Supporting Information

Dienyl Homoallyl Alcohols via Palladium Catalyzed Ene-Type Reaction of Aldehydes with 1,3-Dienes

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Experimental Section

Reactions employed oven-dried glassware unless otherwise noted. Thin layer chromatography (TLC) employed glass 0.25 mm silica gel plates with UV indicator (Merck, Silica gel $60F_{254}$). Flash chromatography columns were packed with 230-400 mesh silica gel as a slurry in hexane. Gradient flash chromatography was conducted eluting with a continuous gradient from hexane to the indicated solvent. Proton and carbon NMR data were obtained with a JEOL-GX400 with tetramethylsilane as an internal standard. Chemical shift values were given in ppm downfield from the internal standard. Infrared spectra were recorded with a JASCO A-100 FT-IR spectrophotometer. High resolution mass spectra (HRMS) were measured with a JEOL JMS-DX303.

Solvents and Reagents

Tetrahydrofuran was dried and distilled from benzophenone and sodium immediately prior to use under nitrogen atmosphere. $Pd(OAc)_2$, PPh_3, dppf [1,1'-bis(diphenylphosphino)ferrocene], DPEphos [2,2'-bis(diphenylphosphino)diphenyl Ether], BINAP [2,2'-bis(diphenylphosphino)-1,1'-binaphthyl], Xantphos [4,5-bis(diphenylphosphino)-9,9-dimethylxanthene] (Aldrich), Et_3B (1.0 M THF solution), *n*-Bu_3B (1.0 M THF solution), Ph_3B (0.25 M THF solution), Et_2Zn (1.0 M hexane solution) (Aldrich) were purchased and used without further purification. Isoprene, 2,3-dimethyl-1,3-butadiene, 2-methyl-1,3-pentadiene, myrcene, and methyl sorbate (Tokyo Kasei Kogyo Co., Ltd) were purchased and distilled prior to use. Benzaldehyde, *p*-methoxybenzaldehyde, *p*-chlororbenzaldehyde, dihydrocinnamaldehyde, isovaleraldehyde, cyclohexanecarbaldehyde (Aldrich) were purchased and distilled prior to use by Kugelrohr apparatus. 2-Hydroxy tetrahydrofuran and 2-hydroxy tetrahydropyran were prepared according to the literature.[1]

General procedure for the Pd-catalyzed coupling reaction of aldehyde with isoprene (run 6, Table 1): To a solution of $Pd(OAc)_2$ (22.4 mg, 0.1 mmol) and Xantphos (57.8 mg, 0.1 mmol) in dry THF (5 mL) were successively added benzaldehyde (106 mg, 1 mmol), isoprene (400 mL, 4 mmol), and triethylborane (2 mmol, 1.0 M THF solution) via syringe under nitrogen atmosphere. The mixture was stirred at ambient temperature for 24 h. The mixture was diluted with 30 mL of EtOAc and washed with 2 N HCl, sat. $NaHCO_3$, and then brine. The extract was dried ($MgSO_4$) and concentrated in vacuo and the residual oil was subjected to column chromatography over silica gel (hexane/EtOAc = 10/1 v/v) to give **1a** (173 mg, 99%, $R_f = 0.47$; hexane/ethyl acetate = 4/1 v/v).

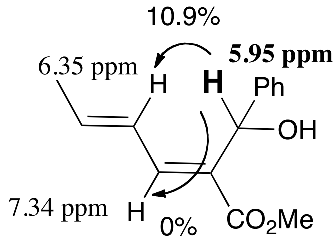
3-Methylene-1-phenylpent-4-en-1-ol (1a); IR (neat): 3381 (br), 3030 (m), 2930 (m), 1597 (m), 1495 (w), 1454 (m), 1377 (w), 1194 (w), 1043 (m), 893 (s), 760 (m), 700 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.10 (br s, 1 H), 2.58 (dd, J = 14.1, 9.0 Hz, 1 H), 2.67 (dd, J = 14.1, 4.1 Hz, 1 H), 4.83 (dd, J = 9.0, 4.1 Hz, 1 H), 5.09 (s, 1 H), 5.13 (d, J = 10.7 Hz, 1 H), 5.15 (s, 1 H), 5.32 (d, J = 17.6 Hz, 1 H), 6.41 (dd, J = 17.6, 10.7 Hz, 1 H), 7.23-7.39 (m, 5 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 42.2, 72.2, 114.2, 118.7, 125.7, 127.4, 128.3, 138.2, 142.6, 144.0. High-resolution MS, calcd for $C_{12}H_{14}O$: 174.1045. Found m/z (relative intensity): 174.0988 (M^+, 6.9), 188.1178 (100).

4-Methyl-3-methylene-1-phenylpent-4-en-1-ol (1b); IR (neat): 3381 (br), 3082 (w), 3032 (w), 2947 (m), 1805 (w), 1599 (s), 1495 (m), 1452 (s), 1190 (w), 1041 (s), 895 (s), 760 (m), 700 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.95 (s, 3 H), 2.04 (brs, 1 H), 2.58 (dd, J = 14.1, 9.5 Hz, 1 H), 2.79 (dd, J = 14.1, 3.8 Hz, 1 H), 4.82 (dd, J = 9.5, 3.8 Hz, 1 H), 5.07 (s, 2 H), 5.19 (s, 1 H), 5.24 (s, 1 H), 7.25-7.39 (m, 5 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.1, 44.6, 72.5, 113.6, 115.4, 125.7, 127.4, 128.3, 142.2, 144.1, 144.3. High-resolution MS, calcd for $C_{13}H_{16}O$: 188.1201. Found m/z (relative intensity): 188.1171 (M^+, 100).

(*E*)-3-Methylene-1-phenylhex-4-en-1-ol (1c); IR (neat): 3395 (br), 3032 (m), 2910 (m), 2876 (m), 1649 (w), 1605 (m), 1493 (w), 1452 (m), 1051 (w), 966 (w), 756 (m), 700 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.80 (d, J = 6.7 Hz, 3 H), 2.07 (d, J = 2.4 Hz, 1 H), 2.51 (dd, J = 14.0, 9.4 Hz, 1 H), 2.69 (dd, J = 14.0, 3.6 Hz, 1 H), 4.82 (ddd, J = 9.4, 3.6, 2.4 Hz, 1 H), 4.95 (s, 1 H), 5.04 (s, 1 H), 5.83 (dq, J = 15.7, 6.7 Hz, 1 H), 6.12 (d, J = 15.7 Hz, 1 H), 7.27-7.39 (m, 5 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 18.4, 43.3, 72.1, 116.0, 125.7, 126.1, 127.4, 128.3, 132.7, 142.5, 144.1. High-resolution MS, calcd for $C_{13}H_{16}O$: 188.1201. Found m/z (relative intensity): 188.1171 (M^+, 100).

7-Methyl-1-phenyl-3-vinylocta-3,6-dien-1-ol (1d); (*Z* : *E* = 3 : 1); IR (neat): 3383 (br), 3086 (w), 2970 (m), 2914 (s), 2856 (m), 1636 (w), 1593 (w), 1495 (m), 1452 (s), 1375 (m), 1026 (m), 905 (m), 756 (m), 700 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$, *Z* isomer) δ 1.63 (s, 3 H), 1.69 (d, J = 1.2 Hz, 3 H), 2.01 (d, J = 2.2 Hz, 1 H), 2.44 (dd, J = 13.9, 9.5 Hz, 1 H), 2.71 (dd, J = 13.9, 3.9 Hz, 1 H), 2.88 (t, J = 7.2 Hz, 2 H), 4.80 (ddd, J = 9.5, 3.9, 2.2 Hz, 1 H), 5.07 (tq, J = 7.2, 1.2 Hz, 1 H), 5.20 (d, J = 11.0 Hz, 1 H), 5.35 (d, J = 17.6 Hz, 1 H), 5.43 (t, J = 7.2 Hz, 1 H), 6.74 (dd, J = 17.6, 11.0 Hz, 1 H), 7.26-7.38 (m, 5 H); ^1H NMR (400 MHz, $CDCl_3$, *E* isomer) δ 1.59 (s, 3 H), 1.68 (d, J = 1.2 Hz, 3 H), 1.96 (d, J = 2.4 Hz, 1 H), 2.64 (dd, J = 13.8, 5.0 Hz, 1 H), 2.77 (dd, J = 13.8, 8.7 Hz, 1 H), 2.88 (t, J = 7.2 Hz, 2 H), 4.84 (ddd, J = 8.2, 5.0, 2.4 Hz, 1 H), 4.99 (tq, J = 7.2, 1.2 Hz, 1 H), 5.02 (d, J = 11.0 Hz, 1 H), 5.24 (d, J = 17.9 Hz, 1 H), 5.52 (t, J = 7.2 Hz, 1 H), 6.34 (dd, J = 17.9, 11.0 Hz, 1 H), 7.26-7.38 (m, 5 H); ^{13}C NMR (100 MHz, $CDCl_3$, *Z* isomer) δ 17.8, 25.6, 26.7, 44.2, 72.1, 114.3, 121.8, 125.7, 127.2, 128.2, 132.2, 132.3, 132.4, 132.7, 144.1; ^{13}C NMR (100 MHz, $CDCl_3$, *E* isomer) δ 17.7, 25.6, 27.5, 44.2, 72.9, 114.3, 121.6, 125.6, 127.3, 128.2, 132.2, 132.3, 132.4, 132.7, 144.2. High-resolution MS, calcd for $C_{17}H_{22}O$: 242.1671. Found *m/z* (relative intensity): 242.1667 (M^+, 37.4), 226.1681 (100).

(2*E*,4*E*)-Methyl 2-[hydroxyl(phenyl)methyl]hexa-2,4-dienoate (1e); IR (neat): 3487 (br), 3061 (w), 3032 (w), 2997 (m), 2961 (m), 2918 (m), 1695 (s), 1637 (s), 1602 (m), 1493 (m), 1435 (s), 1304 (m), 1236 (s), 1018 (m), 976 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 1.91 (dd, J = 7.0, 1.5 Hz, 3 H), 3.69 (s, 3 H), 4.11 (d, J = 8.7 Hz, 1 H), 5.81 (d, J = 8.7 Hz, 1 H), 6.27 (dq, J = 14.6, 7.0 Hz, 1 H), 6.57 (ddq, J = 14.6, 11.6, 1.5 Hz, 1 H), 7.21-7.37 (m, 6 H); ^1H NMR (400 MHz, C_6D_6) δ 1.37 (dd, J = 6.8, 1.7 Hz, 3 H), 3.19 (s, 3 H), 4.22 (d, J = 10.5 Hz, 1 H), 5.71 (dq, J = 14.8, 6.8 Hz, 1 H), 5.95 (d, J = 10.5 Hz, 1 H), 6.35 (ddq, J = 14.8, 11.5, 1.7 Hz, 1 H), 7.05 (t, J = 7.4 Hz, 2 H), 7.18 (d, J = 7.4 Hz, 1 H), 7.34 (d, J = 11.5 Hz, 1 H), 7.56 (d, J = 7.4 Hz, 2 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 19.0, 51.7, 69.7, 125.2, 126.0, 126.9, 128.1, 128.4, 140.8, 141.6, 142.8, 167.9. High-resolution MS, calcd for $C_{14}H_{16}O$: 232.1099. Found *m/z* (relative intensity): 232.1084 (M^+, 100).



NOE Increment of irradiation at the bold face proton of compound **1e** (C_6D_6).

1-(4-Methoxyphenyl)-3-methylenepent-4-en-1-ol (1f); IR (neat): 3406 (br), 3086 (w), 2912 (m), 2835 (m), 1612 (m), 1593 (m), 1514 (s), 1248 (s), 1175 (m), 1036 (m), 901 (m), 831 (m) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 1.98 (d, J = 2.1 Hz, 1 H), 2.57 (dd, J = 14.1, 9.0 Hz, 1 H), 2.67 (dd, J = 14.1, 4.3 Hz, 1 H), 3.80 (s, 3 H), 4.80 (ddd, J = 9.0, 4.3, 2.1 Hz, 1 H), 5.08 (s, 1 H), 5.13 (d, J = 10.7 Hz, 1 H), 5.16 (s, 1 H), 5.32 (d, J = 17.6 Hz, 1 H), 6.40 (dd, J = 17.6, 10.7 Hz, 1 H), 6.88 (d, J = 8.5 Hz, 2 H), 7.30 (d, J = 8.5 Hz, 2 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 41.5, 54.7, 71.2, 113.1, 113.5, 118.0, 126.3, 135.6, 137.7, 142.1, 158.4. High-resolution MS, calcd for $C_{13}H_{16}O_2$: 204.1150. Found *m/z* (relative intensity): 204.1150 (M^+, 83.1), 137.0560 (100).

