

Table S1a. ORDER OF CRYSTALLIZATION, ML-1A

Map #	Wo then Di	Wo then Qz	Ap, Wo, Di	Additional remarks
1	✓	✓		Holey Qz
2	✓	✓		Holey Qz
3			Ap then Wo	Pct nucleated on Wo
4				“Atoll” of Wo + Ap + Brt
5				Urn in Cal
6				Hapo-K replacing Wo
7		✓		Cal included in Wo, Qz
8		✓		Pct nucleated on Wo
9				Hapo-K replacing Di
10				Shared growth surfaces
11				Hapo-K replacing Wo
12		✓		Pct nucleated on Wo
13				Shared surfaces, Qz, Wo
14	✓			Cluster of Di
15		✓		Shared growth surfaces
16				“Atoll” of Wo + Qz
17			Di then Ap	
18	✓			Qz then Di, Wo
19		✓	Shared surfaces	Pct nucleated on Wo
20				Qz then Wo
21		✓		Holey Qz
22			Di then Ap	Qz then Di (subhedral)
23				“Atoll” of Wo grains
24				“Semi-atoll” of Wo grains
25	✓	✓	Shared surfaces	
26				Late fill of Hapo-K
27	✓			Qz then Di
28				Qz, Wo share surfaces
29	✓		Ap then Di	Qz then Di
30				Gn in Wo
31				Cal, Qz, Mag in Wo
32		✓		Holey quartz
33				Di then Wo, Qz
34	✓	✓		Qz then Di
35			Ap then Wo	Pct nucleated on Wo
36				Pct nucleated on Wo
37				Pct nucleated on Wo
38				Pct nucleated on Wo
39				Late fill of Hapo-K
40		✓		Pct nucleated on Wo

Symbols used: Ap: apatite, Brt: baryte, Di: diopside, Gn: galena, Hapo-K: hydroxyapophyllite-(K), Pct: pectolite, Qz: quartz, Urn: uraninite, Wo: wollastonite. The matrix is blue calcite.

Table S1b. ORDER OF CRYSTALLIZATION, MKL-1066

Map #	Wo, Di	Wo, Qz	Ap	Additional remarks
1		, Qz → Wo	Ap Wo	Wo locally subhedral
2				Tubular incl. of Cal in Wo
3				“Atoll”: Wo, Qz, Kfs, Pl
4	, Di → Wo		Ap Wo	Aln-(La) on Wo
5	, Di → Wo			Mg → Fe zoning in Di
6			Ap → Wo	Wo locally subhedral
7				Wo > Di > Qz layers in Cal
8				Py at Cal–Wo contact
9		Wo → Qz		Kfs Wo
10				Wo > Qz > Di layers in Cal
11	, Wo → Di		Di → Ap,	A Wo+Di+Ap cluster
12				Pl Pyh (a bit ragged)
13			Ap Di	Wo Ttn
14				Py in Kfs (leached)
15				Roundish grains in Cal
16				(Kfs+Pl) → Wo
17				Pl Wo, Zo
18				Wo-dominant layers
19				Di → Kfs, late Zo, Aln-La
20				Pyh → Wo
21				Di ≈ Wo layer in Cal
22				Late Py along a crack
23				Late Pct on Wo, with Gr?
24				Late Pct on Wo, with Gr?
25				Late Pct on Wo, with Gr?
26			Ap → Wo	Gr present
27				Kfs Wo; ragged Pyh
28			Ap Di	
29				Py in cavity in Cal
30	, Wo → Di			Hapo-K in Cal
31			Ap → (Kfs+Pl)	Late Py
32				(Kfs+Pl) → Wo, Qz
33				Kfs → Zo
34				Kfs Ttn
35				Subhedral Urn
36	Di → Wo		Ap Di, Wo	(Kfs+Pl) → Di; Ttn Wo
37				(Kfs+Pl) → Wo; Pyh
38				Qz → Di; Pyh → Py
39				Corroded Pyh → Wo
40			Ap (Kfs+Pl)	Ttn → (Kfs+Pl); late Zo
41				Late Zo, Py, Aln-La
42				Roundish Kfs in Cal
43				Gr in Cal
44				Striking Fe zoning in Di
45			Ap Di	Qz → Di; Fe-rich Di at rim
46				(Kfs+Pl) → Zo
47				Late Urn around Kfs

48			Pyh→Wo
49			Apy→Pyh
50			Kfs→Di; Pyh→Wo

Symbols used: Aln-La: allanite-(La), Ap: apatite, Apy: arsenopyrite, Cal: calcite, Di: diopside, Gr: graphite, Hapo-K: hydroxyapophyllite-(K), Kfs: K-feldspar, Pct: pectolite, Pl: plagioclase, Py: pyrite, Pyh: pyrrhotite, Qz: quartz, Urn: uraninite, Wo: wollastonite, Zo: zoisite. A horizontal arrow (→) indicates the order of crystallization, whereas the parallel symbol (||) indicates coeval growth.

Table S1c. ORDER OF CRYSTALLIZATION, MKL-1028B

Map #	Wo, Di	Wo, Qz	Ap	Additional remarks
1				Hapo-K replaced Di
2				(Kfs, Pl) Wo, Di
3			Anhedral	
4				Sp + Ccp
5				Sp + Ccp
6				Cal → Ttn
7			Ap Di	
8				Wo + Di band
9				Closeup of band
10			Suspended	
11			Ap → Cal	Late Hapo-K decoration
12				Roundish Di, no zoning
13				Cal → Wo
14				(Kfs, Pl) → Wo; Ali
15				Kfs → Wo → Cal
16	, Wo→Di			Rsd
17				Top of a band
18				Subhedral Wo in Cal; Rsd
19			Anhedral	Zo+Prh+Ab+Kfs after Pl
20			Anhedral	Zo+Prh+Ab+Kfs after Pl
21			Ap → Cal	Subhedral Wo
22				Stack of subhedral Wo
23	, Wo→Di			
24				(Kfs, Pl) Wo; Hapo-K
25	Wo→Di			Outline of Di: resorption?
26				Hapo-K replaces Di
27			Anhedral	Hapo-K; Pct replaces Wo
28			Ap Di, Wo	
29				Part of a band
30				Hapo-K replaces Di
31				Same, closeup
32			Ap Wo	
33				Wo → (Kfs, Pl)

Symbols used: Ab: albite, Ali: alietite, Ap: apatite, Cal: calcite, Ccp: chalcopryite, Crn: corundum, Di: diopside, Hapo-K: hydroxyapophyllite-(K), Kfs: K-feldspar, Pct: pectolite, Pl: plagioclase, Rsd: riversideite, Sp: sphalerite, Wo: wollastonite, Zo: zoisite. A horizontal arrow (→) indicates the order of crystallization, whereas the parallel symbol (||) indicates coeval growth. Note that quartz is absent.

Table S1d. MINERAL ASSEMBLAGES IN SECTION MKL-1021

Map #	Wo, Di	Symplectite?	Fap	Additional remarks
1			✓	Bullet-shaped Ap in Cal
2	Wo	✓	✓	Sch, Fapo-K, Ali
3	Wo	✓	✓	Fap Flr
4	Wo+Fl Di	✓	✓	Outer ribbon of Di
5	Wo Di	✓		Sch
6	Wo Di	✓		Layers of Ali; Di ribbon
7	Wo Di	✓		Outer ribbon of Di, Wo
8		✓		Mly part of ribbon
9		✓		"Ali": part of symplectite
10		✓		Fapo-K + Ali zone; Bul
11		✓		Mly
12	Wo+Fl Di	✓		Mly part of ribbon
13	Wo Di	✓		Wo, Flr rim; Fapo-K, Mly
14		✓		Mly
15		✓		Fapo-K, Ali
16	Wo Di	✓		Ali, Mly
17	Wo Di	✓		Mly
18	Di			Anhedral Di, Fe-rich rim
19	Wo Di	✓		Albite + holtstamite, Kfs
20	Di			Subhedral, corroded look
21			✓	Subhedral, corroded look
22	Di			Anhedral, corroded look
23				Late baryte, UK1
24				Late anhydrite, UK1
25				Late UK1
26				Late Fapo-K, Ali
27				Late Fapo-K, Brt
28				Late Brt, Prh
29				Ali along a crack
30	Di			Cal + Di
31			✓	Subhedral Fap
32				Subhedral, amoeboid Dol
33	Di, Wo	✓		Fapo-K, Ali
34	Di	✓		Di+Wo+Flr rim, Cst, Ali
35	Di			Ragged look, Fe-rich rim

Calcite is the mineral forming the matrix for all these assemblages; dolomite is present only in map 32. Symbols used: Ab: albite, Ali: alietite, Brt: baryte, Cal: calcite, Cst: cassiterite, Di: diopside, Dol: dolomite, Fap: apatite, Fapo-K: hydroxyapophyllite-(K), Flr: fluorite, Hts: holtstamite, Kfs: K-feldspar, Kto: katoite (?), Mly: malayaite, Sch: scheelite, UK1: Ca–Sn–S unknown mineral, Wo: wollastonite. The parallel symbol (||) indicates a shared growth-surface and, presumably, coeval growth. Alietite, ideally $\text{Ca}_{0.2}\text{Mg}_6(\text{Si,Al})_8\text{O}_{20}(\text{OH})_4 \cdot 4\text{H}_2\text{O}$, is a

member of the smectite group. Fluorapophyllite-(K) has the formula $\text{KCa}_4\text{Si}_8\text{O}_{20}(\text{F}, \text{OH}) \cdot 8\text{H}_2\text{O}$. Katoite, $\text{Ca}_3\text{Al}_2\text{Si}_3(\text{OH})_{12}$, is a hydrogarnet. Malayaite, CaSnSiO_5 , is the tin analog of titanite.

