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Bis(cyclohexylammonium) tetrachlorido-oxalato-stannate(IV)

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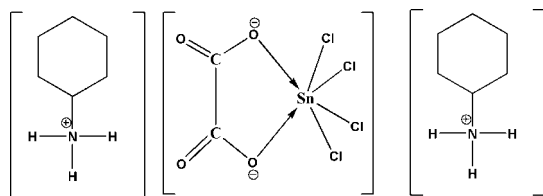
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Key indicators: single-crystal X-ray study; $T = 115$ K; mean $\sigma(\text{C}-\text{C}) = 0.006$ Å; R factor = 0.035; wR factor = 0.083; data-to-parameter ratio = 21.8.

The title salt, $(\text{C}_6\text{H}_{14}\text{N})_2[\text{Sn}(\text{C}_2\text{O}_4)\text{Cl}_4]$, was obtained as a by-product from the reaction between $2\text{C}_6\text{H}_{14}\text{N}^+ \cdot \text{C}_2\text{O}_4^{2-} \cdot 1.5\text{H}_2\text{O}$ and $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$. The cyclohexylammonium cation has a chair conformation. The complex anion consists of an oxalate anion chelating the SnCl_4 moiety, resulting in a distorted octahedral coordination sphere of the Sn^{IV} atom with the O atoms in equatorial *cis* positions. In the crystal, cations and anions are linked through $\text{N}-\text{H} \cdots \text{O}$ and $\text{N}-\text{H} \cdots \text{Cl}$ interactions into a layered arrangement parallel to (100).

Related literature

For applications of organotin(IV) compounds, see: Evans & Karpel (1985). For background to organotin(IV) chemistry, see: Ballmann *et al.* (2009); Meriem *et al.* (1989); Ng & Kumar Das (1997); Yin & Wang (2004); Zhang *et al.* (2006). For background to halogenidotin(IV) chemistry, see: Sarr & Diop (1990); Qamar-Kane & Diop (2010); Willey *et al.* (1998); Diallo *et al.* (2009). For related crystal structures with an oxalato-tin(IV) moiety, see: Skapski *et al.* (1974); Gueye *et al.* (2012); Sow *et al.* (2010, 2013).



Experimental

Crystal data

 $(\text{C}_6\text{H}_{14}\text{N})_2[\text{Sn}(\text{C}_2\text{O}_4)\text{Cl}_4]$
 $M_r = 548.87$
 Monoclinic, $P2_1/c$
 $a = 11.2293$ (9) Å

 $b = 15.715$ (1) Å
 $c = 12.8464$ (10) Å
 $\beta = 93.238$ (2)°
 $V = 2263.4$ (3) Å³
 $Z = 4$
 Mo $K\alpha$ radiation
 $\mu = 1.62$ mm⁻¹
 $T = 115$ K
 $0.17 \times 0.08 \times 0.03$ mm

Data collection

 Nonius KappaCCD diffractometer
 Absorption correction: multi-scan
 (Blessing, 1995)
 $T_{\text{min}} = 0.770$, $T_{\text{max}} = 0.953$

 9402 measured reflections
 4979 independent reflections
 4503 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.025$

Refinement

 $R[F^2 > 2\sigma(F^2)] = 0.035$
 $wR(F^2) = 0.083$
 $S = 1.12$
 4979 reflections

 228 parameters
 H-atom parameters constrained
 $\Delta\rho_{\text{max}} = 1.03$ e Å⁻³
 $\Delta\rho_{\text{min}} = -0.99$ e Å⁻³

Table 1

Selected bond lengths (Å).

Sn1—O2	2.121 (2)	Sn1—Cl2	2.3667 (9)
Sn1—O1	2.155 (2)	Sn1—Cl1	2.3794 (9)
Sn1—Cl3	2.3547 (9)	Sn1—Cl4	2.4407 (8)

Table 2

Hydrogen-bond geometry (Å, °).

