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The crystal structure of köttigite

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Abstract

Köttigite, $(Zn_{2.44}Co_{0.42}Ni_{0.14})(AsO_4)_2 \cdot 8H_2O$, from the type locality (Schneeberg, East Germany) crystallizes in space group $C2/m$ with $a = 10.241(3)$, $b = 13.405(3)$, $c = 4.757(2)$A, $\beta = 105.21(2)°$, and $Z = 2$. Isotypy with vivianite is confirmed: the hydrogen atoms have been located and the crystal structure refined using 812 Zr-filtered Mo$K\alpha$ data to an R value of 0.054 ($R_w = 0.057$). The transition metals are randomly distributed over insular single and double (edge-sharing) octahedral groups of O atoms and H_2O molecules connected by AsO_4 tetrahedra to form complex slabs parallel to (010). These sheets are held together by hydrogen bonding alone, thereby accounting for the perfect {010} cleavage of the mineral. Shortening of the shared edge relative to the unshared edges within the octahedral dimer (0.139A) is well within the rather wide range of values observed in other Zn compounds containing shared octahedral edges.

Introduction

The mineral köttigite, ideally $Zn_3(AsO_4)_2 \cdot 8H_2O$, has long been recognized as a member of the vivianite group of minerals with the general formula $M_3(TO_4)_2 \cdot 8H_2O$. The monoclinic members of this family include the phosphates vivianite (M = Fe), bobierrite (Mg), and baricite (Mg,Fe), and the arsenates köttigite, parasymplesite (Fe), hoernesite (Mg), annabergite (Ni), and erythrite (Co). In addition, both vivianite and parasymplesite have been observed in a closely-related triclinic modification as the minerals metavivianite and symplesite (Ritz *et al.*, 1974).

The topology of the monoclinic structure type was shown by Mori and Ito (1950)[2] to consist of octahedral edge-sharing dimers, $M_2O_6(H_2O)_4$, and insular octahedra, $MO_2(H_2O)_4$, linked by TO_4 tetrahedra into complex sheets parallel to (010). However, the atomic coordinates were not refined, and the details of this interesting structure remain in doubt. The structure of the triclinic dimorph is still unknown.

The structural analysis of köttigite was initiated as part of a continuing study of Zn stereochemistry and, in particular, of the characteristics of Zn octahedron shared-edge shortening. Material from the type locality in Schneeberg, East Germany, was kindly made available for study by B. D. Sturman of the Royal Ontario Museum (ROM specimen number M15537).

Experimental

The crystal selected for data collection was a pale red transparent platelet displaying well-developed {010} faces, and having the dimensions 0.098 × 0.093 × 0.037 mm. Detailed morphological, optical, chemical and X-ray data for the material have been reported by Sturman (1976); the chemical composition determined in that study has been included in the abstract. The crystal was oriented with the c^* axis slightly displaced from the ϕ axis of a Picker FACS 1 four-circle diffractometer. Unit-cell parameters were refined by least-squares methods to give the best fit between calculated and observed angles 2θ, χ, and ϕ, measured at 25±2°C with Mo$K\alpha_1$ radiation (λ = 0.70926A), for 30 automatically centered reflections in the range 2θ = 30–45°. The resultant cell dimensions $a = 10.241(3)$[3], $b = 13.405(3)$, $c = 4.757(2)$A, $\beta = 105.21(2)°$ [unit-cell volume = 630.2(2)A^3] agree well with values reported by Sturman (1976).

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[2] Note that monoclinic $Fe_3(AsO_4)_2 \cdot 8H_2O$ is (incorrectly) referred to as symplesite rather than parasymplesite by Mori and Ito (1950).

[3] E.s.d.'s, given in parentheses, refer to the last decimal place.

