reflexions predicted for the L-Ta_2O_5 structure are 080, 0,14,0, 0,30,0 *etc.* In α-UO_3 on the other hand the reflexions with observable intensity in the electron diffraction patterns are 090, 0,13,0, 0,31,0 *etc.* However, slight alteration in the y coordinates of some of the metal atoms is sufficient to effect this change in intensities. The neutron diffraction pattern for α-UO_3 was also calculated assuming the atom positions in L-Ta_2O_5 (except for the proportion of oxygen atoms displaced in the z direction because of the presence of uranium vacancies) but with occupation parameters modified to allow for the missing uranium atoms and in accordance with one distortion plane per unit cell. The correlation was rather poor $R(I)=0{\cdot}17$ but relaxation of uranium atoms in the [100] direction to correspond more closely to an ideal hexagonal arrangement reduced the R index to 0·09. A full refinement of such a large cell is impracticable from powder data but the indications from both the neutron and the electron diffraction experiments are that in α-UO_3 the position of the metal atoms approximate more closely to hexagonal symmetry than in L-Ta_2O_5.

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The Crystal Structure of Hanksite, $KNa_{22}[Cl(CO_3)_2(SO_4)_9]$ and its Relation to the K_2SO_4 I Structure Type

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The crystal structure of hanksite, $KNa_{22}[Cl(CO_3)_2(SO_4)_9]$, has been determined by three-dimensional X-ray analysis and refined by least-squares methods, using anisotropic thermal parameters; final $R=0{\cdot}034$. The crystals are hexagonal ($P6_3/m$): $a=10{\cdot}490$, $c=21{\cdot}240$ Å, $Z=2$. The structure exhibits an ordered distribution of both SO_4 tetrahedra and CO_3 groups. The results of heating experiments are presented and similarities to a hexagonal phase of the solid solution series Ca_2SiO_4–$Ca_3(PO_4)_2$ with respect to the K_2SO_4 I structure type are discussed.

Introduction

The mineral hanksite, $KNa_{22}[Cl(CO_3)_2(SO_4)_9]$, belongs to the sulphates containing CO_3 groups. Ramsdall (1939) found hexagonal symmetry with the unit-cell dimensions $a=10{\cdot}46$ Å, $c=21{\cdot}18$ Å. $P6_3$ and $P6_3/m$ are proposed as possible space groups. A structure determination has, however, not been attempted. Furthermore Ramsdell (1939) found that the diffraction pattern of the high-temperature hexagonal Na_2SO_4–Na_2CO_3 series resembles the hanksite pattern. Additional reflexions indicate that the unit cell of hanksite has a c axis three times and an a axis twice the size of those of the Na_2SO_4–Na_2CO_3 series, or of Na_2SO_4 I. Eysel (1971) believes that hanksite is a variety of the hexagonal K_2SO_4 I structure type (high-temperature form, space group $P6_3mc$) with non-identical unit cell. A unit cell similar to that of hanksite with corresponding cell dimensions has been detected (Saalfeld, 1971) in the solid solution series Ca_2SiO_4–$Ca_3(PO_4)_2$. In order to get further information on the crystallographic relations of these compounds the structure determination of hanksite was carried out. Kato (1972) has recently published preliminary results of this investigation.

Experimental

A crystal sphere (∅ = 0·2 mm), ground from a hanksite sample from Searles Lake, San Bernardino County, California, was used for the determination of the lattice constants and the intensity measurements. The following unit-cell parameters were obtained by a least-squares adjustment of high angle Cu $K\alpha$ reflexions: $a = 10{\cdot}490 \pm 0{\cdot}001$, $c = 21{\cdot}240 \pm 0{\cdot}001$ Å. There are two formula weights per unit cell. The intensity measurements of 1535 reflexions were carried out on an automated Siemens diffractometer with Cu $K\alpha$ radiation. Corrections for absorption ($\mu R = 1{\cdot}07$) and extinction were applied. The $N(z)$ test (Howells, Phillips & Rogers, 1950) suggested the space group $P6_3/m$.