1-(4-Chlorophenyl)-3-methylenepent-4-en-1-ol (1g); IR (neat): 3369 (br), 3086 (w), 2931 (m), 2330 (w), 1595 (m), 1491 (s), 1090 (s), 1015 (s), 903 (s), 829 (m) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 2.06 (br s, 1 H), 2.53 (dd, J = 14.1, 9.0 Hz, 1 H), 2.67 (dd, J = 14.1, 4.1 Hz, 1 H), 4.82 (dd, J = 9.0, 4.1 Hz, 1 H), 5.07 (s, 1 H), 5.15 (d, J = 10.8 Hz, 1 H), 5.17 (s, 1 H), 5.30 (d, J = 17.6 Hz, 1 H), 6.41 (dd, J = 17.6, 10.8 Hz, 1 H), 7.25-7.33 (m, 5 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 42.3, 71.5, 114.3, 118.9, 127.0, 128.4, 133.1, 138.0, 142.2, 142.3. High-resolution MS, calcd for $C_{12}H_{13}ClO$: 208.0655. Found *m/z* (relative intensity):

208.0626 (M^+, 40.6), 193.0404 (100).

5-Methylene-1-phenylhept-6-en-3-ol (1h); IR (neat): 3312 (br), 3050 (w), 3010 (w), 2922 (s), 2851 (m), 1620 (w), 1595 (m), 1508 (s), 1456 (m), 1246 (m), 1037 (m), 897 (m), 698 (m) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 1.83 (m, 2 H), 2.28 (dd, J = 13.8, 9.0 Hz, 1 H), 2.53 (dd, J = 13.8, 3.8 Hz, 1 H), 2.70 (ddd, J = 13.8, 7.8, 8.6 Hz, 1 H), 2.84 (ddd, J = 13.8, 7.8, 8.6 Hz, 1 H), 3.79 (m, J = 9.0, 3.8 Hz, 1 H), 5.08 (s, 1 H), 5.09 (d, J = 10.8 Hz, 1 H), 5.16 (s, 1 H), 5.21 (d, J= 17.6 Hz, 1 H), 6.37 (dd, J = 17.6, 10.8 Hz, 1 H), 7.16-7.29 (m, 5 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 32.1, 38.8, 40.1, 69.0, 114.2, 118.3, 125.7, 128.3, 138.3, 141.9, 142.9. High-resolition MS, calcd for $C_{14}H_{18}O$: 202.1358. Found *m/z* (relative intensity): 202.1334 (M^+, 9.9), 184.1227 (100).

2-Methyl-6-methyleneoct-7-en-4-ol (1i); IR (neat): 3358 (br), 3088 (w), 2957 (s), 2931 (s), 2870 (m), 1595 (m), 1468 (m), 1367 (m), 1261 (m), 1022 (m), 991 (m), 897 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 0.92 (d, J = 6.8 Hz, 3 H), 0.94 (d, J = 6.3 Hz, 3 H), 1.28 (ddd, J = 13.8, 8.6, 4.3 Hz, 1 H), 1.46 (ddd, J = 13.8, 8.7, 5.4 Hz, 1 H), 1.82 (qqdd, J = 6.8, 6.3, 5.4, 4.3 Hz, 1 H), 2.21 (dd, J = 13.9, 8.9 Hz, 1 H), 2.48 (dd, J = 13.9, 3.9 Hz, 1 H), 3.82 (dddd, J = 8.9, 8.7, 8.6, 3.9 Hz, 1 H), 5.09 (s, 1 H), 5.11 (d, J = 10.7 Hz, 1 H), 5.15 (s, 1 H), 5.25 (d, J = 17.6 Hz, 1 H), 6.39 (dd, J = 17.6, 10.7 Hz, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 22.2, 23.5, 24.8, 40.7, 46.6, 67.7, 114.1, 118.2, 138.5, 143.2. High-resolution MS, calcd for $C_{10}H_{18}O$: 154.1358. Found *m/z* (relative intensity): 154.1325 (M^+, 24.5), 135.1141 (100).

1-Cyclohexyl-3-methylenepent-4-en-1-ol (1j); IR (neat): 3414 (br), 3086 (w), 2926 (s), 2852 (s), 1593 (m), 1450 (m), 1394 (w), 1261 (w), 1086 (w), 991 (m), 895 (m) cm^{-1}; ^1H-NMR (400 MHz, $CDCl_3$) δ 1.06-1.80 (m, 11 H), 1.90 (br s, 1 H), 2.14 (dd, J = 13.9, 10.0 Hz, 1 H), 2.59 (dd, J = 13.9, 2.7 Hz, 1 H), 3.50 (ddd, J = 10.0, 5.7, 2.7 Hz, 1 H), 5.08 (s, 1 H), 5.09 (d, J =

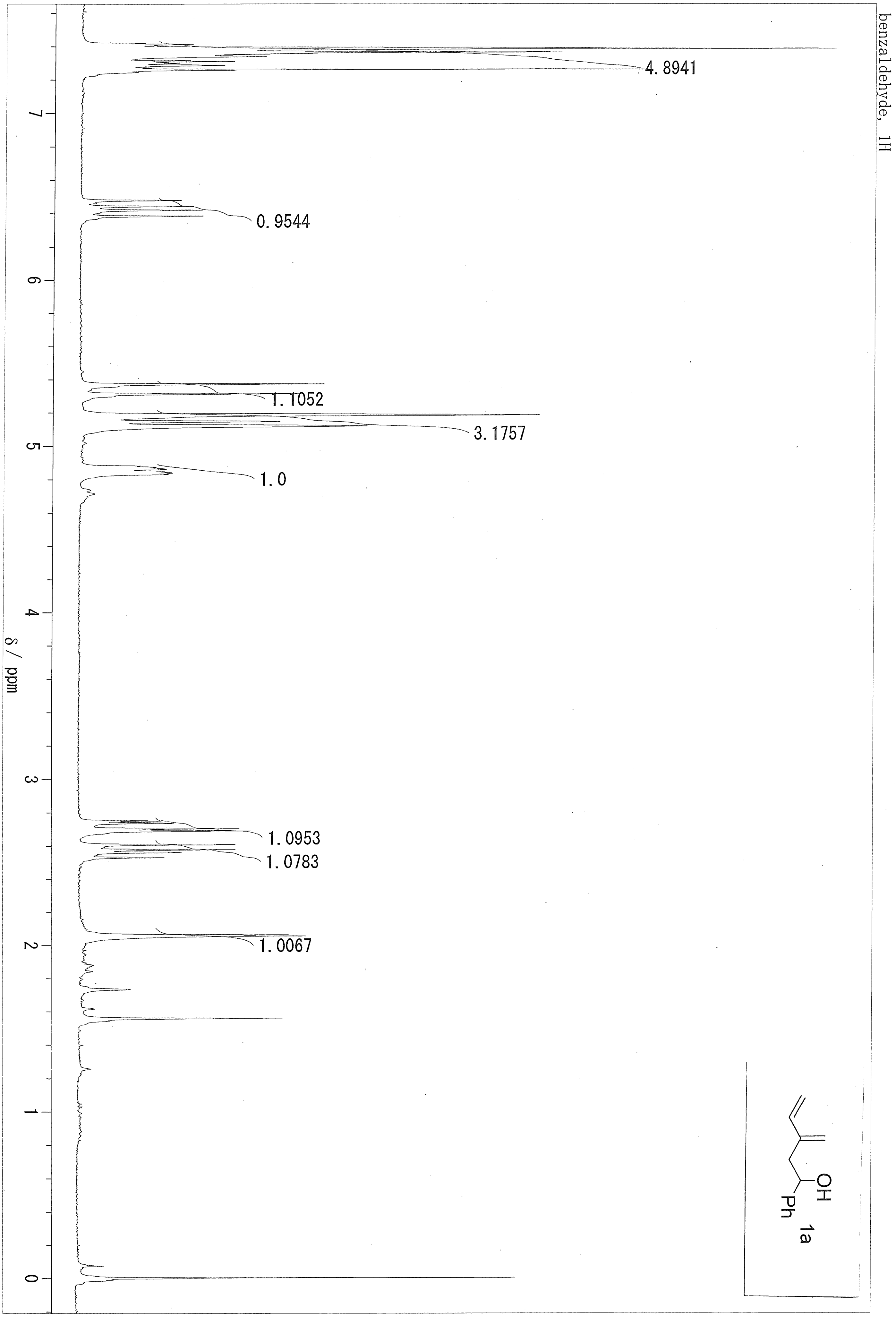
10.3 Hz, 1 H), 5.15 (s, 1 H), 5.23 (d, *J* = 17.6, 1 H), 6.38 (dd, *J* = 17.6, 10.3 Hz, 1 H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ 26.7, 28.3, 29.2, 36.9, 43.6, 73.4, 114.1, 118.2, 138.4, 143.6. High-resolution MS, calcd for $C_{12}H_{20}O$: 180.1514. Found *m/z* (relative intensity): 180.1506 (M^+, 29.5), 162.1354 (100).

6-Methyleneoct-7-ene-1,4-diol (1k); IR (neat): 3306 (br), 3086 (w), 2935 (s), 2872 (m), 2359 (w), 1703 (w), 1595 (s), 1435 (s), 1404 (s), 1227 (s), 999 (m), 899 (s), 748 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.67-1.83 (m, 4 H), 2.17 (s, 2 H), 2.29 (dd, *J* = 13.9, 9.0 Hz, 1 H), 2.50 (dd, *J* = 13.9, 3.8 Hz, 1 H), 3.68 (m, 2 H), 3.80 (ddm, *J* = 9.0, 3.8 Hz, 1 H), 5.10 (s, 1 H), 5.12 (d, *J* = 11.1 Hz, 1 H), 5.17 (s, 1 H), 5.26 (d, *J* = 17.6 Hz, 1 H), 6.39 (dd, *J* =17.6, 11.1 Hz, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 29.3, 34.1, 40.2, 62.9, 69.6, 114.2, 118.3, 138.3, 142.9. High-resolution MS, calcd for $C_9H_{16}O_2$: 156.1150. Found *m/z* (relative intensity): 156.1146 (M^+, 87.9), 138.1017 (100).

7-Methylenenon-8-ene-1,5-diol (1l); IR (neat): 3331 (br), 3088 (w), 2937 (s), 2864 (m), 1595 (m), 1437 (m), 1404 (m), 1072 (m), 1028 (m), 899 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.49-1.63 (m, 6 H), 2.23 (dd, *J* = 13.9, 8.9 Hz, 1 H), 2.51 (dd, *J* = 13.9, 3.8 Hz, 1 H), 3.66 (t, *J* = 6.2 Hz, 2 H), 3.75 (m, 1 H), 5.09 (s, 1 H), 5.11 (d, *J* = 10.9 Hz, 1 H), 5.15 (s, 1 H), 5.24 (d, *J* = 17.6 Hz, 1 H), 6.38 (dd, *J* = 17.6, 10.9 Hz, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 22.0, 32.7, 36.8, 40.2, 62.9, 69.5, 114.2, 118.3, 138.4, 143.1. High-resolution MS, calcd for $C_{10}H_{18}O_2$: 170.1307. Found *m/z* (relative intensity): 170.1304 (M^+, 94.6), 137.0912 (100).

