Am-79-097

American Mineralogist, Volume 64, pages 1010-1017, 1979

The crystal structure of davidite

BRYAN M. GATEHOUSE

Chemistry Department, Monash University
Clayton, Victoria 3168, Australia

IAN E. GREY

CSIRO Division of Mineral Chemistry, P.O. Box 124
Port Melbourne, Victoria 3207, Australia

AND PATRICK R. KELLY

Geology Department, School of Earth Sciences
University of Melbourne
Parkville, Victoria 3052, Australia

Abstract

Davidite from the Pandora Prospect, Pima County, Arizona, crystallizes in the space group $R\bar{3}$ with lattice parameters $a = 9.190(3)$A, $\alpha = 68.73(1)°$. Its formula, determined from microprobe analysis, is $REE_{0.91}U_{0.33}Ca_{0.20}Y_{0.25}(Sr,Th,Pb)_{0.09}Ti_{12.52}Fe_{3.97}Mg_{0.24}Cr_{0.21}Al_{0.14}(Mn,V,Zr,Nb,Sc)_{0.23}O_{38}$. In its natural state the mineral is metamict. The crystal structure was reconstituted by heating in air at 920°C for two hours. Davidite is isostructural with the crichtonite-group minerals, having a structure based on a close-packed anion lattice with a mixed stacking sequence (hhc ⋯), and with rare-earth elements (REE), M(0), occupying a site in the anion framework. The uranium atom does not substitute for REE in M(0), but occupies an octahedral site M(1) along with yttrium and small REE. The remaining small metal atoms, mainly titanium and iron, occupy a tetrahedral site, M(2), and three other octahedral sites, M(3), M(4), and M(5). A comparison is made of the site occupancies and average metal–oxygen bond lengths for five crichtonite-group minerals—senaite, crichtonite, davidite, loveringite, and landauite. A linear correlation is observed between the unit-cell edge, a_{rh}, and the M(1)–O bond length.

Introduction

The mineral davidite, an iron titanate containing a considerable amount of rare earths and uranium, was first described and named by Mawson (1906). The type material, found at Radium Hill, South Australia, occurs in an intimate intergrowth with ilmenite and rutile. Early studies were hampered by the metamict nature of the mineral, and the fact that samples reconstituted by heat treatments gave powder diffraction patterns that proved difficult to index. In a study on davidites from various localities, Pabst (1961) reconstituted samples from Norway and Arizona to single crystals and determined the space group and unit-cell parameters, rhombohedral $R\bar{3}$ or $R3$ with $a = 9.178$A, $\alpha = 68°48'$. Using these parameters, Pabst was able to completely index powder patterns of davidites from various localities and validate the mineral as a distinct species. Specific gravity data and chemical analyses were consistent with a cell content of 36 O, and Pabst proposed a general formula $Y_6Z_{15}O_{36}$, where Y = large cations: Ca, Fe^{2+}, REE, U, Pb, *etc.*, and Z = small cations: Ti, V, Cr, Fe^{3+}.

Rouse and Peacor (1968) pointed out the close structural relationship between davidite, crichtonite, and senaite as shown by their similar unit-cell parameters, powder patterns, and compositions. From preliminary single-crystal X-ray studies, they determined that the structures were based on a close-packed anion framework, with a nine-layer stacking

0003-004X/79/0910-1010$02.00

Tab 5.

