N(C6) amino group is H bonded to N(1) and N(7) of the adjacent molecules in both (I) and (II), to form ribbons along 2_1 axes. These ribbons are connected by H bonds O(2′)—N(3) in (I), and O(*W*)—N(3) and O(*W*)—O(3′) in (II).

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Acta Cryst. (1990). C**46**, 1513–1515

Structure of Tetramethylammonium Hydrogen Phthalate

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(*Received* 12 *January* 1990; *accepted* 12 *March* 1990)

Abstract. *N*,*N*,*N*,-Trimethylmethanaminium 1,2-benzenedicarboxylate, $C_4H_{12}N^+.C_8H_5O_4^-$, M_r = 239·3, monoclinic, $P2_1/c$, a = 12·960 (4), b = 8·591 (2), c = 11·384 (2) Å, β = 94·55 (3)°, V = 1263·5 Å^3, Z = 4, D_x = 1·258 Mg m^{-3}, λ(Mo $K\alpha$) = 0·71069 Å, μ = 0·09 mm^{-1}, F(000) = 512, room temperature (295 K), wR = 0·040 for 1195 observed reflections. The phthalate anions form infinite chains along [001] *via* a strong intermolecular hydrogen bond [O···O distance 2·555 (4) Å]. There are (100) layers of anions and cations. The tetramethylammonium ion has the usual tetrahedral configuration.

Introduction. As part of a study of acid salts of phthalic acid, new examples of compounds with intramolecular hydrogen bonds were sought. IR spectroscopic investigations of the title compound (Barry, Finkelstein & Ross, 1982; Barry, Finkelstein, Ross, Mateescu, Valeriu & Svensson, 1988) suggested the presence of an asymmetric hydrogen bond. In order to confirm this result and to distinguish between an intermolecular and an intramolecular bond, this X-ray structure analysis was undertaken.

Experimental. The material was synthesized from a stoichiometric solution of tetramethylammonium hydroxide and phthalic acid in methanol (Barry, Finkelstein & Ross, 1982). The crystals were commonly twinned, as seen in (*h*0*l*) and (*h*1*l*) Weissenberg photographs. No twinning was visible in the (*hk*0) plane. An (*h*0*l*) precession photograph clearly showed that the twin plane was (100). From these X-ray photographs, the space group was unambiguously determined as $P2_1/c$. The structure was determined on an untwinned splinter. Its quality was checked with optical polarizing microscopy and Weissenberg photographs. Since this substance is moisture sensitive, it was necessary to place the crystal (0·1 × 0·3 × 0·5 mm) in a sealed capillary. Lattice parameters were refined using 20 reflections in the range $34 < 2\theta < 44°$. The intensities of 4083 reflections were collected on a Siemens–Stoe AED-2 diffractometer in the $\theta/2\theta$ mode, no absorption correction was applied due to the small absorption coefficient. The maximum ($\sin\theta/\lambda$) was 0·704 Å^{-1}; range of h, k, l was −18/18, 0/12, 0/16. Standard reflections $43\bar{2}$, $2\bar{1}3$ and $3\bar{1}\bar{4}$, monitored every hour, showed no significant variation. 2750 reflections were

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Table 1. *Fractional atomic coordinates* (x10^4) *and equivalent isotropic thermal parameters* (Å^2 × 10^3) *for non*-H *atoms*

U_{eq} is one third of the trace of the orthogonalized U tensor.

	x	y	z	U_{eq}
N	3741 (2)	4380 (4)	2958 (3)	39 (1)
C1	1796 (3)	206 (4)	2037 (3)	35 (1)
C2	1590 (3)	101 (4)	3222 (3)	37 (1)
C3	692 (3)	802 (5)	3587 (4)	54 (2)
C4	2 (4)	1568 (6)	2806 (5)	71 (2)
C5	205 (4)	1621 (6)	1633 (5)	70 (2)
C6	1087 (3)	959 (5)	1251 (4)	52 (1)
C7	2762 (3)	−464 (5)	1559 (3)	41 (1)
C8	2322 (3)	−700 (5)	4097 (3)	39 (1)
C9	4094 (4)	5854 (5)	3576 (5)	51 (1)
C10	4167 (4)	4352 (7)	1776 (4)	58 (2)
C11	2592 (4)	4336 (8)	2854 (6)	74 (2)
C12	4170 (4)	3010 (6)	3657 (5)	58 (2)
O1	1836 (2)	−1423 (4)	4924 (3)	58 (1)
O2	3253 (2)	−689 (3)	4071 (2)	47 (1)
O3	2830 (2)	−1928 (3)	1504 (2)	59 (1)
O4	3385 (2)	482 (4)	1218 (3)	67 (1)