Reference

1) S. Kodato, M. Nakagawa, K. Nakayama, T. Hino, *Tetrahedron*, **1989**, *45*, 7247.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δ / ppm
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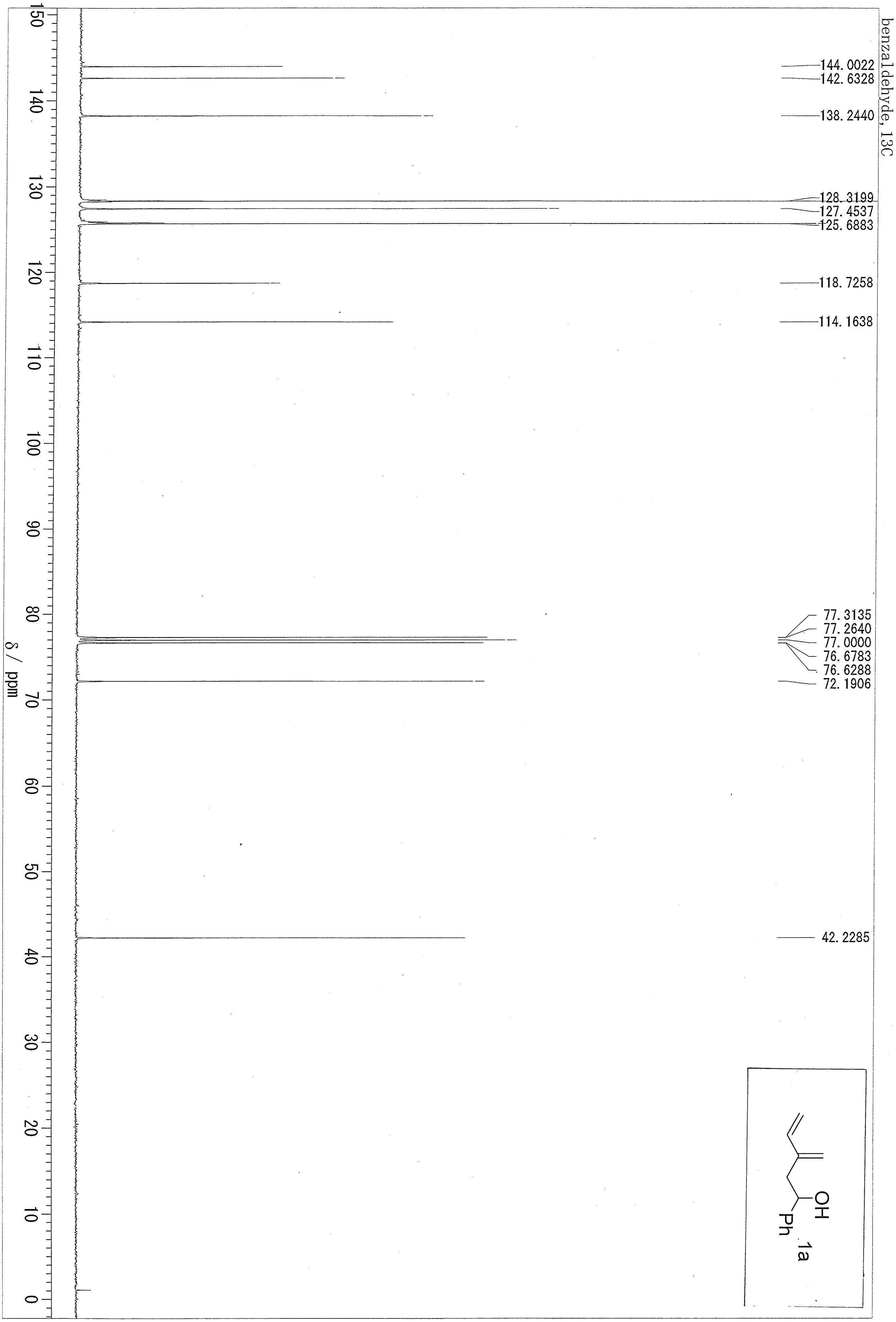
6
5
4
3
2
1
0
OH
Ph
1a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77.0000
76.6783
76.6288
72.1906
42.2285
δ / ppm
150
140
130
120
110
100
90
80
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50
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30
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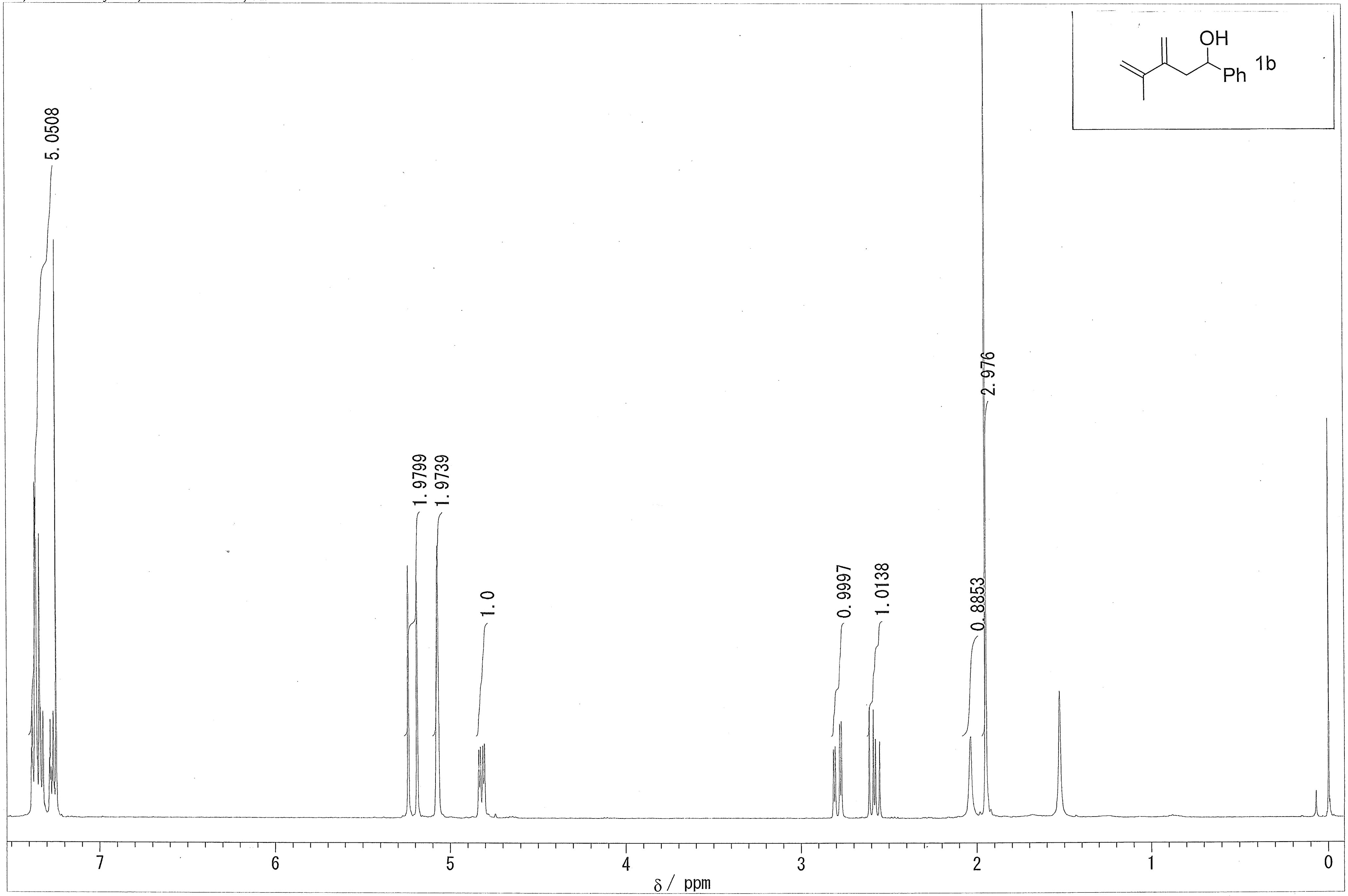
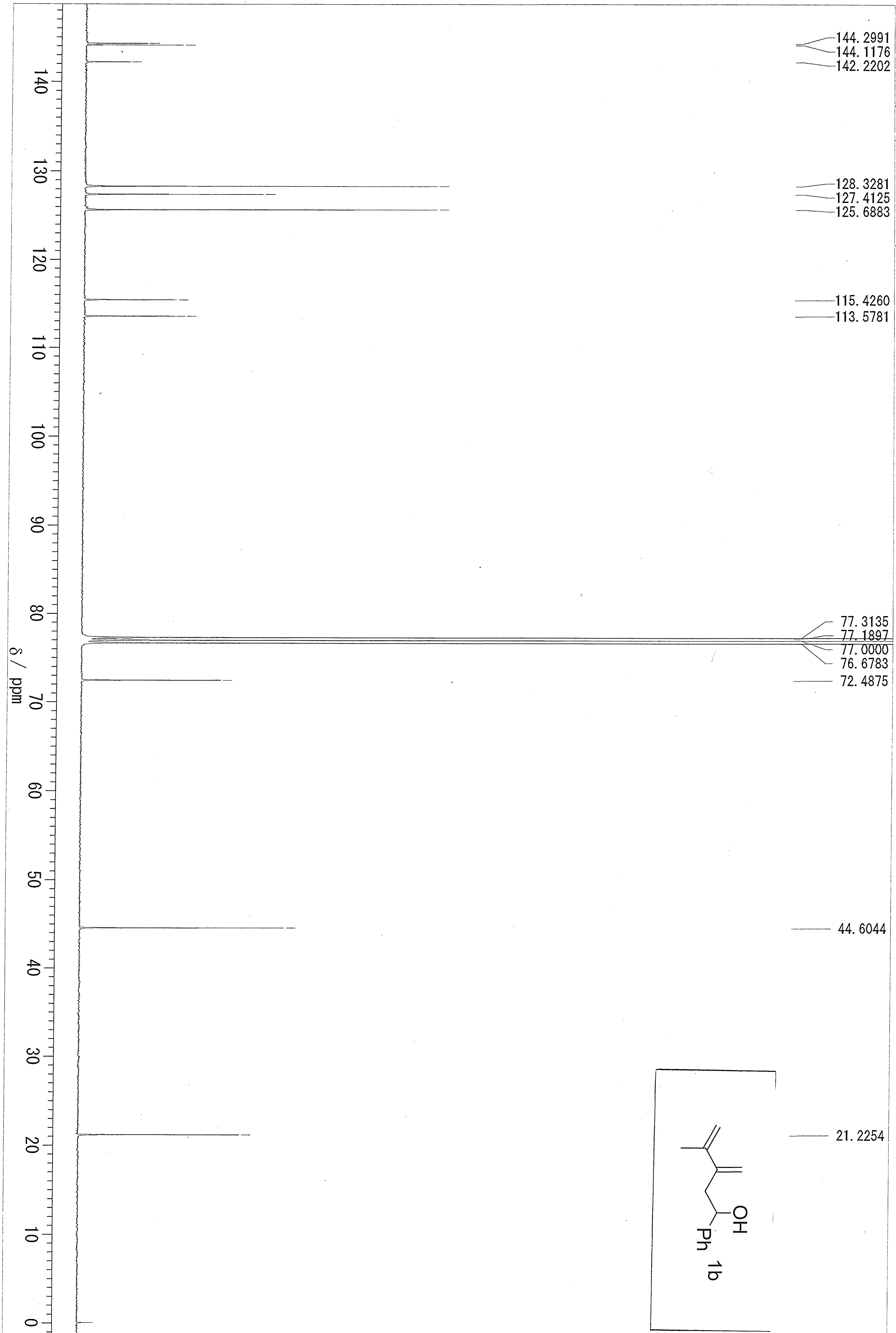
Ph
1a

