STRUCTURE GROUP Includes:

<i>bornhardtite</i>	Co_3Se_4
<i>carrollite</i>	$\text{Cu}(\text{Co,Ni})_2\text{S}_4$
<i>daubréelite</i>	FeCr_2S_4
<i>fletcherite</i>	$\text{Cu}(\text{Ni,Co})_2\text{S}_4$
<i>florensovite</i>	$\text{Cu}(\text{Cr}_{1.5}\text{Sb}_{0.5})\text{S}_4$
<i>greigite</i>	Fe_3S_4

<i>indite</i>	FeIn ₂ S ₄	
<i>kalininite</i>	ZnCr ₂ S ₄	
<i>linnaeite</i>	Co ²⁺ Co ³⁺ S ₄	
<i>polydymite</i>	Ni ₃ S ₄	
<i>[siegenite]</i>	(Co,Ni) ₃ S ₄	jvs: may be unnecessary name.]
<i>trüstedtite</i>	Ni ₃ Se ₄	
<i>tyrrellite</i>	(Cu,Co,Ni) ₃ Se ₄	
<i>violarite</i>	FeNi ₂ S ₄	

Spinel structure type.

Nomenclature: *T Wagner NJ Cook* 1999 CM 37 545-58.

linnaeite Co²⁺Co³⁺S₄. *Spinel* structure type; linnaeite subtype.

Structure: *synthetic*, XRPD, **D Lundqvist A Westgren** 1938 ZaaC 239 85-8 (L629).

lintisite Na₃LiTi₂Si₄O₁₄.2aq. (1,2,3)-connected octahedral-tetrahedral net.

Polysomatic relation to *kukisvumite*.

Structure: **S Merlino M Pasero AP Khomyakov** 1990 ZK 193 137-48 (M1012).

Occurrence: MM 60 536.

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

liottite ~₂(Ca₁₁NagK₄)(Al₁₈Si₁₈O₇₂)(SO₄)₄(CO₃)₂Cl₃(OH)₄.2aq.

Cancrinite structure group: 6-layer ABABAC subtype; Consortium for Theoretical Frameworks net 124, IZA-SC code LIO. Review: **Sabelli** p. 41.

Structure, (Na,K)₁₆Ca₈(Al₁₈Si₁₈O₇₂)(SO₄)₅Cl₄: **P Ballirano S Merlino E Bonaccorsi** 1996 CM 34 1021-30.

Occurrence & crystallography: **S Merlino P Orlandi** 1977 AM 62 321-6.

XRPD: **P Ballirano & 4 others** 1995 PD 10 13-9 ().

Occurrence: MM 42 526.

lipscombite (Fe²⁺,Mn)Fe³⁺₂(PO₄)₂(OH)₂.

Replaces *iron-lazulite*: MM 30 737-8. *Lazulite* structure group.

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

Synthetic: **I Vencato E Mattievich YP Mascarenhas** 1989 AM 74 456-60;

Y Song & 4 others 2003 JSSC 175 63-71(9814).

Synthetic Fe₇(Fe_{0.5}Fe_{0.5})₁₈(PO₄)₁₄(OH)₂: **EN Matirienko & 3 others** 1981 J Struct Chem 22 91-5.

Thermal dehydration: **D Rouzies J Varloud JMM Millet** 1994 JCSF 90 3335-9 (R523).

Synthetic Mn/Co/Cr-substituted, Mössbauer: **D Rouzies P Moral JMM Millet** 1995 JPC 99 12576-80 (R598).

liroconite Cu₂Al(As/PO₄)(OH)₄.4aq.

Edge-vertex-connected octa-tetra net with dangling aq from Cu.

Structure: **G Giuseppetti A Coda F Mazzi C Tadini** 1962 PM 31 19-42;

RV Kolesova 1967 SPD 12 535-9;

RV Kolesova EG Fesenko 1968 SPC 13 324-8 (K637);

PC Burns RK Eby FC Hawthorne 1991 AC C47 916-9 (B994).

lisetite Na₂CaAl₄Si₄O₁₆. Isostructural with Ba analog *banalsite*.

Structure: **G Rossi R Oberti DC Smith** 1986 AM 71 1378-83.

Occurrence: MM 52 727

lishizhenite ZnFe₂(SO₄)₄.14aq.

Occurrence: **W Li G Chen** 1990 Acta Min Sinica 10 299 = MM 60 536.

lisitsynite KBSi₂O₆.

Similar structure units to *synthetic* Li-A(BW) zeolite, but different connectivity.

Occurrence/SC-XRD structure: **EV Sokolova FC Hawthorne AP Khomyakov** 2001 CM 39 159-6.

Occurrence: **APK GN Nechelyustov EVS FCH** 2001 ZVMO 129 35-42.

liskeardite (Al,Fe)₃AsO₄(OH)₆.5aq.

Structure determination not found.

