An Introduction to ICDD and the Powder Diffraction File

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History

- Hanawalt, J. D. & Rinn, H. W. (1936). *Identification of crystalline materials*. *Ind. Eng. Chem. Anal. Ed.* **8**, 244-247, reprinted in (1986) *Powder Diffraction* **1**, 2-6.
- Hanawalt, J. D., Rinn, H. W. & Frevel, L. K. (1938). *Chemical analysis by X-ray diffraction. Ind. Eng. Chem. Anal. Ed.* **10**, 457-512, reprinted in part in (1986) *Powder Diffraction* **1**, 7-14.
- 1941 Joint Committee for Chemical Analysis by Powder Diffraction Methods, supported by Committee E-4 of the American Society for Testing and Materials (ASTM)
- 1969 independent non-profit Joint Committee on Powder Diffraction Standards (JCPDS).
- 1978 name change to the International Centre for Diffraction Data

Products and Services

- PDF-2 (5 year) 316,820 entries (2021)
- PDF-4+ (annual) 444,133 (2021)
- PDF-4 Organics 547,295 (2021)
- WebPDF-4, PDF-4 Minerals (48,946), PDF-4/Axiom (97,789)
- SIeve/SIeve+
- Powder Diffraction, Advances in X-ray Analysis
- Denver X-ray Conference, Pharmaceutical Powder Diffraction Symposium
- Clinics and Workshops
- Grant-in-Aid

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Powder XRD Analysis



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Physical Properties	E -ANT - Antlerite (group) E -APA - Apatite (group)	AFR - SAPO-40 AFS - MAPSO-46		4_fused_rings 4_Hetero_ato	ms_in_ring(s)		
Reference	APH - Aphthitalite (supergroup)	AFT - AIPO4-52		4_membered_	ring		
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References	Compound Name:	: Sodium Carbonate	
Comments	Mineral Name:	Natrite IMA No: 1981-005	
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	37.97%	75.95%	00-024-0461	😐 I	Au96.05 Mg3.95	Gold Magnesium	
	37.97%	75.95%	01-072-5352	● I	Au96.05 Mg3.95	Gold Magnesium	
	37.97%	75.95%	04-007-1482	🔴 В	Au96.05 Mg3.95	Gold Magnesium	
	37.97%	75.95%	04-007-1483	🥚 В	Au96.05 Mg3.95	Gold Magnesium	
	37.97%	75.95%	04-019-4954	<u> </u>	Au96.05 Mg3.95	Gold Magnesium	V
	GOM (WA): 49 ₩g).83% ● GOM (UV	VA): 99.67%				Au
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PDF #	QM	Chemical Formula	Compound Name	Mineral Name	D1 (Å)	D2 (Å)	D3 (Å)	SYS	Auth SPGR	XtlCell a (Å)	XtlCell c (Å)	AuthCell Vol (Å3)	L1 (Å)
🚖 00-043-0697	🥥 S	👔 (Ca, Mg) C O ₃	Calcium Magnesium Carbonate	Calcite, magnesian	3.004200	1.889150	2.262510	R	R-3c	4.943	16.852	356.53	3.8204
00-060-0473	● I	(Ca, Mg)(CO ₃)	Calcium Magnesium Carbonate		3.008920	1.860030	2.267010	R	R-3c	4.955	16.898	359.24	3.8240
01-086-2336	🔵 S	(Mg _{0.129} Ca _{0.871})(CO ₃)	Magnesium Calcium Carbonate	Calcite, magnesian	2.999470	2.259940	1.853450	R	R-3c	4.938	16.832	355.47	3.8126
01-089-1304	🔵 S	(Mg _{0.03} Ca _{0.97})(CO ₃)	Magnesium Calcium Carbonate	Calcite, magnesian, syn	3.025470	1.869360	1.904940	R	R-3c	4.978	16.988	364.57	3.8442
01-089-1305	🔵 S	(Mg _{0.06} Ca _{0.94})(CO ₃)	Magnesium Calcium Carbonate	Calcite, magnesian, syn	3.018190	1.864700	1.901030	R	R-3c	4.963	16.957	361.72	3.8336
04-008-8067	🔴 В	Ca _{0.9} Mg _{0.1} (CO ₃)	Calcium Magnesium Carbonate	Calcite, magnesian	3.002300	1.890090	1.855100	R	R-3c	4.941	16.854	356.34	3.8153
04-012-6929	🔵 S	Ca _{0.845} Mg _{0.155} (C O ₃)	Calcium Magnesium Carbonate		3.025480	1.869370	2.278600	R	R-3c	4.978	16.988	364.57	3.8442
04-012-6930	🔵 S	Ca _{0.715} Mg _{0.285} (CO ₃)	Calcium Magnesium Carbonate		3.018190	2.272170	1.864700	R	R-3c	4.963	16.957	361.72	3.8336
04-013-2116	🔵 S	Ca _{0.936} Mg _{0.064} (C O ₃)	Calcium Magnesium Carbonate	Calcite, magnesian	3.020030	1.865910	1.901900	R	R-3c	4.967	16.963	362.47	3.8365
04-019-9173	😐 P	Ca _{0.758} Mg _{0.242} (CO ₃)	Calcium Magnesium Carbonate		2.965820	2.238700	1.833360	R	R-3c	4.896	16.600	344.60	3.7759

