AM-79-109

American Mineralogist, Volume 64, pages 993–1001, 1979

The crystal structure of wairakite

YOSHIO TAKÉUCHI

Mineralogical Institute, Faculty of Science
University of Tokyo, Hongo, Tokyo 113, Japan

FIORENZO MAZZI

C.N.R. Centro di Studio per la Cristallografia Strutturale
c/o Istituto di Mineralogia dell'Università, Pavia, Italy

NOBUHIKO HAGA

Mineralogical Institute, Faculty of Science
University of Tokyo, Hongo, Tokyo 113, Japan

AND ERMANO GALLI

Istituto di Mineralogia e Petrologia dell'Università
Modena, Italy

Abstract

The crystal structure of wairakite has been determined and refined to R = 3.6%, using a crystal from Onikobe, Miyagi Prefecture, Japan: $I2/a$, a = 13.692(3), b = 13.643(3), c = 13.560(3)A, β = 90.5(1)°, $Z = Ca_{7.19}Na_{1.12}K_{0.01}(Si_{32.59}Al_{15.38})O_{96} \cdot 16H_2O$. The location of Ca atoms is fixed to a set of eightfold positions among four distinct sets of positions available for cations, the eightfold positions being occupied by 0.899 Ca and 0.059 Na. The Na atoms are nearly evenly distributed over the available cation positions with occupancies of 0.05–0.07. The Al atoms are preferentially concentrated in two sets of tetrahedral positions associated to Ca; the Al fraction in the tetrahedral positions are the same. The ratio of Ca fraction in the Ca site to Al fraction in the tetrahedra is almost unity. These structural features characterize the monoclinic symmetry of wairakite. The occurrence of twinning on (110) characteristic of wairakite can be explained in terms of the structure. However, to elucidate structurally the nature of the wairakite–analcime solid solution, further structural study is required, particularly of crystals with intermediate compositions.

Introduction

Wairakite, $Ca[Al_2Si_4O_{12}] \cdot 2H_2O$ (Steiner, 1955), the calcium analogue of analcime, $Na_2[Al_2Si_4O_{12}] \cdot 2H_2O$, is a zeolite which occurs widely in low-grade metamorphic rocks. The first X-ray studies by Coombs (1955) showed that the mineral was a distortion derivative of analcime and had a monoclinic body-centered cell. A marked feature of wairakite crystals is the presence of complex, fine lamellar twinnings which presumably originated in transformation during crystal formation (Coombs, 1955). Synthetic work by Liou (1970) showed the existence of a tetragonal disordered phase at temperatures ranging from 300 to 460°C; the transformation from the disordered phase to ordered wairakite is gradual and sluggish.

In a recent paper, Mazzi and Galli (1978) reported the existence of various non-cubic structures for analcime, primarily due to the difference in Al ordering in the analcime framework, which was originally reported as cubic with a space group *Ia3d* (Taylor, 1930). It is thus of particular interest to determine the mode of distribution of Al and Ca underlying the distortion of the analcime framework to yield the

0003–004X/79/0910–0993$02.00

deposit

Table 3. Anisotropic temperature factor coefficients ($\times 10^3$)

(standard errors in parentheses)

Atom	β_{11}	β_{22}	β_{33}	β_{12}	β_{13}	β_{23}
M2	2.55(9)	2.34(9)	2.29(9)	-2.15(7)	-1.17(7)	1.06(7)
T11A	0.53(8)	0.71(8)	0.70(8)	0.24(7)	-0.05(6)	0.08(6)
T11B	0.45(8)	0.92(8)	0.80(8)	0.11(6)	0.02(6)	-0.16(6)
T12A	0.62(8)	0.63(8)	0.88(9)	-0.14(7)	0.14(6)	0.11(6)
T12B	0.82(8)	0.70(8)	0.94(9)	-0.16(7)	-0.18(6)	-0.00(7)
T2A	0.62(9)	0.70(9)	0.84(9)	0.08(7)	0.11(7)	-0.36(7)
T2B	0.59(9)	0.59(9)	0.95(9)	0.03(7)	0.06(7)	0.22(7)
O11A	1.6(2)	2.3(3)	1.1(2)	-0.1(2)	0.5(2)	-0.1(1)
O11B	2.2(2)	2.0(2)	0.6(2)	-0.6(2)	-0.1(1)	0.3(2)
O12A	2.1(2)	1.7(2)	0.8(2)	-0.1(2)	-0.0(1)	-0.2(2)
O12B	1.4(2)	1.7(2)	1.0(2)	-0.7(2)	0.0(1)	-0.0(1)
O21A	0.8(2)	2.9(3)	2.5(3)	0.6(2)	0.5(1)	-0.8(2)
O21B	0.6(2)	2.3(2)	2.9(3)	0.8(2)	-0.0(2)	0.6(2)
O22A	2.4(3)	0.8(2)	2.5(3)	-0.6(2)	-0.7(2)	-0.2(2)
O22B	1.6(2)	1.2(2)	2.6(3)	-0.9(2)	0.1(2)	0.3(2)
O31A	3.0(3)	1.0(2)	2.1(3)	0.6(2)	-0.1(2)	0.5(2)
O31B	3.2(3)	0.9(2)	2.2(3)	0.2(2)	0.1(2)	-0.6(2)
O32A	1.0(2)	3.0(3)	2.7(3)	-0.5(2)	-1.2(2)	0.2(2)
O32B	0.7(2)	3.4(2)	1.9(3)	-0.1(2)	0.3(2)	0.7(2)
W A	5.7(4)	4.7(4)	10.0(6)	1.8(4)	2.1(4)	0.7(4)
W B	6.0(4)	6.0(4)	5.8(5)	1.2(3)	-0.3(3)	-0.7(3)

