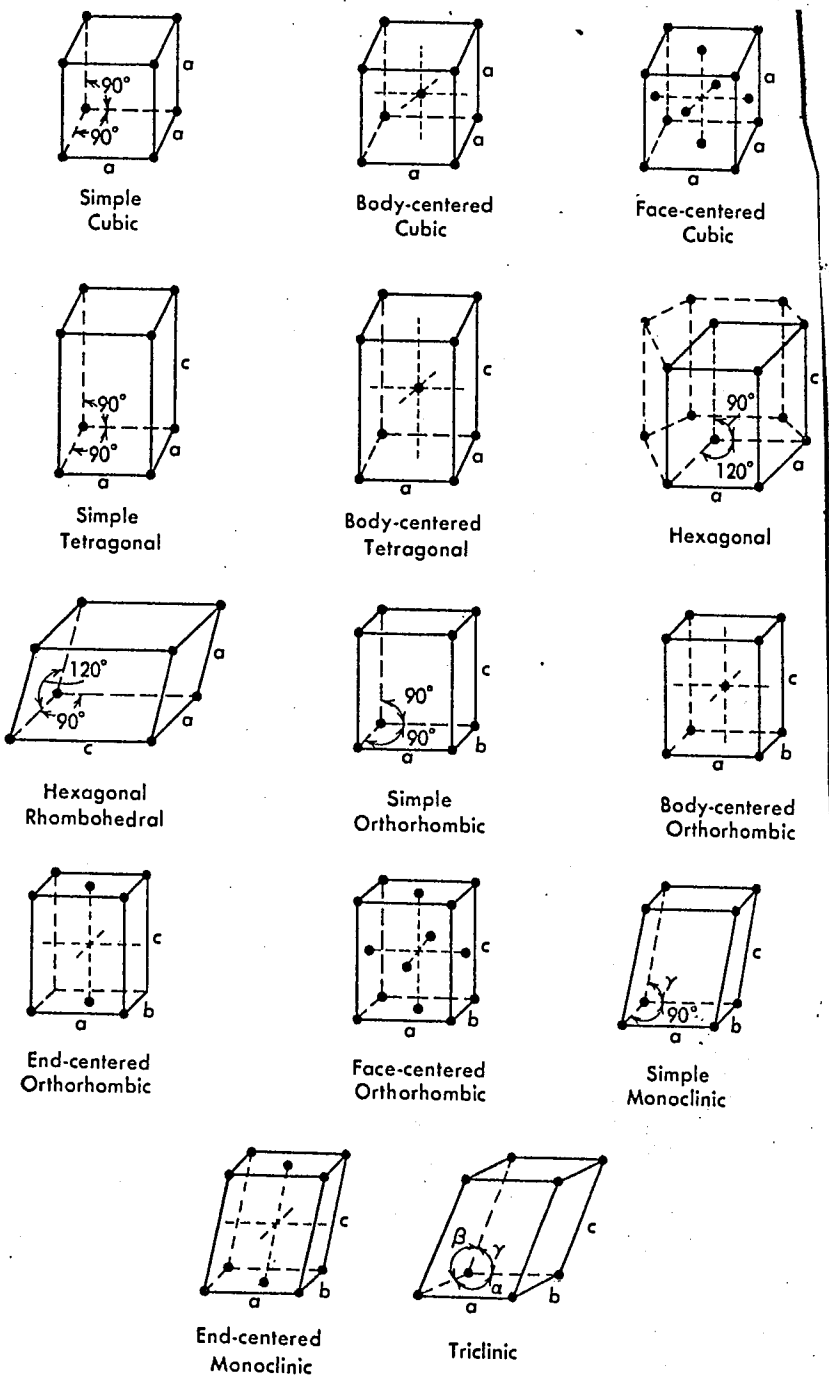


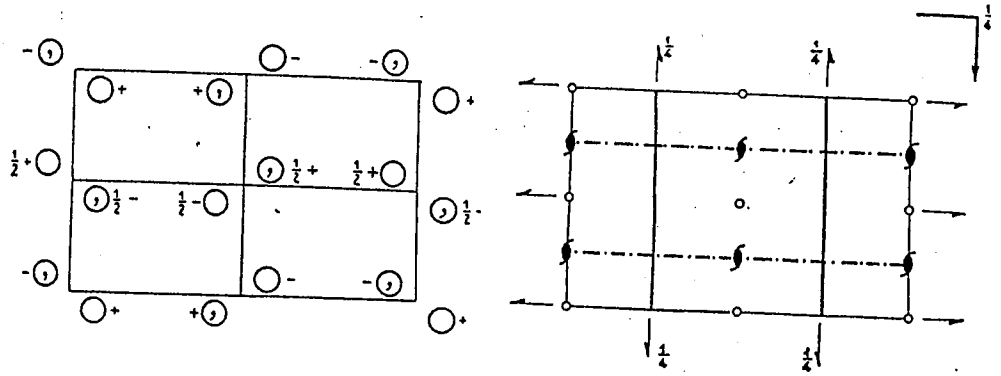
Figure 2–1. The fourteen space lattices.