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PDF #	OM	Chemical Formula	Compound Name	Mineral Name	D1 (Å)	D2 (Å)	D3 (Å)	SYS	Auth SPGR	XtlCell a (Å)	XtlCell c (Å)	AuthCell Vol (Å3)	L1 (Â)
* 00-043-0697	S	🚹 (Ca, Mg) C O3	Calcium Magnesium Carbonate	Calcite, magnesian	3.004200	1.889150	2.262510	R	R-3c	4.943	16.852	356.53	3.8204
01-086-2336	S	(Mg _{0.129} Ca _{0.871})(CO ₃)	Magnesium Calcium Carbonate	Calcite, magnesian	2.999470	2.259940	1.853450	R	R-3c	4.938	16.832	355.47	3.8126
01-089-1304	🔵 S	(Mg _{0.03} Ca _{0.97})(CO ₃)	Magnesium Calcium Carbonate	Calcite, magnesian, syn	3.025470	1.869360	1.904940	R	R-3c	4.978	16.988	364.57	3.8442
01-089-1305	🔵 S	(Mg _{0.06} Ca _{0.94})(CO ₃)	Magnesium Calcium Carbonate	Calcite, magnesian, syn	3.018190	1.864700	1.901030	R	R-3c	4.963	16.957	361.72	3.8336
04-008-8067	🔴 В	Ca _{0.9} Mg _{0.1} (C O ₃)	Calcium Magnesium Carbonate	Calcite, magnesian	3.002300	1.890090	1.855100	R	R-3c	4.941	16.854	356.34	3.8153
04-013-2116	🔵 S	Ca _{0.936} Mg _{0.064} (C O ₃)	Calcium Magnesium Carbonate	Calcite, magnesian	3.020030	1.865910	1.901900	R	R-3c	4.967	16.963	362.47	3.8365
04-019-9173	😐 P	Ca _{0.758} Mg _{0.242} (CO ₃)	Calcium Magnesium Carbonate		2.965820	2.238700	1.833360	R	R-3c	4.896	16.600	344.60	3.7759



[Environment (Ambient)] And [Only (Mg And Ca And C And O)] And [Space Group Number Is 167] And [Status (Primary, Alternate)]

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A Case Study: The 6H Perovskite Ba₃CaSb₂O₉

Chris Ling The University of Sydney

Data from 1-BM-C C2/c, a = 5.99898(7), b = 10.37797(19), c = 14.8658(3) Å, $\beta = 91.384(2)^{\circ}, V = 925.23(3)$ Å³