Heating experiments show that hanksite decomposes above 700 °C forming hexagonal solid-solution crystals, Na_2SO_4 V and NaCl. The hexagonal phase has the lattice parameters $a = 5{\cdot}340$, $c = 7{\cdot}110$ Å (space group $P6_3mc$) and is identical with the K_2SO_4 I type.

Structure determination and refinement of hanksite

On the basis of the chemical composition and the space group symmetry a model of the structure was proposed. The orientation of the SO_4 tetrahedra and CO_3 groups was found by the 'refinement of rigid-body groups' (Scheringer, 1965). After some cycles of least-squares refinement (Busing, Martin & Levy 1962) with anisotropic thermal parameters and isotropic extinction corrections (Zachariasen, 1967, 1968) all atoms could be located. The R index was reduced to 0·034. The scattering factors for the atoms were taken from Hanson, Herman, Lea & Skillman (1964). The atomic parameters are listed in Table 1, the anisotropic thermal parameters in Table 2 and the observed and calculated structure factors in Table 3.

Table 1. *Final positional parameters* (× 10^5)

The standard deviations are given in parentheses in units of the last decimal place.

	Position	x	y	z
Na(1)	12(*i*)	17859 (10)	36108 (9)	7435 (4)
Na(2)	12(*i*)	47753 (10)	−5305 (10)	16093 (3)
Na(3)	6(*h*)	34702 (14)	14658 (13)	$\frac{1}{4}$*
Na(4)	6(*g*)	$\frac{1}{2}$*	0	0
Na(5)	4(*f*)	$\frac{2}{3}$*	$\frac{1}{3}$*	12453 (6)
Na(6)	4(*e*)	0	0	17343 (6)
K	2(*b*)	0	0	0
C	4(*f*)	$\frac{1}{3}$*	$\frac{2}{3}$*	6968 (11)
O(1)	12(*i*)	38952 (18)	11372 (17)	14331 (6)
O(2)	12(*i*)	32254 (16)	7997 (16)	3420 (6)
O(3)	12(*i*)	44832 (16)	32454 (15)	8017 (6)
O(4)	12(*i*)	19578 (15)	15492 (16)	10588 (6)
O(5)	12(*i*)	19815 (18)	42962 (18)	19287 (6)
O(6)	12(*i*)	40396 (15)	80833 (14)	6986 (5)
O(7)	6(*h*)	9206 (22)	19996 (21)	$\frac{1}{4}$*
O(8)	6(*h*)	35549 (23)	36790 (23)	$\frac{1}{4}$*
S(1)	12(*i*)	33868 (5)	16841 (5)	9082 (2)
S(2)	6(*h*)	20856 (7)	35652 (8)	$\frac{1}{4}$*
Cl	2(*d*)	$\frac{2}{3}$*	$\frac{1}{3}$	$\frac{1}{4}$*

* These values are not × 10^5.

Table 2. *Anisotropic thermal parameters* (× 10^4)

Temperature factors are of the form $\exp\,[-(h^2\beta_{11}\ldots 2kl\beta_{23})]$. Standard deviations are equal to or smaller than ±0·0003.

	β_{11}	β_{22}	β_{33}	β_{12}	β_{13}	β_{23}
Na(1)	56	40	16	22	−3	−1
Na(2)	61	67	10	38	−3	−3
Na(3)	88	57	10	35	0	0
Na(4)	50	47	8	20	0	3
Na(5)	55	55	14	28	0	0
Na(6)	54	54	9	27	0	0
K	55	55	8	27	0	0
C	39	39	4	20	0	0
O(1)	90	71	10	54	−1	5
O(2)	74	59	10	35	0	−6
O(3)	59	40	13	13	−1	4
O(4)	49	68	14	35	6	4
O(5)	77	72	15	35	−7	10
O(6)	46	31	10	15	1	1
O(7)	56	41	11	11	0	0
O(8)	60	68	12	36	0	0
S(1)	33	26	6	15	1	1
S(2)	33	30	8	16	0	0
Cl	80	80	11	40	0	0