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H	FO	FC	AC	BC
K= 0 L= 0				
4	141	139	-119	72
6	1613	1579	1573	136
8	288	299	299	-2
10	1155	1142	1137	108
12	857	839	835	77
K= 1 L= 0				
1	907	753	-752	-46
3	998	885	883	62
5	1190	1147	-1144	-82
7	107	18	16	8
9	326	315	314	28
11	653	633	-628	-78
13	271	261	257	45
K= 2 L= 0				
2	379	367	-367	-21
4	365	353	352	27
6	1386	1354	1351	92
8	332	351	-349	-43
10	482	493	488	68
12	386	384	381	41
K= 3 L= 0				
1	718	630	629	25
3	1709	1609	1603	130
5	248	229	228	-14
7	1163	1155	1153	72
9	736	713	708	86
11	266	235	-234	-23
13	761	753	747	94
K= 4 L= 0				
2	1017	954	-951	-78
4	431	427	-426	-29
6	113	140	136	36
8	882	890	-886	-94
10	226	188	187	21
12	89	98	-98	-3
K= 5 L= 0				
1	471	435	433	41
3	1839	1791	1785	144
5	879	911	911	3
7	1418	1426	1423	87
9	597	587	579	99
11	254	227	-227	-10
13	907	894	888	105
K= 6 L= 0				
0	847	783	778	83
2	587	579	-578	-46
4	182	160	160	1
6	685	710	707	64
8	571	567	-563	-65
10	332	315	312	45
12	76	107	105	20
K= 7 L= 0				
1	64	40	34	-21
3	686	695	690	79
5	696	706	-703	-57
7	337	345	344	27
9	410	404	402	45
11	402	391	-387	-58
K= 8 L= 0				
0	2661	2687	2683	144
2	463	468	468	17
4	337	351	346	60
6	1210	1207	1201	120
8	83	90	90	-8
10	864	832	826	94
12	603	618	615	66
K= 9 L= 0				
1	812	797	-795	-53
3	570	571	569	46
5	811	817	-812	-85
7	68	99	-99	-3
9	27	122	121	16
11	615	601	-596	-80
K= 10 L= 0				
0	1944	1964	1960	125
2	170	124	124	3
4	208	202	197	45
6	1040	1056	1051	103
8	20	44	-39	-20
10	605	576	571	79
K= 11 L= 0				
1	140	91	90	-1
3	897	898	894	92
5	314	325	-323	-35
7	379	384	382	42
9	487	490	487	57
11	250	229	-226	-39
K= 12 L= 0				
0	635	511	508	59
2	548	547	-544	-56
4	92	131	-130	-14
6	362	376	373	42
8	531	536	-531	-71
10	93	108	105	27
K= 13 L= 0				
1	328	308	305	38
3	1091	1089	1081	126
5	429	426	426	5
7	861	851	847	76
9	418	429	420	87
K= 14 L= 0				
0	294	363	359	53
2	429	427	-423	-56
4	119	124	-123	-16
6	173	171	167	37
8	488	453	-448	-70
K= 15 L= 0				
1	178	140	140	2
3	537	530	523	85
5	193	138	-135	-28
7	417	416	414	41
K= 16 L= 0				
0	771	841	835	100
2	104	59	59	-2
4	259	252	250	34
6	541	559	553	82
K= 17 L= 0				
1	328	316	-314	-40
3	268	239	236	38
5	441	437	-432	-66
K= 18 L= 0				
0	1033	1054	1049	107
2	198	152	152	12
4	198	135	128	44
K= 0 L= 1				
4	340	348	347	26
6	897	907	905	67
8	1458	1491	1485	131
-8	1081	1094	1088	115
10	74	56	56	-5
-10	976	926	922	80
12	707	710	703	97
-12	197	197	197	4
-14	762	725	715	116
K= 1 L= 1				
1	784	698	-696	-43
-1	908	883	881	61
3	54	55	-30	-46
-3	1558	1562	-1559	-84
5	892	893	891	62
-5	492	481	-481	9
7	1274	1296	-1294	-78
-7	530	522	521	26
9	119	118	-118	6
-9	403	389	-381	-81
11	405	455	454	30
-11	206	232	227	47
13	427	419	-413	-73
-13	295	316	-316	-19
K= 2 L= 1				
0	288	226	-225	-22
2	2043	1960	1957	113
-2	397	377	376	30
4	56	85	83	-18
-4	1180	1172	1168	92
6	170	200	198	23
-6	433	440	-438	-44
8	761	774	768	89
-8	899	902	899	74
10	208	219	-215	-42
-10	491	464	462	41
12	490	519	515	63
-12	309	275	-274	-31
-14	536	521	514	84
K= 3 L= 1				
1	345	288	287	27
-1	2050	1981	1977	130
3	483	466	466	22
-3	416	408	407	-15