There are peaks unaccounted for:

20	$d (\lambda = 1.182279 \text{ Å})$	Intensity
22.87	2.9817	400
28.05	2.4392	70
28.44	2.4065	60
31.63	2.1619	150
32.51	2.1118	300
40.14	1.7226	260
46.70	1.4915	140
52.58	1.3346	110
55.04	1.2794	80

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📔 New d-	List	Complete	e Phases	Match Window (°)): 0.3 🗸	✓ Min GOM: 2000 ✓			🌌 Create Graph	Intens	sity Ratios 🔻										
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GOM 🐣	PDF #	Peaks Matched	(Chemical Formula		(Compound I	Vame	Mineral Nam	e	Phase	Status	QM	Coords	I/Ic	D1 (Å)	D2 (Å)	D3 (Å)	D4 (Å)	D5 (Å)	
7214	04-012-0403	8 of 43 (19%)	Ba ₂ Cu _{0.10}	Pr Ru _{0.90} O ₆	Barium Co	opper Praseody	ymium Ruth	enium Oxide				P	0 I	1	5.91	2.981660	2.108900	1.724360	2.113470	1.490830	^
7158	04-012-0402	8 of 50 <i>(16%)</i>	Ba ₂ Pr Ru O	6	Barium Pr	raseodymium Ri	uthenium O	xide				Α	● I	1	5.98	2.981660	2.989740	2,108930	1.724400	2.113490	
7012	01-084-9262	8 of 29 <i>(28%)</i>	(Ba _{1.60} Ca ₀	_{).40}) La Nb O ₆	Barium Ca	alcium Lanthanu	um Niobium	Oxide				P	9 I		5.38	2.980870	2.989250	2,108190	1.724000	2.113320	
6870	04-022-2891	8 of 25 (32%)	Ba1.6 Ca0.4	La Eu _x Nb O ₆	Barium Ca	alcium Europium	n Lanthanur	n Niobium Oxide				P	<u></u> Θ Ρ	1	5.15	2.980890	2.989270	2.108190	1.724360	2.113340	
6768	04-002-4363	7 of 14 <i>(50%)</i>	Ba ₂ Y Nb O ₆	5	Barium Yt	ttrium Niobium (Oxide					A	— Р	1	15.39	2,983990	1.722810	2,110000	1.492000	1.334480	
6768	04-002-6579	7 of 14 <i>(50%)</i>	Ba ₂ Y Zr O ₆		Barium Yt	ttrium Zirconium	n Oxide					P	9 P	1	15.19	2.983990	1.722810	2.110000	1.492000	1.334480	
6754	04-021-7855	7 of 14 (50%)	Ba ₂ Ca _{0.79}	0.13 Nb1.08 O5.68	Barium Ca	alcium Yttrium N	Niobium Oxid	le				P	<u> </u>	1	14.1	2.982860	1.722150	2.109200	1.491430	1.333980	
6720	04-005-7520	7 of 14 (50%)	Ba2 Y ND O	5	Barium Yt	ttrium Niobium (Oxide					A	<u> </u>	1	15.39	2.982580	1.721990	2,109000	1.491290	1.333850	
6720	04-007-0162	7 of 14 (50%)	Ba2 Y ND O	5	Barium Yt	ttrium Niobium (Oxide					A	P	1	15.39	2.982580	1.721990	2.109000	1.491290	1.333850	
6705	04-015-2511	7 of 9 (78%)	Ba Y _{0.2} Zr _{0.}	8 02.9	Barium Yt	ttrium Zirconium	n Oxide					P	I	1	14.98	2.984400	1.723040	2.110290	1.492200	1.334660	~
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Diffraction 1,000 900 800 700 500 400 300 200 100 0 1	Patterns Phases F 3.5 14.0 14.5	Peaks (7 of 9)	16.0 16.4	5 17.0 17.5	18.0 18.5 1	9.0 19.5	20.0 20.	5 21.0 21.5 22.0 2	2.5 23.0 23.5 24 2θ (°)	4.0 24.5	25.0 25.8	5 26.0	26.5	27.0	27.5 28.	0 28.5 2	29.0 29.5	— New Se — Barium 30.0 30.	ssion Yttrium Nic	obium Oxide 31.5 32.0	