TABLE 2.2.1 **The 14 Bravais Lattices and Conventional Unit Cells**

System	Number of lattices in system	Lattice symbols	Nature of unit-cell axes and angles[1]	Lengths and angles to be specified	Symmetry of lattice[2]
Triclinic	1	P	$a\neq b\neq c$ $\alpha\neq\beta\neq\gamma$	a, b, c α, β, γ	$\bar{1}$
Monoclinic[3]	2	1st setting $\begin{cases}P\\B\end{cases}$	$a\neq b\neq c$ $\alpha=\beta=90°\neq\gamma$	a, b, c γ	$2/m$
		2nd setting $\begin{cases}P\\C\end{cases}$	$a\neq b\neq c$ $\alpha=\gamma=90°\neq\beta$	a, b, c β	
Orthorhombic	4	P C[4] I F	$a\neq b\neq c$ $\alpha=\beta=\gamma=90°$	a, b, c	mmm
Tetragonal	2	P[5] I	$a=b\neq c$ $\alpha=\beta=\gamma=90°$	a, c	$4/mmm$
Cubic	3	P I F	$a=b=c$ $\alpha=\beta=\gamma=90°$	a	$m3m$
Trigonal	1	R[6]	$a=b=c$ $\alpha=\beta=\gamma$ $<120°, \neq 90°$	a α	$\bar{3}m$
Hexagonal	1	P[7]	$a=b\neq c$ $\alpha=\beta=90°$ $\gamma=120°$	a, c	$6/mmm$

(1) The symbol $\neq$ implies non-equality by reason of symmetry; accidental equality may, of course, occur.
(2) For explanation of the symmetry symbols see section 3.1.
(3) The side-centred monoclinic lattice is conventionally taken as B in the 1st setting (z-axis unique) and as C in the 2nd setting (y-axis unique). It would be an equally correct description to take A in either case, but this would not distinguish which setting had been chosen. (See Preface to Volume I for the reason for listing alternative settings in the monoclinic system.)
(4) When referring to lattices alone, it is conventional to call the side-centred orthorhombic lattice C. In the space groups of the point group $mm2$, the "z-axis unique" convention requires that the side-centred lattice shall sometimes be called C, and sometimes A (or B).
(5) The tetragonal lattices P and I may also be described as C and F, but only if the a, b vectors chosen are not the shortest ones perpendicular to c.
(6) The R-lattice is here described on rhombohedral axes, but it may also be referred to hexagonal axes. Where it is necessary to distinguish these the symbols R_{obv} or R_{rev} (see p. 20) are used for the description on rhombohedral axes and R_{hex} for that on hexagonal axes.
(7) In the 1935 *Tables* the symbol C was used to denote the hexagonal lattice. The reasons for this, although valid, do not outweigh the confusion caused. The lattice is, in fact, primitive and is therefore called P. It is common to both the trigonal and hexagonal systems (see pp. 10, 11).

System of Symmetry	Special Directions	Symmetry Class Symbols	Example
Cubic	Four-fold, four-fold inversion or two-fold axis (cube-edge); three-fold axis (cube-diagonal); two-fold or one-fold axis (face-diagonal).	$m\,3\,m$	fluorite
		$\bar{4}\,3\,m$	blende
		$m\,3$	pyrite
		$4\,3$	no example known
		$2\,3$	sodium uranyl acetate
Tetragonal	Four fold or four-fold inversion axis (prism axis); two-fold, two-fold inversion or one-fold axis (edge of the square base); two-fold, two-fold inversion or one-fold axis (diagonal of the square base).	$4/m\,m\,m$	idocrase
		$\bar{4}\,2\,m$	chalcopyrite
		$4\,m\,m$	strontium hydroxide
		$4/m$	scheelite
		$4\,2$	nickel sulphate
		4	iodosuccinimide
		$\bar{4}$	pentaerythritol
Hexagonal	Six-fold or six-fold inversion axis (prism axis); two-fold, two-fold inversion or one-fold axis (edge of the hexagonal base); two-fold, two-fold inversion or one-fold axis (perpendicular to edge of the hexagonal base).	$6/m\,m\,m$	beryl
		$6\,m\,m$	pyrrhotine
		$\bar{6}\,m\,2$	benitoite
		$6/m$	apatite
		$6\,2$	lithium iodate
		6	iodoform
		$\bar{6}$	no example known
Rhombohedral	Three-fold or three-fold inversion axis (prism axis); two-fold, two-fold inversion or one-fold axis (edge of the triangular base, i.e. the line joining mid-points of median edges of the rhombohedron).	$3\,m$	tourmaline
		$\bar{3}\,m$	calcite
		$3\,2$	quartz
		3	sodium periodate
		$\bar{3}$	phenakite
Orthorhombic	The directions of the three mutually perpendicular two-fold or two-fold and two-fold inversion axes.	$m\,m\,m$	barytes
		$m\,m$	struvite
		$2\,2\,2$	sodium potassium tartrate
Monoclinic	Two-fold or two-fold inversion axis.	$2/m$	euclase
		m	scolecite
		2	sucrose
Triclinic	No special directions.	$\bar{1}$	copper sulphate
		1	strontium tartrate



Origin at $\bar{1}$

Number of positions, Wyckoff notation, and point symmetry			Co-ordinates of equivalent positions	Conditions limiting possible reflections
8	d	1	x,y,z; $\frac{1}{2}+x,\frac{1}{2}-y,\frac{1}{2}-z$; $\bar{x},\frac{1}{2}+y,\bar{z}$; $\frac{1}{2}-x,\bar{y},\frac{1}{2}+z$; $\bar{x},\bar{y},\bar{z}$; $\frac{1}{2}-x,\frac{1}{2}+y,\frac{1}{2}+z$; $x,\frac{1}{2}-y,z$; $\frac{1}{2}+x,y,\frac{1}{2}-z$.	General: hkl: No conditions $0kl$: $k+l=2n$ $h0l$: No conditions $hk0$: $h=2n$ $h00$: $(h=2n)$ $0k0$: $(k=2n)$ $00l$: $(l=2n)$
4	c	m	$x,\frac{1}{4},z$; $\bar{x},\frac{3}{4},\bar{z}$; $\frac{1}{2}-x,\frac{3}{4},\frac{1}{2}+z$; $\frac{1}{2}+x,\frac{1}{4},\frac{1}{2}-z$.	Special: as above, plus
4	b	$\bar{1}$	$0,0,\frac{1}{2}$; $0,\frac{1}{2},\frac{1}{2}$; $\frac{1}{2},0,0$; $\frac{1}{2},\frac{1}{2},0$.	no extra conditions
4	a	$\bar{1}$	$0,0,0$; $0,\frac{1}{2},0$; $\frac{1}{2},0,\frac{1}{2}$; $\frac{1}{2},\frac{1}{2},\frac{1}{2}$.	hkl: $h+l=2n$; $k=2n$