Table of structure factors

(7 pages)

MS 3603

The crystal structure of wairakite
By
Y. Takéuchi, F. Mazzi, N. Haga & E. Galli

H	FO	FC
K,L=	0	0
2	181	186
4	545	-532
8	243	238
10	158	160
12	45	38
14	29	-30
16	31	-24
K,L=	1	0
3	24	-25
5	54	-57
7	44	-39
9	49	49
11	80	-80
13	69	-70
K,L=	2	0
0	173	-176
2	219	-223
6	60	58
8	146	-144
10	114	-110
16	29	-31
K,L=	3	0
3	61	60
5	91	87
7	41	-36
9	68	69
15	74	73
K,L=	4	0
0	584	-569
4	302	302
6	226	225
10	85	-89
14	57	54
K,L=	5	0
1	26	21
3	76	-73
5	69	-70
11	76	-75
13	44	-44
K,L=	6	0
0	46	-42
2	30	27
4	255	-256
6	252	-252
8	95	91
10	66	60
12	131	-128
14	58	-54
K,L=	7	0
1	28	23
7	120	121
13	35	34
K,L=	8	0
0	326	321
2	174	178
6	104	-101
8	35	38
10	138	137
12	58	57
K,L=	9	0
1	32	-28
3	44	-37
7	37	29
9	79	-75
13	57	60
K,L=	10	0
0	162	-163
2	138	-134
4	122	120
6	91	87
8	141	-138
10	104	-105
12	28	27
K,L=	11	0
5	43	37
11	40	41
K,L=	12	0
2	36	-31
6	149	149
8	82	79
K,L=	13	0
7	29	-33
K,L=	14	0
4	112	-112
6	85	-90
K,L=	16	0
0	69	-69
2	80	85
K,L=	1	1
-10	60	59
-8	32	33
-6	47	43
-4	29	-27
-2	175	-185
0	14	12
2	198	208
4	21	-20
6	143	-137
10	237	-240
14	164	167
16	30	-23
K,L=	2	1
-15	91	88
-11	121	-123
-9	122	-116
-7	59	-55
-5	56	66
-1	194	-205
1	196	204
3	42	42
5	74	-77
7	51	-46
11	41	35
K,L=	3	1
-10	57	-52
-8	75	-70
-4	107	109
2	21	-24
4	164	-158
8	184	179
10	192	192
12	43	-43
14	131	-128
K,L=	4	1
-15	91	-92
-13	67	-64
-11	113	109
-7	181	-182
-3	114	110
1	23	-18
3	101	-97
5	49	47
7	89	85
11	57	-52
15	37	34
K,L=	5	1
-6	50	-47
-2	75	83
0	31	31
4	25	-21
6	57	54
10	179	184
14	102	-101
K,L=	6	1
-15	30	-29
-13	36	-32
-11	103	105
-9	164	166
-7	38	34
-5	90	-86
-1	128	124
1	130	-125
3	39	-36
9	35	28
K,L=	7	1
-14	24	-18
-8	78	70
-4	121	-121
-2	35	35
0	29	-32
2	38	-37
4	187	187
6	61	62
8	206	-201
10	92	-87
12	63	64
14	90	90
K,L=	8	1
-13	31	28
-11	196	-192
-7	232	230
-3	142	-137
1	34	31
3	147	145
7	83	-78
9	37	35
11	47	41
K,L=	9	1
-10	34	33
-6	38	42
-2	52	-47
2	79	78
4	50	48
6	146	-144
8	58	-58
10	34	-28
K,L=	10	1
-7	68	-70
-5	127	-131
-3	182	186
-1	145	145
1	155	-157
3	85	-83
5	65	58
9	45	-42
K,L=	11	1
-10	31	-29
-8	62	-63
-4	65	66
-2	31	27
2	103	-103
4	137	-131
6	67	66
8	175	177
12	24	-24
K,L=	12	1
-7	81	-73
3	47	-44
5	38	38
7	57	60
K,L=	13	1
-4	39	38
4	51	-45
6	47	47
K,L=	14	1
-7	54	55
-5	85	88
-3	117	-116
-1	114	-113
1	107	105
3	46	45
5	61	-61
7	55	-56
K,L=	15	1
-4	54	-55
-2	45	-41
2	49	50
4	96	96
K,L=	0	2
-12	38	-33
-10	43	50
-8	253	254
-6	93	97
-4	186	-183
2	49	-48
4	72	70
6	32	-31
10	55	-54
12	104	-100
16	87	93
K,L=	1	2
-9	76	75
-7	139	-141
-5	147	-151
-3	72	-75
-1	95	107
1	116	111
3	164	-166
5	204	-205
7	95	-96
9	74	76
11	92	-89
13	87	-86
15	26	24
K,L=	2	2
-16	85	-88
-12	41	39
-10	114	-111
-8	130	-129
-6	27	22
-4	27	21
-2	40	-42
0	75	-79
2	27	24
4	50	48

