Mineral structures G&H
Updated to 092306 by J V Smith

gabrielite $Tl_2AgCu_2As_3S_7$.
Structure: SC-XRD, **T Balic-Zunic & 4 others** 2006 CM 44 141-58.
Occurrence: Binntal, Switzerland, **S Graeser 3 others** 2006 CM 44 135-40.
gabrielsonite $PbFeAsO_4OH$. *Conichalcite/descloizite* structure type.
Descloizite mineral group.
Structure type deduced from cell data: **PB Moore** 1967 Arkiv Min Geol 41-5 = AM 53 1063-4.
Occurrence: MM 36 1151.

[DATOLITE-GADOLINITE-HERDERITE STRUCTURE GROUP Includes:

	boron subgroup	beryllium subgroup
bakerite	$Ca_4B_5Si_3O_{15}(OH)_5$	
bergslagite		$CaBeAsO_4(OH)$
calciogadolinite		$(Ca,RE)_2FeBe_2Si_2(O,OH)_{10}$
calcybeborosilite		$CaYBeBSi_2O_8(OH)_2$
datolite	$CaBSiO_4(OH)$	
drugmanite		
euclase		$BeAlSiO_4(OH)$
gadolinite		general name: $RE_2Fe^{2+}Be_2Si_2O_{10}$
gadolinite-Ce		$(Ce,La,Nd,Y)_2FeBe_2Si_2O_{10}$
gadolinite-Y		$Y_2FeBe_2Si_2O_{10}$
herderite		$CaBe(PO_4)(F,OH)$
hingganite-Ce		$YBeSiO_4(OH)$
hingganite-Yb		$(Yb,Y)BeSiO_4(OH)$
homilite	$Ca_2(Fe,Mg)B_2Si_2O_{10}$	
hydroxylherderite		$CaBe(PO_4)(OH)$
minasgeraisite		$CaY_2Be_2Si_2O_{10}$
väyrynenite		$MnBePO_4(OH,F)$

General crystal chemistry: **F Demartin & 4 others** 1993 CM 30 127-36;
RK Rastsvetaeva & 3 others 1995 CrR 41 217-21.
Synthetic $Fe^{2+}Y_2Be_2Si_2O_{10}$: **J Ito** 1965 Proc Japan Acad 41 404-7 & 42 634-5.
Synthetic $Ca(La/Y)Fe^{3+}Be_2Si_2O_{10}$ & $CaBaYBe_2Si_2O_{10}$, match natural mineral *calciogadolinite*
(occurrence: **T Nakai** 1938 Bull Chem Soc Japan 13 591-4): **J Ito** 1967 AM 52 1523-7.
Synthetic $(Mn/Fe/Zn/Co/Cu/Mg/Ni/H_2)Be_2Si_2O_{10}/Fe^{3+}YCaBe_2Si_2O_{10}$, Mössbauer: **J Ito SS Hafner** 1974 AM 59 700-8.
Synthetic $NiYb_2Be_2Si_2O_{10}$: **FF Foit Jr GV Gibbs** 1975 ZK 141 375-86 (F356).

gadolinite
Structure: **PV Pavlov NV Belov** 1959 SPC 4 300-14;
$RE_2Fe^{2+}_{0.9}Be_2Si_2O_{9.7}(OH)_{0.3}$, **R Miyawaki I Nakai K Nagashima** 1984 AM 69 948-53;
F Demartin & 4 others 1993 CM 30 127-36.
gadolinite-Ce $(Ce,La,Nd,Y)_2FeBe_2Si_2O_{10}$. Gadolinite structure group.
Structure determination not found.
Occurrence: **TV Segalstad AO Larsen** 1978 AM 63 188-96.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
gadolinite-Y $Y_2FeBe_2Si_2O_{10}$. Gadolinite structure group.
Structure: **F Demartin & 4 others** 1993 CM 30 127-36.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
gagarinite $NaCaLnF_6$. Stuffed UCl_3 structure type.
Occurrence: MM 33 1134.
Synthetic $NaCaREF_6$-$Na_{1.5}RE_{1.5}F_6$: structure, **OV Frank-Kamenetskaya & 3 others** 1994 CrR 39 923-8.

Synthetic $KPbLaF_6$: structure, **A Dib MT Roux S Aléonard** 1987 JSSC 66 47-55.

gagarinite-Y $NaCaY(F,Cl)_6$. Stuffed UCl_3 structure type.

Structure: **AA Voronkov NG Shumyatskaya YuA Pyatenko** 1962 J Struct Chem 3 666-9;
OV Frank-Kamenetskaya & 3 others 1994 CrR 39 1009-14 (F413);
JM Hughes JW Drexler 1994 CM 32 563-5.

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

Synthetic $NaYF_4$: **BP Sobolev DA Mineev VP Pashutin** 1963 SPD 8 545-7(S1319).

gageite $(Mn,Mg,Zn)_{42}(Si_4O_{12})_4O_6(OH)_{40}$.

Polytypic: $2M_1$ isostructural with *balangeroite*, & 1Tc.

Structure: substructure, **PB Moore** 1969 AM 54 1005-17 (M1263);
monoclinic & triclinic polytypes, **G Ferraris M Mellini S Merlino** 1987 AM 72 382-91;
orthorhombic type, review of various papers on chemistry & polytypism, **H de Bruiyn WA van der Westhuizen GJ Beukes** 1994 NJMM 193-204 (D479).

gahnite $ZnAl_2O_4$. *Spinel* structure group.

Structure: quenched from high-T, **JC Waerenborgh & 3 others** 1994 PCM 21 460-81.

Sn-substituted (*limaite*): MM 30 736.

Compressibilty to 43 GPa, XRPD structure: **D Levy & 3 others** 2001 PCM 28 612-8 (3466).

Synthesis from heating of Zn-exch LTA zeolite: **LM Colyer & 3 others** 1997 JPCB 101 10105-14.

Occurs in metamorphosed base-metal sulfides, Colorado; exploration guide: **A Heimann & 2 others** 2005 CM 43 601-22.

gaidonnayite $Na_2ZrSi_3O_9.2aq$.

Dimorphic with *catapleiite* : **JA Mandarino V Anderson** 1989 CM 16 195-8.

Isostructural with *georgechaoite*.

Structure: **GY Chao** 1985 CM 23 11-5;
G Donnay GY Chao 1986 CM 24 417-9.

Unnamed analogs M35 $[Na_{2-x}(Zr,Mn)Si_3(O,OH)_9.naq]$ & M36 $[(Na_2(Zr,Fe)Si_3(O,OH)_9.naq)]$:
AP Khomyakov EI Semenov 1979 DAN SSSR 248 219-22.

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

MM 39 913.

Synthetic, XRPD: **SR Jale A Ojo FR Fitch** 1999 ChC 411-2 (J335).

Synthetic series AV-4, Zr/Ti range, XRPD/SEM/NMR/TGA: **Z Lin & 5 others** 1999 JPCB 103 957-63 (L974).

gainesite $Na_2Zr_2Be(PO_4)_4.1\text{-}2aq$. Isostructural with *mccrillisite* & *selwynite*.

Structure: **PB Moore & 4 others** 1983 AM 68 1022-8.

New data indicating 1-2 aq, requires revised crystal structure: **EE Foord & 4 others** 1994 CM 32 839-42.

gaitite $Ca_2Zn(AsO_4)_2.2aq$. *Collinsite* structure type.

Dimorphic with *zincroselite* in *roselite* structure group.

Structure: SC-XRD, **P Keller F Lissner T Schleid** 2004 EJM 16 353-9.

Occurrence: **BD Sturman PJ Dunn** 1980 CM 18 197-200 (S1401).

galaxite $(Mn,Fe,Mg)(Al,Fe)_2O_4$. *Spinel* structure group.

Structure determination not found.

Occurrence: MM 23 629; Dana.

galeite $Na_{15}(SO_4)_5F_4Cl$. Review: **Sabelli** p. 31.

Structure: **L Fanfani & 3 others** 1975 MM 40 357-61.

Occurrence: MM 31 959-60.

GALENA STRUCTURE GROUP *Halite* structure type. Includes

alabandite	MnS	
altaite	PbTe	
clausthalite	PbSe	
galena	PbS	
herzenbergite	SnS	orthorhombic distortion
keilite	(Fe,Mg)S	
niningerite	(Mg,Fe,Mn)S	
oldhamite	CaS	
teallite	$PbSnS_2$	orthorhombic distortion

Review of derivatives: **A Skowron ID Brown** 1994 AC B50 524-38 (S1374).

High-P transitions in Bi, Sb & Pb(S/Se/Te): **J Maclean & 6 others** 1996 AC A52 Suppl C-529.
galena PbS. Galena/*halite* structure type.
Structure: **Y Noda S Ohta S Sato Y Saito** 1983 AC B39 312-7;
thermal parameters 120-298 K, **Y Noda & 6 others** 1987 AC C43 1443-5 (N386).
Surface electronic structure/chemical reactivity: **JA Tossell DJ Vaughan** 1987 CM 25 381-92 (T353).
Surface oxidation/sorption, aqueous Au, STM: **CM Eggleston MF Hochella Jr** 1991 S 254 983-6 (E422).
Distribution of Ag & Sb, *diaphorite* & *franckeite* inclusions: **TG Sharp PR Buseck** 1993 AM 78 85-95 (1417).
Chmeical speciation of Ag, EPR: **P Costagliola & 6 others** 2003 AM 88 1345-50.
Interaction with *Bacillus polymyxa*, application to leaner ore mining: **D Santhiya S Subramanian KA Natarajan** 2001 JCIS 235 289-97, 298-309 (1637);
surface chemistry, **do** 2002 JCIS 256 237-48.
Photoacoustic properties: **PM Nikolic & 9 others** 2001 PCM 28 44-51(1407).
Step edges on (100), STM & theory, vs adsorption: **U Becker KM Rosso** 2001 AM 86 862-70.
Cd/Hg uptake under hydrothermal growth: **VL Tauson & 4 others** 2005 EJM 17 599-610.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
galenobismutite $PbBi_2S_4$. cf. Ag-free *lillianite*,
Structure: **FE Wickman** 1951 Ark Mineral Geol 1 219-25 = MA 11-535;
Y Iitaka W Nowacki 1962 AC 15 691-8 (I10);
Y Takéuchi J Takagi 1974 Proc Japan Acad 50 222-5;
SC-XRD, **D Pinto & 5 others** 2006 CM 44 159-75.
Anomalous Pb/Bi: **R Wulf** 1995 MP 52 187-96 (W674).
galgenbergite $Ca(REE)_2(CO_3)_4.aq$. Compare with *kimuraite, kamphaugite*-Y, & *sahamalite*.
Occurrence and structure: **CE Hollerer** 1998 Mitt Österreich Mineral Ges 143 200-1.
galileiite $NaFe_4(PO_4)_3$.
Occurrence: troilite nodules, IIIA & B iron meteorites, XRPD: **EJ Olsen IM Steele** 1997 MPS 32 A155-6 (212).
[K analog identified, but not characterized.]
Occurrence in meteorites: **AE Rubin** 1997 MPS 32 733-4
13 phosphates in IIIAB irons, **EJ Olsen & 5 others** 1999 MPS 34 285-300 (210).
galkhaite $(Cs,Tl)(Hg,Cu,Zn)_6(As,Sb)_4S_{12}$. *Tetrahedrite* structure group.
Structure: **V Divjakovic W Nowacki** 1975 NJMM 291-3 (D232);
do 1975 ZK 142 262-70 (D254);
LN Kaplunnik EA Pobedimskaya NV Belov 1976 SPD 20 723-4 (K662);
TT Chen JT Szymanski 1981 CM 19 571-81.
MM 39 913.
gallite $CuGaS_2$. *Chalcopyrite* structure group.
Structure: *synthetic*, **T Hahn et al** 1953 ZaaC 271 153-70.
Occurrence & *synthetic*, **H Strunz BH Geier E Seeliger** 1958 NJMM 241-64.
gallobeudantite $PbGa_3[(As/S)O_4]_2(OH)_6$. Analog of *beudantite*.
Occurrence & crystal structure: **JL Jambor & 3 others** 1996 CM 34 1305-15.
gamagarite $Ba_2(Fe,Mn)(VO_4)_2(OH)$. *Brackebuschite* structure group.
Structure: **R Basso A Palenzaro L Zefiro** 1987 NJMM 295-304 (B1386).
Occurrence: MM 27 269.
gananite BiF_2-alpha.
Occurrence: **L Cheng & 4 others** 1984 Yanshi Kuangwu Ji Ceshi 3 119 = MM 54 665.
jvs: find synthetic.
ganomalite $Pb_9Ca_{5.4}Mn_{0.6}Si_9O_{33}$.
Intermediate between *nasonite* & *pyromorphite* structures.
Incomplete structure: **PJ Dunn & 3 others** 1985 MM 49 579-82.
Structure: **S Carlson & 3 others** 1997 ZK 212 208-12 (C893).
Similar $Pb_5Ge_3O_{11}$: **RW Newnham & 2 others** 1973 J Solid State Phys 6 378=83.
Synthesis Mn-free analog, analyses Längban specimens: **G Charalampides** 1994 Mineral Wealth 91 33-46 = AM 81 520.
ganophyllite $\sim(K,Na,Ca)_{1\text{-}1.5}(Mn,Al)_8(Si,Al)_{12}(O,OH)_{32}.\sim$4-6aq (Kato);
$\sim(K,Na,Ca)_6(Mn,Al)_{24}(Si,Al)_{40}O_{96}(OH)_{16}.\sim$21aq (Eggleton).

Related to *bannisterite*, Na-rich *eggletonite*, *ekmanite &* Ca-rich *tamaite*.
Structure: polytypism, **DA Jefferson** 1978 AC A34 491-7 (J269);
sub-cell model, large anisotropic displacement factors, **T Kato** 1980 MJJ 10 1-13 (K911);
double-atom model, **RA Eggleton S Guggenheim** 1986 MM 50 307-15 (E396);
incommensurate modulation, SAED/HRTEM/AEM/XRD structure, **DC Noe DR Veblen** 1999 AM 84 1088-98.
Occurrence: MM 43 1061.
IMA 99-011: CM 38 246.

ganterite $Ba_{0.5}(Na,K)_{0.5}Al_2(Si_{2.5}Al_{1.5})O_{10}(OH)_2$. Mica type.
Occurrence, XRPD, IR/Raman: **S Graeser & 3 others** 2003 CM 41 1271-80.
Occurrence & IR/Raman: **C Ma GR Rossman** 2006 AM 91 702-5.

gaotaiite Ir_3Te_8.
Occurrence, XRPD = *synthetic* PDF 9-925: **Z Yu** 1995 Acta Mineral Sinica 15 1-4 = MR 27 117.

garavellite $FeSbBiS_4$.
Structure determination not found.
Occurrence: **F Gregorio & 3 others** 1979 MM 43 99-102.

garibaldite S-beta-monoclinic. Trimorphic with S-alpha *sulfur* & S-gamma *rosickyite*.
Occurrence: MM 29 982.
[jvs: the nature of *garibaldite* should be checked.]

GARNET STRUCTURE GROUP Includes

almandine	$Fe^{2+}_3Al_2Si_3O_{12}$
andradite	$Ca_3Fe^{3+}_2Si_3O_{12}$
berzeliite	$(Ca,Na)_3(Mg,Mn)_2As_3O_{12}$
calderite	$(Mn,Ca)_3(Fe,Al)_2Si_3O_{12}$
cryolithionite	$Li_3Na_3Al_2F_{12}$
goldmanite	$Ca_3(V,Al,Fe)_2Si_3O_{12}$
grandite	between grossular & andradite
grossular	$Ca_3Al_2Si_3O_{12}$
henritermierite	$Ca_3(Mn^{3+},Al)_2Si_3O_8(OH)_4$
hydrogarnet	general term for hydroxyl-garnets
hydrogrossular	$Ca_3Al_2Si_{3-x}O_{12-4x}(OH)_{4x}$
hydrougrandite	hydroxyl variant of grandite
katoite	$Ca_3Al_2Si_{s-x}O_{12-4x}(OH)_{4x}$: a hydrogrossular
kimzeyite	$Ca_3(Zr,Ti)_2(Si,Al,Fe)_3O_{12}$
knorringite	$Mg_3Cr_2Si_3O_{12}$
manganberzeliite	$(Ca,Na)_3(Mn,Mg)_2As_3O_{12}$
majorite	$Mg_3(Fe,Al,Si)_2Si_3O_{12}$
morimotoite	$Ca_3TiFe^{2+}Si_3O_{12}$
palenzonaite	$Ca_{2.4}Na_{0.6}Mn_2V_{2.4}As_{0.3}Si_{0.3}O_{12}$
pyrope	$Mg_3Al_2Si_3O_{12}$
schäferite	$NaCa_2Mg_2(VO)_3$
schorlomite	$CaTi_2Fe_2SiO_{12}$
spessartine	$Mn_3Al_2Si_3O_{12}$
uvarovite	$Ca_3Cr_2Si_3O_{12}$
yafsoanite	$(Ca,Pb)_3Te_2Zn_3O_{12}$
[*yamatoite*	$Mn_3V_2Si_3O_{12}$ hypothetical endmember]
[?imanite?	not mineral;

titaniferous slag, $Ca_3Ti_2Si_3O_{12}$: Russian acronym, AM 44 907;
industrial product, structure, **AB Woodland CR Ross II** 1994 PCM 21 117-32.
Isostructural with *petzite* Ag_3AuSe_2, *fischesserite* Ag_3AuTe_2 & *uytenbogaardtite* Ag_3AuS_2.
Scandium garnet, melilite skarn, Russia: occurrence & SC-XRD structure; solid solution between

kimseyite-schorlomite & *Sc-andradite*: **IO Galuskina 4 others** 2005 AM 90 1688-92.
Garnets & hydrogarnets, crystal chemistry & crystallography: **R Basso** 1985 NJMM 108-14.
Silicate garnets, structure review: **GA Novak & GV Gibbs** 1971 AM 56 791-825.
Structure interpreted as cylinder packing: **S Andersson M O'Keeffe** 1977 ZK 267 605-6.
Non-ideal solid solution: **L Ungaretti M Leona M Merli R Oberti** 1995 EJM 7 1299-312 (U40).
Structural constraints on chemical variability of natural garnets: **M Merli & 6 others** 1995 EJM 7 1239-49 (M1351).
Color: **E Fritsch GR Rossman** 1993 MR 24 63.
Charge-contrast imaging, environmental SEM: **SJ Cuthbert JO Buckman** 2005 AM 90 701-7.
Crystal structures & chemistry: **PH Ribbe SC Eriksson** 1993 MR 24 63-4.
Pyrope-almandine, 14 members, SC-IR: **AM Hofmeister & 3 others** 1996 AM 81 418-28.
Pyrope, almandine-grossular join, SC-XRD & Ca K-edge XANES: **S Quartieri & 4 others** 1995 PCM 22 159-69 (Q18).
Melanite, Ti bonding, XPS: **C Malitesta & 3 others** 1995 EJM 7 847-58.
Pyrope-almandine-grossular, immiscibility deduced from inclusions, Garnet Ridge AZ: **LH Wang EJ Essene Y Zhang** 2000 AM 85 41-6.
Grandite: $Gr_{0.36}And_{0.64}$, **S Gali** 1984 AGH 19 287-93;
3 orthorhombic, **Y Takéuchi & 3 others** 1982 ZK 158 53-99;
sectoral texture, **M Akizuki & 3 others** 1998 NJMM 565-6 (A872);
anomalous birefringence, **AG Shtukenberg DY Popov YO Punin** 2002 MM 66 275-86;
ugrandites, growth ordering & anomalous birefringence, **AG Shtukenberg & 2 others** 2005 MM 69 537-50.
Static lattice energy & vibrational energy: **G Ottonello M Bokreta PF Sciuto** 1996 AM 81 429-47.
Al 1s XAS: **Z Wu & 5 others** 1996 PRB 54 2967-79 (W808).
Geologic occurrence: **PJ Modreski** 1993 MR 24 64-5.
Tetragonal relatives of garnet include TAPP inclusions in lower-mantle diamonds and various *synthetic* arsenates, vanadates & germanates, review; *synthetic* $Mg_{2.1}Fe_{3.2}Ge_{2.6}O_{12}$, SC-XRD structure: **D Levy J Barbier** 2000 AM 85 1053-60.
Crystal chemistry >20 GPa: **Z Li H Ahsbahs A Kutoglu SS Hafner** 1996 ACA 52 C-538.
Transformation of natural Udachnaya kimberlite garnet to orthorhombic *perovskite* at high P, and to $LiNbO_3$-type on P release: **N Funamori & 3 others** 1997 S 275 513-5 (F520).
Pyrope-grossular: thermodynamics of mixing & ordering, **VL Vinograd & 6 others** 2004 MM 68 101-21; low-T heat capacity/entropy of mixing, **E Dachs CA Geiger** 2006 AM 91 894-906.
Thermodynamic model: **RG Berman LYa Aranovich** 1996 CMP 126 1-24 (B1572).
Molar volumes of mixing, almandine-pyrope/-spessartite, & crystal chemistry of aluminosilicate garnets, XRPD & Mössbauer : **CA Geiger A Feenstra** 1997 AM 82 571-81.
Raman of silicate: **BA Kolesov CA Geiger** 1998 PCM 25 142-51 (K1049).
OH defects, garnets from mantle xenoliths, Siberian kimberlites: **SS Matsyuk K Langer A Hösch** 1998 CMP 132 163-79 (M1666).
Electron density of 7 garnets: **H Sawada** 1999 JSSC 142 273-8 (S2010).
Crystal chem, 6 melanites, Mt. Vulture: **F Scordari E Schingaro G Pedrazzi** 1999 EJM 11 855-69 (S2116).
Metamorphic garnet with abundant inclusions of *clinopyroxene*, *rutile* & *apatite*, subduction of continental material to >200 km: **K Ye B Cong D Ye** 2000 N 407 734-6 (Y271).
H in almandine-spessartite, tracer of granite pegmatite evolution: **EH Arredondo GR Rossman GR Lumpkin** 2001 AM 86 485-90.
Structures high P, quantum mechanics**: EV Akhmatskaya & 3 others** 1999 ZK 214 808-19.
Almandine/grossular/pyrope/uvarovite/andradite, elasticity <3 GPa: **Z Wang S Ji** 2001 AM 86 1209-18.
Almandine-pyrope-grossular, XRPD: **M Chnielova P Martinec Z Weiss** 1997 EJM 9 403-9.
Pyrope-majorite, thermal equation of state: **Y Wang & 4 others** 1998 PEPI 105 59-71 (W883).
Metastable gt, oceanic crust, top of lower mantle: **T Kobo & 8 others** 2002 N 420 803-6 (8540).
Calderite-/*franklinite-rich spinel,* amphibolite-facies hydrothermal sediments **M Stalder A Rozendaal** 2005 CM 43 585-99.
H in natural garnets from NRA & FTIR: **J Maldener & 3 others** 2003 PCM 30 337-44 (9241).
Synthetic pyrope-majorite: elastic wave velocity <9 GPa, **J Liu & 3 others** 2000 PEPI 120 153-63 (L1062);
10 to 18 GPa, **GD Gwanmesia & 5 others** 2000 PCM 27 445-52 (G1208).
Post-garnet transitions in *enstatite*-pyrope system to *ilmenite* & *perovskite* types, 23-28 GPa 1873-2273 K, XRPD: **A Kubo M Akaogi** 2000 PEPI 121 85-102 (387).
Trace-element partition/diffusion with andesite melt: **J Koepke & 3 others** 2003 EJM 15 883-92.
Diffusion of Mg/Ca/Mn/Fe: **WD Carlson** 2006 91 54-66.
Hydrogarnets: stabilization of Mn(III) in natural, **U Hålenius** 2004 MM 86 335-41.

Garnet-omphacite from eclogites: Mössbauer, **Y Li Y Zheng B Fu** 2005 AM 90 90-100.
Oxygen heterogeneity in Pyrenees: **D Vielzeuf & 2 others** 2005 AM 90 463-72.
Zoning vs calculated metamorphic P-T, metapelite: **CA Zuluaga & 2 others** 2005 AM 90 1619-28.
Na-amphibole exsolution from gt-peridotite, NW China: **S Song & 4 others** 2005 AM 90 814-20.
Occurrence: banded iron formation, Kola Peninsula, **GYu Ivanyuk & 3 others** 2005 ZVMO 134 82-9.
Reaction rims in eclogite facies: **LM Keller & 4 others** 2006 AM 91 1024-38.
Site preference/local geometry of Sc: pyrope-grossular, **R Oberti & 5 others** 2006 AM 91 1230-9;
andradite-CaScSiO, **S Quartieri & 6 others 1240-8.**
Pyrope-almandine: electrical conductivity to 19 GPa 1973 K: **C Romano & 3 others** 2006 AM 91 1371-7.
Synthetic pyrope-grossular, 2.5 GPa, effect of Cr: **A Orlando D Borrini** 2003 MP 78 37-51.
Synthetic high-pressure Cd/Ca germanates: **CT Prewitt AW Sleight** 1969 S 163 386-7 (P653).
Synthetic Ti-rich, ND/Mössbauer: **HP Weber D Virgo FE Huggins** 1975 CIWYB 74 575-9 = MA 78-4012.
Synthetic $Ca_{12}Al_{14}O_{32}F_2$: **PP Williams** 1973 AC B29 1550-1.
High-P $MgSiO_3$, tetragonal, 17GPa & 2073K: **RJ Angel et al** 1989 AM 74 509-12.
Synthetic $Y_3Fe_5O_{12}$ (YIG): **M Bonnet & 3 others** 1975 AC B31 2233;
H Ohashi T Fujita T Osawa 1981 JJAMPEG 76 58-60;
SC-XRD & optical spectroscopy, **CR Ross II & 3 others** 1996 AM 81 61-6;
low-pressure polymorph, **H Ohashi T Osawa A Sato** 1995 AC C51 2213-5 (O309).
Synthetic $Y_{2.25}Lu_{0.75}Al_5O_{12}$: 1989 SPC 34 323-6.
Synthetic $Na_3Sc_2V_3O_{12}$: 1989 Z Struct Khim 30 113-22.
Synthetic $(Y,Nd)_3Al_5O_{12}$: 1989 SPC 34 1295-7.
Synthetic $(Y,Lu)_3Al_5)_{12}$: 1989 SPC 34 436.
Synthetic $Tb_3Fe_5O_{12}$: 1990 JSSC 84 39-51.
Synthetic $Ca_3In_2Si_3O_{12}$: **J Ito** 1968 AM 53 1663-73.
Synthetic $Ca_3(Zr_1Fe_1)(FeO_4)(SiO_4)_{2-x}(OH)_{4x}$, $Ca_3(Ti_1Fe_1)(FeO_4)(SiO_4)_{2-x}(OH)_{4x}$,
$Sr_3Fe_2(SiO_4)_{2-x}(OH)_{4x}$, $Ca_3Fe_2(SiO_4)_{2-x}(OH)_{4x}$: **J Ito C Frondel** 1967 AM 52 1105-9.
Synthetic $Sr_3Al_2(OH)_{12}$ & $Sr_3Fe_2(OH)_{12}$: **NN Nevskii & 4 others** 1982 SPD 27 427-8.
Synthetic $Sr_3In_2(OH)_{12}$: **J Ito** 1968 AM 53 1663-73.
Synthetic $Ca_3Al_2O_6$.6aq & dehydration product: **H Bartl** 1969 NJMM 404-13.
Synthetic $Ba_3In_2(OD)_{12}$: 1990 JSSC 87 173-7.
Synthetic $Mn_3Fe_2Ge_3O_{12}$: **MD Lind S Geller** 1969 ZK 129 427-34.
Synthetic $Cd_3Al_2Si_3O_{12}$: **H Ohashi T Osawa K Tsukimura** 1985 JJAMPEG 80 499-502.
Synthetic $Gro_{34}Sp_{26}CaMnGt_{40}$: **R Arni K Langer E Tillmanns** 1985 PCM 12 279-82.
Synthetic $Gd_{3-x}Ca_xGa_{5-x}Zr_xO_{12}$: **M Julien-Pouzol S Jaulmes Z Le Hui** 1988 CRASP II 306 531-5.
Synthetic $Ca_xSn_xGa_{8-2x}O_{12}$, x = 2.5-3: **A Rulmont & 4 others** 1995 JSSC 118 6-9 (R587).
Synthetic $Y_3Fe_{5-x}Ga_xO_{12}$ (x 0-5): **A Naksatsuka A Yoshiasa S Takeno** 1995 AC B51 737-45.
Synthetic $(Mg,Ni)_3Al_2Si_3O_{12}$: SC-XRD & optical spectroscopy, **CR Ross II & 3 others** 1996 AM 81 61-6.
Synthetic $Y_3(Al,Cr)_2Al_3O_{12}$, electron density: **H Sawada** 1997 JSSC 134 182-6 (S1879).
Synthetic Mg/Fe/Mn/Ca-AlSi binaries, powder IR: **CA Geiger** 1998 EJM 10 407- 22.
Synthetic GrPy, SC-XRD structure: **CA Geiger T Armbruster** 1999 ZK 214 211-5 (G1166).
Synthetic pyrope-grossular 1273-1673 K 3 GPa, local Ca-Mg distribution by Si NMR: **A Bosenick CA Geiger BL Phillips** 1999 AM 84 1422-32.
Synthetic pyrope-almandine, almandine-grossular & pyrope-grossular, local structural heterogeneity: **TB Ballaran & 3 others** 1999 PCM 26 554-69 (B1940).
Synthetic $Ca_3Fe_2Ge_3O_{12}/Ca_3Y_2Ge_3O_{12}/Mg_3Y_2Ge_3O_{12}$: **D Levy J Barbier** 1999 AC C55 1611-4.
Synthetic pyrope/grossular, XAS of Yb: **S Quartieri & 3 others** 1999 PCM 27 88-94 (Q25).
Synthetic $Na_6Zn_3(AsO_4)_4$.3aq, SC-XRD structure: **TM Gesing R Wartchow** 1999 ZK 214 145-6.
Synthetic $Na_3(Fe,Al)_2Te_3O_{12}$, SC-XRD structure: **B Wedel K Sugiyama** 1999 ZK 214 151-2.
Synthetic $Ca_3Mn_2Ge_3O_{12}$, SC-XRD structure/TEM: **S Heinemann R Miletich** 2000 AM 85 993-1000.
Synthetic $Ca_{12}Al_{14}O_{32}F_2$: cement phase related to garnet, XRPD structure, **U Costa P Ballirano** 2000 PD 15 56-61.
Synthetic Na$Ca_3Mg_2V_3O_{12}$, SC-XRD structure: **A Nakatsuka & 3 others** 2003 ACC 59 i133-5.
Synthetic almandine-spessartine, XAFS of Mn & Fe: **A Sani & 5 others** 2004 EJM 16 801-8 (10835).