OBSERVED AND CALCULATED STRUCTURE FACTORS FOR ARIZ R3DAR REFINEMENT

H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC
-1	0	1	45	52	-3	1	3	11	5	-3	-1	4	402	397	1	3	4	13	-9	-3	-1	5	38	36
-1	1	1	14	8	-2	1	3	9	7	-2	-1	4	44	-41	2	3	4	43	40	-1	-1	5	81	-80
-2	-1	2	30	27	-1	1	3	72	70	-1	-1	4	12	12	3	3	4	79	82	0	-1	5	122	120
-1	-1	2	146	142	0	1	3	169	192	0	-1	4	38	37	-4	4	4	110	110	1	-1	5	104	-100
0	-1	2	49	-44	1	1	3	173	-171	1	-1	4	58	56	-3	4	4	106	-102	2	-1	5	110	107
1	-1	2	70	75	2	1	3	159	162	2	-1	4	154	-153	-2	4	4	153	151	3	-1	5	51	50
-2	0	2	95	92	-3	2	3	58	60	3	-1	4	164	162	0	4	4	12	-6	4	-1	5	27	27
-1	0	2	13	-10	-2	2	3	33	32	-4	0	4	15	-7	1	4	4	17	-17	-5	0	5	122	119
0	0	2	56	61	-1	2	3	196	193	-3	0	4	21	-19	2	4	4	88	93	-4	0	5	29	-29
1	0	2	38	-36	0	2	3	57	55	-2	0	4	27	28	3	4	4	33	-33	-3	0	5	24	22
-2	1	2	182	-183	1	2	3	181	185	-1	0	4	24	-25	4	4	4	147	150	-2	0	5	17	-16
-1	1	2	16	17	2	2	3	49	50	0	0	4	41	42	-5	-4	5	75	75	-1	0	5	48	-48
0	1	2	51	-52	-3	3	3	31	-33	1	0	4	191	187	-4	-4	5	48	47	0	0	5	146	-139
1	1	2	13	-5	-2	3	3	106	104	2	0	4	29	29	-1	-4	5	36	36	1	0	5	91	90
-2	2	2	21	23	-1	3	3	17	14	3	0	4	12	-9	0	-4	5	31	-32	2	0	5	35	33
-1	2	2	64	62	0	3	3	29	32	-4	1	4	12	2	1	-4	5	63	63	3	0	5	12	7
0	2	2	177	177	1	3	3	18	-20	-3	1	4	97	97	2	-4	5	64	62	-5	1	5	13	9
1	2	2	38	36	2	3	3	16	20	-2	1	4	12	6	4	-4	5	56	55	-4	1	5	32	31
2	2	2	64	77	3	3	3	91	-98	-1	1	4	148	146	-5	-3	5	45	43	-3	1	5	16	-10
-3	-2	3	13	6	-4	-3	4	47	-47	0	1	4	100	-98	-4	-3	5	33	31	-1	1	5	82	79
-2	-2	3	38	35	-3	-3	4	11	5	1	1	4	12	12	-3	-3	5	34	-36	0	1	5	152	153
-1	-2	3	79	79	-2	-3	4	35	-34	2	1	4	34	35	-2	-3	5	67	67	1	1	5	31	29
0	-2	3	9	5	-1	-3	4	126	122	3	1	4	67	72	-1	-3	5	127	-123	2	1	5	284	286
1	-2	3	65	69	0	-3	4	36	-38	-4	2	4	88	87	2	-3	5	57	58	3	1	5	13	12
2	-2	3	35	-37	1	-3	4	15	16	-3	2	4	74	72	3	-3	5	40	-39	4	1	5	20	-18
3	-1	3	79	-77	2	-3	4	17	-19	-2	2	4	121	121	4	-3	5	91	93	-5	2	5	22	23
-2	-1	3	113	115	3	-3	4	32	32	-1	2	4	16	-13	-5	-2	5	54	53	-4	2	5	20	17
0	-1	3	131	137	-4	-2	4	30	31	0	2	4	32	35	-3	-2	5	45	45	-2	2	5	125	-123
1	-1	3	71	69	-3	-2	4	25	23	1	2	4	39	-42	-2	-2	5	41	39	-1	2	5	122	119
2	-1	3	150	150	-2	-2	4	83	84	2	2	4	20	25	-1	-2	5	35	35	0	2	5	44	-46
-3	0	3	42	45	-1	-2	4	11	-11	3	2	4	36	32	0	-2	5	70	66	1	2	5	11	-7
-2	0	3	18	-20	0	-2	4	13	17	-4	3	4	26	25	1	-2	5	157	159	2	2	5	30	-28
-1	0	3	33	34	1	-2	4	17	-16	-3	3	4	25	-23	2	-2	5	33	32	3	2	5	139	140
0	0	3	87	84	2	-2	4	63	-58	-2	3	4	65	-64	3	-2	5	48	51	4	2	5	41	-41
1	0	3	51	-44	3	-2	4	52	50	-1	3	4	65	66	4	-2	5	31	30	-4	3	5	81	83
2	0	3	152	-151	-4	-1	4	22	21	0	3	4	124	-123	-5	-1	5	38	-37	-3	3	5	82	76