H	FO	FC
6	54	-46
8	78	80
10	89	90
16	72	76
K,L=	3	2
-15	28	23
-11	53	51
-9	168	168
-7	103	-102
-5	132	124
-3	309	307
-1	122	128
1	143	150
3	280	272
5	139	129
7	70	-64
9	146	147
15	47	53
K,L=	4	2
-14	63	67
-12	40	44
-4	41	44
-2	74	73
0	84	85
2	55	55
6	115	-111
8	104	-107
10	55	54
12	55	52
14	51	-54
K,L=	5	2
-11	77	-72
-9	68	-67
-5	66	-59
-3	116	-112
-1	159	-163
1	188	-192
3	121	-115
5	52	-47
9	83	-77
11	37	-38
15	46	-39
K,L=	6	2
-14	57	-56
-12	135	-134
-8	77	78
-6	92	-89
-4	64	-64
-2	27	-24
6	101	99
12	65	60
K,L=	7	2
-11	43	-37
-7	244	246
-3	153	-146
-1	102	103
1	96	98
3	82	-79
5	31	29
7	199	199
K,L=	8	2
-10	66	68
-8	75	77
-4	46	47
0	68	-63
2	44	-42
6	84	79
8	36	-31
10	91	-92
12	49	-41
14	43	-40
K,L=	9	2
-13	36	36
-11	49	47
-9	90	-87
-5	107	-106
-3	170	-168
-1	119	119
1	61	58
3	213	-210
5	67	-67
9	111	-110
K,L=	10	2
-12	35	37
-10	65	-62
-8	126	-123
-4	36	33
0	34	-32
8	56	52
10	46	40
K,L=	11	2
-11	74	73
-5	90	91
-3	78	79
-1	102	107
1	77	76
3	45	43
5	121	120
9	29	-24
11	67	68
K,L=	12	2
-6	33	30
-4	42	-37
0	80	77
6	95	-92
K,L=	13	2
-9	29	35
-1	118	-114
1	76	-76
9	45	49
K,L=	14	2
-4	35	-28
-2	46	-40
K,L=	15	2
-3	55	56
3	64	66
5	29	-27
K,L=	16	2
0	56	-56
2	28	-28
K,L=	1	3
-14	120	-124
-12	90	89
-10	197	199
-8	143	-142
-6	67	65
-4	90	93
-4	90	93
-2	34	-36
0	21	18
2	74	-71
4	72	-73
4	72	-73
6	72	73
8	81	74
14	44	-40
K,L=	2	3
-13	33	-31
-9	87	85
-7	161	156
-3	264	-263
-1	27	-19
3	218	213
5	47	-36
7	267	-262
9	98	-91
13	41	35
15	66	63
K,L=	3	3
-14	94	96
-12	38	-34
-10	200	-205
-6	139	140
-2	224	-220
0	29	27
2	261	260
4	29	29
6	131	-129
8	81	-79
10	47	40
12	52	47
K,L=	4	3
-15	28	-23
-1	77	80
1	86	-85
7	87	-87
9	45	42
11	45	46
13	81	-80
15	56	-58
K,L=	5	3
-14	69	72
-10	127	-132
-8	88	86
-6	52	-51
-4	48	-45
8	62	-59
10	67	-64
14	67	69
K,L=	6	3
-9	66	-56
-7	136	-139
-3	159	157
1	35	28
3	131	-133
5	41	-41
7	170	168
9	151	152
13	59	-59
K,L=	7	3
-14	38	-37
-10	73	71
-8	55	57
-6	169	-167
-4	35	-30
-2	218	217
0	36	-39
2	250	-247
4	29	28
6	136	131
8	61	55
12	32	-29
K,L=	8	3
-11	48	-47
-7	57	49
-5	68	69
-3	29	-27
-1	104	-102
1	154	156
5	52	-44
7	141	144
9	67	-65
11	125	-121
13	79	82
K,L=	9	3
-8	53	55
-6	178	172
-4	35	-37
-2	149	-146
2	114	117
6	118	-110
10	75	74
K,L=	10	3
-11	56	60
-9	62	64
-3	145	-147
-1	113	-116
1	149	156
3	132	131
5	146	-143
7	57	-63
K,L=	11	3
-8	105	-107
-4	40	40
2	39	37
10	42	-38
K,L=	12	3
-1	63	63
1	53	-51
3	50	-43
K,L=	13	3
-8	41	-40
-6	68	-63
-4	60	59
-2	50	47
2	45	-40
4	39	-37
6	46	45
K,L=	14	3
-7	44	-43
-3	72	72
-1	64	62
1	122	-115
3	79	-74
5	67	71
K,L=	15	3
-4	31	-26
-2	38	-37
K,L=	0	4
-14	75	-76
-12	139	-136
-8	72	-69
-6	166	-160
-4	73	75
-2	125	-127

