of the zinc and chlorine atoms. A three-dimensional Fourier synthesis using phases determined by these atoms then established the positions of the nitrogen and carbon atoms. Refinement of both positions and temperature factors proceeded by a few Fourier sections and several difference syntheses. A final over-all Reliability Index of 15·5 was obtained.* For special classes of reflections the indices were:

$h+l = 2n$;	$k = 2n$	14·9
$h+l = 2n$;	$k = 2n+1$	16·7
$h+l = 2n+1$;	$k = 2n$	15·8
$h+l = 2n+1$;	$k = 2n+1$	15·0

The structure exhibited a high temperature factor for the lighter elements and hydrogen atom contributions were not calculated. Atomic positions and individual isotropic temperature factors are listed in Table 1. All atoms are in positions 4*c* except Cl(2), C(3), and C(6), which are in 8*d*.

Table 1. *Atomic positional parameters and temperature factors for* $[N(CH_3)_4]_2ZnCl_4$

	x	*y*	*z*	*B*
Zn	0·2460	0·2500	0·4075	4·000
Cl_1	0·0630	0·2500	0·4070	7·400
Cl_2	0·3060	0·0445	0·3400	7·400
Cl_3	0·3130	0·2500	0·5418	8·300
N_1	0·1530	0·2500	0·0975	5·000
N_2	0·4945	0·2500	0·8240	5·500
C_1	0·2770	0·2500	0·0970	8·000
C_2	0·1085	0·2500	0·0020	8·500
C_3	0·1115	0·3910	0·1450	9·000
C_4	0·4405	0·2500	0·7345	8·500
C_5	0·4030	0·2500	0·8935	9·500
C_6	0·5660	0·3910	0·8340	9·000

Discussion

The refinement of the three-dimensional data yielded the expected tetrahedral configuration for the $ZnCl_4^{--}$ ion. Bond lengths and bond angles are given in Table 2.

Table 2. *Bond lengths and angles in* $[N(CH_3)_4]_2ZnCl_4$, *with standard deviations*

$Zn–Cl_1$	2·245±0·006 Å	$Cl_1–Zn–Cl_2$	109·1±0·22°
$Zn–Cl_2$	2·243±0·006	$Cl_1–Zn–Cl_3$	111·7±0·22
$Zn–Cl_3$	2·240±0·006	$Cl_2–Zn–Cl_3$	108·3±0·22
$N_1–C_1$	1·521±0·019	$Cl_2–Zn–Cl_2'$	110·4±0·22
$N_1–C_2$	1·579±0·019	$C_1–N_1–C_2$	109·9±0·97
$N_1–C_3$	1·549±0·019	$C_1–N_1–C_3$	109·3±0·97
$N_2–C_4$	1·539±0·019	$C_2–N_1–C_3$	109·4±0·97
$N_2–C_5$	1·557±0·019	$C_3–N_1–C_3'$	109·4±0·97
$N_2–C_6$	1·546±0·019	$C_4–N_2–C_5$	108·3±0·97
		$C_4–N_2–C_6$	109·6±0·97
		$C_5–N_2–C_6$	109·8±0·97
		$C_6–N_2–C_6'$	109·7±0·97

Shorter interionic distances:

Cl··· Cl	5·293, 5·523 Å
CH_3 ··· CH_3	3·515, 3·562
CH_3 ··· Cl	3·374, 3·509

This structure is very similar to that of Cs_2ZnCl_4 (Brehler, 1957) with the Cs^+ ions being replaced by $N(CH_3)_4^+$ ions and with each unit-cell edge expanded by a little over 20%.

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* The table of calculated and observed structure factors may be obtained from E. C. Lingafelter.

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Crystallographic evidence for the existence of B_7O*.

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Boron can combine with oxygen in different atomic proportions. In addition to the familiar B_2O_3, boron oxides containing less oxygen have been reported in the literature. The existence of the gaseous BO has been proven convincingly (Albrecht & Mallett, 1954), whereas the characterization of a suboxide B_3O (Kahlenberg, 1925) has been less than satisfactory. This note presents crystallographic evidence of the occurrence of the suboxide, B_7O.

In a preliminary study (Eding, 1956), the brown microcrystalline material which had been obtained from the American Potash & Chemical Corporation was found to contain only traces of nitrogen and magnesium, besides boron and oxygen; its analytical formula was $B_{6.6}O$. Its X-ray pattern did not agree with that of any of the known boron modifications or of boron oxide, or with any of their combinations. The material appeared to be homogeneous, because partial chemical dissolution did not change the X-ray pattern. These results could be reasonably explained by assuming that the sample was B_7O, contaminated by about 2% of B_2O_3. However, it could also be the suboxides $B_{13}O_2$ or B_6O contaminated with boron, or even a new modification of B containing amorphous B_2O_3.