$D-\text{H} \cdots A$	$D-\text{H}$	$\text{H} \cdots A$	$D \cdots A$	$D-\text{H} \cdots A$
N1—H1A \cdots O4	0.89	1.97	2.853 (3)	169
N1—H1B \cdots O1 ⁱ	0.89	2.18	3.038 (4)	163
N1—H1C \cdots O3 ⁱⁱ	0.89	2.01	2.875 (4)	162
N2—H2A \cdots O4	0.89	2.25	2.887 (4)	129
N2—H2A \cdots Cl4 ⁱ	0.89	2.78	3.315 (3)	120
N2—H2B \cdots Cl4 ⁱⁱⁱ	0.89	2.38	3.262 (3)	169
N2—H2C \cdots O3	0.89	2.02	2.869 (4)	158

Symmetry codes: (i) $-x + 1, y - \frac{1}{2}, -z + \frac{1}{2}$; (ii) $x, -y + \frac{3}{2}, z - \frac{1}{2}$; (iii) $x, -y + \frac{3}{2}, z + \frac{1}{2}$.

Data collection: COLLECT (Nonius, 1998); cell refinement: DENZO-SMN (Otwinowski & Minor, 1997); data reduction: DENZO-SMN; program(s) used to solve structure: SIR92 (Altomare *et al.*, 1993); program(s) used to refine structure: SHELXL97 (Sheldrick, 2008); molecular graphics: ORTEP-3 for Windows (Farrugia, 2012) and Mercury (Macrae *et al.*, 2006); software used to prepare material for publication: WinGX (Farrugia, 2012).

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: WM2756).

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supporting information

Acta Cryst. (2013). E69, m473–m474 [doi:10.1107/S1600536813019284]

Bis(cyclohexylammonium) tetrachlorido(oxalato)stannate(IV)

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S1. Comment

Various applications of organotin(IV) compounds exist in many fields, e.g. related to agriculture, medicine, anti-fouling paints and wood preservatives (Evans & Karpel, 1985). Therefore new organotin compounds have been the research subject of many groups (Ballmann *et al.*, 2009; Meriem *et al.*, 1989; Ng & Kumar Das, 1997; Zhang *et al.*, 2006). Our group has previously reported several halogenidotin(IV) derivatives (Diallo *et al.*, 2009; Qamar-Kane & Diop, 2010). In this work, we report the results of the reaction between $(C_6H_{14}N)_2(C_2O_4) \cdot 1.5H_2O$ with $SnCl_2 \cdot 2H_2O$ leading to the formation of the title compound, $(C_6H_{14}N)_2[Sn(C_2O_4)Cl_4]$, (I).

The asymmetric unit of (I) consists of an oxalate anion chelating a $SnCl_4$ moiety (Fig. 1). The C—O distances in the oxalate anion [C1—O3 = 1.227 (4)  ; C2—O4 = 1.217 (4)  ; C1—O1 = 1.286 (4)  ; C2—O2 = 1.290 (4)  ] indicate double and single bonds, respectively. The Sn—O distances [Sn1—O1 = 2.155 (2)  ; Sn1—O2 = 2.121 (2)  ] and the Sn—Cl distances [Sn1—Cl1 = 2.3794 (9)  ; Sn1—Cl2 = 2.3667 (9)  , Sn1—Cl3 = 2.3547 (9)   and Sn1—Cl4 = 2.4407 (8)  ] (Table 1) are in good agreement with those of previously reported Sn—O and Sn—Cl bonds of related compounds (Willey *et al.*, 1998; Skapski *et al.*, 1974; Sow *et al.*, 2010, 2013). The coordination sphere around the Sn^{IV} atom can be described as a slightly distorted octahedron with the O atoms of the oxalate ligand occupying equatorial *cis*-positions. The greatest deviation from the ideal octahedral geometry is manifested in the contraction of the Cl2—Sn1—Cl4 angle to 171.25 (3)  .