Synthetic pyrope-almandine, electron absorption Cr^{3+}: **MN Taran & 4 others** 2004 PCM 31 650-7 (10897).
Synthetic CaGeO: SC-XRD structure: **A Nakatsuka & 2 others** 2005 AM 90 755-7.

garnierite General name for hydrous Ni-Mg silicates, review: **GT Faust** 1966 AM 51 279-8.

garrelsite $NaBa_3B_7Si_2O_{16}(OH)_4$.
Structure: **S Ghose C Wan HH Ulbrich** 1976 AC B32 824-32 (G500).
Occurrence: MM 31 960.

garronite $NaCa_{2.5}Al_6Si_{10}O_{32}.13aq$. *Zeolite* group.
Gismondine structure type, IZA-SC code GIS, Consortium for Theoretical Frameworks net 23.
Structure: domain structure, **G Gottardi A Alberti** 1974 MM 39 898-9;
G Artioli 1992 AM 77 189-96;
space group, **G Artioli M Marchi** 1999 PD 14 190-4 (A898).
Crystal habit & twinning: **DG Howard** 1994 NJMM 91-6.
Occurrence: **GPL Walker** 1962 MM 33 173-86.

gartrellite $Pb(Cu,Fe)_2(As/SO_4)_2(CO_3,aq)_{0.7}$.
Related to *tsumcorite*, *helmutwinklerite* & *thometzekite*.
Structure determination not found
Occurrence: **EH Nickel & 3 others** 1989 Australian Mineral 4 83-9 = AM 75 932.
Redefined: MR 30 175.

garyansellite $(Mg,Fe)_6(PO_4)_4(OH)_3.3aq$. Isostructural with Mn-rich *kryzhanovskite*.
Structure determination not found.
Occurrence: **BD Sturman PJ Dunn** 1984 AM 69 207-9.

gasparite-Ce $(Ce,other\ REE)AsO_4$. *Monazite* structure group.
Structure: SC-XRD, P-rich, Sweden, **U Kolitsch D Holtstam K Gatedal** 2004 EJM 16 111-6 (10132).
Occurrence: **S Graeser H Schwander** 1987 SMPM 67 103-13 = MM 52 725.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.

gaspéite $(Ni,Mg,Fe)CO_3$. *Calcite* structure type.
Occurrence: MM 35 1135;
CM 38 1371-6.
Synthetic $NiCO_3$: **F Pertlik** 1986 AC C42 4-5 (P569).

gatehouseite $Mn_5(PO_4)_2(OH)_4$. Isostructural with As analog *arsenoclasite*. Layer structure.
Compare with *cornubite*, *gatehousite*, *ludjibaite*, *pseudomalachite*, *reichenbachite* & *reppiaite*.
Structure review: **J Barbier** 1996 EJM 8 77-84.
Structure: *synthetic*, **FA Ruszala JB Anderson E Kostiner** 1977 IC 16 2417-22.
Occurrence: **A Pring WD Birch** MM 57 309-13.

gatelite-Ce $CaRE_3[Al_2(Al,Mg)(Mg,Fe,Al)][Si_2O_7][SiO_4]_3(O,F)(OH,O)_2$.
Epidote/törnebohmite polysomatic structure.
Nearly isotopic with *vastmanlandite-Ce* $Ca(Ce,La)_3Al_2Mg_2(Si_2O_7)(SiO_4)_3F(OH)_2$.
Occurrence & SC-XRD structure: **P Bonazzi L Bindi G Parodi** 2003 AM 88 223-8.

gatumbaite $CaAl_2(PO_4)_2(OH)_2.aq$.
Structure determination not found.
Occurrence: **O von Knorring A-M Fransolet** 1977 NJMM 561-8 (V195) = AM 63 793-4.

gaudefroyite $Ca_4Mn^{3+}_{3-x}(BO_3)_3(CO_3)(O,OH)_3$.
Structure: **M-M Granger J Protas** 1965 CRASP 260 4553-5 = MA 19-95;
OV Yakubovich MA Simonov NV Belov 1975 SPC 20 87-9 (Y130);
electron-loss near-edge, **LAJ Garvie PR Buseck AJ Craven** 1995 CM 33 1157-66;
TEM, **I Hassan** 2000 AM 85 1188-94.
Occurrence: MM 33 1134.

gaultite $\sim Na_4Zn_2Si_7O_{18}.5aq$. Zeolite structure group.
Isostructural *synthetic* VPI-7; IZA-SC code VSV; Consortium for Theoretical Frameworks net 860.
Structure: **TS Ercit J van Velthuizen** 1994 CM 32 855-63.
Occurrence: MM 60 531.

gaylussite $Na_2Ca(CO_3)_2.5aq$.
Structure: **B Dickens WE Brown** 1969 IC 8 2093-103.

Dehydration, FTIR spectroscopy: **ME Böttcher P Gehlken** 1996 NJMM 73-91 (B1465).
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).

gearksite $CaAl_3(F,OH)_{11}.aq$.

Structure: SC-XRD, **F Marchetti N Perchiazzi** 2000 AM 85 231-5.
Occurrence: MM 31 960.

gearksutite $CaAlF_4(OH).aq$. Sr chemical analog is *tikhonenkovite* $SrAlF_4OH.aq$.

Structure determination not found.
Occurrence: **Dana**.
[*paragearksutite* has slightly less water: MM 28 735.]

gebhardite $Pb_8(As_2O_5)_2OCl_6$.

Structure: **P Klaska W Gebert** 1981 Fortsch Mineral 59 88-90.
Occurrence: MM 48 573.

gedrite $(Mg,Fe)_5Al_2Si_6Al_2O_{22}(OH)_2$. *Amphibole* structure group, *orthorhombic* subtype.

Structure: **JJ Papike M Ross** 1970 AM 55 1945-72.
Synthetic, 1 GPa, 1073 K: **H Fischer W Schreyer WV Maresch** 1999 CMP 136 184-91 (F664).

[gedroitzite *Synthetic* $Na_2O.Al_2O_3.3SiO_2.2aq$; also occurs in alkaline soil. MM 25 630.]

geerite Cu_8S_5. XRPD similar to *sphalerite*.

Occurrence: **RJ Goble G Robinson** 1980 CM 18 519-23.
NQR of Cu in *synthetic*: **VN Ashkin & 4 others** 1994 ZVMO 123 59-63.

geffroyite $(Cu,Fe,Ag)_9(Se,S)_8$. *Pentlandite* structure group.

Structure determination not found.
Occurrence: **Z Johan P Picot F Ruhlmann** 1982 TMPM 29 151-67 = AM 67 1074.

gehlenite $Ca_2Al(SiAl)O_7$. *Melilite* structure type.

Structure: **SJ Louisnathan** 1970 CM 10 822-37;
PK Korczak H Schichl F Raaz 1972 FM 50 211-22;
M Kimata N Ii 1982 NJMA 144 254-67 (K749);
YuZ Novik YuI Sigalovskaya 1988 ZK 185 701;
YuI Sigolovskay YuZ Nozik AB Toubis 1989 SPC 34 185-9 = SR 56A 257;
IP Swainson & 3 others 1992 PCM 19 185-95;
Bragg-Williams model for ordering T, **MT Dove & 3 others** 1996 AM 81 349-62;
simulation of Al/Si order, **S Thayaparam MT Dove V Heine** 1994 PCM 21 110-6.
Optical spectra for ferrous Fe: **GR Rossman MN Taran** 2001 AM 86 896-903.
Raman, premelting & Ca mobility: **MA Bouhifd & 3 others** 2002 PCM 29 655-62 (8580).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Synthetic $Mn_2Al_2SiO_7$: MM 28 733.
Synthesis: **N Ii I Shindo** 1979 JCG 46 569-74.
Synthetic Sr-: **C Brisi F Abbatista** 1960 = MM 35 1154;
M Kimata 1984 ZK 167 103-16.
Synthetic $CaGa_2SiO_7$: **P Korczak F Raaz** 1967 Osterr Akad Wiss Math-Naturw Kl 383-7 = MA 69-155.
Synthetic $Ca_2(Al,Zn)(Si,Al)_2O_7$: **IV Rozhdestvenskaya & 4 others** 1995 CrR 40 629-31 (R594).
Synthetic Cr^{4+}/B^{3+}-doped: **ZV Panina & 3 others** 1995 CrR 40 593-7 (P570).
Synthetic Cr- & B-doped $Ga_2Al(AlSi)O_7$: **YuA Malinovskii ZV Panina** 1996 CrR 41(2) 222-9.
Synthetic Cr doped, structure: **GM Kuz'micheva EV Zharikov AL Denisov** 1995 Zh Neorg Khim 40 1422-8.
Synthetic $Ca_5Al_6MgSiO_{17}$ with gehlenite module: **I Dodony PR Buseck** 2001 PCM 28 428-34.

geigerite $Mn_5(AsO_3OH)_2(AsO_4)_2.10aq$. Isostructural with *chudobaite* & *lindackerite* $(Cu,Co,Ni)Cu_4(AsO_4)_2(AsO_3OH)_2.9aq$.

Structure: **S Graeser & 4 others** 1989 AM 74 676-84.

geikielite $MgTiO_3$. *Ilmenite* structure type.

Structure: **BA Wechsler RB Von Dreele** 1984 AC B45 542-9.
High-T Raman: **B Reynard F Guyot** 1994 PCM 21 441-50.
Exsolution in *spinel*: **E Reusser R Giere GR Lumpkin** 2001 AM 86 1435-46.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

geminite $Cu(AsO_3OH).aq$. Polymorph of *pushcharovskite*.

Structure: **MA Cooper FC Hawthorne** 1995 CM 33 1111-8;
M Prencipe & 3 others 1996 Vestn Mosk Univ Ser 4 Geol 66-74 = AM 83 911.
Occurrence: **H Sarp P Perroud** 1990 SMPM 70 309-14 = AM 77 671.

genkinite $(Pt,Pd)_4S_3$.

Structure determination not found.
Occurrence: **LJ Cabri & 3 others** 1977 CM 15 389-92.
Phase relations in Pd-Pt-Sb: **W Kim GY Chao** 1996 NJMM 351-64 (K886).

genthelvite $(Zn,Fe,Mn)_4Be_3(SiO_4)_3S$. *Helvite* mineral group.

Sodalite structure type: **I Hassan HD Grundy** 1985 AM 70 186-92.
Optical spectra for ferrous Fe: **GR Rossman MN Taran** 2001 AM 86 896-903.
Occurrence: MM 27 269.

[gentnerite $Cu_8Fe_3Cr_{11}S_{18}$.

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

geocronite $Pb_{14}(Sb,As)_6S_{23}$. Isostructural with As analog *jordanite*.

Structure: **RW Birnie CW Burnham** 1976 AM 61 963-70.

georgbarsanovite $Na_{12}(Mn,Sr,REE)_3Ca_6Fe_3Zr_3NbSi_{25}O_{76}Cl_2.aq$. Eudialyte group.

Occurrence: in prep.

georgbokiite $Cu_5O_2(SeO_3)_2Cl_2$.

Structure: **SV Krivovichev TF Semenova SK Filatov** 1998 CrR 43 1003-6 (K1125)
SV Krivovichev & 3 others 1999 ZK 214 135-8 (K1159).
synthetic, **J Galy J Bonnet S Andersson** 1979 Acta Chem Scand 33 383.
Occurrence: **LP Vergasova & 5 others** 1999 DES 364 134-8 (V341).

georgechaoite $KNaZrSi_3O_9.2aq$. Isostructural with *gaidonnayite*.

Structure: **S Ghose P Thakur** 1985 CM 23 5-10.
Occurrence: MM 50 746.

georgeericksenite $Na_6CaMg(IO_3)_6(CrO_4)_2.12aq$.

Description & crystal structure: **MA Cooper & 5 others** 1998 AM 83 390-9.

georgeite $Cu_5(CO_3)_3(OH)_4.6aq$. Amorphous analog of *malachite*.

Synthesis & correction of composition: **AM Pollard & 3 others** 1991 AM 55 163-6.
Occurrence: MM 43 1061.

georgiadesite $Pb_4(AsO_3)Cl_4(OH)$.

Structure: SC-XRD, **M Pasero D Vacchiano** 2000 MM 64 879-84.
Occurrence: **RC Rouse PJ Dunn** 1983 MM 47 219-20.

gerasimovskit $\sim(Mn,Ca)(Nb,Ti)_5O_{12}.9aq$. Related to *manganbelyankinite*.

Amorphous.
Occurrence: AM 43 1220-1.

gerdtremmelite $(Zn,Fe)(Al,Fe)_2[(AsO_4)(OH)_5]$.

Structure determination not found.
Occurrence: **K Schmetzer O Medenbach** 1985 NJMM 1-6 (S1483) = AM 71 845.

gerenite-Y $(Ca,Na)_2(Y,REE)_3Si_6O_{18}.2aq$.

Structure: **LE Groat** 1998 CM 36 801-8.
Occurrence & XRD: **JL Jambor & 5 others** 1998 CM 36 793-800.

gerhardtite $Cu_2(NO_3)(OH)_3$. Orthorhombic polymorph. Sheet structure.

Dimorphic with *rouaite*.
Structure, *synthetic*: **B Bovio S Locchi** 1982 J Cryst Spectr Res 12 507-17.
Monoclinic polytype: **H Effenberger** 1983 ZK 165 127-35.

GERMANITE STRUCTURE GROUP Includes:

chatkalite	$Cu_6Sn_2FeS_8$
colusite	$Cu_{13}V(As,Sn,Sb)_3S_{16}$
germanite	$Cu_{13}Ge_2Fe_2S_{16}$
germanocolusite	$Cu_{13}V(Ge,As)_3S_{16}$
maikainite	$Cu_{10}(Fe,Cu)_3MoGe_3S_{16}$.

mawsonite $Cu_6SnFe_2S_8$
morozeviczite $\sim(Pb,Fe)_6Ge_{\sim 2}S_8$
ovamboite $Cu_{10}(Fe,Cu,Zn)_3WGe_3S_{16}$.
polkovicite $\sim(Fe,Pb)_6(Ge,Fe)_{\sim 1}S_8$
renierite $Cu_{10}(Zn,Cu)Ge_{2-x}As_xFe_4S_{16}$
stibiocolusite $Cu_{13}(Sb,Sn,As)_3S_{16}$

[jvs: further work needed to clarify relations; check whether superstructure of *sphalerite* & *sulvanite*; *chatkalite* & *mawsonite* have similar XRPD & tetragonal symmetry; the others appear to be cubic, isostructural with *germanite*; polytypism & superstructures may turn up; XRD of *colusite*, *germanite* & *renierit*e, **J Murdoch** 1953 AM 38 794-801.]

germanite $Cu_{13}Ge_2Fe_2S_{16}$.
Structure: **RT Tettenhorst CE Corbato** 1984 AM 69 943-7.
EMP analyses: color variants containing W & V: **BH Geier J Ottemann** 1970 NJMA 114 89107;
new composition $Cu^{1+}{}_{10}(Cu^{2+},Fe,Zn)_3Fe^{3+}Ge_3S_{16}$: **EM Spiridonov** 1987 DAN 295 477-81 = AM 74 951.

germanocolusite $Cu_{13}V(Sb,As)_3S_{16}$. *Germanite* structure group.
Structure: XRPD matches *colusite*, **EM Spiridonov** 1992 Vest Moskov Univ 4 Geol 50-4 = AM 79 387-91.

gersdorffite NiAsS. Isostructural with *joliffeite* NiAsSe.
Boundary with *krutovite* $NiAs_2$: **EM Spiridonov TN Chvileva** 1995 DAN 341 785-7 = AM 83 403.
Structure: **P Bayliss NC Stephenson** 1967 MM 36 38-42;
disorder, **P Bayliss** 1968 AM 53 290-3;
type III, **P Bayliss NC Stephenson** 1968 MM 36 940-7;
P Bayliss 1982 AM 67 1058-64;
do 1986 CM 24 27-33.
Reactivity with air & water, XPS: **DA Jackson & 4 others** 2003 AM 88 890-900.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Unnamed CoAsSe with unindexed XRPD: **LJ Cabri & 4 others** 1991 CM 29 411-8.

gerstleyite $Na_2(Sb,As)_8S_{13}.2aq$.
Structure: **I Nakai DE Appleman** 1981 Chemistry Letters 1327-30 = MA 82M/1149;
synthetic, XRPD, **M Mamiya I Nakai** 1996 MJJ 18 17-22 (M1402).
Occurrence: MM 31 960.

gerstmannite $(Mg,Mn)_2ZnSiO_4(OH)_2$. Compare *holdenite* & *kolicite*.
Structure: **PB Moore T Araki** 1977 AM 62 51-9 (M1035).
Occurrence: MM 42 524.

getchellite $As_{0.98}Sb_{1.02}S_3$.
Structure: synthetic, **TR Guillermo BJ Wuensch** 1973 AC B29 2536-41;
natural, **A Kyono M Kimata** 2004 AM 89 696-700.
Occurrence: MM 35 1135.

geversite $Pt(Sb,Bi)_2$. *Pyrite* structure group.
Structure determination not found.
Occurrence: **EF Stumpfl** 1961 MM 32 833-47;
MR 26 144.
Phase relations in Pd-Pt-Sb: **W Kim GY Chao** 1996 NJMM 351-64 (K886).
Hydrothermal synthesis & characterization: **VI Tikhomirova AV Chichagov** 2000 DES 373A 974-6 (180).

gianellaite $Hg_4(SO_4)N_2$. *Cristobalite* connectivity, similar to *mosesite*.
Review: **Sabelli** p. 30.
Structure: **G Tunell & 3 others** 1977 NJMM 119-31.

[**giannettite** $\{Na_2Ca[Ti(O,OH)_2(Si_2O_7)_2]\}\{Ca_3(Ca_{0.7}Mn_{0.1}Fe0.1Ce_{0.1})\}F_2$.
Compare with *rinkite* and *mosandrite* structure groups, still ill-defined & subject to revision.
Composition between *götzenite* & *hainite* (probably).
Giannetite is acentric in contrast to *götzenite*.
Structure: **RK Rastsvetaeva DYu Pushcharovskii D Atensio** 1995 CrR 40 574-8 (R593).
Occurrence: MM 28 730.
Discredited: AM 85 266.]

gibbsite $Al(OH)_3$. Quadrimorphic with *bayerite*, *doyleite* & *nordstrandite*.
Structure: **HD Megaw** 1934 ZK 87 185-204;
H Saalfeld M Wedde 1974 ZK 139 129-35.
Quantum-mechanical study: **JD Gale & 3 others** 2001 JPCB 105 10236-42.
High-P XRPD/Raman, inversion (? triclinic polymorph, *nordstrandite*): **E Huang & 4 others** 1996 GRL 23 3083-6 (H1125).
XRD to 53 GPa, IR to 25 GPa, phase change to orthorhombic at 2 GPa: **H Liu & 6 others** 2004 PCM 31 240-6 (10313).
SC-Raman & FTIR, structural OH: **S Wang CT Johnson** 2000 AM 85 739-44.
Dissolution, nitric acid, AFM: **CD Peskleway GS Henderson FJ Wicks** 2003 AM 88 27-36.
Occurrence: MM 33 1135.
Cation array, Al oxides/hydroxides/oxyhydroxides: **A Ramos-Gallardo A Vegas** 1996 ZK 211 299-303 (R665).
Molecular dynamics modeling: **BJ Teppen & 4 others** 1997 JPC B 101 1579-87 (T504).
Amorphous $Al(OH)_3$ in altered *feldspar*: **M Kawano K Tomita** 1996 ClClM 44 672-6 (K882).
Mixed Ni-Al hydroxide formation on *gibbsite/montmorillonite/pyrophyllite*, time-resolved XAS:
AM Scheidegger & 3 others 1998 GCA 62 2233-45 (386).
Spectral reflectance, implications for Mars: **EA Cloutis JF Bell III** 2000 JGR 105 7053-70.
Multiple-quantum & cross-polarized Al MAS NMR of mechanical mixtures of *gibbsite* and
kaolinite that produce *mullite* ceramic: **SE Ashbrook et al** 2000 JPCB 104 6408-16.
Synthetic Li-intercalates: **AV Besserguenev & 6 others** 1997 ChM 9 241-7 (B1554);
intercalationLi/Cl/Br/NO_3/OH/SO_4, time-resolved XRPD, **AM Fogg D O'Hare** 1999 ChM 11 1771-5 (F663).
Industrial use as flame retardant, paper additive, & feedstock for Bayer aluminum process.
Adsorption, Hg (II) *quartz*/gibbsite, experiment/model: **D Sarkar & 2 others** 1999 SSSAJ 63 1626-36 (S2141).
Adsorption of *glycophosate* broad-spectrum herbicide on microcrystalline gibbsite, Cu-complex,
model for soil, XAS: **WE Dubbin G Sposito M Zavarin** 2000 Soil Science 165 699-707.
Formation in tropical acid soil: **Y Bhattacharyya DK Pal P Srivastava** 2000 ClM 35 827-40 (452)
Model of K & Na cations on surfaces: **SD Fleming & 3 others** 2001 JPCB 105 5099-105 (2096).
Ni sorption: kinetics, thermodynamics vs T, **KG Scheckel DL Sparks** 2001 SSSAJ 65 719-28 (2097);
surface area/citrate sorption, EXAFS, **NU Yamaguchi AC Scheinost DLS** 2002 ClClM 50 784-90 (8660).
New *synthesis* of fine-grained: **Y Cesteros & 3 others** 2001 ChM 13 2595-600 (2936).
Growth morphology: **C Sweegers & 5 others** 2001 JCG 233 567-82 (3118);
do & 6 others 2002 JPCB 106 1004-12 (7053).
Thermal decomposition, IR: **JT Kloprogge HD Ruan RL Frost** 2000 JMS 37 1121-9 (7252).
Quantum model for IR/Raman, OH stretching: **E Balan and 3 others** 2006 AM 91 115-9.
giessenite $(Cu,Fe)_2Pb_{26}(Bi,Sb)_{20}S_{57}$.
Monoclinic Bi-rich analog of orthorhombic Sb-rich *izoklakeite*.
Kobellite homologous series: N = 4.
Structure determination not found.
Occurrence: **S Graeser DC Harris** 1986 CM 24 19-20;
E Makovicky S Karup-Møller 1986 CM 24 21-5.
gilalite $Cu_5Si_6O_{17}.7aq$.
Structure determination not found.
Occurrence: **FP Cesbron SA Williams** 1980 MM 43 639-41.
GILLESPITE STRUCTURE GROUP. Includes:

cuprorivaite	$CaCuSi_4O_{10}$
effenbergite	$BaCuSi_4O_{10}$
gillespite	$BaFeSi_4O_{10}$-low-pressure phase I
wesselsite	$SrCuSi_4O_{10}$

Synthetic (Ca/Sr/Ba)$CuSi_4O_{10}$, "Egyptian blue": **A Pabst** 1959 AC 12 733-9.
Synthetic $BaCuSi_4O_{10}$: **J Janczak R Kubiak** 1992 AC C48 1299-301;
HC Lin FL Liao SL Wang 1992 AC C48 1297-9.
Synthetic $BaCuSi_2O_6$, related, but not isostructural: 1989 AM 74 952-5.
Synthetic $CaCrSi_4O_{10}$, structure & optics: **HL Belsky & 3 others**1984 AM 69 771-6.
Synthetic (Ca/Sr/Ba)$CrSi_4O_{10}$, SC-XRD structure: **R Miletich & 3 others** 1997 AM 82 697-707.
gillespite $BaFeSi_4O_{10}$.
Phase change I-II. **A Pabst** 1943 AM 28 372-90;
leached: **A Pabst** 1958 AM 43 970-80;

I & II, **RM Hazen CW Burnham** 1974 AM 59 1166-76;
II, **RM Hazen CW Burnham** 1975 AM 60 937-8;
I/II: **RM Hazen LW Finger** 1983 AM 595-603 (H576);
linear dichroism, Fe 2p absorption edge, **G van den Laan & 3 others** 1996 Chem Phys Lett 252 272-6.
Polarized XAS: **GA Waychunas GE Brown Jr** 1990 PCM 17 420-30 (W590);
single-crystal linearly-polarized XAS of Fe, **PF Schofield & 3 others** 1998 MM 62 65-75.
Optical spectra for ferrous Fe: **GR Rossman MN Taran** 2001 AM 86 896-903.

gillulyite $Tl_2(As,Sb)_8S_{13}$.
Structure: **FF Foit Jr PD Robinson JR Wilson** 1995 AM 80 394-9;
reinterpretation, **E Makovicky T Balic-Zunic** 1999 AM 284 400-6.

gilmarite $Cu_3(AsO_4)(OH)_3$. Polymorph of *clinoclase*.
Description & structure: **H Sarp R Cerny** 1999 EJM 11 549-55 (S2062).

giniite $Fe^{2+}Fe^{3+}{}_4(PO_4)_4(OH)_2.2aq$.
Crystallographic data: **P Keller** 1980 NJMM 561-3.
Occurrence: **P Keller** 1980 NJMM 49-56 (K702) = AM 65 1066.
Thermal behavior of *synthetic*: **D Rouzies J Varioud JM Millet** 1994 JCSF 90 3335-9 (R523).
Synthesis, important for iron mill waste: **JL Jambor JE Dutrizac** 1986 NJMA 15951-8 (J255).

ginorite $Ca_2B_{14}O_{20}(OH)_6.5aq$.
Probable analog of *strontioginorite* $(Sr,Ca)_2B_{14}O_{23}.8aq$ & *strontium ginorite* $Sr_2B_{14}O_{23}.8aq$.
Structure determination not found.
Occurrence: **RD Allen H Kramer** 1957 AM 42 56-61; MM 23 629.

[ginzburgite $Ca_4Be_2Al_4Si_7O_{24}(OH)_4.3aq$.
Occurrence: **AV Voloshin & 4 others** 1986 Min Zhurn 8 85 = MM 52 725.
Not approved by IMA: = *roggianite*.]

giorgiosite $Mg_5(CO_3)_4(OH)_2.4aq$. *Lansfordite* mineral group of hydrated Mg carbonates.
XRPD, unindexed: **G Raade** 1970 AM 55 1457-65.
Structure determination not found.
Occurrence: **A Lacroix** 1905 BSFMC 28 198-200.

giraudite $(Cu,Zn,Ag)_{12}(As,Sb)_4$. *Tetrahedrite* structure group.
Isostructural with As analog *hakite*.
Structure determination not found.
Continuous s s between *mercurian giraudite & hakite*: **H Förster D Rhede G Tischendorf** 2002 CM 40 1161-70.
Complete solid solution with *tennantite*, **H Förster D Rheide** 2004 CM 42 1719-32.
Occurrence: **Z Johan P Picot F Ruhlmann** 1982 TMPM 29 151-67 (J251) = MM 48 573.

girdite $H_2Pb_3(Te^{4+}O_3)(Te^{6+}O_6)$.
Structure determination not found.
Occurrence: **SA Williams** 1979 MM 43 453-7.

girvasite $NaCa_2Mg_3(PO_4)_2[PO(OH)_2](CO_3)(OH)_2.4aq$.
Structure: **EV Sokolova YuK Egorov-Tismenko** 1990 Sov Phys Dokl 35 308-10 (S1300).
Occurrence: MM 54 665.

GISMONDINE STRUCTURE GROUP Includes:

amicite	$K_4Na_4Al_8Si_8O_{32}.10aq$
garronite	$NaCa_{2.5}Al_6Si_{10}O_{32}.13aq$
gismondine	$Ca_2Al_4Si_4O_{16}.9aq$
gobbinsite	$Na_3(K_2,Ca)_{1.5}Al_6Si_{10}O_{32}.12aq$

Zeolite group; gismondine subgroup; structure type, IZA-SC code GIS, Consortium for Theoretical Frameworks net 23.
Occurrence of possible (K,Na,Ba) analog M14 in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
Hydrothermal synthesis: **H Ghobarkar O Schaf** 1999 MRB 34 517-25.
Synthetic Na-P zeolites: ion-exchange derivatives of tetragonal, **AM Taylor R Roy** 1964 AM 49 656-82;
dehydration & ion-exchanged types: **do** 1965 J Chem Soc 4028-43;
Na-P1: **C Baerlocher WM Meier** 1972 ZK 135 339-54 (B754);

high-silica Na-P: **U Häkansson L Fälth S Hansen** 1990 AC C46 1363-4 (H995);
high-silica Na-P2: **S Hansen U Häkansson L Fälth** 1990 AC C46 1361-2 (H788);
crystal chemistry: **S Hansen & 3 others** 1993 Z 13 276-80 (H832).

Synthetic $Na_2BeSi_4O_{10}.2.5(aq,Cl_2)$: **S Ueda M Koizumi** 1972 Nature Phys Sci 238 139-40.

Synthetic beryllophosphate: -G, ion-exchange, **EN Coker LVC Rees** 1992 JCSF 88 263-72, 273-6;
with pyridine, SC-XRD structure: **H Zhang & 6 others** 2001 ChM 13 2042-8 (2098).

Synthetic $C_4NH_{10}CoGaP_2O_8$: **AR Dowley AM Chippindale** 1996 ChC 673-4 (R651).

Synthetic $[NH_2Me_2][Al_2P_2O_8F]$, XRPD structure: **J-L Paillaud B Marler H Kessler** 1996 ChC 1293-4 (P621).

Synthetic (Si,Al,P)O-43: **DE Akporiaye & 3 others** 1996 Z 17 517-22 (A719).

Synthetic MAPO-43, NMR: **DG Akolekar RF Howe** 1997 JCSF 93 3263-8 (A764).

Synthetic $AlCoP_2O_8$, structure: **P Feng X Bu GD Stucky** 1997 N 388 735-40 (F556).

Synthetic low-Si Ca-P, XRD structure: **BR Albert AK Cheetham CJ Adams** 1998 MMM 21 127-32, 133-42 (A838, 839).

Synthetic ZnGa-organic, SC-XRD structure: **AM Chippindale AR Cowley KJ Peacock** 1998 MMM 24 133-41 (C1074).

Synthesis 4 endmembers from glass, hydrothermal: **H Ghobarkar O Schäf** 1999 MRB 34 517-25 (G1167).

Synthetic Co aluminophosphate enclosing ethylenediamine & other organics, SC-XRD structure:
GJ Gainsford KR Morgan AD Rae 1998 AC C54 1564-6 (G1135);
HF mineralizer, **AN Christensen RG Hazell** 1999 Acta Chem Scand 53 403-9.

Synthetic Ga, TNU-2, XRPD, NMR, SEM: **HH Cho & 5 others** 2000 ChM 12 2292-300 (C1156).

Synthetic CoPO.ethylenediamine, SC-XRD structure: **H Yuan & 6 others** 2000 IC 39 1476-9.

Synthetic maximum-Al&P, model for XRPD structure: **J Hill & 4 others** 2000 PCCP 2 4249-54 (H1506).

Synthetic $NH_4(Zn,Co)BP_2O_8$, SC-XRD structure: **G Schafer H Borrmann R Kniep** 2000 MMM 41 161-7 (461).

Synthetic MAP (Na-gismondine), used as detergent builder, ion exchange with Na to Li/K/Rb/Ca and Mg/Ca/Sr/Ba, XRPD, MAS-NMR & TA: **S Allen & 4 others** 2002 PCCP (7725).

Synthetic $K_4Li_4Al_8Ge_8O_{32}.8aq$, SC-XRD structure: **AJ Celestian & 4 others** 2003 ACC 59 i74-6 (9282).

gismondine / gismondite $Ca_2Al_4Si_4O_{16}.9aq$.

Zeolite group; gismondine structure type, IZA-SC code GIS, Consortium for Theoretical Frameworks net 23.

Structure: **K Fischer** 1963 AM 48 664-72;
R Rinaldi G Vezzalini 1985 Stud Surf Sci Catal 24 481-92 (R607;
ND 15K, **G Artioli R Rinaldi Å Kvick JV Smith** 1986 Z 6 361-6 (A661);
exchanged with Ag/Cs/Ba/Li/Na/K/Rb, **T Bauer WH Baur** 1998 EJM 10 133-47 (B1807).

Crystal chemistry, no K-rich gismondines: **G Vezzalini R Oberti** 1984 BM 107 905-12 (V114).