Discussion

The structure of hanksite (Fig. 1) consists of isolated SO_4 tetrahedra, 12 of which are located in general position with a strong tilt with regard to the sixfold axis. The remaining six tetrahedra lie in the basal mirror planes at $z = \frac{1}{4}$ and $z = \frac{3}{4}$. The CO_3-group positions are threefold. The atomic distances and bond angles of the anionic groups are listed in Table 4. The SO_4 tetrahedra are not regular but somewhat distorted. Baur (1964) and Larson (1965) have tabulated the S–O distances and bond angles of different sulphate structures. The variation interval for the S–O distances and O–S–O angles of the hanksite tetrahedra is very narrow and agrees well with values mentioned in the literature. The Cl ions are in special positions with point symmetry $\bar{6}$. The distances from a Cl ion to the next two Na(5) and three Na(3) are 2·665 and 2·918 Å respectively. The K ions are surrounded by six nearest oxygen neighbours at a distance of 2·929 Å and six other oxygens at a distance of 3·137 Å. The geometry about the Na ions is distorted octahedral with Na–O distances ranging from 2·288 to 2·687 Å. Only Na(3) has four nearest oxygen neighbours in tetrahedral arrangement with an average distance of 2·537 Å.

Table 3. *Observed and calculated structure factors*

		F_o	F_c
H	K	L = 0	
1	1	36	32
1	2	35	32
1	3	39	39
1	4	54	52
1	5	133	135
1	6	28	29
1	7	23	13
1	8	42	42
1	9	15	17
1	10	13	17
2	0	113	110
2	1	174	165
2	2	373	369
2	3	31	30
2	4	162	155
2	5	17	6
2	6	20	14
2	7	40	37
2	8	173	169
2	9	7	4
2	10	10	9
3	0	34	33
3	1	155	160
3	2	101	100
3	3	58	61
3	4	43	44
3	5	24	25
3	6	34	33
3	7	74	72
3	8	20	16
3	9	34	34
4	0	113	111
4	1	40	34
4	2	44	42
4	3	131	123
4	4	272	273
4	5	63	67
4	6	59	59
4	7	46	44
4	8	51	49
5	0	169	165
5	1	13	16
5	2	15	5
5	3	101	99
5	4	103	103
5	5	108	106
5	6	38	36
5	7	19	16
6	0	306	293
6	1	12	11
6	2	33	36
6	3	11	5
6	4	64	64
6	5	93	90
6	6	154	145
7	0	10	0
7	1	11	4
7	2	53	43
7	3	75	76
7	4	34	35
7	5	52	49
8	0	48	46
8	1	117	115
8	2	163	165
8	3	5	1
8	4	13	17
9	0	14	14
9	1	12	6
9	2	30	27
9	3	45	42
10	0	19	18
10	1	7	6
10	2	12	2
11	0	55	54
H	K	L = 1	
1	0	8	6
1	1	27	28
1	2	34	33
1	3	145	144
1	4	45	44
1	5	131	133
1	6	11	8
1	7	23	24
1	8	57	55
1	9	9	8
1	10	4	1
2	0	6	5
2	1	98	96
2	2	16	14
2	3	70	70
2	4	21	19
2	5	7	0
2	6	7	4
2	6	3	4
2	7	67	67
2	8	28	25
2	9	6	1
2	10	40	37
3	0	25	24
3	1	13	14
3	2	31	33
3	3	26	24
3	4	40	33
3	5	54	54
3	6	6	3
3	7	5	5
3	8	49	47
3	9	7	9
4	0	93	91
4	1	34	34
4	2	13	4
4	3	54	54
4	4	10	8
4	5	22	20
4	6	3	3
4	7	10	9
4	8	8	12
5	0	122	125
5	1	92	92
5	2	39	39
5	3	79	79
5	4	13	13
5	5	15	17
5	6	50	50
5	7	9	6
6	0	39	39
6	1	12	13
6	2	6	0
6	3	24	19
6	4	50	51
6	5	8	9
6	6	18	13
7	0	24	23
7	1	65	66
7	2	100	101
7	3	14	12
7	4	29	27
7	5	13	13
8	0	60	57
8	1	37	36
8	2	29	26
8	3	5	2
8	4	16	17
9	0	5	9
9	1	41	41
9	2	27	29
9	3	11	9
10	0	8	5
10	1	22	23
10	2	16	22
11	0	46	45
H	K	L = 2	
1	0	5	2
1	1	10	9
1	2	22	23
1	3	92	93
1	4	40	41
1	5	49	49
1	6	17	17
1	7	30	30