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GOM 🐣	PDF #	Peaks Matched	0	hemical Formula				Compound	Name		Mineral	Name		Phase	Status	QM	Coords	I/Ic	LS1 (Å)	LS2 (Å)	LS3 (Å)	LS4 (Å)	LS5 (Å)	
7318	04-012-0403	8 of 43 <i>(19%)</i>	Ba2 Cu0.10	^{or Ru} 0.90 ^O 6	Bariu	um Coppe	er Praseod	ymium Ruth	enium Oxide						P	0 I	1	5.91	2.981660	2.113470	2.108900	1.724360	1.494850	^
7184	04-018-0963	7 of 24 (29%)	Ba ₂ Y Ta O ₆		Bariu	um Yttriu	m Tantalun	n Oxide						Low tem	A	B	1	11.67	2.982230	2.112070	2.105450	1.722690	1.719990	
6868	01-084-9262	8 of 29 (28%)	(Ba _{1.60} Ca ₀	.40) La Nb O ₆	Bariu	um Calciu	um Lanthan	um Niobium	Oxide						P	<u> </u>		5.38	2.989250	2.980870	2.113320	2.108190	1.724000	
6854	04-022-2891	8 of 25 (32%)	Ba1.6 Ca0.4	La Eu _x Nb O ₆	Bariu	um Calciu	Im Europiur	m Lanthanur	m Niobium Ox	ide					P	P	1	5.15	2.989270	2.980890	2.113340	2.108190	1.724360	
6845	04-012-0402	8 of 50 (16%)	Ba ₂ Pr Ru O		Bariu	um Prase	odymium R	Luthenium O	xide						A	I	1	5.98	2.989740	2.981660	2.113490	2.108930	1.724400	
6/96	04-009-4989	8 of 32 (25%)	Ba H _{0.6} SD ₀	4 2.9	Bariu	um Thalliu	um Antimor	ny Oxide							P	O P	~	13.98	2.982660	2.970000	2.112/50	2,105390	1.722940	
6601	04-002-4363	7 of 14 (50%)	Ba V 7c O		Bariu Bariu	im Yttriu	m Niodium	Oxide							A	O P	1	15.39	2,983990	2,436420	2.110000	1.722810	1.492000	
6601	04-002-0379	7 of 9 (70%)	Ba Y Nb.	- W O-	Bariu	um Yttriu	m Niobium	Tuposten O	vide						P		-	15.19	2,903990	2,436420	2.110000	1,722010	1.492000	
6595	04-014-0985	7 of 14 /5/96)	Ba, Y Nb O,	2 ** 0.2 * 3	Bariu	im Yttriu	m Niobium	Ovide	XIUE						Δ		5	15.30	2,903990	2,436740	2.110000	1.722010	1.492190	
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Diffraction 1,000 900 800 700 200 100 0 1	Patterns Phases 1	Peaks (7 of 9)	16.0 16.5	17.0 17.5	18.0 18.5	19.0	19.5	20.0 20.	5 21.0 2	21.5 22.0 22.	5 23.0 23.5	24.0	24.5	25.0 25.5	5 26.0	26.5	27.0	27.5 28	.0 28.5	29.0 29.5	— New Se — Barium 30.0 30	ssion Yttrium Nio	obium Oxide? 31.5 32.0	
Diffraction 1,000 900 800 700 200 100 200 100 0	Patterns Phases I	Peaks (7 of 9)	16.0 16.5	i 17.0 17.5	18.0 18.5	i 19.0	19.5	20.0 20.	5 21.0 2	21.5 22.0 22.	5 23.0 23.5 2θ (°)	24.0	24.5	25.0 25.5	5 26.0	26.5	27.0	27.5 28	.0 28.5	29.0 29.5	— New Se — Barium 30.0 30.	ssion Yttrium Nio	obium Oxide? 31.5 32.0	
Diffraction 1,000 900 800 700 200 100 0 1	Patterns Phases 1	Peaks (7 of 9)	16.0 16.5	17.0 17.5	18.0 18.5	; 19.0	19.5	20.0 20.	5 21.0 2	21.5 22.0 22.	5 23.0 23.5 2θ (°)	24.0	24.5	25.0 25.5	5 26.0	26.5	27.0	27.5 28	.0 28.5	29.0 29.5	— New Se — Barium 30.0 30.	ssion Yttrium Nio	obium Oxide? 31.5 32.0	