Dehydration: **LP Van Reeuwijk** 1971 AM 56 1655-9;
G Vezzalini S Quartieri A Alberti 1993 Z 13 34-42.

Identification of gismondine & *phillipsite* using XRD: MA 96M/3988.

Occurrence, 40 places in Ireland & Iceland with compositions from $Ca_4Al_8Si_8O_{32}.17aq$ to $Na_{1.2}Ca_{2.8}Al_{6.7}Si_{9.3}.17aq$: **GPL Walker** 1962 MM 33 187-201.

= *synthetic Na-P.*

Synthetic $Al_6Mg_2P_8O_{32}.2NC_6H_{16}$: **JJ Pluth JV Smith JM Bennett** 1989 JAChS 111 1692-8.

Synthetic $C_4NH_{10}CoGaP_2O_8$: **AR Cowley AM Chippindale** 1996 ChC 673-4.

New *synthesis* procedure: **GM Johnson A Tripathi JB Parise** 1999 ChM 11 10-2 (J330).

HF mineralizer in synthesis: **AN Christensen RG Hazell** 1999 Acta Chem Scand 53 403-9.

Synthetic $K_{5.8}Ga_{5.8}Si_{10.2}.3.4aq$, SC-XRD struct: **A Tripathi & 4 others** 2001 AC C 57 344-6.

Synthetic $BePO_4$, SC-XRD structure: **H Zhang & 6 others** 2001 ChM 13 2042-8 (2098).

Synthetic Na-P with Al=Si, (Mn/Cd/Sr/Ba/Pb)-exchanged, XRPD structure: **JG Nery YP Mascarenhas AK Cheetham** 2003 MMM 57 229-48 (8574).

[gismondine-Ba Gismondine zeolite family.

Occurrence: lead smelting slag, UK, **RSW Braithwaite & 3 others** 2001 J Russell Soc 7 83-5.]

gittinsite $CaZrSi_2O_7$. Isostructural with *keivite* $Yb_2Si_2O_7$ & *thortveitite* $(Sc,Y)_2Si_2O_7$.

Structure: **JN Roelofsen-Ahl RC Peterson** CM 1989 27 703-8.

giuseppettite $Na_{42}K_{16}Ca_6Si_{48}Al_{48}O_{192}(SO_4)_{10}Cl_2.5aq$. *Cancrinite* structure group: ABABABACBABABABC-16-layer type.

Structure: SC-XRD, **E Bonaccorsi** 2004 MMM 73 129-36 (10630).

Occurrence: **F Mazzi C Tadini** 1981 NJMM 103-10.

gjerdingenite-Fe $K_2(Fe, Mn)(Nb,Ti)_4(Si_4O_{12})_2(O,OH)_4.6aq$. *Labuntsovite* group.
Occurrence, SC-XRD: **G Raade & 3 others** 2002 CM 40 1629-39**.**
gjerdingenite-Mn **(**$K,Na)_2(Mn,Fe)(Nb,Ti)_4(Si_4O_{12})_2(O,OH)_4.6aq$. *Labuntsovite* group.
Occurrence, SC-XRD: **G Raade & 5 others** 2004 EJM 16 979-87**.**
gladite $CuPbBi_5S_9$.
Structure contains 2 *bismuthinite* & 4 *krupkaite* slabs: **A Pring** 1989 AM 74 250-5.
Structure: **V Synecek J Hybler** 1974 NJMM 541-60;
T Kohatsu BJ Wuensch 1976 AC B32 2401-9;
excess Cu/Pb, SC-XRD, **D Topa E Makovicky T Balic-Zunic** 2002 CM 40 1147-59.
gladiusite $(Fe,Mg)_4Fe(III)_4(PO_4)(OH)_{11}.aq$.
Structure: **E Sokolova & 3 others** 2001 CM 39 1121-30.
Occurrence: **RP Liferovich & 6 others** 2000 CM 38 1477-85.
glagolevite $Na(Mg,Al)_6[Si_3AlO_{10}](OH,O)_8$. *Chlorite* group; several polytypes.
Structure: SC-XRD, **SV Krivovichev & 5 others** 2004 AM 80 1138-42.
Occurrence: **MV Seredkin & 11 others** 2003 ZVMO 132 67-75.
glaserite This term is used for a structure type.
The mineral name has been replaced by *aphthitalite*, to which all structural references are assigned for convenience.
[Ca_2SiO_4 occurs as 6 types: gamma (*olivine*); beta (*larnite,* deformed low K_2SO_4 type); alpha (hexagonal, *glaserite* = high K_2SO_4 type); alpha-low (several orthorhombic derivatives including analog of *bredigite*) and high-pressure (K_2NiF_4): summary of complex literature, **C Remy F Guyot M Madon** 1995 PCM 22 419-27 (R608).]
Synthetic $K_4MnMo_4O_{15}$, SC-XRD, similar connectivity to glaserite: **SF Solodovnikov ES Zolotova ZA Solodovnikova** 1997 J Struct Chem 38 83-8 (S1741).
Synthetic $NaMgPO_4$, $Na_2CaMg(PO_4)_2$ & $Na_{18}Ca_{13}Mg_2(PO_4)_{18}$: **J Alkemper H Fuess** 1998 ZK 213 282-87 (A227).
Synthetic $Na_3Fe(PO_4)_2$: XRPD stru, IR/Mössbaur, **VA Morozov & 5 others** 2001 JSSC 160 377-81 (3146).
Synthetic $K_2CsYb(PO_4)_2$: **L Rghioui & 3 others** 2002 AC C58 190-1 (7695).
glauberite $Na_2Ca(SO_4)_2$. Review: **Sabelli** p. 34.
Structure: **G Cocco E Coprazzo C Sabelli** 1965 ZK 122 175-84;
T Araki T Zoltai 1967 AM 52 1272-7.
glaucocerinite $Zn_{13}Al_8Cu_7(SO_4)_2.34aq$.
Raman vs OH: **RL Frost & 4 others** 2004 AM 89 1130-7.
Occurrence: MM 23 630.
glaucochroite $CaMnSiO_4$. *Olivine* structure type.
Structure determination not found.
Crystallography: **JH O'Mara** 1951 AM 36 918.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
glaucodot (Co,Fe)AsS. *Arsenopyrite* structure group.
Dimorphic with *alloclasite*.
Structure determination not found.
Occurrence: **Dana**.
glaucocerinite or **glaucokerinite** $(Zn,Cu)_{10}Al_6(SO_4)_3(OH)_{32}.18aq$.
Hydrotalcite/pyroaurite structure group.
Review: Sabelli, no structure determination.
New data, review double-layer *brucite*/interlayer minerals: **G Raade CJ Elliott VK Din** 1985 MM 49 583-90.
glauconite $(K,Na)(Fe,Al,Mg)_2(Si,Al)_4O_{10}(OH)_2$. *Mica* structure group; 1M polytype.
Structure determination not found.
Stacking faults: **BA Sakharov & 5 others** 1990 ClM 25 419-35.
Structural change during dehydroxylation/rehydration, XRPD: **F Muller & 3 others** 2000 ClClM 48 572-85 (M1861).
glaucophane $Na_2(Mg,Fe)_3Al_2Si_8O_{22}(OH)_2$.
Amphibole structure group; *monoclinic* subtype.
Structure: **JJ Papike JR Clark** 1968 AM 53 1156-73;
4 GPa, **P Comodi & 3 others** 1991 EJM 3 485-99;

IR, model of Al/Si order, **EJ Palin & 5 others** 2003 EJM 15 893-92.
Role of water in synthesis: **DM Jenkins JC Corona** 2006 AM 91 1055-68.
glaucosphaerite / glaukosphaerite $(Cu,Ni)_2(CO_3)(OH)_2$. *Rosasite* structure group.
Occurrence & cell dimensions: **MW Pryce J Just** 1974 MM 39 737-43.
Cell dimensions from XRPD: **JL Jambor** 1976 CM 14 574-6.
glucine $CaBe_4(PO_4)_2(OH)_4$. 0.5aq.
Structure determination not found.
Occurrence: **NA Grigoriev** 1963 ZVMO 92 691-6 = AM 49 1152.
glushinskite MgC_2O_4.2aq.
Originally defined as *beta* type (= *synthetic*):
MJ Wilson D Jones JD Russell 1980 MM 43 837-40 (W869);
MJ Wilson P Bayliss 1987 MM 51 327-8.
Alpha type (= *synthetic*) later found: **UW Cowgill** 1989 MM 53 505-7 (C1002).
Occurrence: MM 33 1135.
Crystallography *synthetic* Mg/Mn/Fe/Co/Ni/Zn:
J-P Lagier H Pézérat J Dubernat 1969 Rev Chim Mineral 6 1081-93;
J Dubernat H Pézérat 1974 JAC 7 387-93.
[jvs: check whether isostructural with *humboldtine*.]
gmelinite-Na $(Na_2,Ca)Al_2Si_4O_{12}$.6aq. *Zeolite* mineral group. IZA-SC code GME.
Consortium for Theoretical Frameworks tetrahedral net 82.
Structure: **K Fischer** 1966 NJMM (1) 1-13 (F66);
Na- & Ca-rich natural, **E Galli E Passaglia PF Zanazzi** 1982 NJMM (4) 145-55 (G454).
Al order, NMR and models: **M Kato K Takahashi** 2000 JPC B 104 4074-9 (K1233).
Pd clusters & CO, models of interaction: **V Dura-Vila JD Gale** 2001 JPC B 105 6158-71 (2099).
Crystal chemistry: **E Passaglia D Pongiluppi G Vezzalini** 1978 NJMM 310-24.
Synthetic Ba-exchanged: **AG Vigdorchik YuA Malinovskii** 1986 SPC 31 519-21 (V120).
Synthetic Na-, K-, & Ca-exchanged natural: **M Sacerdoti E Passaglia R Carnevali** 1995 Z 15 276-81 (S1442).
Synthetic beryllophosphat, polyethylene polyamine, SC-XRD structure: **H Zhang & 6 others** 2001 ChM 13 2042-8 (2098).
gmelinite-K $(K,Na,Ca)_6Al_7Si_{17}O_{48}$.22aq. **Zeolite** mineral group.
IZA-SC code GME. Consortium for Theoretical Frameworks tetrahedral net 82.
Occurrence: K-rich natural, **G Vezzalini S Quartieri E Passaglia** 1990 NJMM 504-16;
AP Khomyakov LI Polezhaeva Yu Malinovsky 2001 ZVMO 3 71-9.
gobbinsite $\sim Na_3(K_2,Ca)_{1.5}Al_6Si_{10}O_{32}$.12aq. *Zeolite* group; *gismondine* structure type,
IZA-SC code GIS, Consortium for Theoretical Frameworks net 23.
Structure: **LB McCusker C Baerlocher R Nawaz** 1985 ZK 171 281-9
godlevskite $(Ni,Fe)_9S_8$.
Structure: **ME Fleet** 1987 AC C43 2255-7;
ME Fleet 1988 CM 26 283-91 (F391).
Occurrence: MM 37 758;
EM Spiridonov & 3 others 1997 DES 357 1206-8.
godovikovite $NH_4(Al,Fe)(SO_4)_2$. Analog of *sabieite* $NH_4Fe(SO_4)_2$.
Occurrence: **EP Shcherbakova LF Bazhenova BV Chesnokov** 1988 ZVMO 117 208.
goedkenite $(Sr,Ca)_2Al(PO_4)_2(OH)$. *Brackebuschite* structure group.
Structure determination not found.
Occurrence: **PB Moore AJ Irving AR Kampf** 1975 AM 60 957-64. MM 40 907.
goethite FeO(OH)-alpha. Quadrimorphic with *akaganeite*, *feroxyhyte* & *lepidocrocite*.
Entropy/heat capacity of *goethite, lepidocrocite & maghemite*: **J Majzlan & 5 others** 2003 AM 88 846-54.
Structure: **A Szytuta & 7 others** 1968 Physica Status Solidi 26 429-34;
JB Forsyth IG Hedley CE Johnson 1968 J Phys C 1 179-88;
apparent shift of cell repeat for nanocrystalline, **H Stanjek** 2002 ClM 37 629-38;
H-bonded O…O at high P, **T Nagai H Kagi T Yamanaka** 2003 AM 88 1423-7;
Deuterated, MAS-NMR, **KE Cole & 4 others** 2004 JPCB 108 6938-40 (10332).
Cell dimensions for *synthetic* Co/Ni/Cu/Zn/Cd/Pb-substituted: **F Gerth** 1990 GCA 54 363-71.
Natural & *synthetic* Ni-substituted, XAS: **ML Carvalho-e-Silva & 5 others** 2003 AM 88 876-82.
Adsorption, Co/Cu/Pb/Zn/Cd: **EA Forbes AM Posner JP Quirk** 1976 J Soil Sci 27 154-66.

Cu/Pb/Zn/Cd adsorption in seawater: **LS Baliatrieri JW Murray** 1982 GCA 46 1253-65.
Se oxyanion adsorption, XAS: **KF Hayes & 5 others** 1987 S 238 783-6 (H686).
Pb adsorption, XAS: AL Roe & 5 others 1991 La 7 367-73 (R532).
Au(III)Cl & Au(I)thiosulfate adsorption: **ML Machesky WO Andrade AW Rose** 1991 GCA 55 769-76.
Cu/Pb/Zn adsorption in water: **Z Kooner** 1992 Environ Geol 21 242-50.
Selenate adsorption: **A Manceau L Charlet** 1994 JCIS 168 87-93.
Aluminous, dehydroxylation: **HD Ruan RJ Gilkes** 1995 ClCLM 43 196-211.
AFM of porous: **L Fischer Z Mühlen GW Brümmer H Niehus** 1996 Eur J Soil Sci 47 329-34.
Cd multisite adsorption: **P Venema T Hiemstra WH Van Riemsdijk** 1996 JCIS 183 515-27.
In acidic groundwater, XRPD, Mössbauer & SEM: **CRB Herbert Jr** 1997 ClClM 45 261-73 (H1210).
Pb(II) mononuclear sorption, XAS & bond-valence: **JR Bargar GE Brown Jr GA Parks** 1997 GCA 61 2639-52 (B1682).
Pb(II) & Pb(II)-chloro adsorption complexes, XAFS: **JR Bargar GE Brown Jr GA Parks** 1998 GCA 62 193-207 (B1801).
Overgrowth on *hematite* synthesized in phosphate media, AFM & TEM: **B Barrón & 3 others** 1997 AM 82 1091-100.
Surface microtopography: **J Rakovan U Becker MF Hochella Jr** 1999 AM 84 884-94.
Arsenite oxidation on Mn-substituted, XAS: **X Sun HE Doner M Zavarin** 1999 ClClM 47 474-80 (S211).
Hg adsorption: **P Bonnissel-Gissinger M Alnot J Lickes J Ehrhardt** 1999 JCIS 215 313-22;
EXAFS & density function, **CR Collins DM Sherman KV Ragnarsdottir** 1999 JCIS 219 343-50 (C1128).
Cu/Cd reaction 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).
Sr adsorption, EXAFS: **N Sahai SA Carroll S Roberts PA O'Day** 2000 JCIS 222 198-212.
Pb(II) adsorption, effect of inorganic ligand, EXAFS & FTIR: sulfate, **JD Ostergren** 2000 JCIS 225 483-93 (O426);
carbonate, **JD Ostergren & 4 others** 2000 JCIS 225 466-82 (O427).
Al,Fe,S,Si zoning, EPMA: **RB Herbert Jr** 1999 Geol For Forh 121 221-6 (H1441).
Goethite-*hematite* phase change, XRPD: **AF Gualtieri P Venturelli** 1999 AM 84 895-904.
Spectral reflectance, implications Mars: **EA Cloutis JF Bell III** 2000 JGR 105 7053-70 (C1141).
Persistence of *mackinawite* to 393 K when anoxic, & oxic transformation to *greigite*, *pyrite*,
magnetite & goethite, time-resolved XRD: **CL Cahill & 3 others** 2000 ChG 167 53-63 (C1145).
Benzenecarboxylate surface complex, IR & models: **J Boily P Persson S Sjoberg** 2000 GCA 64 3453-73 (B2052).
Crystal chemistry natural minor Cr/Co/Cu/Zn & *synthetics*, EXAFS: **A Manceau & 6 others** 2000 GCA 64 3643-61.
Dechlorination of CCl_4 by Fe(II) on catalytic goethite surface: **JE Amonette & 4 others** 2000 EST 34 4606-13 (94).
Carbonate adsorption for closed & open carbon dioxide: **M Villalobos JA Leckie** 2000 GCA 64 3787-802 (105);
FTIR, **do** 2001 JCIS 235 15-32 (1257).
Phosphate sorption at high concentration, as at fertilizer particle in soil: **L Celi E Barberis FA Marsan** 2000 SoS 165 657-64 (382).
Solid solution with *groutite*, XRPD structure, Mn & Fe XAFS: **AC Scheinost & 4 others** 2001 AM 86 139-46.
Kinetics of dissolution: **O Larsen D Postma** 2001 GCA 65 1367-79 (1619).
Bicarbonate adsorption, FTIR: **H Wijnja CP Schulthess** 2001 SSSAJ 65 324-30 (1603).
Ferri/ferro-cyanide adsorption re former gas plants & coke ovens**: T Rennert T Mansfeldt** 2001 EJSS 52 121-8 (1738).
Arsenate absorption/desorption, pH/phosphate/oxalate: **F Liu A DeCristofaro A Violante** 2001 SoS 166 197-208 (1735).
Cu(II) bonding, goethite-humate complexes: **TE Alcacio & 5 others** 2001 GCA 65 1355-66.
Inositol hexaphosphate vs inorganic phosphate: **L Celi M Presta F Ajmore-Marsan E Barberis** 2001 SSSAJ 65 753-60.
Goethite-coated sand for Cd/Pb adsorption from water: **C Lai C Chen B Wei C Lee** 2001 JESH 36 747-63 (2101).
Surface interaction, *Shewalla* bacterium, AFM: **SK Lower MF Hochella Jr TJ Beveridge** 2001 S 292 1360-3 (1802).
Glyphosate/phosphate adsorpt, KCl & $CaCl_2$ background electrolytes: **AL Gimsing OK Borggard** 2001 ClClM 49 270-5.
Ca & phosphate adsorption: **RPJJ Rietra T Hiemstra WH Van Riemsdijk** 2001 EST 35 3369-74 (2930).
Uranyl sorption-desorption & surface precipitation: **DE Giammar JG Hering** 2001 EST 35 3332-7 (2931).
Selenate/sulfate adsorption vs. pH: **RPJJ Rietra & 2 others** 2001 JCIS 240 384-90 (3146).
As(V)/arsenite(III) adsorption with/without organic C: **M Grafe MJ Eick PR Grossl** 2001 SSSAJ 65 1680-7 (3636).
Competitive adsorption of phosphate/arsenate: **Z Hongshao R Stanforth** 2001 EST 4753-7 (3785).
In Fe oxide coatings on sand in Atlantic coastal plain, HR-TEM: **RL Penn & 3 others** 2001 G 29 843-6 (3156).
Ni/Zn sorption, amorphous & crystalline Fe oxides: **P Trivedi L Axe** 2001 JCIS 244 221-9 (5439).
Dissolution: promoted by *trihydroxamate* siderophores, **C Cocozza & 6 others** 2002 GCA 66 431-38 (5906);
EDTA-promoted, oxyanion effect: **JL Campbell MJ Eick** 2002 ClClM 50 336-41 (7465).
Cr/Mn/Ni incorporation, mechanism, EXAFS: **Balwant Singh & 4 others** 2002 ClM 37 639-50.
W-bearing: SEM, XRPD, Raman, EMPA: **M Tarassov & 3 others** 2002 EJM 14 977-86 (8345).
Reductive dissolution kinetics of Al-subst: **E Gonzalez MC Ballesteros EH Rueda** 2002 ClClM 50 470-7.
Synthetic Cd/Fe (II), XRPD structure: **EE Sileo PS Solis CO Paiva-Santos** 2003 PD 18 50-5 (8595).
Synthetic Cd-substituted, XRPD structure: **T Huynh & 3 others** 2003 ClClM 51 397-492 (9266).
Glycophosphate/phosphate adsorption, AFM: **K Dideriksen SLS Stipp** 2003 GCA 67 3313-27 (9349).
Nanophase, dominant O-OH phase in lake/marine sediments: **C van der Zee & 3 others** 2003 G 31 993-6.
Si-, hydrothermal sediments, Red Sea: **N Taitel-Goldman & 2 others** 2004 ClClM 52 115-29 (10077).

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

gold Au. *Copper* structure group.

Cubic closest packing of spheres = face-centered cubic.

Solid-solution with *silver*: *high-grade gold* is 100-56 mol % Au; *electrum* 56-15 Au; *kuestelite* 15-6; & silver is 6-0.

Lattice dynamics & EOS to HP: **CW Greeff MJ Graf** 2004 PRB 69 154107 (10109).

Nanoclusters formed by reacting Au^{3+} with *chalcopyrite, green rust, pyrite & stibnite*, SEM/TEM/EXAFS: **DM Heasman DM Sherman KV Ragnarsdottir** 2003 AM 88 725-38.

Nanoparticle diamond-like crystals of Au & *silver*, S 312 420-4.

Nanoparticles in Carlin deposit, TEM/STEM: **CS Palenik & 5 others** 2004 AM 89 1359-66.

Pd-bearing, Brazil: **AR Cabral & 4 others** 2003 CM 41 473-8;
AR Cabral B Lehmann 2003 MM 67 453-63.

Massive sulfide ores, Urals: **IV Vikent'ev** 2003 DES 393A 9 1284-8.

Gold-silver vein deposits, Korea: **SJ Pak S Choi S Choi** 2004 MM 68 467-87.

Transport from porphyry to epithermal by magmatic vapor: **CA Heinrich & 3 others** 2004 G 32 761-4 (10617).

Special issue on gold: RoM 79 1.

Placer, Argentina: CM 42 169-82.

New Brunswick, Canada: CM 42 851-71.

Mouska mine, Canada: CM 42 1079-96.

Gold-dominated alloys in meteorites: **AE Rubin** 1997 MPS 32 231-47.

Gold-bearing fluid from magnetite crystallization, convergent-zone magma: **W Sun & 3 others** 2004 N 431 975-8 (10748).

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

Role of CO_2 in formation of gold deposits: **GN Phillips KA Evans** 2004 N 429 860-3.

Inclusions in *olivine* phenocrysts of picrite lava: **Z Zhang & 3 others** 2006 AM 91 1178-83.

goldamalgam-gamma (Au,Ag)Hg. Beta-brass structure type.

Isostructural *moschellandsbergite* Ag_2Hg_3 from 5-line XRPD pattern: AM 70 215.

Occurrence: MM 50 747.

Other materials related to beta-brass are *belendorffite* Hg_6Cu_7 & *kolymite* Cu_7Hg_6.

[*colombianite* has 57% Hg: MM 29 979.]

goldfieldite $Cu_{12}(Sb,As)_4(Te,S)_{13}$. *Tetrahedrite* structure group.

Crystallography, mineral chemistry & nomenclature: **AG Trudu U Knittel** 1998 CM 36 1115-37.

Structure, As-: **MT Dmitriyeva VA Yefremov VA Kovalenker** 1987 DAN 297 141-4 (D480);
U Knittel 1989 MP 40 145-54 (K32).

Se-bearing, XRPD refinement: **D Pohl W Liesmann VM Okrugin** 1996 NJMM 1-8 (P601).

Synthetic $Cu_{12-x}Te_4S_{13}$, structure: **R Kalbskopf** 1974 TMPM 21 1-10.

goldichite $KFe(SO_4)2.4aq$. Review: **Sabelli** p.26.

Structure: **EF Graeber A Rosenzweig** 1971 AM 56 1917-33.

Occurrence: MM 30 733.

Breakdown of Na,K- Maus' salt to *ferrinatrite* & *goldichite*: **F Scordari E Scandale** 1980 ZK 151 325-30 (S1458).

Synthetic $KIn(SO_4)_2.4aq/NH_4In(SO_4)_2.4aq/NH_4In(SeO_4)_2.4aq$: **NM Mukhatarova & 3 others** 1979 SPD 24 140-2.

goldmanite $Ca_3(V,Al,Fe)_2Si_3O_{12}$. *Garnet* structure type.

Structure: **GA Novak GV Gibbs** 1971 AM 56 791-825.

Occurrence: MM 33 1135;
black shales, Korea, **GY Jeong YH Kim** 1999 MM 63 253-6..

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

goldquarryite **(**Cu,void)$(Cd,Ca)_2Al_3(PO_4)F_2.12aq$.

Structure: **MA Cooper** 2004 CM 42 753-61.

Occurrence: **AC Roberts et al** 2003 MR 34 237.

gonnardite $\sim Na_{6.5}Ca_{1.5}Al_{9.3}Si_{10.7}O_{40}.12aq$. *Zeolite* mineral group.

Natrolite structure type.

Is polysomatic mixture of *natrolite* & *thomsonite*: **M Ross MJK Flohr DR Ross** 1992 AM 77 685-703.

Structure: **ST Amirov MA Asratkulu KhS Mamedov NV Belov** 1972 SPD 17 316-7;
F Mazzi AO Larsen G Gottardi E Galli 1986 NJMM 219-28 (M799);
holotype, XRPD structure, discreditation of *tetranatrolite*, **G Artioli E Galli** 1999 AM 84 1445-50;
Al & Si, MAS-NMR, **PS Neuhof & 4 others** 2002 AM 87 1307-20.

Synthetic, morphology of hydrothermal: **H Ghobarkar O Schäf** 1997 Z 19 259-61 (G958).
gonyerite $(Mn,Mg)_5Fe(Si_3Fe)O_{10}(OH)_8$. *Chlorite* structure group.
Structure determination not found.
Occurrence: **C Frondel** 1955 AM 40 1090-4.
goosecreekite $CaAl_2Si_6O_{16}.10aq$. *Zeolite* mineral group.
IZA-SC structure code GOO. Consortium for Theoretical Frameworks net 608.
Structure: **RC Rouse DR Peacor** 1986 AM 71 1494-501.
Occurrence in Norway, XRPD: **G Raade H Berg** 2002 PD 17 247-9 (7960).
Modeling using water potential: **N Almora-Barrios & 4 others** 2001 CC 531-2 (1431).
Occurrence: MM 46 519.
gorceixite $BaAl_3(PO_4)(PO_3OH)(OH)_6$. *Crandallite* structure group. Review: **Sabelli** p.34.
Structure: **EW Radoslovich PG Slade** 1980 NJMM 157-70;
EW Radoslovich 1982 NJMM 446-64.
Synthesis, XRPD: **RG Schwab & 3 others** 1990 NJMM 113-26 (S1453).
Occurrence: marine sandstones: **B Rasmussen** 1996 AJS 296 601-32 (R677);
fossil bone: **JMV Coutinho & 3 others** 1999 CM 37 945-50.
Ferrazite = gorceixite: MM 60 841-2.
gordaite $NaZn_4(SO_4)(OH)_6Cl.6aq$.
Structure: **G Adiwidjaja & 3 others** 1997 ZK 212 704-7.
Occurrence: **J Schlülter & 4 others** 1997 NJMM 155-62 (S1701);
L Nasdala & 3 others 1998 AM 83 1111-6.
Cuprian, occurrence in dumps: **S Jahn T Witzke** 1990 CEr 59 223-32 (J354).
Synthetic $3Zn(OH)_2.ZnSO_4.3$ & 5aq, structure: **IJ Bear & 4 others** 1986 AC B42 32-9.
[Slag material, Val Varenna, Italy, structure with same sheet: **PC Burns AC Roberts AJ Nikischer** 1998 EJM 10 923-30 (B1892).]
gordonite $MgAl_2(PO_4)_2(OH)_2.8aq$. *Paravauxite* structure type.
Structure: **PB Leavens AL Rheingold** 1988 NJMM 265-70 (L652).
Also *mangangordonite*: AM 74 1402.
Occurrence: MM 22 620.
görgeyite $K_2Ca_5(SO_4)_6.aq$. Review: **Sabelli** p. 34.
Structure: **GW Smith R Walls** 1980 ZK 151 49-60 (S1459);
NN Mukhtarova & 4 others 1980 SPD 25 323-5 (M1121);
synthetic, **JT Kloprogge & 4 others** 2004 AM 89 266-72.
Occurrence: MM 30 734.
gormanite $Fe_3Al_4(PO_4)_4(OH)_6.2aq$.
Series with Mg analog *souzalite*, but question of symmetry.
Structure: XRPD, **A Le Bail PW Stephens F Hubert** 2003 EJM 15 719-23 (10228).
Occurrence: **BD Sturman & 3 others** 1981 CM 19 381-7.
gortdrumite $(Cu,Fe)_6Hg_2S_5$.
Structure determination not found.
Occurrence: **GM Steed** 1983 MM 47 35-6.
goslarite $ZnSO_4.7aq$.
Epsomite structure type.
Structure: SC-XRD & neutron PD of deuterated, **JL Anderson RC Peterson IP Swainson** 2005 MM 69 259-72.
Review: **Sabelli** p. 8.
Occurrence: **Dana**.
gottardiite $Na_{2.5}K_{0.2}Mg_{3.1}Ca_{4.9}Al_{18.8}Si_{117.2}O_{272}.93aq$. Zeolite mineral group.
IZA-SC code NES. Consortium for Theoretical Frameworks net 763.
Structure: **A Alberti & 3 others** 1996 EJM 8 69-75 (A684).
Occurrence: **E Galli & 3 others** 1996 EJM 8 687-93 (G872).
Synthetic isostructural NU-87: **MC Shannon & 3 others** 1991 N 353 47-20.
gottlobite $CaMg(VO_4,AsO_4)(OH)$. *Adelite* structure group.
Occurrence & SC-XRD structure: **T Witzke & 3 others** 2000 NJMM 444-54 (117).

götzenite $(Ca,Na,RE)_3(Ti,Al)Si_2O_7(OH)_2$.
Compare with *rinkite*, *seidozerite* and *mosandrite* structure groups, still ill-defined & subject to revision.
Rinkite is an improper polytype: **CC Christiansen JJ Ronsbo** 2000 NJMM 496-506 (295).
Lower Na than *giannetite*: also centric vs. acentric.
Should be isostructural with *hainite*.
Structure: **E Cannillo F Mazzi G Rossi** 1972 SPC 16 1026-30 (C299).
Occurrence: MM 31 960.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
goudeyite $Cu_6(Al,Y)(AsO_4)_3(OH)_6.3aq$. *Mixite* structure group. Review: (E289).
Structure determination not found.
Occurrence: **WS Wise** 1978 AM 63 704-8.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
gowerite $CaB_5O_8(OH).B(OH)_3.3aq$.
Structure: **JA Konnert JR Clark CL Christ** 1972 AM 57 381-96.
Occurrence: MM 32 959.
goyazite $SrAl_3(PO_4)_2(OH)_5.aq$. *Crandallite* structure group.
Structure: **T Kato** 1971 NJMM 241-7;
T Kato 1987 MJJ 390-6.
neodymian goyazite see.
Synthesis & XRPD: **RG Schwab & 3 others** 1990 NJMM 113-26 (S1453).
Synthetic (Nd,Ce,La,etc): (M1251).
Occurrence: Beauvoir, France, **B Charoy & 3 others** 2003 CMP 1445 673-9 (9572).
graemite $CuTeO_3.aq$.
Structure determination not found.
XRPD: **AE Lam et al** 1999 GAC/MAC.
Occurrence: **SA Williams P Matter III** 1975 MR 6 32-4 = AM 60-486.
[*Synthetic* $CuTeO_3$: **O Lindqvist** 1972 Acta Chem Scand 26 1423-30.]
graeserite $Fe_4Ti_3AsO_{13}(OH)$. *Derbylite* group.
Pb-substituted $Pb_{0.14}(Fe,Ti)_7AsO_{12+x}(OH)_{2-x}$, structure: **P Berlepsch T Armbruster** 1998 SMPM 78 1-9.
Occurrence & crystallography: **MS Krzemnicki E Reusser** 1998 CM 36 1083-8.
GRAFTONITE STRUCTURE GROUP Includes:

beusite	$(Mn,Fe,Ca,Mg)_3(PO_4)_2$
chursinite	$Hg_3(AsO_4)_3$.
farringtonite	$Mg_3(PO_4)_2$
graftonite	$(Fe,Mn,Ca)_3(PO_4)_2$

Synthetic $(Fe_{1-x}Me_x)_3(PO_4)_2$: cation distributions, Mössbauer, **AG Nord T Ericsson** 1982 ZK 161 209-24.
Synthetic $CdZn_2(PO_4)_2$ & $Cd_2Zn(PO_4)_2$: **C Calvo JS Stephens** 1968 Can J Chem 46 903-15.
Synthetic $Cd_3(AsO_4)_2$: **G Engel WE Klee** 1970 ZK 132 332-39.
Synthetic $Hg_3(PO_4)_2$: **K Aurivillius BA Nilsson** 1974 ZK 141 1-10.
Synthetic gamma-$Zn_2Co(PO_4)_2$ & $Zn_{1.5}Co_{1.5}(PO_4)_2$: **AG Nord** 1984 AC B40 191-4.
Synthetic $(Co,Fe)_3(PO_4)_2$: **AG Nord & 4 others** 1985 Chem Scripta 25 189-93 = MA 87M/3986.
Synthetic CoCu phosphates: **CE Bamberger ED Specht LM Anovitz** 1998 JACeS 81 2799-804 (B1865).
graftonite $(Fe,Mn,Ca)_3(PO_4)_2$. *Graftonite* structure type. See *grattarolaite*.
Structure: **C Calvo** 1968 AM 53 742-50;
AG Nord T Ericsson 1982 AM 67 826-32.
Occurrence: intergrown *wolfeite,* Gamsberg, S Afr, **M Stalder A Rozendaal** 2002 MM 66 915-27.
In meteorites: **AE Rubin** 1997 MPS 32 231-47;
13 phosphates in IIIAB irons, **EJ Olsen & 5 others** 1999 MPS 34 285-300 (210).
Synthetic $Fe_3(PO_4)_2$: **E Kostiner JR Rea** 1974 IC 13 2876-83.
gramaccioliite-Y $(Pb,Sr)(Y,Mn)(Ti,Fe)_{18}Fe_2O_{38}$. *Crichtonite* group.
Occurrence & SC-XRD structure: **P Orlandi & 5 others** 2004 EJM 16 171-5 (10139).
grandidierite $(Mg,Fe)Al_3(BO_4)(SiO_4)O$. Analog of **ominelite** $(Fe,Mg)Al_3BSiO_9$.
Structure: **DA Stephenson PB Moore** 1968 AC B24 1518-22 (S294).