5	1621	1659	1654	127
-5	1136	1157	1155	76
7	75	49	47	-14
-7	892	870	865	88
9	618	640	637	65
-9	149	123	-121	-22
11	647	630	624	83
-11	993	930	924	101
13	76	136	-134	-24
-13	311	259	258	31
K= 4 L= 1				
0	1928	1727	-1725	-80
2	809	742	-740	52
-2	1059	994	993	-26
4	799	821	-818	-74
-4	855	857	856	35
6	66	31	-9	-29
-6	1570	1560	-1557	-98
8	407	384	382	38
-8	69	34	-26	21
10	588	624	-618	-88
-10	191	175	-175	-7
12	50	25	-17	19
-12	551	534	-529	-74
-14	473	456	454	45
K= 5 L= 1				
1	1123	1049	1048	44
-1	1858	1829	1824	144
3	828	827	826	38
-3	262	213	213	2
5	1551	1555	1549	141
-5	1415	1433	1430	91
7	216	176	176	2
-7	1135	1138	1133	102
9	725	748	744	78
-9	21	53	53	-7
11	717	699	692	94
-11	1064	1027	1021	113
-13	309	298	295	42
K= 6 L= 1				
0	812	761	-759	-48
2	667	658	653	82
-2	538	523	523	4
4	207	196	-191	-43
-4	712	726	723	63
6	70	55	55	-1
-6	879	888	-885	-67
8	435	443	439	63
-8	555	537	534	48
10	343	351	-346	-61
-10	174	150	149	18
12	312	294	291	41
-12	405	425	-422	-50
K= 7 L= 1				
1	348	329	-328	-19
-1	1016	999	996	79
3	196	183	-182	-23
-3	502	508	-505	-59
5	901	897	894	79
-5	215	217	215	30
7	506	517	-514	-54
-7	345	353	350	43
9	130	166	164	24
-9	408	393	-388	-59
11	348	353	351	45
-11	523	478	474	61
-13	86	63	-63	-3
K= 8 L= 1				
0	407	401	401	15
2	1762	1768	1762	141
-2	873	893	891	64
4	247	262	261	17
-4	1473	1520	1515	121
6	563	573	571	55
-6	131	43	42	-8
8	1043	1055	1049	115
-8	935	941	936	101
10	96	34	32	-10
-10	693	679	676	68
-12	85	56	56	-2
K= 9 L= 1				
1	478	493	-491	-50
-1	380	400	397	45
3	92	141	-131	-53
-3	1315	1293	-1290	-88
5	512	505	503	47
-5	444	455	-455	-2
7	1166	1173	-1170	-82
-7	412	377	377	14
9	210	210	-210	-4
-9	320	315	-304	-83
11	355	367	367	20
-11	84	77	69	34
K= 10 L= 1				
0	74	139	139	1
2	1477	1453	1448	123
-2	515	496	493	48
4	77	93	92	4
-4	1158	1184	1180	103
6	399	383	380	41
-6	18	81	-78	-20
8	823	854	849	99
-8	678	679	674	85
-10	552	520	517	55
-12	46	13	-5	-12
K= 11 L= 1				
1	194	162	-162	0
-1	1009	1040	1036	92
-3	74	17	17	-4
-5	209	103	-96	-36
-7	263	264	-261	-33
-9	88	55	55	-3
K= 12 L= 1				
-7	449	445	442	57
9	245	272	270	37
-9	180	187	-183	-39
-11	489	463	457	71
K= 13 L= 1				
1	481	523	522	40
-1	1043	1070	1063	126
3	479	485	483	35
-3	184	111	111	4
5	993	996	989	122
-5	805	816	812	80
7	171	82	82	4
-7	728	740	735	90
9	484	492	487	68
-9	88	55	55	-3
K= 14 L= 1				
0	622	612	-610	-57
2	82	77	57	51
-2	234	220	219	-13
4	319	328	-324	-52
-4	365	358	356	37
6	90	18	-6	-17
-6	680	701	-697	-73
8	266	225	222	38
-8	224	127	124	25
K= 15 L= 1				
1	90	94	94	4
-1	639	638	633	85
3	85	33	33	0
-3	177	146	-143	-29
5	575	582	576	83
-5	376	411	409	44
7	124	90	-86	-27
-7	255	318	314	54
K= 16 L= 1				
0	77	9	9	-4
2	741	757	751	98
-2	276	346	344	36
4	89	117	117	-1
-4	591	584	578	82
6	187	192	189	30
-6	94	125	-123	-21
K= 17 L= 1				
1	224	236	-233	-38
-1	193	208	204	37
3	156	146	-140	-41
-3	575	586	-582	-69
5	311	253	250	38
-5	163	129	-129	0
K= 18 L= 1				
0	236	127	126	10
2	689	736	729	105
-2	351	357	354	47
-4	671	691	685	90
K= 0 L= 2				
0	17	93	53	76
2	1080	1110	1110	21
-2	890	991	982	134
4	2352	2486	2482	153
-4	943	995	995	0