H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC
-2	3	5	32	-29	-3	-4	6	29	-29	0	-1	6	51	47	4	2	6	18	-12	-6	6	6	20	-26
-1	3	5	19	-18	-2	-4	6	78	77	2	-1	6	52	-51	5	2	6	51	-51	-5	6	6	15	-6
0	3	5	22	-20	0	-4	6	17	17	3	-1	6	23	24	-5	3	6	52	-53	-4	6	6	21	-20
2	3	5	56	63	1	-4	6	54	52	4	-1	6	78	-76	-4	3	6	71	-70	-3	6	6	17	-20
4	3	5	63	65	2	-4	6	44	-41	5	-1	6	26	27	-3	3	6	78	80	-2	6	6	61	63
-5	4	5	100	100	3	-4	6	111	-110	-6	0	6	41	41	-2	3	6	20	18	-1	6	6	25	22
-4	4	5	52	-51	4	-4	6	26	29	-5	0	6	87	-85	-1	3	6	45	46	0	6	6	76	78
-3	4	5	47	48	5	-4	6	50	-49	-4	0	6	17	16	0	3	6	42	40	2	6	6	12	14
-2	4	5	23	20	-6	-3	6	15	-10	-3	0	6	13	-15	1	3	6	60	66	3	6	6	37	38
-1	4	5	44	45	-5	-3	6	21	18	-2	0	6	65	66	2	3	6	17	-16	4	6	6	94	96
0	4	5	24	26	-4	-3	6	91	-88	0	0	6	148	146	4	3	6	81	80	6	6	6	252	253
1	4	5	359	356	-3	-3	6	59	57	2	0	6	16	18	5	3	6	110	111	-6	-6	7	17	22
2	4	5	19	-19	-2	-3	6	29	27	3	0	6	31	29	-6	4	6	44	44	-3	-6	7	30	31
3	4	5	73	77	-1	-3	6	14	15	4	0	6	106	105	-5	4	6	42	42	-2	-6	7	27	31
4	4	5	42	46	0	-3	6	18	14	5	0	6	33	-32	-4	4	6	66	65	-1	-6	7	47	47
-5	5	5	24	-26	1	-3	6	107	106	-6	1	6	40	42	-3	4	6	14	11	0	-6	7	27	-31
-4	5	5	17	15	2	-3	6	60	-60	-5	1	6	24	26	-2	4	6	167	166	3	-6	7	36	-42
-3	5	5	30	-29	3	-3	6	74	73	-4	1	6	47	47	-1	4	6	61	-59	4	-6	7	28	26
0	5	5	39	39	5	-3	6	29	31	-3	1	6	93	93	0	4	6	13	15	5	-6	7	98	99
1	5	5	12	-5	-6	-2	6	45	44	-2	1	6	26	-25	1	4	6	23	21	-7	-5	7	55	-55
2	5	5	13	15	-5	-2	6	24	23	-1	1	6	50	53	2	4	6	16	19	-5	-5	7	38	38
4	5	5	15	16	-4	-2	6	83	83	0	1	6	49	50	3	4	6	76	-76	-4	-5	7	64	63
-6	-5	6	15	-10	-3	-2	6	65	-64	1	1	6	23	-20	4	4	6	116	116	-2	-5	7	186	186
-5	-5	6	46	46	-2	-2	6	69	71	2	1	6	39	37	5	4	6	57	-58	1	-5	7	16	-15
-4	-5	6	13	11	-1	-2	6	38	35	3	1	6	80	80	-6	5	6	53	-52	2	-5	7	71	71
-3	-5	6	29	27	0	-2	6	102	105	4	1	6	34	-36	-5	5	6	53	54	3	-5	7	57	-56
-2	-5	6	68	-67	1	-2	6	12	12	5	1	6	86	90	-4	5	6	53	-55	4	-5	7	76	77
-1	-5	6	84	84	2	-2	6	100	98	-6	2	6	19	-12	-3	5	6	21	-18	6	-5	7	21	20
0	-5	6	18	12	3	-2	6	13	10	-5	2	6	51	-51	-2	5	6	17	19	-7	-4	7	34	32
1	-5	6	61	60	4	-2	6	12	8	-4	2	6	71	72	-1	5	6	113	113	-6	-4	7	27	-29
2	-5	6	18	16	5	-2	6	19	7	-3	2	6	103	-102	0	5	6	35	-37	-5	-4	7	21	19
3	-5	6	68	69	-5	-1	6	25	26	-2	3	6	86	85	1	5	6	41	42	-4	-4	7	19	-19
4	-5	6	20	-19	-4	-1	6	39	-39	-1	2	6	47	45	2	5	6	112	109	-2	-4	7	51	-50
5	-5	6	58	57	-3	-1	6	22	24	0	2	6	43	42	3	5	6	56	-54	-1	-4	7	24	23
-6	-4	6	36	36	-2	-1	6	13	-8	2	2	6	91	93	4	5	6	120	-122	0	-4	7	31	-29
-5	-4	6	18	-15	-1	-1	6	76	76	3	2	6	236	-237	5	5	6	32	33	1	-4	7	25	26