1	8	30	33
1	9	25	25
1	10	40	40
2	0	33	32
2	1	69	69
2	2	28	28
2	3	6	3
2	4	65	69
2	5	30	29
2	6	29	31
2	7	23	24
2	8	62	62
2	9	4	1
3	0	6	5
3	1	93	88
3	2	28	27
3	3	134	133
3	4	44	44
3	5	9	4
3	6	51	49
3	7	64	64
3	8	10	7
3	9	7	3
4	0	26	26
4	1	7	4
4	1	3	4
4	2	19	13
4	3	47	46
4	4	52	53
4	5	18	15
4	6	20	13
4	7	8	5
4	8	13	16
5	0	8	7
5	1	10	12
5	2	36	38
5	3	74	74
5	4	12	10
5	5	30	32
5	6	64	62
5	7	13	14
6	0	63	63
6	1	52	54
6	2	34	33
6	3	16	11
6	4	12	9
6	5	6	3
6	6	44	44
7	0	34	34
7	1	40	35
7	2	63	63
7	3	22	23
7	4	60	59
7	5	30	29
8	0	22	23
8	1	60	60
8	2	73	72
8	3	15	15
8	4	37	33
9	0	49	43
9	1	54	53
9	2	29	29
9	3	7	5
10	0	32	31
10	1	14	13
11	0	14	14
H	K	L = 3	
1	0	39	35
1	1	33	34
1	2	16	16
1	3	27	27
1	4	39	39
1	5	23	31
1	6	39	39
1	7	6	4
1	8	36	37
1	9	42	41
1	10	11	9
2	0	242	219
2	1	37	36
2	2	144	140
2	3	9	3
2	4	47	44
2	5	19	17
2	6	52	51
2	7	14	14
2	8	19	20
2	9	4	0
3	0	9	7
3	1	60	60
3	2	19	17
3	3	95	96
3	4	13	13
3	5	17	14
3	6	23	22
3	7	7	3
3	8	5	2
3	9	24	22
4	0	115	101
4	1	15	14
4	2	35	34
4	3	13	13
4	4	10	4
4	5	21	23
4	6	65	64
4	7	6	7
4	8	62	60
5	0	32	31
5	1	61	61
5	2	15	17
5	3	15	14
5	4	27	27
5	5	15	16
5	6	15	11
5	7	16	12
6	0	57	54
6	1	66	66
6	2	103	103
6	3	14	1
6	4	79	78
6	5	29	26
6	6	10	4
7	0	26	29
7	1	6	2
7	2	20	19
7	3	14	14
7	4	7	6
7	5	9	1
8	0	56	54
8	1	51	50
8	2	13	12
8	3	15	19
8	4	33	33
9	0	54	55
9	1	42	43
9	2	16	16
9	3	14	12
10	0	27	29
10	1	21	21
11	0	22	20
H	K	L = 4	
0	0	76	75
1	0	38	37
1	1	21	19
1	2	11	12
1	3	55	56
1	4	82	80
1	5	[illegible]	[illegible]
1	6	10	7
1	7	65	67
1	8	33	33
1	9	17	17
1	10	37	34
2	0	34	34
2	1	63	64
2	2	21	19
2	3	9	4
2	4	25	25
2	5	39	40
2	6	65	65
2	7	16	16
2	8	18	17
2	9	9	7
3	0	79	79
3	1	70	72
3	2	75	75
3	3	27	27
3	4	8	8
3	5	64	65
3	6	46	47
3	7	23	24
3	8	26	26
3	9	42	42
4	0	69	69
4	1	19	18
4	2	47	46
4	3	60	61
4	4	27	27
4	5	18	18
4	6	89	90
4	7	21	21
4	8	44	45
5	0	11	12
5	1	58	61
5	2	65	67
5	3	67	69
5	4	17	17
5	5	38	38
5	6	10	12
5	7	18	22
6	0	21	21
6	1	45	47
6	2	105	108
6	3	23	24
6	4	57	57
6	5	23	23
6	6	32	33
7	0	36	37
7	1	20	19
7	2	40	40
7	3	35	35
7	4	45	46
7	5	12	11
8	0	95	96
8	1	56	53
8	2	34	34
8	3	9	9
8	4	30	29
9	0	66	66
9	1	16	14
9	2	8	6
9	3	8	1
10	0	43	42
10	1	19	17
11	0	13	13
H	K	L = 5	
1	0	59	58
1	1	69	66
1	2	5	7
1	3	17	17
1	4	142	143
1	5	39	40
1	6	28	27
1	7	54	55
1	8	7	6
1	9	25	25
1	10	13	14
2	0	18	17
2	1	132	130
2	2	8	1
2	2	3	1
2	3	24	22
2	4	7	3
2	5	76	75
2	6	30	30
2	7	65	65
2	8	5	4
2	9	15	11
3	0	41	43
3	1	49	48
3	2	88	89
3	3	49	43
3	4	38	39
3	5	27	27
3	6	31	32
3	7	23	22
3	8	28	27
3	9	16	18
4	0	10	12
4	1	113	121
4	2	50	51
4	3	56	55
4	4	27	26
4	5	15	13
4	6	6	4
4	7	22	21
4	8	22	19
5	0	67	67
5	1	45	45
5	2	89	90
5	3	47	48
5	4	11	9
5	5	19	19
5	6	9	4
5	7	19	20
6	0	26	27
6	1	41	41
6	2	56	57
6	3	55	55
6	4	13	11
6	5	19	16
6	6	9	9
7	0	13	14
7	1	8	6
7	2	17	15
7	3	27	30
7	4	35	35
7	5	4	9
8	0	41	42
8	1	39	39
8	2	6	2
8	3	19	21
8	4	22	23
9	0	70	69
9	1	17	16
9	2	6	0
9	3	11	11
10	0	51	52
10	1	11	12
H	K	L = 6	
0	0	298	283
1	0	24	24
1	1	70	73
1	2	58	56
1	3	40	42
1	4	69	70
1	5	60	61