Table S2. COMPOSITION OF MALAYAITE IN MKL-1021

Anal.	55	12	13		55	12	13	ave.
SiO ₂ wt. %	23.07	23.00	23.04	Si <i>apfu</i>	0.999	0.998	0.988	0.995
SnO ₂	49.42	49.65	47.59	Sn	0.853	0.860	0.813	0.842
TiO ₂	3.23	3.11	3.50	Ti	0.104	0.102	0.114	0.107
Nb ₂ O ₅	0.53	0.56	0.83	Nb	0.010	0.010	0.015	0.012
Ta ₂ O ₅	0.60	0.56	1.01	Ta	0.008	0.008	0.013	0.010
ZrO ₂	0.14	0.17	0.31	Zr	0.003	0.003	0.008	0.005
Al ₂ O ₃	0.22	0.22	0.34	Al	0.010	0.010	0.018	0.127
FeO	0.21	0.13	0.21	Fe	0.008	0.005	0.008	0.007
CaO	21.44	21.44	22.11	Ca	0.994	0.996	1.014	1.001
SrO	0.08	0.00	0.08	Sr	0.003	0.000	0.003	0.002
Na ₂ O	0.09	0.08	0.10	Na	0.008	0.008	0.008	0.008
Total	99.04	98.91	99.20	Σ cations	3.000	3.000	3.002	

The compositions were established by wavelength-dispersion electron-probe analysis at three spots (map 17). The ideal formula of malayaite is CaSnSiO₅; the structural formula of malayaite, the tin analog of titanite, in sample MKL-1021 is: (Ca_{1.001}Sr_{0.002}Na_{0.008})_{Σ1.011}(Sn_{0.842}Al_{0.127}Ti_{0.107}Nb_{0.012}Ta_{0.010}Fe_{0.007}Zr_{0.005})_{Σ1.110}Si_{0.995}O₅.

Table S3. COMPOSITION OF HOLTSTAMITE IN MKL-1021

Anal.	61	62	64	67	68		61	62	64	67	68
SiO ₂ wt.%	37.40	38.29	38.12	37.58	36.90	Si <i>apfu</i>	2.781	2.886	2.884	2.849	2.763
P ₂ O ₅	0.04	0.00	0.00	0.00	0.06	P	0.003	0.000	0.000	0.000	0.004
SO ₃	0.24	0.00	0.00	0.22	0.20	S	0.013	0.000	0.000	0.013	0.011
						Σ Z site	2.797	2.886	2.884	2.862	2.778
Al ₂ O ₃	23.64	22.87	22.76	22.80	23.82	Al	2.069	2.030	2.027	2.035	2.100
CaO	36.77	36.78	36.68	36.53	36.07	Ca	2.927	2.968	2.971	2.965	2.892
MgO	0.04	0.02	0.00	0.00	0.04	Mg	0.004	0.003	0.000	0.000	0.005
SrO	0.00	0.00	0.05	0.00	0.08	Sr	0.000	0.000	0.002	0.000	0.003
K ₂ O	0.05	0.05	0.14	0.11	0.12	K	0.005	0.005	0.013	0.011	0.011
F	3.15	1.41	1.59	1.69	3.86	Σ X,Y sites	5.005	5.006	5.013	5.011	5.011
Cl	0.02	0.00	0.00	0.01	0.02						
Subtotal	101.31	99.40	99.34	98.94	101.13	F	0.740	0.336	0.381	0.405	0.913
-(O=F,Cl)	1.33	0.59	0.67	0.71	1.63	Cl	0.002	0.000	0.000	0.002	0.003
						OH	0.070	0.120	0.073	0.145	0.000
TOTAL	99.98	98.81	98.67	98.23	99.50						

The compositions, expressed in wt.%, were established at five spots in map 19 by wavelength-dispersion electron-probe analysis. The recalculated compositions, expressed in atoms per formula unit (*apfu*), are based on filled Ca (X) + Al (Y) sites (5.000 *apfu*). The Z site in this hydrogarnet structure is almost completely filled by Si + P + S. The small difference from 3.000 in the occupancy of the tetrahedral site consists of a tetrahedral array of F, OH and Cl. In the case of composition 68, the measured amount of F and Cl fills the available position. Note that these Z-site occupancies are calculated by difference, and subject to accumulated analytical errors. The ideal composition of holtstamite is Ca₃Al₂Si₂□O₈(OH)₄, where □ stands for a vacant tetrahedrally coordinated site.

Table S4. COMPOSITION OF FLUORAPOPHYLLITE-(K) IN SAMPLE MKL-1021

Anal. Map	20 2	21 2	32 6	33 6	34 6	35 6	36 6	37 6	38 6	52 9	53 9	54 9
SiO ₂ wt. %	55.90	59.68	50.33	56.70	52.68	52.40	51.43	56.86	58.07	53.56	55.84	56.30
Al ₂ O ₃	0.07	0.08	0.03	0.06	0.11	0.09	0.10	0.64	0.06	0.04	0.07	0.05
P ₂ O ₅	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
SO ₃	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00
MgO	0.15	0.14	0.04	0.03	0.04	0.03	0.05	0.00	0.00	0.16	0.04	0.22
CaO	21.40	22.46	24.03	22.30	21.77	21.97	21.87	21.61	21.70	25.09	21.72	21.14
SrO	0.09	0.07	0.05	0.06	0.05	0.06	0.06	0.05	0.04	0.12	0.06	0.08
Na ₂ O	0.16	0.17	0.10	0.28	0.12	0.33	0.19	0.57	0.14	0.12	0.09	0.08
K ₂ O	3.60	3.85	3.83	3.55	4.08	3.51	3.97	2.82	3.92	3.40	3.81	4.12
F	4.31	2.29	1.65	2.21	1.62	1.79	1.91	2.06	1.34	1.56	2.50	2.05
Cl	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-(O=F, Cl)	1.82	0.96	0.70	0.93	0.68	0.75	0.80	0.87	0.57	0.66	1.05	0.86
Total	83.90	87.61	79.81	84.27	79.79	79.43	78.78	83.77	84.70	83.72	83.08	83.18
Anal. Map	83 33	84 33	85 33	86 33	87 33	88 33	103 34	104 34	105 34	106 34	107 34	
SiO ₂ wt. %	59.87	54.33	52.70	53.27	54.11	56.75	54.17	52.84	54.31	50.84	55.84	
Al ₂ O ₃	0.17	0.12	0.50	0.60	0.25	0.28	0.12	0.21	0.23	0.04	0.23	
P ₂ O ₅	0.05	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
SO ₃	0.15	0.00	0.00	0.00	0.23	0.19	0.00	0.14	0.75	0.54	1.08	
MgO	0.17	0.29	0.02	0.07	0.36	0.07	0.07	0.04	0.00	0.19	0.23	
CaO	21.48	21.33	22.14	22.03	22.24	21.94	21.26	21.73	21.57	22.14	21.39	
SrO	0.08	0.11	0.15	0.10	0.07	0.10	0.07	0.09	0.17	0.10	0.32	

Na ₂ O	0.13	0.12	0.25	0.19	0.14	0.11	0.15	0.14	0.22	0.29	0.17
K ₂ O	3.91	3.61	3.37	3.33	3.70	3.98	3.84	4.00	3.52	3.36	3.72
F	2.02	2.22	2.04	1.61	2.13	2.61	2.03	1.75	2.13	1.88	2.24
Cl	0.00	0.02	0.07	0.05	0.02	0.01	0.00	0.00	0.03	0.03	0.04
–(O=F, Cl)	0.85	0.94	0.87	0.69	0.90	1.10	0.86	0.74	0.91	0.80	0.95
Total	87.19	81.30	80.37	80.86	82.35	84.96	80.85	80.20	82.02	78.58	84.31

Anal. Map	20 2	21 2	32 6	33 6	34 6	35 6	36 6	37 6	38 6	52 9	53 9	54 9
Ca <i>apfu</i>	3.275	3.220	4.063	3.366	3.533	3.587	3.636	3.213	3.200	3.993	3.330	3.216
Mg	0.031	0.029	0.009	0.006	0.009	0.006	0.012	0.000	0.000	0.035	0.009	0.047
Sc	0.007	0.006	0.005	0.005	0.004	0.006	0.005	0.004	0.003	0.010	0.005	0.007
Σ Ca site	3.313	3.255	4.077	3.377	3.546	3.599	3.653	3.217	3.203	4.038	3.344	3.270
K	0.655	0.657	0.771	0.639	0.788	0.682	0.786	0.499	0.689	0.644	0.695	0.745
Na	0.045	0.044	0.030	0.077	0.036	0.097	0.056	0.152	0.037	0.036	0.026	0.021
Σ K site	0.700	0.701	0.801	0.716	0.824	0.779	0.842	0.651	0.726	0.670	0.721	0.766
Si	7.984	7.984	7.942	7.989	7.981	7.984	7.982	7.892	7.991	7.957	7.988	7.992
P	0.005	0.003	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000
S	0.000	0.000	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.037	0.000	0.000
Al	0.011	0.013	0.005	0.011	0.019	0.016	0.018	0.104	0.009	0.006	0.012	0.008
Σ T site	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
O	19.648	19.591	20.368	19.729	19.949	19.981	20.065	19.483	19.562	20.302	19.699	19.649
F	1.947	0.967	0.825	0.983	0.777	0.860	0.936	0.905	0.585	0.731	1.130	0.919
Cl	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OH	0.000	0.442	0.000	0.285	0.274	0.159	0.000	0.612	0.853	0.000	0.171	0.432