unique (R_{int} = 0·015); 1555 of them with $I < 2\sigma(I)$ were rejected as unobserved. The structure was solved by direct methods using *SIR*88 (Burla, Camalli, Cascarano, Giacovazzo, Polidori, Spagna & Viterbo, 1989), which located the positions of all non-H atoms, and was refined (based on F) by *SHELX*76 (Sheldrick, 1976). All H atoms were located in the difference Fourier synthesis map. Final refinement yielded wR = 0·040, R = 0·073 (H atoms having isotropic, all other atoms anisotropic temperature factors; isotropic extinction correction; 224 parameters varied). Weights were calculated according to $w = 1/\sigma^2$, maximum Δ/σ was 0·002. The isotropic extinction parameter g was 3·4 (3) × 10^{-7} [$F' = F(1 - gF^2/\sin\theta)$]. Maximum and minimum heights in the final difference Fourier synthesis map were 0·31 and −0·32 e Å^{-3}, respectively. Atomic coordinates and equivalent isotropic thermal parameters for all non-H atoms are listed in Table 1.* In addition, the programs *ORFFE* (Busing, Martin & Levy, 1964), *ORTEP*II (Johnson, 1976) and *XANADU* (Roberts & Sheldrick, 1975) were used. Atomic scattering factors were taken from *International Tables for X-ray Crystallography* (1974).

Discussion. The packing of the ions is shown by a stereographic *ORTEP* plot in Fig. 1. The anions as well as the cations are arranged in layers parallel to (100). Each layer is connected to one of its own type (anion or cation) by van der Waals contacts and to one of the other type by ionic bonds; consequently, planes of weak and strong bonding alternate. The most striking feature within the layers is the presence of a short intermolecular hydrogen bond [O(1)···O(3) distance 2·555 (4) Å] between adjacent carboxylic and carboxylate groups. These bonds form infinite chains of phthalate ions which extend parallel to [001]. The hydrogen bond is clearly asymmetric with interatomic distances of O(1)—H(1) 1·11 (5) and H(1)···O(3) 1·49 (5) Å, and an angle O(1)—H(1)—O(3) of 161 (5)°. The geometry of the phthalate anion is shown in Fig. 2. The C—O distances within the carboxylic group differ significantly. They are more comparable within the carboxylate group, with the C—O distance of the hydrogen-bond acceptor O(3) being slightly longer than C—O(4). The groups are rotated out of the mean plane of the benzene ring by the following angles: O(1)—C(8)—O(2) 35·5, O(3)—C(7)—O(4) 69·1°. The tetramethylammonium ion is almost tetrahedral. The N—C distances range from 1·485 (6) to 1·502 (6) Å, C—N—C angles from 108·3 (4) to 111·6 (4)°. The methyl groups are also well defined; C—H distances are in the range 0·89 (4)–1·13 (4) Å and H—C—H angles are in the range 104 (3)–121 (3)°.

The compound represents a new structure type among the anhydrous acid phthalates (Cambridge

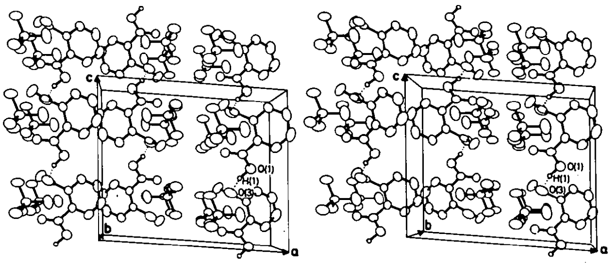

Fig. 1. Stereoscopic view of the crystal structure. Thermal ellipsoids are drawn at the 50% probability level. H atoms have a fixed radius, dotted lines indicate hydrogen bonds.

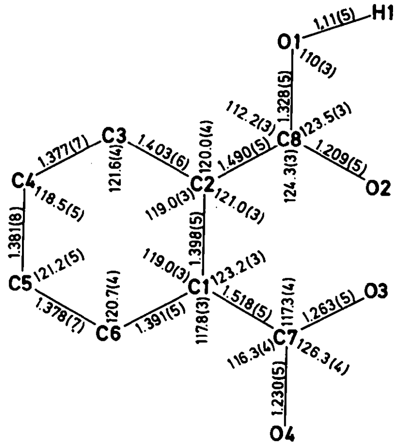

Fig. 2. Bond lengths (Å) and angles (°) in the phthalate anion.