1	6	30	32
1	7	140	142
1	8	6	0
1	9	84	84
1	10	6	3
2	0	297	296
2	1	54	47
2	2	87	91
2	3	23	23
2	4	175	179
2	5	44	42
2	6	128	127
2	7	77	75
2	8	59	59
2	9	30	29
3	0	34	35
3	1	10	9
3	2	14	10
3	3	110	111
3	4	41	39
3	5	34	34
3	6	15	15
3	7	10	6
3	8	22	26
3	9	55	55
4	0	314	313
4	1	107	112
4	2	223	231
4	3	121	125
4	4	156	157
4	5	122	124
4	6	131	133
4	7	43	43
4	8	76	74
5	0	141	144
5	1	77	79
5	2	73	74
5	3	14	10
5	4	64	65
5	5	50	50
5	6	20	20
5	7	72	66
6	0	164	165
6	1	78	79
6	2	192	195
6	3	62	61
6	4	110	109
6	5	76	76
6	6	37	43
7	0	50	50
7	1	73	74
7	2	55	54
7	3	48	47
7	4	7	4
7	5	13	8
8	0	129	130
8	1	82	83
8	2	85	84
8	3	53	55
8	4	66	65
9	0	23	23
9	1	48	48
9	2	25	26
9	3	37	37
10	0	80	79
10	1	49	50
H	K	L = 7	
1	0	128	127
1	1	131	129
1	2	21	19
1	3	29	27
1	4	15	16
1	5	30	30
1	6	51	51
1	7	6	2
1	8	77	79
1	9	24	20
1	10	9	9
2	0	20	21
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1	7	24	24
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1	10	45	49
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2	3	10	6
2	4	27	27
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7	2	18	18
7	3	15	13
7	4	19	13
7	5	10	9
8	0	76	76
8	1	10	9
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10	0	30	33
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1	5	47	47
1	6	51	54
1	7	11	10
1	8	22	21
1	9	16	16
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2	2	10	7
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3	4	73	74
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6	2	39	39
6	3	17	16
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6	5	8	1
7	0	63	63
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7	2	53	54
7	3	32	32
7	4	12	13
8	0	31	31
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8	3	38	37
9	0	21	23
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9	2	21	19
10	0	8	5
H	K	L = 11	
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1	4	15	15
1	5	18	19
1	6	61	63
1	7	33	32
1	8	25	24
1	9	11	10
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2	1	66	67
2	2	33	34
2	3	63	63
2	4	33	32
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3	3	17	17
3	4	8	2
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3	7	22	22
3	8	9	8
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4	4	6	4
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4	7	36	37
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5	2	7	6
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5	5	5	5
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6	2	40	40
6	3	24	24
6	4	28	26
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7	1	20	18
7	2	47	46
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8	3	32	34
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9	1	26	24
10	0	20	19
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1	7	34	35
1	8	25	25
1	9	8	7
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H	K	L = 13	
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5	3	36	36
5	4	39	39