H	FO	FC
0	745	-737
2	105	100
4	105	108
6	301	-302
8	126	-124
12	59	55
K,L=	1	4
-13	143	-147
-11	85	-82
-9	140	137
-5	174	-172
-3	133	-135
1	45	-44
3	79	-84
5	52	52
7	137	138
9	37	-32
13	34	36
15	34	38
K,L=	2	4
-10	63	57
-4	129	129
-2	123	125
0	22	16
2	173	170
4	50	48
6	26	24
8	161	160
10	58	55
12	41	-36
14	31	34
K,L=	3	4
-15	69	68
-9	82	87
-5	118	121
-3	48	52
-1	98	-98
1	104	-103
5	52	52
7	87	86
9	94	-91
11	46	-42
15	36	-34
K,L=	4	4
-12	63	58
-8	56	-53
-6	43	-42
-4	30	-30
-2	90	-90
0	111	117
2	114	-114
4	65	-70
8	91	-87
10	59	-66
12	89	-93
K,L=	5	4
-15	24	28
-13	39	35
-11	45	-46
-9	113	-113
-7	88	-86
3	72	72
5	26	-21
7	125	-124
9	40	40
11	144	149
13	51	47
K,L=	6	4
-12	50	54
-6	126	130
-4	34	33
-2	37	44
0	257	255
4	82	81
6	139	137
8	42	-38
10	57	57
12	154	152
K,L=	7	4
-9	65	62
-7	101	101
-5	89	-84
-1	145	146
1	120	116
5	98	-96
7	100	-97
9	83	82
13	70	-72
K,L=	8	4
-12	58	-59
-10	104	-105
-6	48	46
-4	104	-100
-2	117	-116
0	135	-134
2	106	-108
4	76	-75
10	51	-50
K,L=	9	4
-11	39	-38
-7	70	68
-5	39	-31
-3	57	-53
-1	86	-85
1	52	-46
3	39	32
5	43	42
9	52	48
11	64	-62
K,L=	10	4
-10	38	39
-8	40	41
-2	84	80
2	80	83
6	31	28
8	103	106
12	50	-50
K,L=	11	4
-9	65	-66
-5	136	135
-3	62	61
-1	100	-101
1	81	-84
3	51	51
5	52	48
9	31	-31
K,L=	12	4
-10	56	58
-8	35	-30
-6	137	-133
0	54	-45
6	105	-102
8	60	-54
K,L=	13	4
-7	62	-64
-5	69	-65
-1	80	78
1	61	63
3	40	-39
5	72	-72
K,L=	14	4
-6	39	38
-4	45	45
-2	31	34
0	62	62
4	42	37
K,L=	15	4
-1	81	82
1	55	57
K,L=	1	5
-10	72	-64
-8	42	-43
-6	79	-78
-4	29	28
-2	161	166
0	37	-38
2	29	-26
4	122	121
6	32	33
8	109	-103
10	173	176
12	46	45
14	90	-91
K,L=	2	5
-11	36	-34
-9	101	104
-7	117	115
-5	51	-51
-3	111	-103
-1	82	85
1	85	-92
5	63	62
7	101	99
9	42	42
K,L=	3	5
-8	86	84
-6	44	45
-4	53	-52
0	56	-52
2	108	-97
4	62	60
8	30	-26
10	91	-92
12	42	-36
14	35	34
K,L=	4	5
-15	59	64
-13	80	80
-11	59	-54
-7	79	76
-1	66	64
1	46	-36
3	42	43
5	35	-31
7	66	-62
11	61	61
K,L=	5	5
-14	30	-29
-10	80	82
-8	35	30
-4	49	-44
-2	98	-99
2	38	-32
4	26	-22
10	148	-147
14	74	78
K,L=	6	5
-9	103	-104
-7	32	-32
-1	55	-52
1	104	103
3	45	48
7	68	-68
9	80	-75
13	57	59
K,L=	7	5
-12	35	32
-8	109	-106
-6	46	-42
-4	105	103
0	68	68
2	85	82
4	110	-111
6	49	-50
8	77	78
K,L=	8	5
-13	33	-37
-11	85	86
-7	59	-59
-5	71	71
-1	56	-53
3	95	-94
5	74	75
7	67	62
9	76	-79
11	57	-56
K,L=	9	5
-12	34	-33
-10	133	-132
-6	48	47
6	97	97
8	40	42
K,L=	10	5
-9	57	-49
-5	113	114
-3	138	-140
-1	83	-85
1	127	129
5	92	-90
9	130	134
11	69	68
K,L=	11	5
-10	64	69
-8	76	76
-4	63	-59
4	89	86
8	71	-67
10	33	25
K,L=	12	5
-3	31	31
-1	46	46
7	34	-32
K,L=	13	5
-8	35	38
-4	76	-74