Symmetry of special projections

(001) pgm; $a'=a/2$, $b'=b$

(100) cmm; $b'=b$, $c'=c$

(010) pgg; $c'=c$, $a'=a$

COLLECTION OF SIMULATED XRD POWDER PATTERNS FOR ZEOLITES

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Second Revised Edition
1990

Published on behalf of the Structure Commission
of the International Zeolite Association

Butterworth–Heinemann

MFI Tetrapropylammonium ZSM-5

COMPOSITION: $Na_{0.3}Al_{0.3}Si_{95.7}O_{192}(C_{12}H_{28}NOH)_4$
Synthetic

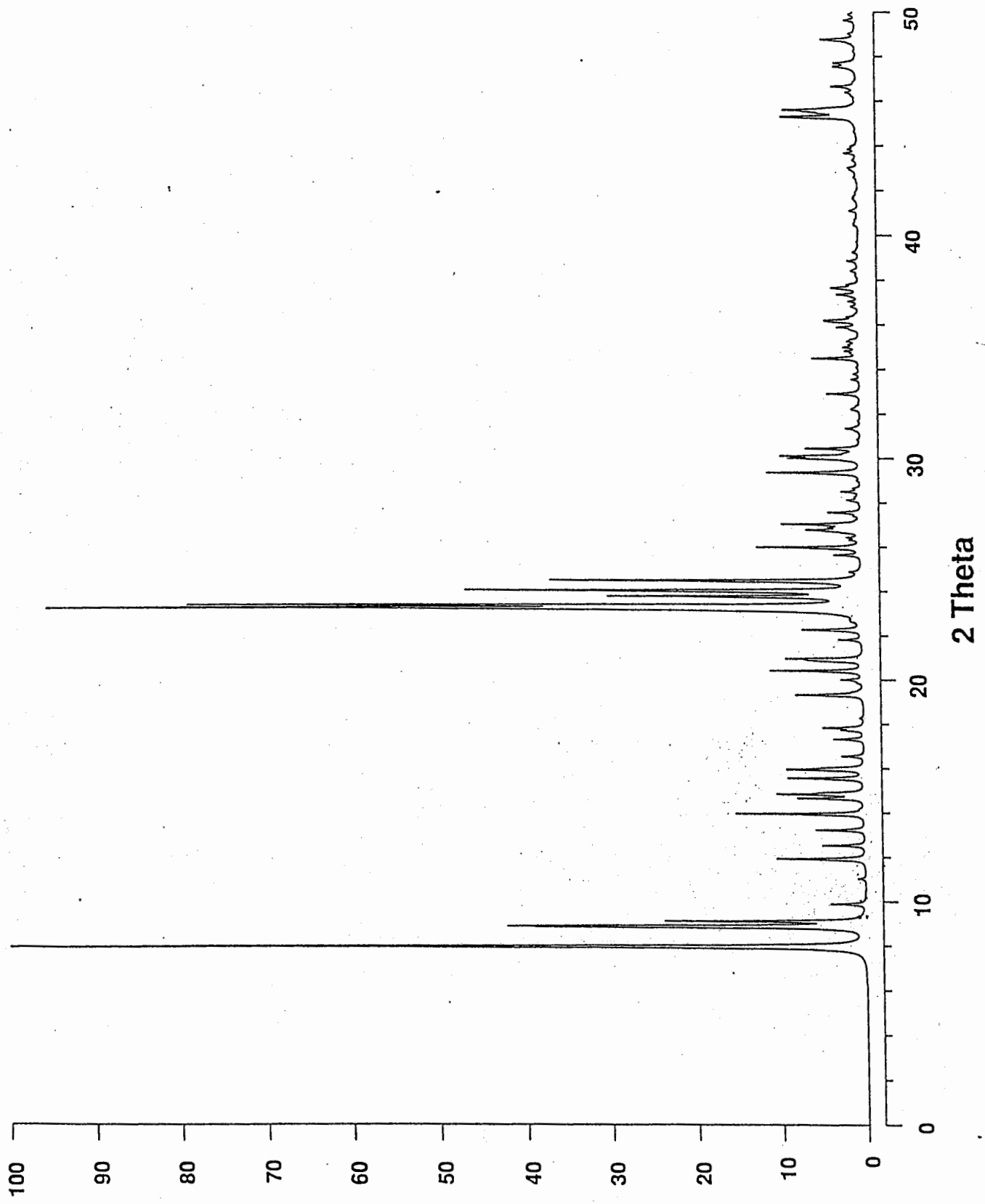
CRYSTAL DATA: Orthorhombic Pnma (62)
a = 20.022 b = 19.899 c = 13.383
α = 90.00 β = 90.00 γ = 90.00
X-ray single crystal refinement Rw = 0.044

REFERENCE: H. van Koningsveld, H. van Bekkum, and J. C. Jansen
Acta Cryst. B34, 127-132 (1987)