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6	5	13	14
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7	3	14	13
7	4	18	16
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8	2	11	12
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H	K	L = 14	
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1	1	19	18
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1	4	11	12
1	5	94	97
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1	7	33	33
1	8	40	40
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2	2	12	10
2	3	10	9
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2	8	8	9
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3	2	26	26
3	3	43	45
3	4	24	25
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4	2	86	86
4	3	18	18
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6	4	38	38
7	0	17	16
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H	K	L = 17	
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1	2	25	24
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6	2	23	30
6	3	22	23
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7	1	11	10
7	2	7	6
8	0	60	59
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4	3	56	57
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7	1	29	27
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1	4	9	8
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1	6	14	14
2	1	33	33
2	2	66	66
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2	5	22	21
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3	1	12	11
3	2	14	14
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4	2	7	6
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4	4	23	24
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7	0	13	12
H	K	L = 21	
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2	3	21	21
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4	2	29	29
5	0	14	13
5	1	21	21
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6	1	32	32
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2	0	8	8
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2	2	24	23
2	3	40	40
3	0	8	7
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3	2	37	37
3	3	30	30
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4	1	8	6
4	2	9	10
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6	0	37	37
H	K	L = 23	
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1	2	23	22
1	3	18	18
1	4	11	11
2	0	69	69
2	1	12	12
2	3	48	48
2	4	51	52
3	0	18	17
3	2	23	23
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4	1	21	21
4	2	60	60
5	0	25	25
H	K	L = 24	
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1	2	16	16
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2	0	15	14
2	1	12	13
2	2	115	114
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3	0	9	7
3	1	30	30
3	2	16	16
H	K	L = 25	
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2	0	20	20
2	1	22	23
3	0	16	15
H	K	L = 26	
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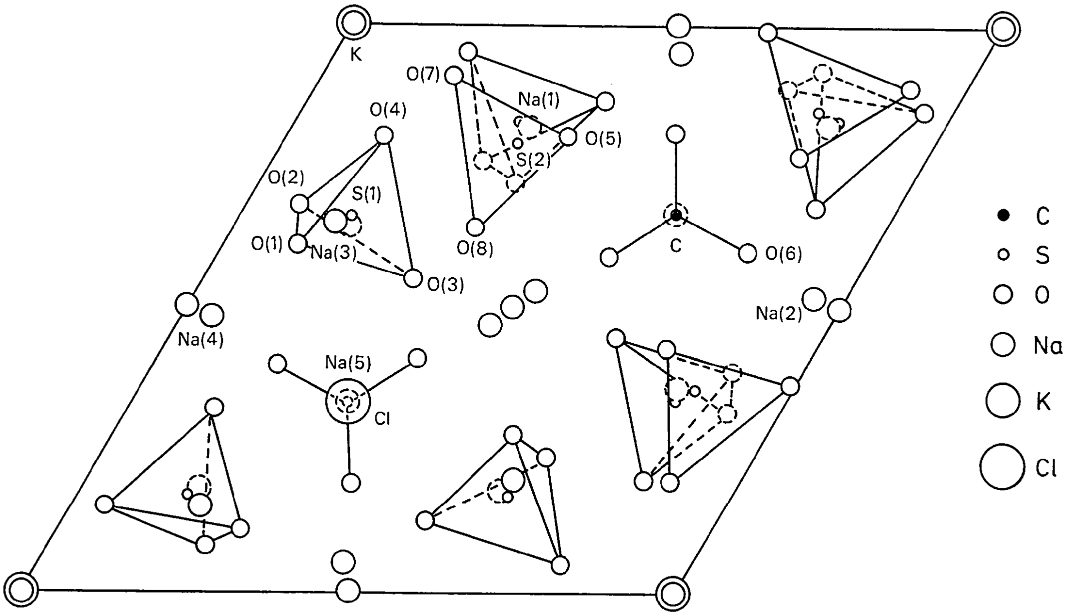