2,3-dimethyl-1,3-butadiene, 1H

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77.0000
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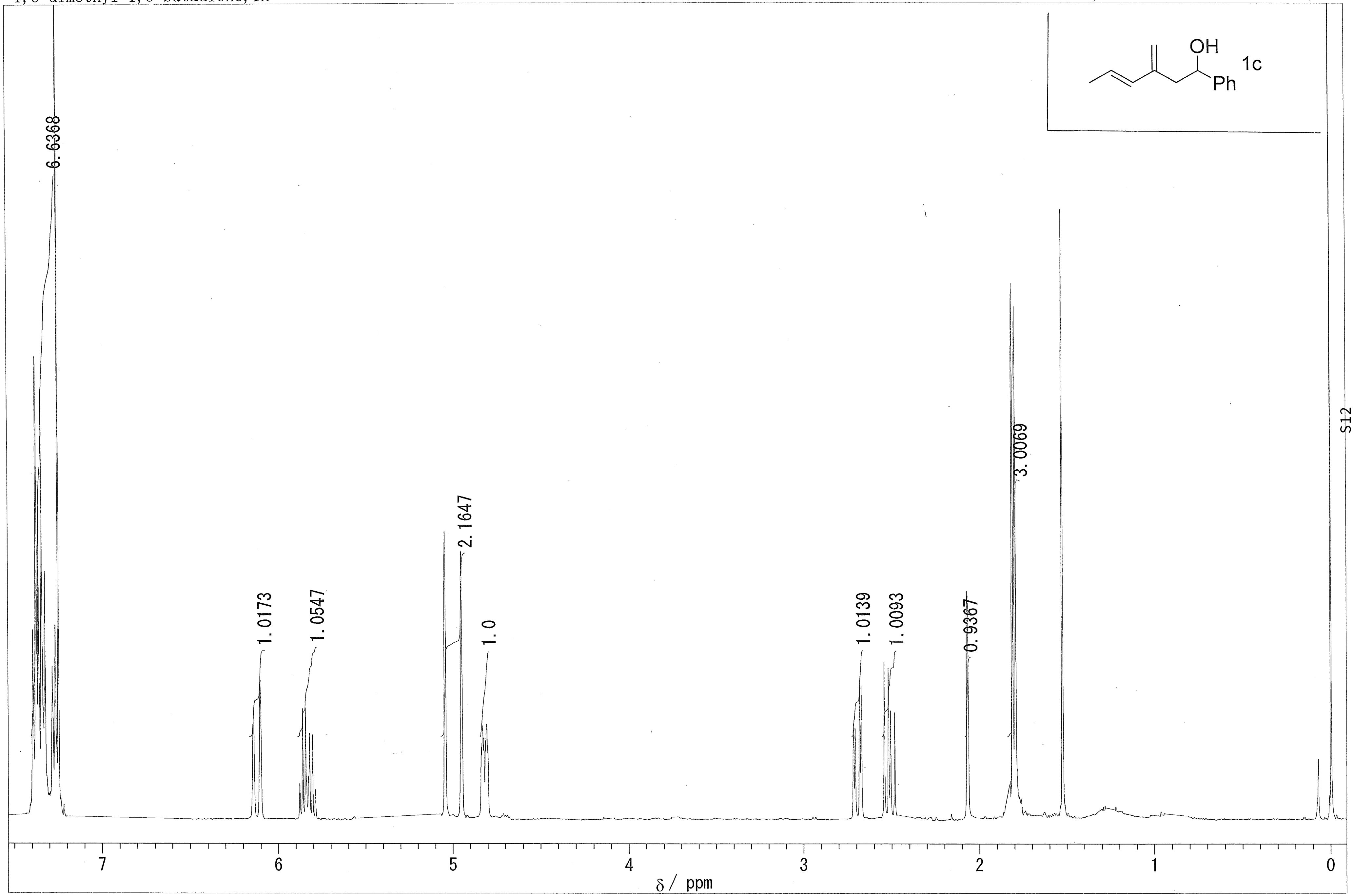
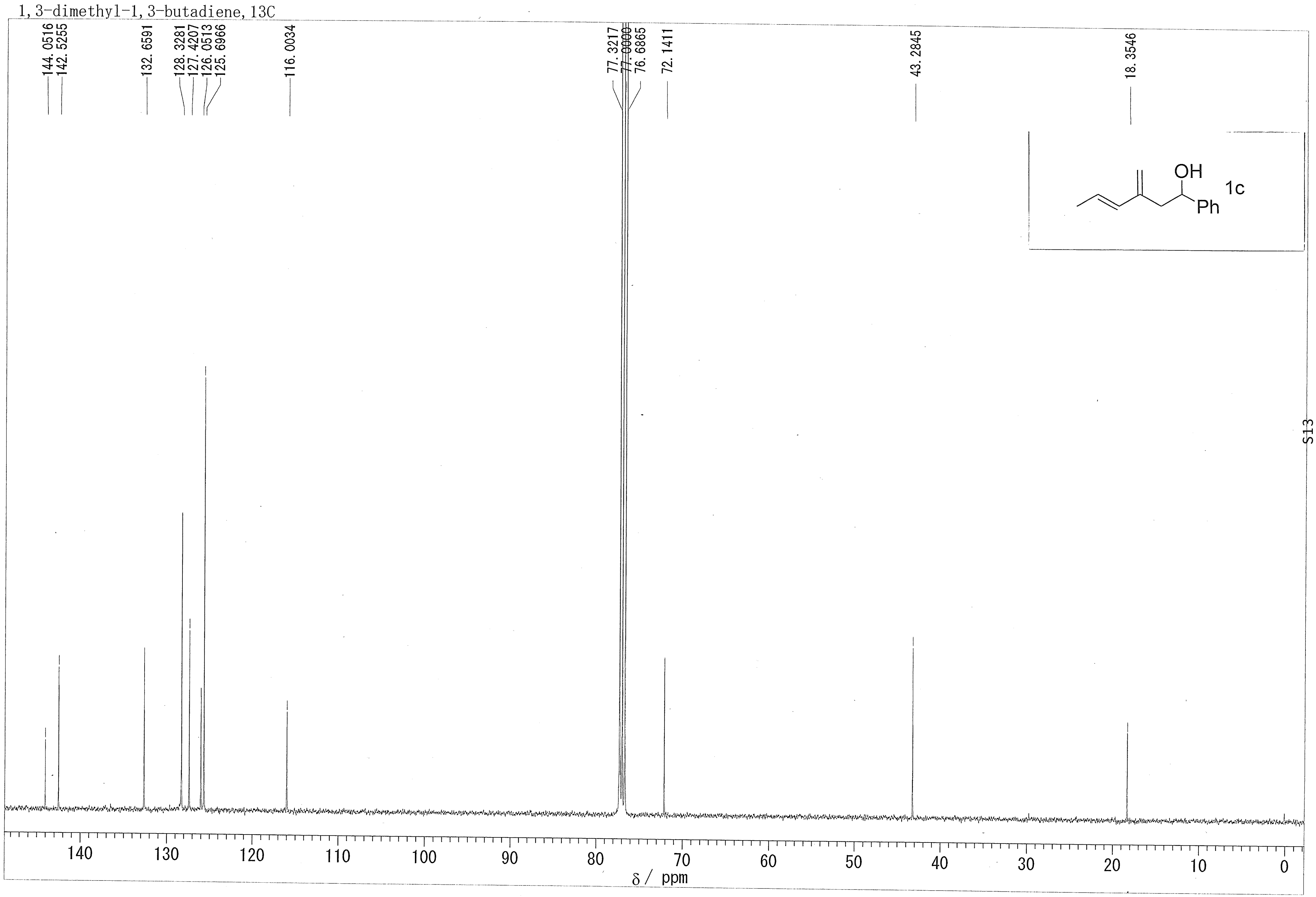
44.6044
21.2254
δ / ppm
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
OH
Ph
1b

1,3-dimethyl-1,3-butadiene, 1H

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77.0000
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18.3546
OH
Ph
1c
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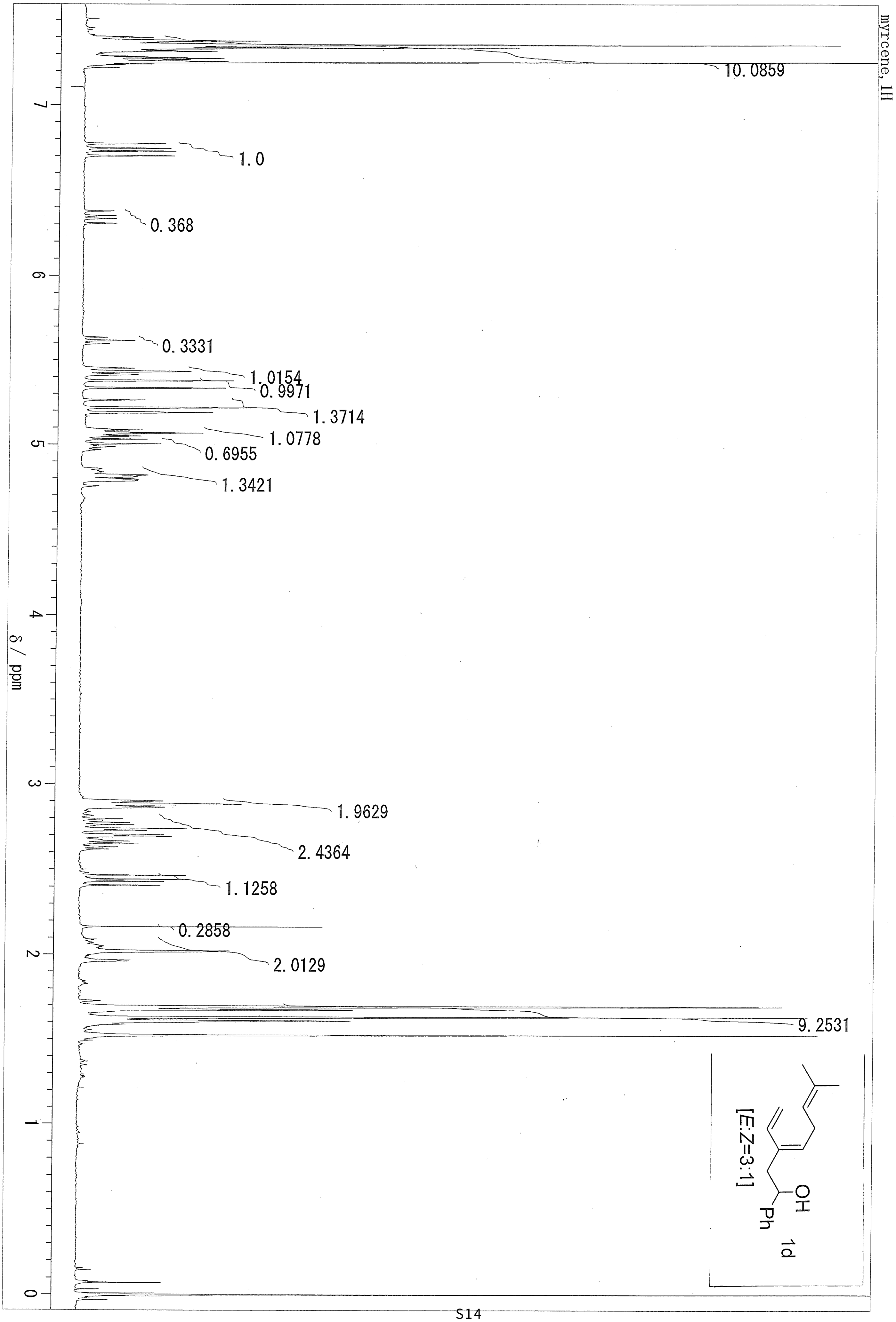
130
120
110
100
90
80
70
60
50
40
30
20
10
0
δ / ppm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δ / ppm
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0.6955
1.3421
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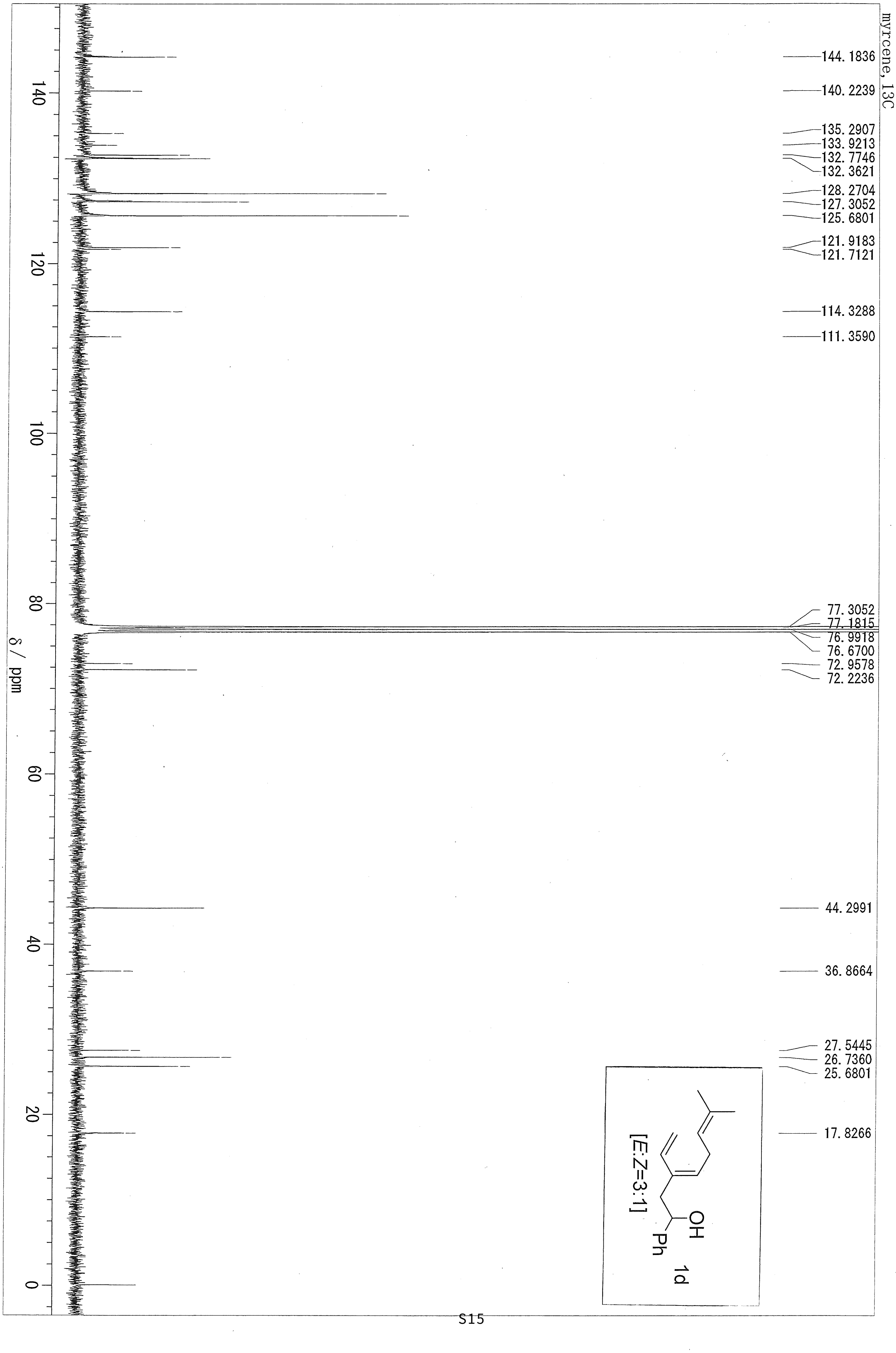
1d
[E:Z=3:1]