2θ	d	I rel	h	k	l
7.95	11.126	63.4	1	0	1
7.96	11.105	46.7	0	1	1
8.83	10.011	29.1	2	0	0
8.89	9.949	34.1	0	2	0
9.11	9.711	23.6	1	1	1
9.89	8.943	4.4	2	1	0
11.04	8.016	1.0	2	0	1
11.90	7.436	2.7	2	1	1
11.93	7.417	9.9	1	2	1
12.54	7.057	5.3	2	2	0
13.23	6.691	6.4	0	0	2
13.95	6.346	16.2	1	0	2
14.65	6.046	8.3	1	1	2
14.83	5.973	10.1	3	0	1
14.91	5.943	3.7	0	3	1
15.49	5.720	0.8	3	1	1
15.55	5.697	9.5	1	3	1
15.93	5.563	5.7	2	0	2
15.96	5.553	5.2	0	2	2
16.03	5.529	3.4	2	3	0
16.55	5.358	1.7	2	1	2
16.57	5.351	1.3	1	2	2
17.32	5.121	3.4	3	2	1
17.35	5.110	0.5	2	3	1
17.72	5.005	2.4	4	0	0
17.83	4.975	5.3	0	4	0
19.31	4.598	8.1	3	1	2
19.36	4.586	2.1	1	3	2
19.45	4.563	0.8	4	1	1
20.01	4.438	2.6	3	3	1
20.40	4.354	4.6	1	0	3
20.40	4.353	7.0	0	1	3
20.84	4.262	3.2	2	3	2
20.88	4.254	4.0	1	1	3
20.95	4.241	8.5	4	2	1
21.81	4.075	3.0	2	0	3
22.25	3.995	5.8	4	3	0
22.27	3.992	0.8	0	4	2
22.29	3.989	1.7	1	2	3
22.63	3.929	0.7	4	1	2
22.71	3.915	0.6	1	4	2
23.11	3.849	3.9	3	3	2
23.19	3.836	100.0	5	0	1
23.23	3.829	0.8	4	3	1
23.32	3.815	78.5	0	5	1
23.74	3.747	31.1	1	5	1
23.99	3.709	48.2	3	0	3
24.04	3.702	4.1	0	3	3
24.06	3.698	1.9	2	5	0
24.46	3.640	40.3	1	3	3
24.88	3.579	1.2	5	2	1
25.63	3.475	3.0	3	2	3
25.66	3.472	0.6	2	3	3
25.97	3.430	13.8	4	3	2
26.32	3.386	1.3	5	1	2
26.44	3.372	1.6	1	5	2
26.64	3.346	1.3	0	0	4
26.72	3.337	2.7	6	0	0
26.77	3.330	5.9	4	0	3
26.88	3.316	2.8	0	6	0
27.02	3.300	9.9	1	0	4
27.10	3.291	0.5	6	1	0
27.40	3.256	0.7	1	1	4
27.55	3.238	0.7	6	0	1
27.56	3.237	1.6	3	3	3
27.56	3.237	2.1	2	5	2
28.08	3.178	0.7	1	6	1
28.12	3.173	1.3	2	0	4
28.26	3.158	0.7	4	2	3
28.50	3.132	2.5	1	2	4
28.66	3.115	0.9	4	5	0
29.34	3.044	12.1	3	5	2
29.40	3.038	0.9	5	4	1
29.44	3.034	0.6	4	5	1
29.98	2.981	1.1	6	3	0
29.99	2.980	7.5	5	0	3
30.05	2.973	1.1	3	4	3
30.09	2.970	9.4	0	5	3
30.22	2.958	0.8	3	1	4
30.43	2.938	7.3	1	5	3
31.34	2.855	1.9	5	2	3
32.18	2.782	0.6	4	0	4
32.24	2.776	0.7	0	4	4
32.89	2.723	4.6	6	3	2
33.54	2.672	1.1	6	0	3
34.49	2.601	6.6	5	5	2
34.69	2.586	0.9	2	0	5
34.81	2.577	1.8	7	3	1
34.98	2.565	1.7	4	3	4
35.09	2.557	0.9	6	5	0
35.25	2.546	1.4	5	1	4
35.33	2.540	0.9	1	5	4
35.75	2.512	0.5	6	5	1
35.79	2.509	0.6	5	6	1
35.88	2.503	2.6	8	0	0
36.11	2.487	1.9	0	8	0
36.16	2.484	1.9	3	0	5
36.19	2.482	2.1	0	3	5
36.21	2.481	1.1	2	5	4
36.34	2.472	0.6	3	6	3
36.35	2.472	0.8	4	7	0
36.81	2.442	0.9	8	1	1
37.04	2.427	1.2	8	2	0
37.25	2.414	0.6	2	8	0
37.35	2.408	2.6	7	0	3
37.57	2.394	0.7	5	3	4
37.62	2.391	2.2	3	5	4
37.66	2.389	2.1	6	5	2
37.80	2.380	1.4	1	7	3
38.40	2.344	0.7	8	0	2
38.84	2.319	1.5	4	7	2
40.44	2.230	0.5	0	0	6
41.08	2.197	1.1	4	8	1
42.57	2.124	0.5	7	2	4
42.92	2.107	0.8	3	5	5
43.00	2.104	1.0	3	1	6
43.34	2.088	0.6	6	0	5
43.66	2.073	1.8	8	3	3
43.83	2.066	0.6	3	8	3
45.25	2.004	6.8	8	0	4
45.29	2.002	7.1	10	0	0
45.44	1.996	3.3	0	8	4
45.52	1.993	4.1	4	8	3
45.59	1.990	9.1	0	10	0
45.68	1.986	2.7	1	8	4
46.35	1.959	0.8	1	10	1
46.38	1.958	0.9	2	8	4
46.64	1.948	3.6	4	3	6
47.51	1.914	2.2	8	5	3
47.55	1.912	1.4	3	8	4
47.68	1.907	0.9	0	10	2
47.70	1.907	2.3	9	3	3
48.59	1.874	0.6	2	10	2
48.71	1.870	2.1	5	3	6
48.75	1.868	4.2	3	5	6
49.60	1.838	0.9	3	0	7
49.63	1.837	0.9	0	3	7
49.89	1.828	0.7	8	0	5
50.09	1.821	1.2	9	2	4
50.31	1.814	0.7	4	5	6
51.55	1.773	1.0	10	5	1