MAS-NMR of penta Mg: **KJD MacKenzie RH Meinhold** 1997 AM 82 479-82.
Fe K-edge XAS of Fe(II): **F Farges** 2001 PCM 28 619-29 (3467).
Optical spectra for ferrous Fe: **GR Rossman MN Taran** 2001 AM 86 896-903.

grandreefite $Pb_2SO_4F_2$.

Structure: **AR Kampf** 1991 AM 76 278-82.
Isostructural with $La_2SO_4O_2$.
Occurrence: **AR Kampf PJ Dunn EE Foord** 1989 AM 74 927-33.

grantsite $Na_4CaV^{4+}{}_2V^{5+}{}_{10}O_{32}.8aq$.

Vanadium bronze structure group; *hewettite* subgroup.
Review: **HT Evans Jr JM Hughes** 1990 AM 75 508-21.
Structure: **HT Evans Jr JM Hughes** 1965 AM 50 8-21.
Occurrence: MM 33 1135.

graphite C. Polymorphic with *diamond* & *lonsdaleite.*

Low-P form that goes into disordered diamond-lonsdaleite when shocked to high P.
Structure: early papers not listed;
H Lipson AR Stokes 1942 Proc R Soc London A181 101-5;
T Anno CA Coulson 1961 Proc R Soc London A264 165-75;
S Ergun 1973 Nature Phys Sci 241 65-7 = MA 74-925;
ND, **P Trucano R Chen** 1975 N 258 136-7;
R Chen P Trucano RF Stewart 1977 AC A33 823-8;
thermal motion at 300K, **R Chen P Trucano** 1978 AC A34 979-82;
layer sequences, ED natural, **NV Trubkin MI Novgorodova** 1995 CrR 41 982-7 (T502);
XRPD, **JY Howe & 3 others** 2003 PD 18 150-4 (9061).
AFM: **SAC Gould K Burke PK Hansma** 1989 PRB 40 5363-6 (383);
growth spirals: **J Rakovan JA Jaszczak** 2002 AM 87 17-24.
XRD/TEM of natural polycrystalline recovered from high P: **S Endo & 4 others** 1994 PRB 49 22-7 (E419).
Cubic graphite, alternative form of diamond: **TG Shumilova GN Kablis EV Pushkarev** 2002 DES 387 958-61 (7997).
Hydrothermal during metamorphism & gold mineralization: **IK Pitcairn & 3 others** 2005 JGSL 162 429-32 (11032).
In meteorites: **AE Rubin** 1997 MPS 32 231-47;
metal-associated, primitive chondrites, **S Mostefaoul & 3 others** 2000 GCA 64 1945-64;
ferromagnetic nodule, Canyon Diablo, **JMD Coey & 4 others** 2002 N 420 156-9 (8375);
from supernovae, **TK Croat & 4 others** 2003 GCA 67 4705-26;
xenoliths in Krymka LL3.1 chondrite, **VP Semenenko & 2 others** 2004 GCA 455-75 (9897).
Synthetic carbon micro-trees: **PM Ajayan et al** 2000 N 404 243 (1396).
Review of physical properties, intercalation compounds, exfoliated form, activated form, fibers & oxidation protection: **DDL Chung** 2002 JMS 37 1475-89 (7176).

gratonite $Pb_9As_4S_{15}$.

Structure: **H Rösch** 1963 NJMA 99 307-37;
B Ribár W Nowacki 1969 ZK 128 321-38 (R175).
Occurrence: MM 25 630;
DHM Alderton D Mitchell R Giddens 1995 MM 59 573-4.

grattarolaite Fe_3PO_7. Related to *graftonite*.

Structure: *synthetic*, **A Modaressi & 4 others** 1983 JSSC 47 245-55.
Occurrence, XRPD, TEM: **C Cipriani & 3 others** 1997 EJM 9 1101-6 (C987).

graulichite-Ce $CeFe^{3+}{}_3(AsO_4)_2(OH)_6$. *Crandallite* mineral group; *alunite* structure type.

Occurrence & structure: **F Hatert & 3 others** 2003 EJM 15 733-9 (9318).

gravegliaite $MnSO_3.3aq$.

Structure: **R Basso G Lucchetti A Palenzona** 1991 ZK 197 97-106 (B1098).

grayite $(Th,Pb,Ca)PO_4.aq$. *Rhabdophane* mineral group.

Structure determination not found.
Occurrence: MM 31 962;
JR Dooley Jr JC Hathaway 1961 US Geol Surv Prof Paper 424-C 339-41;
MA 96M/2142.

grechishchevite $Hg_3S_2(Br,Cl,I)_2$.

Structure determination not found.
Possible tetragonal polymorph of *arzakite*.
Occurrence: **VI Vasil'ev LV Usova NA Pal'chik** 1989 Geol Geofis 7 61 = AM 76 1729.

green rust $Fe^{2+}_4Fe^{3+}_2SO_4(OH)_{12}.3aq$.

Description: **HFW Taylor** 1973 MM 39 377-89 (T186);
Z Karim 1986 SSSAJ 50 247-50.
Occurrence: & matching XRPD with *carrboydite*/*hydrohonessite*/*mountkeithite*/*unnamed NiAl sulfate*, **EH Nickel JE Wildman** 1981 MM 44 333-7;
with *siderite*, bacterially-reduced anoxic sediments, Seine estuary, France, ^{57}Fe Mössbauer/microRaman, comparison with *synthetics*: **A Boughriet & 3 others** 1997 JCSF 93 3209-15 (B1672).
As(V) adsorption, surface complexes, EXAFS: **SR Randall & 2 others** 2001 GCA 65 1015-23 (1644).
Abiotic reduction of chlorinated ethylenes: **W Lee B Batchelor** 2002 EST 36 5348-54 (8532).
See *fougerite*.

greenalite $(Fe^{2+},Fe^{3+})_{2-3}Si_2O_5(OH)_4$. *Kaolinite-serpentine* structure group.

Structure: **S Guggenheim & 3 others** 1982 CM 20 1-18 (G426);
modulated, **S Guggenheim RA Eggleton** 1998 CM 36 163-79.
Occurrence: MA 15-22.

greenockite CdS. Dimorphic with *hawleyite*. *Wurtzite-2H* structure type.
Structure: *synthetic*, **FG Smith** 1955 AM 40 696-7;
synthetic, **AW Stevenson M Milanko Z Barnea** 1984 AC B40 521-30.
Occurrence, *wurtzite-greenockite*: **CS Hurlbut Jr** 1957 AM 42 184-90.

gregoryite $(Na_2,K_2,Ca)CO_3$.

Structure determination not found.
Occurrence: **J Gittins D McKie** 1980 Li 13 213-5 (G734) = AM 66 879;
AA Church AP Jones 1995 JP 36 869-89 = AM 81 517.

greifensteinite $Ca_2Be_4(Fe,Mn)_5(PO_4)_6(OH)_4.6aq$.

Analog of *roscherite* (Mn,Fe) & *zanazzite* (Mg).
Occurrence & SC-XRD structure: **NV Chukanov & 3 others** 2002 ZVMO 31 47-52.

greigite **(**$Fe^{2+},Fe^{3+})_3S_4$. *Spinel* structure type; *linnaeite* mineral group.

See *smythite*.
Occurrence: **BJ Skinner RC Erd FS Grimaldi** 1964 AM 49 543-55;
SA Williams 1968 AM 53 2087-8;
pedogenesis, MA 95M/1307.
Magnetism: **AP Roberts** 1995 EPSL 134 227-36 = MA 96M/2470.
Transformation from *mackinawite*, XRPD and TEM: **AR Lennie & 5 others** 1997 AM 82 302-9.
Biogenic in soil: **H Stanjek & 4 others** 1994 Eur J Soil Sci 45 97-103 (S1855);
anisotropic XR peak broadening, **H Stanjek J Schneider** 2000 AM 85 839-46.
Magnetism/microstructure/composition in magnetotactic bacteria: **T Kasama & 6 others** 2006 AM 91 1216-29.
Persistence of *mackinawite* to 393 K when anoxic, oxic transformation to greigite/*pyrite*/*magnetite*/*goethite*, time-resolved XRD: **CL Cahill & 3 others** 2000 ChG 167 53-63 (C1145).
Transformation of FeS to greigite or *pyrite* affected by aldehyde: **D Rickard IB Butler A Oldroyd** 2001 EPSL 189 85-91 (2102).
Oxidation of *mackinawite* to greigite + S then to *magnetite* + S: **S Boursiquot & 4 others** 2001 PCM 28 600-11(3468).
Phase relations: **CI Dell** 1972 AM 57 1303-4.
In meteorites: **AE Rubin** 1997 MPS32 231-47.

grechishchevite $Hg_3S_2(Br,Cl,I)_2$

Occurrence: **VI Vasil'ev** 1989 Sov Geol Geophys 7 61-8.
Synthetic polymorph: SC-XRD structure, **NV Pervukhina & 4 others** 2003 CM 41 1445-53.

greifensteinite $Ca_2Be_4(Fe,Mn)_5(PO_4)_6(OH)_4.6aq$. *Roscherite* group.

Structure: **RK Rastvetaeva & 2 others** 2002 Dokl Chem 383 78-81;
Zn-bearing, SC-XRD, **AA Barinova & 3 others** 2004 CrR 49 942-5 (10961).
Occurrence:**NV chukanov & 3 others** 2002 ZVMO 131 47-52.

grenmarite $(Zr,Mn)_2(Zr,Ti)(Mn,Na)(Na,Ca)_4(Si_2O_7)_2(O,F)_4$. Isostructural with *seidozerite.*

Occurrence & SC-XRD structure: **M Bellezza & 4 others** 2004 EJM 16 971-8.

griceite LiF. *Halite* structure type.

Occurrence: **J Van Velthuizen GY Chao** 1989 CM 27 125-7.

grimaldite (Cr,Al)O(OH). Isostructural with *heterogenite* CoOOH.

$NaHF_2$ structure topology. Matches *synthetic* CrOOH.

Occurrence: **C Milton et al** 1976 US Geol Surv Prof Paper 887 1-29 = AM 62 593.

grimselite $K_3Na(UO_2)(CO_3)_3.aq$.

Structure: **Y Li PC Burns** 2001 CM 39 1147-51 (2014).

Enthalpy of formation: **K Kubatko & 3 others** 2005 AM 90 1284-90.

Occurrence: MM 38 992.

Synthetic $K_3Na(UO_2)(CO_3)_3$: **F Mazzi F Rinaldi** 1961 PMR 30 1-20 (M1245).

Synthetic $K_3UO_2(CO_3)_3$: **A Anderson & 3 others** 1980 Can J Chem 58 1651-8.

Synthetic $(NH_4)_4(UO_2)(CO_3)_3$: **R Grazioni G Bombieri E Forsellini** 1972 JCSD 2059-61.

Synthetic $Rb_3Na(UO_2)(CO_3)_3.0.5aq$: **KHKubatko PC Burns** 2004 ACC 60 i25-5 (10341).

griphite $Na_4Ca_6(Mn\ Fe,Mg)_{19}Li_2Al_8(PO_4)_{24}(F,OH)_8$. Not a *garnetoid*.

Structure: **R Rinaldi** 1978 BM 101 543-7.

grischunite $\sim NaCa_2Mn_2[Fe,Mn]Mn_2(AsO_4)_6.2aq$. .

Isostructural *bederite* $Ca_2Mn_2Fe_2Mn_2(PO_4)_6.2aq$ &

wicksite $NaCa_2(Fe,Mn)_4MgFe^{3+}(PO_4)_6.2aq$.

Structure: **R Bianchi T Pilati G Mannucci** 1987 AM 72 1225-9.

grossite $CaAl_4O_7$. 2,3-vertex-connected tetrahedral net. See *hibonite & mayenite.*

Structure: *synthetic*, **ER Boyko L Wisnyi** 1958 AC 11 444-5 (B1300).

New mineral: **D Weber A Bischoff** 1994 EJM 6 591-4 (W638).

Oxygen triclusters, ^{17}O MAS-NMR: **JF Stebbins JV Oglesby S Kroeker** 2001 AM 86 1307-11.

Occurrence in chondritic meteorites: MA 95M/1964.

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

[Natural $CaAlO_4$: ***unnamed mineral*** from CH chondrite Northwest Africa 470 **MA Ivanova & 5 others** 2002 MPS 37 1337-44.]

grossular $Ca_3Al_2Si_3O_{12}$. *Garnet* structure type.

Structure: **W Prandl** 1966 ZK 123 81-116;
GA Novak GV Gibbs 1971 AM 56 791-825;
EP Meagher 1975 AM 60 218-28;
RM Hazen LW Finger 1978 AM 63 297-303 (H506);
GA Lager GR Rossman FJ Rotella AJ Schultz 1987 AM 72 766-8;
SC-XRD at 100, 293 & 525 K & IR, **CA Geiger T Armbruster** 1997 AM 82 740-7;
100 - 600K, **U Dodehorst CA Geiger T Armsbruster** 2002 AM 87 542-9.

Al XANES: **A Mottana & 4 others** 19977 AM 82 497-502.

Synthetic pyrope-grossular series, XRPD 20-295 K: **A Bosenick CA Geiger** 1997 JGR B10 22649-57 (B1715).

Mn(III) & red color: **CA Geiger A Stahl GR Rossman** 1999 EJM 11 1109-13 (G1181).

Mn-grossular: **GA Novak GV Gibbs** 1971 AM 56 791-825.

Fe-grossular (*hessonite*): neutron, **G Pieper & 3 others** 1983 NJMA 147 147-59 (P552).

SC-XRD, hydrostatic compression to 15 GPa: **L Zhang & 3 others** 1999 PCM 27 52-8 (Z217).

High-P transformation to Ca analog of $MgSiO_3$ *perovskite*: **H Yusa & 2 others** 1995 PEPI 92 25-31 (Y165).

Ca self-diffusion: **CS Schwandt RT Cygan HR Westrich** 1996 AM 81 448-51.

H extraction & deuteration: **A Kurka M Blanchard J Ingrin** 2005 MM 69 359-72.

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

groutellite $Mn^{4+}Mn^{3+}O_3OH$. Related to *ramsdellite*.

Structure: N & XRPD, & dehydration, **JE Post PJ Heaney** 2004 AM 89 969-75.

groutite $Mn^{3+}O(OH)$. *Diaspore* structure group.

Structure: **RL Collin WN Lipscomb** 1949 AC 2 104-6;
LS Dent-Glasser L Ingram 1968 AC B24 1233-6;
solid solution with *goethite*, XRPD structure, Mn/Fe XAFS: **AC Scheinost & 4 others** 2001 AM 86 139-46.

Occurrence: MM 27 269.
Sb-substituted: AM 52 859-60.
[grovesite $(Mn,Mg,Al)_3(Si,Al))_2(O,OH)_9$.
Chlorite-like, but relation to *pennantite* is unclear: see *kellyite*.
Occurrence: **FA Bannister MH Hey W Campbell Smith** 1955 MM 30 645-7.]
grumantite $NaSi_2O_4OH.aq$. Spiral Si_2O_5OH chain.
Structure: **NA Yamnova & 4 others** 1989 SPD 34 284-5 (Y117) = MA 89M/0199.
Occurrence: MM 52 725.
See *kanemite* $NaHSi_2O_4(OH)_2.2aq$, *natrosilite* $Na_2Si_2O_5$, *makatite* $Na_2Si_4O_6(OH)_5]_2.4aq$ &
revdite $Na_{16}[SO_{15}(OH)_6](OH)_{10}.28aq$.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
grumiplucite $HgBi_2S_4$.
Matches *synthetic*, structure: **WG Mumme JA Watts** 1980 AC B36 1300-4.
Occurrence, XRD & OD character: **P Orlandi A Dini F Olmi** 1998 CM 36 1321-6.
grunerite $(Fe,Mg)_7Si_8O_{22}(OH)_2$.
Amphibole structure group; monoclinic subtype; series with *cummingtonite*.
Structure: **S Ghose E Hellner** 1959 JG 67 691-701 (G55);
LW Finger 1969 MSA Spec Publ 2 95-100 (F124);
magnetic order, **S Ghose DE Cox N Van Dang** 1987 PCM 14 36-44;
composition ordering in series with *cummingtonite*, **M Hirschmann BW Evans H Tang** 1994 AM 79 862-77.
gruzdevite $Cu_6Hg_3Sb_4S_{12}$. *Nowackiite* structure group.
Isotypic with *aktashite* $Cu_6Hg_3As_4S_{12}$.
Structure determination not found.
Occurrence: **EP Spiridonov et al** 1982 DAN SSSR 261 971-6 = AM 67 855.
guanajuatite $Bi_2(Se,S)_3$. *Stibnite* structure type. Dimorphic with *paraguanajuatite*.
Isostructural with *aikinite, bismuthinite & stibnite*.
Synthetic Bi_2Se_3-II: **EY Atabaeva SA Mahkov SV Popova** 1973 SPC 18 104-5.
guanglinite Pd_3As. Structure determination not found.
XRPD similar to *synthetic* Pd_3As: **Baini et al** 1974 Can J Chem 42 620-9.
Occurrence: **T Yu & 4 others** 1974 Acta Geol Sin 2 202-18 = AM 61 184;
Z Peng C Chang L Ximen 1978 Acta Geol Sinica 326-36 = AM 65 408
(commentary: match with *isomertierite* is seriously questioned).
guanine $C_5H_3(NH_2)N_4O$. [jvs Presumably matches *synthetic*.]
Structure determination not found.
Occurrence: **PJ Bridge** 1973 MM 39 467-9 & 1974 39 889-90.
guarinoite $(Zn,Co,Ni)_6(SO_4)(OH,Cl)_{10}.5aq$.
Compare with *theresemanganite* $(Co,Zn,Ni)_6(SO_4)(OH,Cl)_{10}.8aq$.
Structure determination not found.
Occurrence: **H Sarp** 1993 Archives des Sciences 46 37-44 = AM 78 1314-5.
guayanaite CrOOH. Isostructural with InOOH.
Occurrence: MM 36 1151.
gudkovaite-Mn $CaK_2Mn(Ti,Nb)_4(Si_4O_{12})_2(O,OH)_4.5aq$. *Labuntsovite* mineral group.
Occurrence & SC-XRD structure: **IV Pekov & 4 others** 2002 ZVMO 51-5 (8771).
gudmundite FeSbS. *Arsenopyrite* structure group.
Structure: **MJ Buerger** 1939 ZK 101 290-316 (B1301).
Occurrence: MM 22 620.
Gudmundite-*antimony* mineralization, Quebec ophiolite: **C Normand M Gauthier M Jebrak** 1996
EcG 91 149-63 (N408).
guerinite $Ca_5H_2(AsO_4)_4.9aq$. Dimorphic with *ferrarisite*.
Structure: **M Catti G Ferraris** 1974 AC B30 1789-94 (C744A).
Occurrence: MM 33 1135; AM 66 365-91.
See *picropharmacolite*.
guettardite $Pb(Sb,As)_2S_4$. Dimorphic with *twinnite*. See *boulangerite*.

Structure determination not found.
Occurrence: **JL Jambor** 1967 CM 9 191-213.

gugiaite $Ca_2BeSi_2O_7$. *Melilite* structure type.

Structure: *synthetic*, **M Kimata M Ohashi** 1982 NJMA 143 210-22 (K748);
natural, XRPD, **Z Yang & 4others** 2001 NJMM 186-92 (2000).
Occurrence: MM 33 1136.

guildite $CuFe(SO_4)_2OH.4aq$. Review: **Sabelli** p.15.

Structure: **C Wan S Ghose GR Rossman** 1978 AM 63 478-83.
Compare *chaidamuite*.
Occurrence: MM 21 565.

guilleminite $Ba(UO_2)_3(SeO_3)_2O_23aq$.

Sheet structure with topological resemblance to *phosphuranylite*.
Same sheet as *marthozite* $Cu(UO_2)_3(SeO_3)_2O_2.8aq$, different interlayer.
Review: **PC Burns ML Miller RC Ewing** 1996 CM 34 845-80.
Structure: **MA Cooper FC Hawthorne** 1995 CM 33 1103-9.
Occurrence: **R Pierrot J Toussaint T Verbeek** 1965 BSFMC 88 132-5.

[**gunnbjarnite** = *Fe-sepiolite*.
Occurrence, MM 29 983;
Lovozero, **VN Chukanova & 3 others** 2002 GI 40 1225-9 (8750).]

gunningite $(Zn,Mn)SO_4.aq$. *Kieserite* structure type. Review: **Sabelli** p. 32.

Structure: **JL Jambor RW Boyle** 1962 CM 7 209-18;
Y Le Fur J Coing-Boyat G Bassi 1966 CRASP C262 632-5.
Occurrence: MM 33 1136.
Synthetic Zn-: **M Wildner G Giester** 1991 NJMM 296-306.

gupeiite Fe_3Si.

Matches *synthetic* Fe_3Si-alpha-prime: PDF 11-616.
Occurrence: AM 71 228 = MM 50 747.
[jvs: check whether is a *taenite* type with interstitial Si.]

gustavite $PbAgBi_3S_6$. *Lillianite* homologous series, subtype 4,4.

Structure determination not found.
Occurrence: **S Karup-Møller** 1970 CM 10 174-90.
Gustavite-*pavonite* intergrowth: **S Karup-Møller E Makovicky** 1979 NJMA 102 351-67 (K689).

gutkovaite-Mn $CaK_2Mn(Ti,Nb)_4(Si_4O_{12})_2(O,OH)_4.5aq$. *Labuntsovite* group.

Occurrence & SC-XRD structure: **IV Pekov & 4 others** 2002 ZVMO 131 51-7.

gutsevichite $?(Al,Fe)_3(P/VO_4)_2(OH)_3.8aq$.

Structure determination not found.
Occurrence: **EA Ankinovich** 1961 ZVMO 90 104 = AM 46 1200 [jvs: inadequate description].

guyanaite (Cr,Fe,Al)OOH. Trimorphic with *bracewellite* & *grimaldite*.
InO(OH) structure type.
Occurrence: **C Milton & 4 others** 1976 US Geol Survey Prof Paper 887 1-29 = AM 62 593.

gwihabaite $(NH_4,K)NO_3$.

Occurrence & XRD: **JEJ Martini** 1996 Bull S African Speleological Assoc 36 19-21 = AM 84 194.

GYPSUM STRUCTURE GROUP Includes:

brushite	$CaHPO_4.2aq$
churchite	$YPO_4.2aq$
gypsum	$CaSO_4.2aq$
pharmacolite	$CaHAsO_4.2aq$

Brushite is commonly called *weinschenkite*.
Brushite & pharmacolite structures perturbed by hydrogen bonding.
Related to *rapidcreekite* structure by twin geometry.

gypsum $CaSO_4.2aq$. Gypsum structure group. Review: Sabelli p.29.

Structure: neutron, **M Atoji RE Rundle** 1958 J Chem Phys 29 1306-11 = MA 16- 613;
neutron, **WA Denne DW Jones** 1969 ZK 130 314-7;

WF Cole CJ Lancucki 1974 AC B20 921-9
BF Pedersen D Semmingsen 1982 AC B38 1074-7;
inelastic neutron scatter, dynamics molecular water, **B Winkler B Hennion** 1994 PCM 21 539-45;
neutron PD, deuterated, 4-320 K, **PF Schofield KS Knight IC Stretton** 1996 AM 81 847-51;
do, static compressibility to 5.4 GPa, **IC Stretton & 3 others** 1997 GRL 24 1267-70 (S1692);
SC-ND, 50/115/200 K, **PF Schofield & 3 others** 2000 ZK 215 707-10 (992);
IR, Raman <21 GPa 300 K, **E Knittle W Phillips Q Williams** 2001 PCM 28 630-40;
SC-XRD vs XRPD identification, **AG de la Torre & 4 others** 2004 PD 19 240-6 (10631).
Dehydration: micro-Raman **PSR Prasad A Pradhan TN Gowd** 2001 CuS 80 1203-5 (G2103);
9-373 K, **CH Chio SK Sharma DW Muenow** 2004 AM 89 390-5;
300-430 K, FTIR, direct formation of *anhydrite*, **PSR Prasad & 3 others** 2005 AM 90 672-8;
298-403 K, hydrothermal AFM on (010), **G Jordan JM Astilleros** 2006 AM 619-27.
Occurrence in fertilizers: **JR Lehr & 4 others** 1966 *Crystallographic Properties of Fertilizer Compounds*, Tenn Valley Auth Chem Eng Bull 6, 163p (L758).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Cathodoluminescence Eu- *synthetic*: **F Cesbron & 3 others** 1997 CRASP 324 IIa 353-60 (C900).
Controlled dehydration: **E Badens & 6 others** 1998 JSSC 139 37-44 (B1843).
Synthetic $CaSeO_4.2aq$: **RR Krüger W Abriel** 1991 AC C47 1958-9 (K758).

gyrolite $NaCa_{16}Si_{23}AlO_{60}(OH)_8.14\ aq.$
Structurally related to *minehillite*, *reyerite* & *truscottite.*
Structure: **PJ Dunn & 3 others** 1984 AM 69 1150-5;
S Merlino 1988 MM 52 377-87 (M1036).
Early papers ignored because of confused crystallographic data.
Phase relations of *gyrolite*, *tobermorite* & *xonotlite*: **SG Zürn KT Fehr** 1997 EJM Suppl 9-1 406 (Z139).
Hydrothermal *synthesis* from Ca silicate glass: **N Yamaguchi & 4 others** 2001 JMSL 20 489-90 (2104).
Hydrothermal *synthesis* $Ca_8Si_{12}O_{30}(OH)_4.7\ aq$, XRPD: **S Shaw & 2others** 2002 AM 87 533-41.
Synthetic Zn-: IR, XRD structure, TG, **G krassimir & 3 others** 2004 EJM 16 43 (10638).
Occurrence of Al-free at Lizard, Cornwall: **NJ Elton JJ Hooper VAD Holyer** 1998 MM 62 271-2.

gysinite-(Nd) $Pb(Nd,La)(CO_3)_2(OH).aq.$ Isotypic with Sr analog *ancylite*.
Structure: **B Chabot H Sarp** 1985 ZK 171 155-8.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
Occurrence: Harz, MA 96M/4937.

haapalaite $(Fe,Ni)_4Mg_3S_4(OH)_6$. *Valleriite* structure type.
Structure determination not found.
Occurrence: **M Huhma et al** 1973 Bull Geol Soc Finlande 45 103-6 = AM 58 1111-2.
In meteorites (complex formula): **AE Rubin** 1997 MPS 32 231-47.

hackmanite S-bearing *sodalite*.
Structure: **RC Peterson** 1983 CM 21 549-52.

[haematophanite $Pb(Cl,OH)_2.4PbO.2Fe_2O_3$.
Occurrence: MM 22 621.]

hafnon $(Hf,Zr)SiO_4$. *Zircon* structure type.
Structure: *synthetic*, **JA Speer BJ Cooper** 1982 AM 87 804-8.
Heavy-ion irradiation/decomposition/amorphization/recrystallization: **A Meldrum & 3 others** 1999 PRB 59 3981-6.
Free energy of formation: **HStC O-Neil** 2006 AM 91 1134-41.
Occurrence: MM 40 907.

hagendorfite $(Na,Ca)Mn(Fe,Mg)_2(PO_4)_3$. *Alluardite* structure group.
Structure determination not found.
Occurrence: **H Strunz** 1954 NJMM 252-5;
PB Moore J Ito 1979 MM 43 227-35.

haggertyite $\sim BaMgFe_2Ti_5Fe_4O_{19}$. *Magnetoplumbite* structure type.
Occurrence & structure: **IE Grey D Velde AJ Criddle** 1998 AM 83 1323-9.
Paragenesis in lamproite: **D Velde** 2000 AM 85 420-9.

häggite $V_2O_2(OH)_3$.
Double-edge-sharing octahedral chains sharing vertices with octahedra.

Compare with *doloresite*.
Occurrence & structure: **HT Evans Jr ME Mrose** 1958 AC 11 56-8 (E308);
HT Evans Jr ME Mrose 1960 AM 45 1144-66.

haidingerite $CaH(AsO_4).aq$.