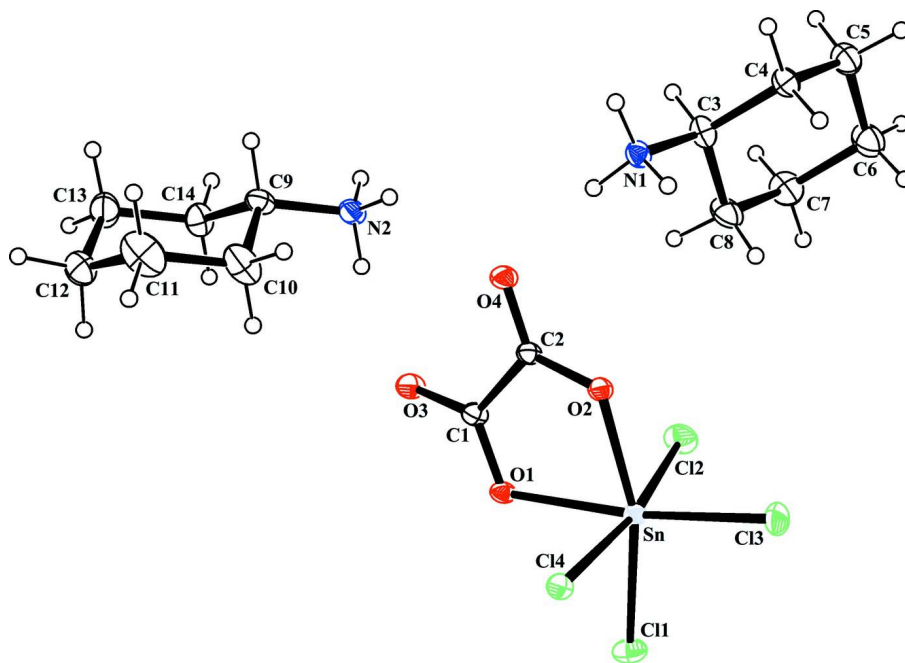
The stannate(IV) anion interacts with the two distinct cyclohexylammonium cations (both with chair conformation) through N—H   O and N—H   Cl hydrogen bonds (Table 2), leading to a two-dimensional network extending parallel to (100) (Fig. 2).

S2. Experimental

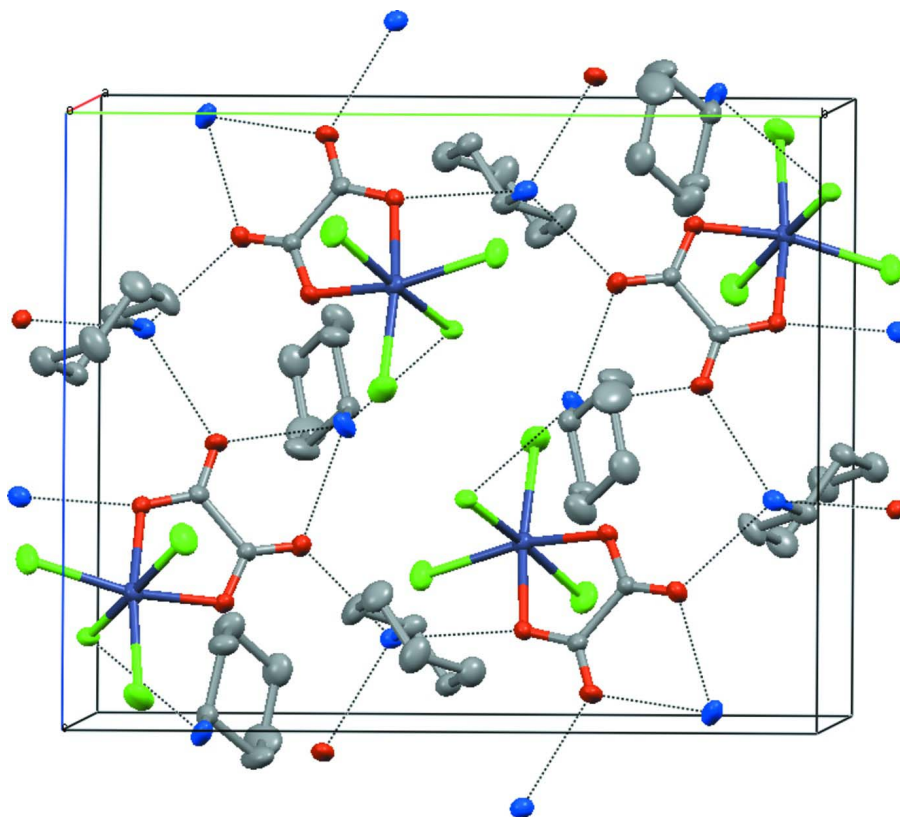
Chemicals were purchased from Sigma-Aldrich, and used without further purification. The title compound was obtained by reacting $(C_6H_{14}N)_2(C_2O_4) \cdot 1.5H_2O$ (0.09 g, 0.286 mmol) with $SnCl_2 \cdot 2H_2O$ (0.20 g, 0.890 mmol) in 25 ml of ethanol (96%). After slow solvent evaporation of the solvent at room temperature, colourless crystals suitable for X-ray diffraction analysis were obtained.