H	FO	FC	AC	BC
6	357	378	378	24
-6	1979	2071	2068	120
8	524	542	539	58
-8	856	912	909	80
10	770	814	805	120
-10	72	82	91	7
12	127	98	-98	-8
-12	852	826	817	123
-14	148	163	162	23

K= 1 L= 2

H	FO	FC	AC	BC
1	967	938	947	59
-1	986	1073	-1069	-84
3	582	592	-591	-39
-3	258	267	-266	12
5	489	519	-517	-46
-5	320	322	321	23
7	559	575	572	61
-7	684	713	-709	-82
9	614	633	-629	-71
-9	295	302	298	48
11	67	14	13	5
-11	259	213	-212	-22
-13	284	268	-264	-47

K= 2 L= 2

H	FO	FC	AC	BC
0	664	576	575	32
2	28	34	24	-24
-2	1105	1197	1193	89
4	1091	1119	1113	108
-4	249	270	-266	-44
6	202	203	-203	-17
-6	864	889	885	76
8	300	333	332	19
-8	352	352	349	40
10	629	676	671	85
-10	75	133	-129	-30
12	320	310	-307	-41
-12	754	736	731	89
-14	85	92	-91	-8

K= 3 L= 2

H	FO	FC	AC	BC
1	2183	1910	1906	126
-1	74	31	-26	-16
3	508	510	509	27
-3	1226	1287	1284	79
5	96	18	6	16
-5	1097	1192	1188	87
7	1099	1153	1147	120
-7	314	321	-321	-21
9	168	149	148	-14
-9	1007	1013	1007	106
11	373	416	412	56
-11	479	474	473	32
-13	82	91	91	2

K= 4 L= 2

H	FO	FC	AC	BC
0	321	297	-295	-24
2	1165	1130	-1127	-79
-2	151	132	127	33
4	344	429	426	53
-4	1191	1255	-1251	-98
6	493	484	-479	-67
-6	454	460	459	24
8	248	239	-238	-29
-8	77	211	-211	-10
10	165	165	160	39
-10	855	832	-829	-76
-12	405	407	405	45
-14	309	250	-246	-46

K= 5 L= 2

H	FO	FC	AC	BC
1	2289	2121	2116	140
-1	487	477	477	1
3	586	574	572	43
-3	1591	1641	1638	94
5	70	97	-92	31
-5	992	1063	1058	101
7	1215	1244	1237	133
-7	421	424	-424	-6
9	456	475	475	1
-9	1250	1232	1226	118
11	515	533	528	68
-11	757	750	749	45
-13	197	158	158	14

K= 6 L= 2

H	FO	FC	AC	BC
0	408	380	380	6
2	545	514	-511	-48
-2	669	683	681	61
4	625	605	600	80
-4	769	814	-811	-67
6	303	307	-304	-39
-6	578	596	594	50
8	100	62	61	-3
-8	56	103	102	16
10	409	423	418	62
-10	400	434	-431	-50
-12	593	572	568	67

K= 7 L= 2

H	FO	FC	AC	BC
1	967	928	925	77
-1	909	894	-893	-60
3	48	25	19	-16
-3	268	276	274	32
5	218	237	-235	-25
-5	647	672	670	42
7	593	615	610	76
-7	454	483	-479	-60
9	335	359	-355	-50
-9	414	446	442	63
11	74	89	87	20
-11	74	38	-37	-5
-13	195	173	-171	-30

K= 8 L= 2

H	FO	FC	AC	BC
0	375	382	376	64
2	553	537	537	12
-2	961	975	967	118
4	1654	1640	1634	135
-4	356	384	383	-7
6	230	232	231	16
-6	1364	1367	1363	105
8	401	416	413	48
-8	661	659	656	68
10	644	674	666	107
-10	78	33	33	1
-12	736	702	694	109

K= 9 L= 2

H	FO	FC	AC	BC
1	587	585	583	44
-1	757	748	-743	-87
3	616	620	-619	-46
-3	282	302	-302	0
5	559	552	-550	-53
-5	74	12	-5	11
7	354	370	367	47
-7	663	657	-652	-85
9	550	544	-539	-74
-9	197	190	187	35
-11	251	213	-211	-29