Tetrapropylammonium ZSM-5

MFI



443S

ATLAS OF ZEOLITE STRUCTURE TYPES

W.M.Meier and D.H.Olson

Second Revised Edition
1987

Published on behalf of the
Structure Commission of the International Zeolite Association

by

Butterworths
London Boston Durban Singapore Sydney Toronto Wellington

* Cancrinite	CAN
Cancrinite hydrate	CAN
CF-3	MTN
* Chabazite	CHA
* Chiavennite	CHI
Clinoptilolite	HEU
CoAPO-44	CHA
CoAPO-47	CHA
* CoAPO-50	AFY
Cs aluminosilicate bikitaite	BIK
Cs beryllosilicate pollucite	ANA
Cs,Fe silicate pollucite	ANA
(Cs,K)-ZK-5	KFI
$CsAlSiO_4$	ABW
CSZ-3	FAU
CZH-5	MTW
* Dachiardite	DAC
Danalite	SOD
* Deca-dodecasil 3R	DDR
Desmine	STI
* Dodecasil-1H	DOH
Dodecasil-3C	MTN
ECR-5	CAN
* Edingtonite	EDI
Encilite	MFI
Epidesmine	STI
* Epistilbite	EPI
* Erionite	ERI
* EU-1	EUO
EU-13	MTT
* Faujasite	FAU
* Ferrierite	FER
Flokite	MOR
FU-9	FER
FZ-1	MFI
G	SOD
Gallogermanate zeolite A	LTA
Gallosilicate analcime	ANA
Gallosilicate ABW	ABW
Gallosilicate cancrinite	CAN
Gallosilicate mazzite	MAZ
Gallosilicate natrolite	NAT
Gallosilicate sodalite	SOD
Gallosilicate zeolite L	LTL
Garronite	GIS
Genthelvite	SOD
* Gismondine	GIS
Gismondite	GIS
* Gmelinite	GME
Gobbinsite	GIS
Gonnardite	NAT
* Goosecreekite	GOO
Harmotome	PHI
Hauyn	SOD
Haydenite	CHA
Helvin	SOD
Hershelite	CHA
* Heulandite	HEU
Holdstite	MTN
Hsianghualite	ANA
Hydroxo sodalite	SOD
ISI-1	TON
ISI-4	MTT
ISI-6	FER
K-F	EDI
K-M	MER
Kehoeite	ANA
KZ-1	MTT
KZ-2	TON
* L	LTL
Large port mordenite	MOR

STRUCTURE TYPE INDEX

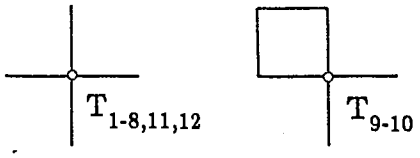
Type species are marked by an asterisk. To make the index as informative as possible all reported species and designations have been included in this section, provided the structure type assignment appears reasonably well established. Even a number of occasionally used but discredited names of mineral species have been included in this index for the aforementioned reason. Moreover, the inclusion of a synthetic species designation in this index must not be interpreted to mean that the designation has been formally recognized or generally accepted but merely that the material has one of the established structure types. References are to be found on the respective data page for the structure types. In case of minerals it is recommended to consult "Natural Zeolites" by G. Gottardi and E. Galli (1985).

* A	LTA
Acadialite	CHA
* Afghanite	AFG
Alpha	LTA
* $AlPO_4$-5	AFI
* $AlPO_4$-11	AEL
* $AlPO_4$-12-TAMU	ATT
* $AlPO_4$-16	AST
$AlPO_4$-17	ERI
$AlPO_4$-20	SOD
$AlPO_4$-21	ATF
$AlPO_4$-24	ANA
* $AlPO_4$-25	ATF
$AlPO_4$-33	ATT
$AlPO_4$-37	FAU
$AlPO_4$-42	LTA
* $AlPO_4$-C	APC
* $AlPO_4$-D	APD
$AlPO_4$-H3	APC
$AlPO_4$-pollucite	ANA
Aluminate sodalite	SOD
Aluminogermanate cancrinite	CAN
Aluminosilico-phosphate analcime	ANA
Amicite	GIS
Ammonioleucite	ANA
AMS-1B	MFI
* Analcime	ANA
Analcite	ANA
Arduinite	MOR
AZ-1	MFI
Barium silicate merlinoite	MER
Barrerite	STI
Basic cancrinite	CAN
Basic sodalite	SOD
Beryllosilicate gismondine	GIS
Bicchulite	SOD
* Bikitaite	BIK
BOR-C	MFI
Boralite C	MFI
Boralite D	MEL
* Brewsterite	BRE
Ca-D	ANA
Ca-Q	MOR

Secondary building units: 5-1

Framework density: 17.9 T/1000Å^3

Loop configuration of T-atoms:



Coordination sequences:

T_1	(8)	4	12	22	41	61	88	125	159	198	250
T_2	(8)	4	12	22	39	64	91	117	158	209	247
T_3	(8)	4	12	23	37	62	91	120	157	206	250
T_4	(8)	4	12	21	36	61	90	122	159	196	251
T_5	(8)	4	12	24	38	63	93	123	157	206	247
T_6	(8)	4	12	22	40	61	88	124	156	197	253
T_7	(8)	4	12	24	38	56	90	132	164	193	241
T_8	(8)	4	12	21	37	63	90	121	155	201	253
T_9	(8)	4	11	23	39	62	93	119	153	204	254
T_{10}	(8)	4	11	22	36	61	93	120	154	200	255
T_{11}	(8)	4	12	22	38	59	92	125	159	202	250
T_{12}	(8)	4	12	23	38	59	89	126	161	196	246

Channels: {[010] **10** 5.3 x 5.6 ↔ [100] **10** 5.1 x 5.5}***

Fault planes: (100)

Type species: **ZSM-5** $Na_n[Al_nSi_{96-n}O_{192}]$ ~ 16 H_2O
with n < 27
orthorhombic, Pnma, a=20.1, b=19.9, c=13.4 Å[1,2]

Isotypic framework structures: Silicalite[3] (see also Appendix MFI)

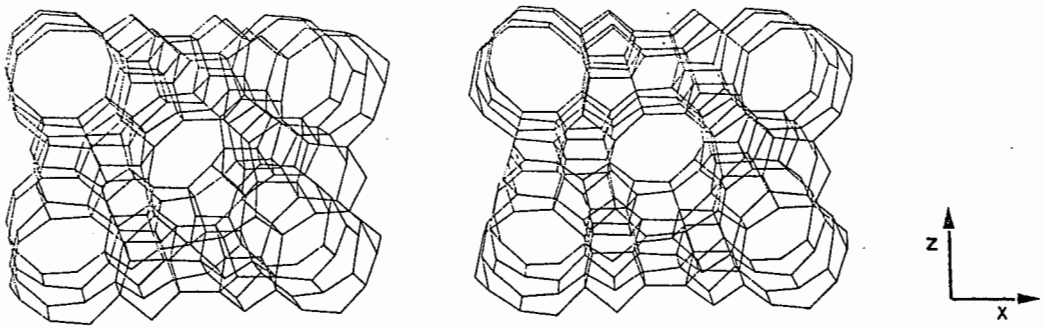
Alternate designations: Silicalite I

References:

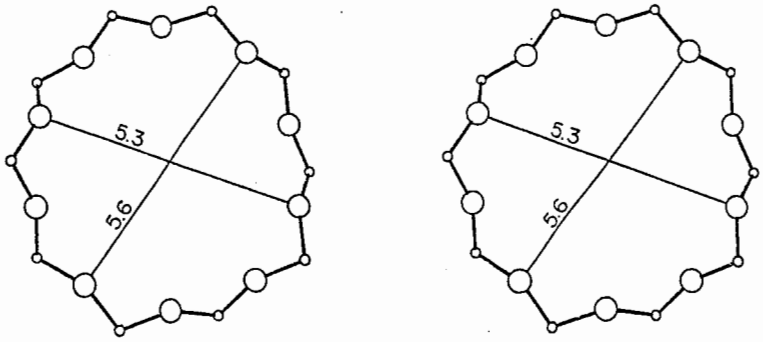
(1) G. T. Kokotailo, S. L. Lawton, D. H. Olson and W. M. Meier, Nature 272, 437 (1978).

(2) D. H. Olson, G. T. Kokotailo, S. L. Lawton and W. M. Meier, J. Phys. Chem. 85, 2238 (1981).

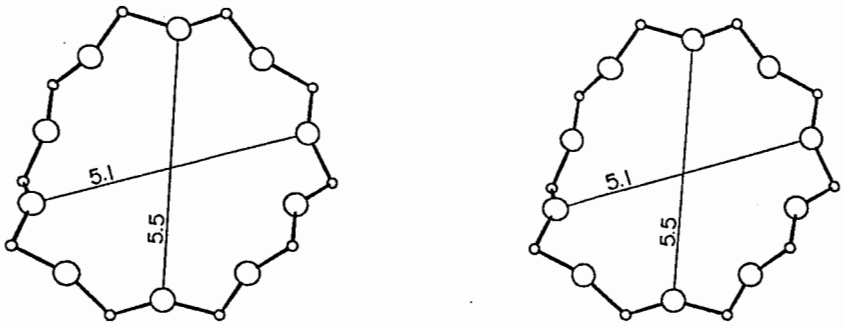
(3) E. M. Flanigen, J. M. Bennett, R. W. Grose, J. P. Cohen, R. L. Patton, R. M. Kirchner and J. V. Smith, Nature 271, 512 (1978).



framework viewed along [010]



10-ring viewed along [010]
(straight channel)



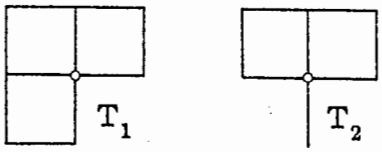
10-ring viewed along [100]
(sinusoidal channel)

See Appendix MFI

Secondary building units: single 6-rings

Framework density: 16.4 T/1000Å^3

Loop configuration of T-atoms:



Coordination sequences:
T_1(24) 4 9 17 29 46 69 98 131 162 187
T_2(12) 4 10 21 35 49 66 89 117 150 190

Channels: [001] **12** 7.1*

Fault planes: (001)

Type species: **Linde Type L** $K_6Na_3[Al_9Si_{27}O_{72}] \cdot 21\ H_2O$
hexagonal, P6/mmm, a=18.4, c=7.5 Å[1]

Isotypic framework structures:
Gallosilicate L[2,3]
Perlialite[4,5]
LZ-212[6]

References:

(1) R. M. Barrer and H. Villiger, Z. Kristallogr. 128, 352 (1969).