Occurrence: **Dana**.

litharge PbO-alpha (tetragonal red).

Low-T stable polymorph beta (yellow) *massicot* is high-T phase.

Has flat layer in contrast to corrugated layer of *massicot*.
 Complex transitions & incommensurate phases.
 Isostructural with *mackinawite* Fe₂S₈ & *romarchite* SnO.
Mereheadite Pb₂O(OH)Cl is related to litharge & synthetic Pb oxyhalides.
 Structure: **WJ Moore Jr L Pauling** 1941 JChS 63 1392-4;
J Waser HA Levy SW Paterson 1953 AC 6 661-3;
 NPD, **J Leciejewicz** 1961 AC 14 1304;
 N&XR scattering/ED of incommensurate PbO- α , compared with isostructural
 Pb_{1-x}Ti_xO & SnO: **D Le Bellac & 6 others** 1995 PRB 52 13184-94 (L700).
 Mechanically-induced phase transformations: **VV Zyryanov** 1997 Inorg Mater 33 1039-45 (Z145).
Synthetic Pb_{1-x}Ti_xO_{1+x}, x = 0-0.8, α & β -PbO types: 1990 MRB 25 979-86.
Synthetic SnO: **J Pannetier G Denes** 1980 AC B36 2763-5.
Synthetic (Sn/Pd/Pt)S: **J Waser HA Levy SW Paterson** 1953 AC 6 661-3;
J Leciejewicz 1961 AC 14 66 & 1304.
lithiomarsturite LiCa₂Mn₂HSi₅O₁₅. 5-repeat *pyroxenoid* with disorder.
 Occurrence & incomplete structure determination: **DR Peacor & 4 others** 1990 AM 75 409-14.
lithiophilite Li(Mn²⁺,Fe²⁺)PO₄. *Olivine* structure type.
 Isostructural with Mg-analog *triphylite*.
 Structure: **AD Wadsley** 1952 AC 5 676-80;
 triphylite series, SC-XRD, **A Losey & 4 others** 2004 CM 42 1105-15.
 With *asbolane*, laterite weathering of ultrabasite, XAS Co/Ni: **A Manceau S Llorca G Calas** 1987 GCA 51 103-13 (M966).
Sicklerite is ferrian analog. See *simferite*.
lithiophorite (Al,Li)MnO₂(OH)₂.
 Structure: **AD Wadsley** 1952 AC 5 676-80;
L Pauling B Kamb 1982 AM 67 817-21.
 Trigonal, not monoclinic as given earlier: **JE Post DE Appleman** 1994 AM 79 370-4.
 Cu substitution in banded iron ore, EXAFS: **A Manceau & 4 others** 1990 AM 75 490-4 (429).
Synthetic sub-micrometer: **D Yang M Wang** 2003 CICIM 51 96-101 (8609).
lithiophosphatite Li₃PO₄- γ .
 Hexagonal close packing of oxygen with tetrahedral cations.
 Similar to *enargite* Cu₃AsS₄.
 All cations in tetrahedra; similar to *olivine* if replace octahedra with tetrahedra.
 Structure: **F Zambonini F Laves** 1932 ZK 83 26-8;
J Zemann 1960 AC 13 863-7 (Z84);
synthetic, **OS Bondareva MA Simonov NV Belov** 1978 SPD 23 287-8 (B1108);
 electron density, **OV Yakubovich VS Urusov** 1997 CrR 42 261-8 (Y190).
 Occurrence: MM 31 965.
lithiotantite Li(Ta,Nb)₃O₈.
 Structure determination not found.
 Occurrence: **AV Voloshin & 3 others** 1983 MZh 5 91-5 = MA 69 1191.
lithiowodginite (Li,Mn,Fe)(Ta,Nb,Sn)₃O₈. *Wodginite* structure type.
 Occurrence: **AV Voloshin YaA Pakhomovoski AYU Bakhchisaraitsev** 1990 MZh 112 94.
lithosite K₆Al₄Si₈O₂₅.2aq.
 1,2-vertex-connected tetrahedral net; CTF net 1129.
 Structure: **ZV Pudovkina LP Solov'eva YuA Pyatenko** 1986 SPD 31 941-2 (P464).
 Occurrence: MM 48 576.
 Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
litudionite KNaCuSi₄O₁₀. Essentially isostructural with Fe analog *fenaksite*.
 Structure: **JM Martin Pozas G Rossi V Tazzoli** 1975 AM 60 471-4 (M548).
Synthetic, as tubular fibers: **P Calvert** 1992 N 357 365-6 (C1131).
litvinskite Na₂(vacancy,Na,Mn)Zr[Si₆O₁₂(OH,O)₆]. *Lovozerite* group.
 Occurrence, XRD, IR: **IV Pekov & 5 others** 2000 ZVMO 129 45-53 = AM 86 377.
 Structure: **NA Yamnova et al** 2001 Kryst 46 230-3.

liveingite $\text{Pb}_9\text{As}_{13}\text{S}_{28}$. *Sartorite* mineral group.