K= 10 L= 2

H	FO	FC	AC	BC
0	259	289	285	49
2	322	341	341	-1
-2	804	829	823	100
4	1226	1223	1218	118
-4	133	171	169	-19
6	129	4	1	4
-6	927	943	939	88
8	352	334	332	35
-8	420	446	443	54
-10	88	18	15	-10
-12	634	587	579	95

K= 11 L= 2

H	FO	FC	AC	BC
1	863	877	872	89
-1	311	312	-310	-37
3	106	59	59	2
-3	417	400	397	47
5	69	9	7	-6
-5	601	615	613	56
7	646	666	660	86
-7	182	212	-208	-39
9	272	206	-203	-32
-9	483	471	465	74
-11	177	82	82	10

K= 12 L= 2

H	FO	FC	AC	BC
0	78	59	-59	-10
2	470	496	-493	-57
-2	317	310	307	39
4	297	344	339	57
-4	618	617	-612	-74
6	317	353	-350	-49
-6	273	233	231	31
8	161	32	-28	-16
-8	86	66	-66	1
-10	380	379	-375	-56

K= 13 L= 2

H	FO	FC	AC	BC
1	1194	1229	1222	122
-1	281	276	276	3
3	292	322	320	39
-3	903	889	885	82
5	86	30	-9	29
-5	646	648	642	89
7	807	830	822	116
-7	73	204	-204	-3
-9	814	810	803	103

K= 14 L= 2

H	FO	FC	AC	BC
0	83	39	-37	-12
2	500	507	-503	-57
-2	185	207	204	35
4	262	309	305	51
-4	604	605	-601	-73
6	194	230	-225	-48
-6	252	295	294	27
-8	90	43	-43	-1

K= 15 L= 2

H	FO	FC	AC	BC
1	639	657	652	82
-1	311	291	-290	-30
3	194	165	165	5
-3	465	441	438	45
5	99	81	-81	-3
-5	475	473	470	53
-7	375	282	-280	-32

K= 16 L= 2

H	FO	FC	AC	BC
0	282	311	308	37
2	157	34	33	-5
-2	543	544	538	80
4	619	651	644	94
-4	91	96	-94	-21
-6	570	570	566	70

K= 17 L= 2

H	FO	FC	AC	BC
1	337	286	284	36
-1	445	455	-450	-68
3	242	254	-252	-35
-3	37	75	-75	2
-5	91	45	44	10

K= 18 L= 2

H	FO	FC	AC	BC
-2	459	453	445	-87

K= 0 L= 3

H	FO	FC	AC	BC
0	1786	1558	1552	128
2	870	946	943	75
-2	310	344	344	-1
4	551	584	583	16
-4	1121	1238	1232	119
6	1286	1319	1312	141
-6	862	887	884	78
8	77	61	58	21
-8	547	545	544	10
10	428	410	408	48
-10	1106	1103	1096	127
-12	92	54	49	23
-14	412	371	370	36

K= 1 L= 3

H	FO	FC	AC	BC
1	1001	1044	-1041	-82
-1	157	120	119	15
3	243	233	226	56
-3	236	250	249	21
5	220	192	-189	-33
-5	526	567	-561	-81
7	75	80	-76	-44
-7	460	491	489	50
9	315	326	320	59
-9	522	524	-523	-26
-11	451	444	-442	-47
-13	485	467	464	52

K= 2 L= 3

H	FO	FC	AC	BC
0	1091	968	964	85
2	174	174	171	32
-2	223	214	-209	-44
4	70	137	-134	-26
-4	816	895	891	77
6	991	1048	1043	102
-6	445	449	447	37
8	116	108	-107	-15
-8	164	148	-145	-28
10	83	64	63	14
-10	714	707	702	90
-12	80	58	-57	-10
-14	88	151	151	6

K= 3 L= 3

H	FO	FC	AC	BC
1	122	68	-66	-18
-1	1258	1259	1257	78
3	1183	1191	1185	118
-3	908	1001	997	83
5	346	360	359	26
-5	293	341	-341	-20
7	133	116	116	12
-7	1168	1214	1209	108
9	777	804	797	111
-9	483	473	472	30
-11	64	31	31	5
-13	697	679	672	97