S3. Refinement

All H atoms, on carbon and nitrogen atoms, were placed at calculated positions using a riding model with C—H = 0.97   (methylene) or 0.98   (methine) and N—H = 0.89   with $U_{iso}(H) = 1.2U_{eq}(C)$ and $U_{iso}(H) = 1.5U_{eq}(N)$.

**Figure 1**

A view of the molecular entities of compound (I) with atom labelling. Displacement ellipsoids are drawn at the 30% probability level.

**Figure 2**

The crystal packing of compound (I) viewed approximately along [100]. Hydrogen atoms are omitted for clarity. Intermolecular hydrogen-bonding interactions of the types N—H...O and O—H...O are shown by dotted lines. Displacement ellipsoids are drawn at the 30% probability level. Colour code: Sn dark grey, O red, N blue, Cl green, C grey.

Bis(cyclohexylammonium) tetrachlorido(oxalato)stannate(IV)

Crystal data

$(C_6H_{14}N)_2[Sn(C_2O_4)Cl_4]$

$M_r = 548.87$

Monoclinic, $P2_1/c$

Hall symbol: $-P\ 2_1/c$

$a = 11.2293\ (9)\ \text{\AA}$

$b = 15.715\ (1)\ \text{\AA}$

$c = 12.8464\ (10)\ \text{\AA}$

$\beta = 93.238\ (2)^\circ$

$V = 2263.4\ (3)\ \text{\AA}^3$

$Z = 4$

$F(000) = 1104$

$D_x = 1.611\ \text{Mg m}^{-3}$

Mo $K\alpha$ radiation, $\lambda = 0.71073\ \text{\AA}$

Cell parameters from 41791 reflections

$\theta = 1.0\text{--}27.5^\circ$

$\mu = 1.62\ \text{mm}^{-1}$

$T = 115\ \text{K}$

Prism, colourless

$0.17 \times 0.08 \times 0.03\ \text{mm}$

Data collection

Nonius KappaCCD
diffractometer

Radiation source: fine-focus sealed tube

Graphite monochromator

φ scans ($\kappa = 0$) + additional ω scans

Absorption correction: multi-scan
(Blessing, 1995)

$T_{\min} = 0.770$, $T_{\max} = 0.953$

9402 measured reflections

4979 independent reflections

4503 reflections with $I > 2\sigma(I)$

$R_{\text{int}} = 0.025$
 $\theta_{\text{max}} = 27.5^\circ$, $\theta_{\text{min}} = 2.7^\circ$
 $h = -14 \rightarrow 10$

$k = -20 \rightarrow 12$
 $l = -16 \rightarrow 16$

Refinement

Refinement on F^2
 Least-squares matrix: full
 $R[F^2 > 2\sigma(F^2)] = 0.035$
 $wR(F^2) = 0.083$
 $S = 1.12$
 4979 reflections
 228 parameters
 0 restraints
 Primary atom site location: structure-invariant
 direct methods