Anal.	83	84	85	86	87	88	103	104	105	106	107
Map	33	33	33	33	33	33	34	34	34	34	34

Ca <i>apfu</i>	3.058	3.352	3.561	3.499	3.492	3.287	3.355	3.501	3.353	3.700	3.221
Mg	0.034	0.063	0.006	0.016	0.080	0.014	0.016	0.009	0.000	0.044	0.048
Sc	0.006	0.009	0.013	0.009	0.006	0.008	0.006	0.008	0.014	0.009	0.026
Σ Ca site	3.098	3.424	3.580	3.524	3.578	3.309	3.377	3.518	3.367	3.753	3.295

K	0.662	0.676	0.645	0.629	0.693	0.710	0.721	0.767	0.651	0.669	0.666
Na	0.035	0.033	0.073	0.056	0.041	0.030	0.044	0.040	0.062	0.088	0.045
Σ K site	0.697	0.709	0.718	0.685	0.734	0.740	0.765	0.807	0.713	0.757	0.711

Si	7.954	7.968	7.912	7.896	7.931	7.935	7.980	7.946	7.879	7.930	7.849
P	0.006	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S	0.014	0.000	0.000	0.000	0.026	0.020	0.000	0.016	0.081	0.063	0.114
Al	0.026	0.021	0.088	0.104	0.043	0.045	0.020	0.038	0.040	0.007	0.038
Σ T site	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.001

O	19.394	19.746	19.895	19.814	19.872	19.616	19.749	19.870	19.542	20.000	19.405
F	0.849	1.031	0.968	0.753	0.986	1.152	0.947	0.835	0.979	0.929	0.997
Cl	0.000	0.004	0.017	0.013	0.004	0.003	0.000	0.000	0.008	0.007	0.009
OH	0.757	0.219	0.120	0.420	0.138	0.229	0.304	0.295	0.471	0.064	0.589

The compositions were established by wavelength-dispersion electron-probe analysis. The ideal composition of fluorapophyllite-(K) is $\text{KCa}_4\text{Si}_8\text{O}_{20}\text{F}\cdot 8\text{H}_2\text{O}$. The formula was recalculated on the basis of $\Sigma(\text{Si} + \text{Al} + \text{P} + \text{S})$ equal to 8.000 atoms per formula unit. We assume that $\Sigma(\text{O} + \text{OH} + \text{F} + \text{Cl})$ equals 21 *apfu*. The F content at the anion site exceeds the inferred OH content in every case, which justifies the label fluorapophyllite-(K).

Table S5. COMPOSITIONS OF "ALIETTITE" IN MKL-1021

Anal. Map	16 2	17 2	18 2	19 2	26 2	27 6	28 6	29 6	30 6	31 6	46 9	47 9	Ali	Ali	Liz	Sap
SiO ₂ wt. %	44.94	35.08	39.44	47.52	33.47	48.19	29.40	47.87	36.74	47.91	38.23	37.72	53.2	49.4	44.3	51.3
Al ₂ O ₃	4.40	2.67	3.52	4.75	1.97	3.46	2.75	5.06	3.81	3.13	2.58	3.84	3.5	5.0	2.2	4.4
Fe ₂ O ₃													3.5	4.8	0.5	1.1
FeO	0.44	0.31	0.24	0.22	0.20	0.27	0.25	0.40	0.36	0.28	0.23	0.21		1.5	1.8	
MnO	0.15	0.17	0.15	0.14	0.13	0.18	0.16	0.18	0.15	0.18	0.14	0.16				
MgO	19.32	16.38	19.23	23.48	11.47	16.77	13.99	23.30	18.93	17.07	14.32	18.21	27.4	28.6	40.7	23.5
CaO	2.26	2.32	2.67	2.78	2.51	2.24	2.28	2.43	2.34	2.30	3.19	2.70	1.1	0.6	1.3	
SrO	0.09	0.09	0.07	0.08	0.06	0.10	0.06	0.08	0.06	0.11	0.05	0.06				
Na ₂ O	0.05	0.00	0.03	0.06	0.07	0.05	0.04	0.00	0.00	0.07	0.00	0.00	1.2	0.4	1.1	
K ₂ O	0.10	0.11	0.17	0.12	0.14	0.16	0.22	0.10	0.09	0.12	0.14	0.12		0.2		
F	0.09	0.21	0.33	0.24	0.06	0.45	0.12	0.89	0.36	0.24	0.78	0.43				
Cl	0.02	0.00	0.00	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.04	0.03				
-(O=F, Cl)	0.04	0.09	0.14	0.11	0.03	0.19	0.05	0.37	0.15	0.10	0.34	0.19				
TOTAL	71.83	57.26	65.72	79.30	50.08	71.70	49.22	79.95	62.70	71.30	59.35	63.30				
Anal. Map	48 9	49 9	50 9	51 9	91 33	92 33	93 33	94 33	99 34	100 34	101 34					
SiO ₂ wt. %	41.21	36.00	35.93	48.60	50.58	49.22	43.16	46.44	39.43	45.97	45.11					
Al ₂ O ₃	3.94	3.55	2.89	4.62	5.61	4.91	4.17	4.50	3.55	5.69	6.75					
FeO	0.30	0.19	0.27	0.28	0.26	0.26	0.30	0.29	0.31	0.37	0.66					
MnO	0.11	0.12	0.19	0.15	0.18	0.22	0.20	0.20	0.25	0.25	0.09					
MgO	21.68	17.29	16.46	24.35	23.68	21.82	19.45	19.12	16.78	24.83	21.73					
CaO	2.51	3.06	2.34	2.69	3.33	3.65	2.95	3.68	4.45	2.92	4.81					

SrO	0.00	0.05	0.05	0.07	0.14	0.12	0.07	0.12	0.10	0.09	0.07
Na ₂ O	0.05	0.05	0.04	0.04	0.14	0.19	0.05	0.10	0.22	0.15	0.28
K ₂ O	0.25	0.22	0.17	0.18	0.14	0.17	0.08	0.10	0.18	0.11	0.10
F	0.31	0.10	0.11	0.42	0.50	0.76	0.09	0.72	0.34	0.23	0.65
Cl	0.04	0.05	0.04	0.00	0.01	0.03	0.03	0.00	0.03	0.06	0.20
–(O=F, Cl)	0.14	0.05	0.05	0.18	0.21	0.33	0.04	0.30	0.15	0.11	0.32
TOTAL	70.27	60.64	58.45	81.22	84.37	81.01	70.51	75.02	65.49	80.57	80.14

The compositions were established by wavelength-dispersion electron-probe analysis. Shown on the right are the compositions of well-characterized samples of aliettite (Ali), lizardite (Liz) and saponite (Sap).

Table S6. COMPOSITION OF DIOPSIDE IN SAMPLE MKL-1021

Anal. Map	27 6	28 6	46 17	47 17	48 17	62 19	63 19	64 19	83 33	84 33	85 33	86 33	96 34	97 34	98 34
SiO ₂ wt. %	53.60	53.77	54.30	53.89	54.28	54.82	54.05	53.98	53.01	53.87	51.53	52.89	53.70	53.54	53.59
TiO ₂	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SnO ₂	0.06	0.13	0.00	0.03	0.05	0.03	0.05	0.00	0.06	0.04	0.07	0.00	0.00	0.04	0.04
Al ₂ O ₃	0.29	0.71	0.32	0.53	0.91	0.27	1.01	0.66	1.78	0.76	1.70	0.44	0.48	1.13	0.72
FeO	5.00	4.96	3.90	4.02	4.83	3.97	4.63	5.61	5.61	4.81	6.17	4.29	5.57	5.11	4.22
MnO	0.26	0.35	0.28	0.29	0.32	0.30	0.30	0.47	0.37	0.37	0.43	0.30	0.31	0.33	0.27
MgO	14.40	14.39	15.44	15.14	14.70	15.29	14.58	13.92	13.60	14.37	13.00	14.95	14.22	14.27	14.80
CaO	24.63	24.41	24.56	24.20	24.42	24.60	24.41	24.33	24.14	24.40	24.13	24.99	24.38	24.43	24.36
SrO	0.07	0.00	0.05	0.05	0.06	0.08	0.00	0.06	0.07	0.00	0.05	0.00	0.09	0.07	0.09
Na ₂ O	0.15	0.33	0.12	0.17	0.26	0.09	0.35	0.17	0.37	0.24	0.37	0.19	0.18	0.39	0.33
Total	98.46	99.07	98.97	98.31	99.81	99.45	99.39	99.20	99.03	98.86	97.45	98.05	98.94	99.30	98.43
Si <i>apfu</i>	2.006	1.999	2.009	2.007	1.999	2.017	1.998	2.008	1.978	2.004	1.965	1.988	2.004	1.988	1.999
Ti	0.002	0.004	0.000	0.001	0.001	0.001	0.001	0.000	0.002	0.001	0.002	0.000	0.000	0.001	0.001
Al	0.013	0.031	0.014	0.023	0.039	0.012	0.044	0.029	0.078	0.033	0.076	0.019	0.021	0.049	0.032
Fe ²⁺	0.156	0.154	0.121	0.125	0.149	0.122	0.143	0.175	0.175	0.150	0.197	0.135	0.174	0.159	0.132
Mn	0.008	0.011	0.009	0.009	0.010	0.009	0.009	0.015	0.012	0.012	0.014	0.010	0.010	0.010	0.009
Mg	0.803	0.797	0.852	0.841	0.807	0.839	0.803	0.772	0.756	0.797	0.739	0.838	0.791	0.790	0.823
Ca	0.990	0.972	0.976	0.968	0.966	0.973	0.967	0.972	0.968	0.973	0.988	1.006	0.978	0.975	0.977
Na	0.011	0.024	0.009	0.012	0.019	0.006	0.025	0.012	0.027	0.017	0.027	0.014	0.013	0.028	0.024
Σ cations	3.991	3.993	3.988	3.986	3.989	3.979	3.991	3.983	3.995	3.987	4.008	4.009	3.992	4.000	3.996