H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC
2	-4	7	47	46	2	-1	7	24	-24	5	2	7	112	114	3	5	7	23	24	-5	-5	8	35	34
3	-4	7	29	30	3	-1	7	59	57	6	2	7	86	-86	4	5	7	130	-133	-2	-5	8	17	18
4	-4	7	16	10	4	-1	7	53	56	-7	3	7	18	-15	5	5	7	17	-17	-1	-5	8	17	14
6	-4	7	23	17	5	-1	7	25	-24	-6	3	7	56	56	6	5	7	33	35	0	-5	8	55	-53
-7	-3	7	20	-17	6	-1	7	51	52	-4	3	7	110	108	-5	6	7	49	49	1	-5	8	46	43
-5	-3	7	33	32	-7	0	7	71	71	-2	3	7	53	55	-4	6	7	36	38	2	-5	8	34	-34
-4	-3	7	36	35	-6	0	7	32	31	-1	3	7	45	45	-3	6	7	47	48	3	-5	8	44	45
-3	-3	7	21	19	-3	0	7	119	119	0	3	7	85	85	-1	6	7	25	25	4	-5	8	17	16
-2	-3	7	74	73	-2	0	7	59	-59	1	3	7	49	-49	0	6	7	63	62	5	-5	8	20	20
0	-3	7	55	53	-1	0	7	94	92	2	3	7	86	88	1	6	7	69	70	6	-5	8	19	-18
1	-3	7	40	-38	1	0	7	24	22	3	3	7	44	44	3	6	7	64	67	7	-5	8	57	59
2	-3	7	20	-16	2	0	7	56	-55	4	3	7	67	72	5	6	7	30	-27	-5	-4	8	18	-13
3	-3	7	16	14	3	0	7	85	88	5	3	7	30	29	6	6	7	37	40	-4	-4	8	99	98
4	-3	7	66	69	4	0	7	20	-17	6	3	7	119	120	-5	7	7	71	-73	-3	-4	8	36	-37
6	-3	7	164	161	5	0	7	100	102	-7	4	7	25	19	-4	7	7	29	30	-1	-4	8	18	-11
-7	-2	7	15	6	6	0	7	18	21	-6	4	7	46	-47	-3	7	7	21	20	1	-4	8	74	-73
-6	-2	7	71	-74	-7	1	7	51	-52	-5	4	7	30	28	-1	7	7	35	-35	2	-4	8	73	74
-5	-2	7	90	91	-6	1	7	42	44	-4	4	7	27	27	0	7	7	78	75	4	-4	8	16	-15
-3	-2	7	55	54	-4	1	7	73	74	-3	4	7	17	-14	1	7	7	86	-85	5	-4	8	27	-29
-2	-2	7	38	36	-3	1	7	43	42	-2	4	7	50	50	2	7	7	57	58	7	-4	8	20	-21
-1	-2	7	84	82	-2	1	7	83	83	-1	4	7	64	66	4	7	7	53	53	-6	-3	8	21	17
0	-2	7	41	-39	0	1	7	14	10	0	4	7	48	-49	5	7	7	16	12	-5	-3	8	52	48
1	-2	7	55	56	1	1	7	13	-12	1	4	7	55	57	6	7	7	63	65	-4	-3	8	19	-17
2	-2	7	25	-28	2	1	7	45	47	2	4	7	16	-13	7	7	7	103	-105	-2	-3	8	16	-14
3	-2	7	50	52	3	1	7	18	-18	3	4	7	73	74	-2	-7	8	34	-31	-1	-3	8	15	-13
4	-2	7	27	26	4	1	7	47	48	4	4	7	51	51	-1	-7	8	33	33	0	-3	8	61	58
5	-2	7	63	62	5	1	7	60	59	5	4	7	32	31	0	-7	8	48	-49	1	-3	8	116	113
6	-2	7	45	-44	6	1	7	19	-19	6	4	7	26	-27	3	-7	8	51	49	2	-3	8	16	18
-7	-1	7	31	-29	-5	2	7	46	44	-7	5	7	76	-78	-4	-6	8	22	20	3	-3	8	112	113
-6	-1	7	28	25	-2	2	7	22	-19	-6	5	7	46	49	-3	-6	8	19	-20	4	-3	8	37	38
-5	-1	7	23	-22	-1	2	7	13	11	-5	5	7	23	19	-2	-6	8	22	22	5	-3	8	29	-29
-3	-1	7	36	36	0	2	7	78	-76	-4	5	7	35	33	-1	-6	8	22	23	7	-3	5	48	47
-2	-1	7	54	-53	1	2	7	64	64	-2	5	7	51	49	0	-6	3	33	33	-7	-2	8	20	14
-1	-1	7	78	-76	2	2	7	16	13	-1	5	7	157	-156	1	-6	8	34	35	-6	-2	8	138	136
0	-1	7	55	56	3	2	7	16	9	1	5	7	59	-60	2	-6	8	92	92	-5	-2	8	27	-32
1	-1	7	76	-76	4	2	7	30	30	2	5	7	38	37	4	-6	8	20	19	-2	-2	8	44	46