myrcene, 13C
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121.7121
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77.3052
77.1815
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76.6700
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72.2236
44.2991
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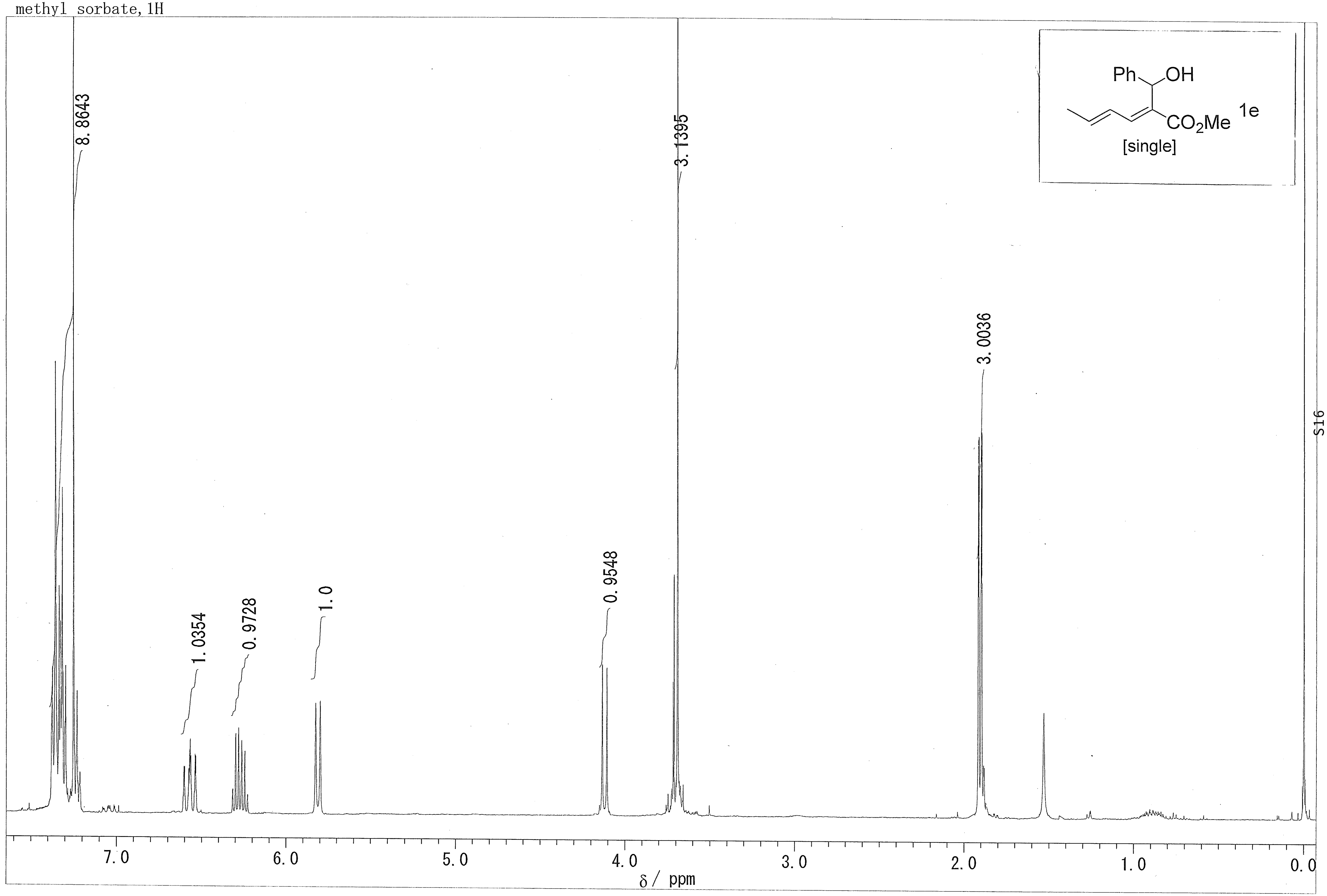
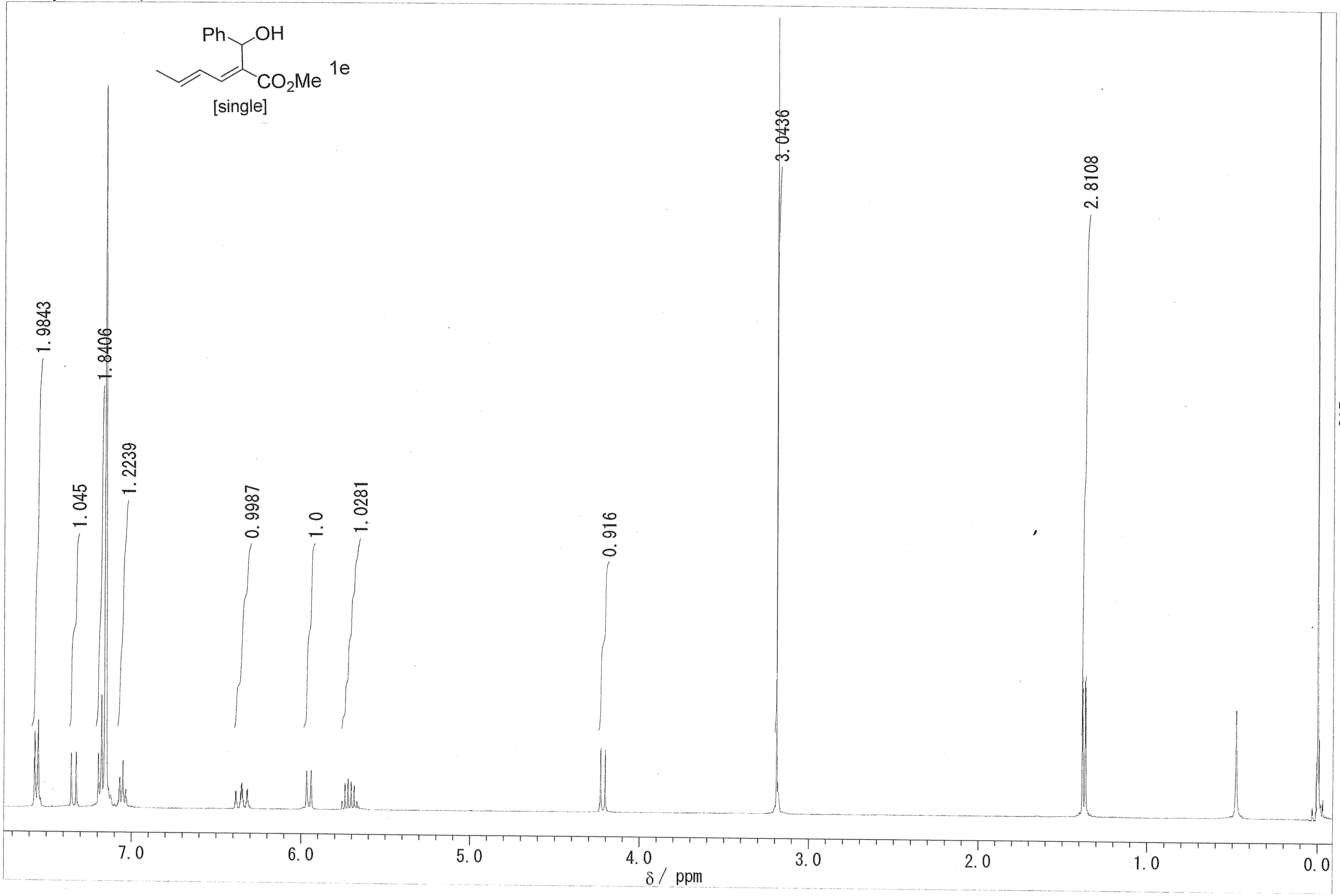
27.5445
26.7360
25.6801
17.8266
140
120
100
80
60
40
20
0
δ / ppm
OH
Ph
1d
[E:Z=3:1]

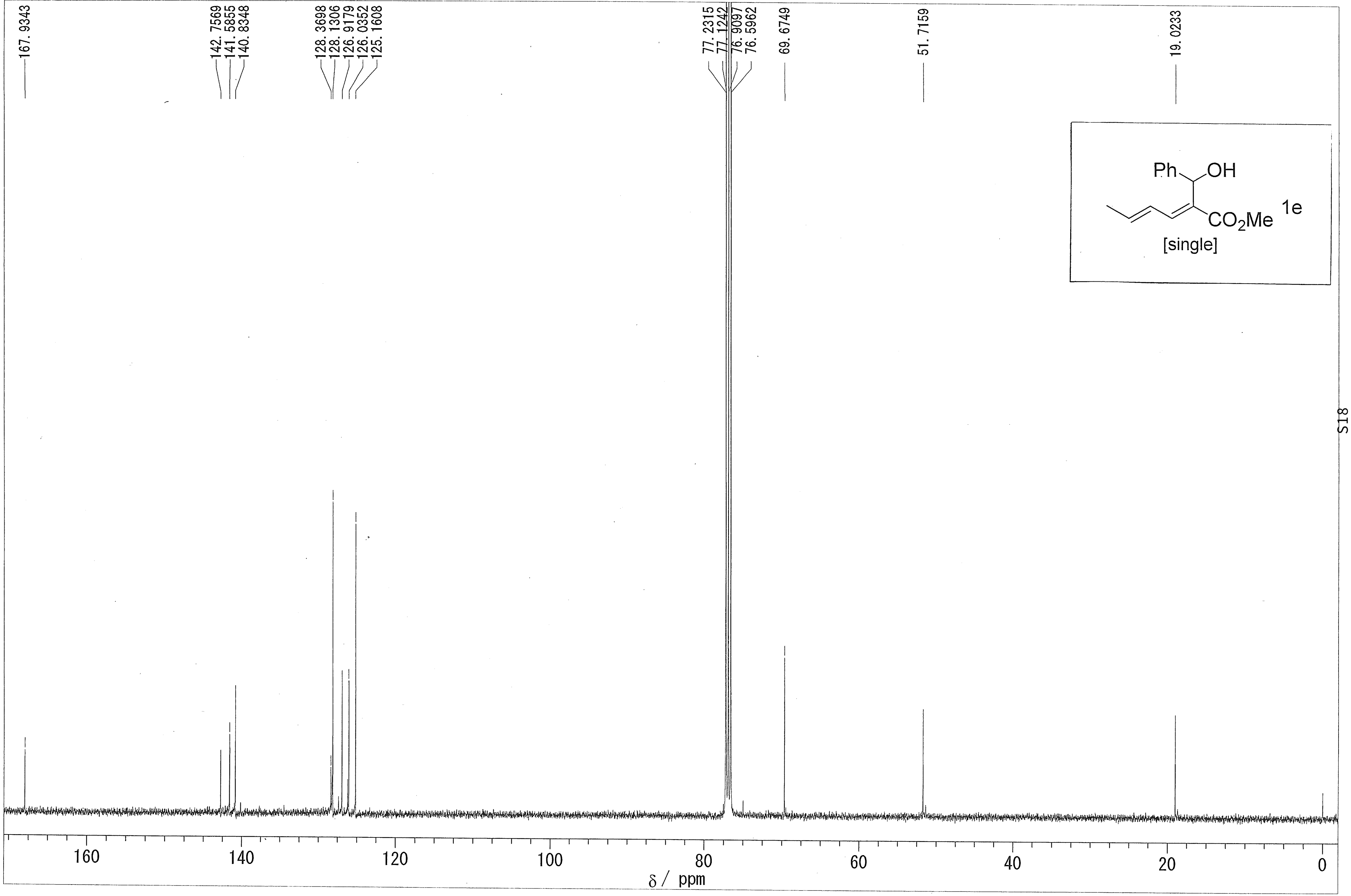


methyl sorbate, 1H
8.8643
1.0354
0.9728
1.0
0.9548
3.1395
3.0036
Ph
OH
CO_2Me
1e
[single]
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
δ / ppm