Fig. 1. Structure of hanksite (*c*-axis projection).

Table 4. *Interatomic distances and bond angles*

The standard deviations are equal to or smaller than ±0·0028 Å for the bond lengths and equal to or smaller than ±0·13° for the bond angles.

(*a*) Tetrahedral groups

S(1)–O(1)	1·470 Å	Range of 6 O–O	2·389–2·427 Å
S(1)–O(2)	1·476	Mean of 6 O–O	2·404
S(1)–O(3)	1·474	Range of 6 O–S–O	108·4–110·7°
S(1)–O(4)	1·469	Mean of 6 O–S–O	109·5
Mean of 4	1·472		
S(2)–O(5)	1·468 Å	Range of 6 O–O	2·384–2·427 Å
S(2)–O(5′)	1·468	Mean of 6 O–O	2·408
S(2)–O(7)	1·478	Range of 6 O–S–O	107·6–111·5°
S(2)–O(8)	1·485	Mean of 6 O–S–O	109·5
Mean of 4	1·475		

(*b*) Carbonate group

C–O(6)	1·287 Å

(*c*) Na–Cl distances

Na(3)–Cl	2·918 Å
Na(5)–Cl	2·665

(*d*) Cation–oxygen distances

K——O(4)	2·929 Å	Na(3)–O(1)	2·368 Å
K——O(2)	3·137	Na(3)–O(7)	2·994
Na(1)–O(4)	2·355	Na(3)–O(8)	2·279
Na(1)–O(5)	2·598	Na(3)–O(7′)	2·506
Na(1)–O(6)	2·397	Na(4)–O(2)	2·502
Na(1)–O(6′)	2·420	Na(4)–O(6)	2·288
Na(2)–O(1)	2·381	Na(5)–O(1)	2·687
Na(2)–O(6)	2·309	Na(5)–O(3)	2·435
		Na(6)–O(4)	2·362
		Na(6)–O(7)	2·440

The superstructure of low-temperature hanksite can be explained by ordered distribution of CO_3 groups, K and Cl ions and the arrangement of the tilted SO_4 tetrahedra. A similar type of ordering is found in the structure of a PO_4-containing phase of Ca_2SiO_4, where the high-temperature form is isostructural with K_2SO_4 I. The low temperature form shows a hexagonal superstructure with the space group $P6_1$. This superstructure ($a = 10·76$, $c = 21·73$ Å) which is comparable with hanksite, is caused by an ordered distribution of SiO_4 and PO_4 groups. The structure determination (Jarchow & Saalfeld, in preparation) revealed that as with hanksite the tetrahedra are tilted with respect to the sixfold axis. Other structural relationships, however, do not exist due to the difference in chemical composition and space group symmetry.

Eysel (1971) discusses the distribution of $[XO_4]$ tetrahedra and planar $[XO_3]$ groups in solid-solution series of compounds crystallizing in the K_2SO_4 I type. A statistical distribution should not affect magnitude and symmetry of the unit cell. By ordering of the atomic groups, however, new periodicities can occur in connexion with supercells and change in symmetry. Hanksite serves well to illustrate this possibility. In the low-temperature form all atoms occupy definite positions and a superstructure results. At high temperatures the decomposition product consists mainly of a hexagonal phase with unit-cell and space-group symmetry comparable with K_2SO_4 I. A statistical distribution of SO_4 and CO_3 groups must be assumed. As in K_2SO_4 I the SO_4 tetrahedra can no longer be tilted with regard to the *c* axis. A detailed structure determination is in preparation.

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