Wo mol.%	50.26	49.63	40.63	49.49	49.52	49.89	49.62	49.94	49.94	49.91	50.29	50.27	49.75	49.68	49.74
En	40.77	40.71	43.33	42.99	41.38	43.01	41.25	39.66	39.04	40.90	37.62	41.85	40.23	40.27	41.90
Fs	8.38	8.45	6.60	6.89	8.16	6.78	7.84	9.76	9.65	8.30	10.70	7.20	9.36	8.62	7.14
Aeg	0.59	1.21	0.44	0.63	0.95	0.33	1.29	0.63	1.38	0.89	1.39	0.69	0.66	1.43	1.21
Mg#	83.0	82.8	86.8	87.4	83.5	86.5	84.1	80.2	80.2	83.1	77.8	85.2	81.1	82.4	85.4

The compositions were established by wavelength-dispersion electron-probe analysis. For purposes of recalculation, the small amount of Sn was combined with Ti, and that of Sr was combined with Ca. Ideally, diopside contains 25.90% CaO, 18.61% MgO and 55.49% SiO₂. Leaving out composition 85, which seems anomalously low in SiO₂, the average Mg# of the fourteen other compositions is 83.7.

Table S7. MINERALS ENCOUNTERED
IN SPECIMEN ML-3A, IHALAINEN DEPOSIT, FINLAND

#	Early minerals	Retrograde-stage minerals
1	Wo, Di, Ap, Ms, Kfs, Ab, Cal	Pg, Pct, Hts, Grs, Lws
2	Wo, Di, Kfs, Cal	Hts, Grs, Gon, Lws
3	Ms, Kfs, Ab, Cal	Hts, Grs, Lws, Scp (?)
4	Ms, Kfs, Ab, Cal	Pg, Hts, Grs
5	Wo, Ms, Kfs, Cal	Pct, Prh, Pg, Tr, Hcmic
6	Wo, Ms, Kfs, Cal	Pct, Pg, Hts, Grs, Lws, Ep
7	Ms, Kfs, Ab, Cal	Pct, Pg, Hts, Grs
8	Ms, Ap, Kfs, Ab, Cal	Pct, Pg, Hts, Grs, Lws
9	Wo, Di, Ms, Kfs, Ab, Cal	Pct, Pg, Hts, Grs, Lws, Prh
10	Wo, Di, Ms, Kfs, Ab, Cal	Pct, Pg, Lws
11	Wo, Di, Ms, Kfs, Ab, Cal	Pct
12	Wo, Di, Ms, Kfs, Ab, Cal	Pg, Hts, Grs
13	Wo, Kfs, Ab, Cal	Pct, Pg
14	Wo, Di, Ms, Kfs, Ab, Cal	Pct, Pg
15	Wo, Kfs, Ab, Cal	Pct, Pg, Hts, Grs, Fsm
16	Wo, Di, Ms, Kfs, Ab, Cal	Pct, Pg
17	Di, Ap, Cal	
18	Di, Anh, Cal	
19	Di, Ap, Cal	
20	Wo, Di, Ms, Cal	Pct, Hts, Grs, Pg, Lws
21	Wo, Kfs	Pct, Hts, Grs, Pg
22	Wo, Kfs	Pct, Hts, Grs, Pg
23	Wo, Di, Kfs, Ab, Cal	Hts, Grs
24	Wo, Di, Kfs, Ab, Ek, Cal	Pct, Hts, Grs, Pg
25	Wo, Ap, Ms, Kfs, Cal	Pct, Hts, Grs, Pg
26	Kfs, Cal	Pct, Hts, Grs
27	Wo, Ap, Cal	Pct, Hts, Grs
28	Wo, Kfs, Cal	Pct, Hts, Grs, Pg, Lws, Xon
29	Wo, Kfs, Ab	Pct, Hts, Grs, Pg, Lws
30	Wo, Di, Cal	Pct, Hts, Grs, UK2
31	Wo, Di, Cal	Ali, Fsm, UK3
32	Wo, Di, Ms, Cal	Pct, Hts, Grs, Lws
33	Wo, Di, Cal	Pct, Hts, Grs, Lws
34	Wo, Di, Kfs, Ab, Cal	Hts, Grs, Lws
35	Wo, Di, Kfs, Cal	Pct, Hts, Grs, Ep
36	Wo, Di, Ms	Pct, Hts, Grs, Pg, Lws
37	Di, Cal	Hts, Grs, Pg, UK2, Fsm, Zo
38	Wo, Cal	Pct, Hts, Grs, Pg, UK1, UK2
39	Wo, Fsm, Cal	Pct
40	Wo, Sch, Cal	Pct, Pg, Lws
41	Wo, Di, Ms, Cal	Pct, Hts, Grs, Lws
42	Wo, Di, Ms	Pct, Hts, Grs
43	Wo, Di, Ms, Ap	Pct, Hts, Grs, Pg

44	Wo, Di, Ms, Ksp, Cal	Pct, Hts, Grs, Pg
45	Wo, Di, Ms, Cal	Hts, Grs, Pg, Lws, Vgn
46	Wo, Di, Ms, Kfs	Pct, Hts, Grs, Pg
47	Wo, Kfs, Ms	Pct, Hts, Grs, Pg
48	Wo, Di, Ms	Pct, Hts, Grs, Pg, Lws
49	Wo, Di, Ms, Cal	Pct, Hts, Grs, Pg, Gon, Zo
50	Wo, Di, Ms, Cal	Pct, Pg, Rbn
51	Di, Cal	Fapo-K, Fsm, Brt, UK2
52	Wo, Cal	Pct, Hts, Grs, Lws, Vgn, Zo
53	Wo	Pct, Hts, Grs, Lws, Vgn
54	Wo, Cal	Pct, Hts, Grs, Lws, Vgn
55	Wo, Ms, Kfs, Cal	Pct, Hts, Grs, Lws, Vgn
56	Wo, Di, Ms	Pct, Hts, Grs, Pg
57	Wo, Ms, Ap	Pct, Hts, Grs, Pg
58	Wo, Ms, Ap	Pct, Hts, Grs, Lws

The polished thin section was scanned in plane- and cross-polarized light, and fifty-eight areas of interest were selected for imaging. The minerals were identified on the basis of their energy-dispersion spectrum. Whether they are early or retrograde in origin is inferred from textural information. Symbols used: Ab: albite, Ali: aliettite, Anh: anhydrite, Ap: apatite, Brt: baryte, Cal: calcite, Di: diopside, Ek: ekanite, Ep: epidote, Fsm: fersmite, Gon: gonnardite, Grs: grossular, Fapo-K: fluorapophyllite-(K), Hcmic: hydroxycalciumicrolite, Hts: holtstamite, Kfs: K-feldspar, Lws: lawsonite, Ms: muscovite, Pct: pectolite, Pg: paragonite, Prh: prehnite, Rbn: reinhardbraunsite, Sch: scheelite, Scp: scapolite, Tr: tremolite, Vgn: vuagnatite, Wo: wollastonite, Xon: xonotlite, Zo: zoisite. Unknown minerals UK1, UK2 and UK3 are described in the text.