Secondary atom site location: difference Fourier
 map
 Hydrogen site location: inferred from
 neighbouring sites
 H-atom parameters constrained
 $w = 1/[\sigma^2(F_o^2) + (0.0196P)^2 + 5.6981P]$
 where $P = (F_o^2 + 2F_c^2)/3$
 $(\Delta/\sigma)_{\text{max}} = 0.001$
 $\Delta\rho_{\text{max}} = 1.03 \text{ e } \text{\AA}^{-3}$
 $\Delta\rho_{\text{min}} = -0.99 \text{ e } \text{\AA}^{-3}$

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted R -factor wR and goodness of fit S are based on F^2 , conventional R -factors R are based on F , with F set to zero for negative F^2 . The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating R -factors(gt) *etc.* and is not relevant to the choice of reflections for refinement. R -factors based on F^2 are statistically about twice as large as those based on F , and R -factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (\AA^2)

	x	y	z	$U_{\text{iso}}^*/U_{\text{eq}}$
Sn1	0.67656 (2)	0.922515 (13)	0.212827 (17)	0.02314 (7)
C1	0.5332 (3)	0.8427 (2)	0.3693 (2)	0.0240 (6)
C2	0.5332 (3)	0.77851 (19)	0.2768 (2)	0.0222 (6)
O1	0.5778 (2)	0.91628 (13)	0.35167 (16)	0.0231 (5)
O2	0.5826 (2)	0.80588 (14)	0.19492 (17)	0.0248 (5)
O3	0.4905 (2)	0.82201 (15)	0.45140 (17)	0.0326 (6)
O4	0.4875 (2)	0.70888 (14)	0.28564 (17)	0.0282 (5)
Cl1	0.74421 (8)	1.05949 (5)	0.26855 (7)	0.0349 (2)
Cl2	0.83254 (8)	0.84828 (6)	0.30516 (8)	0.0403 (2)
Cl3	0.75536 (10)	0.91018 (6)	0.04748 (8)	0.0428 (2)
Cl4	0.49591 (7)	0.98965 (5)	0.13685 (6)	0.02334 (16)
N1	0.5547 (2)	0.58436 (17)	0.1384 (2)	0.0254 (6)
H1A	0.5344	0.6179	0.1904	0.038*
H1B	0.5045	0.5406	0.1325	0.038*
H1C	0.5515	0.6138	0.0792	0.038*
C3	0.6796 (3)	0.5518 (2)	0.1610 (3)	0.0317 (7)
H3	0.6778	0.5129	0.2204	0.038*
C4	0.7205 (3)	0.5014 (2)	0.0690 (3)	0.0305 (7)
H4A	0.7208	0.5379	0.0081	0.037*
H4B	0.6654	0.4550	0.0536	0.037*
C5	0.8453 (4)	0.4659 (3)	0.0929 (3)	0.0397 (9)
H5A	0.8435	0.4252	0.1496	0.048*