H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC
-1	-2	8	96	-94	-3	1	8	38	39	-6	4	8	34	32	-1	7	8	38	35	7	-4	9	50	49
0	-2	8	67	65	-2	1	8	36	-36	-3	4	8	30	-28	0	7	8	17	12	-5	-3	9	30	31
1	-2	8	19	-17	-1	1	8	18	18	-2	4	8	18	-9	1	7	8	19	23	-4	-3	9	24	26
3	-2	8	67	-66	1	1	8	37	39	-1	4	8	31	-29	2	7	8	20	-14	-3	-3	9	31	32
4	-2	8	91	91	2	1	8	36	-34	0	4	8	21	19	3	7	8	25	23	-2	-3	9	82	80
5	-2	8	32	-34	3	1	8	14	7	1	4	8	38	37	4	7	8	122	-126	-1	-3	9	16	-13
6	-2	8	15	10	4	1	8	23	-23	2	4	8	25	-26	5	7	8	43	44	0	-3	9	35	31
7	-2	8	45	44	5	1	8	17	17	3	4	8	60	-61	6	7	8	20	-21	1	-3	9	34	32
-7	-1	8	16	-12	7	1	8	33	34	4	4	8	42	43	-3	8	8	27	-29	2	-3	9	24	-21
-5	-1	8	34	34	-7	2	8	16	9	5	4	8	49	-49	-2	8	8	46	47	3	-3	9	24	23
-3	-1	8	60	58	-6	2	8	25	-27	6	4	8	18	-20	-1	8	8	19	18	4	-3	9	39	38
-2	-1	8	46	43	-5	2	8	16	-12	7	4	8	61	61	0	8	8	97	97	5	-3	9	40	-39
-1	-1	8	17	-9	-4	2	8	57	57	-4	5	8	37	-36	2	8	8	48	50	6	-3	9	51	53
1	-1	8	13	7	-3	2	8	54	-55	-3	5	8	78	78	3	8	8	29	28	7	-3	9	17	16
2	-1	8	24	22	-2	2	8	15	6	-1	5	8	14	8	4	8	8	41	40	8	-3	9	20	17
3	-1	8	54	55	-1	2	8	42	41	0	5	8	44	45	5	8	8	31	-32	-5	-2	9	16	-11
4	-1	8	25	-27	0	2	8	30	34	1	5	8	105	105	6	8	8	64	66	-4	-2	9	62	-62
5	-1	8	14	12	1	2	8	14	-14	2	5	8	84	-84	7	8	8	39	39	-3	-2	9	38	36
6	-1	8	16	9	2	2	8	87	89	3	5	8	101	102	-1	-6	9	47	46	-2	-2	9	46	-43
7	-1	8	71	-71	3	2	8	24	-23	6	5	8	18	-15	0	-6	9	22	24	-1	-2	9	55	50
-7	0	8	19	20	4	2	8	61	60	7	5	8	59	61	1	-6	9	49	47	0	-2	9	29	27
-6	0	8	66	66	5	2	8	24	-27	-5	6	8	32	32	3	-6	9	44	42	1	-2	9	39	38
-4	0	8	55	54	7	2	8	19	-15	-4	6	8	42	43	-3	-5	9	34	-33	2	-2	9	21	-19
-3	0	8	39	-40	-7	3	8	75	72	-3	6	8	33	-34	-2	-5	9	26	27	3	-2	9	45	46
-2	0	8	14	11	-6	3	8	46	-46	-2	6	8	43	43	0	-5	9	28	27	4	-2	9	116	-117
0	0	8	76	75	-5	3	8	61	80	0	6	8	49	49	1	-5	9	30	33	6	-2	9	28	-27
1	0	8	26	27	-2	3	8	55	-55	1	6	8	59	59	3	-5	9	46	-47	7	-2	9	41	42
2	0	8	230	225	-1	3	8	90	92	2	6	8	96	97	4	-5	9	17	14	8	-2	9	29	-27
4	0	8	36	38	0	3	8	16	-15	4	6	8	42	43	5	-5	9	23	-25	-5	-1	9	17	-6
5	0	8	17	12	1	3	8	97	99	5	6	8	24	23	-4	-4	9	44	-44	-4	-1	9	25	-25
6	0	8	45	47	2	3	8	52	51	6	6	8	24	24	-3	-4	9	17	9	-3	-1	9	58	-58
7	0	8	71	-71	3	3	8	103	102	7	6	8	32	-31	-1	-4	9	59	60	-2	-1	9	91	90
-7	1	8	30	25	4	3	8	15	-5	-5	7	8	32	33	0	-4	9	36	-36	-1	-1	9	18	11
-6	1	8	40	37	5	3	8	45	47	-4	7	8	32	-37	1	-4	9	67	64	0	-1	9	17	16
-5	1	8	49	49	6	3	8	29	-28	-3	7	8	28	27	5	-4	9	85	88	2	-1	9	30	30
-4	1	8	45	-46	7	3	8	17	15	-2	7	8	26	-26	6	-4	9	20	-19	4	-1	9	18	16