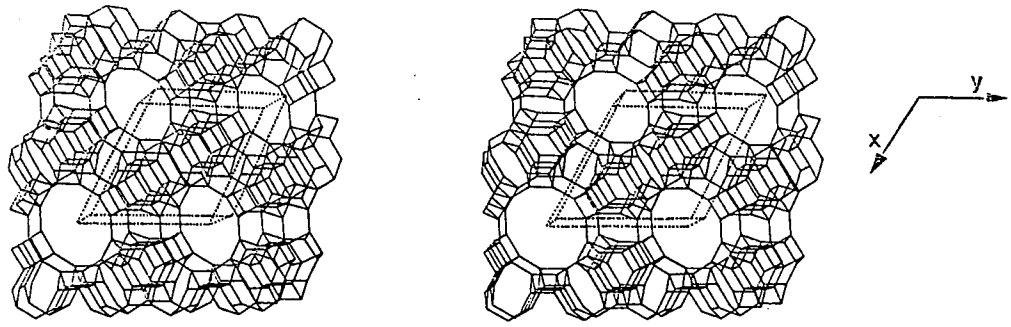
(2) P. A. Wright, J. M. Thomas, A. K. Cheetham, A. K. Nowak, Nature 318, 611 (1985).

(3) J. M. Newsam, Mater. Res. Bull. 21, 661 (1986).

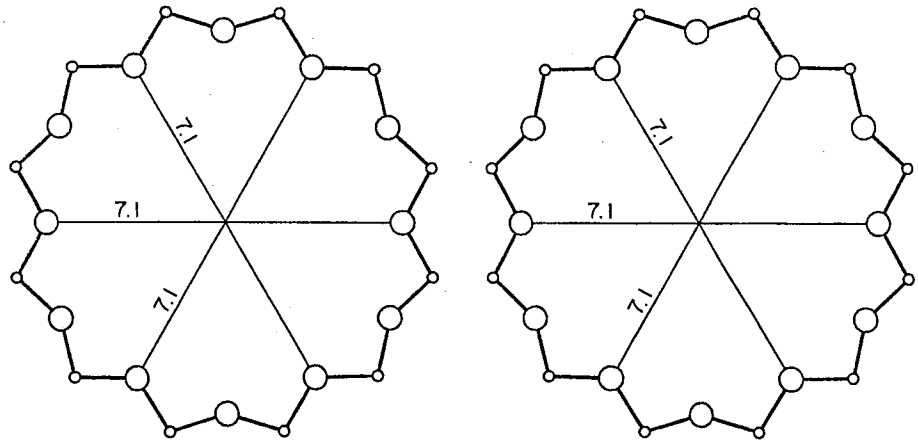
(4) R. Rinaldi, Proc. 6th IZC, Reno, 1983 (Butterworths, 1984), p 570.

(5) Y. P. Menshikov, Zap. Vses. Mineral. O-va. 113, 607 (1984).

(6) D. W. Breck and G. W. Skeels, US Patent 4,503,023 (1985).



framework viewed along [001]

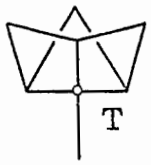


12-ring viewed along [001]

Secondary building units: double 4-rings, (single 4-rings), 8-rings or 6-2

Framework density: 12.9 T/1000Å^3

Loop configuration of T-atoms:



Coordination sequence: T(24) 4 9 17 28 42 60 81 105 132 162

Channels: <100> **8** 4.1***

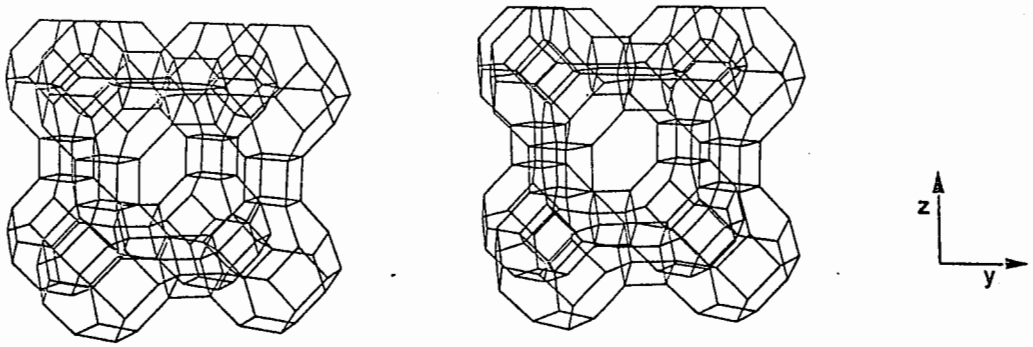
Type species: **Linde Type A** $\{Na_{12}[Al_{12}Si_{12}O_{48}] \cdot 27\ H_2O\}_8$
cubic, $Fm\bar{3}c$, a=24.6 Å[1,2]
(pseudocell, Pm3m, a′ =12.3 Å)

Isotypic framework structures:

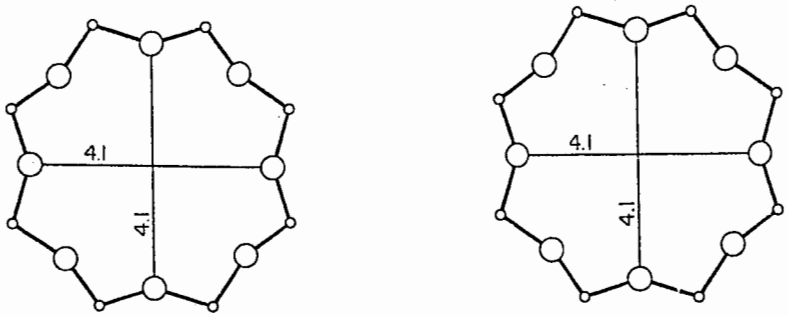
Alpha[3]
Gallogermanate zeolite A[4]
LZ-215[5]
N-A[6]
SAPO-42[7]
ZK-4[8]
ZK-21[9]
ZK-22[9]