Table S8. COMPOSITION OF CLINOPYROXENE IN ML-3A

Anal. Map	20 9	43 23	46 23	47 23	66 16	67 16	94 30	95 30	103 31	127 51	128 51
SiO ₂ wt. %	53.51	53.41	53.76	53.79	54.66	56.92	54.63	55.20	55.27	54.82	54.10
TiO ₂	0.00	0.16	0.14	0.12	0.03	0.00	0.02	0.00	0.03	0.02	0.02
SnO ₂	0.00	0.24	0.22	0.28	0.19	0.00	0.24	0.06	0.14	0.17	0.18
Al ₂ O ₃	3.04	3.38	2.76	2.66	2.46	0.06	2.20	1.06	1.36	2.78	3.18
FeO	0.74	1.10	1.22	2.65	0.71	0.10	1.04	1.11	1.32	0.98	1.02
MnO	0.10	0.16	0.11	0.46	0.12	0.00	0.14	0.13	0.16	0.15	0.16
MgO	16.49	15.88	16.27	15.18	16.58	17.97	16.46	16.89	16.78	16.24	15.33
CaO	23.90	23.89	24.23	23.66	24.34	24.65	24.86	25.24	25.42	25.42	25.49
SrO	0.06	0.05	0.00	0.00	0.06	0.06	0.00	0.06	0.05	0.00	0.00
Na ₂ O	0.32	0.32	0.29	0.36	0.35	0.00	0.38	0.27	0.34	0.26	0.31
K ₂ O	0.02	0.11	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	98.18	98.70	99.05	99.23	99.50	99.76	99.97	100.02	100.87	100.84	99.79
Si <i>apfu</i>	1.962	1.952	1.960	1.970	1.977	2.041	1.974	1.996	1.985	1.964	1.960
Ti	0.000	0.011	0.010	0.011	0.006	0.000	0.007	0.002	0.005	0.005	0.005
Al	0.131	0.146	0.119	0.115	0.105	0.003	0.094	0.045	0.058	0.117	0.136
Fe	0.023	0.034	0.037	0.081	0.021	0.003	0.031	0.034	0.040	0.029	0.031
Mn	0.003	0.005	0.003	0.014	0.004	0.000	0.004	0.004	0.005	0.005	0.005
Mg	0.901	0.870	0.884	0.829	0.894	0.961	0.887	0.910	0.898	0.867	0.828
Ca	0.941	0.937	0.946	0.928	0.945	0.949	0.962	0.980	0.980	0.976	0.990
Na	0.023	0.023	0.020	0.026	0.025	0.000	0.027	0.019	0.024	0.018	0.022
K	0.001	0.005	0.002	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Σ cations	3.985	3.978	3.982	3.976	3.977	3.957	3.986	3.989	3.994	3.981	3.977
Wo mol. %	49.77	50.29	50.02	49.42	50.04	49.62	50.35	50.33	50.34	51.48	52.76
En	47.66	46.42	46.74	44.12	47.32	50.22	46.39	46.76	46.15	45.77	44.16
Fs	1.37	2.08	2.15	5.11	1.34	0.16	1.87	1.93	2.29	1.80	1.92
Aeg	1.20	1.22	1.08	1.36	1.30	0.00	1.39	0.97	1.22	0.95	1.16
Mg#	97.2	95.7	95.7	89.8	97.3	99.7	96.1	96.0	95.2	96.2	95.8

The compositions were established by wavelength-dispersion electron-probe analysis. For purposes of recalculation, the small amount of Sn was combined with Ti, and that of Sr was combined with Ca.

Table S9. COMPOSITION OF MUSCOVITE IN ML-3A

Anal. Map	56 16	57 16	58 16	62 16	63 16	64 16
SiO ₂ wt. %	46.41	45.96	45.81	46.11	50.69	47.25
Al ₂ O ₃	37.25	37.91	37.38	38.28	39.15	36.44
CaO	0.04	0.11	0.12	0.12	0.04	0.00
SrO	0.05	0.07	0.06	0.14	0.07	0.07
Na ₂ O	0.05	0.29	0.17	0.48	0.06	0.10
K ₂ O	9.78	10.01	9.74	9.44	10.14	9.43
Rb ₂ O	0.46	0.35	0.36	0.52	0.56	0.43
Cl	0.00	0.00	0.00	0.00	0.02	0.00
TOTAL	94.04	94.70	93.64	95.09	100.91	93.71
Si <i>apfu</i>	3.083	3.042	3.059	3.033	3.139	3.143
^{IV} Al	0.917	0.958	0.941	0.967	0.861	0.857
^{VI} Al	2.000	2.000	2.000	2.000	2.000	2.000
Ca	0.002	0.008	0.008	0.008	0.003	0.000
Sr	0.002	0.003	0.002	0.005	0.002	0.003
Na	0.006	0.037	0.022	0.061	0.007	0.012
K	0.829	0.846	0.830	0.792	0.802	0.800
Rb	0.020	0.015	0.016	0.022	0.022	0.018
Cl	0.000	0.000	0.000	0.000	0.002	0.000
OH	0.878	0.929	0.902	0.919	0.851	0.850
Σ cations	6.859	6.909	6.878	6.888	6.838	6.833
Σ oxygen	11.405	11.439	11.419	11.419	11.409	11.408
Σ + charges	21.932	21.949	21.936	21.919	21.965	21.966

The compositions were established by wavelength-dispersion electron-microprobe analysis. The compositions were recalculated on the basis of Al + Si = 6 atoms per formula unit. End-member muscovite, KAl₂(Si₃Al)O₁₀(OH)₂, contains 11.87% K₂O, 38.57% Al₂O₃, 45.46% SiO₂ and 4.07% H₂O. Our specimen contains (K_{0.817}Rb_{0.019}Na_{0.006}Ca_{0.005}Sr_{0.003})_{Σ0.850}^{VI}Al_{2.000}(Si_{3.083}^{IV}Al_{0.917})_{Σ4.000}O_{11.112}(OH)_{0.888}. The compositions are unusual in being Rb-enriched.

Table S10. COMPOSITION OF PARAGONITE IN ML-3A

Anal. Map	6 9	7 9	13 9	26 3	61 16	122 40	123 40
SiO ₂ wt. %	59.56	53.78	60.42	58.35	57.14	55.01	55.18
P ₂ O ₅	0.00	0.00	0.00	0.00	0.04	0.00	0.05
SO ₃	0.00	0.00	0.00	0.00	0.24	0.18	0.34
Al ₂ O ₃	24.20	25.27	24.15	25.01	30.00	28.73	28.63
MgO	0.00	0.00	0.00	0.00	0.00	0.04	0.03
CaO	0.12	0.63	0.30	0.20	0.62	0.95	1.48
SrO	0.05	0.00	0.06	0.09	0.00	0.00	0.00
Na ₂ O	8.30	7.08	9.47	8.45	10.52	10.74	10.49
K ₂ O	0.55	0.23	0.07	0.06	0.05	0.00	0.00
Cl	0.02	0.01	0.00	0.03	0.02	0.01	0.03
Subtotal	92.80	87.00	94.47	92.19	98.63	95.66	96.23
–(O=F, Cl)	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Total	92.80	87.00	94.47	92.18	98.63	95.66	96.22
Si <i>apfu</i>	3.381	3.218	3.399	3.322	3.082	3.090	3.092
P	0.000	0.000	0.000	0.000	0.002	0.000	0.002
S	0.000	0.000	0.000	0.000	0.010	0.008	0.014
^{IV} Al	0.619	0.782	0.601	0.678	0.906	0.902	0.892
^{VI} Al	1.000	1.000	1.000	1.000	1.001	1.000	0.999
Mg	0.000	0.000	0.000	0.000	0.002	0.003	0.002
Ca	0.007	0.041	0.018	0.012	0.036	0.057	0.089
Sr	0.002	0.000	0.002	0.003	0.000	0.000	0.000
Na	0.914	0.821	1.033	0.932	1.100	1.169	1.139
K	0.040	0.018	0.005	0.004	0.004	0.000	0.000
Cl	0.002	0.001	0.000	0.003	0.001	0.001	0.002

The compositions were established by wavelength-dispersion electron-probe analysis. They were recalculated on the basis of six cations of Si + P + S + Al (^{IV}Al and ^{VI}Al) per formula unit. The ideal formula of paragonite is NaAl₂(AlSi₃)O₁₀(OH)₂.

Table S11. COMPOSITION OF PECTOLITE IN ML-3A

Anal. Map	19 9	55 5	65 16	92 30	93 30	116 38	117 38	125 40	126 40	54 5
SiO ₂ wt. %	53.56	55.96	55.52	56.80	55.52	56.15	54.78	54.78	54.24	55.41
P ₂ O ₅	0.00	0.00	0.06	0.06	0.07	0.03	0.03	0.05	0.03	0.00
SO ₃	0.00	0.00	0.21	0.22	0.33	0.16	0.17	0.23	0.21	0.00
Al ₂ O ₃	0.09	0.18	0.20	0.25	0.21	0.63	0.24	0.19	0.34	0.00
MnO	0.06	0.00	0.00	0.00	0.00	0.23	0.26	0.15	0.13	0.09
MgO	0.00	0.03	0.03	0.08	0.00	0.51	0.03	0.06	0.06	0.00
CaO	31.68	27.74	32.10	31.18	32.86	31.68	32.73	32.00	32.15	3.08
SrO	0.00	0.06	0.09	0.06	0.06	0.00	0.07	0.05	0.05	0.00
Na ₂ O	9.09	8.76	9.04	8.43	8.34	8.48	8.67	9.03	8.94	7.98
K ₂ O	0.04	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cl	0.00	0.00	0.02	0.01	0.00	0.00	0.02	0.00	0.00	0.00
Total	94.52	92.78	96.52	95.81	98.67	97.26	98.37	96.54	96.15	66.56
Si <i>apfu</i>	2.994	2.989	2.984	2.973	2.971	2.952	2.977	2.976	2.968	3.000
P	0.000	0.000	0.000	0.003	0.003	0.001	0.001	0.002	0.001	0.000
S	0.000	0.000	0.003	0.009	0.013	0.007	0.007	0.009	0.008	0.000
Al	0.006	0.011	0.013	0.016	0.013	0.040	0.015	0.012	0.022	0.000
Σ T site	3.000	3.000	3.000	3.001	3.000	3.000	3.000	2.999	2.999	3.000
Mn	0.003	0.000	0.000	0.000	0.000	0.010	0.012	0.007	0.006	0.004
Mg	0.000	0.002	0.003	0.006	0.000	0.041	0.002	0.005	0.005	0.000
Ca	1.898	1.587	1.789	1.789	1.842	1.805	1.860	1.863	1.885	0.179
Sr	0.000	0.002	0.003	0.002	0.002	0.000	0.002	0.001	0.002	0.000
Na	0.986	0.907	0.912	0.875	0.846	0.874	0.892	0.951	0.949	0.838
K	0.000	0.003	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Cl	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000

The compositions were established by wavelength-dispersion electron-probe analysis. Pectolite, ideally NaCa₂Si₃O₈(OH), contains 33.74 wt. % CaO, 9.32% Na₂O, 54.23% SiO₂, and 2.71% H₂O. The compositions have been recalculated on the basis of Σ Si + P + S + Al = 3.000 *apfu*. The mineral in the last column, with Si : (Na + Ca) = 3 : 1, could be gonnardite.