H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC
5	-1	9	56	57	4	2	9	50	50	-4	6	9	27	-24	9	9	9	59	-58	5	-1	10	39	37
6	-1	9	96	96	5	2	9	117	118	-3	6	9	56	54	0	-5	10	71	-67	7	-1	10	68	68
7	-1	9	18	19	7	2	9	171	171	-2	6	9	49	47	1	-5	10	37	38	9	-1	10	18	9
8	-1	9	31	31	8	2	9	59	60	-1	6	9	62	64	2	-5	10	32	-32	-5	0	10	37	-35
-5	0	9	20	21	-6	3	9	20	21	0	6	9	24	-24	-2	-4	10	68	69	-4	0	10	31	27
-4	0	9	52	53	-4	3	9	50	49	1	6	9	37	37	0	-4	10	35	35	-3	0	10	24	26
-3	0	9	72	71	-3	3	9	23	23	2	6	9	38	-36	2	-4	10	34	36	-2	0	10	23	-24
-1	0	9	117	116	-2	3	9	159	157	3	6	9	31	-27	3	-4	10	36	-42	-1	0	10	30	31
0	0	9	16	-8	-1	3	9	23	-26	5	6	9	42	43	4	-4	10	47	44	0	0	10	32	30
1	0	9	27	-23	0	3	9	32	36	6	6	9	26	-25	-3	-3	10	48	45	1	0	10	56	-54
2	0	9	13	9	1	3	9	14	3	7	6	9	23	24	-1	-3	10	48	47	2	0	10	47	47
3	0	9	37	38	2	3	9	19	20	-1	7	9	17	-16	0	-3	10	25	-24	4	0	10	38	39
4	0	9	62	-64	3	3	9	90	-92	0	7	9	46	46	2	-3	10	19	-16	5	0	10	50	52
5	0	9	63	61	4	3	9	105	106	1	7	9	36	-34	3	-3	10	64	63	6	0	10	20	19
6	0	9	26	-23	5	3	9	19	-16	3	7	9	43	43	5	-3	10	23	13	7	0	10	37	-38
7	0	9	48	50	6	3	9	29	28	5	7	9	30	-29	6	-3	10	35	38	8	0	10	30	32
8	0	9	18	-17	7	3	9	22	-21	6	7	9	76	77	7	-3	10	15	-17	9	0	10	65	-66
-5	1	9	78	-78	8	3	9	61	63	7	7	9	67	-66	-4	-2	10	27	27	-5	1	10	45	45
-4	1	9	38	35	-4	4	9	18	-19	8	7	9	37	33	-3	-2	10	24	20	-4	1	10	25	27
-3	1	9	36	-35	-3	4	9	17	13	-3	8	9	54	50	-1	-2	10	31	-30	-3	1	10	43	42
-2	1	9	21	-23	-2	4	9	19	-18	-2	8	9	56	-56	1	-2	10	38	-39	-2	1	10	27	-29
-1	1	9	21	-17	-1	4	9	16	12	-1	8	9	98	98	2	-2	10	21	19	-1	1	10	30	27
0	1	9	123	123	1	4	9	47	48	1	8	9	17	8	3	-2	10	20	22	0	1	10	111	-111
1	1	9	41	-43	6	4	9	13	8	3	8	9	60	61	4	-2	10	21	19	2	1	10	35	-37
2	1	9	21	19	7	4	9	31	30	4	8	9	35	-34	5	-2	10	15	-10	3	1	10	67	67
3	1	9	69	66	8	4	9	23	-27	5	8	9	108	110	6	-2	10	48	51	5	1	10	75	7
4	1	9	16	-9	-2	5	9	74	75	6	8	9	44	48	7	-2	10	29	-29	6	1	10	19	-19
5	1	9	91	-89	-1	5	9	23	-15	7	8	9	91	93	8	-2	10	30	27	9	1	10	65	67
6	1	9	48	47	0	5	9	72	72	8	8	9	15	10	-4	-1	10	23	-24	-4	2	10	32	29
-6	2	9	19	19	1	5	9	20	-17	-2	9	9	44	40	-3	-1	10	83	80	-3	2	10	26	19
-5	2	9	23	-23	2	5	9	20	22	0	9	9	36	38	-1	-1	10	27	26	-2	2	10	35	36
-2	2	9	18	11	3	5	9	18	-17	3	9	9	32	-30	0	-1	10	26	26	0	2	10	28	27
-1	2	9	74	72	4	5	9	58	59	4	9	9	34	35	1	-1	10	85	83	1	2	10	62	63
0	2	9	13	-3	5	5	9	18	17	5	9	9	28	28	2	-1	10	46	-45	2	2	10	81	83
1	2	9	33	33	6	5	9	155	156	7	9	9	20	-17	3	-1	10	69	71	3	2	10	14	-11
3	2	9	42	-40	8	5	9	61	59	8	9	9	37	37	4	-1	10	30	32	4	2	10	47	49