H5B	0.8720	0.4365	0.0321	0.048*
C6	0.9310 (4)	0.5365 (3)	0.1229 (4)	0.0478 (11)
H6A	0.9388	0.5738	0.0636	0.057*
H6B	1.0088	0.5124	0.1415	0.057*
C7	0.8886 (4)	0.5888 (3)	0.2157 (3)	0.0439 (10)
H7A	0.8893	0.5532	0.2774	0.053*
H7B	0.9428	0.6360	0.2299	0.053*
C8	0.7630 (3)	0.6227 (3)	0.1914 (3)	0.0418 (9)
H8A	0.7352	0.6516	0.2522	0.050*
H8B	0.7641	0.6637	0.1349	0.050*
N2	0.3881 (3)	0.65674 (19)	0.4780 (2)	0.0357 (7)
H2A	0.3940	0.6415	0.4118	0.054*
H2B	0.4276	0.6197	0.5194	0.054*
H2C	0.4191	0.7084	0.4880	0.054*
C9	0.2600 (3)	0.6577 (2)	0.5030 (3)	0.0305 (7)
H9	0.2261	0.6012	0.4884	0.037*
C10	0.1935 (4)	0.7220 (3)	0.4339 (3)	0.0507 (12)
H10A	0.2013	0.7073	0.3613	0.061*
H10B	0.2274	0.7781	0.4459	0.061*
C11	0.0621 (5)	0.7226 (4)	0.4580 (4)	0.0613 (14)
H11A	0.0208	0.7657	0.4157	0.074*
H11B	0.0271	0.6679	0.4395	0.074*
C12	0.0451 (4)	0.7404 (3)	0.5710 (4)	0.0463 (10)
H12A	-0.0388	0.7354	0.5841	0.056*
H12B	0.0699	0.7983	0.5871	0.056*
C13	0.1164 (4)	0.6793 (3)	0.6413 (4)	0.0460 (10)
H13A	0.0836	0.6225	0.6326	0.055*
H13B	0.1095	0.6960	0.7134	0.055*
C14	0.2475 (3)	0.6780 (3)	0.6171 (3)	0.0357 (8)
H14A	0.2831	0.7330	0.6333	0.043*
H14B	0.2892	0.6355	0.6599	0.043*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Sn1	0.02712 (12)	0.02014 (12)	0.02230 (12)	0.00106 (8)	0.00262 (8)	0.00254 (8)
C1	0.0337 (17)	0.0208 (15)	0.0172 (14)	0.0033 (13)	0.0001 (12)	0.0019 (11)
C2	0.0309 (17)	0.0183 (14)	0.0176 (14)	0.0010 (12)	0.0023 (12)	-0.0001 (11)
O1	0.0344 (12)	0.0175 (10)	0.0173 (10)	0.0006 (9)	0.0015 (9)	-0.0013 (8)
O2	0.0372 (13)	0.0199 (11)	0.0180 (10)	-0.0011 (9)	0.0073 (9)	-0.0024 (8)
O3	0.0566 (17)	0.0251 (12)	0.0170 (11)	-0.0004 (11)	0.0104 (11)	-0.0013 (9)
O4	0.0425 (14)	0.0202 (11)	0.0227 (11)	-0.0028 (10)	0.0078 (10)	-0.0031 (9)
Cl1	0.0358 (5)	0.0249 (4)	0.0430 (5)	-0.0060 (3)	-0.0077 (4)	0.0024 (3)
Cl2	0.0355 (5)	0.0359 (5)	0.0487 (5)	0.0104 (4)	-0.0055 (4)	0.0070 (4)
Cl3	0.0523 (6)	0.0416 (5)	0.0369 (5)	0.0105 (4)	0.0239 (4)	0.0083 (4)
Cl4	0.0294 (4)	0.0237 (4)	0.0168 (3)	0.0014 (3)	0.0000 (3)	0.0001 (3)
N1	0.0298 (15)	0.0261 (14)	0.0206 (13)	0.0021 (11)	0.0031 (11)	-0.0023 (10)
C3	0.0303 (18)	0.0380 (19)	0.0271 (17)	0.0054 (15)	0.0022 (14)	-0.0047 (14)