Structure: **M-T Le Bihan** 1961 AC 14 1211-2;

M-T Le Bihan 1962 BSFMC 85 15-47;

P Engel W Nowacki 1970 ZK 131 356-75 (E314).

livingstonite HgSb_4S_8 .

Structure: **N Niizeki MJ Buerger** 1957 ZK 109 129-57;

T Srikrishnan W Nowacki 1975 ZK 141 174-92 (S1407).

Synthesis: **JR Craig** 1970 AM 55 919-24.

lizardite $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$.

Structure: **JC Rucklidge J Zussman** 1965 AC 19 381-9;

I Krstanovic 1968 ZK 126 163-9 (K134);

GW Brindley H-M Wan 1975 AM 60 863-71;

1T type, **M Mellini** 1982 AM 67 587-98;

1T & 2H₁ types, **M Mellini PF Zanazzi** 1987 AM 72 943-8;

1T type, **M Mellini C Viti** 1994 AM 79 1194-8;

1T type, H sites/thermal expansion, NPD, **M Gregorkiewitz & 3 others** 1996 AM 81 1111-6;

aluminian 2H₂, SC-XRD: **MF Brigatti & 3 others** 1997 AM 82 931-5;

1T-, electron density, **L Benco** 1997 EJM 9 811-9 (B1742);

1T-, Mössbauer & IR, **Y Fuchs J Linares M Mellini** 1998 PCM 26 111-5 (F635);

1T- & 2H, SC-XRD, 770 K: **S Guggenheim W Zhan** 1998 CM 36 1587-94;

1T-, EM structure, **AP Zhukhlistov BB Zvyagin** 1998 CrR 43 950-5 (Z189);

1T-, 3R- & 6-layer, **AP Zhukhlistov & 2 others** 2004 CrR 49 975-81 (10965).

Ab initio Hartree-Fock calculation, 1T: **L Smrcok L Benco** 1996 AM 81 1405-12;

P-induced stronger H bonding, **L Benco L Smrcok** 1998 EJM 10 483-90 (B1834).

IR, 1st-principles calculation: **E Bal and 4 others** 2002 AM 87 1286-90.

Scrolling of thin crystals in TEM: **PJ Wicks EJ Chatfield** 2005 CM 43 1993-2004.

Occurrence: MM 31 965.

2 lizardites, single- & alternate-direction-serpentine layers: **I Krstanovic L Karanovic** 1995 NJMM 193-201 (K765).

Composition gap with *chrysotile*, Elba, Italy, TEM of microstructure from recrystallization of

chrysotile to *polygonal serpentine* & lizardite : **C Viti M Mellini** 1997 EJM 9 585-96.

Image of hydroxyl surface using AFM: **FJ Wicks K Kjoller GS Henderson** 1992 CM 30 83-91.

High-P phase changes of lizardite & *antigorite*, room-T stability of quenched phases E,

superhydrous B & D, in situ XRPD: **SR Shieh & 3 others** 2000 EPSL 177 69-80 (S2169).

Ordered lizardite-*saponite*, S Africa kimberlites: **AI Gorshkov & 6 others** 2002 DES 382 86-90 (7554).

6-layer, 1T & 3R in Katoka kimberlite: **AP Zhukhlistov & 2 others** 2004 DES 396 551-5 (10378).

Iodochnikovite $2(\text{U,Th})\text{O}_2 \cdot 3\text{UO}_3 \cdot 14\text{TiO}_2$.

Occurrence: MM 31 965 & 33 1141. Earlier use of name ignored: MM 30 738.

Iokkaite-Y $\text{CaY}_4(\text{CO}_3)_7 \cdot 9\text{aq}$.

Some structural resemblance to *kimuraite* & *tengerite-Y* implied by cell dimensions, XRPD: **K**

Nagashima & 7 others 1986 AM 71 1028-33.

Occurrence: **V Perttunen** 1971 Bull Geol Soc Finlande 43 67-72 = AM 56 1838.

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

LÖLLINGITE STRUCTURE GROUP OF ANTIMONIDES & ARSENIDES Compressed

marcasite structure type with $c/a \sim 0.55$ & $c/b \sim 0.48$. Includes:

clinosaflorite $(\text{Co,Fe,Ni})\text{As}_2$

löllingite FeAs_2

omeiite OsAs_2

safflorite $(\text{Co,Fe})\text{As}_2$

seinäjokite $(\text{Fe,Ni})(\text{Sb,As})_2$

Wells p 615 gives list of compounds that fall in normal marcasite structure group and the compressed- marcasite group (löllingite).

Clinosaflorite is slightly monoclinic, but otherwise similar to orthorhombic safflorite.