K= 4 L= 3

H	FO	FC	AC	BC
0	944	865	864	32
2	129	150	149	-19
-2	1403	1442	-1439	-96
4	885	926	-922	-76
-4	375	398	-397	24
6	208	236	230	52
-6	49	118	-118	-13
8	537	545	-542	-60
-8	470	488	-483	-75
10	224	197	-195	-27
-10	437	445	442	46
-12	346	362	-359	-50

K= 5 L= 3

H	FO	FC	AC	BC
1	103	118	-118	-3
-1	1487	1428	1425	93
3	1324	1269	1263	131
-3	1318	1400	1397	98
5	583	589	588	41
-5	116	164	-164	-5
7	269	255	253	25
-7	1144	1202	1196	120
9	891	892	884	122
-9	606	571	569	43
-11	133	121	120	17
-13	787	769	762	107

K= 6 L= 3

H	FO	FC	AC	BC
0	841	789	787	58
2	121	74	73	8
-2	733	718	-715	-66
4	517	529	-527	-48
-4	374	387	383	51
6	682	679	675	76
-6	268	207	207	14
8	227	236	-234	-35
-8	381	388	-385	-49
10	504	512	508	67
-12	102	130	-127	-27

K= 7 L= 3

H	FO	FC	AC	BC
1	618	564	-561	-58
-1	408	416	414	34
3	592	588	584	73
-3	366	359	357	39
5	78	46	-44	-13
-5	556	565	-562	-59
7	75	144	-141	-25
-7	628	664	661	65
9	439	436	430	72
-9	78	39	-39	-7
-11	246	273	-272	-29
-13	407	418	413	63

K= 8 L= 3

H	FO	FC	AC	BC
0	1148	1126	1120	112
2	663	614	611	63
-2	80	130	130	-8
4	314	313	313	8
-4	970	998	992	105
6	1067	1080	1073	125
-6	646	680	676	66
8	85	54	52	14
-8	264	257	257	3
-10	822	833	825	112
-12	109	66	64	16

K= 9 L= 3

H	FO	FC	AC	BC
1	1000	983	-979	-85
-1	81	37	-37	4
3	84	54	35	42
-3	151	197	197	10
5	190	183	-179	-39
-5	445	453	-445	-83
7	84	61	-36	-49
-7	239	221	218	36
-9	567	583	-582	-33
-11	449	408	-405	-51

K= 10 L= 3

H	FO	FC	AC	BC
0	847	831	826	96
2	405	358	355	48
-2	32	68	65	-20
4	168	175	175	-4
-4	774	774	769	89
6	867	870	863	109
-6	424	435	431	52
8	32	29	-29	3
-8	184	144	144	-8
-10	713	687	681	98

K= 11 L= 3

H	FO	FC	AC	BC
1	98	152	-147	-37
-1	489	493	490	48
3	604	608	602	83
-3	304	337	333	52
5	161	30	30	3
-5	313	279	-277	-38
7	110	14	11	-8
-7	694	692	687	76
-9	86	82	82	8
-11	90	79	-78	-13

K= 12 L= 3

H	FO	FC	AC	BC
0	406	418	416	38
2	108	8	-4	-7
-2	649	626	-622	-73
4	433	437	-434	-56
-4	80	72	-65	31
6	364	321	317	55
-6	147	34	-34	-1
-8	282	307	-302	-56
-10	297	331	327	48

K= 13 L= 3

H	FO	FC	AC	BC
1	85	42	-42	0
-1	843	843	839	82
3	806	802	794	114
-3	818	847	843	86
5	400	386	384	37
-5	141	50	-50	-2
-7	767	768	761	105
-9	359	360	358	39

K= 14 L= 3

H	FO	FC	AC	BC
0	444	441	440	34
2	88	71	70	-8
-2	664	677	-673	-72
4	484	492	-489	-55
-4	195	30	-12	27
-6	90	21	20	-3
-8	302	296	-291	-55