References:

(1) T. B. Reed and D. W. Breck, J. Am. Chem. Soc. 78, 5972 (1956).
(2) V. Gramlich and W. M. Meier, Z. Kristallogr. 133, 134 (1971).
(3) R. L. Wadlinger, E. J. Rosinski and C. J. Plank, U.S. Patent 3,375,205 (1968).
(4) R. M. Barrer, J. W. Baynham, F. W. Bultitude and W. M. Meier, J. Chem. Soc. 1959, 195 (1959).
(5) D. W. Breck and G. W. Skeels, US Patent 4,503,023 (1985).
(6) R. M. Barrer and P. J. Denny, J. Chem. Soc. 1961, 971 (1961).
(7) B. M. Lok, C. A. Messina, R. L. Patton, R. T. Gajek, T. F. Cannan and E. M. Flanigen, J. Am. Chem. Soc. 106, 6092 (1984).
(8) G. T. Kerr, Inorg. Chem. 5, 1537 (1966).
(9) G. H. Kuehl, Inorg. Chem. 10, 2488 (1971).



framework viewed along [100]

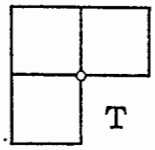


8-ring viewed along [100]

Secondary building units: double 6-rings, 6-2 (single 4- or 6-rings)

Framework density: 12.7 T/1000 Å^3

Loop configuration of T-atoms:



Coordination sequence: T(192) 4 9 16 25 37 53 73 96 120 145

Channels: <111> **12** 7.4***

Fault planes: (111)

Type species: **Faujasite** $(Na_2,Ca,Mg)_{29}[Al_{58}Si_{134}O_{384}] \cdot 240\ H_2O$
cubic, Fd3m, a=24.7 Å[1,2]

Isotypic framework structures:
Linde X[3,4]
Linde Y[5,6]
SAPO-37[7]
CSZ-3[8]
LZ-210[9]
and numerous other compositional variants

References:

(1) G. Bergerhoff, W. H. Baur and W. Nowacki, N. Jb. Miner. Mh. 1958, 193 (1958).

(2) W. H. Baur, Am. Mineral. 49, 697 (1964).

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(4) D. H. Olson, J. Phys. Chem. 74, 2758 (1970).

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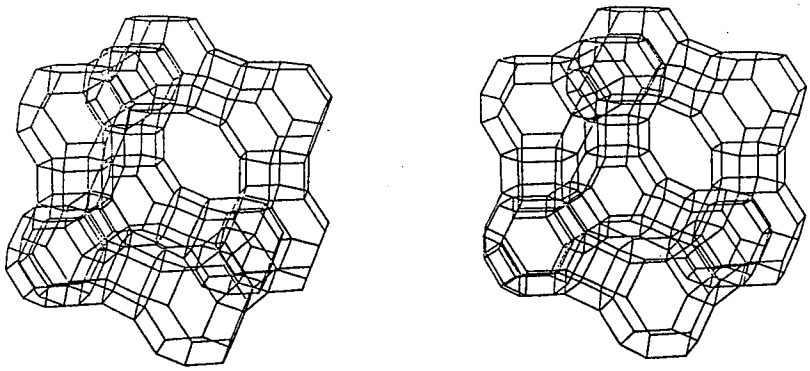
(6) M. L. Costenoble, W. J. Mortier and J. B. Uytterhoeven, J.C.S. Faraday Trans. I, 72, 1877 (1976).

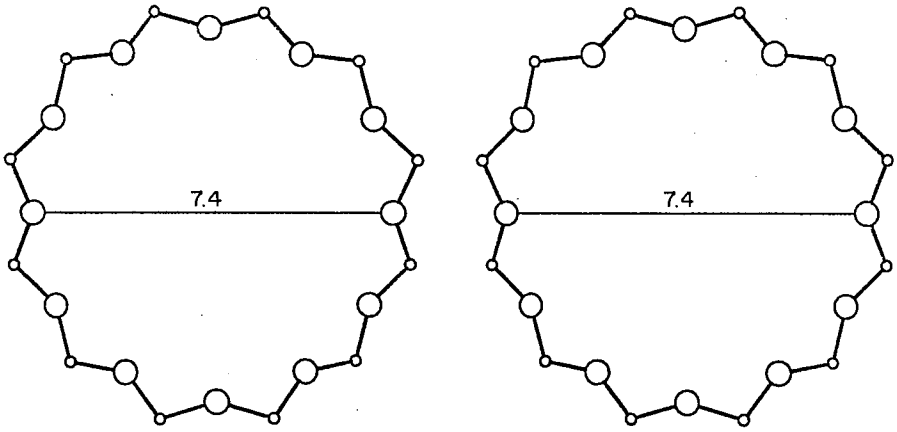
(7) B. M. Lok, C. A. Messina, R. L. Patton, R. T. Gajek, T. R. Cannan and E. M. Flanigen, J. Am. Chem. Soc. 106, 6092 (1984).

(8) D. E. W. Vaughan and M. G. Barrett, US Patent 4,333,859 (1982).

(9) D. W. Breck and G. W. Skeels, US Patent 4,503,023 (1985).



framework viewed along [111]



12-ring viewed along [111]