The following have axial ratios that fit better with the normal marcasite structure than the compressed one.

costibite CoSb₂
nisbite NiSb₂
rammelsbergite NiAs₂

löllingite/loellingite FeAs₂.

Löllingite structure: subgroup of *marcasite* supergroup; compressed marcasite structure type.

Structure: **MJ Buerger** 1932 ZK 32 165-87;

EH Roseboom 1963 AM 48 271-99;

A Kjekshus T Rakke AF Andresen 1974 Acta Chem Scand A28 996-1000 (K726);

XPS, **RA Jones HW Nesbitt** 2002 AM 87 1692-8.

Surface reconstruction/As-polymerization, fractured surface: **HW Nesbitt I Uhlig R Szargan** 2002 AM 87 1000-4.

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

lomonosovite Na₂Ti₂Si₂O₉.Na₃PO₄. *Murmanite*-lomonosovite mineral group.

Loses phosphate easily to give *murmanite*.

General description but no coordinates: **AD Khalikov & 3 others** 1965 DES 162 138-40.

Structure: **NV Belov & 3 others** 1977 SPD 22 422-4 (B1110).

Occurrence: MM 27 271.

Intermediate *beta*-: MM 33 1141.

londonite (Cs,K,Rb)Al₂Be₂(B,Be)₆O₁₄. Analog of *rhodizite*.

Occurrence & XRPD: **WB Simmons & 3 others** 2001 CM 39 747-55;

-*rhodizite* gem quality, **BM Laurs & 4 others** 2002 GG 38(4) 326-39 (9109).

lonecreekite (NH₄)Fe(SO₄)₂ · 12aq. *Alum* structure type from cell data.

Raman: **RL Frost JT Kloprogge** 2001 NJMA 27-40 (951).

Occurrence: **JEJ Martini** 1983 Ann Geol Surv S Africa 17 29-34 = AM 71 229.

Dehydrates to anhydrous *sabieite*.

lonsdaleite C. Polymorphic with *diamond* & *graphite*.

2H hexagonal analog of 3C cubic *diamond*.

Occurrence: **C Frondel UB Marvin** 1967 N 214 587-9; **do** 1967 S 155 995-7.

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

loparite-Ce (Na,Ce,Sr,Ca)(Ti,Nb,Ta,Fe³⁺)O₃. *Perovskite* structure group.

Complex symmetry changes and composition variations.

Structure: **HR Gaertner** 1930 NJM 61 1-30;

SC-XRD, **RH Mitchell PC Burns AR Chakhmouradian** 2000 CM 38 145-52;

NV Subkova et al 2000 CrR 45 210-4 (1744).

Solid solution with *thorutite*, *synthesis*, Th-substituted loparites:

XRPD structures, **RH Mitchell AR Chakhmouradian** 1998 MM 62 341-53 (M1732);

do JSSC 138 307-12.

Lovozero Complex, calcian niobian loparite-Ce: **RH Mitchell AR Chakhmouradian** 1996 CM 34 977-90.

Gardiner Complex, E. Greenland, composition range: **LS Campbell & 3 others** 1997 MM 61 197-212.

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

Nioboloparite = *Nb-loparite*: MM 31 968;

discredited, **RH Mitchell AR Chakhmouradian VN Yakovenchuk** 1996 CM 34 991-9.

Metaloparite, water-bearing, occurrence: MM 26 339.

Light-rare-earths ore: **JB Hedrick SP Sinha VD Kosynkin** 1997 JAICo 250 467-70 (H1175).

[K,Cr-bearing *tausonite* (called K-Cr-loparite) in Zimbabwe diamond: **MG Kopylova & 5 others** 1997 Russian Geol Geophys = AM 83 402.]

Loparite/*metaloparite*, Siberia, XRPD/IR: **AR Chakhmouradian & 3 others** 1999 MM 63 519-34.

lopezite K₂Cr₂O₇.

Structure: *synthetic*, **EA Kuz'min VV Ilyukhin NV Belov** 1967 SPD 12 293-6 (K642).

Occurrence: MM 25 635.

lorandite TlAsS₂. Superstructure based on SnS prototype.

Weissbergite is analog with triclinic superstructure.

Structure: **A Zemmann J Zemmann** 1959 AC 12 1002-6;

CR Knowles 1965 ACA Mtg Gatlinburg;

ME Fleet 1973 ZK 138 147-60 (F417);

XPS, I **Grzetic TB Zunic** 1993 PCM 20 286-96;
T Balic-Zunic E Makovicky Y Möelo 1995 NJMA 168 213-35 (B1326).