C4	0.0336 (18)	0.0315 (18)	0.0265 (17)	0.0019 (14)	0.0022 (14)	-0.0053 (14)
C5	0.037 (2)	0.039 (2)	0.043 (2)	0.0051 (17)	0.0044 (17)	-0.0049 (17)
C6	0.034 (2)	0.046 (2)	0.063 (3)	0.0009 (18)	0.004 (2)	-0.015 (2)
C7	0.034 (2)	0.049 (2)	0.047 (2)	-0.0044 (18)	-0.0078 (18)	-0.0111 (19)
C8	0.038 (2)	0.038 (2)	0.049 (2)	-0.0018 (17)	0.0006 (18)	-0.0200 (18)
N2	0.054 (2)	0.0232 (14)	0.0315 (15)	0.0092 (13)	0.0196 (14)	0.0088 (12)
C9	0.042 (2)	0.0235 (16)	0.0261 (16)	0.0048 (14)	0.0021 (15)	0.0010 (13)
C10	0.071 (3)	0.057 (3)	0.0249 (18)	0.030 (2)	0.0033 (19)	0.0093 (18)
C11	0.059 (3)	0.072 (3)	0.051 (3)	0.024 (3)	-0.022 (2)	0.000 (2)
C12	0.038 (2)	0.044 (2)	0.058 (3)	0.0096 (18)	0.0054 (19)	0.005 (2)
C13	0.042 (2)	0.049 (2)	0.048 (2)	0.0089 (19)	0.0129 (19)	0.012 (2)
C14	0.039 (2)	0.045 (2)	0.0228 (17)	0.0058 (17)	0.0025 (15)	0.0030 (15)

Geometric parameters (Å, °)

Sn1—O2	2.121 (2)	C7—C8	1.524 (6)
Sn1—O1	2.155 (2)	C7—H7A	0.9700
Sn1—Cl3	2.3547 (9)	C7—H7B	0.9700
Sn1—Cl2	2.3667 (9)	C8—H8A	0.9700
Sn1—Cl1	2.3794 (9)	C8—H8B	0.9700
Sn1—Cl4	2.4407 (8)	N2—C9	1.491 (5)
C1—O3	1.227 (4)	N2—H2A	0.8900
C1—O1	1.286 (4)	N2—H2B	0.8900
C1—C2	1.559 (4)	N2—H2C	0.8900
C2—O4	1.217 (4)	C9—C10	1.514 (5)
C2—O2	1.290 (4)	C9—C14	1.514 (5)
N1—C3	1.505 (4)	C9—H9	0.9800
N1—H1A	0.8900	C10—C11	1.524 (7)
N1—H1B	0.8900	C10—H10A	0.9700
N1—H1C	0.8900	C10—H10B	0.9700
C3—C8	1.493 (5)	C11—C12	1.501 (7)
C3—C4	1.515 (5)	C11—H11A	0.9700
C3—H3	0.9800	C11—H11B	0.9700
C4—C5	1.524 (5)	C12—C13	1.515 (6)
C4—H4A	0.9700	C12—H12A	0.9700
C4—H4B	0.9700	C12—H12B	0.9700
C5—C6	1.504 (6)	C13—C14	1.521 (5)
C5—H5A	0.9700	C13—H13A	0.9700
C5—H5B	0.9700	C13—H13B	0.9700
C6—C7	1.544 (6)	C14—H14A	0.9700
C6—H6A	0.9700	C14—H14B	0.9700
C6—H6B	0.9700		
O2—Sn1—O1	76.97 (8)	C8—C7—H7A	109.6
O2—Sn1—Cl3	92.35 (6)	C6—C7—H7A	109.6
O1—Sn1—Cl3	168.53 (7)	C8—C7—H7B	109.6
O2—Sn1—Cl2	88.73 (7)	C6—C7—H7B	109.6
O1—Sn1—Cl2	87.92 (6)	H7A—C7—H7B	108.1