H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC
6	2	10	48	-48	7	5	10	37	38	8	9	10	17	-14	8	0	11	51	54	2	4	11	15	6
7	2	10	37	38	8	5	10	67	-68	1	10	10	20	-16	9	0	11	30	28	3	4	11	31	32
8	2	10	48	47	9	5	10	75	74	2	10	10	57	56	-3	1	11	24	-26	4	4	11	26	26
9	2	10	31	-34	-2	6	10	17	4	3	10	10	57	-58	-2	1	11	39	40	5	4	11	66	65
-4	3	10	42	-45	-1	6	10	61	-60	4	10	10	61	60	0	1	11	16	14	6	4	11	31	-32
-2	3	10	21	20	0	6	10	69	70	7	10	10	15	-13	2	1	11	75	78	7	4	11	76	76
0	3	10	64	-66	1	6	10	34	-35	8	10	10	44	41	3	1	11	28	-31	8	4	11	31	31
1	3	10	47	49	4	6	10	74	75	10	10	10	106	108	4	1	11	49	48	-3	5	11	35	36
2	3	10	51	-49	5	6	10	36	-35	0	-3	11	28	29	6	1	11	26	26	-2	5	11	29	27
3	3	10	43	43	6	6	10	36	36	2	-3	11	26	22	7	1	11	26	-26	-1	5	11	32	-30
5	3	10	66	67	7	6	10	50	48	3	-3	11	40	-42	8	1	11	42	41	0	5	11	36	37
7	3	10	44	41	9	6	10	58	-56	5	-3	11	35	-33	9	1	11	23	-18	2	5	11	32	-35
8	3	10	83	-83	-3	7	10	48	50	-2	-2	11	40	-39	-3	2	11	50	51	3	5	11	62	63
9	3	10	15	9	-2	7	10	15	-9	-1	-2	11	16	-16	-2	2	11	53	-54	4	5	11	46	47
-4	4	10	93	95	0	7	10	18	-10	0	-2	11	41	44	-1	2	11	56	55	5	5	11	49	-51
-3	4	10	36	-36	1	7	10	20	-19	1	-2	11	32	31	1	2	11	41	38	6	5	11	54	54
-2	4	10	38	35	3	7	10	56	57	3	-2	11	54	51	2	2	11	29	30	8	5	11	22	21
-1	4	10	46	47	5	7	10	60	58	5	-2	11	21	14	3	2	11	73	75	9	5	11	32	38
0	4	10	56	-58	6	7	10	14	16	-2	-1	11	21	19	5	2	11	16	16	10	5	11	39	38
1	4	10	73	-75	7	7	10	19	-18	-1	-1	11	60	-65	7	2	11	47	48	-2	6	11	57	-59
2	4	10	60	60	9	7	10	73	73	0	-1	11	68	68	8	2	11	18	-11	-1	6	11	27	27
4	4	10	18	10	-2	8	10	23	22	2	-1	11	52	51	9	2	11	36	37	0	6	11	18	1
5	4	10	26	24	0	8	10	44	44	3	-1	11	19	16	10	2	11	44	46	1	6	11	61	61
6	4	10	33	33	1	8	10	17	15	4	-1	11	61	61	-3	3	11	46	-46	2	6	11	16	-21
7	4	10	29	-30	2	8	10	114	113	5	-1	11	25	-24	-2	3	11	28	29	3	6	11	35	3
8	4	10	21	-20	3	8	10	18	-22	6	-1	11	41	41	0	3	11	35	34	4	6	11	81	-80
9	4	10	50	51	4	8	10	57	59	7	-1	11	19	-19	1	3	11	35	34	5	6	11	22	-21
-3	5	10	37	34	5	8	10	21	17	8	-1	11	38	36	2	3	11	16	12	6	6	11	70	-71
-2	5	10	16	9	7	8	10	56	-56	-2	0	11	26	-22	3	3	11	31	-29	7	6	11	32	36
-1	5	10	14	10	8	8	10	66	69	-1	0	11	28	27	4	3	11	16	14	9	6	11	61	60
0	5	10	41	45	-1	9	10	38	-41	2	0	11	31	33	5	3	11	88	-91	10	6	11	25	-27
1	5	10	79	79	1	9	10	20	13	3	0	11	32	-36	8	3	11	27	24	0	7	11	33	29
3	5	10	170	172	2	9	10	27	-26	4	0	11	70	-71	10	3	11	57	59	1	7	11	41	42
4	5	10	19	11	3	9	10	22	22	5	0	11	34	31	-2	4	11	22	-26	2	7	11	33	36
5	5	10	14	-8	4	9	10	14	8	6	0	11	24	-25	-1	4	11	70	72	3	7	11	21	-17
6	5	10	16	-14	5	9	10	20	17	7	0	11	26	-28	1	4	11	85	85	5	7	11	59	62