loranskite-Y (Y,Ce,Ca)ZrTaO₆.
Structure determination not found.
Occurrence: **Dana**.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

lorenzenite Na₂Ti₂Si₂O₉. Edge-sharing octahedra vertex-connected to tetrahedra.
Structure: **Chin'-Han MA Simonov NV Belov** 1969 SPD 14 516-9 (S1317) = MA 70-2107;
MR Sundberg M Lehtinen R Kivekäs 1987 AM 72 173-7 (S1093A).
Nb,Fe-, Oslo region: **AO Larsen G Raade PC Saebø** 1992 NGT 72 381-4 = MA 94M/4700.
MAS-NMR, ²⁹Si: **ML Balmer & 4 others** 1997 JPCB 101 9170-9 (B1738);
A Labouriau TG Higley WL Earl 1998 JPCB102 2897-904.

lorettoite Pb₇O₆Cl₂. Resurrected after discreditation.
Occurrence in Laurium slags: **G Schnorrer-Köhler** 1986 Lapis 11 25-9 = AM 78 677.
Synthesis: **R Edwards & 3 others** 1992 MM 56 53-65.
[*Synthetic* Pb₇O₄(OH)₄Cl₂: SC-XRD structure, **SV Krivovichev PC Burns** 2002 EJM 14 135-9.]

loseyite (Mn,Zn)₇(CO₃)₂(OH)₁₀. Isostructural with Zn analog *sclarite*.
Structure: **RJ Hill** 1981 AC B37 1323-8 (H984).
Occurrence: MM 22 623.

lotharmeyerite Ca(Zn,Mn³⁺)₂(AsO₄)₂(aq,OH)₂.
Lotharmeyerite subgroup of *tsumcorite* group.
Occurrence: **PJ Dunn** 1983 MR 14 35-6;
AR Kampf JE Shigley GR Rossman 1984 MR 15 223-6.

[louderbackite ?2FeO.3(Fe,Al)₂O₃.10SO₃.35aq.
Occurrence: MM 21 569.]

loudounite NaCaZr₄Si₁₆O₄₀(OH)₁₁.8aq.
Structure determination not found.
Occurrence: **PJ Dunn D Newbury** 1983 CM 21 37-40.

loughlinite ~Na₂Mg₃Si₆O₁₆.8aq. Compare with *sepiolite*.
Structure determination not found.
Occurrence: **JJ Fahey M Ross JM Axelrod** 1960 AM 45 270-81; MM 28 732;
with *sepiolite* in Turkey, **S Kadir H Bas Z Karakas** 2002 CM 40 1091-102.

lourenswalite (K,Ba)₂(Ti,Mg,Ca,Fe)₄(Si,Al,Fe)₆O₁₄(OH)₁₂.
Structure determination not found.
Occurrence: **DE Appleman & 4 others** 1987 MM 51 417-25.

lovdarite ~Na₃KBe₂Si₇O₁₈.4.5aq. *Zeolite* mineral group.
IZA-SC code LOV. Consortium for Theoretical Frameworks net 572.
Structure: **S Merlino** 1990 EJM 2 809-17.
Occurrence: MM 39 918;
Ilimaussaq, **OV Petersen & 4 others** 2002 NJMM 23-30 (5945).
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).

lovingite (Ca,Ce)(Ti,Fe,Cr,Mg)₂O₃₈. *Crichtonite* structure group.
Structure: **BM Gatehouse IE Grey IH Campbell P Kelly** 19978 AM 63 28-36.
Stability & crystal chemistry: **RC Peterson IE Grey LMD Cranswick C Li** 1998 CM 36 763-74.
Occurrence: MM 42 526.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

LOVOZERITE STRUCTURE GROUP Includes:

<i>combeite-HT</i>	Na ₅ Ca ₃ (Fe,Mn) _{0.6} Si ₆ O ₁₈	Type I
<i>combeite-LT</i>	Na ₄ Ca ₄ Si ₆ O ₁₈	Type I
<i>combeite</i>	Na ₄ Ca ₄ Si ₆ O ₁₈	Type I
<i>imandrite</i>	Na ₆ Ca _{1.5} FeSi ₆ O ₁₅	Type II
<i>kapustinite</i>	Na _{5.5} Mn _{0.25} ZrSi ₆ O ₁₆ (OH) ₂	