To establish the identity of the material, a quantitative X-ray powder-study was undertaken. With Cu *Kα* radiation, forty-four fairly sharp lines were obtained, some of

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Table 1. *Observed and calculated spacings of* B_7O

Philips powder camera ($r = 5·74$ cm.) *Cu Kα* radiation

Line	Intensity*	$d_{\text{obs.}}$	$d_{\text{calc.}}$		*hkl*
1	*m*	4·343	4·349		101
2	*s*	4·114	4·102		200
3	*m*	3·715	3·704		011
4	*w*	2·679	2·677		020
5	*vs*	2·571	2·565		002
6	*vs*	2·284	2·280		121
7	*w*	2·251	2·242		220
8	*w*	2·178	2·175		202
9	*vw*	2·049	2·051		400
10	*w*	1·855	1·852		022
11	*vw*	1·737	1·744		130
12	*w*	1·691	1·688		222
13	*w*	1·649	1·651		131
14	*vw*	1·640	1·637		230
15	*s*	1·464	1·465		032
16	*m*	1·448	1·450		303
17	*s*	1·430	1·435		331
18	*vw*	1·403	1·400	1·399	313, 520
19	*m*	1·340	1·339		040
20	*m*	1·282	1·282		004
21	*vw*	1·274	1·272		240
22	*w*	1·261	1·267		104
23	*w*	1·244	1·247		014
26	*vw*	1·189	1·187		042
27	*w*	1·158	1·157		024
28	*w*	1·142	1·142	1·140	701, 242
29	*vw*	1·121	1·121		440
30	*vw*	1·090	1·087		404
31	*m*	1·026	1·025	1·027	800, 442
32	*m*	1·007	1·007	1·007	424, 810
33	*vvw*	0·9916	0·9903	0·9929	722, 514
34	*vvw*	0·9277	0·9259		044
35	*vw*	0·9098	0·9092		723
36	*w*	0·8917	0·8923		060
37	*m*	0·8776	0·8791	0·8794	061, 803
38	*w*	0·8691	0·8699		505
39	*vw*	0·8558	0·8550		006
40	*w*	0·8450	0·8440		444
41	*vvw*	0·8350	0·8368		206
42	*vw*	0·8253	0·8255		262
43	*vw*	0·8153	0·8160	0·8143	306, 026
44	*vw*	0·8068	0·8067		316

* *s* = strong, *m* = medium, *w* = weak, *v* = very.

which were back reflections, an indication of high degree of order in the structure. The observed reflections could be indexed on the basis of an orthorhombic unit cell. The dimensions, obtained by trial and error, are ($\lambda(\text{Cu } K\alpha) = 1·5418$ Å)

$$a = 8·20(4),\quad b = 5·35(4),\quad c = 5·13(0) \text{ Å} .$$

The density of the material, determined experimentally by flotation, is $d = 2·64(4)$ g.cm.$^{-3}$. The observed and the calculated spacings, given in Table 1 agree to better than 0·5%. The differences are within the limit of accuracy of the measurements. Thus, the X-ray pattern arises from one homogeneous phase only.

From the unit-cell dimensions and the density, the mass of one mole of unit-cells is calculated to be 358·8. Assuming 4 equivalent units per unit cell, which is reasonable for an orthorhombic cell, the equivalent weight for the structural unit is 89·7. This agrees satisfactorily with the theoretical formula weight of B_7O, 91·7, especially if one considers possible experimental errors. The experimental density is likely to be lower than the true density of a material, because of air inclusion in the grains of the samples, and thus the observed formula weight tends to be low also. Compound $B_{6·5}O$ (or $\frac{1}{2}\,B_{13}O_2$) would have the formula weight of 86·3, about 4% *smaller* than the observed value; therefore, the material studied is less likely to be this oxide. Thus, the existence of the boron suboxide B_7O appears to be established.

The structure of B_7O is probably closely related to that of elemental boron, in particular its tetragonal modification (Hoard *et al.*, 1958). This is indicated by the close similarity of the *c*-axes of the two structures (for tetragonal boron $c_0 = 5·06$ Å). The relative densities of B_7O and B also suggest this. Their ratio (2·64/2·31) is nearly equal to the mass ratio B_7O/B_7; the oxygen atoms are accommodated in the boron lattice without expanding it significantly. To establish the structure of B_7O unequivocally, single crystal data will be needed. Such work is not planned in this laboratory.

The author is indebted to the American Potash & Chemical Corporation, Los Angeles, for the sample of B_7O. Credit is due to Dr Dale Coulson and Dr Harold Eding for the analytical and the preliminary X-ray studies, and to Mrs H. Johnson for the experimental measurements.

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Book Reviews

Works intended for notice in this column should be sent direct to the Editor (P. P. Ewald, Polytechnic Institute of Brooklyn, 333, Jay Street, Brooklyn 1, N.Y., U.S.A.). As far as practicable books will be reviewed in a country different from that of publication.

Kompendium der Kristallkunde. By W. F. de Jong. Pp. viii + 258, with 227 figs. and 41 tables. Vienna: Springer. 1959. Price S. 264, DM. 44, $10·50. 75*s*.

This work is a translation into German of the author's *Compendium der Kristalkunde* already reviewed in this journal (*Acta Cryst.* (1952), **5**, 858). A few diagrams have been added, a few have been redrawn, and some material has been rearranged and slightly expanded, but in the main the translation follows the original very closely and therefore shares its merits and shortcomings. Among the merits is to be reckoned the ambitious coverage, ranging over morphological crystallography, structure analysis, crystal chemistry, and solid-state physics; among the inevitable shortcomings is the extremely superficial treatment which most of these topics receive. Thus piezoelectricity, the classical tensor theory of elasticity,