H	FO	FC	H	FO	FC	H	FO	FC	H	FO	FC	H	FO	FC
4	32	31	-5	61	-64	-12	30	30	-12	79	-78	2	55	-57
6	59	-59	-3	204	-201	-8	71	-68	-10	56	-51	4	43	-37
8	44	-42	-1	50	-41	-6	99	-96	-8	178	181	6	52	52
K,L=	14	5	1	133	-127	-4	91	-88	-6	66	-58	8	97	91
-5	95	-97	3	173	-174	-2	52	50	-4	112	-111	10	68	64
-3	39	43	5	66	-65	0	143	142	0	30	-31	K,L=	6	7
-1	50	49	9	141	-137	4	80	-77	2	115	117	-9	85	84
1	68	-68	K,L=	4	6	6	89	-89	4	68	67	-7	119	118
3	31	36	-14	38	-34	10	54	49	6	122	-120	-3	153	-152
5	74	78	-12	97	-98	K,L=	9	6	8	92	-87	-1	37	-28
K,L=	15	5	-10	94	-92	-11	52	-55	14	38	36	3	88	92
0	31	31	-6	73	70	-9	53	51	K,L=	2	7	7	120	-124
K,L=	0	6	-4	38	-36	-5	110	116	-13	35	37	K,L=	7	7
-14	27	-27	-2	141	-139	-3	138	134	-9	108	-111	-10	46	41
-12	97	95	0	174	-172	-1	124	-121	-7	171	-168	-6	126	125
-10	33	32	2	57	-53	3	199	203	-5	51	45	-4	65	-63
-8	242	-241	6	84	82	9	91	88	-3	263	264	-2	206	-206
-6	124	-126	8	144	145	11	41	39	-1	44	45	0	84	84
-4	133	132	12	64	-62	K,L=	10	6	1	26	-20	2	246	244
2	34	25	14	31	29	-10	42	43	3	138	-134	6	158	-159
4	60	53	K,L=	5	6	-8	101	100	5	78	79	8	69	-64
8	181	-182	-13	81	80	0	77	74	7	231	222	K,L=	8	7
12	158	159	-11	114	116	4	71	-69	9	70	-69	-11	78	78
14	30	34	-7	34	-30	8	32	29	11	53	-51	-7	124	-122
K,L=	1	6	-3	67	68	K,L=	11	6	13	53	52	-5	68	-68
-15	27	31	-1	142	140	-7	53	-52	K,L=	3	7	-3	154	156
-13	61	-58	1	158	160	-5	75	-77	-14	24	20	-1	105	105
-11	65	-62	3	33	34	-3	32	-29	-10	50	52	1	245	-241
-9	47	-43	7	78	76	-1	53	-48	-8	79	-81	3	40	-35
-7	160	159	9	86	92	1	47	-43	-6	81	-80	5	102	105
-5	82	85	13	44	-40	3	36	-37	-4	109	110	7	83	-79
-1	37	-28	K,L=	6	6	5	129	-130	-2	180	177	11	33	29
1	39	-30	-12	132	131	9	32	29	0	41	-38	K,L=	9	7
3	179	183	-8	63	-57	K,L=	12	6	2	212	-210	-10	40	-42
5	177	182	-6	75	71	-6	45	42	4	33	-35	-6	63	-60
9	66	-67	-4	77	78	-4	72	74	6	151	154	0	58	-55
11	138	139	0	66	-61	-2	90	-88	8	99	97	2	44	-42
13	126	125	2	51	47	0	182	-179	10	52	-51	4	58	57
15	41	-39	4	115	113	4	108	108	12	51	-49	6	69	67
K,L=	2	6	6	70	-68	6	85	85	K,L=	4	7	8	60	-56
-10	95	92	8	56	-52	8	70	-71	-11	39	-42	10	99	-100
-8	97	98	K,L=	7	6	K,L=	13	6	-7	57	57	K,L=	10	7
-2	84	84	-9	60	58	-1	88	94	-3	80	-78	-9	65	-64
0	142	141	-7	127	-132	1	46	48	-1	83	-85	-7	34	30
2	43	-37	-5	37	34	5	64	60	1	133	134	-3	63	63
4	86	-85	-3	76	72	7	46	49	3	33	36	-1	56	53
6	61	61	-1	155	-156	K,L=	14	6	5	79	-78	1	35	-32
10	44	-42	1	59	-58	-2	31	28	7	35	32	5	52	57
14	46	-42	3	39	39	2	25	20	13	31	31	7	37	-33
K,L=	3	6	5	39	-38	K,L=	15	6	K,L=	5	7	K,L=	11	7
-11	48	-49	7	106	-108	1	26	-29	-10	58	61	-8	36	31
-9	168	-167	11	64	-58	K,L=	1	7	-8	145	-147	-4	37	36
-7	84	83	K,L=	8	6	-14	28	25	-4	82	82	-2	78	75