Structure: **M Cassien P Herpin F Permingeat** 1966 BSFMC 89 18-22;
H Binas 1966 ZaaC 347 133-9 = MA 72-1854;
M Calleri G Ferraris 1967 PM 36 1-23 = MA 19-16;
ND, **G Ferraris DW Jones J Yerkes** 1972 AC B28 209-14 (F447).

haigerachite $KFe_3(H_2PO_4)_6(HPO_4)_2.4aq$

Description, XRPD analogy with *synthetic*: **K Walenta T Theye** 1999 Aufschluss 50 1-7 = AM 85 263-4.

haineaultite $(Na,Ca)_5Ca(Ti,Nb)_5(Si,S)_{12}O_{34}(OH,F)_8.5aq$. Related to *zorite* $Na_3(Ti,Al)_2Si_4(O,OH)_{14}.3aq$ & *chivrualite* $Ca_4(Ti,Nb)_5(Si_6O_{17})_2[(OH,O)_5].13\text{-}14aq$.

Occurrence & SC-XRD structure: **AM McDonald GY Chao** 2004 CM 42 769-80.

hainite *simplified* $Na_2Ca_5(Ti,Zr,Mn,Fe,Nb,Ta)(Si_2O_7)_2F_2(OH)_2$.

Isostructural *götzenite* or *giannetite* in the *mosandrite* or *rinkite* structure groups, still ill-defined.
Occurrence & SC-XRD structure: **D Atencio & 5 others** 1999 CM 37 91-8.
New data but no structure determination: **Z Johan F Cech** 1989 CRASP 308 II 1237-42.

haiweeite $Ca(UO_2)_2Si_6O_{15}.5aq$. *Weeksite* mineral group.

Structure: wrong cell, **RK Rastsvetaeva & 4 others** 1997 CrR 42 927-33 (R810);
correct cell, **P Burns** 2001 CM 39 1153-60 (2013).
Occurrence: **TC McBurney J Murdoch** 1959 AM 44 839-43;
cell dimensions, **M Jimenénez de Abeledo & 3 others** 1960 AM 45 1078-86;
FV Stohl DK Smith 1981 AM 66 610-25.

hakite $(Cu,Hg)_{12}Sb_4(Se,S)_{13}$. *Tetrahedrite* structure group.

Structure determination not found.
Solid solution with *mercurian giraudite*: **H Forster D Rhede G Tischendorf** 2002 CM 40 1161-70.
Occurrence: MM 38 992;
Z Johan M Kvacek 1972 BSFMC 94 45-8 = AM 57 1553-7.

[halagurite Tentative $FeMnSi_2O_6$ *orthopyroxene*: IMA Pisa p.140.]

håleniusite-La (La,Ce)OF. Isostructural with *fluorite*.
Occurrence & XRPD structure: **D Holtstam J Grins PNysten** 2004 CM 42 1097-103.

HALITE STRUCTURE GROUP Includes:

bunsenite	NiO	
carobbiite	KF	
griceite	LiF	
halite	NaCl	
hongquiite	TiO	disordered defects
khamrabaevite	TiC	
lime	CaO	
manganosite	MnO	
monteponite	CdO	
murdochite	$PbCu_6(O,Cl,Br)_8$	defect halite structure type
oldhamite	CaS	
osbornite	TiN	
periclase	MgO	
sylvite	KCl	
tantalum carbide	TaC	
villiaumite	NaF	
wüstite	FeO	

There are many derivatives, e. g.:

crerarite	$(Pt,Pb)Bi_3(Se,S)_{4-x}$

Synthetic $CoLiO_2$ ordered superstructure, **HJ Orman PJ Wiseman** 1984 AC C40 12-4 (O283).
Synthetic (Ca,Th)(N,O) & (Sr,Th)(N,O): **NE Brese FJ DiSalvo** 1995 JSSC 120 372-7 (B1442).
P transformation of *zinc blende* to halite type: **S Desgreniers L Beaulieu I Lepage** 2000 PRB 61 8726-33 (D796).

Double-cell-a,b,2c, number of substitution/vacancy derivatives: **I Sens U Müller** 2002 ZaaC 629 487-92 (8592).

halite NaCl. Halite structure type.

High-P, 3 GPa: **LW Finger H King** 1978 AM 63 337-42.

Structure: atomic displacements, **CJ Martin DA O'Connor** 1978 A34 505-12;
electron density, 1989 AC A45 112
thickness vs order of water layer at (100) surface, **J Arsic & 6 others** 2004 J Chem Phys 120 9720-4 (10314).

Pb(II) effect on crystal growth: **N Kubota H & 4 others** 2000 JCG 220 135-9 (H322).

Thermoelasticity: -*sylvite*, **D Walker & 5 others** 2004 AM 89 204-10.

Dissolution/precipitation on silica interfaces: **G Jordan & 3 others** 2005 EJM 17 399-410.

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

hallimondite $Pb_2(UO_2)(AsO_4)_2.n\ aq$.

Isostructural with P analog *parsonsite*.

Structure: **AJ Locock PC Burns TM Flynn** 2005 AM 90 240-6.

Occurrence: MM 32 989-90;
K Walenta 1965 AM 50 1143-57.

halloysite $Al_2Si_2O_5(OH)_4$. *Kaolinite-serpentine* structure group.

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

Structure: **GB Mitra S Bhattacherjee** 1975 AC B31 2851-7;
Fourier transform Raman, **RL Frost** ClClM 43 1191-5.

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

1 to 0.7 nm transition I Costa Rica soil: **CQ Kautz PC Ryan** 2003 ClClM 51 252-63.

Morphology, weathered *illite* in *kaolinite*: TEM, **GY Jeong & 3 others** 2003 NJMM 421-32 (9574).

Potassium acetate & urea intercalation, heating to 573 K & cooling, change of OH surface, Raman & XRPD: **RL Frost J Kristof** 1997 ClClM 45 551-63;
RL Frost & 3 others 2000 AM 85 1735-43.

K-selective halloysite-rich volcanic soil: **T Takahashi & 4 others** 2001 SSSAJ 65 516-26 (1604).

HALOTRICHITE STRUCTURE GROUP Includes:

apjohnite	$MnAl_2(SO_4)_4.22aq$
bilinite	$FeFe_2(SO_4)_4.22aq$
dietrichite	$ZnAl_2(SO_4)_4.22aq$
halotrichite	$FeAl_2(SO_4)_4.22aq$
pickeringite	$MgAl_2(SO_4)_4.22aq$
redingtonite	$(Fe,Mg,Ni)(Cr,Al)_2(SO_4)_4.22aq$
wupatkite	$CoAl_2(SO_4)_4.22aq$

Review: Sabelli.

halotrichite $FeAl_2(SO_4)_4.22aq$. *Halotrichite* structure group.

Structure: **GA Lovas** 1986 Acta Geol Hungary 29 389-98 = MA 88M/1830.

halurgite $Mg_2[B_4O_5(OH)_4]_2.aq$.

Structure determination not found.

Occurrence: MM 32 990;
VV Lovanova 1962 DAN 143 693-6 = AM 47 1217-8.

Invalid use: AM 81 1513.

hambergite $Be_2BO_3(OH,F)$.

Structure: **WH Zachariasen HA Plettinger M Marezio** 1963 AC 16 1144-6;
5 with 0.07-0.47 F, **PC Burns M Novak FC Hawthorne** 1995 CM 33 1205-13 (B1621).

hammarite $Pb_2Cu_2Bi_4S_9$. 4 *krupkaite* + 2 *aikinite*.

Structure: **H Horiuchi BJ Wuensch** 1976 CM 14 536-9;
A Pring 1989 AM 74 250-5.

hanawaltite $Hg^{1+}_6Hg^{2+}[Cl,OH]_2O_3$.

Description & crystal structure: **AC Roberts & 4 others** 1996 PD 11 45-50 (R811;
JD Grice 1999 CM 37 775-8.

hancockite $(Pb,Ca,Sr)_2(Al,Fe)_3(SiO_4)_3(OH)$. Epidote structure group.

Structure: **WA Dollase** 1971 AM 56 447-64 (D164).

hanksite $KNa_{22}(SO_4)_9(CO_3)_2Cl$. Review: **Sabelli** p. 34.

Structure: **T Araki T Zoltai** 1973 AM 58 799-80;
K Kato H Saalfeld 1972 AC B28 3614-7.

hannayite $(NH_4)_2Mg_3H_4(PO_4)_4.8aq$. Compare with *schertelite* & *struvite*.

Structure: **M Catti M Franchini-Angela** 1976 AC B32 2842-8.

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

hannebachite $CaSO_3.0.5aq$.

Structure: *synthetic*, **G Hentschel E Tillmanns W Hofmeister** 1985 NJMM 241-50 (H946).

Occurrence: MM 53 725.

hanusite Alteration product of *pectolite*. Occurrence: MM 27 269.

hapkeite Fe_2Si.

Occurrence: lunar breccia, SC-XRD structure, **M Anand & 5 others** 2004 PNAS 101 6847-51 (10275).

haradaite $SrVOSi_2O_6$.

Structure: **Y Takéuchi** 1967 MJ 5 98-123 (T375);
$(Sr_{0.9}Ba_{0.1})VOSi_2O_6$, **R Basso & 3 others** 1995 NJMM 281-8 (B1415).

Occurrence: MM 35 1135.

Synthetic $BaUSi_2O_8$, structurally related: **JR Plaisier & 4 others** 1995 ChM 7(4) 738-43 (P531).

Synthetic $SrTiOSi_2O_6$, structure: **T Berger K-J Range** 1996 ZN 51b 1099-103 (B1522).

hardystonite $Ca_2ZnSi_2O_7$. *Melilite* structure type.

Structure: **SJ Louisnathan** 1969 ZK 130 427-37 (L166);
modulated, Franklin Furnace, **L Bindi & 3 others** 2001 AM 86 747-51);
2D modulation at 18-297 K, **B Bagautdinov & 6 others** 2002 PCM 29 346-50.

Synthetic $Ca_2(Al,Zn)(Si,Al)_2O_7$: **IV Rozhdestvenskaya & 4 others** 1995 CrR 40 629-31 (R594).

harkerite $Ca_{24}Mg_8[AlSi_4(O,OH)_{16}]_2(BO_3)_8(CO_3)_8.(aq,Cl)$. Stuffed derivative of *sakhaite*.

Structure: **MP Machin G Miehe** 1976 NJMM 228-32;
G Giuseppetti F Mazzi C Tadini 1977 AM 62 263-72;
^{27}Al MAS-NMR, **PJ Dirken & 4 others** 1995 AM 80 39-45.

Occurrence: MM 28 730.

Metamorphic, Sweden: **D Holtsman J Langhof** 1995 GFF 117 151-2 = MA 96M/2060.

harmotome $(Ba,K)_{1-2}(Si,Al)_8O_{16}.6aq$. *Zeolite* mineral group.

IZA-SC code PHI. Consortium for Theoretical Frameworks tetrahedral net 24.

Structure: proposal, **RM Barrer FW Bultitude IS Kerr** 1959 JCS 521-8;
R Sadanaga F Marumo Y Takéuchi 1961 AC 14 1153-63 (S55);
R Rinaldi JJ Pluth JV Smith 1974 AC B30 2426-33;
Inelastic ND, **F Pechar H Fuess** 1983 Acta Mont 64 59-67 = CA 101:57850k;
sector twinning & proposal that space group is P1, **M Akizuki** 1985 AM 70 822-8;
IR/reflection spectroscopy, **E Stuckenschmidt H Fuess F Pechar** 1988 PCM 15 461-4;
incoherent inelastic & quasielastic neutron scattering, **E Stuckenschmidt H Fuess** 1988 Ber Bunsen-Ges Phys Chem 92 1083-9 = CA 110-29384d;
XRD 293/100 K, ND 15 K, **E Stuckenschmidt H Fuess Å Kvick** 1990 EJM 2 861-74 (S1064);
quasi-elastic neutron scattering, water motion, **R Stockmeyer** 1998 Ber Bunsen-Ges 102 623-8 = CA 128:286640s.

Low-T thermodynamics: **IE Paukov IA Belitskii YuA Kovalevskaya** 2002 GI 40 513-5 (7350).

harrisonite $Ca(Fe,Mg)_6(SiO_4)_2(PO_4)_2$. Layer structure.

Structure: **JD Grice AC Roberts** 1993 CM 31 781-5.

harstigite $Ca_6MnBe_4[SiO_4]_2[Si_2O_7]_2(OH)_2$.

Structure: **K-F Hesse G Stümpfl** 1986 ZK 177 143-8.

hartite Phyllocladane.

History, occurrence in Czech Republic.

SC&P-XRD structure: **V Bouska & 5 others** 1998 AM 83 1340-6.

hashemite $Ba(Cr,S)O_4$. *Barite* structure type.

Structure: **EN Duesler EE Ford** 1986 AM 71 1217-20;

M Pasero P Davoli 1987 AC C43 1467-9.
Occurrence: MM 48 574.
hastingsite $NaCa_2(Fe,Mg)_4Fe(Al_2Si_6)O_{22}(OH)_2$.
Amphibole structure group; monoclinic subtype.
Cl-rich: **K Makino K Tomita K Suwa** 1993 MM 57 677-85.
hastite $CoSe_2$.
Marcasite structure subgroup in marcasite supergroup. Dimorphic with *trogtalite*.
Structure determination not found.
Occurrence: **P Ramdohr M Schmitt** 1955 NJMM 133-42 (R536).
hatchite $TlPbAgAs_2S_5$. Isostructural with *wallisite* $TlPb(Cu,Ag)As_2S_5$.
Structure: **F Marumo W Nowacki** 1967 ZK 125 250-65 (M1246);
A Edenharter W Nowacki 1970 ZK 131 397-417.
hatrurite Ca_3SiO_5. Equals *alite* in cement.
Structure determination not found.
Occurrence: **S Gross** 1978 AM 63 425 = MM 42 524.
[*alite Synthetic* monoclinic Ca_3SiO_5. Equals mineral *hatrurite*.
Structure: **H O'Daniel E Hellner** 1950 NJMM 108-11;
JW Jeffrey 1952 AC 5 26-35;
WG Mumme 1995 NJMM (4) 145-60 (M1238).
May be 7 polymorphs with 4 basic structure types:
triclinic, **R Golovastikov R Matveeve NV Belov** 1975 SPC 20 441-5;
rhombohedral, **AM Il'inets Y Malinowskii NN Nevskii** 1985 SPD 30 191-2;
XRPD profile refinement, **JC Taylor LP Aldridge** 1993 PD 8 138-44.]

HAUCHECORNITE STRUCTURE GROUP includes

arsenohauchecornite	$Ni_{18}Bi_3As_{16}$	
bismutohauchecornite?	$Ni_9Bi_2S_8$	inadequate description
hauchecornite	$Ni_9Bi(Sb,Bi)S_8$	
tellurohauchecornite	Ni_9BiTeS_8	
tucekite	$Ni_9Sb_2S_8$	

hauchecornite $Ni_9Bi(Sb,Bi)S_8$. Hauchecornite structure type.
Structure: **V Kocman EW Nuffield** 1974 CM 12 269-74.
hauckite $Fe_3(Mg,Mn)_{24}Zn_{18}(SO_4)_4(CO_3)_2(OH)_{81}$.
Review: **Sabelli**, no structure.
Occurrence: **PJ Dunn DR Peacor BD Sturman** 1980 AM 65 192-5.
hauerite MnS_2. *Pyrite* structure group.
Structure: **T Chattopadhyay & 3 others** 1992 ZK 199 13-24.
hausmannite $Mn^{2+}Mn^{3+}{}_2O_4$. Tetragonal distortion of *spine*l structure.
Ferrimagnetic with Curie temperature at 42K.
Isostructural with Zn analogs *hetaerolite* & *hydrohetaerolite*.
Structure: **D Jarosch** 1987 MP 37 15-23 = MA 88M/1821;
XRPD pattern, extra detail: **KW Mandernack J Post BM Tebo** 1995 GCA 59 4393-408.
Magnetic hausmannite with 3-11 wt % Fe_2O_3: **J Gutzmer & 3 others** 1995 MM 59 703-16.
Magnetic properties vs. Fe: **V Baron & 3 others** 1998 AM 83 786-93.
Synthetic $(Mn_xAl_{1-x})_3O_4$, x 0.33-1, spinel series, magnetics & structure: **Y Nakamura & 4 others** 1995 IEEE Trans Magn 31 4154-6 = CA 124:192005d.
Low-T oxidation: **S Fritsch & 3 others** 1998 MRB 33 1185-94 (F616).
Hydrohausmannite is mixture with *feitknecki*te.
haüyne / hauyne / haüynite $(Na,Ca)_{4-8}Al_6Si_6O_{24}(SO_4,Cl)_{1-2}$. *Sodalite* structure group.
Structure: **H Saalfeld** 1961 ZK 115 132-40 (S52);
J Löhn H Schulz 1968 NJMA 3 201-10 (L183);
I Hassan H Grundy 1991 CM 29 123-30;
antiphase boundaries & clusters, MA 91M/2625;
TEM of optically isotropic & anisotropic, **H Xu DR Veblen** 1995 AM 80 87-93;

K-rich, Italy, **VG Evsyunin & 3 others** 1996 CrR 41 659-62 (E387)
orthorhombic, Italy, **NB Bolotina & 3 others** 2003 CrR 48 914-8;
phase transition & high-T-, XRPD, **I Hassan SM Antao JB Parise** 2004 MM 68 499-513.
XRPD, modulation in Laacher See: **AN Sapozknikov VG Ivanov LF Piskunova** 1996 PD 12 3-6.
Gem quality from Eifel: **L Kiefert HA Hanni** 2000 Gems & Gemology Fall 246-53 (K1279).
La Palma spinel dunite, Raman/SAED-TEM: **E Wulff-Pedersen & 7 others** 2000 AM 85 1397-405.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

hawleyite CdS-beta. *Sphalerite* structure type. Dimorphic with *greenockite*.
Structure: alpha & beta, **F Ulrich W Zachariasen** 1925 ZK 62 260-73;
WO Milligan 1934 JPC 38 797-800.
Occurrence: MM 31 961.

hawthorneite $Ba[Ti_3Cr_4Fe_4Mg]O_{19}$.
Magnetoplumbite structure type; transitional to *yimengite*.
Structure: **IE Grey IC Madsen SE Haggerty** 1987 AM 72 633-6;
SE Haggerty & 5 others 1989 AM 74 668-75.
Occurrence: MM 54 665.

haxonite $(Fe,Ni)_{23}C_6$. Analog of *isovite* $(Cr,Fe)_{23}C_6$.
Structure: **ERD Scott** 1971 N 229 61-2 = AM 59 209.
Occurrence: MM 38 992.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

haycockite $Cu_4Fe_5S_8$.
Structure: **JF Rowland SR Hall** 1975 AC B31 2105-12.
Occurrence: MM 38 992.

haynesite $(UO_2)_3(OH)_2(SeO_3)_2$. 5aq.
Structure determination not found.
Occurrence: **M Deliens P Piret** 1991 CM 29 561-4.

heazlewoodite Ni_3S_2-alpha.
Structure: **ME Fleet** 1977 AM 62 341-5;
JB Parise 1980 AC B36 1179-80.
Synthetic transformation to -beta fast-ionic conductor at 838 K: **H Fjellvåg A Andersen** 1994 Acta Chem Scand 48 290-3 = MA 97M/1361.
Synthetic, phase transition to beta: **A Kitazake A Sugaki** 2001 NJMM 41-8 (952).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

hechtsbergite $Bi_2O(OH)(VO_4)$. Iso with As analog *atelestite* & P analog *smrkovecite*.
Occurrence, XRPD & imprecise structure: **W Krause & 4 others** 1997 NJMM 6 271-87 (K997).

hectorfloresite $Na_9(IO_3)(SO_4)_4$.
Structure: **GE Ericksen & 5 others** 1989 AM 74 1207-14.

hectorite $Na_{0.3}(Mg,Li)_3Si_4O_{10}(F,OH)_2$. *Smectite* mineral group.
Structure determination not found.
Synthetic TMA-pillared: SC-XRD structure: **W Seidl J Breu** 2005 ZK 220 169-76 (11034).
Occurrence: MM 26 357; Dana.
Synthetic fluorohectorite, charge homogeneity: **J Breu & 4 others** 2001 ChM 13 4213-20 (3633);
hydration transitions, XRPD, **GJ da Silva & 3 others** 2003 PRB 67 094114 (8941).
Synthetic pillared *fluoro*-: XRD/HRTEM/EDX, **S Witkowski & 6 others** 1994 ClM 29 743-9.
XPS of Al & model: **T Ebina & 4 others** 1997 JPCB 101 1125-9 (E395).
Co-sorbed at edges: polarized EXAFS, **ML Schegel & 3 others** 1999 JCIS 215 140-5;
high/low ionic strength, EXAFS: **ML Schlegel L Charlet A Manceau** 1999 JCIS 220 392-405 (S2130).
Dissolution in acid water, AFM: **D Bosbach & 3 others** 2000 AM 85 1209-16.
Synthetic intercalated with organic cations: **Y Yan T Bein** 1993 ChM 5 905-7 (Y173).
Crystallization, monitored by SAXS & NMR: **KA Carrado & 5 others** 2000 ChM 12 3052-9 (362).
Dissolution, AFM: **BR Bickmore & 4 others** 2001 AM 86 411-23.
Epitaxial growth of Zn phyllosilicate on edges: **ML Schlegel & 4 others** 2001 GCA 65 4155-70 (3637).
Adsorption cationic dyes, trimethylammonium anchor: **S Holzheu H Hoffman** 2002 JCIS 245 16-23 (4346).
Synthesis 3D ordered intercalation compounds: **J Breu W Seidl J Senker** 2004 ZaaC 630 80-90 (9670).
Synthetic: CA 130:83704j.

hedenbergite $CaFeSi_2O_6$. *Pyroxene* structure group.
Structure: high-T, **ME Cameron & 3 others** 1973 AM 58 594-618;
AV Maslenikov VN Zaitsev 1978 ZVMO 107 113-5;
to 10 GPa, **L Zhang & 3 others** 1997 AM 82 245-58.
Magnetic order, **JMD Coey S Ghose** 1985 Solid State Comm 53/2 143-5;
properties, **E Baum & 3 others** 1997 PCM 24 294-300.
Magnesian-: Mössbauer **SG Eeckhout E De Grave** 2003 AM 88 1129-37 & 1138-44.
Nuclear forward scattering to 68 GPa: **L Zhang & 6 others** 1998 AM 84 447-53.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
hedleyite Bi_7Te_3?
Tetradymite group with triple-*c* superstructure: **P Bayliss** 1991 AM 76 257-65.
Occurrence: MM 27 270.
hedyphane $Pb_3Ca_2(AsO_4)_3Cl$. *Apatite* structure type.
Structure: **RC Rouse PJ Dunn DR Peacor** 1984 AM 69 922-7.
Hedyphane-antigorite oriented intergrowth: (H986).
heideite $(Fe,Cr)_{1+x}(Ti,Fe)_2S_4$.
[jvs: ?isostructural with *brezinaite*; *synthetic* $FeTi_2S_4$ has defect NiAs *niccolite* structure.]
Occurrence: **K Keil R Brett** 1974 AM 59 465-70.
In meteorites: **AE Rubin** 1997 MPS 32 231-47;
G Kurat & 3 others 2004 MPS 39 53-60.
heidornite $Na_2Ca_3B_5O_8(SO_4)_2Cl(OH)_2$. Review: **Sabelli** p.41.
Structure: **H Burzlaff** 1967 NJMM 157-69; MA 70-2138.
Occurrence: MM 31 961.
[heikolite correct spelling. MM 30 734.]
heinrichite $Ba(UO_2)_2(AsO_4)_2.10\text{-}12aq$. *Autunite* structure group.
Compare with *metaheinrichite* in *metaautunite* structure group.
Structure determination not found.
Occurrence: **EB Gross et al** 1958 AM 43 1134-43.
hejtmanite $Ba(Mn,Fe)_2TiO(Si_2O_7)(OH,F)_2$. Mn-dominant analog of *bafertisite*.
Structure determination not found.
Occurrence: **S Vrana M Rieder ME Gunter** 1992 EJM 4 35-43 (V218).
heliophyllite $?Pb_6As_2O_7Cl_4$.
Structure determination not found.
Occurrence: **Dana**.
HELLANDITE STRUCTURE GROUP

ciprianiite	$Ca_4[(Th,U)REE)]_2Al[(B_4Si_4O_{22})(OH)_2$
hellandite-Ce	$(Ca_3REE)_4Ce_2Al[Si_4B_4O_{22}](OH)_4$
hellandite-Y	$(Ca_3REE)_4Y_2Al[Si_4B_4O_{22}](OH)_4$
mottanaite-Ce	$Ca_4(CeCa)_2AlBe_2][(B_4Si_4O_{22})O_2$
tadzhikite-Ce	$Ca_4Ce_2Ti[(B_4Si_4O_{22})(OH)_2$

Re-definition, nomenclature & crystal chemistry: **R Oberti & 4 others** 2002 AM 87 745-52.
hellandite-Ce $(Ca_3REE)_4Ce_2Al[Si_4B_4O_{22}](OH)_4$. Hellandite structure group.
Structure: **M Mellini S Merlino** 1977 AM 62 89-99;
non-metamict Th-rich hellandite-Ce, SC-XRD, crystal chemistry of hellandite mineral group: **R Oberti & 3 others** 1999 AM 84 913-21.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
hellandite-Y $(Ca_3REE)_4Y_2Al[Si_4B_4O_{22}](OH)_4$. Hellandite structure group.
Re-definition, nomenclature & crystal chemistry: **R Oberti & 4 others** 2002 AM 87 745-52.
hellyerite $NiCO_3.6aq$.
XRPD matches *synthetic*.
Structure determination not found.
Occurrence: MM 32 960;
KL Williams IM Threadgold AW Hounslow 1959 44 533-8.

helmutwinklerite $PbZn_2(AsO_4)_2.2aq$.

Structure determination not found.

Occurrence: **G Schnorrer-Köhler** 1980 Aufschuss 31 43-9 = AM 65 1067;
MM 43 1061.

HELVITE MINERAL GROUP OF BERYLLIUM SILICATE SULFIDE WITH SODALITE STRUCTURE TYPE. Includes:

danalite	$(Fe,Mn,Zn)_4Be_3(SiO_4)_3S$
genthelvite	$(Zn,Fe,Mn)_4Be_3Si_3O_{12}S$
helvite	$Mn_4Be_3(SiO_4)_3S$

helvite $Mn_4Be_3(SiO_4)_3S$. *Sodalite* structure type.

Structure: **L Pauling** 1930 ZK 74 213-25 (P624);
WW Holloway Jr TJ Giordano DR Peacor 1972 AC B28 114-7 (H1000);
I Hassan HD Grundy 1985 AM 70 186-92;
high-P, abrupt shrinkage at 3 GPa, **Y Kudoh Y Takéuchi** 1985 ZK 173 305-12 (K417).

HEMATITE STRUCTURE GROUP Includes:

corundum	Al_2O_3
eskolaite	Cr_2O_3
hematite	Fe_2O_3
karelianite	V_2O_3

Hydrohematite has defect hematite structure with 3H replacing some Fe.

Synthetic $Mg_{3.4}Mn_{0.6}Ta_2O_9$: partial ordering, 1989 ZaaC 573 19-23.

Corundum-hematite solid solution, thermodynamics & crystal chemistry, & $FeAlO_3$ phase: **J Majzlan A Navrotsky BJ Evans** 2002 PCM 29 515-26.

hematite Fe_2O_3. Alpha polymorph. Dimorphic with *maghemite*.

Solid solution with *ilmenite*, acquires self-reversed thermoremanent magnetization important for paleomagnetism; **P Robinson & 3 others** 2002 *Lamellar magnetism in the haematite-ilmenite series as an explanation for strong remanent magnetism*, N 418 517-8 (7861);
do 2004 AM 89 725-47;
RJ Harrison 2006 *Monte Carlo simulation*, AM 91 106-23.

Structure: **L Pauling SB Hendricks** 1925 JAChS 47 781-90;
G Shirane & 3 others 1962 J Phys Soc Japan 17 1598;
RL Blake & 3 others 1966 AM 51 123-9;
LW Finger RM Hazen 1980 J Appl Phys 51 5362-7 (F224);
MYu Antipin & 5 others 1985 SPD 30 257-8;
VG Tsirel'son & 5 others 1988 SPD 33 89-91(T395);
resonant diffraction, **KD Finkelstein Q Shen S Shastri** 1992 PRL 69 1612-5 (F551);
EN Maslen & 3 others 1994 AC B50 435-41;
electron density residual, **H Sawada** 1996 MRB 31 141-6 (S1580)
Zn doping on structure & magnetics, **I Ayub & 7 others** 2000 JSSC 156 408-14 (1318);
Raman to 62 GPa, **S Shim TS Duffy** 2001 AM 87 318-26;
XRPD to 76 GPa, transition to rhenium oxide (II)-type, **GK Rozenberg & 5 others** 2002 PRB 65 06412 (6115);
apparent shift of cell repeat for nanocrystalline, **H Stanjek** 2002 ClM 37 629-38;
nature of high-P transition, **J Badro & 6 others** 2002 PRL 89 205504-1-4 (8018);
magnetic linear dichroism, **PA van Aken S Lauterbach** 2003 PCM 30 469-77.

Kinetic & equilibrium Fe isotope fractionation: **JL Skulan BL Beard CM Johnson** 2002 GCA 66 2995-3015 (7979).

Static compression: **H Liu & 4 others** 2003 PCM 30 559-69.

Surface properties

STM: **CM Eggleston MF Hochella Jr** 1992 AM 77 911-22.

Biphase ordering, FeO (111)/hematite (0001), STM/LEED: **NG Condon & 5 others** 1995 PRL 75 1961-4 (C427).

Electronic structure of basal surface & interpretation of STM image:
U Becker MF Hochella Jr E Apra 1996 AM 81 1301-14;
CM Eggleston 1999 AM 84 1061-70.

Jump-induced dissolution & regeneration of dissolution-active sites at water interface at pH 3 & 6:
SD Samson CM Eggleston 2000 GCA 64 3675-83 (S2224).
Pb(II) sorption, XAS/bond-valence: **JR Bargar GE Brown Jr GA Parks** 1997 GCA 61 2639-52 (B1682).
Water interaction, 1x1 & 2x1 surfaces: **MA Henderson SA Joyce JR Rustad** 1998 SuS 417 66-81 (385).
Water vapor, XPS: **P Liu & 4 others** 1998 SuS 417 53-65 (L998).
U(VI)-carbonato-sorption complexes, FTIR/EXAFS: **JR Bargar R Reitmeyer JA Davis** 1999 EST 33 2481-3 (B1944).
Co(II) sorption on colloidal hematite, relevance to nuclear fuel: **M Gunnarsson & 4 others** 2000 JCIS 231 326-36 (132).
Sulfate-reducing bacteria producing iron sulfides & S species: **AL Neal & 5 others** 2001 GCA 65 223-5 (944).
Sorbed organic matter, aggregate structure, AFM: **K Namjesnik-Dejanovic PA Maurice** 2000 GCA 65 1047-57 (1643).
Al/Mn/Ni-substituted, rate of dissolution: **MA Wells RJ Gilkes RW Fitzpatrick** 2001 ClClM 49 60-72 (1331).
Cu & fulvic acid, water- interface: **I Christl R Kretzschmar** 2001 GCA 65 3435-42 (3470).
Visible diffuse reflectance vs color & crystallography: **J Torrent V Barron** 2002 ClClM 51 309-17.
Sr adsorption vs T: **ON Karaseva LI Ivanova LZ Lakshtanov** 2003 GI 41 183-98 (9788).