K= 15 L= 3

H	FO	FC	AC	BC
1	290	229	-227	-30
-1	423	417	415	46
3	519	533	528	77
-3	339	395	392	50
-5	328	288	-287	-31

H	FO	FC	AC	BC
-7	522	511	506	70
K= 16	L= 3			
0	519	548	543	76
2	182	222	219	37
-2	189	91	-89	-21
-4	513	498	493	71
K= 0	L= 4			
0	410	325	325	-3
2	783	828	820	116
-2	1583	1817	1813	11
4	419	482	477	69
-4	758	834	831	73
6	184	193	193	9
-6	110	100	-99	10
8	951	1012	1004	127
-8	1006	1027	1019	126
-10	348	305	304	22
-12	508	492	490	39
K= 1	L= 4			
1	70	31	26	17
-1	71	96	-94	18
3	513	529	-524	-77
-3	489	525	-519	-78
5	349	370	366	54
-5	581	597	595	50
7	251	221	-219	-27
-7	442	475	-474	-28
-9	395	382	-379	-45
-11	439	450	447	51
-13	453	424	-421	-55
K= 2	L= 4			
0	521	465	-463	-43
2	761	758	754	78
-2	716	790	786	76
4	407	422	421	32
-4	425	440	439	34
6	152	192	-190	-27
-6	251	212	-210	-27
8	562	582	575	93
-8	785	787	781	90
-10	136	34	-33	-11
-12	46	61	60	8
K= 3	L= 4			
1	786	724	720	75
-1	783	750	746	77
3	93	43	38	-20
-3	169	119	-117	-20
5	959	975	969	108
-5	974	1034	1029	106
7	83	133	131	24
-7	382	387	386	27
-9	200	198	198	7
-11	706	711	704	98
-13	97	99	-98	-11
K= 4	L= 4			
0	984	896	-891	-91
2	444	413	412	30
-2	174	206	204	27
4	182	183	-183	-15
-4	79	58	-57	-14
6	709	746	-743	-71
-6	811	860	-856	-73
8	314	355	351	51
-8	280	265	261	45
-10	171	189	-182	-51
-12	225	223	-221	-30
K= 5	L= 4			
1	889	813	808	88
-1	844	778	773	90
3	329	278	278	-5
-3	74	111	-111	-5
5	1185	1189	1183	120
-5	1089	1171	1165	118
7	164	155	151	36
-7	710	725	724	41
-9	341	314	314	20
-11	653	639	630	108
K= 6	L= 4			
0	698	686	-683	-64
2	594	621	619	54
-2	364	369	365	51
4	170	166	166	10
-4	220	234	234	12
6	428	438	-436	-46
-6	410	433	-430	-47
8	453	442	436	71
-8	481	490	486	67
-10	65	94	-90	-29
-12	66	91	-90	-9
K= 7	L= 4			
1	263	221	219	34
-1	343	339	337	36
3	478	424	-420	-56
-3	327	337	-332	-56
5	491	483	478	68
-5	520	513	509	65
7	87	63	-62	-10
-7	184	186	-185	-10
-9	84	159	-156	-27
-11	502	490	486	63
K= 8	L= 4			
0	202	103	102	-10
2	780	722	715	103
-2	1253	1226	1222	102
4	453	407	403	59
-4	634	630	627	62
6	126	89	89	3
-6	112	70	-70	3
8	802	812	804	112
-8	224	212	212	16
K= 9	L= 4			
1	80	62	-62	6
-1	280	232	-232	7
3	437	433	-426	-79
-3	569	529	-523	-80
5	266	250	247	41
-5	442	441	439	37
-7	357	400	-398	-34
-9	433	383	-380	-49
-11	312	277	275	40
K= 10	L= 4			
0	88	49	-44	-21
2	563	554	547	88
-2	929	920	916	87
4	334	350	347	46
-4	412	410	407	48
6	108	39	38	-8
-6	99	87	-87	-7
-8	695	708	702	97
-10	205	71	71	5
K= 11	L= 4			
1	369	355	351	47
-1	351	336	333	48
3	211	167	-163	-36
-3	90	152	-148	-36
5	465	469	463	77
-5	586	583	578	75
-7	166	47	-46	6
-9	28	13	-6	-11
K= 12	L= 4			
0	551	542	-538	-69
2	312	307	305	35
-2	204	202	199	33
4	93	18	18	-3
-4	84	7	-7	-3
-6	356	417	-413	-54
-8	322	309	305	48
K= 13	L= 4			
1	584	550	544	77
-1	530	482	476	79
3	232	211	211	-2
-3	91	57	-57	-2
-5	810	801	794	103
-7	493	483	482	37
K= 14	L= 4			
0	482	500	-496	-68
2	326	293	291	31
-2	83	160	158	29