H	FO	FC
2	84	-81
4	36	-38
8	50	52
K,L=	12	7
-3	47	-38
-1	72	-66
1	58	56
3	45	42
K,L=	13	7
-4	39	-40
K,L=	14	7
1	32	26
K,L=	0	8
-14	76	82
-12	111	116
-10	63	-60
-8	50	54
-6	150	148
-2	52	54
0	273	270
2	136	-134
4	34	41
6	283	281
8	60	61
12	31	-26
K,L=	1	8
-13	117	122
-11	105	105
-9	64	-61
-7	40	-32
-5	110	110
-3	113	114
1	56	57
3	130	134
7	170	-161
9	37	-38
11	35	28
K,L=	2	8
-4	133	-131
-2	34	-29
2	148	-145
4	59	-51
8	123	-115
10	53	-45
K,L=	3	8
-13	56	51
-9	70	-68
-7	66	-59
-5	103	-100
-1	87	82
1	55	49
3	43	-37
5	72	-63
7	73	-68
9	45	41
K,L=	4	8
-12	58	-54
-2	91	93
2	132	133
6	42	-37
8	82	78
10	76	79
12	75	80
K,L=	5	8
-13	31	-31
-11	34	-25
-9	57	56
-7	137	131
-5	47	48
3	66	-59
7	153	152
9	42	35
11	115	-116
13	65	-66
K,L=	6	8
-8	62	-55
-6	81	-77
-2	58	-61
0	197	-196
2	48	49
4	49	-43
6	140	-143
10	41	-39
12	85	-85
K,L=	7	8
-11	37	-33
-9	48	-48
-7	52	-47
-5	54	49
-3	39	-34
-1	135	-131
1	110	-102
5	94	92
9	85	-88
11	70	69
K,L=	8	8
-10	72	74
-8	36	43
-4	100	95
-2	53	53
4	66	68
6	101	107
8	77	78
K,L=	9	8
-11	85	89
-7	85	-79
-3	52	49
-1	86	84
1	50	52
7	64	-57
9	80	-80
K,L=	10	8
-4	44	-48
-2	46	-42
0	44	42
2	76	-78
4	38	-41
8	65	-67
K,L=	11	8
-7	48	-44
-5	98	-97
-1	98	98
1	49	46
3	93	-95
5	57	-52
7	30	29
K,L=	12	8
-6	86	88
0	82	82
2	40	38
4	29	25
K,L=	13	8
-5	61	66
-3	28	26
-1	62	-64
1	51	-48
3	33	38
5	48	52
K,L=	14	8
0	48	-50
K,L=	1	9
-12	28	-25
-6	100	98
-4	61	-56
-2	193	-193
0	89	86
2	81	75
4	125	-122
6	62	-64
8	85	83
K,L=	2	9
-13	62	-66
-11	96	95
-9	70	69
-7	40	38
-3	143	-144
-1	102	-96
1	165	158
3	100	101
5	67	-61
7	133	-133
9	60	-61
K,L=	3	9
-12	43	46
-8	81	-80
-6	93	-90
-4	80	78
-2	128	129
2	90	-87
6	131	134
10	95	-93
K,L=	4	9
-11	42	38
-9	54	-52
-7	72	-68
-5	47	44
3	79	-74
7	68	63
11	45	-40
K,L=	5	9
-10	73	-69
-2	86	81
2	46	47
4	68	63
8	48	-41
10	82	84
K,L=	6	9
-11	26	-25
-9	43	-46
-7	64	-63
-5	74	73
-3	164	161
-1	44	43
1	135	-130
3	84	-80
5	46	50
7	93	99
9	46	50
K,L=	7	9
-8	108	111
-6	67	68
-4	119	-116
-2	85	-80
2	49	52
4	50	49
6	106	-103
10	114	116
K,L=	8	9
-11	33	-34
-9	85	84
-5	98	-95
-3	39	-41
3	99	99
5	51	-51
7	48	-47
9	39	45
K,L=	9	9
-10	106	111
-8	46	-49
-6	82	-82
-4	45	42
-2	83	82
2	118	-113
6	41	42
10	42	-50
K,L=	10	9
-9	113	118
-7	59	58
-5	106	-107
-1	32	30
3	61	57
5	38	37
7	48	-47
9	94	-101
K,L=	11	9
-4	38	37
-2	42	-38
4	51	-49
K,L=	12	9
1	29	-25
3	54	-51
K,L=	13	9
-2	55	-56
0	32	29
2	93	99
K,L=	0	10
-12	40	-37
-8	135	137
-6	40	34
-4	76	-77
-2	38	37
0	28	31
4	35	-29
8	175	169
12	98	-97
K,L=	1	10
-11	34	-31
-9	73	-71
-5	183	186
-1	295	-301
1	143	-143
3	69	69
5	65	70
7	40	-38
9	97	-95