Occurrence

Occurrence: red Latosol soil, **AT Goulart & 2 others** 1997 PCM 25 63-9 (G99).
Concretions on Mars: **MA Chan & 4 others** 2004 N 429 731-4, news & views 706-8 (10388);
Comparison with Earth, **MA Chan & 4 others** 2005 GSAT 15 4-10..
Opportunity Rover, & *jarosite* on Mars: **G Klingelhofer & 18 others** 2004 S 306 1740-5 (10875).
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

General

Beta polymorph by heating beta-FeOOH 973K: **H Braun KJ Gallagher** 1972 Nature Phys Sci 240 13-4.
Growth from ferric gels, XAS: **JM Combes & 3 others** 1989 GCA 53 583-94 (C606),
do 90 54 1083-91 (C734).
Goethite-hematite phase change, XRPD: **AF Gualtieri P Venturelli** 1999 AM 84 895-904.
Heat conversion, *lepidocrocite* to Al-hematite: **Van San & 6 others** 2001 PCM 28 488-97 (2932).
Ilmenite- solid solution:
phase transition, NPD, **RJ Harrison SAT Redfern RI Smith** 2000 AM 85 194-205;
thermodynamics, **RJ Harrison U Becker SAT Redfern** 2000 AM 85 1694-705;
short/long range order, <1273 K, NPD structure, **RJ Harrison SAT Redfern** 2001 PCM 28 399-412 (2938);
exsolution lamellae, TEM vs magnetism, **T Kasama U Golla-Schindler A Putnis**, 2003 AM 88 1190-6.
Synthetic Sn/Ti-doped: **FJ Berry & 4 others** 1997 JSSC 130 272-6 (B1660).
Synthetic Mg-doped, XRPD structure: **FJ Berry & 5 others** 1998 JSSC 140 428-30 (B1895).
Synthetic Sn/Ti/Mg-substituted, NPD/Mössbauer: **FJ Berry & 5 others** 2000 JSSC 151 157-62 (B2000).
Synthetic Fe/Mn/Ni, EXAFS: **B Singh & 4 others** 2000 ClClM 48 521-7 (S2227).
Synthetic Al-substituted, from heating of *lepidocrocite*: **E Van San & 6 others** 2001 PCM 28 488-97 (3638).
Sulfur dioxide adsorption on photoexcited: **DS Toledano VE Henrich** 2001 JPCB 105 3872-7 (2105).
Synthetic hollow nanowire: **Y Xiong & 4 others** 2004 IC 43 6540-2 (10752).

hematolite $(Mn,Mg,Al)_{15}(AsO_3)(AsO_4)_2(OH)_{23}$. *Mcgovernite* group.
May be related homologously to *kraisslite*.
Structure: **PB Moore T Araki** 1978 AM 63 150-9 (M1264).
Ferric analog: **PJ Dunn DR Peacor** 1983 MM 47 381-5.

hematophanite $Pb_4Fe_3O_8(OH,Cl)$. Related to *perovskite* topology.
Structure: **RC Rouse** 1973 MM 39 49-53.
Synthetic $Pb_2Sr_2Cu_2TaO_8Cl$: **R Li** 1997 JSSC 130 154-6 (L836).

hemihedrite $Pb_{10}Zn(CrO_4)_6(SiO_4)_2F_2$.
Isostructural series with *iranite*: **L Fanfani PF Zanazzi** 1967 MM 36 522-9.
Structure: **WJ McLean JW Anthony** 1970 AM 55 1103-14 (M1247).
Occurrence: MM 37 958.

hemimorphite $Zn_4Si_2O_7(OH)_2.aq$.
Structure: **GA Barclay EG Cox** 1960 ZK 113 23-9;
WS McDonald DWJ Cruickshank 1967 ZK 124 180-91 (M197);
MA Simonov NV Belov 1976 Sov Phys Dokl 21 607-8;
neutron, **RJ Hill & 4 others** 1977 ZK 146 241-59;
heating, **BJ Cooper GV Gibbs FK Ross** 1981 ZK 156 305-21;
IR from 82 to 373 K, **E Libowitzky GR Rossman** 1997 EJM 9 793-802 (L909);
proton disorder & IR, **E Libowitzky & 3 others** 1997 EJM 9 803-10 (L910);

water/OH, Raman, **B Kolesov** 2006 AM 91 1355-62.
Synthetic $K_2Mn_2Zn_4[SiO_4][Si_2O_7]$: **MA Simonov NV Belov** 1976 SPD 21 476-8 (S271).
Heterogeneous catalyst, adding primary alcohol to alkyne/allene: **K Breuer & 5 others** 1999 AnCh 38 1401-5 (B1926).

hemloite $(As,Sb)_2(Ti,V,Fe,Al)_{12}O_{23}(OH)$.
Ordered intergrowth of *tomichite/rutile/goethite* layers. *Derbylite* group.
Structure: **DC Harris & 4 others** 1989 CM 27 427-40.

hemusite Cu_6SnMoS_8. *Stannite* structure group.
Should be isostructural with *kiddcreekite* & superstructure of *sphalerite* type.
Structure determination not found.
Occurrence: **GI Terziev** 1971 AM 56 1847-8; Sb & Bi varieties, (S1445).
Sb-bearing: MP 45 11-7.

hendersonite $CaV^{4+}{}_4V^{5+}{}_{12}.4aq$. *Vanadium bronze* structure group; *hewettite* subgroup.
Review: **HT Evans Jr JM Hughes** 1990 AM 75 508-21.
Structure determination not found.
Occurrence: **ML Lindbergh et al** 1962 AM 47 1252-72.

hendricksite $K(Zn,Mg,Mn)_3(Si_3Al)O_{10}(OH)_2$.
Mica structure group; 1-layer monoclinic subtype.
Structure: **J-L Robert M Gaspérin** 1985 TMPM 34 1-14 (R559).
Occurrence: MM 36 1152.

heneuite $CaMg_5(CO_3)(PO_4)_3(OH)$.
Structure: **C Rømming G Raade** 1986 NJMM 351-9 (R577).
Occurrence: MM 52 725.

henmilite $Ca_2Cu[B(OH)_4]_2(OH)_4$. Review: **Sabelli**, isolated tetrahedron.
Structure: **I Nakai** 1986 AM 71 1236-9.
Occurrence: MM 52 725.

hennomartinite $SrMn_2[Si_2O_7](OH)_2.aq$.
Lawsonite $CaAl_2Si_2O_7(OH)_2.aq$ structure type: isostructural with *hennomartinite* $SrMn_2[Si_2O_7](OH)_2$ aq, *itoigawaite* $SrAl_2Si_2O_7(OH)_2.aq$ & *noélbensonite* $BaMn_2Si_2O_7(OH)_2.aq$.
Structure: **T Armbruster R Oberhänsli V Bermanec** 1992 EJM 4 17-22;
phase change ~368/423 K, structures RT & 518 K, **E Libowitzky T Armbruster** 1996 AM 81 9-18.
Occurrence: MM 60 532.

henritermierite $Ca_3(Mn^{3+},Al)_2Si_2O_8(OH)_4$.
Garnet structure family with tetragonal symmetry.
Structure: **A Aubry & 3 others** 1969 BSFMC 92 126-33.
Structure, compressibility <9 GPa, H-bonding, dehydration, SC-XRD/IR: **T Armbruster & 7 others** 2001 AM 86 147-58.
Occurrence: MM 37 958.

henryite $Cu_4Ag_3Te_4$.
Face-centered cubic packing of spheres, but ordering scheme is speculative.
Structure determination not found.
Occurrence: **AJ Criddle et al** 1983 BM 106 511-7 (C745).

henrymeyerite ~$BaFeTi_7O_{16}$. Undistorted *hollandite* structure.
Occurrence & description, SC-XRD structure: **RH Mitchell & 4 others** 2000 CM 38 617-26.

hentschelite $CuFe_2(PO_4)_2(OH)_2$. *Lazulite* structure group. Review: (E289).
Structure: **NH Sieber & 3 others** 1984 Fortschr Mineral 62 231-3;
NH Sieber E Tillmans W Hofmeister 1987 AC C43 1855-7 (S1095).
$CuFe_2(AsO_4)_2(OH)_2$: **H Effenberger** 1988 AC C44 2041-3.

herbertsmithite $Cu_3Zn(OH)_6Cl_2$. Solid solution with *Zn-stabilized paratacamite*.
Definition: **RSW Braithwaite & 3 others** 2004 MM 68 527-39.

hercynite $(Fe,Mg)Al_2O_4$. *Spinel* structure group.
Structure: **RJ Hill** 1984 AM 69 937-42;
JC Wagrenborgh & 3 others 1994 PCM 21 460-8.
Cation distribution vs T, ND: **RJ Harrison SAT Redfern HSC O'Neill** 1998 AM 83 1092-9.

Heat capacity, 3-400 K: **S Klemme JC van Miltenburg** 2003 AM 88 68-72.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

DATOLITE-GADOLINITE-HERDERITE STRUCTURE GROUP Includes

	boron subgroup	beryllium subgroup
bakerite	$Ca_4B_4(BO_4)(SiO_4)_3(OH)_3.aq$	
bergslagite		$CaBeAsO_4(OH)$
calciogadolinite		$(Ca,RE)_2FeBe_2Si_2(O,OH)_{10}$
calcybeborosilite		$CaYBeBSi_2O_8(OH)_2$
datolite	$CaBSiO_4(OH)$	
euclase		$BeAlSiO_4(OH)$
gadolinite		general name for $RE_2Fe^{2+}Be_2Si_2O_{10}$
gadolinite-Ce		$(Ce,La,Nd,Y)_2FeBe_2Si_2O_{10}$
gadolinite-Y		$Y_2FeBe_2Si_2O_{10}$
herderite		$CaBe(PO_4)(F,OH)$
hingganite-Ce		$CeBeSiO_4(OH)$
hingganite-Y		$(Y,Yb,Er)BeSiO_4(OH)$
hingganite-Yb		$(Yb,Y)BeSiO_4(OH)$
homilite	$Ca_2(Fe,Mg)B_2Si_2O_{10}$	
hydroxylherderite		$CaBe(PO_4)(OH)$
minasgeraisite		$CaY_2Be_2Si_2O_{10}$
väyrynenite		$MnBePO_4(OH,F)$

herderite $CaBe(PO_4)(F,OH)$. *Datolite-gadolinite*-herderite mineral group.
F-rich analog of *hydroxylherderite*.
Structure: **PV Pavlov NV Belov** 1959 SPC 4 300-14.
[*herschelite* (discredited MR 30 174) $(Na,Ca,K)AlSi_2O_6.3aq$.
Zeolite mineral group; *chabazite* structure type.
Structure determination not found.
Occurrence: **B Mason** 1962 AM 47 985-7.]

herzenbergite SnS. Orthorhombic distortion of *galena* structure.
Isostructural with *teallite* $PbSnS_2$, except for possible cation ordering.
Structure: **W Hoffmann** 1935 ZK 92 161-73 (H947).
Synthetic teallite solid solution, XRPD: **H Kayashi A Kitakaze A Sugaki** 2001 MM 65 645-51.
Occurrence: MM 24 611.
Montesite $PbSn_4S_5$ may be solid solution: occurrence, MM 29 990.

hessite Ag_2Te-III.
Structure: **AJ Frueh Jr** 1959 ZK 112 44-52.
Occurrence: Erzgebirge, Germany, **H Forster** 2004 NJMA 180 101-13

hetaerolite $ZnMn_2O_4$. *Spinel* structure group; tetragonal distortion.
Compare with *hydrohetaerolite*.
Structure determination not found.
Occurrence: **Dana**.

heterogenite-3R CoOOH.
Isostructural with *grimaldite* & $NaHF_2$.
Polytypic with *heterogenite-2H*.
Structure: **M Deliens H Goethals** 1973 MM 39 152-7.
[jvs: *heterogenite* was described as colloidal, and *stainierite* as crystalline: MM 21 627.]

heterogenite-2H CoOOH. Polytypic with *heterogenite-3R*.
Structure determination not found.
Occurrence: **M Deliens H Goethals** 1973 MM 39 152-7.

heteromorphite $Pb_7Sb_8S_{19}$. *Plagionite* homologous series, n = 2.
Review: **A Skowron ID Brown** 1994 AC B50 524-38 (S1374).
Structure: **A Edenharter W Nowacki** 1975 NJMM 193-5;
A Edenharter 1980 ZK 151 193-202 (E365).
heterosite $(Fe,Mn)PO_4$. Should be isostructural with Mn analog *purpurite*.
Triphylite structure subgroup of phosphates *in olivine* structure group, but with missing cation.
Structure: **W Eventoff R Martin DR Peacor** 1972 AM 57 45-51.
heulandite ~$(Na,K)Ca_4(Al_9Si_{27}O_{72})$.24aq. *Zeolite* mineral group.
Varieties are *–Ba, -Ca, -K, -Na-, Sr-*: -Ca is most typical.
IZA-SC structure code HEU. Consortium for Theoretical Frameworks net 602.
Chemical series with *clinoptilolite*.
Enumeration of 4-connected nets containing *bru* unit: **A Alberti** 1979 AM 64 1188-93.
Structure: **AB Merkle M Slaughter** 1967 AM 52 273-6;
do 1968 AM 53 1120-38;
A Alberti 1972 TMPM 18 129-46 (A647);
H Bartl 1973 ZK 137 440-1;
Al ordering, **M Kato S Satokawa K Itabashi** 1997 Stud Surf Sci Catal 105A 229-35;
SIMS, XPS/SEM, natural, pH 2-12, **KV Ragnarsdottir & 2 others** 1996 ChG 131 167-81 (R690);
IR, **MS Joshi & 3 others** 1997 Mater Chem Phys 48 160-3 = CA 127:111293h;
-Ba, SC-XRD, **A Larsen & 5 others** 2005 EJM 17 143-53 (.
High-P <5 GPa, SC-XRD struct: **P Comodi GD Gatta PF Zanazzi** 2001 EJM 13 497-505 (2107).
Dehydration behavior of 17 natural heulandites: **G Valueva** 1995 EJM 7 1411-20 (V243).
Heulandite-B, **A Alberti** 1973 TMPM 19 173-84 (A207).
Heat behavior of Ca/Na/K/Rb-exchanged: **A Alietti G Gottardi L Poppi** 1974 TMPM 21 291-8.
Ca-NH_4-dehydrated, **WJ Mortier JR Pearce** 1981 AM 66 309-14.
K-heulandite 293, 373 & 593 K: **E Galli & 4 others** 1983 AC B39 189-97 (G465).
Dehydration: **A Alberti G Vezzalini** 1983 TMPM 31 259-70 (A381).
Neutron, natural & part-dehydrated: **TW Hambley JC Taylor** 1984 JSSC 54 1-9.
Near-IR of dehydrated & rehydrated: **A Alberti G Vezzalini L Erre P Piu** 1985 Z 5 289-91.
Natural/partly-dehydrated heulandite-*clinoptilolite*s 100K: **T Armbruster ME Gunter** 1991 AM 76 1872-83.
NMR: **RL Ward HL McKague** 1994 JPC 98 1232-7.
Hydrated Na/K, **SP Gabuda & 4 others** 1996 Zh Strukt Khim 37 891-900 = CA 127:42516u.
Na- & Pb-exchanged: **MR Gunter & 3 others** 1994 AM 79 675-82.
Natural-Ca & partly-Ag-exchanged: **N Bresciani-Pahor & 4 others** 1980 JCSD 1511-4.
Ag-exchanged: **N Bresciani-Pahor & 3 others** 1982 JCSD 2288-91.
Natural Ba,Sr-rich: **BE Miller ED Ghent** 1973 CM 12 188-92.
Natural K-exchanged: **P Nørnberg** 1990 MM 54 91-4.
Natural Na/K/Rb/Cs-exchanged 100K, SC-XRD: **P Yang T Armbruster** 1966 JSSC 123 140-9.
AFM, (010) surface of natural: **G Binder & 4 others** 1996 Z 16 2-6.
AFM, cation positions, natural & Ag/Rb-exchanged: **M Koiyama M Gu H Wu** 2001 JPCB 105 4680-3 (2106).
Th uptake from aqueous solution: A **Godelitsas & 4 others** 1996 CEr 56 143-56 (G859).
AFM of pyridine adlayer on (010): **M Komiyama & 3 others** 1996 JPC 100 15198-201 (K856).
Na/K/Rb/Cs exchange, diffusion kinetics: **P Yang & 3 others** 1997 AM 82 517-25.
Synthesis: **S Khodabandeh ME Davis** 1997 MiMa 9 149-60 = CA 127:12475n;
D Zhao L Kevan R Szostak 1997 Z 19 366-9;
Si-rich using seeds & alkalis: **D Zhao R Szostak L Kevan** 1998 JMC 8 233-9.
NH_4-exchanged, SC-XRD structure 100 K: **P Yang T Armbruster** 1998 EJM 10 461-71 (Y233).
Cation effects, models: **YM Channon & 3 others** 1998 MMM 24 153-61 (C1080).
Dealuminated treated with RECl solution, SC-XRD structure: **T Wüst J Stolz T Armbruster** 1999 AM 84 1126-34.
Growth texture & symmetry, -Ca Poona: **M Akizuki Y Kudoh S Nakamura** 1999 CM 37 1307-12.
Cd-exch, SC-XRD structure, wastewater cleanup:
J Stolz P Yang T Armbruster 2000 MMM 37 233-42 (S2182);
step-dehydration/topology change, **N Doebelin T Armbruster** 2003 MMM 61 85-104.
Alkylammonium-exchange, SC-XRD: **J Stolz T Armbruster B Hennessy** 2000 ZK 215 278-87 (S2183).
Optics: **JL Palmer ME Gunter** 2000 AM 85 225-30.
Thermochemistry: **I Kiseleva & 3 others** 2001 AM 85 448-55.

Sr-exchanged, stepwise dehydration, SC-XRD: **N Dobelin T Armbruster** 2003 AM 88 527-33.
Ion-exchange with Na/K/Ca/Sr, thermodynamics: **T Fridriksson & 3 others** 2004 AJS 304 287-332 (10836).

hewettite $CaV_6O_{16}.9aq$. Vanadium bronze structure group; *hewettite* subtype.

Structure not fully determined; related to $Li_3V_6O_{16}$.

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

Structure: **H-G Bachmann** 1962 BMP 8 210-4;
HT Evans Jr 1989 CM 27 181-8.

Synthetic $BaV_6O_{16}.naq$, SC-XRD structure: **Y Oka & 3 others** 1998 JSSC 140 219-25 (O387).

hexaferrum (Fe,Ru) & (Fe,Os) & (Fe,Ir). Hexagonal polymorph of *native iron*.

Occurrence & XRPD: **AG Mochalov & 4 others** 1998 ZVMO 127 41-51 = AM 84 1686.

HEXAHYDRITE STRUCTURE GROUP Includes

bianchite	$(Zn,Mg)SO_4.6aq$
chvaleticeite	$(Zn,Fe)SO_4.6aq$
ferrohexahydrite	$FeSO_4.6aq$
hexahydrite	$MgSO_4.6aq$
moorhouseite	$(Co,Ni,Mg)SO_4.6aq$
nickel-hexahydrite	$NiSO_4.6aq$

Review: **Sabelli**.

hexahydrite $MgSO_4.6aq$.

Structure: **A Zalkin H Ruben DH Templeton** 1964 AC 17 235.
Occurrence: MM 42 525.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

hexahydroborite $CaB_2(OH)_8.2aq$.

Structure: **MA Simonov & 4 others** 1976 DAN SSSR 228 1337-40.

hexatestibiopanickelite $(Ni,Pd)_2SbTe$. *Niccolite* structure group.

Structure: **P Bayliss** 1990 CM 28 751-5.
Occurrence: MM 40 907.

heyite $Pb_5Fe_2(VO_4)_2O_4$.

Structure determination not found.
Occurrence: **SA Williams** 1973 MM 39 65-8.

heyrovskýite $Pb_6Bi_2S_9$.

Lillianite homologous series, subtype 7,7; also Ag,Bi variant.
Structure: **Y Takéuchi J Takagi** 1974 Proc Japan Acad Sci 50 76-9.
Occurrence: MM 38 992.
Ag-bearing: **E Makovicky WG Mumme BF Hoskins** 1991 CM 29 553-9.
Se-bearing, Vulcano, Italy, XRPD: **YS Borodaev & 7 others** 2003 CM 41 429-40.
Double *c* : **A Ertl E Libowitsky F Pertlik** 1994 Mitt Osterr Mineral Ges 139 135-42.
Phase equilibria, $Pb_9Bi_4S_{15}$: **H Liu LLY Chang** 1994 AM 79 1159-6.

hiärneite $(Ca,Na,Mn)_2(Zr,Mn)_5(Sb,Ti,Fe)_2O_{15}$. Isostructural with *calzirtite*.

Occurrence, IR, Raman, XRPD: **D Holtstam** 1997 EJM 9 843-8 (H1279).

hibbingite $Fe_2(OH)_3Cl$-beta.

See *kempite* & *atacamite*.
Duluth Complex; ED, **B Saint-Eidukat H Kucha H Keppler** 1994 AM 79 555-61.
Occurrence Noril'sk Complex & Korshunovskoye iron ores, solid solution with *kempite*: **B Saint-Eidukat NS Rudashevsky AG Polozov** 1998 MM 62 251-5.
Occurrence in corroded iron meteorites: **VF Buchwald CB Koch** 1995 Meteoritics 30 493.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.

hibonite $(Ca,Ce)(Al,Fe,Ti,Si,Mg)_{12}O_{19}$. See *grossite* & *mayenite*.

Magnetoplumbite structure type: **K Kato** 1967 Nw 54 536. See *beta-alumina*.
Optical absorption & Fe Mössbauer: **D Holtstam** 1996 PCM 23 452-60 (H1142).
Synthetic $(Ca/Sr)Al_{12}O_{19}$: NMR of 4-coordinated Al: **L Du JF Stebbins** 2004 JPCB 108 (10091).

Occurrence: MM 31 961.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
In meteorites: **AE Rubin** 1997 MPS 32 231-47;
orange in Allende, **SB Simon AM Davis L Grossman** 2001 MPS 36 331-50;
Murchison, **KK Marhas JN Goswami AM Davis** 2002 S 298 2182-5;
R chondrite, excess Mg, **A Bischoff G Srinivasan** 2003 MPS 38 5-12.
Synthetic $Sr(Al/Ga/Fe)_{12}O_{19}$: JSSC 87 186-94.
Synthetic $PbAl_{12}O_{19}$: JSSC 85 318-20.
Synthetic $La_{0.4}Gd_{0.6}MgAl_{11}O_{19}$: J Chem Phys 93 7076-84.
Synthetic $LaFeAl_{11}O_{19}$: 1989 JSSC 81 192-202 = SR 56A 120.
Synthetic $Ca_2Mg_2Al_{28}O_{46}$ (CAM-I) & $CaMg_2Al_{16}O_{27}$ (CAM-II) phases, modeled as hibonite/*spinel magnetoplumbite* structures, phase relations: **M Göbbels E Woermann J Jung** 1995 JSSC 120 358-63 (G825).
hidalgoite $PbAl_3(AsO_4)(SO_4)(OH)_6$. *Beudantite* structure group. Review: Sabelli p. 25-6.
Structure: **K Walenta** 1966 TMPM 11 121-64.
Occurrence: MM 30 734.
hieratite K_2SiF_6. Anti*fluorite* connectivity with SiF_6 octahedra.
Isostructural with NH_4 analog *cryptohalite*.
Structure determination not found.
Occurrence: **Dana**. [jvs: check for structure of synthetic.]
[*Camermanite* is hexagonal dimorph occurring in salt factories: MM 29 977-8.]
HILAIRITE STRUCTURE GROUP Includes:

calciohilairite	$CaZrSi_3O_9.3aq$
hilairite	$Na_2ZrSi_3O_9.3aq$
komkovite	$BaZrSi_3O_9.3aq$
pyatenkoite-Y	$Na_5(Y,Dy,Gd)TiSi_6O_{16}.6aq$
sazykinaite-Y	$Na_5YZrSi_6O_{18}.6aq$

Summary of cell data: **AP Khomyakov & 2 others** 1993 ZVMO 122 76-82 (K659A).
[jvs: need to check structures in detail for cation ordering, etc.]
2-connected octahedral-tetrahedral net; Consortium for Theoretical Frameworks net 1103.
hilairite $Na_2ZrSi_3O_9.3aq$.
Structure: **GD Ilyushin & 4 others** 1981 SPD 26 916-7 (I112) = MA 83M/4219;
GD Ilyushin LN Dem'yanets 1988 SPC 33 383-7 (I90).
Occurrence: MM 39 914.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** (1995).
RE analog $Na_2(Na_{2.4}K_{0.6})(Zr_{0.7}Ti_{0.2}Nb_{0.1})(Y_{0.8}RE_{0.2})Si_5O_{18}.6aq$: **RK Rastsvetaeva AP Khomyakov** 1992 SPC 37 845-7 (R484).
hilgardite $Ca_2B_5O_9Cl.aq$. Polymorphic with *parahilgardite* & *Cl-tyretskite*. Polytypic.
2-vertex-connected 3D net of 3 tetrahedra & 2 triangles: CTF nets 1062, 1063 & 1064.
[*kurgantaite* $SrCaB_5O_9Cl.1aq$ is Sr analog of *hilgardite* (1744).]
Nomenclature: **S Ghose** 1985 AM 70 636-7; also AM 69 214.
Stereoisomerism: **S Ghose** 1982 AM 67 1265-72.
Structure: **S Ghose C Wan** 1977 N 270 594-5;
triclinic polytype, **IM Rumanova ZI Iorysh NV Belov** 1977 DAN SSSR 236 91-4;
4M (monoclinic) polytype, **S Ghose C Wan** 1979 AM 64 187-95;
proton NMR, **MJ Peltre & 3 others** 1980 AM 65 346-8;
3A (anorthic) polytype, **C Wan S Ghose** 1983 AM 68 604-13;
1A polytype, **PC Burns FC Hawthorne** 1994 AC C50 653-5 (B1095);
new centrosymmetric type, **EL Belokoneva & 3 others** 1998 CR 43 810-9 (B1864), **TA Borisova OV Dimitrova EL Belokoneva** 2002 CrR 47 390-3 (7369).
Synthetic $Sr_2B_5O_9OH.aq$, SC-XRD structure: **J Barbier H Park** 2001 CM 39 129-36.
Synthetic $Na_{0.5}Pb_2B_5O_9(OH)_{0.5}$, SC-XRD structure: **EL Belokoneva & 3 others** 2000 CrR 45 744-53 (1739).
Synthetic $Pb_2B_5O_9Br$: XRPD structure: **EL Belokoneva & 3 others** 2003 CrR 48 49-53 (8790.

Occurrence: MM 25 631.
Strontio-hilgardite-1Tc: AM 53 2084-7.
hilgardite-1A (= Cl-tyretskite): **LM Anovitz ES Grew** 1996 ReM 33.
hillebrandite $Ca_2SiO_3(OH)_2$. Natural analog of Ca-Si-hydrate in Portland cement.
Structure: proposal, **HS Mamedov NV Belov** 1955 DAN SSSR 123 741-3;
determination, **Y Dai JE Post** 1995 AM 80 841-4 (D528).
TEM of domains & superstructure: **H Xu PR Buseck** 1996 AM 81 1371-9.
TEM of decomposition to *larnite*: **YJ Kim WM Kriven** 1995 JMR 10 3084-7 (K709).
Ca-EXAFS, Si NMR: **N Lequex & 3 others** 1999 JACeS 82 1299-306 (L987).
Dehydration hillebrandite, *tobermorite* & *xonotlite*, TGA/DSC, SAXS/WAXS: **S Shaw CMB Henderson BU Komanschek** 2000 ChG 167 141-59 (S2150).
Occurrence: after *melilite*, Bushveld Complex, **IS Buick & 3 others** 2000 SAfFG 103 249-54 (2077).
hillite $Ca_2(Zn,Mg)(PO_4)_2.2aq$. *Fairfieldite* structure group.
Occurrence & SC-XRD structure: **OV Yakubovich & 5 others** 2003 CM 41 981-8.
hingganite-Ce $(Ce,Y)BeSiO_4OH$. *Gadolinite* structure group.
Occurrence: **R Miyawak & 4 others** 1987 Kobutsugaku Zasshi 18 17 = MM 54 666.
Not submitted to IMA.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
hingganite-Y $(Y,Yb,Er)BeSiO_4OH$. *Gadolinite* structure group.
Structure: **EI Semenov VD Dusmatov NS Samsonova** 1963 SPC 8 539-41.
Occurrence: & SC-XRD, **F DeMartin A Minaglia CM Gramaccioli** 2001 CM 39 1105-14;
OV Petersen JG Rønsbo ES Leonardsen 1994 NJMM 185-92;
in *talc-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.
[*xinganite* $(Y,Ce)BeSiO_4OH$ should be renamed *hingganite-Y*.
Structure: **X Lulu Z Peng** 1985 Acta Mineral Sinica 5 289-93 = AM 73 441-2.]
hingganite-Yb $(Yb,Y)BeSiO_4OH$. *Gadolinite* structure group.
Structure: **OV Yakubovich & 3 others** 1983 SPC 28 269-71.
Occurrence: MM 48 574;
in *talc-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.
hinsdalite $(Pb,Sr)Al_3(PO_4)(SO_4)(OH)_6$.
Beudantite/crandallite structure type with Si,P disorder; related to *plumbogummite*
[Is *orpheite* a variety of hinsdalite?]
Crystallography only: **J Hak & 3 others** 1969 NJMM 201-12 (H945).
Structure: $PbAl_3(P_{0.69}S_{0.31}O_4)_2(OH,aq)_6$, SC-XRD/ED, **U Kolitsch & 4 others** 1999 EJM 11 513-20 (K1164).
Potential host for toxic elements including radioactive fission products.
hiortdahlite $(Ca,Na)_3ZrSi_2O_7(O,OH,F)_2$.
Wöhlerite/låvenite supergroup; wöhlerite structure group.
Structure: type I, **S Merlino N Perchiazzi** 1985 TMPM 34 297-310 (M1041);
type II, **do** 1987 MP 37 25-35 (M1250);
occurrence, **ER Robles & 4 others** 2001 GGSB 190 131-7 (8708).
hisingerite $\sim Fe^{3+}{}_2Si_2O_5(OH)_4.2aq$.
Precursor to *ferric smectite*; same local structure as *nontronite*:
Structure: **B Lindqvist S Jansson** 1962 AM 47 1356-62.
Mössbauer, IR, & Fe/Si EXAFS, Salton Sea precipitate: **A Manceau et al** 1995 ClClM 43 304-17.
TEM of curved morphology: **RA Eggleton DB Tilley** 1998 ClClM 46 400-13 (E449).
Chrome-alumina variant: MM 48 571-2.
Mn-bearing, in series with *neoticite*: **P Povondra** 1996 J Czech Geol Soc 41 7-14 = MA 97M/0824
hocartite Ag_2FeSnS_4. *Stannite* structure type. Isostructural series with *hocartite*.
Structure determination not found.
Occurrence: **R Caye et al** 1968 BSFMC 91 383-7.

hochelagaite $(Ca,Na,Sr)(Nb,Ti,Si,Al)_4O_{11}.\sim 8aq.$

XRPD similar to *franconite* & *ternovite* $(Mg,Ca)Nb_4O_{11}$. naq.

Structure determination not found.

Occurrence: **JL Jambor & 5 others** 1986 CM 24 449-53 (J266).