A weak peak at 28.44° (2.4065 Å) is still unaccounted for:

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PDF #	QM	Chemical Formula	Compound Name	Mineral Name	D1 (Å)	D2 (Å)	D3 (Å)	SYS	Auth SPGR	XtlCell a (Â)	XtlCell c (Å)	AuthCell Vol (Å3)	L1 (Â)
00-004-0777	- I	Ca O	Calcium Oxide	Lime, syn	2.405000	1.701000	2.778000	С	Fm-3m	4.811	4.811	111.32	2.7780
00-037-1497	🔵 S	Ca O	Calcium Oxide	Lime, syn	2.405870	1.700930	2.777370	С	Fm-3m	4.811	4.811	111.33	2.7773
00-048-1467	<u> </u>	Ca O	Calcium Oxide	Lime, syn	2.405060	1.700810	2.777710	С	Fm-3m	4.811	4.811	111.33	2.7777
01-070-5490	🔵 S	Ca O	Calcium Oxide	Lime, syn	2.407600	1.702430	2.780060	С	Fm-3m	4.815	4.815	111.65	2.7800
01-077-2010	9 I	Ca O	Calcium Oxide	Lime, syn	2.406000	1.701300	2.778210	С	Fm-3m	4.812	4.812	111.42	2.7782
01-077-9574	🔵 S	Ca O	Calcium Oxide	Lime, syn	2.405360	1.700850	2.777470	С	Fm-3m	4.811	4.811	111.33	2.7774
01-080-7710	🔵 S	Ca O	Calcium Oxide		2.408550	1.703100	2.781150	С	Fm-3m	4.817	4.817	111.78	2.781
01-082-1690	🔵 S	Ca O	Calcium Oxide	Lime, syn	2.402450	1.698790	2.774110	С	Fm-3m	4.805	4.805	110.93	2.774
04-002-6758	9 I	Ca O	Calcium Oxide	Lime, syn	2.405000	1.700590	2.777050	С	Fm-3m	4.810	4.810	111.28	2.7770
04-003-7161	0 I	Ca O	Calcium Oxide	Lime, syn	2.404000	1.699880	2.775900	С	Fm-3m	4.808	4.808	111.15	2.7759
04-004-5528	9 I	Ca O	Calcium Oxide		2.401600	1.698190	2.773130	C	Fm-3m	4.803	4.803	110.81	2.773
04-004-8549	9 I	Ba ₂ Sb ₃	Antimony Barium		3.095000	2.414010	3.170170	M	P21/c	15.817	6.934	1475.44	10.2476
04-004-8985	9 I	Ca O	Calcium Oxide	Lime, syn	2.405600	1.701020	2.777750	С	Fm-3m	4.811	4.811	111.37	2.7777
04-005-4757	9 I	Ca O	Calcium Oxide	Lime, syn	2.401000	1.697760	2.772440	С	Fm-3m	4.802	4.802	110.73	2.7724
04-005-6351	9 I	Ca O	Calcium Oxide	Lime, syn	2.407500	1.702360	2.779940	С	Fm-3m	4.815	4.815	111.63	2.7799
04-005-9402	9 I	Ca O	Calcium Oxide	Lime, syn	2.407500	1.702360	2.779940	С	Fm-3m	4.815	4.815	111.63	2.7799
04-006-5940	н	Ca O	Calcium Oxide	Lime, syn	2.410000	1.704130	2.782830	С	Fm-3m	4.820	4.820	111.98	2.7828
04-006-5942	9 I	Ca O	Calcium Oxide	Lime, syn	2.406000	1.701300	2.778210	С	Fm-3m	4.812	4.812	111.42	2.7782
04-006-6519	9 I	Ca O	Calcium Oxide	Lime, syn	2.400000	1.697060	2.771280	С	Fm-3m	4.800	4.800	110.59	2.7712
04-006-9375	0 I	Ca O	Calcium Oxide	Lime, syn	2.405000	1.700590	2.777050	С	Fm-3m	4.810	4.810	111.28	2.7770
04-007-4743	9 I	Ca O	Calcium Oxide	Lime, syn	2.405290	1.700800	2.777400	С	Fm-3m	4.811	4.811	111.33	2.7774
04-007-8376	0 I	Ca O	Calcium Oxide	Lime, syn	2.405000	1.700590	2.777050	С	Fm-3m	4.810	4.810	111.28	2.7770
04-007-9734	9 I	Ca O	Calcium Oxide	Lime, syn	2.409500	1.703770	2.782250	С	Fm-3m	4.819	4.819	111.91	2.7822
04-010-5778	● I	Ca O	Calcium Oxide	Lime, syn	2.407600	1.702430	2.780060	С	Fm-3m	4.815	4.815	111.65	2.7800
04-011-8430	0 I	Ca O	Calcium Oxide	Lime, syn	2.404000	1.699880	2.775900	С	Fm-3m	4.808	4.808	111.15	2.7759
04-011-9020	9 I	Ca O	Calcium Oxide	Lime, syn	2.404850	1.700490	2.776880	С	Fm-3m	4.810	4.810	111.26	2.7768