C13—Sn1—C12	96.10 (4)	C3—C8—C7	110.6 (3)
O2—Sn1—C11	164.34 (6)	C3—C8—H8A	109.5
O1—Sn1—C11	87.86 (6)	C7—C8—H8A	109.5
C13—Sn1—C11	102.47 (4)	C3—C8—H8B	109.5
C12—Sn1—C11	94.62 (3)	C7—C8—H8B	109.5
O2—Sn1—C14	86.17 (7)	H8A—C8—H8B	108.1
O1—Sn1—C14	84.01 (6)	C9—N2—H2A	109.5
C13—Sn1—C14	91.21 (3)	C9—N2—H2B	109.5
C12—Sn1—C14	171.25 (3)	H2A—N2—H2B	109.5
C11—Sn1—C14	88.47 (3)	C9—N2—H2C	109.5
O3—C1—O1	124.4 (3)	H2A—N2—H2C	109.5
O3—C1—C2	120.1 (3)	H2B—N2—H2C	109.5
O1—C1—C2	115.5 (3)	N2—C9—C10	109.3 (3)
O4—C2—O2	125.4 (3)	N2—C9—C14	110.7 (3)
O4—C2—C1	119.5 (3)	C10—C9—C14	110.9 (3)
O2—C2—C1	115.1 (3)	N2—C9—H9	108.6
C1—O1—Sn1	114.25 (19)	C10—C9—H9	108.6
C2—O2—Sn1	115.71 (19)	C14—C9—H9	108.6
C3—N1—H1A	109.5	C9—C10—C11	109.7 (4)
C3—N1—H1B	109.5	C9—C10—H10A	109.7
H1A—N1—H1B	109.5	C11—C10—H10A	109.7
C3—N1—H1C	109.5	C9—C10—H10B	109.7
H1A—N1—H1C	109.5	C11—C10—H10B	109.7
H1B—N1—H1C	109.5	H10A—C10—H10B	108.2
C8—C3—N1	111.1 (3)	C12—C11—C10	112.0 (4)
C8—C3—C4	112.4 (3)	C12—C11—H11A	109.2
N1—C3—C4	110.4 (3)	C10—C11—H11A	109.2
C8—C3—H3	107.6	C12—C11—H11B	109.2
N1—C3—H3	107.6	C10—C11—H11B	109.2
C4—C3—H3	107.6	H11A—C11—H11B	107.9
C3—C4—C5	110.5 (3)	C11—C12—C13	111.5 (4)
C3—C4—H4A	109.6	C11—C12—H12A	109.3
C5—C4—H4A	109.6	C13—C12—H12A	109.3
C3—C4—H4B	109.6	C11—C12—H12B	109.3
C5—C4—H4B	109.6	C13—C12—H12B	109.3
H4A—C4—H4B	108.1	H12A—C12—H12B	108.0
C6—C5—C4	110.4 (3)	C12—C13—C14	111.8 (3)
C6—C5—H5A	109.6	C12—C13—H13A	109.3
C4—C5—H5A	109.6	C14—C13—H13A	109.3
C6—C5—H5B	109.6	C12—C13—H13B	109.3
C4—C5—H5B	109.6	C14—C13—H13B	109.3
H5A—C5—H5B	108.1	H13A—C13—H13B	107.9
C5—C6—C7	111.7 (4)	C9—C14—C13	110.2 (3)
C5—C6—H6A	109.3	C9—C14—H14A	109.6
C7—C6—H6A	109.3	C13—C14—H14A	109.6
C5—C6—H6B	109.3	C9—C14—H14B	109.6
C7—C6—H6B	109.3	C13—C14—H14B	109.6
H6A—C6—H6B	107.9	H14A—C14—H14B	108.1

C8—C7—C6

110.5 (3)

Hydrogen-bond geometry (\AA , $^\circ$)

<i>D</i> —H \cdots <i>A</i>	<i>D</i> —H	H \cdots <i>A</i>	<i>D</i> \cdots <i>A</i>	<i>D</i> —H \cdots <i>A</i>
N1—H1A \cdots O4	0.89	1.97	2.853 (3)	169
N1—H1B \cdots O1 ⁱ	0.89	2.18	3.038 (4)	163
N1—H1C \cdots O3 ⁱⁱ	0.89	2.01	2.875 (4)	162
N2—H2A \cdots O4	0.89	2.25	2.887 (4)	129
N2—H2A \cdots Cl4 ⁱ	0.89	2.78	3.315 (3)	120
N2—H2B \cdots Cl4 ⁱⁱⁱ	0.89	2.38	3.262 (3)	169
N2—H2C \cdots O3	0.89	2.02	2.869 (4)	158

Symmetry codes: (i) $-x+1, y-1/2, -z+1/2$; (ii) $x, -y+3/2, z-1/2$; (iii) $x, -y+3/2, z+1/2$.