H	FO	FC
11	117	-119
K,L=	2	10
-10	59	-62
-8	47	-46
-2	77	-78
0	98	-100
2	40	35
4	43	41
6	76	-71
K,L=	3	10
-9	96	96
-5	118	116
-3	126	119
-1	132	-129
3	170	167
5	111	112
7	45	47
9	56	59
K,L=	4	10
-12	58	63
-10	58	57
-4	75	69
-2	85	84
0	95	94
8	82	-80
K,L=	5	10
-9	90	87
-7	79	-74
-5	220	-217
-1	171	174
1	59	52
3	173	-174
5	210	-213
7	33	-26
9	64	62
K,L=	6	10
-10	29	28
-6	67	-61
-4	51	-52
2	49	-46
4	70	-75
6	51	46
K,L=	7	10
-9	93	-88
-7	50	57
-1	114	113
3	34	27
5	52	49
K,L=	8	10
-8	52	51
-6	50	43
-4	49	47
0	67	-63
4	66	67
6	47	51
K,L=	9	10
-9	78	-82
-7	105	102
-5	48	43
-3	90	-89
-1	74	-72
1	138	-136
3	45	-45
5	131	131
9	143	-152
K,L=	10	10
-8	54	-52
-2	35	-39
0	67	-67
4	41	43
6	39	-38
K,L=	11	10
-5	37	-33
-1	95	100
1	53	54
3	43	-45
5	51	52
K,L=	12	10
-2	58	58
0	106	107
4	55	-60
K,L=	1	11
-10	42	-44
-8	81	-80
-6	113	111
-4	38	34
-2	47	-50
0	61	65
4	43	-37
6	39	32
8	41	38
K,L=	2	11
-11	37	-31
-7	60	57
-3	61	-55
1	84	-87
5	49	-44
7	35	-31
9	169	170
K,L=	3	11
-10	46	44
-6	46	-41
8	43	-43
K,L=	4	11
-11	29	31
-9	32	32
-7	35	-34
-5	56	-54
-3	41	37
-1	62	61
1	78	-71
5	59	58
7	51	-47
K,L=	5	11
-8	132	132
-6	36	-35
-4	77	-76
2	45	40
6	48	-55
8	38	-36
K,L=	6	11
-7	31	-31
-3	33	30
1	61	63
3	38	37
9	78	-80
K,L=	7	11
-8	39	47
-2	46	44
0	37	-34
2	48	-51
K,L=	8	11
-7	85	83
-5	70	67
-3	106	-101
-1	47	-46
1	158	160
3	30	-32
5	84	-82
7	97	103
K,L=	9	11
-4	83	82
-2	61	62
2	39	-34
6	24	18
K,L=	10	11
1	40	-40
3	108	-110
K,L=	11	11
-4	40	-38
-2	53	-55
2	32	25
K,L=	0	12
-10	108	107
-8	41	-38
-6	155	-151
-4	44	-35
-2	40	33
2	73	64
4	141	-155
6	187	-194
K,L=	1	12
-11	63	-66
-9	34	-35
-5	41	-37
-3	51	-42
1	37	-37
3	90	-86
5	36	-29
7	64	63
9	30	34
K,L=	2	12
-8	59	-56
-6	39	32
-4	108	109
0	47	-40
2	105	106
4	53	56
8	60	60
K,L=	3	12
-9	37	29
-5	61	58
3	41	43
K,L=	4	12
-10	43	-44
-6	71	69
-2	101	-102
0	91	-86
2	75	-76
4	45	44
6	48	43
8	83	-77
10	43	-45
K,L=	5	12
-7	63	-62
-5	60	-57
7	60	-59
9	47	-47
K,L=	6	12
-8	82	86
-6	34	33
-4	93	-90
-2	54	58
0	164	167
2	50	-49
6	102	104
8	36	35
K,L=	7	12
-7	35	33
-3	41	41
-1	43	44
1	59	54
5	39	-38
K,L=	8	12
-6	39	-39
-4	54	-50
-2	35	32
0	40	31
2	32	-33
4	64	-58
6	90	-90
K,L=	9	12
-1	46	-41
5	61	-62
K,L=	10	12
-4	66	71
0	60	-61
2	55	61
4	50	53
K,L=	1	13
-8	37	36
-6	53	-51
-2	77	76
0	63	-59
4	102	106
8	87	-92
K,L=	2	13
-9	27	-29
-7	33	33
-3	33	31
-1	34	31
9	19	16
K,L=	3	13
6	44	-45
8	67	63
K,L=	4	13
-5	40	-44
-3	70	66
-1	40	38
1	67	-66
5	40	41
K,L=	5	13
-8	45	-42
-2	36	-32
2	72	-71
4	61	-62
6	55	57
8	42	49
K,L=	6	13
-5	51	-51
-3	74	-73
K,L=	7	13
6	51	51
K,L=	8	13
-5	61	62