Table S12. MIXED FELDSPAR COMPOSITIONS
IN DIKELETS IN ML-3A

Anal. Map	1 9	2 9	3 9	24 3	25 3	37 23	38 23
SiO ₂ wt. %	53.29	58.11	58.98	54.27	54.01	57.06	57.30
Al ₂ O ₃	22.60	21.55	20.15	22.21	22.25	21.43	21.99
CaO	4.35	0.64	0.26	4.71	4.66	0.86	0.78
SrO	0.13	0.09	0.09	0.16	0.10	0.12	0.13
Na ₂ O	3.72	6.23	6.18	1.91	2.29	6.98	3.00
K ₂ O	9.03	8.47	9.41	10.09	9.79	7.38	11.21
Rb ₂ O	0.63	0.57	0.58	0.60	0.54	0.95	1.44
Total	93.75	93.66	95.65	94.95	93.44	94.78	95.85
Si <i>apfu</i>	2.511	2.727	2.769	2.493	2.538	2.707	2.611
Al	1.256	1.192	1.115	1.203	1.232	1.199	1.181
Ca	0.220	0.032	0.013	0.232	0.235	0.044	0.038
Sr	0.004	0.002	0.002	0.004	0.003	0.003	0.003
Na	0.340	0.567	0.562	0.170	0.208	0.642	0.265
K	0.543	0.507	0.563	0.592	0.587	0.447	0.652
Rb	0.019	0.017	0.018	0.018	0.016	0.029	0.042
Σ <i>T</i> site	3.767	3.919	3.884	3.696	3.770	3.906	3.792
Σ <i>M</i> site	1.126	1.125	1.158	1.016	1.049	1.165	1.000
Or mol. %	49.9	46.6	50.2	60.0	57.5	40.9	69.4
Ab	30.2	50.4	48.5	16.7	19.8	55.1	26.5
"An"	19.9	3.0	1.3	23.2	22.7	4.0	4.1

The compositions were acquired by wavelength-dispersion electron-probe analyses. As there is no Ca-bearing plagioclase present, the "An" quoted is a reflection of the presence of lawsonite, intersected by the electron beam. In lawsonite, which partially replaces albite, Ca, Al and Si are present in the same proportion as in anorthite.

Table S13. COMPOSITION OF K-FELDSPAR IN ML-3A

Anal.	4	8	9	14	27	31	34	40	41	44	45	51
Map	9	9	9	9	3	3	3	23	23	23	23	5
SiO ₂ wt. %	67.12	66.18	67.87	69.22	69.82	68.05	69.39	69.46	69.29	69.12	69.07	68.59
Al ₂ O ₃	18.51	18.11	18.48	19.36	18.71	18.26	18.48	18.97	18.70	18.58	18.67	16.40
CaO	0.26	0.26	0.07	0.57	0.23	0.20	0.16	0.07	0.19	0.17	0.19	0.11
SrO	0.09	0.11	0.12	0.09	0.06	0.09	0.07	0.08	0.12	0.11	0.08	0.11
Na ₂ O	0.79	0.88	0.72	0.80	0.95	0.86	0.72	1.21	0.76	0.80	0.83	0.84
K ₂ O	14.97	14.85	15.24	13.29	14.76	15.23	15.18	13.48	15.17	14.38	14.78	12.83
Rb ₂ O	0.84	0.88	0.77	0.78	0.76	0.80	0.76	1.42	1.65	1.60	1.62	0.87
TOTAL	102.57	101.28	103.27	104.12	105.33	103.49	104.78	105.05	105.89	104.77	105.23	99.74
Si <i>apfu</i>	3.019	3.020	3.030	3.029	3.042	3.034	3.045	3.040	3.031	3.041	3.034	3.124
Al	0.981	0.974	0.972	0.999	0.961	0.959	0.956	0.978	0.964	0.964	0.966	0.880
Ca	0.013	0.013	0.003	0.027	0.011	0.010	0.007	0.003	0.009	0.008	0.009	0.005
Sr	0.002	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.002	0.003
Na	0.069	0.078	0.062	0.068	0.081	0.075	0.061	0.103	0.065	0.069	0.070	0.074
K	0.859	0.865	0.868	0.742	0.820	0.866	0.850	0.753	0.847	0.807	0.828	0.746
Rb	0.024	0.026	0.022	0.022	0.021	0.023	0.021	0.040	0.047	0.045	0.046	0.025
Σ cations	4.947	4.979	4.960	4.889	4.938	4.969	4.942	4.919	4.966	4.937	4.955	4.857
Or mol. %	88.3	89.1	89.0	76.4	84.1	88.9	87.1	79.3	89.4	85.2	87.4	77.1
Ab	6.9	7.8	6.2	6.8	8.1	7.5	6.1	10.3	6.5	6.9	7.0	7.4
An	1.5	1.6	0.6	2.9	1.3	1.2	0.9	0.5	1.2	1.1	1.1	0.8

Si <i>apfu</i>	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
Al	1.000	0.994	1.002	1.004	0.993	1.001	1.019	0.996	1.005	1.000
Ca	0.013	0.013	0.003	0.011	0.010	0.008	0.004	0.009	0.009	0.009
Sr	0.002	0.003	0.003	0.002	0.002	0.002	0.002	0.003	0.003	0.002
Na	0.070	0.079	0.064	0.084	0.077	0.064	0.107	0.067	0.072	0.073
K	0.875	0.882	0.894	0.857	0.896	0.890	0.784	0.874	0.842	0.857
Rb	0.025	0.026	0.023	0.022	0.024	0.022	0.042	0.048	0.047	0.047
Σ cations	4.985	4.997	4.989	4.980	5.002	4.987	4.958	4.997	4.978	4.988
Or	90.0	90.8	91.7	87.9	92.0	91.2	88.0	92.2	88.9	90.4
Ab	7.0	7.9	6.4	8.4	7.7	6.4	11.4	6.7	7.2	7.3
An	1.5	1.6	0.6	1.3	1.2	1.0	0.6	1.2	1.2	1.1

The compositions were established by wavelength-dispersion electron-probe analysis. End-member K-feldspar contains 16.92% K₂O, 18.32% Al₂O₃ and 64.76% SiO₂. The SiO₂ content established by electron-probe analysis is unrealistically high. The contents of the above table have been recalculated with an "adjusted" Si content of 3.000 *apfu*, leaving out the fourth and the last sample. This has resulted in minor changes that make the compositions much more realistic.

Table S14. COMPOSITION OF "PREHNITE" IN ML-3A

Anal. Map	21 9	22 9	23 9	50 5	52 5	118 38
SiO ₂ wt. %	34.95	34.58	40.36	40.23	43.57	30.22
Al ₂ O ₃	23.37	23.88	27.97	19.29	17.61	15.36
FeO	0.00	0.00	0.00	0.08	0.08	1.85
MnO	0.00	0.00	0.00	0.12	0.09	3.14
MgO	0.03	0.00	0.03	0.07	0.05	0.00
CaO	35.47	36.31	24.75	28.09	22.45	35.44
Na ₂ O	0.00	0.00	0.05	0.00	0.09	0.18
K ₂ O	0.12	0.10	4.13	0.45	2.12	0.00
Rb ₂ O	0.00	0.00	0.09	0.00	0.12	0.00
F	0.30	0.30	0.62	0.30	0.28	0.17
Si <i>apfu</i>	2.435	2.382	2.829	3.026	3.451	2.451
Al	1.918	1.939	2.311	1.710	1.644	1.468
Ca	2.647	2.679	1.860	2.264	1.905	3.081

The compositions were acquired by wavelength-dispersion electron-probe analysis. The ideal formula of prehnite is Ca₂Al₂Si₃O₁₀(OH)₂. It contains 43.71 wt. % SiO₂, 24.72% Al₂O₃, 27.20% CaO and 4.37% H₂O. The domains analyzed may well be mixtures containing prehnite and other calcic secondary minerals.