[hochschildite $PbSnO_3$.5-6aq. Alteration of **teallite**. Occurrence; MM 26 337.]

hodgkinsonite $MnZn_2SiO_4(OH)_2$.

Structure: **JE Rentzeperis** 1963 ZK 119 117-38 (R537);
LP Solov'eva NV Belov 1964 SPD 8 867-70, 1139-40 (S1320,1321).

hodrushite $Cu_8Bi_{12}S_{22}$.

Related to *cuprobismutite*, *padëraite* & *synthetic* $Cu_4Bi_5S_{10}$ (MA 76-236).

Cell dimensions indicate double-layer structure: **K Mariolacos & 3 others** 1975 AC B31 703-8.

Structure: **V Kupcik E Makovicky** 1968 NJMM 236-7 (K701);
cell dimensions, **M Kodera V Kupcik E Makovicky** 1970 MM 37 641-8;
D Topa & 2 others 2003 CM 41 1481-501.

Occurrence: MM 37 958.

hoelite $C_{14}H_8O_2$. **Roberts et al** p.370.

hoganite $Cu(CH_3COO)_2.aq.$

Occurrence & XRPD = *synthetic*: **DE Hibbs & 4 others** 2002 MM 66 459-64.

HÖGBOMITE STRUCTURE GROUP Includes:

magnesiohögbomite-2N2S	$Mg(Al,Fe,Ti)_4O_7$	*c* = 18 (8H)
magnesiohögbomite-2N3S		23 (10T)
magnesiohögbomite-6N6S		56 (24R)
ferrohögbomite-2N2S	$(Fe_3ZnMgAl)Al_{14}FeTi]O_{30}(OH)_2$	18 (8H)
ferronigerite-2N1S	$(Zn,Mg,Fe)(Sn,Zn)_2(Al,Fe)_{12}O_{22}(OH)_2$	14 (6T)
-6N6S		56 (24R)
magnesionigerite-2N1S	$(Mg,Fe)(Sn,Zn)_2(Al,Fe)_{12}O_{22}(OH)_2$	14 (6T)
magnesionigerite-6N6S	$(Mg,Fe)(Sn,Zn)_2(Al,Fe)_{12}O_{22}(OH)_2$	55 (24R)
ferrotaaffeite-6N'3S	$(Be,Zn,Mg)FeAl_4O_8$	41 (9(R)
magnesiotaaffeite-2N'2S	$Mg_3Al_8BeO_{16}$	18 (8H)
magnesiotaaffeite-6N'3S	$(Mg,Fe,Zn)_2Al_6BeO_{12}$	41 (9R)
zincohögbomite	$Zn_{0.79}Fe_{0.65}Mg_{0.04}Co_{0.01}Ni_{0.05}Cr_{0.01}Ti_{0.24}Al_{3.98}O_8$	
-2N2S		18 (8H)
2N6S		(16H)
zinconigerite-6N6S		55 (24R)
	$Sn_{5.2}Ti_{0.8}Li_{1.7}(Zn6.1Fe_{5.7}Mn_{0.1})(Al_{44.8}Mg_{0.8})O_{90}(OH)_6$.	

Revised nomenclature (N = *nigerite*; S = *spinel*): **T Armbruster** 2002 EJM 14 389-95 (7149).

Polytypism/polysomatism causes subtle structural differences;
[jvs: possibly many more types & chemical variants to be discovered.]

høgtuvaite $(Ca,Na)_2$ $(Fe,etc.)_6(Si,Be,Al)_6O_{20}$. *Aenigmatite* structure type.

Structure: **RI Grauch & 7 others** 1994 CM 32 439-48;
no detailed analysis because of repetitive twinning.

hohmannite $Fe_2(SO_4)_2(OH)_2.7aq.$

Related to *amarantite & metahohmannite* $Fe_2[O(SO_4)_2].4aq.$ Review: **Sabelli** p.20.

Structure: **P Scordari** 1978 MM 42 144-6 & M9-11.

holdawayite $Mn_6(CO_3)_2(OH)_7(Cl,OH)$. See *defernite*.

Structure: **DR Peacor RC Rouse** 1988 AM 73 637-42.

Occurrence: MM 52 726.

holdenite $(Mn,Mg)_6Zn_3(AsO_4)_2(SiO_4)(OH)_8$. Compare *gerstmannite* & *kolicite*.

Structure: **PB Moore T Araki** 1977 AM 62 513-21.

Occurrence: MM 21 565.

holfertite Hydrated uranyl titanate; complex because of OD structure.

Occurrence & structure: **E Sokolova & 3 others** 2005 CM 43 1545-52. AM 91 1204.

HOLLANDITE STRUCTURE GROUP Includes:

ankangite	$Ba(Ti,V,Cr)_8O_{16}$
coronadite	$Pb(Mn^{4+},Mn^{2+})_8O_{16}$
cryptomelane	$K(Mn^{4+},Mn^{2+})_8O_{16}$
henrymeyerite	$\sim BaFeTi_7O_{16}$
hollandite	$Ba(Mn^{4+},Mn^{2+},Fe^{3+})_8O_{16}$
manjiroite	$(Na,K)(Mn^{4+},Mn^{2+})_8O_{16}$.n aq
mannardite	$BaTi_6V^{3+}{}_2O_{16}$.aq
priderite	$(K,Ba)(Ti,Fe^{3+})_8O_{16}$
redledgeite	$BaTi_6Cr^{3+}{}_2O_{16}$.aq
strontiomelane	$SrMn\ (IV)_6Mn(III)_2O_{16}$
IMA 95-005	$(Sr,Ba,K)Mn_8O_{16}$

high-pressure feldspar polymorphs

Sr partition, hollandite/*piemontite* minerals in schist: **M Enami Y Banno** 2001 AM 86 205-14.
Hollandite-*strontiomelane* with *kanonaite* & *braunite*: **W Schreyer & 2 others** 2001 CMP 141 560-71 (3154).
High-P hollandite-structure polymorph of *albite* in maskelynite glass of Sixiangkou L6 chondrite:
P Gillet 2000 S 287 1633-6, 1602-3 (G1185); Tenham meteorite, AM 86 940.
Structure review: **RW Cheary** 1986 AC B42 229-36.
Thermochemistry, framework & layer manganese dioxide phases: **S Fritsch** 1998 ChM 10 474-9 (F596).
Synthetic high-P $KAlSi_3O_8$: **AE Ringwood AF Reid AD Wadsley** 1967 AC 23 1093-5;
H Yamada Y Matsui E Ito 1984 MJJ 12 29-34;
J Zhang J Ko RM Hazen CT Prewitt 1993 AM 78 493-9;
with *omphacite*/*stishovite*, Zagami meteorite, **F Langenhorst J Poirier** 2000 EPSL 176 259-65 (L1050);
lower-mantle conditions in DAC, **F Tutti LS Dubrovinsky SK Saxena** 2001 GRL 28 2735-8 (2108).
Synthetic high-pressure $(Sr/Ba)Al_2Si_2O_8$: **AF Reid AE Ringwood** 1969 JSSC 1 6-9.
Synthetic $(Sr/Ba)(Ti/Sn)_{4-2x}(Al/Cr/Ga/In)_{2x}O_8$: **FC Mulhoff et al** 1985 AC B41 98-101 (M1304).
Synthetic $Ba_x\ (M^{3+}Ti^{4+})_8O_{16}$ to simulate SYNROC: **RW Cheary** 1986 AC B42 229-36 (C765).
Synthetic $K_{1.33}Mn_8O_{16}$ & cation order in hollandite-type structures: **J Vicat & 3 others** 1986 AC B42 162-7 (V230).
Synthetic K/Rb/Cs-substituted Ba-hollandites: **RW Cheary** 1987 AC B43 28-34 (C766).
Synthetic $K_{0.06}TiO_2$: 1989 JSSC 81 78-2 = SR 56A 132.
Synthetic $K_{1.35}Ti_8O_{16}$: 1989 JSSC 83 61-8 = SR 56A 132-3.
Synthetic $Ba_x(Mg_xTi_{8-x})O_{16}$, x 1.14, 1.20, 1.33: **RW Cheary R Squadrito** 1989 AC B45 205-12.
Synthetic $Ca_{0.5}(Mg,Fe,Mn)_{0.5}Al_2Si_2O_8$ from natural garnet, 50 GPa: **M Madon & 2 others**1989 N 342 422-5.
Synthetic $Ba_xTi^{3+}{}_{2x}Ti^{4+}{}_{8-2x}O_{16}$, x 1.1 & 1.3: **RW Cheary** 1990 AC B46 599-609 (C768).
Synthetic $Ba_xCs_y(Ti^{3+}{}_{y+2x}Ti^{4+}{}_{8-2x-y})O_{16}$: **RW Cheary** 1991 AC B47 325-33 (C769).
Synthetic $K_{1.54}Mg_{0.77}Ti_{7.23}O_{16}$: **E Rosshirt F Frey H Boysen** 1991 NJMA 163 101-15 (R568).
Synthetic $(Ba_{1.14}K_{0.05})(Ti_{5.8}V_{1.3}Cr_{0.4}Fe_{0.2}Mg_{0.2}Al_{0.1})(O,OH)_{16}$: **MT Dmitriyeva & 4 others** 1992 DES 326 158-62.
Synthetic $Ba_{1.33}Mg_{1.33}Ti_{6.67}O_{16}$: **RW Cheary R Squadrito** 1992 AC A48 15-27 (C761).
Synthetic $Pb_{0.8}Al_{1.6}Si_{2.4}O_8$: **RT Downs & 3 others** 1995 AM 80 937-40.
Synthetic $CaSiO_3$ & $Ca,Mg,Fe)Al_2Si_2O_8$, high-P, EM: **I Ahmed-Zaïd M Madon** 1995 EPSL 129 233-47.
Synthetic OMS-2 manganese oxide octahedral molecular sieves with hollandite/*cryptomelane* 2x2 connectivity, industrial term [compare with OMS-1 with *todorokite* 3x3 connectivity & OL-1 with *birnessite* layer connectivity]: **SL Suib LE Iton** 1994 ChM 6 429-33 (S1249); **Y-G Yin & 3 others** 1994 IC 33 4384-9 (Y138).
Synthetic Ni /Cu molecular sieves, OMS-2 type: **Y-G Yin & 3 others** 1995 IC 34 4187-93 (Y161).
Synthetic $Ba_{0.5}Bi_{0.9}V_8O_{16}$: **J Feldmann H Müller-Buschbaum** 1996 ZN 51b 1037-9 (F511).
Synthetic $K_2Cr_8O_{16}$ with full cation occupancy of tunnel: **O Tamada & 3 others** 1996 JSSC 126 1-6 (T490).

Synthetic $Ba_xFe_{2x}Ti_{8-2x}O_{16}$ x 1.143 & 1.333, XRPD, superlattice, phase transition with T: **JM Loezos VA Venderath AR Drews** 1999 PD 14 31-5 (L982).
Synthetic Cr-, XRPD-structure: **S Ching & 4 others** 2001 ChC 2486-7 (3635).
Synthetic alpha-MnO_2, NPD structure: **N Kijima & 4 others** 2004 JSSC 177 1258-67 (10280).

hollandite $Ba(Mn^{4+},Mn^{2+},Fe^{3+})_8O_{16}$.

Sr-rich, in braunite ores: **R Cabella G Lucchetti P Marescotti** 1995 NJMM 395-407.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
hollingworthite (Rh,Ru,Pt)AsS. *Cobaltite* structure group.
Isostructural series with *irarsite*.
Structure: *synthetic,* **F Hulliger** 1963 N 198 382-3 & **FH E Morse** 1965 JPCS 26 429-33; **P Bayliss** 1986 CM 24 27-33.
Occurrence: MM 35 1135.
Osmian: MM 60 973-8.
holmquistite $Li_2(Mg,Fe)_3Al_2Si_8O_{22}(OH)_2$.

Amphibole mineral group; orthorhombic structure type. Dimorphic with *clinoholmquistite*.
Structure: **MC Irusteto EJW Whittaker** AC B31 145-50;
F Walter EM Walitzi K Mereiter 1989 ZK 188 95-101 (W118);
Raman, **JT Kloprogge & 3 others** 2001 NJMA 1-17 (950);
IR & Raman, **do** 2001 JMSL 20 1497-9 (3637);
Raman, **JT Kloprogge MH Case RL Frost** 2001 MM 65 775-85.
Oxidation & dehydroxylation upon heating, IR & Mossbauer: **K Ishida** 1999 MJ 21 157-66 (I253).
holtedahlite $Mg_2(PO_4)(OH)$.

Dimorphic with *althausite*. Analog of *satterlyite* $(Fe^{2+},Mg,Fe^{3+})_2(PO_4)OH$.
Structure: natural & *synthetic*, **C Rømming G Raade** 1989 MP 40 91-100.
Occurrence: MM 46 519.
IR & NMR of protons: **F Brunet T Schaller** 1996 AM 81 385-94.
holtite $[Al_6(Al_{0.43}Ta_{0.27})B[(Si_{2.25}Sb_{0.75})O_{15}(O,OH)_{2.25}$. Related to *dumortierite.*
Structure: **BF Hoskins WG Mumme MW Pryce** 1989 MM 53 457-63.
SC-XRD structure of phase I & XRPD of II: **SS Karantsev & 5 others** 2005 Krystallogr 50 49-54.
Occurrence: MM 38 992;
Poland, MA 97M/4169.
homilite $Ca_2(Fe,Mg)B_2Si_2O_{10}$. *Gadolinite* structure group.
Structure: **R Mijawaki I Nakai K Nagashima** 1985 AC C41 13-5.
honessite $Ni_6Fe_2(SO_4)(OH)_{16}.4aq$. *Hydrotalcite/pyroaurite* structure group.
Isostructural with carbonate *reevesite*.
Cf *hydrohonessite*, crystal chemistry, paragenesis: **DL Bish A Livingstone** 1981 MM 44 339-43.
Review: Sabelli p.21.
Occurrence: MM 31 962.
CuAl analog from Argyll: **A Livingstone** 1990 MM 54 649-53.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
hongquiite TiO. *Halite* structure type with disordered defects.
[TiO_x has wide range of x 0.7 to 1.2 at high-T, & of structural transitions upon cooling; XRPD of natural mineral may indicate cubic symmetry but need check; also Ti/O ratio should be checked].
Structure: *synthetic*, low-T monoclinic, **D Watanabe & 3 others** 1967 AC 23 307-13 (W724).
Occurrence: **Yu T & 4 others** 1974 Acta Geol Sinica 2 202-18 = AM 61 184-5.
hongshiite CuPt.
Structure: check against *synthetic* [rhombohedral *a* 7.59Å alpha 91°, **JO Linde** 1937 Ann Phys Leipzig 30 151 = **Pearson** p.311-2].
Occurrence: AM 65 408 is wrong;
revision, **Z Yu** 1982 Bull Inst Geol, Chinese Acad Geol Sci 4 78-81 = AM 69 411-2.
Possible occurrence: **LJ Cabri JH G Laflamme** 1997 MR 28 97-105.
Occurrence: **R Kwitko & 6 others** 2002 CM 40 711-23.
hopeite $Zn_3(PO_4)_2.4aq$.

Edge-shared Zn octahedra sharing vertices with P tetrahedra.
Dimorphic with *parahopeite*. Polytypic with *phosphophyllite*.
Structure: **KhS Mamedov R Gamidov NV Belov** 1961 SPC 6 91-4 (M1133);
RS Gamidov & 3 others 1965 DAN 150 106-9 (G813);
F Liebau 1965 AC 18 352-4;
revision of earlier paper, **A Kawahara Y Takano M Takahashi** 1973 MJJ 7 289-97;
A Whitaker 1975 AC B31 2026-35;
RJ Hill JB Jones 1976 AM 61 987-95;
H-bonding, **L Herschke & 3 others** 2004 CEJ 10 2795-803 (10352).
Occurrence in fertilizers: **JR Lehr & 4 others** 1966 *Crystallographic Properties of Fertilizer Compounds*, Tenn Valley Auth Chem Eng Bull 6, 163p (L758).
Synthesis, cell dimensions & SG: **P Reinert & 3 others** 1999 12th Int Zeolite Conf 1757-63.
hörnesite $Mg_3(AsO_4)_2.8aq$. *Vivianite* structure type.
Detailed structure analysis not found.
Occurrence: **S Koritnig P Süsse** 1966 NJMM 11 349-51 = AM 52 1588.
Solid solution *annabergite-erythrite-hörnesite*: **JL Jambor JE Dutrizac** 1995 CM 33 1063-71.
Ni-, occurrence: Japan, MA 97M/2013.
horsfordite Cu_5Sb. Inadequate description: **Dana**.
horvåthite-Y $NaY(CO_3)F_2$.
Occurrence & XRD: **JD Grice GY Chao** 1997 CM 35 743-9.
hotsonite $Al_5(PO_4)(SO_4)(OH)_{10}.8aq$.
XRPD: **H de Bruijn & 3 others** 1989 MM 53 385-6.
Occurrence: **OK Ivanov & 3 others** 1990 ZVMO 121-6 (I118) = AM 76 1734. MM 50 747.
howardevansite $NaCuFe_2(VO_4)_3$. Ribbon structure.
Structure: **JM Hughes & 3 others** 1988 AM 73 181-6.
Synthetic $NaFe_3V_3O_{12}$: **F-D Martin H Müller-Buschbaum** 1995 ZN 50b 51-5 (M1336).
howieite $Na(Fe,Mn)_{10}(Fe,Al)_2Si_{12}O_{31}(OH)_{13}$.
Structure: **HR Wenk** 1973 Nw 60 254-5 = MA 74-140;
do 1974 AM 59 86-97.
Occurrence: MM 35 1136.
howlite $Ca_2B_5SiO_9(OH)_5$. Silicoborate spiral.
Structure: **JJ Finney & 3 others** 1970 AM 55 716-28;
DT Griffen 1988 AM 73 1138-44;
boron K-edge XANES, **ME Fleet S Muthupari** 2000 AM 85 1009-21.
hsianghualite $Ca_3Li_2Be_3(SiO_4)_3F_2$. *Analcime zeolite/feldspathoid* families.
ANA type of 3D net.
Structure: **Section of Crystal Structure Analysis, Acad Geol Sci Acad Sinica** 1973 Acta Geol Sinica 240-2 = MA 74-1926;
RK Rastsvetaeva & 3 others 1991 SPD 36 11-3 (R492).
Occurrence: MM 32 960.
huanghoite $BaCe(CO_3)_2F$. *Parisite* mineral group.
Structure: **J Quian P Fu Y Kong G Gong** 1982 Acta Phys Sinica 31 577-84 = MA 85M/3834;
Z-M Yang F Pertlik 1993 NJMM 163-71;
MA 85M/3833,
94M/1614.
Occurrence: MM 33 1136.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
Polysomatic huanghoite-*zhonghuacerite*: **Z Yang K Tao P Zhang** 1996 NJMM 264-70 (Y181).
Synthetic $BaSm(CO_3)_2F$: **N Mercier M Leblanc** 1993 Eur J Solid State Inorg Chem 30 195-205.
See *cebaite* & *zhonghuacerite*.
huangite $Ca_{0.5}Al_3(SO_4)_2(OH)_6$. *Alunite* structure group. Ca analog of *walthierite*.
Structure: **G Li & 4 others** 1992 AM 77 1275-84.
hubeite $Ca_2MnFe[Si_4O_{12}(OH)].2aq$. Related to *babingtonite, inesite & rhodonite*.

Structure: SC-XRD, **MA Cooper FC Hawthorne** 2004 CM 42 825-34.
Occurrence & XRPD: **FC Hawthorne & 5 others** 2002 MR 33 465-71.

huebnerite $MnWO_4$. *Wolframite* structure group.

Based on alpha-PbO_2 (*scrutinyite*) connectivity. Isostructural series with Fe analog *ferberite*.

Structure: ND of magnetics at 4 K, **H Dachs E Stoll H Weitzel** 1967 ZK 125 120-9;
ND of $(Mn,Fe)WO_4$, **H Weitzel** 1970 ZK 131 289-313, 1976 ZK 144 238-58.

huegelite $Pb_2(UO_2)_3(AsO_4)_2(OH)_4.3aq$.

Phosphuranylite mineral group; beware of problems.
Structure determination not found.
Occurrence: **K Walenta** 1979 TMPM 26 11-9 (W690).

huemulite $Na_4MgV_{10}O_{28}.24aq$.

Crystallography, mineral & *synthetic*: **CE Gordillo & 3 others** 1966 AM 51 1-13.

hulsite $(Fe,Mg)_2(Fe,Sn,Mg)(BO_3)O_2$.

Mg analog is *magnesiohulsite* & Al analog is *alumino-magnesiohulsite*
$Mg_2(Al_{1-2x}Mg_xSn_x)O_2(BO_3)$.

6 Å Zigzag Borate: **MA Cooper FC Hawthorne** 1998 CM 36 1171-93.
Structure: **NA Yamnova MA Simonov NV Belov** 1975 SPC 20 89-90 (Y131);
do 1975 SPD 23 105-7 (Y114);
JA Konnert & 5 others 1976 AM 61 116-22.
Paragenesis of hulsite series, Yakutia & Karelia: **VV Rudnev** 1996 ZVMO 125 1 89-109.
Synthetic $Ni_{2.7}Sb_{0.3}BO_5$: **K Bluhm HK Müller-Buschbaum** 1990 J Less-Common Metals 158 339-45 (B1439) = SR 57A 242.

Synthetic $Mn^{II}SrMn^{III}(BO_3)O_2$: **A Utzolino K Bluhm** 1996 ZN 51b 1433-8 (U44).

humberstonite $Na_7K_3Mg_2(NO_3)_2.6aq$. Isostructural with *ungemachite.*

Structure: **PC Burns FC Hawthorne** 1994 CM 32 381-5 (B1611).
Occurrence: MM 36 1152.

humboldtine $FeC_2O_4.2aq$. Compare with *glushinskite*.

Structure: **F Mazzi C Garavelli** 1957 PMR 26 269-303 (M1325);
S Caric 1959 BSFMC 82 50-65 = MA 14-393.
Synthetic $(Mg/Mn/Fe/Co/Ni/Zn)C_2O_4.2aq$: **J Dubernat H Pezerat** 1974 JACr 7 387-93 (D561).

HUMITE STRUCTURE GROUP Includes:

alleghanyite	$Mn_5(SiO_4)_2(OH)_2$	
[*calciochondrodite*	$Ca_5(SiO_4)_2(OH)_2$]	* alternate name below
[*calcium chondrodite*	$Ca_5(SiO_4)_2(OH)_2$]	*
chondrodite	$Mg_5(SiO_4)_2(F,OH)_2$	
[*chondrodite, calcium*	$Ca_5(SiO_4)_2(OH)_2$]	*
chondrodite-titanian clinohumite	$(Mg,Fe)_9(SiO_4)_4\ (F,OH)_2$	
clinohumite-titanian humite	$(Mg,Fe)_7(SiO_4)_3(F,OH)_2$	
jerrygibbsite	$Mn_9(SiO_4)_4(OH)_2$	dimorphic with *sonolite*
leucophoenicite	$Mn_7(SiO_4)_3(OH)_2$	
manganhumite	$(Mn,Mg)_7(SiO_4)_3(F,OH)_2$	
norbergite	$Mg_3SiO_4(F,OH)_2$	
sonolite	$Mn_9(SiO_4)_4(OH,F)_2$	dimorphic with *jerrygibbsite*

Polysomatic series.
Crystal chemistry: **NW Jones PH Ribbe GV Gibbs** 1969 AM 54 391-411.
Ti, F & OH substitution: **PH Ribbe** 1979 AM 64 1027-35.
Ti(IV)-Fe(II) charge transfer, polarized electronic absorption/XRD: **K Langer & 3 others** 2002 EJM 14 1027-32 (8674).
Electron microscopy: **TJ White BG Hyde** 1982 PCM 8 22-63.
Crystal chemistry, SC-XRD structure, Fe-rich clinohumite: **AN Platonov & 4 others** 2001 ZK 216 154-64 (1669).

humite $(Mg,Fe)_7(SiO_4)_3(F,OH)$. Humite structure group.
Structure: **PH Ribbe GV Gibbs** 1971 AM 56 1155-73;
Mg,Mn-, **CA Francis PH Ribbe** 1978 AM 63 874-7.
Synthetic $Mg_7Si_3O_{12}(OH)_2$: **B Wunder & 3 others** 1995 AM 80 638-40.
hummerite $KMgV_5O_{14}.8aq$.
Structure: SC-XRD, **JM Hughes & 3 others** 2002 CM 40 1429-35.
Occurrence: **AD Weeks EA Cisney AM Sherwood** 1951 AM 36 326-7.
hunchunite Au_2Pb.
Occurrence: **S Wu Y Yang Q Song** 1992 Acta Min Sinica 12 319 = MM 60 532.
hungchaoite $MgB_4O_5(OH)_4.7aq$.
Structure: **C Wan S Ghose** 1977 AM 62 1135-43.
huntite $CaMg_3(CO_3)_4$. Isostructural with *daqingshanite*.
Structure: **DL Graf WF Bradley** 1962 AC 15 238-42;
WA Dollase RJ Reeder 1986 AM 71 163-6.
Occurrence: MM 30 734.
In white pigment of Egyptian tombs: **M Uda & 7 others** 2000 Nw 87 260-3 (U364).
Synthetic huntite-II polymorph, quenched from 6 GPa ~1300K: **L Liu C Lin** 1995 EPSL 134 297-305 (L697).
Synthetic borates, $(Y/Nd/Sm/Eu/Gd/Tb/Dy/Ho/Yb/Er)Al_3B_4O_{12}$, also Cr-: AM 47 1380-3.
Synthetic $Y_{1-x}Nd_x(Al_{0.7}Ga_{0.3})_3(BO_3)_4$ & $Y_{1-x}Yb_xAl_3(BO_3)_4$: **G Aka & 4 others** 1995 JMC 5 583-7 (A591).
Synthetic $(Y/La/Nd)Fe_3(BO_3)_4$, structure, magnetic order/ vibrations: **JA Campá & 5 others** 1997 ChM 9 237-40 (C876).
hureaulite $Mn_5(PO_4)_2[PO_3OH]_2.4aq$. Isostructural with *sainfeldite*
$Ca_5(AsO_4)_2(AsO_3OH]_2.4aq$ & *villyaellenite* $(Mn,Ca)_5(AsO_3OH)_2(AsO_4)_2.4aq$.
Structure: **PB Moore T Araki** 1973 AM 58 302-7 (M1150);
S Menchetti C Sabelli 1973 AC B29 2541-8;
synthetic, **Y Gerault A Riou Y Cudennec** 1987 AC C43 1829-30 (G811);
XRPD, **HS De Amorim & 3 others** 1996 JMSL 15 1895-7 (D606).
Occurrence: MM 29 984. [Also used for ZnS-4H: MM 29-984.]
hurlbutite $CaBe_2(PO_4)_2$. *Paracelsian* structure type.
Structure: **VV Bakakin NV Belov** 1961 SPD 5 1141-4 (B1130);
JT Lindbloom GV Gibbs PH Ribbe 1974 AM 59 1267-71;
VV Bakakin GM Rylov VI Alekseev 1975 SPC 19 798-9.
Synthetic $SrZn_2(PO_4)_2$-alpha: **A Hemon G Courbion**1990 JSSC 85 164-8 (H1040).
hutchinsonite $(Pb,Tl)_2As_5S_9$.
Structure: **Y Takéuchi S Ghose W Nowacki** 1965 ZK 121 321-48 (T87);
Y Matsushita Y Takéuchi 1994 ZK 209 475-8 (M1142).
Hutchinsonite family of merotypes: **E Makovicky** 1997 EMU Notes in Mineralogy 1 237-71;
P Berlepsch & 4 others 2001 ZK 216 273-7 (2001).
huttonite $ThSiO_4$. *Monazite* structure group. Dimorphic with *thorite*.
Structure: **M Taylor RC Ewing** 1978 AC B34 1074-9.
Heavy-ion irradiation, decomposition, amorphization, recrystallization: **A Meldrum & 3 others** 1999 PRB 59 3981-6.
Occurrence: MM 29 984.
hyalophane $(K,Ba)Al(Si,Al)_3O_8$.
Feldspar structure group; intermediate composition range between *celsian* & K-feldspar.
Structure: **R De Pieri S Quareni KM Hall** 1977 AC B33 3073-6.
hyalotekite $(Ba,Pb,Ca,K)_6(B,Si,Al)_2(Si,Be)_{10}O_{28}(F,Cl)$.
Isotypic with *kapitsaite-Y* $(Ba,K,Pb,Na)_4(Y,Ca,REE)_2Si_8B_2(B,Si)_2O_{28}F$.
Approximately similar to *gillespite*.
Structure: **PB Moore T Araki S Ghose** 1982 AM 67 1012-20.
New occurrence, chemical range & crystal chemistry: **ES Grew & 5 others** 1994 MM 58 285-97.
Pb analog, Langban, superstructure, transitions: **AG Christy & 4 others** 1998 MM 62 77-92.
[hydralsite *synthetic* decomposition product of *kaolinite*: MM 30 734.]
hydro-andradite *Garnet* type. Occurrence: MM 37 958.
hydroastrophyllite $(H_3O,K)_2Ca(Fe,Mn)_{5-6}Ti_2Si_8O_{26}(OH)_4F$. *Astrophyllite* structure group.