H	FO	FC
-3	74	-71
1	61	65
K,L=	9	13
-2	49	-49
0	46	49
2	93	101
K,L=	0	14
-6	45	-47
-2	40	-35
0	42	-32
2	53	-52
4	38	38
6	48	41
8	128	-131
K,L=	1	14
-5	106	-102

H	FO	FC
-1	185	182
1	54	54
3	54	-52
7	44	45
K,L=	2	14
-6	35	32
-4	41	39
-2	42	42
0	36	35
6	54	55
K,L=	3	14
-7	28	26
-5	55	-56
-3	58	-61
-1	90	89
3	82	-82

H	FO	FC
5	36	-43
7	57	-56
K,L=	4	14
-4	30	-31
-2	34	-30
0	32	-27
4	43	-39
6	61	-60
K,L=	5	14
-5	89	91
-1	75	-72
3	87	86
5	94	99
K,L=	6	14
-2	36	37
2	36	33

H	FO	FC
K,L=	7	14
-1	79	-86
3	26	-28
K,L=	8	14
0	34	-33
K,L=	1	15
-6	77	-81
-2	30	27
0	44	-46
K,L=	2	15
1	47	47
5	47	51
K,L=	3	15
-4	41	41
2	33	27
4	28	-23

H	FO	FC
K,L=	4	15
-1	31	-23
1	64	62
K,L=	0	16
-2	79	-81
0	75	-74
K,L=	2	16
0	36	37