<i>kazakovite</i>	$\text{Na}_6\text{MnTiSi}_6\text{O}_{18}$	Type I
<i>koashvite</i>	$\text{Na}_6(\text{Ca},\text{Mn})(\text{Fe},\text{Ti})\text{Si}_6\text{O}_{18}$	Type II
<i>litvinskite</i>	$\text{Na}_2(\text{vacancy},\text{Na},\text{Mn})\text{Zr}[\text{Si}_6\text{O}_{12}(\text{OH},\text{O})_6]$	Type unspecified
<i>lovozerite</i>	$\sim\text{H}_3\text{Na}_3\text{Ca}(\text{Zr},\text{Ti})\text{Si}_6\text{O}_{18}$	Type I
<i>lovozerite-Na-Sn-1</i>	$\text{Na}_8\text{SnSi}_6\text{O}_{18}$	Type I
<i>lovozerite-Na-Sn-2</i>	$\text{Na}_8\text{SnSi}_6\text{O}_{18}$	Type I
<i>lovozerite-Na₆Ca₃</i>	$\text{Na}_6\text{Ca}_3\text{Si}_6\text{O}_{18}$	Type I
<i>lovozerite-Na₄Ca₄</i>	$\text{Na}_4\text{Ca}_4\text{Si}_6\text{O}_{18}$	Type I
<i>lovozerite-Na₆Cd₃</i>	$\text{Na}_6\text{Cd}_3\text{Si}_6\text{O}_{18}$	Type II
<i>lovozerite-Na-Mn-1</i>	$\text{Na}_5(\text{Na},\text{Mn})_3\text{MnSi}_6\text{O}_{18}$	Type II
<i>lovozerite-Na-Mn-2</i>	$\text{Na}_6\text{Mn}_3\text{Si}_6\text{O}_{18}$	Type II
<i>lovozerite-Na-Nd</i>	$\text{Na}_7\text{Ca}_2\text{NdSi}_6\text{O}_{18}$	Type II
<i>lovozerite-M</i>	$\text{H}_6\text{Na}_2\text{ZrSi}_6\text{O}_{18}$	Type I
<i>oxy-lovozerite</i>		
<i>tisinalite</i>	$\text{H}_3\text{Na}_3\text{MnTiSi}_6\text{O}_{18}$	Type I
<i>tricalciumaluminatite</i>	$\text{Ca}_9\text{Al}_6\text{O}_{18}$	Type II
<i>zirsinalite</i>	$\text{Na}_6\text{CaZrSi}_6\text{O}_{18}$	Type I
<i>unnamed M39</i>	$\text{Na}_8\text{ZrSi}_6\text{O}_{18}$	Type I
<i>unnamed M40</i>	$\text{Na}_{<6}(\text{Mn},\text{Ca})_{<1}\text{ZrSi}_6(\text{O},\text{OH})_{18}$	Type I
<i>unnamed M41</i>	$\text{Na}_5\text{ZrSi}_6\text{O}_{15}(\text{OH})_3$	Type I
<i>unnamed M42</i>	$\text{Na}_6\text{FeTiSi}_6\text{O}_{18}$	Type I
<i>unnamed M43</i>	$\text{H}_3\text{Na}_3\text{FeTiSi}_6\text{O}_{18}$	Type I
<i>unnamed M44</i>	$\text{Na}_7\text{Ca}(\text{Mn},\text{Fe},\text{Zr},\text{Ti},\text{Y})\text{Si}_6\text{O}_{18}$	Type II
<i>unnamed M45</i>	$\text{Na}_7\text{Ca}(\text{Fe},\text{Mn},\text{Zr},\text{Ti},\text{Y})\text{Si}_6\text{O}_{18}$	Type II

M39 is Ca-free analog of *zirsinalite*, with half-*c* of hexagonal cell; unstable in air to form M41. M40 is stable in air.

Review of 24 members of lovozerite family with postulated aristotype related to *perovskite*, 2 symmetry types I & II: **YuA Malinovsky H Burzlaff W Rothammel** 1993 AC B49 158-64 (M1103).

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

Synthetic $\text{Na}_8\text{SnSi}_2\text{O}_6$, hexagonal, half-*c* like M39, structure: **AN Safronov & 3 others** 1980 DAN 255 1114-6.

lovozerite $\sim\text{Na}_2\text{Ca}(\text{Zr},\text{Ti})\text{Si}_6\text{O}_{12}(\text{OH},\text{O})_6$.aq.

Structure: **VV Ilyukhin NV Belov** 1960 SPC 5 186-98 = MA 15-262;

VV Ilyukhin NV Belov 1961 DAN USSR ES 131 379-82 (I122) = MA 16-26;

YuL Kapustin AV Bykova ZV Poduvkina 1973 Izvest Akad Nauk SSSR Ser Geol no. 8 106-12 = AM 59 633;

NA Yamnova YuK Egorov-Tismenko IV Pekov 2001 Krist 1019-23.

Occurrence: MM 25 635.

Oxy-lovozerite is alteration product requiring further characterization.

Probably formed *eudialyte* to *zirsinalite* to *lovozerite*.

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

Synthetic $\text{Na}_5(\text{Na},\text{Ca})_2(\text{Nd},\text{Ca})_2\text{Si}_6\text{O}_{18}$: 1989 SPC 34 181-4.

löweite $\text{Na}_{12}\text{Mg}_7(\text{SO}_4)_{13}$.15aq. Review: **Sabelli** p. 34.

Structure: **JH Fang PD Robinson** 1970 AM 55 378-86.

Synthetic $\text{Na}_{12}\text{Mn}_7(\text{SO}_4)_{13}$.15aq: **E Matzat** 1970 NJMA 113 1-12.

luanheite $\sim\text{Ag}_3\text{Hg}$.