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* Lists of structure factors, anisotropic thermal parameters, complete molecular geometry and H-atom parameters have been deposited with the British Library Document Supply Centre as Supplementary Publication No. SUP 52853 (15 pp.). Copies may be obtained through The Technical Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

Structural Database, 1989). Although the lattice constants are comparable, it is not a monoclinic distortion of the orthorhombic potassium hydrogen phthalate type (Okaya, 1965). In this structure, the hydrogen phthalate residues form dimers *via* intermolecular hydrogen bonds instead of chains. All calculations were carried out on a MicroVAX and on the PDP 10 at the Rechenzentrum der Universität Kiel.

Thanks are due to Mrs U. Bennewitz for retouching the drawings.

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Acta Cryst. (1990). C**46**, 1515–1519

Structures of Novel Calmodulin Inhibitors KS504a, KS504b and KS504e

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(*Received* 15 *August* 1989; *accepted* 31 *October* 1989)

Abstract. (I) KS504a: (1R^*,3S^*)-2,2,4,4-tetrachloro-5-dichloromethylene-3-hydroxycyclopentane-1-spiro-2′-(3′R^*)-3′-chlorooxirane, $C_7H_3Cl_7O_2$, $M_r = 367{\cdot}27$, monoclinic, $P2_1/n$, $a = 9{\cdot}247$ (1), $b = 16{\cdot}593$ (1), $c = 8{\cdot}351$ (1) Å, $\beta = 100{\cdot}65$ (1)°, $V = 1259{\cdot}1$ (3) Å^3, $Z = 4$, $D_x = 1{\cdot}94$ g cm^{-3}, Mo $K\alpha$, $\lambda = 0{\cdot}71073$ Å, $\mu = 15{\cdot}7$ cm^{-1}, $F(000) = 720$, $T = 293$ K, $wR = 0{\cdot}078$ for 2264 observed reflections. (II) KS504b, (1S,3S)-2,2,4,4-tetrachloro-5-dichloromethylene-3-hydroxycyclopentane-1-spiro-2′-(3′R)-3′-chlorooxirane, $C_7H_3Cl_7O_2$, $M_r = 367{\cdot}27$, orthorhombic, $P2_12_12_1$, $a = 15{\cdot}543$ (2), $b = 36{\cdot}509$ (3), $c = 6{\cdot}793$ (1) Å, $V = 3855$ (1) Å^3, $Z = 12$, $D_x = 1{\cdot}27$ g cm^{-3}, Mo $K\alpha$, $\lambda = 0{\cdot}71073$ Å, $\mu = 10{\cdot}3$ cm^{-1}, $F(000) = 1440$, $T = 293$ K, $wR = 0{\cdot}054$ for 1567 observed reflections. (III) KS504e: (4S^*)-3,3,5,5-tetrachloro-4-hydroxy-2-trichloromethyl-1-cyclopentenecarbaldehyde, $C_7H_3Cl_7O_2$, $M_r = 367{\cdot}27$, monoclinic, $P2_1$, $a = 8{\cdot}861$ (2), $b = 11{\cdot}892$ (3), $c = 6{\cdot}121$ (3) Å, $\beta = 90{\cdot}15$ (3)°, $V = 644{\cdot}9$ (6) Å^3, $Z = 2$, $D_x = 1{\cdot}89$ g cm^{-3}, Mo $K\alpha$, $\lambda = 0{\cdot}71073$ Å, $\mu = 15{\cdot}3$ cm^{-1}, $F(000) = 360$, $T = 293$ K, $wR = 0{\cdot}051$ for 1449 observed reflections. The structures of these three compounds are novel and have not previously been observed in natural products from microorganisms. The absolute configuration of (II) was determined by the Bijvoet method. The five-membered rings adopt envelope conformations.

Introduction. Ca^{2+} acts as a second messenger in the control of a variety of cell functions and many of the effects of the ion are transmitted by calmodulin. In the course of studies on inhibitors or antagonists of the Ca^{2+}-messenger system, Nakanishi, Ando, Kawamoto, Yasuzawa, Sano & Kase (1989) found a novel group of calmodulin inhibitors, (I) and (II), from *Mollisia ventosa* KAC-1148. When (I) is heated at 333 K in acidic ethyl acetate solution with hydrochloric acid it yields (III), which shows a similar activity to (I). (II) does not yield (III) under the same conditions (Nakanishi *et al.*, 1989). (I), (II) and (III) inhibit Ca^{2+}/calmodulin-dependent cyclic nucleotide phosphodiesterases. The I_{50} values for the effect of the enzyme from bovine brain are 98, 93 and 133 μM, respectively. Usual chemical and spectroscopic methods suggested that the three compounds have novel structures as implied by their formulae of $C_7H_3Cl_7O_2$ but could not determine the structures

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