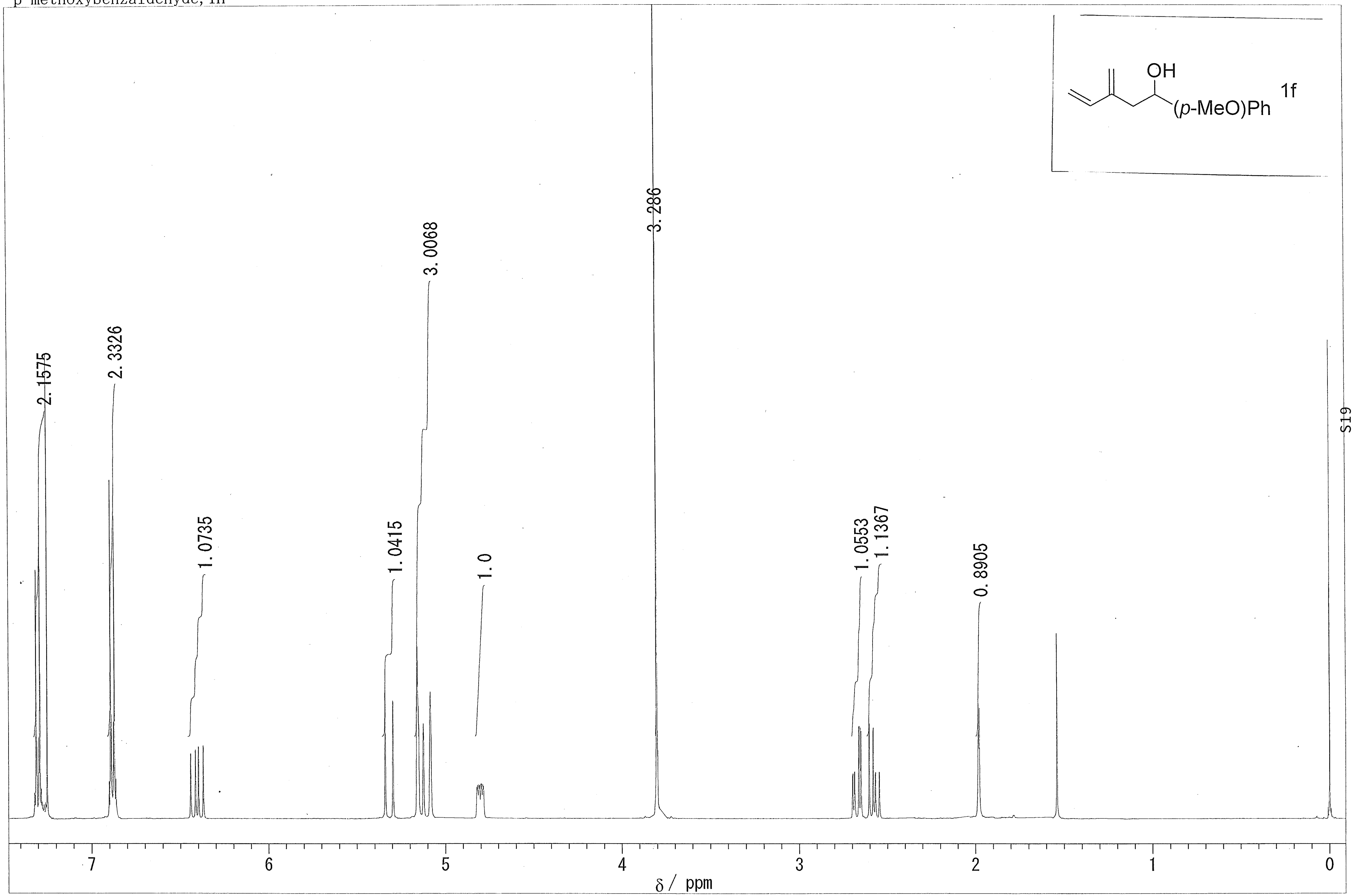
methyl sorbate, C6D6 solvent C_6D_6



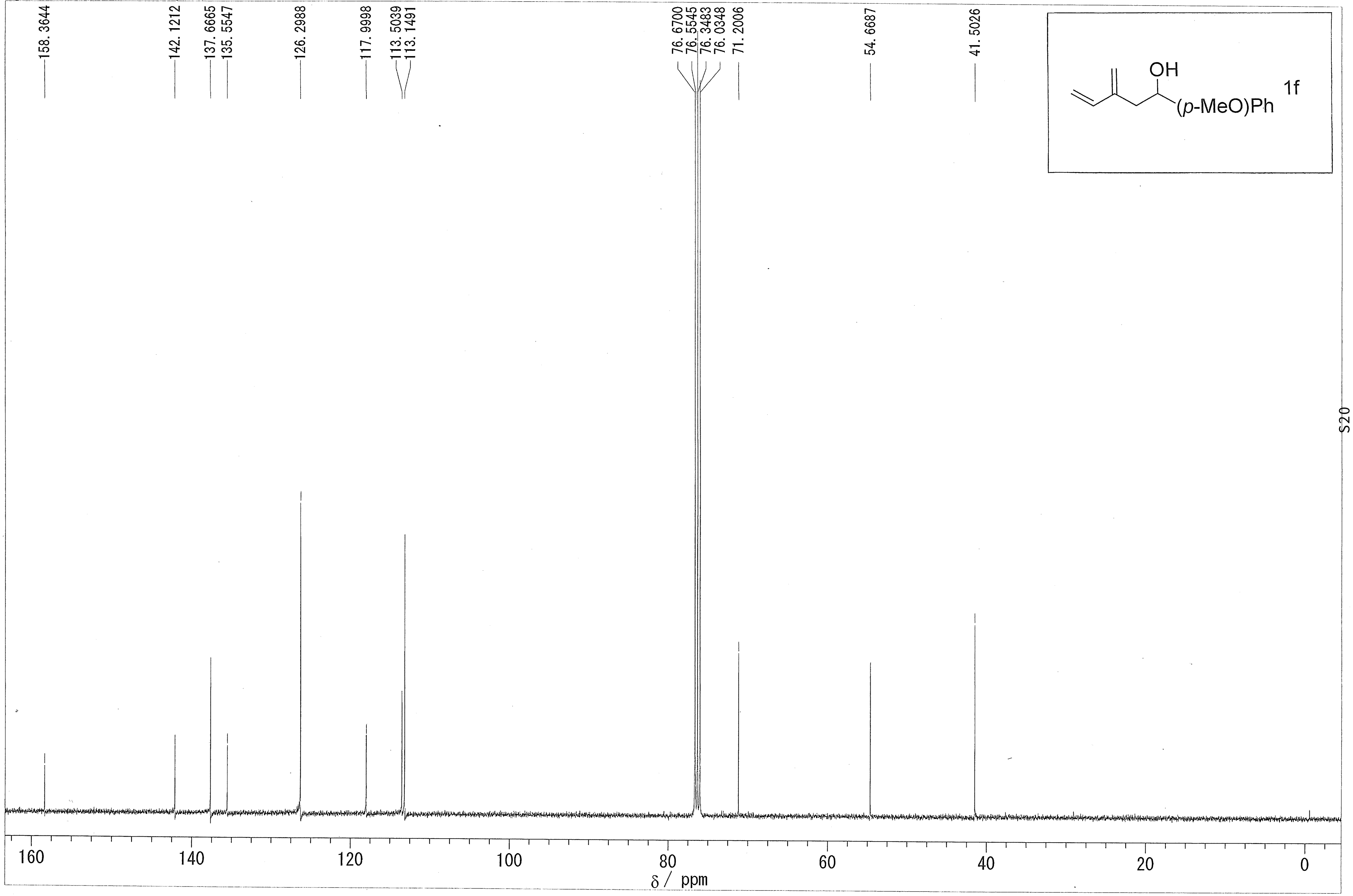
methyl sorbate, 13C



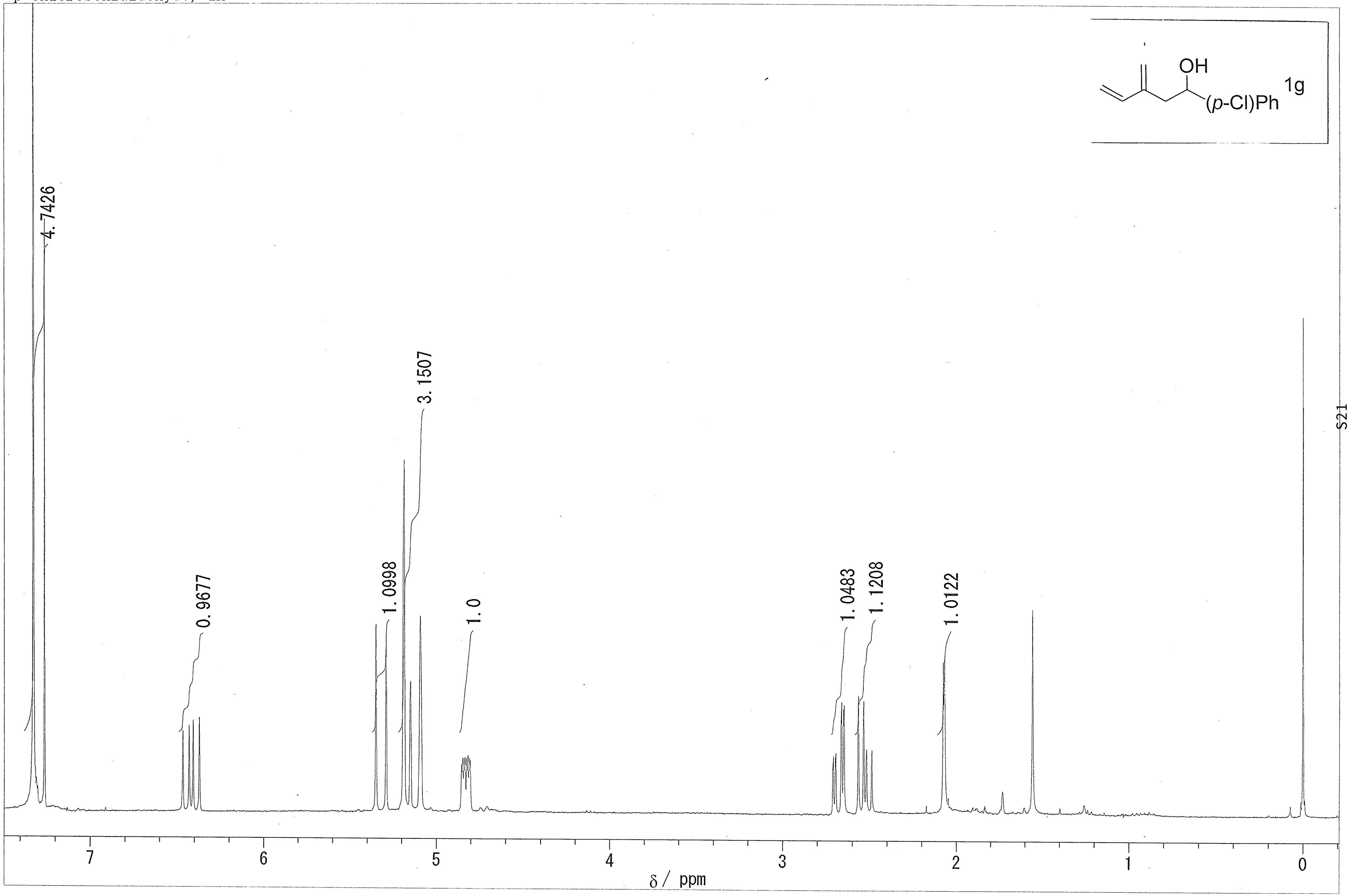
p-methoxybenzaldehyde, 1H



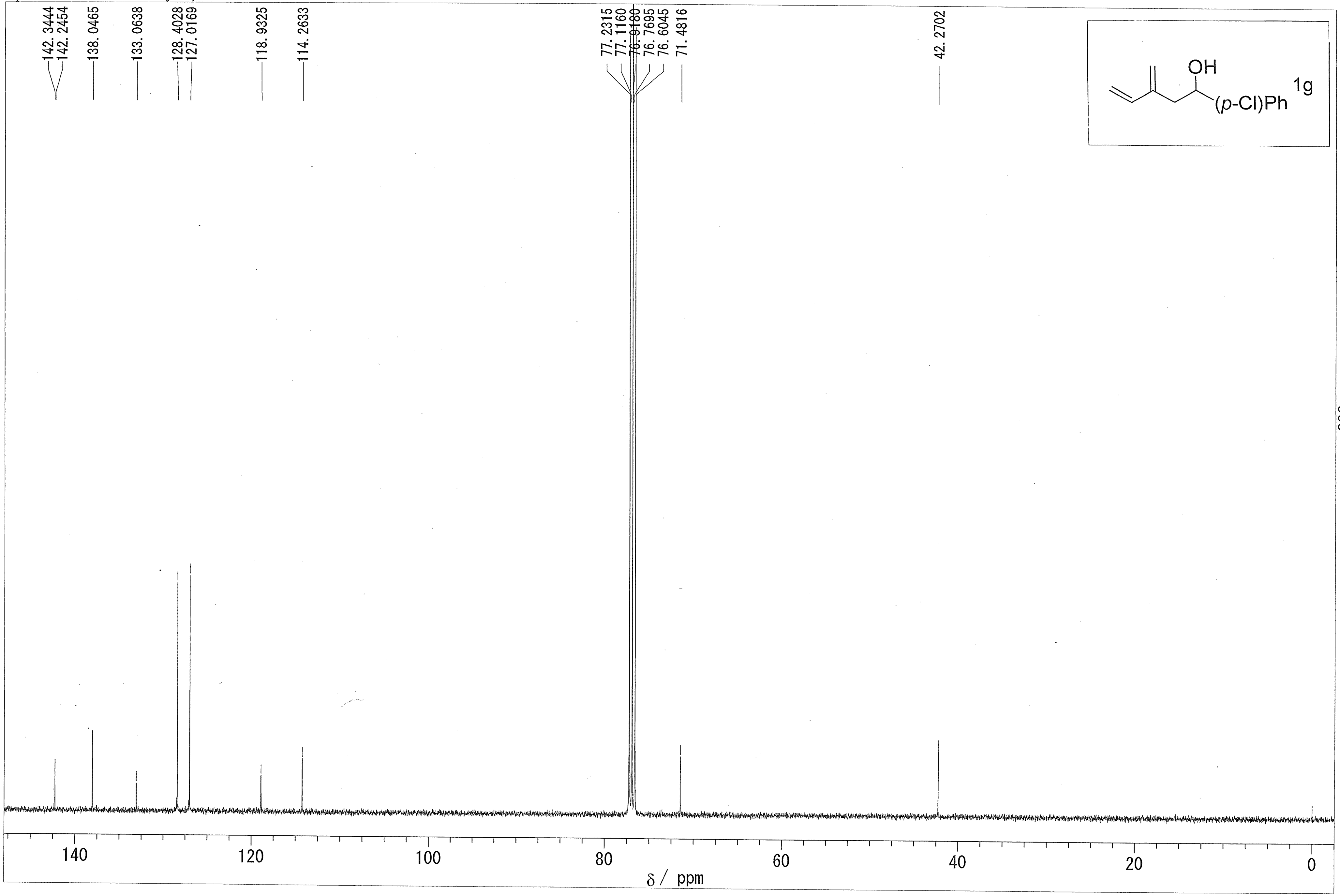
p-methoxybenzaldehyde, 13C



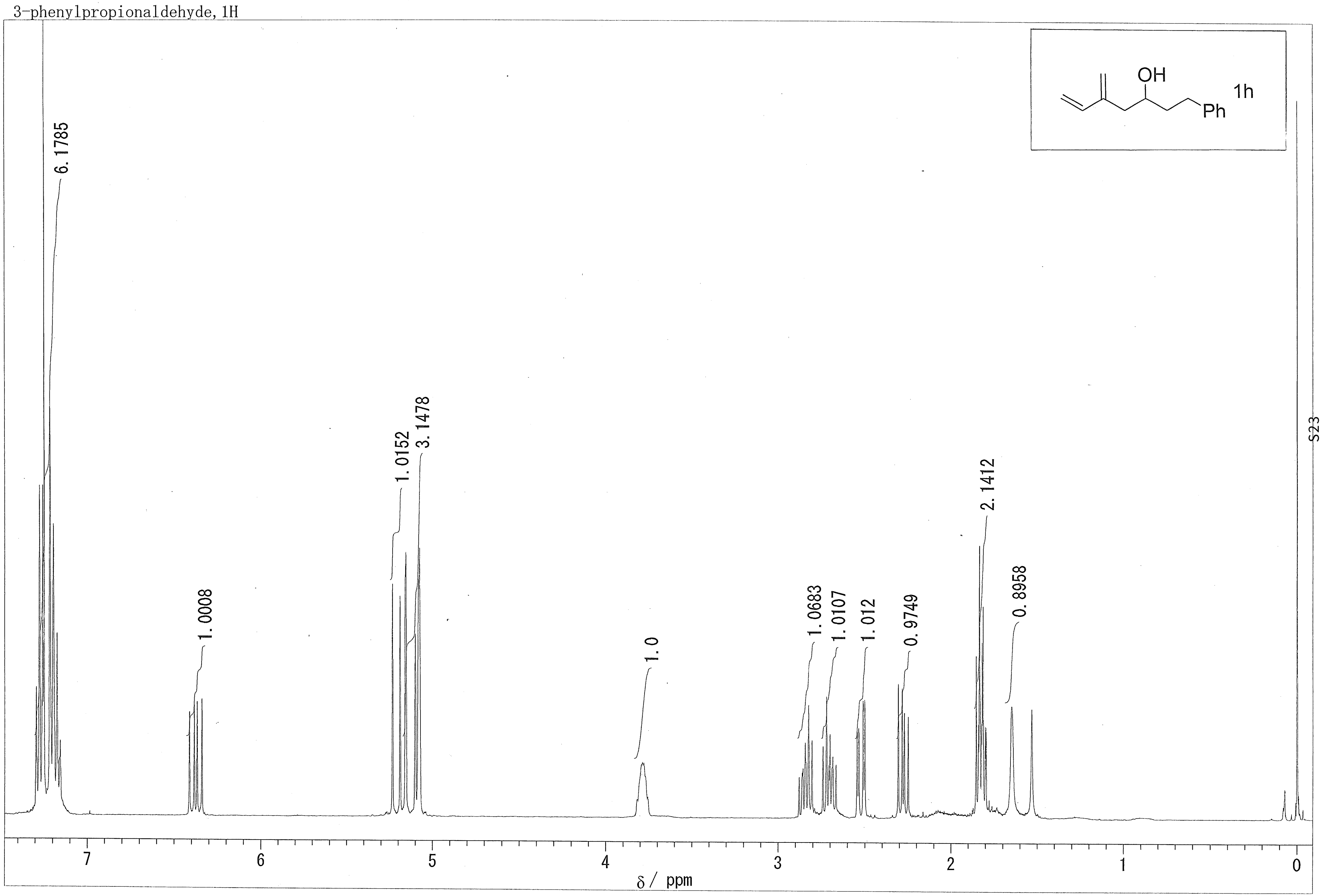