Structure determination not found.

Occurrence: **D Shao & 3 others** 1984 Acta Mineral Sinica 4 97-101 = AM 73 192-3.

luberoite Pt_5Se_4 .

Structure: **J Jedwab & 4 others** 1992 EJM 4 683-92.

Occurrence: **T Augé P Maurizot** 1995 CM 33 1023-45.

May be S analog of *luberoite*.

lucasite-Ce $\text{CeTi}_2(\text{O},\text{OH})_6$. PbSb_2O_6 structure type.
Essentially isostructural with Ca analog *kassite*, but may be subtle differences involving distortion.
Structure: **EH Nickel IE Grey IC Madsen** 1987 AM 72 1006-10.

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

luddenite $\text{PbCu}_2\text{Si}_5\text{O}_{14}$. 14aq.

Structure determination not found.

Occurrence: **SA Williams** 1982 MM 46 363-4.

ludjibaite $\text{Cu}_5(\text{PO}_4)_2(\text{OH})_4$. Layer structure. Review: (E289).

Polymorphic with *pseudomalachite*.

Structure: **GL Shoemaker JB Anderson E Kostiner** 1981 AM 66 176-81.

Occurrence: **P Piret M Deliens** 1988 BM 111 167-71; MM 62 727.

ludlamite $\text{Fe}_3(\text{PO}_4)_2$. 4aq.

Structure: **T Ito H Mori** 1951 AC 4 412-6 (I127A);

low-T, 209 K, **SC Abrahams JL Bernstein** 1966 JCP 44 2223-9 (A604);

ND, 4K, below Curie transition, **SC Abrahams** JCP 44 2230-7 (A605).

General description: **PB Moore** 197 AM 56 1-17.

ludlockite $\text{PbFeAs}_{10}\text{O}_{22}$.

Structure: **MA Cooper FC Hawthorne** 1996 CM 34 79-89.

Occurrence: **RJ Davis PG Embrey MH Hey** 1970 Proc Int Mineral Assoc 7th Gen Mtg, Mineral Soc Japan Spec Paper 1 264 = AM 57 1003.

LUDWIGITE STRUCTURE GROUP OF ORTHORHOMBIC BORATES IN PINAKIOLITE

MINERAL GROUP Includes:

azoproite $(\text{Mg},\text{Fe})_2(\text{Fe},\text{Ti},\text{Mg})(\text{BO}_3)_2\text{O}_2$

bonnacordite $\text{Ni}_2\text{Mn}(\text{BO}_3)_2\text{O}_2$

fredrikssonite $\text{Mg}_2\text{Mn}(\text{BO}_3)_2\text{O}_2$

ludwigite $(\text{Mg},\text{Fe})_2\text{Fe}(\text{BO}_3)_2\text{O}_2$

vonsenite $(\text{Fe},\text{Mg})_2\text{Fe}(\text{BO}_3)_2\text{O}_2$

Modular interpretation of oxyborates: **BB Zvyagin GA Siderenko** 1995 AC B51 7-11 (Z87).

Occurrence *ludwigite-vonsenite*, Asia: **SM Aleksandrov MA Troneva** 2004 GI 42 870-86 (10732).

Synthetic Mg, Mn & Co-: **R Norrestam & 3 others** 1989 ZK 189 33-41 (N329).

Synthetic Co_2CoBO_5 : **W Götz V Herrman** 1966 Naturw 53 475.

Synthetic $\text{Co}_{2.1}\text{Al}_{0.9}\text{BO}_5$, Ni_2AlBO_5 & Cu_2AlBO_5 : 1990 JSSC 84 289-98.

Synthetic $\text{Ni}_2(\text{Cr}/\text{V})\text{BO}_3\text{O}_2$: **R Norrestam & 4 others** 1994 JSSC 111 217-23 (N355).

Synthetic $\text{Mn}^{\text{II}}_2\text{Mn}^{\text{III}}(\text{BO}_3)_2\text{O}_2$: **A Utzolino K Bluhm** 1996 ZN 51b 1433-8.

Synthesis of ludwigite & *vonsenite*: **I Mitov Z & 3 others** 1999 JAICo 289 55-65 (M1754).

Occurrence of ludwigite & *vonsenite*, Siberian skarns: **SM Aleksandrov MA Troneva** 2004 GI 42 449-64 (10431).

ludwigite $(\text{Mg},\text{Fe})_2\text{Fe}(\text{BO}_3)_2\text{O}_2$.

6 Å zigzag borate: **MA Cooper FC Hawthorne** 1998 CM 36 1171-93.

2t2t polytype in ludwigite (orthorhombic) structure subgroup of *pinakiolite* structure family.