Table S15. COMPOSITION OF LAWSONITE IN ML-3A

Anal. Map	5 9	10 9	12 9	30 3	73 28	74 28	75 28	76 28	121 40	124 40
SiO ₂ wt. %	41.06	41.76	39.06	40.81	37.97	37.85	40.06	37.89	43.56	38.02
P ₂ O ₅	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00
SO ₃	0.00	0.00	0.00	0.00	0.14	0.16	0.00	0.20	0.23	0.00
Al ₂ O ₃	31.45	32.22	30.92	30.37	29.08	31.81	30.45	30.43	27.03	29.71
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
CaO	10.97	10.99	11.39	11.24	11.92	12.01	11.96	12.04	9.84	12.10
SrO	0.05	0.12	0.19	0.12	0.00	0.00	0.00	0.00	1.11	0.11
Na ₂ O	3.14	3.33	3.03	2.81	2.91	3.14	3.08	2.94	3.88	3.16
K ₂ O	0.12	0.05	0.08	0.08	0.07	0.07	0.32	0.09	0.00	0.00
Cl	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.00	0.00
Subtotal	86.79	88.47	84.64	85.43	82.10	85.04	85.88	83.61	85.69	83.10
–(O=Cl)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Total	86.79	88.47	84.64	85.43	82.10	85.04	85.88	83.60	85.69	83.10
Si <i>apfu</i>	2.135	2.128	2.082	2.165	2.090	2.002	2.105	2.046	2.308	2.062
P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000
S	0.000	0.000	0.000	0.000	0.006	0.006	0.000	0.008	0.009	0.000
Al	1.927	1.935	1.943	1.898	1.886	1.983	1.886	1.936	1.688	1.899
Mg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000
Ca	0.611	0.600	0.650	0.939	0.703	0.681	0.674	0.696	0.559	0.703
Sr	0.002	0.004	0.006	0.004	0.000	0.001	0.000	0.000	0.034	0.004
Na	0.317	0.329	0.313	0.289	0.311	0.322	0.314	0.307	0.399	0.332
K	0.008	0.003	0.006	0.005	0.005	0.005	0.021	0.006	0.000	0.000
Cl	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.002	0.000	0.000

The compositions were established by wavelength-dispersion electron-probe analysis. They were recalculated on the basis of five cations per formula unit. The formula of pure lawsonite is $\text{CaAl}_2(\text{Si}_2\text{O}_7)(\text{OH})_2 \cdot \text{H}_2\text{O}$, and it contains 32.24% SiO₂, 32.45% Al₂O₃, 17.84% CaO and 11.47% H₂O.

Table S16. COMPOSITION OF HOLTSTAMITE IN ML-3A

Anal. Map	15 9	16 9	17 9	18 9	35 3	36 3	68 28	69 28	70 28	71 28	72 28	88 30	89 30	90 30	91 30
SiO ₂ wt. %	38.05	37.84	37.95	37.70	37.81	37.50	37.59	38.20	37.30	37.45	37.57	32.08	31.53	36.25	33.79
P ₂ O ₅	0.00	0.00	0.00	0.00	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.05	0.03	0.04	0.09
SO ₃	0.00	0.00	0.00	0.00	0.26	0.29	0.00	0.00	0.18	0.00	0.16	0.27	0.18	0.22	0.25
Al ₂ O ₃	23.08	20.20	18.65	19.35	19.27	19.09	20.14	20.47	20.43	19.72	19.81	21.49	22.44	22.79	21.31
FeO	0.00	0.68	0.28	0.35	0.42	0.41	0.86	0.70	0.77	1.06	0.94	0.16	0.17	0.15	0.07
MnO	0.00	0.13	0.12	0.10	0.06	0.08	0.18	0.12	0.16	0.17	0.19	0.00	0.00	0.00	0.00
MgO	0.03	2.14	2.42	2.53	2.16	2.26	1.35	1.08	1.13	1.71	1.47	0.15	0.15	0.10	0.16
CaO	33.72	35.07	34.14	33.85	34.66	34.82	34.81	34.67	34.51	35.11	34.70	34.31	35.07	36.35	35.44
SrO	0.00	0.00	0.05	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na ₂ O	1.06	0.25	0.21	0.17	0.26	0.24	0.53	0.67	0.74	0.40	0.55	0.00	0.00	0.00	0.00
K ₂ O	0.06	0.09	0.05	0.14	0.05	0.07	0.04	0.04	0.06	0.10	0.04	0.00	0.00	0.00	0.00
F	0.21	1.60	1.84	1.69	1.58	1.56	1.79	1.69	1.73	1.85	1.84	4.48	4.94	2.95	3.66
Cl	0.00	0.04	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.03	0.04	0.03
Subtotal	96.21	98.04	95.74	95.91	96.80	96.40	97.38	97.68	97.05	97.62	97.32	93.04	94.54	98.89	94.80
—O=F	0.09	0.67	0.77	0.71	0.67	0.66	0.75	0.71	0.73	0.78	0.78	1.89	2.08	1.24	1.54
—O=Cl	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	96.12	97.36	94.96	95.19	96.12	95.73	96.62	96.96	96.31	96.83	96.53	91.14	92.45	97.64	93.25
Si <i>apfu</i>	2.904	2.873	3.012	2.957	2.952	2.923	2.890	2.943	2.868	2.866	2.900	2.569	2.449	2.742	2.665
P	0.000	0.000	0.000	0.000	0.002	0.003	0.000	0.000	0.000	0.000	0.000	0.004	0.002	0.003	0.006
S	0.000	0.000	0.000	0.000	0.015	0.017	0.000	0.000	0.010	0.000	0.009	0.016	0.011	0.012	0.015
Σ Z site	2.904	2.873	3.012	2.957	2.969	2.943	2.890	2.943	2.878	2.866	2.909	2.589	2.462	2.757	2.686
"H ₄ O ₄ "	0.096	0.127	0.000	0.043	0.031	0.057	0.110	0.057	0.122	0.134	0.091	0.411	0.538	0.243	0.314

Al	2.076	1.808	1.744	1.788	1.773	1.754	1.825	1.859	1.851	1.778	1.802	2.028	2.054	2.032	1.982
Fe	0.000	0.043	0.019	0.023	0.028	0.026	0.055	0.045	0.050	0.068	0.061	0.011	0.011	0.010	0.004
Mn	0.000	0.008	0.008	0.007	0.004	0.005	0.012	0.008	0.010	0.011	0.013	0.000	0.000	0.000	0.000
Mg	0.003	0.242	0.286	0.296	0.251	0.263	0.155	0.124	0.129	0.195	0.169	0.018	0.017	0.012	0.018
Ca	2.758	2.853	2.903	2.845	2.900	2.908	2.868	2.862	2.843	2.878	2.870	2.943	2.919	2.946	2.996
Sr	0.000	0.000	0.002	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Na	0.157	0.037	0.032	0.026	0.039	0.037	0.079	0.099	0.110	0.060	0.082	0.000	0.000	0.000	0.000
K	0.006	0.009	0.005	0.014	0.005	0.007	0.004	0.004	0.006	0.009	0.004	0.000	0.000	0.000	0.000
Σ Ca, Al sites	5.000	5.000	4.999	4.999	5.000	5.000	5.000	5.001	4.999	4.999	5.001	5.000	5.001	5.000	5.000
F	0.050	0.384	0.462	0.420	0.390	0.384	0.435	0.413	0.422	0.448	0.450	1.135	1.214	0.707	0.914
Cl	0.000	0.005	0.004	0.003	0.005	0.005	0.006	0.005	0.005	0.007	0.006	0.006	0.004	0.005	0.004
OH	0.950	0.611	0.534	0.577	0.605	0.611	0.559	0.582	0.573	0.545	0.544	0.000	0.000	0.288	0.096

The compositions, expressed in wt.%, were established by wavelength-dispersion electron-probe analysis. The recalculated compositions, expressed in atoms per formula unit (*apfu*), are based on filled Ca (X) + Al (Y) sites (5.000 *apfu*). The Z site in this hydrogarnet structure is almost completely filled by Si + P + S. The small difference from 3.000 in the occupancy of the tetrahedral site consists of a tetrahedral array of F, OH and Cl. In the case of composition 88 and 89, the measured amount of F and Cl fills the available position. Note that these Z-site occupancies are calculated by difference, and subject to accumulated analytical errors. Ideal composition: $\text{Ca}_3\text{Al}_2(\text{SiO}_4)_2(\text{OH})_4$.

Table S17. COMPOSITION OF ALKALI
FELDSPAR + LAWSONITE MIXTURES
IN ML-3A

Anal.	11	12	39	42
Map	9	9	23	23
SiO ₂ wt. %	49.94	50.59	52.25	60.57
Al ₂ O ₃	29.23	26.01	30.21	24.61
CaO	3.34	4.24	1.23	0.14
SrO	0.08	0.23	0.11	0.07
Na ₂ O	9.11	6.39	6.14	7.70
K ₂ O	0.04	3.67	1.87	2.18
Rb ₂ O	0.00	0.16	0.27	0.17
TOTAL	91.74	91.29	91.08	95.44
Si <i>apfu</i>	2.436	2.523	2.510	2.788
Al	1.680	1.529	1.711	1.335
Ca	0.175	0.227	0.063	0.007
Sr	0.002	0.007	0.003	0.002
Na	0.861	0.618	0.572	0.688
K	0.003	0.233	0.115	0.128
Rb	0.000	0.005	0.008	0.005
Σ cations	5.157	5.142	4.982	4.955
Σ Ca, Na, K	1.041	1.090	0.761	0.832
Or mol. %	0.3	21.8	16.2	16.0
Ab	82.7	56.7	75.2	82.7
"An"	17.0	21.5	8.7	1.3