p-chlorobenzaldehyde, 1H

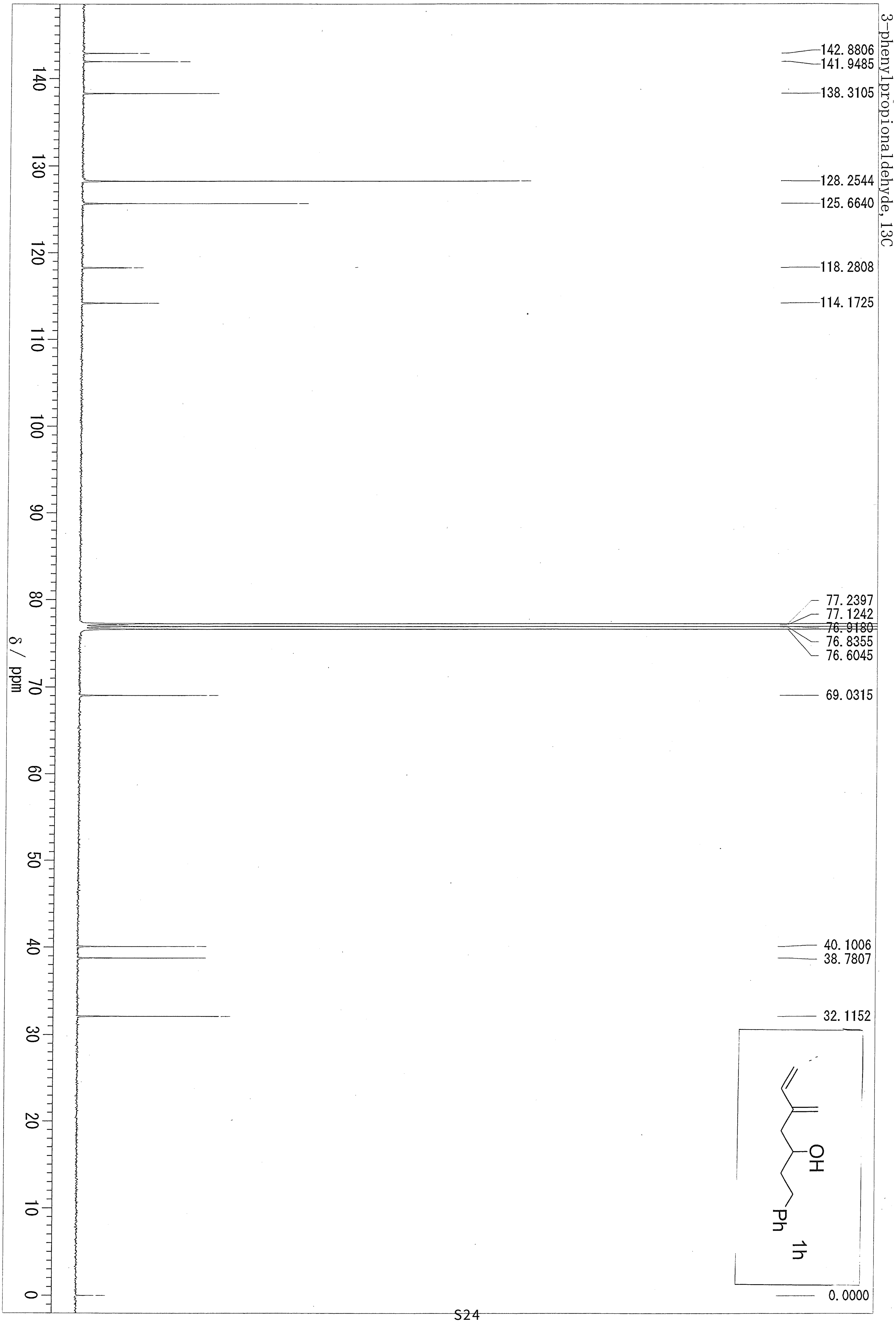


p-chlorobenzaldehyde, 13C

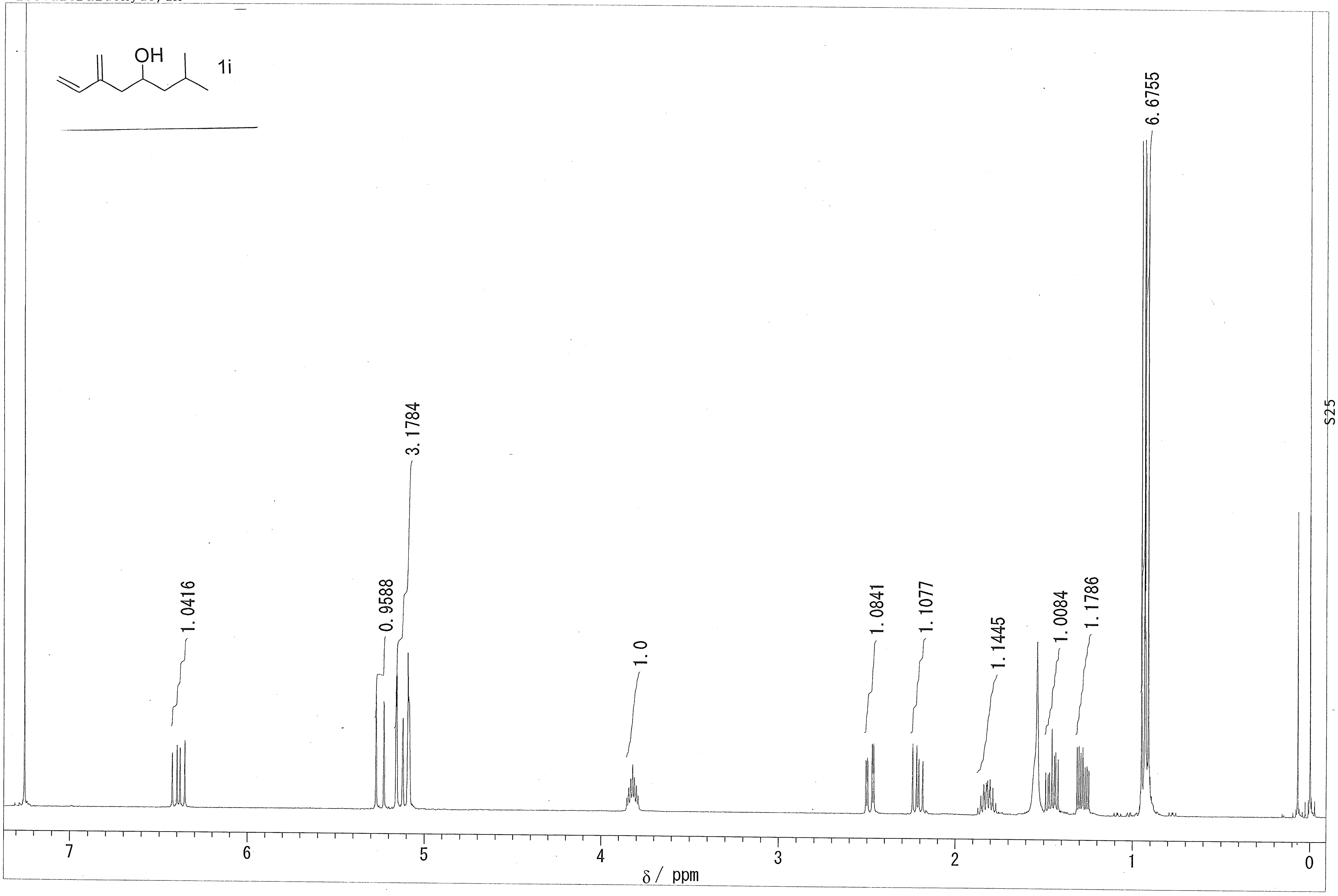


1g

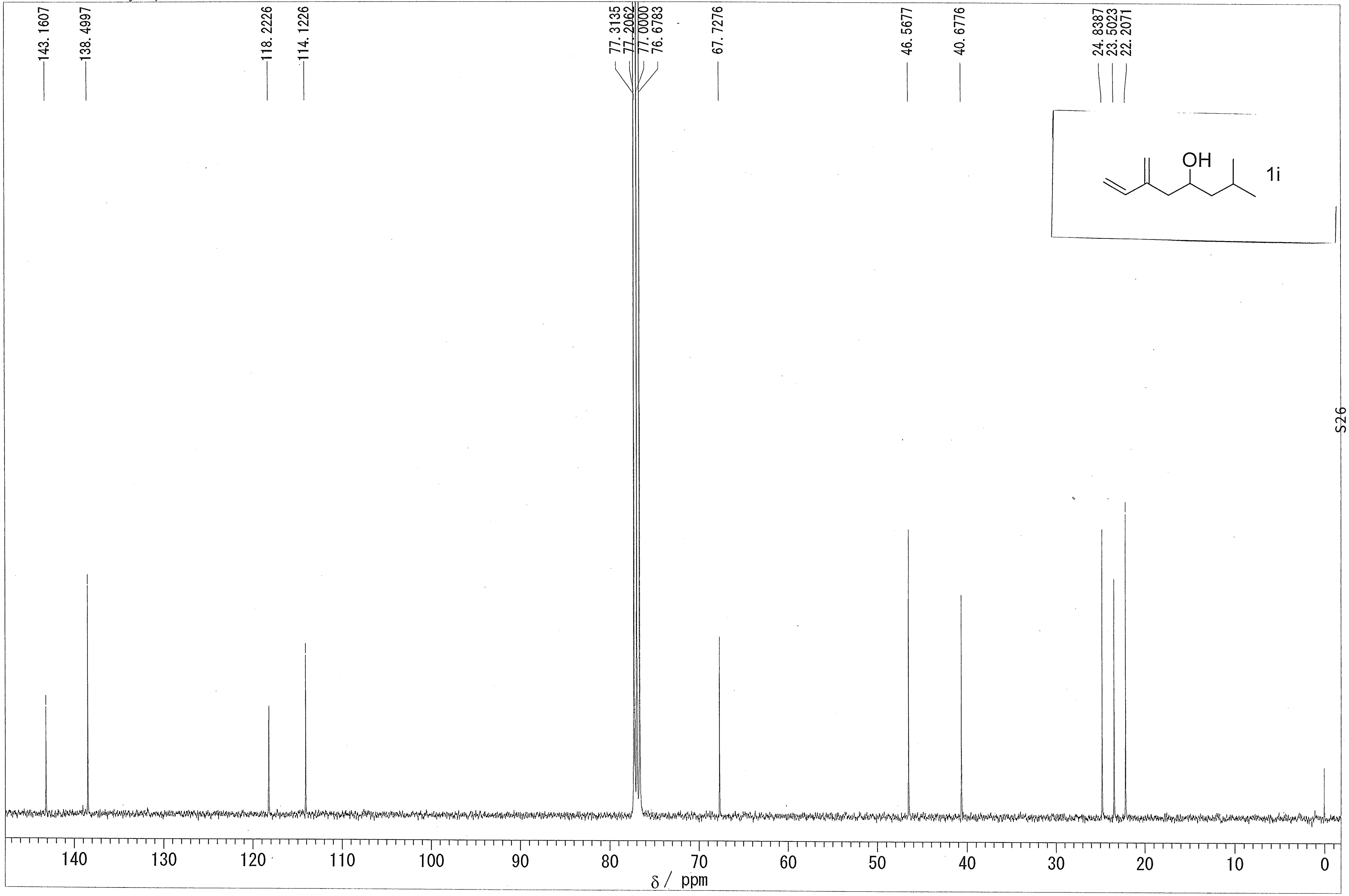

3-phenylpropionaldehyde, 1H
OH
Ph
1h
6.1785
1.0008
1.0152
3.1478
1.0
1.0683
1.0107
1.012
0.9749
2.1412
0.8958
7
6
5
4
3
2
1
0
δ / ppm