Structure: **Y Takéuchi T Watanabe T Ito** 1950 AC 3 98-107;

P Bonazzi S Menchetti 1989 NJMM 69-83 (B1352);

R Norrestam S Dahl J-O Bovin 1989 ZK 187 207-11 (N238);

Y Takéuchi T Kogure 1992 ZK 200 161-7 (T388);

3 crystals, Sweden, SC-XRD, **PWU Appel MF Brigatti** 1999 MM 63 511-8;

MB Irwin RC Peterson 1999 CM 37 939-43;

boron K-edge XANES, **ME Fleet S Muthupari** 2000 AM 85 1009-21;

Ti-, **AA Brovkin IV Rozhdestvenskaya EA Rykova** 2002 CrR 47 412-4 (7372).

Defects, electron microscopy: **J-O Bovin M O'Keeffe** 1981 AC A37 35-42A.

Description: **S Marincea** 1999 CM 37 1343-62.

Cr-, Japan: MA 97M/2013.

Synthesis: **E Barrese M Bellezza A Flamini** 1995 NJMM 49-55.

Synthetic $\text{Co}_5\text{Sn}/\text{Mn}(\text{BO}_3)_2\text{O}_4$: **A Utzolino K Bluhm** 1996 ZN 51b 305-8 (U41).

Synthetic $\text{Co}_3(\text{BO}_3)_2\text{O}_2$: **JLC Rowsell NJ Taylor LF Nazar** 2003 JSSC 174 189-97 (9820).

lueshite NaNbO_3 . *Perovskite* structure group.
 Orthorhombic relative of *isolueshite* $\sim(\text{Na,L a,Ca})(\text{Nb,Ti})\text{O}_3$.
 ?Dimorphic with *natroniobite*.
 XRPD matches *synthetic* in PDF.
 Structure: SC-XRD & EM, **RH Mitchell & 3 others** 2003 18th IMA Mtg Abstr A9-5.
 Occurrence: AM 46 1004.

luetheite $\text{Cu}_2\text{Al}_2(\text{AsO}_4)_2(\text{OH})_4$.aq.
 Isostructural with Fe analog *chenevixite*.
 Structure: SC-XRD of zoned crystal, **PC Burns JV Smith IM Steele** 2000 MM 64 25-30.
 Occurrence: **SA Williams** 1977 MM 41 27-32.

lukechangite-Ce $\text{Na}_3\text{Ce}_2(\text{CO}_3)_4\text{F}$.
 Occurrence & crystal structure: **JD Grice GY Chao** 1997 AM 82 1255-60.
 Iso with *synthetic* La-.
 Resembles *baiyuneboite-Ce* & *huanghoite-Ce*.

lukrahnite $\text{CaCuFe}(\text{AsO}_4)_2(\text{OH})$.aq. *Tsumcorite* group.
 Occurrence & XRPD: **W Krause & 4 others** 2001 NJMA 481-92 (3608).

lulzacite $\text{Sr}_2\text{Fe}(\text{Fe,Mg})_2\text{Al}_4(\text{PO}_4)_4(\text{OH})_{10}$.
 Occurrence & SC-XRD: **Y Moelo & 4 others** 2000 CRASP EPS 330 317-24 (431) = AM 85 1844.

lüneburgite $\text{Mg}_3(\text{PO}_4)_2\text{B}_2(\text{OH})_6$.5aq.
 Structure: **PK Sen Gupta & 3 others** 1991 AM 76 1400-7.

lunijianlaite $\text{Li}_{0.7}\text{Al}_{6.2}(\text{Si}_7\text{AlO}_{20})(\text{OH},\text{O})_{10}$. 1:1 *cookeite-pyrophyllite* interstratification.
 Structure determination not found.
 Occurrence: **Y Kong X Peng D Tian** 1990 Acta Mineral Sinica 10 289-98 = AM 77 447.

lunjokite / lun'okite $(\text{Mn,Ca})(\text{Mg,Fe,Mn})\text{Al}(\text{PO}_4)_2(\text{OH})$.4aq.
Overite structure group from cell data.
 Occurrence: **AV Voloshin YaA Pakhomovskii FN Tyusheva** 1983 ZVMO 112 232-7.

[lusungite $(\text{Sr,Pb})\text{Fe}_3(\text{PO}_4)_2(\text{OH})_5$.aq. *Crandallite* structure group.
 Occurrence: MM 32 966.]
 [SrFe₃(PO₄)₂(OH,aq)₆. New mineral IMA 95-001. *Crandallite* group. MM 60 847.]

luzonite Cu_3AsS_4 . *Stannite* structure group. Dimorphic with *enargite*.
 Structure: **R Gaines** 1957 AM 42 772;
F Marumo W Nowacki 1967 ZK 124 1-8 (M193).
 Stacking disorder, HRTEM & SAED: **M Pósfai M Sundberg** 1998 AM 83 365-72.

lyonsite $\text{Cu}_3\text{Fe}_4(\text{VO}_4)_6$. Review: (E289).
 Structure: **JM Hughes & 3 others** 1987 AM 72 1000-5.