H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC	H	K	L	FO	FC
6	7	11	48	47	8	10	11	20	15	7	1	12	90	88	7	4	12	25	26	3	7	12	54	56
8	7	11	91	94	9	10	11	19	7	-1	2	12	31	31	8	4	12	78	80	5	7	12	16	-13
10	7	11	35	-37	10	10	11	19	-12	0	2	12	53	56	10	4	12	27	28	6	7	12	[illegible]	26
-1	8	11	93	92	3	11	11	32	-30	1	2	12	42	-41	-1	5	12	45	45	7	7	12	56	55
0	8	11	32	-37	4	11	11	46	46	2	2	12	41	39	2	5	12	15	-13	9	7	12	39	36
3	8	11	24	18	5	11	11	28	-24	3	2	12	29	-31	3	5	12	21	16	10	7	12	27	30
4	8	11	56	-57	6	11	11	26	25	6	2	12	35	31	4	5	12	18	-20	1	8	12	45	-44
5	8	11	71	72	7	11	11	17	19	7	2	12	32	-32	5	5	12	30	32	2	8	12	36	35
6	8	11	33	-31	8	11	11	30	30	9	2	12	35	-32	6	5	12	39	41	4	8	12	20	9
7	8	11	41	39	1	-1	12	24	24	-1	3	12	24	-32	7	5	12	22	-25	5	8	12	24	22
8	8	11	21	-13	2	-1	12	15	-11	0	3	12	31	-30	8	5	12	45	-42	6	8	12	36	34
9	8	11	55	56	3	-1	12	32	33	1	3	12	40	40	9	5	12	28	29	7	8	12	27	-22
0	9	11	50	51	4	-1	12	47	-47	2	3	12	32	-28	10	5	12	42	-43	8	8	12	31	28
1	9	11	25	-27	5	-1	12	57	57	4	3	12	57	59	1	6	12	61	-65	9	8	12	91	-93
2	9	11	42	43	-1	0	12	25	-26	6	3	12	29	-28	2	6	12	37	37	2	9	12	41	-45
3	9	11	35	35	1	0	12	18	-13	7	3	12	59	60	4	6	12	28	25	3	9	12	44	46
4	9	11	38	-43	2	0	12	40	39	8	3	12	26	-27	5	6	12	19	22	5	9	12	65	65
5	9	11	55	-57	3	0	12	18	-12	-1	4	12	27	-29	6	6	12	71	72	7	9	12	35	35
7	9	11	19	-19	6	0	12	17	11	0	4	12	64	63	7	6	12	33	-32	9	9	12	17	7
9	9	11	44	48	-1	1	12	64	63	2	4	12	16	16	8	6	12	47	44	4	10	12	69	72
10	9	11	29	30	1	1	12	22	19	3	4	12	37	-41	10	6	12	29	28	5	10	12	24	-28
2	10	11	22	26	4	1	12	19	-21	4	4	12	58	60	0	7	12	31	33	6	10	12	20	-25
5	10	11	57	55	5	1	12	52	50	5	4	12	18	-16	1	7	12	48	47	7	10	12	17	4
7	10	11	113	112	6	1	12	23	27	6	4	12	84	85	2	7	12	39	-36	8	10	12	36	3