Structure determination not found.
Occurrence: **X-ray Lab, Hubei Geologic College** 1974 Sci Geol Sinica 1 18-33 = AM 60 736.
hydrobasaluminite $Al_4(SO_4)(OH)_{10}.12$-36aq. Review: **Sabelli**, no structure.
Occurrence: **P Tien** 1968 AM 53 722-32;
JA Sunderman CW Beck 1969 AM 54 1363-73.
Metabasaluminite, produced by heating at 423 K: MM 29 989.
hydrobiotite 1:1 regular *biotite-vermiculite* layer structure.
History, nomenclature, interpretation of XRD: **GW Brindley PE Zalba CM Bethke** 1983 AM 68 420-5.
Synthetic U(6+) sorption complex, XANES/EXAFS, **EA Hudson & 8 others** 1999 ClClM 47 439-57 (H1439).
hydroboracite $CaMgB_6O_8(OH)_6.3aq$. Chain of 3-rings of 1 triangle & 2 tetrahedra.
Structure: **IM Rumanova A Ashirov** 1964 SPC 8 665-80 (R504);
A Ashirov IM Rumanova NV Belov 1963 SPD 1075-7;
C Sabelli A Stoppioni 1978 CM 16 75-80.
hydrocalumite $Ca_2Al(OH)_6[Cl_{1-x}(OH)_x].3aq$. = Friedel's salt.
Monoclinic & rhombohedral types with *brucite*/interlayer general structure.
Synthetic relatives made because of reactions in Portland cement:
HFW Taylor 1973 MM 39 377-89 (T186;
chloride binding, **UA Birnin-Yaori FP Glasser** 1998 Cement Concrete Res 28 1713-23;
molecular modeling, **AG Kalinichev RJ Kirkpatrick RT Cygan** 2000 AM 85 1046-52..
Structure of $Ca_2Al(OH)_6Cl.2aq$: **A Terzis & 3 others** 1987 ZK 181 29-34.
Crystal structure, natural, review of cement-related phases: **M Sacerdoti E Passaglia** 1988 NJMM 462-75 (S1452).
Occurrence: MM 23 630-1.
[$Ca_4Al_2(OH)_{12}SO_4.6aq$. IMA 96-053. Rhombohedral analog of *hydrocalumite*.]
Lamellar Ca Al hydrate similar to hydrocalumite: **SJ Ahmed HFW Taylor** 1967 N 215 622-3;
SJ Ahmed LS Dent Glasser HFW Taylor 1969 Proc 5th Int Symp Chemistry of Cement, paper II-77, 118-27.
Double-layer struct $3CaO.Al_2O_3.CaSO_4.12aq$: **R Allmann** 1968 NJMM 140-4; **do**, 1977 136-4.
Dehydration/decomposition: 3-step structure change, XRD: **L Vieille & 4 others** 2003 ChM 15 4361-8 (9627); polymer incorporation, 4369-76.
Synthetic bromide relative:
F Le Bel G Grasland 1969 Proc 5th Int Symp Chemistry of Cement, paper II-14, 79-83;
H Kuzel 1969 Proc 5th Int Symp Chemistry of Cement, paper II-29, 104-17.
Synthetic chloride/iodide relatives: **H Kuzel** 1969 Proc 5th Int Symp Chemistry Cement, paper II-29, 104-17.
Synthetic Cl-intercalated, NMR, DSC, XRD: **RJ Kirkpatrick P Yu X Hou Y Kim** 1999 AM 84 1186-90.
Synthetic -hydrotalcite $Ca_2(Al/Ga/Fe/Sc)_2(OH)_6Cl.2aq$: **I Rousselet & 5 others** 2002 JSSC 167 137-44 (7916).
Polymer derivatives: high-T XRPD, **L Vielle & 4 others** 2003 ChM 15 4361-8;
in situ polymerization of styrene-4-sulfonate, **do & 3 others**, 4369-76 (10065).
[*kuzelite* $Ca_4Al_2(OH)_{12}(SO_4).6aq$ is regarded as member of mineral group.]
hydrocerite $(Ce,La,etc.)(Al,etc.)(Si,P)_2O_7.5aq$. Amorphous.
Occurrence: **KA Vlasov MV Kuz'menko EM Es'kova** 1959 Akad Nauk SSSR 427-9 = AM 45 1131.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
hydrocerussite $Pb_3(CO_3)_2(OH)_2$.
Structure: **JM Cowley** 1956 AC 9 391-6 (C747) jvs: warning this structure may be wrong;
N&XRD, **IM Steele JJ Pluth JW Richardson Jr** 1997 in preparation;
synthetic, XRPD, **P Martinetto & 4 others** 2002 AC C58 i82-4 (7452).
Basic lead carbonates, review of *hydrocerussite* & *plumbonacrite*: **JK Olby** 1966 J Inorg Nucl Chem 28 2507-12 = AM 52 563 (concludes that different mineral structures, but M. Fleischer requires proof).
Synthetic $Pb_2(CO_3).BaF_2$: **M Weil** 2002 ACC 58 1132-4 (8054).
[*Synthetic* $Pb_3(CO_3)O_2/NaPb_2(CO_3)_2(OH)$, SC-XRD structure: **SV Krivovichev PC Burns** 2000 MM 64 1077-87.]
Gibbs energy: **MA Mercy & 3 others** 1998 AM 83 739-45.
hydrochlorborite $Ca_2B_4O_4(OH)_7Cl.7aq$.
Three-ring (triangle & 2 tetrahedra) & single tetrahedron.
Structure: **GE Brown JR Clark** 1978 AM 63 814-23.
Occurrence: MM 35 1136.
hydrodelhayelite $KCa_2(Si_7Al)O_{17}(OH)_2.6aq$.

Structure determination not found.
Occurrence: **MD Dorfman MI Chiragov** 1979 New Data on Minerals of the USSR = MA 72 104.
[jvs: is this merely same structure as *delhayelite*, except for minor change of hydration state?].
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.
hydrodresserite $BaAl_2(CO_3)_2(OH)_4.3aq$.
Structure: **JT Szymanski** 1982 CM 20 253-62.
Occurrence: MM 42 525.
hydrogarnet General term for hydroxyl-garnet; includes *katoite*.
From rodingite & metarodingite rocks: **R Basso A Della Giusta L Zefiro** 1981 NJMM 230-6;
R Basso F Cimmino B Messiga 1984 NJMA 148 246-58 (B1368).
Occurrence: MM 26 337.
Synthetic $Ca_3Al_2(OH)_{12}$: **GA Lager T Armbruster J Faber** 1987 AM 72 756-65;
T Armbruster GA Lager 1989 EJM 1 363-9;
deuterated, ND to 9 GPa, **GA Lager RB Von Dreele** 1995 GSAAP 27 A364
& IR, **GA Lager & 3 others** 2005 AM 90 639-44.
Effect of pressure, ab initio study: **RH Nobes & 5 others** 2000 AM 85 1706-15.
See garnet for various synthetics.
[hydrogen H_2. Possible solid phase at low T.
Structure data added from Nov 1996.
Structure: **P Loubeyre & 6 others** 1996 N 383 702-4 (L770).
Making metallic hydrogen: **WJ Nellis** 2000 SA May 84-90 (N526).
Quantum distribution of protons: **H Kitamura et al** 2000 N 404 259-62, news & views, 240-1 (K1226).]
hydroglauberite $\sim Na_4Ca(SO_4)_3.2aq$.
Structure determination not found.
Occurrence: **MN Slyusareva** 1970 ZVMO 98 59-62.
hydrogrossular $Ca_3Al_2Si_{3-x}O_{12-4x}(OH)_{4x}$. *Garnet* structure type.
Ti-rich: **R Basso A Della Giusta L Zefiro** 1981 NJMM 230-6.
Plazolite: **do** 1983 NJMM 251-8 (B758).
Hibschite: **GA Lager & 3 others** 1989 AM 74 840-51;
Katoite: **M Sacerdoti E Passaglia** 1985 BM 108 1-8 (P312);
Occurrence: MM 27 270.
hydrohalite NaCl.2aq.
Structure: *synthetic* at 105K, **B Klewe B Pedersen** 1974 AC B30 2363-71.
[hydrohausmannite is mixture with *feitknecktite*.]
hydrohematite $Fe_{2-x}(OH)_{3x}O_{3-3x}$.
XRPD & IR interpreted as defect *hematite* structure: **E Wolska** 1981 ZK 154 69-75 (W695).
hydrohetaerolite $ZnMn_4O_8.aq$. Tetragonal distortion of *spinel* structure.
Essentially isostructural with *hausmannite* & *hetaerolite*.
Structure: **AD Wadsley** 1955 AM 40 349-53.
hydrohonessite $\sim Ni_{6.4}Fe_{2.6}(SO_4)(OH)_{16}.7aq$.
Hydrated relative to *honessite* & isostructural carbonate *reevesite*.
Crystal chemistry & paragenesis: **DL Bish A Livingstone** 1981 MM 44 339-43.
Review: **Sabelli** p.21.
Occurrence & matching XRPD with *carrboydite*, *mountkeithite*, *unnamed NiAl sulfate* & *green rust*: **EH Nickel JE Wildman** 1981 MM 44 333-7.
CuAl analog: MM 54 649-53.
hydrolepidocrocite **(= hydrogoethite)** FeOOH.aq-gamma.
Occurrence: MM 27 270.
hydromaghemite Intermediate during hydrothermal transformation of *2-line ferrihydite* into *hematite*: **V Barron J Torrent E DE Grave** 2003 AM 88 1679-88.
hydromagnesite $Mg_5(CO_3)_4(OH)_2.4aq$.
Lansfordite mineral group of hydrated Mg carbonates.
Isostructural with Ni analog *widgiemoolthalite* $(Ni,Mg)_5(CO_3)_4(OH)_2.4\text{-}5aq$ & Cu analog *cuprohydromagnesite* $(Cu,Mg)_5(CO_3)_4(OH)_2.4aq$.

Structure: **M Akao F Marumo S Iwai** 1974 AC B30 2670-2;
M Akao S Iwai 1977 AC B33 1273-5 = MA 79-204.

Yoshikawaite $Mg_5(CO_3)_4(OH)_2.8aq$ is higher hydrate that decomposes to *hydromagnesite*.

hydrombobomkulite $(Ni,Cu)Al_4[(NO_3)_2,(SO_4)](OH)_{12}.13\text{-}14aq$.

Review: **Sabelli**, no structure.

Occurrence: **JEJ Martini** 1980 Transvaal Geol Survey S Africa 14 1-110 = AM 67 415-6.

hydromolysite $FeCl_3.6aq$. Review: **Sabelli**, no structure.

Occurrence: **C Garavelli** 1965 ZVMO 94 189 = AM 51 1551.

[hydronephelite = *nepheline hydrate*

jvs: *synthetic* materials are based on the IZA-SC net JBW.

The status of a mineral analog needs clarification.]

hydronium jarosite $(H_3O)Fe_3(SO_4)_2(OH)_6$. Review: **Sabelli**, p.25.

Structure: **CM Warshaw** 1956 AM 41 288-96.

Occurrence: MM 32 961. MM 43 682.]

hydroromarchite $Sn_3O_2(OH)_2$.

Structure: **RA Howie W Moser** 1968 N 219 372-3;
do 1968 AM 58 552.

XRPD matches *synthetic*: 1961 AC 14 65 (D503).

Occurrence: CM 10 916; AM 57 1555; AM 58 552; CM 41 659-69;
corrosion of pewter, **RA Ramik RM Organ JA Mandarino** 2003 CM 41 649-57 .

hydroscarbroite $Al_{14}(CO_3)_3(OH)_{36}.naq$.

Structure determination not found.

Occurrence: **WJ Duffin J Goodyear** 1960 MM 32 362-3;
GW Brindley JJ Cromer 1960 MM 32 363-5.

hydroserpentine $Mg_3Si_2O_5(OH)_4.naq$.

Occurrence: MM 32 961.

[hydrosodalite see *sodalite*.

Occurrence: MM 32 961-2.

Gallosilicate, phase transitions, XRPD: **TM Gesing** 2000 ZK 215 510-7 (G1211).]

HYDROTALCITE/PYROAURITE GROUP OF 3-LAYER RHOMBOHEDRAL CARBONATES, SULFATES & CHLORIDE (compare 2H manasseite)

Includes:

caresite-3T	$Fe_4Al_2(OH)_{12}CO_3.3aq$
charmarite-3T	$Mn_4Al_2(OH)_{12}CO_3.3aq$
comblainite	$(Ni,Co)(OH)_2(CO_3)_{0.5\text{-}x/2}.\ y\ aq$
desautelsite	$Mg_6Mn_2(CO_3)(OH)_{16}.4aq$
eardleyite	$\sim Ni_5Al_3(CO_3)_2(OH)_{14}.5aq$
glaucocerinite	$(Zn,Cu)_5Al_3(SO_4)_{1.5}(OH)_{16}.9\ aq$
honessite	$Ni_6Fe_2(SO_4)(OH)_{16}.4aq$
hydrotalcite	$Mg_6Al_2(CO_3)(OH)_{16}.4aq$
hydrowoodwardite	higher hydrate of *woodwardite* $Cu_{1-x}Al_x(OH)_2(SO_4)_{x/2}.n\ aq,\ x<0.67,\ n>\sim 3x/2$
iowaite	$Mg_6Fe_2(OH)_{16}Cl_2.4aq$
meixnerite	
pyroaurite	$Mg_6Fe_2(CO_3)(OH)_{16}.4aq$
quintinite-3T	$Mg_4Al_2(OH)_{12}CO_3.3aq$
reevesite	$Ni_6Fe_2(CO_3)(OH)_{16}.4aq$
stichtite	$Mg_6Cr_2(CO_3)(OH)_{16}.4aq$
takovite	$Ni_6Al_2(CO_3,OH)(OH)_{16}.4aq$
wermlandite	$Mg_7(Ca,Mg)(Al,Fe)_2(SO_4)_2(OH)_{18}.12aq$
woodallite	$Mg_6Cr_2\ (OH)_{16}Cl_2.4aq$
woodwardite	$Cu_4Al_2(SO_4)(OH)_{12}.2\text{-}4aq$

zincowoodwardite

hydrophilite $CaCl_2$.

Synthetic anhydrous phase has deformed *rutile* structure: Structure Reports IX.

[jvs: the mineralogy may be confused by hydration to *sinjarite* $CaCl_2.2aq$ & *antarcticite* $CaCl_2.6aq$: cf $[Zn_{1-x}Al_xOH_2](SO_4)_{x/2}.n\ aq$

Polytypes, enumeration & diffraction features: **AS Bookin VA Drits** 1993 ClClM 41 551-7.

Review: **HFW Taylor** 1973 *Crystal structures of some double hydroxide minerals*, MM 39 377-89.

Review: double-layer minerals with brucite-like layers/interlayers: **G Raade CJ Elliott VK Din** 1985 MM 49 583-90.

Chemistry between the sheets: **S Carlino** 1997 CB Sept 59-62 (C956).

Experimental determination of polytypes in natural minerals, *manasseite,* 2-layer, *hydrotalcite*, *reevesite* & *stichtite* 3-layer: **AS Bookin VI Cherkashin VA Drits** 1993 ClClM 41 558-64.

Manasseite group has similar, but $2H_1$, structure.

Meixnerite $Mg_6Al_2(OH)_{18}.4aq$, is also rhombohedral, but with half *c* compared with *hydrotalcite*.

Compare with *carrboydite* $(Ni,Cu)_{14}Al_9(SO_4,CO_3)_6(OH)_{43}.7aq$?

Synthetic $Mg_6Al_2(N_2O_5)(OH)_{16}.4aq$: MM 30 742.

Synthetic $LiAl_2(OH)_6$-X-naq: **JC Serna JL Rendon JE Iglesias** 1982 ClM 30 180-4.

Synthetic $Zn_{1-x}Al_x(OH)_2(CO_3)_{x/2}.naq$: **F Thevenot R Szymanski P Chaumette** 1989 ClClM 37 396-402.

Synthetic Co(II)-Fe(III)-type, XRPD: **HCB Hansen CB Koch RM Taylor** 1994 JSSC 113 46-53.

Synthetic $Co_{0.68}Fe_{0.31}(OH)_2(CO_3)_{0.14}.y\ aq$: **HCB Hansen CB Koch** 1994 IC 33 5363-5.

Synthetic Ni-Al-Cr/Fe carbonates, XRPD/IR: **F Kooli K Kosuge A Tsunashima** 1995 JSSC 118 285-91.

Synthetic $Mg_{1-x}Al_x(OH)_2(CO_3)_{x/2}.naq$: **SK Yun TJ Pinnavaia** 1995 ChM 7 348- 54.

Synthetic Mg-Zn-Al hydroxysulfates: **F Cooli & 3 others** 1993 JMS 28 2769-73.

Hydrotalcite-manasseite group: **VA Drits & 3 others**1987 ClClM 35 401-17 (not approved by CNMMN).

Synthetic Ni-Al-decavanadate-pillared: **F Kooli V Rives MA Ulibarri** 1995 IC 34 5114-21.

Synthetic Cr-Zn-hydroxide-pillared: **N Gutmann B Müller H-J Tiller** 1995 JSSC 119 331-8.

*Synthetic s*orbents for phenols in water: **MA Ulibarri & 3 others** 1995 Appl Clay Sci 10 131-45.

Synthetic with silicate anions inside interlamellar domains of Zn-Al & Zn-Cr layered double hydroxides: **C Depege & 5 others** 1996 ChM 8 952-60 (D573).

Inserted nuclear dihydroxo-bridged Cr(III) aquo complex: **N Gutmann B Müller** 1996 JSSC 122 214-20 (G849).

Synthetic polyvanadate-intercalated MgAl hydrotalcite-like: **M Ulibarri & 5 others** 1994 IC 33 2592-9 (U42).

Synthetic Cu/Zn/Co/Al/Cr-: **P Porta S Morpurgo** 1995 Appl Clay Science 10 31-44.

Synthetic Ni-Al-: **E Merlen et al** 1995 Appl Clay Science 10 45-56.

Synthetic oligovanadate pillared: **A Bhattarcharya DB Hall TJ Barnes** 1995 Appl Clay Science 10 57-67.

Synthetic Ni(II)/Mn(III)- & calcined products: **C Barriga & 4 others** 1996 JSSC 124 205-13.

Synthetic intercalated CuCr-: **C Depege & 4 others** 1996 JSSC 126 314-23 (D614).

Thermal behavior Zn-Cr double hydroxides with carbonate/decavanadate: **M del Arco & 3 others**1996 JMC 6 1419-28.

Synthetic Mg-Al-Y-carbonate: **JM Fernández & 4 others** 1997 ChM 9 312-8 (F521).

Synthetic Ni/Mg/Al mixed oxides from hydrotalcite precursors, ND: **M Gazzano & 3 others** 1997 JPCB 101 4514-9.

Synthetic $(Mg_{1-x}Ga_x)(CO_3)_{x/2}.m\ aq$: **E López-Salinas & 3 others** 1997 JPC B 101 5112-7 (L846); **E Lopéz-Salinas & 5 others** 1997 La 13 4748-53 (L859).

Synthetic Al-Mg/Ni/Zn-CO_3-aq: **U Costantino & 3 others** 1998 EJIC 1439-46 (C1072).

Synthetic Mg/Al & Mg/Zn/Al, IR of dehydroxylation: **JT Kloprogge RL Frost** 1999 PCCP 1 1641-7 (K1140).

Synthetic Ni(II) & Fe(II), XRPD, XAS, FT-IR, calcination: **M del Arco & 3 others** 1999 ChM 11 624-33 (D767).

Synthetic Cl-intercalated, NMR, DSC, XRD: **RJ Kirkpatrick P Yu X Hou Y Kim** 1999 AM 84 1186-90.

Synthetic Mg/Ni/Co, FTIR & Raman: **JT Kloprogge RL Frost** 1999 JSSC 146 506-15 (K1178).

Synthetic Mg/Mn/Al double hydroxides, Mn vs catalytic oxidation toluene: **S Velu & 3 others** 1999 MMM 33 61-75 (V356).

Synthetic compounds with selenate & selenite, NMR/XRPD: **X Hou RJ Kirkpatrick** 2000 ChM 12 1890-7 (H1480).

Synthetic Mg-Al-carbonates, XRPD liquid-phase reconstruction: **F Millange RI Walton D O'Hare** 2000 JMC 10 1713-20.

Synthetic borate/silicate-nitrate exchange: **M del Arco et al** 2000 JSSC 151 272-80 (D795).

Nitrate ion structure & dynamics, NMR: **X Hou & 4 others** 2000 AM 85 173-80.

Synthetic Mg-Al, effect of hydrothermal treatment, XRPD, Raman & IR: **L Hickey JT Kloprogge RL Frost** 2000 JMS 35 4347-55 (H1502).

Guest-host relations of anion-exchanged Mg-Al-: **F Malherbe J Besse** 2000 JSSC 155 332-41 (802).

Phenol-intercalated, structure change on heating: **J Cornejo & 4 others** 2000 ClM 35 771-9 (450).

Fluorescein intercalated Zn-Al-: **U Constantino & 5 others** 2000 La 16 10351-8 (700).

Synthetic Mg-Al-, XAS calcinations/rehydration: **JA van Bokhoven & 3 others** 2001 Chem Eur J 7 1258-65 (1689).

Thermal decomposition of Zn/Fe/Al-: **I Crespo & 5 others** 2001 ChM 13 1518-27 (2110).
Textures vs Mg substitution by Cu/Fe: **G Carja & 3 others** 2001 MMM 47 275-84 (3132).
Catalytic organic reactions: **BF Sels DE De Vos PA Jacobs** 2001 Catal Rev 43 443-88 (3920).
Synthetic hydrocalumite- $Ca_2(Al/Ga/Fe/Sc)_2(OH)_6Cl.2aq$: **I Rousselet & 5 others** 2002 JSSC 167 137-44.
Synthetic Mg/Zn/Co/Ni-, thermodynamic stability: **CA Johnston FP Glasser** 2003 ClClM 51 1-8 (8606).
Cl-, far-IR & molecular dynamics model: **J Wang & 3 others** 2003 AM 88 398-409.
Removal of selenite from water: **J Das D das GP Dash KM Parida** 2002 JCIS 251 26-32 (7764).
Synthetic Ti(IV)-: **N Das A Samal** 2004 MMM 72 219-25 (10465).
Synthetic Zn-Al-: **JT Kloprogge & 2 others** 2004 JSSC 177 49047-57 (10864).
Synthetic Mg-Al-SO from acid wastewater: **E Alvarez-Ayuso HW Nugteren** 2005 ClClM 53 18-27.

hydrotalcite $Mg_6Al_2(CO_3)(OH)_{16}.4aq$. Hydrotalcite structure group.

Structure: *synthetic*, 1D, **GJ Ross H Kodama** 1967 AM 52 1036-47;
claim that Ross-Kodama wrong, **R Allman** 1968 AM 53 1057-8; defense, 1058-60;
R Allman HP Jepsen 1969 NJMM 544;
IR & Raman of interlayer anions, **JT Kloprogge & 3 others** 2002 AM 87 623-9.
Hydration, models of structure & energetics: **J Wang & 3 others** 2001ChM 13 145-50 (1009)
With Mg-rich clay in mudstone, Greece: **A Hall MG Stamatakis** 2000 JSR 70 549-58 (H1481).
Ambient *synthesis*, evolution & XRD/TEM/AEM/EXAFS of Co,Al-: **HA Thompson GA Parks GE Brown Jr** 1999 ClClM 47 425-38 (T628).
Phenol-intercalated, structure change on heating: **J Cornejo & 4 others** 2000 ClM 35 771-9 (450).
Nine papers in Appl Clay Sci 2001 18 17-101 = MA 01M/2461-9.
Thermochemistry: **Rk Allada A Navrotsky J Boerio-Goates** 2005 AM 90 329-35.
Synthetic, deuterated, IR/Raman: **JT Kloprogge & 2 others** 2002 JMSL 21 603-5 (7515).
Important in industry as an anion exchanger; occurs as waste product.

hydrotungstite $H_2WO_4.aq$.

Isostructural? with *molybdic acid*, similar crystallography: **RS Mitchell** 1963 AM 48 935-9.
Occurrence: **PF Kerr F Young** 1944 AM 29 192-210;
RS Mitchell 1963 AM 48 935-9.
Synthetic $MoO_3.2aq$: structure, **I Lindqvist** 1950 Acta Chem Scand 4 650-7.

hydrougrandite $(Ca,Mg,Fe)_3(Fe,Al)_2(SiO_4)_{3-x}(OH)_{4x}$. *Garnet* structure group.

Structure determination not found.
Occurrence: **TY Lung** 1965 AM 50 2100.

hydrowoodwardite $Cu_{1-x}Al_x(OH)_2(SO_4)_{x/2}.n\ aq$. *Hydrotalcite* group.

Description: **T Witzke** 1999 NJMM 75-86.

hydroxyapatite see **hydroxylapatite**

hydroxyapophyllite $KCa_4Si_8O_{20}(OH,F).8aq$. *Apophyllite* structure group.

Structure: **VF Ivlev NI Zavarzina SP Gabuda** 1969 SPC 13 705-9 (I117);
GY Chao 1971 AM 56 1234-42;
GY Chao E Prince 1971 AM 56 1243-51;
AA Colville CP Anderson PM Black 1971 AM 56 1222-33;
RC Rouse DR Peacor PJ Dunn 1978 AM 63 199-202.
Occurrence: MM 42 525.
Mineral definition/nomenclature *apophyllite* group: **PJ Dunn RC Rouse JA Norberg** 1978 AM 63 196-9.

hydroxycancrinite $Na_8Al_6Si_6O_{24}(OH)_2.2aq$. *Cancrinite* structure type.

Occurrence: **AP Khomyakov & 3 others** 1992 ZVMO 121 100-5.
Matches *synthetic hydrocancrinite*: structure, **PN Bresciani & 2 others** 1982 AC 38 893-5.
Occurrence in hyperagpaitic alkaline rocks: **Khomyakov** 1995.
Synthetic with Fe substitution: CA 125:291433u.

hydroxyellestadite $Ca_{10}(SiO_4)_3(SO_4)_3(OH,Cl,F)_2$. *Apatite* structure type.

Structure: **K Sudarsanan** 1980 AC B36 1636-9;
JM Hughes JW Drexler 1991 NJMM 327-36 (H976).
Occurrence: MM 38 993.

hydroxylapatite $Ca_5(PO_4)_3OH$. *Apatite* structure type.

Important in medicine because of mineralized tissue & epitaxial growth on octacalcium phosphate: **ME Fernandez & 4 others** 2003 ACB 59 175-81 (8943).

Structure: **AF Posner A Perloff AF Diorio** 1958 AC 11 308-9;
MI Kay RA Young AS Posner 1964 N 204 1050-2;
K Sudarsanan RA Young 1969 AC B25 1534-43;
AA Colville CP Anderson 1971 AM 56 1222-35;
monoclinic, **JC Elliott PE Mackie RA Young** 1973 S 180 1055-7;
JM Hughes M Cameron KD Crowley 1989 AM 74 870-6;
AT Sänger WF Kuhs 1992 ZK 199 123-48;
heated and cooled, XRPD, FTIR, **H Tanaka et al** 2000 PCCP 2 3617-50 (T651).
Synthesis, amino acids with uncharged polar side groups; inhibition of clinical failure of bioprosthetic cardiac valves: **S Koutsopoulos E Dalas** 2001 La 17 1074-9 (2109).
Synthetic nanocrystalline: **J Cihlar K Castkova** 2002 Monat Chem 133 761-71 (7665).
Occurrence: MM 25 632.
In meteorites: **AE Rubin** 1997 MPS 32 231-47.
Synthetic Sr-substituted: **M Kikuchi & 4 others** 1994 JSSC 113 373-8 (K693).
Pb-substituted: **A Bigi & 5 others** 1988 ZK 185 476, 1989 AC B45 247-51(B1366).
Synthetic, XRPD of 5, 14, 20 & 31% Mg: **A Bigi & 5 others** 1996 AC B52 87-92 (B1459).
Synthetic monoclinic, XRPD structure: **T Ikoma & 3 others** 1999 JSSC 144 272-6 (I249).
Synthetic $Ca_9Na_{0.5}(PO_4)_{4.5}(CO_3)_{1.5}(OH)_2$, XRPD structure: **H El Feki JM Savariault A Ben Salah** 1999 JAlCo 287 114-20 (E459).
Dental enamel, caries & crystal chemistry: **SEP Dowker & 3 others** 1999 MM 63 791-800.
Reduced growth of 0001 face by Mg & Zn: **N Kanzaki et al** 2000 JPC B104 4189-94 (K1232).
Interdependence of Pb & Cl exchange: **S Sugiyama et al** 1999 JCIS 320 324-8 (S2129).
Crystallization in presence of lysine: **S Koutsopoulos E Dalas** 2000 JCIS 231 207-12 (138).
Deuterated, FTIR: **T Ishikawa & 4 others** 2000 La 16 10221-6 (701).
Human from aortic valve stenoses: chemical analysis & XRPD structure, **L Stork & 3 others** 2005 ZK 220 201-5 (11035).
Synthetic B-subst, IR/Raman/MAS-NMR: **R Ternane & 7 others** 2002 JAlCo 333 62-71 (6782).
Synthetic Mn-containing: **I Maker & 7 others** 2003 EJIC 1445-51 (8847).
Synthetic Mg-substituted, IR/XRD: **IV Fadeev & 3 others** 2003 IMa 39 947-50 (9582).
Synthetic Cu/Fe/Mn, XRPD structure/TEM: **B Sutter & 3 others** 2003 SSSAJ 67 1935-42 (9614).
Synthetic Cd-: **K Zhu & 3 others** 2004 JSSC 177 4379-85 (10915).
hydroxylbästnäsite-Ce $(Ce,La)(CO_3)(OH,F)$. Isostructural with *bästnäsite*.
Occurrence: **AS Kirilov** 1964 DAN 159 1048-50 = AM 50 108; AM 51 1819.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
hydroxylbästnäsite-La $(Ce,La)(CO_3)(OH,F)$.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
hydroxylbästnäsite -Nd $(Nd,La,Pr)(CO_3)(OH,F)$. Isostructural with *bästnäsite*.
Occurrence: **L Farkas Z Maksimovic G Panto** 1985 NJMM 298-304 (F449). MM 50 747.
Review: **AP Jones F Wall CT Williams** 1996 Rare earth minerals.
[hydroxylcarbonate-La *Bastnäsite* group.
Occurrence/ XRD:**GY Panto Z Maksimovic** 1995 Geol Soc Greece Spec Pap 4 460-4 = MA 98M/3007.]
[hydroxylcarbonate-Nd Bastnäsite group.
Occurrence/ XRD:**GY Panto Z Maksimovic** 1995 Geol Soc Greece Spec Pap 4 460-4 = MA 98M/3007.]
hydroxylchondrodite $Mg_5(SiO_4)_2(OH,F)_2$. *Humite* group.
^{17}O multiple-quantum MAS NMR: **SE Ashbrook AJ Berry S Wimperis** 2001 JAChS 123 6360-6 (2117).
hydroxylclinohumite $Mg_9(SiO_4)_4(OH,F)_2$. Humite group.
Occurrence & SC-XRD structure: **G Ferraris et al** 2000 ZK 215 169-73 (F687).
^{17}O multiple-quantum MAS NMR: **SE Ashbrook AJ Berry S Wimperis** 2001 JAChS 123 6360-6 (2117).
Synthetic, deuterated, NPD, H bonding: **AJ Berry M James** 2001 AM 86 181-4.
Occurrence: AM 85 1843-7.
hydroxylherderite $CaBe(PO_4)(OH)$. *Datolite-gadolinite-herderite* mineral group.
Isostructural series with *herderite*.
Structure: **GA Lager GV Gibbs** 1974 AM 59 918-25.
hydroxypetscheckite
Alteration product of *petscheckite* with XRPD matching *synthetic* UTa_2O_8 (structure: **M Gasparin**

1960 BSFMC 83 1-21), & Fe assigned to position 0,0,0.5 in space group Pbar31m.
Occurrence & crystallography, **A Mücke H Strunz** 1978 AM 63 941-6.

hydroxy-topaz $Al_2SiO_4(OH)_2$ Endmember of *topaz.*

[hydroxy-vishnevite $Na_4(AlSiO_4)_3OH.aq$.

Occurrence: **EI Semenov & 3 others** 1984 Min Zhurn 6 50 = MM 54 666.
Not clear its distinction in *cancrinite* group.]

hydrowoodwardite $Cu_{1-x}Al_x(OH)_2(SO_4)_{x/2}.naq$, x<0.67, n>~3x/2.

Occurrence & XRD: **T Witzke** 1999 NJMM 75-86 (W955).

hydrozincite $Zn_5(CO_3)_2(OH)_6$. Compare *brianyoungite* with different layer repeat.

Structure: **S Ghose** 1964 AC 17 1051-7;
H Effenberger F Pertlik 1985 Osterr Akad Wiss Math-Naturwiss Kl Anz 122 61-2 = MA 88M/0278.
Gibbs energy: **MA Mercy & 3 others** 1998 AM 83 739-45.

[hydrozunyite
Synthetic: MM 40 908.]

hypercinnabar HgS. Trimorphic with *cinnabar* & *metacinnabar*.
Structure determination not found.
Occurrence: **RW Potter HL Barnes** 1978 AM 63 1143-52.

hyttsjöite $Pb_{18}Ba_2Ca_5Mn^{2+}_2Fe^{3+}_2Si_{30}O_{90}Cl$.

Occurrence & layer structure: **ES Grew & 5 others** 1996 AM 81 743-53.