[Just (Ca And Ba And Sb And O)] And [Strong Line = 2.41(0.01) Å] And [Status (Primary, Alternate)]

Search

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There's still a very weak peak at 32.89°/2.0881 Å:

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PDF #	QM	Chemical Formula	Compound Name	Mineral Name	D1 (Å)	D2 (Å)	D3 (Å)	SYS	Auth SPGR	XtlCell a (Å)	XtlCell c (Å)	AuthCell Vol (Å3)	L1 (Â)
00-017-0125	🔴 В	Sb	Antimony		2.940000	2.090000	1.710000	С	Pm-3m	2.960	2.960	25.93	2.9400
00-020-0209	0 🥥	Ca ₃ Sb ₂ O ₆	Calcium Antimony Oxide		2.970000	2.880000	2.080000	Х					4.4200
01-083-8080	9 I	0 ₈	Oxygen		2.158210	2.087170	3.271880	M	C2/m	6.947	3.656	139.90	4.3164
01-083-8081	🔵 S	0 ₈	Oxygen		2.157840	2.085380	3.275620	М	C2/m	6.963	3.657	140.01	4.3156
04-002-2786	9 I	Ba O	Barium Oxide		2.084070	2.899140	2.050000	Т	P4/nmm	4.100	2.998	50.40	2.9980
04-007-9029	🔵 S	Sb	Antimony		2.987500	2.099000	2.126230	R	R-3m	4.198	10.485	160.02	3.4950
04-007-9030	🔵 S	Sb	Antimony		2.983760	2.098000	2.121870	R	R-3m	4.196	10.455	159.41	3.4850
04-013-2320	😐 I	(O ₂)	Oxygen		2.158210	2.087170	3.271880	м	C2/m	6.947	3.656	139.90	4.3164
04-013-2321	S	(0 ₂)	Oxygen		2.157840	2.085380	3.275620	М	C2/m	6.963	3.657	140.01	4.3156
04-017-1162	P	Sb	Antimony		2.929190	2.060000	2.082690	R	R-3m	4.120	10.260	150.82	3.4200