-4	22	44	43	-5
-6	445	441	-438	-53
K= 15	L= 4			
-1	358	362	359	46
-3	226	163	-160	-30
K= 0	L= 5			
0	1235	1097	1092	109
2	78	60	-59	-7
-2	595	602	598	65
4	575	602	593	103
-4	138	235	235	10
6	578	610	607	63
-6	1170	1196	1190	122
-8	69	52	48	19
-10	270	238	235	40
-12	856	848	843	96
K= 1	L= 5			
1	164	248	247	17
-1	517	521	-516	-73
3	149	155	153	20
-3	333	348	344	50
5	589	628	-623	-72
-5	365	398	-397	-28
-7	392	387	-385	-42
-9	435	455	452	50
-11	324	301	-295	-55
K= 2	L= 5			
0	887	766	762	73
2	217	208	-204	-41
-2	251	198	195	29
4	382	400	394	70
-4	199	238	-237	-25
6	176	213	211	31
-6	763	797	792	88
-8	79	74	-73	-13
-10	82	68	67	10
K= 3	L= 5			
1	747	686	683	69
-1	124	146	-145	-20
3	543	540	536	70
-3	711	758	751	101
5	132	97	-95	-22
-5	387	386	385	24
-7	158	211	211	8
-9	637	614	607	96
-11	85	49	-48	-12
K= 4	L= 5			
0	140	89	-85	28
2	796	741	-737	-84
-2	180	156	-155	-15
4	286	290	288	28
-4	318	330	-324	-67
-6	409	439	437	45
-8	451	469	-466	-53
-10	363	352	-351	-28
K= 5	L= 5			
1	1018	910	906	81
-1	136	6	2	-6
3	649	616	611	82
-3	679	685	676	112
5	117	60	-60	-10
-5	413	465	463	36
-7	365	388	387	20
-9	713	697	689	106
-11	86	45	45	-1
K= 6	L= 5			
0	361	343	339	51
2	414	383	-378	-59
-2	122	43	42	9
4	339	346	342	49
-4	288	293	-290	-44
-6	470	527	523	66
-8	149	198	-195	-30
-10	86	77	-76	-7
K= 7	L= 5			
1	321	296	294	32
-1	339	375	-371	-53
3	236	204	202	34
-3	475	437	432	63
-5	88	34	-32	-11
-7	218	160	-158	-25
-9	375	355	350	61
K= 8	L= 5			
0	951	854	849	96
2	94	47	-45	-12
-2	498	442	439	55
4	531	490	481	91
-4	203	108	108	4
-6	891	905	898	109
-8	106	51	50	13
K= 9	L= 5			
1	97	186	186	8
-1	479	447	-441	-75
3	155	86	85	10
-3	120	173	169	37
-5	459	461	-459	-34
-7	387	372	-369	-46
-9	409	386	384	39
K= 10	L= 5			
0	765	730	726	82
2	85	93	-90	-21
-2	320	276	273	43
-4	90	20	-19	-7
-6	786	777	771	95
-8	90	14	-14	3
K= 11	L= 5			
1	267	290	286	43
-1	229	236	-233	-35
-3	532	523	518	72
-5	92	89	89	4
-7	92	45	-44	-10
K= 12	L= 5			
-2	199	75	-75	-4
-4	317	279	-274	-50
K= 0	L= 6			
0	542	425	421	56
2	865	896	890	100
-2	47	75	-75	7
-4	766	790	781	114
-6	220	250	249	16
-8	428	457	456	40
K= 1	L= 6			
1	449	494	-489	-66
-1	452	498	496	49
-3	249	201	-199	-28
-5	463	468	-467	-38
-7	386	357	354	48
-9	258	250	-244	-54
K= 2	L= 6			
0	209	204	203	25
2	422	402	396	68
-2	159	56	-51	-23
-4	566	587	581	83
-6	215	124	-124	-14
-8	198	129	129	11
K= 3	L= 6			
1	161	137	-136	-20
-1	787	721	715	95
-3	280	256	255	19
-5	110	103	103	8
-7	611	610	603	91
-9	145	52	-50	-13
K= 4	L= 6			
0	287	194	-193	-14
2	225	52	43	29
-2	448	382	-377	-61
-4	184	224	219	44
-6	343	319	-315	-51
-8	82	54	-49	-24
K= 5	L= 6			
1	90	62	-62	-8
-1	906	812	805	105
-3	460	433	432	31
-5	245	219	218	19
-7	561	546	536	100
K= 6	L= 6			
0	158	33	32	6
-2	182	132	-126	-40
-4	408	376	371	63
-6	238	233	-231	-31
K= 7	L= 6			
-1	487	423	419	61
-3	68	93	-92	-12
-5	127	192	-191	-22
K= 8	L= 6			
-2	93	16	-16	2
-4	682	634	626	102