Table S18. COMPOSITION OF GONNARDITE IN ML-3A

Anal. Map	77 28	78 28	79 28	80 28	81 28
SiO ₂ wt. %	44.06	48.56	46.20	47.52	48.26
P ₂ O ₅	0.00	0.00	0.06	0.00	0.00
SO ₃	0.00	0.00	0.25	0.19	0.00
Al ₂ O ₃	28.64	27.11	30.39	26.64	26.92
CaO	19.75	17.14	18.58	16.83	17.32
SrO	0.05	0.05	0.00	0.08	0.05
Y ₂ O ₃	0.00	0.00	0.05	0.00	0.00
Na ₂ O	2.28	3.42	2.32	3.57	3.15
K ₂ O	0.24	0.47	0.22	0.47	0.48
Cl	0.28	0.68	0.28	0.68	0.56
-(O=Cl)	0.06	0.15	0.06	0.15	0.13
Total	95.24	97.38	98.29	95.83	95.74
Si <i>apfu</i>	5.662	6.032	5.617	6.010	6.033
P	0.000	0.000	0.006	0.000	0.000
S	0.000	0.000	0.023	0.018	0.000
Al	4.338	3.968	4.354	3.972	3.967
Ca	2.720	2.281	2.420	2.281	2.319
Sr	0.004	0.003	0.000	0.006	0.003
Y	0.000	0.000	0.003	0.000	0.000
Na	0.569	0.825	0.547	0.875	0.763
K	0.112	0.157	0.102	0.170	0.147
Cl	0.008	0.019	0.008	0.019	0.016

The compositions were established by wavelength-dispersion electron-probe analysis. The compositions have been recalculated on the basis of 10 atoms of Si + Al per formula unit. An average of the five compositions give the formula (Ca_{2.404}Na_{0.716}K_{0.138}Sr_{0.003}Y_{0.001})_{Σ3.262}(Al_{4.120}Si_{5.871}S_{0.008}P_{0.001})_{Σ10}O_{20.784}· The H₂O present in the zeolite's formula cannot be assessed, but clearly must be deficient. For comparison, a "textbook" formula of gonnardite is Na₂CaAl₄Si₆O₂₀·7H₂O, and it contains 44.58% SiO₂, 25.22% Al₂O₃, 6.94% CaO, 7.67% Na₂O and 15.60% H₂O.

Table S19. COMPOSITION OF EXOTIC PHASE UK2 IN ML-3A

Anal. Map	82 30	83 30	84 30	85 30	86 30	87 30	104 37	105 37	106 37	110 38	111 38	131 51	132 51	133 51	134 51	135 51
SiO ₂ wt. %	23.45	12.76	14.31	13.16	7.50	14.67	21.36	21.04	21.20	13.63	16.63	25.59	24.95	23.03	25.56	24.19
SO ₃	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.41	0.86	0.94	1.04
Al ₂ O ₃	1.47	0.00	0.55	0.11	0.07	0.41	0.70	0.66	0.31	0.98	1.60	1.41	1.21	1.64	1.19	1.50
TiO ₂	0.74	0.30	0.52	0.37	0.17	0.46	0.31	0.69	0.31	0.93	1.12	0.12	0.10	0.12	0.08	0.08
SnO ₂	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.06	0.00	0.04
ZrO ₂	0.95	0.49	0.73	0.66	0.62	0.72	1.30	1.61	1.22	0.69	0.50	4.62	4.54	4.30	4.29	4.57
Nb ₂ O ₅	17.63	6.50	12.73	8.51	8.19	12.04	10.06	11.04	8.48	11.58	11.52	15.72	14.87	13.85	12.32	13.84
Ta ₂ O ₅	19.26	18.23	19.22	17.15	17.03	18.41	20.04	23.63	22.90	18.36	23.45	26.08	29.09	24.89	24.90	25.41
FeO	0.25	0.21	0.23	0.26	0.24	0.22	0.45	0.39	0.36	0.28	0.36	1.34	1.55	1.65	1.41	1.34
MnO	0.39	0.34	0.34	0.30	0.30	0.36	0.21	0.29	0.22	0.00	0.00	2.59	2.94	2.96	2.85	2.66
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.12	0.05	0.08
CaO	13.29	9.70	11.78	10.87	10.60	11.99	10.28	11.08	9.85	20.41	10.09	12.31	12.64	11.75	12.33	12.50
SrO	0.38	0.21	0.30	0.20	0.12	0.30	0.48	0.44	0.50	0.60	0.46	0.60	0.55	0.43	0.45	0.49
Na ₂ O	0.33	0.42	0.38	0.16	0.21	0.35	0.12	0.16	0.07	0.00	0.00	0.63	0.36	0.36	0.29	0.30
K ₂ O	0.22	0.26	0.21	0.14	0.17	0.23	0.17	0.18	0.16	0.00	0.06	0.42	0.35	0.29	0.66	0.32
F	2.06	0.90	1.03	0.68	0.71	1.14	0.14	0.19	0.00	0.00	0.00	4.38	3.36	10.64	6.19	9.48
Cl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.02	0.02	0.02
Subtotal	80.42	50.32	62.33	52.57	45.93	61.30	65.62	71.40	65.58	67.46	65.89	95.46	96.05	97.17	93.63	97.87
-(O=F)	0.87	0.68	0.43	0.29	0.30	0.48	0.06	0.08	0.00	0.00	0.00	1.85	1.42	4.48	2.61	3.99
Total	79.55	49.64	61.90	52.28	45.63	60.82	65.56	71.32	65.58	67.46	65.89	93.61	94.63	92.69	91.02	93.88

The compositions were established by wavelength-dispersion electron-probe analysis.

Table S20. COMPOSITION OF UK1 IN MKL-1021 AND ML-3A

Section	MKL-1021				ML-3A	
	67	68	69	70	112	113
Anal.	25	25	25	25	38	38
Map						
Si at. prop.	0.000	0.108	0.082	0.125	0.012	0.017
Al	0.006	0.000	0.013	0.006	0.016	0.020
Fe	0.000	0.000	0.000	0.000	0.000	0.224
Mn	0.000	0.000	0.000	0.000	0.000	0.439
Ca	4.142	4.107	4.335	4.014	5.553	6.108
Sr	0.020	0.011	0.020	0.009	0.000	0.007
Sn	2.104	1.910	2.057	1.859	2.335	2.453
Ta	0.000	0.000	0.000	0.000	0.018	0.014
S	21.000	21.000	21.000	21.000	21.000	21.000
F	0.097	0.000	0.000	0.000	0.000	0.308
Cl	0.012	0.017	0.025	0.026	0.008	0.006

These six compositions, established by wavelength-dispersion electron-probe analysis, pertain to a Ca–Sn–S–O phase encountered in two sections. The presence of F and Cl suggests that OH also is present. The compositions are recalculated on the basis of 21 atoms of sulfur (arbitrary choice). The proportion of Ca, Sn and S is very different from that expected in genplesite, $\text{Ca}_3\text{Sn}(\text{SO}_4)_2(\text{OH})_6 \cdot 3\text{H}_2\text{O}$ (Pekov *et al.* 2018), the only IMA-approved mineral containing Ca, Sn, S and O.

Table S21. ANHYDROUS COMPOSITION
OF UNKNOWN MINERAL UK3 IN ML-3A

SiO ₂ wt. %	12.68	CaO	15.90	Nb ₂ O ₅	55.54	F	0.19
P ₂ O ₅	0.05	SrO	0.12	Ta ₂ O ₅	4.49	Cl	0.07
SO ₃	1.27	K ₂ O	0.03	TiO ₂	0.83		
Al ₂ O ₃	0.99	La ₂ O ₃	0.06	ZrO ₂	0.22		
		BaO	0.10	SnO ₂	0.07		
Σ T site	14.99	FeO	2.12	WO ₃	0.33		
		MnO	3.90				
Si <i>apfu</i>	3.418	Ca	4.592	Nb	6.766	F	0.165
P	0.012	Sr	0.019	Ta	0.329	Cl	0.033
S	0.256	K	0.010	Ti	0.168		
Al	0.314	La	0.045	Zr	0.028		
		Ba	0.012	Sn	0.010		
Σ T site	4.000	Fe	0.477	W	0.023		
		Mn	0.891				

This is the only composition, established by wavelength-dispersion electron-probe analysis. It was recalculated on the basis of four cations of Si + P + S + Al, as recommended for komarovite-series minerals (Pekov *et al.* (2004). On that basis, the Nb + Ta should amount to 6 *apfu*, and Ca + Sr should be at most 3 *apfu*. Komarovite has the formula (Ca,Sr,Na)_{6-x}(Nb,Ti)₆(Si₄O₁₂)(O,OH,F)₁₆•nH₂O (Pekov *et al.* 2004). We also considered mongolite, Ca₄Nb₆Si₅O₂₄(OH)₁₀•6H₂O (Vladykin *et al.* 1985). By recalculating the formula with the Si site equal to 5, the amount of Nb + Ta would depart even more that the expected amount, ~6 *apfu*. No other OH-bearing silicate of Ca and Nb is known.

Table S22. COMPOSITION OF SCHEELITE IN ML-3A

CaO wt. %	19.50	19.89	Ca <i>apfu</i>	1.011	1.022
SrO	0.17	0.19	Sr	0.005	0.005
WO ₃	78.36	78.08	W	0.983	0.971
TiO ₂	0.04	0.05	Ti	0.001	0.002
			Σ cations	2.000	2.000
Total	98.07	98.21	O	3.917	3.945

The compositions were established by wavelength-dispersion electron-probe analysis. The compositions have been recalculated on the basis of two cations per formula unit.