[Just (Ca And Ba And Sb And O)] And [Strong Line = 2.09(0.01) Å] And [Status (Primary, Alternate)]

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Quantitative Phase Analysis

Phase	Concentration, wt%
Ba ₃ CaSb ₂ O ₉	88.59(3)
Ba_2CaSbO_6	10.59(9)
CaO	0.53(3)
BaO?	0.28(2)
other	trace





Use of SIeve+ and JADE

"prelithiated Si" ashu003.xrdml



IExpress flower food kadu1852.xrdml



[kadu1852] IExpress flower food (60,40,1/4,0.02,0.7 mm cap) JAK

Supplied with PDF-4

"Sessions"

Inorganic Phases

- Exercise 7-1-1. Believed to be a pure phase, but not sure that the label on the reagent bottle is correct.
- Exercise 7-1-2. A student tried to prepare SrTiO₃ using reagent SrO, but the reaction did not go as planned. Check the SrO.
- Exercise 7-1-3. Check the product of a preparation of CdTiO₃ to see if it is phase pure.

Inorganic Phases

- Exercise 7-1-4. A mixture of three common oxides.
- Exercise 7-1-5. A smear mount of a natural specimen of witherite, BaCO₃.
- Exercise 7-1-6. A white paint.
- Exercise 7-1-7. A black filter deposit from a filter in a new solar hot water system. XRF indicates Fe, Ca, and minor Mg. An acid test indicates the presence of carbonate.

Inorganic Phases

- Exercise 7-1-8. A sample of lime (prepared by heating calcite at 1000°C) was left exposed to the air for several days. What is it now?
- Exercise 7-1-9. A synthetic red phosphor for color television tubes.
- Exercise 7-1-10. A fluorescent screen (which turns out to be a solid solution).

Minerals

- Exercise 7-2-1. A natural specimen of a zinc mineral. Consider data quality of old PDF entries and associations.
- Exercise 7-2-2. A mixture of polymorphs.
- Exercise 7-2-3. A mixture prepared to simulate the pressure-induced changes which can be induced by severe grinding. The specimen was prepared without any special care to avoid preferred orientation.

Minerals

- Exercise 7-2-4. An attempt to estimate the composition of a solid solution mineral.
- Exercise 7-2-5. A hydrothermal ore containing a trace of gold.
- Exercise 7-2-6. Typical raw material used to make dental ceramics (the best grade of whiteware porcelain). It is mined from a pegmatite deposit. We are asked to identify the feldspar(s) present.

Minerals

- Exercise 7-2-7. A mixture of sulfide minerals.
- Exercise 7-2-8. A mineral with low-angle lines and an impurity.
- Exercise 7-2-9. The $< 2\mu m$ fraction of a sedimentary rock (sandstone).

Metals and Alloys

- Exercise 7-3-1. An artificial example to build confidence in identifying multi-phase unknowns
- Exercise 7-3-2. A steel
- Exercise 7-3-3. A corrosion product from a white metal bearing. XRF indicates the presence of Sn, with small amounts of Cu and Sb.

Organic Phases

- Exercise 7-4-1. A tablet, ground to a fine powder and smeared on a zero-background holder.
- Exercise 7-4-2. A potassium-containing compound isolated from a winery.
- Exercise 7-4-3. The product of an organic synthesis which used both NaOH and HCl.
- Exercise 7-4-4. A complete unknown.

Organic Phases

- Exercise 7-4-5. An over-the-counter medication.
- Exercise 7-4-6. A white powder found in an abandoned house.
- Exercise 7-4-7. An over-the-counter pharmaceutical.
- Exercise 7-4-8. A pharmaceutical which is known to contain sulfur.
- Exercise 7-4-9. A mixture which is known to contain CN, Cl, and COOH groups.
- Exercise 7-4-10. A prescription medication which is known to contain S by XRF.