3-phenylpropionaldehyde, 13C
142.8806
141.9485
138.3105
128.2544
125.6640
118.2808
114.1725
77.2397
77.1242
76.9180
76.8355
76.6045
69.0315
40.1006
38.7807
32.1152
0.0000
δ / ppm
OH
Ph
1h

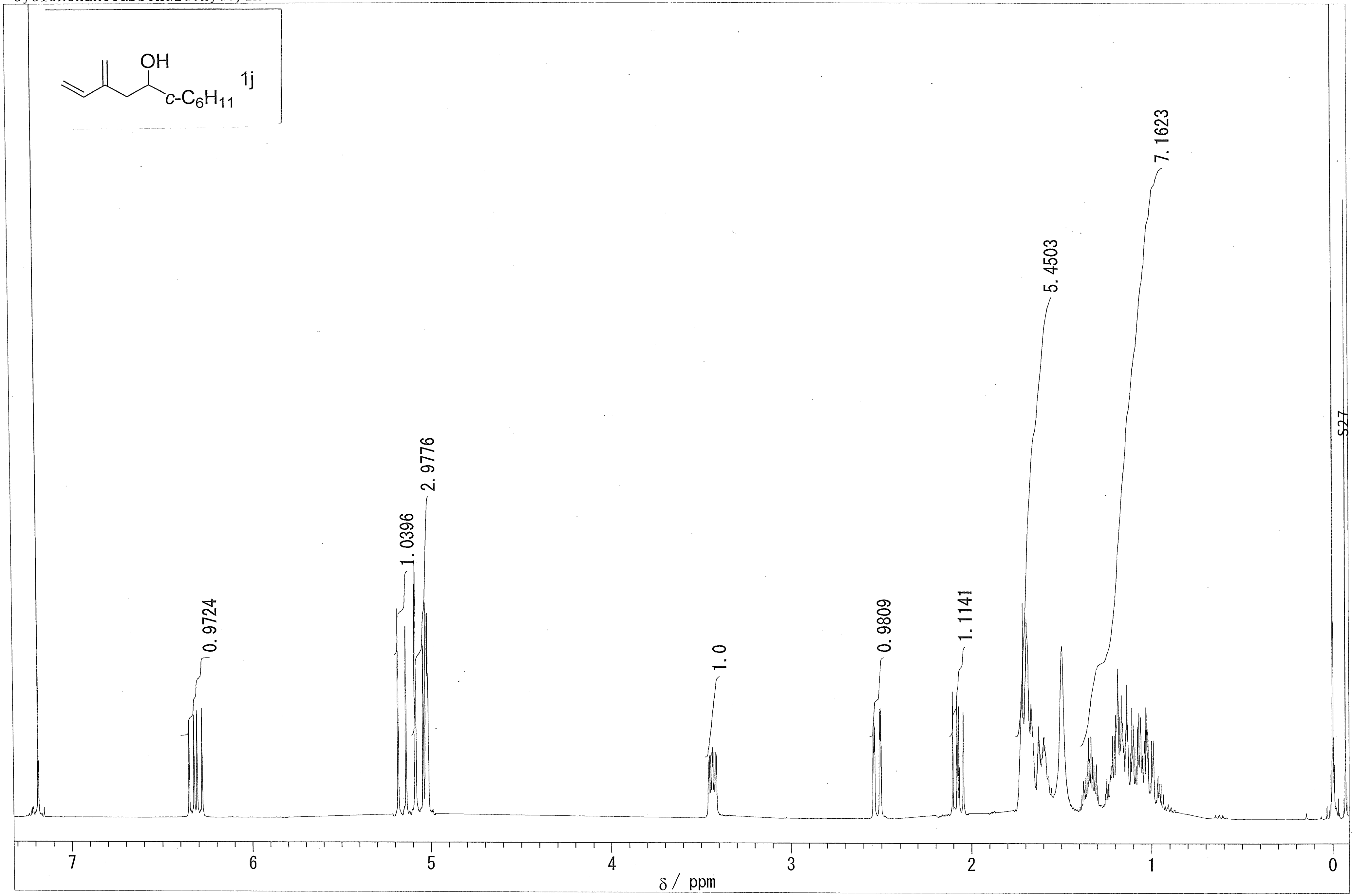
isovaleraldehyde, 1H



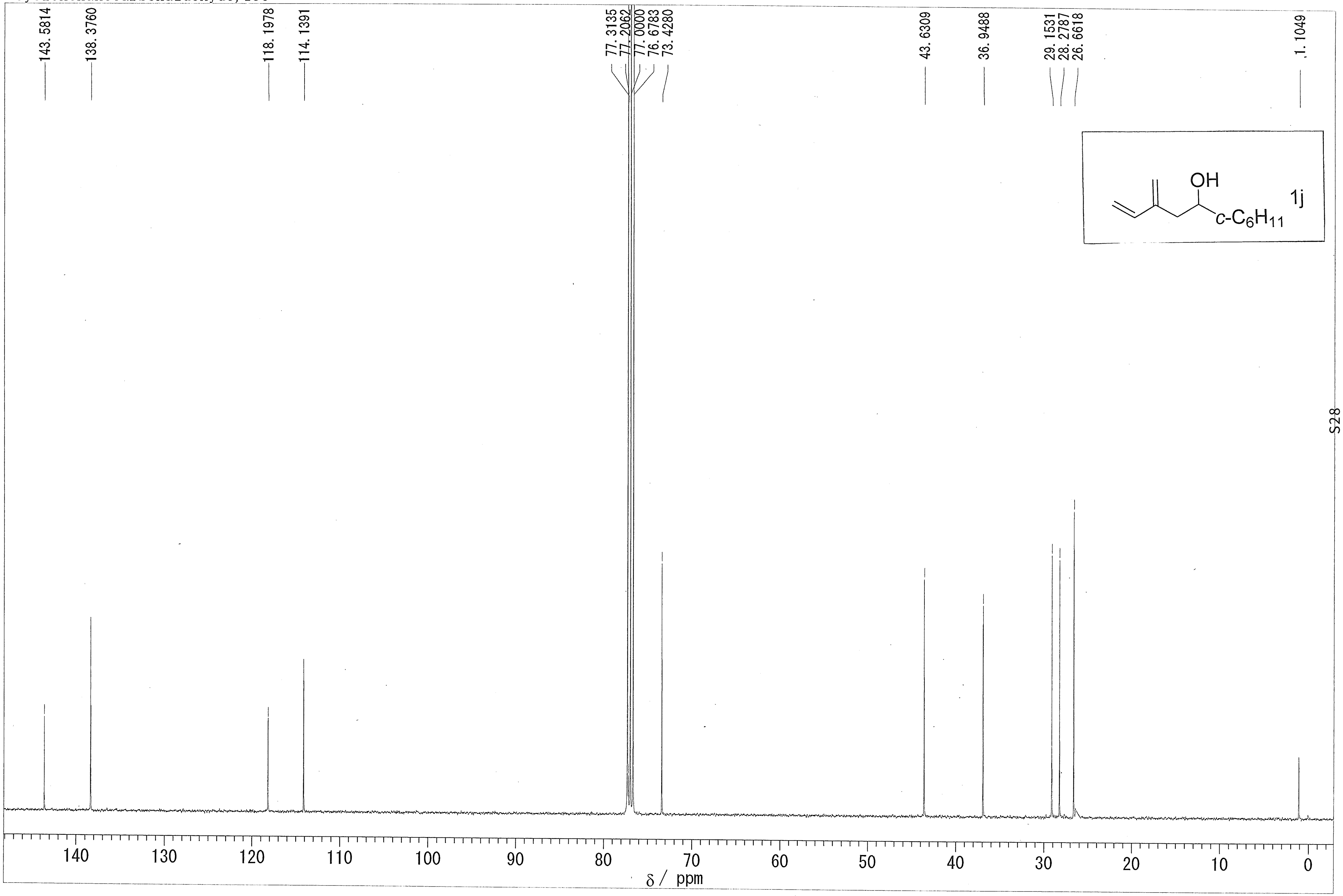
isovaleraldehyde, 13C



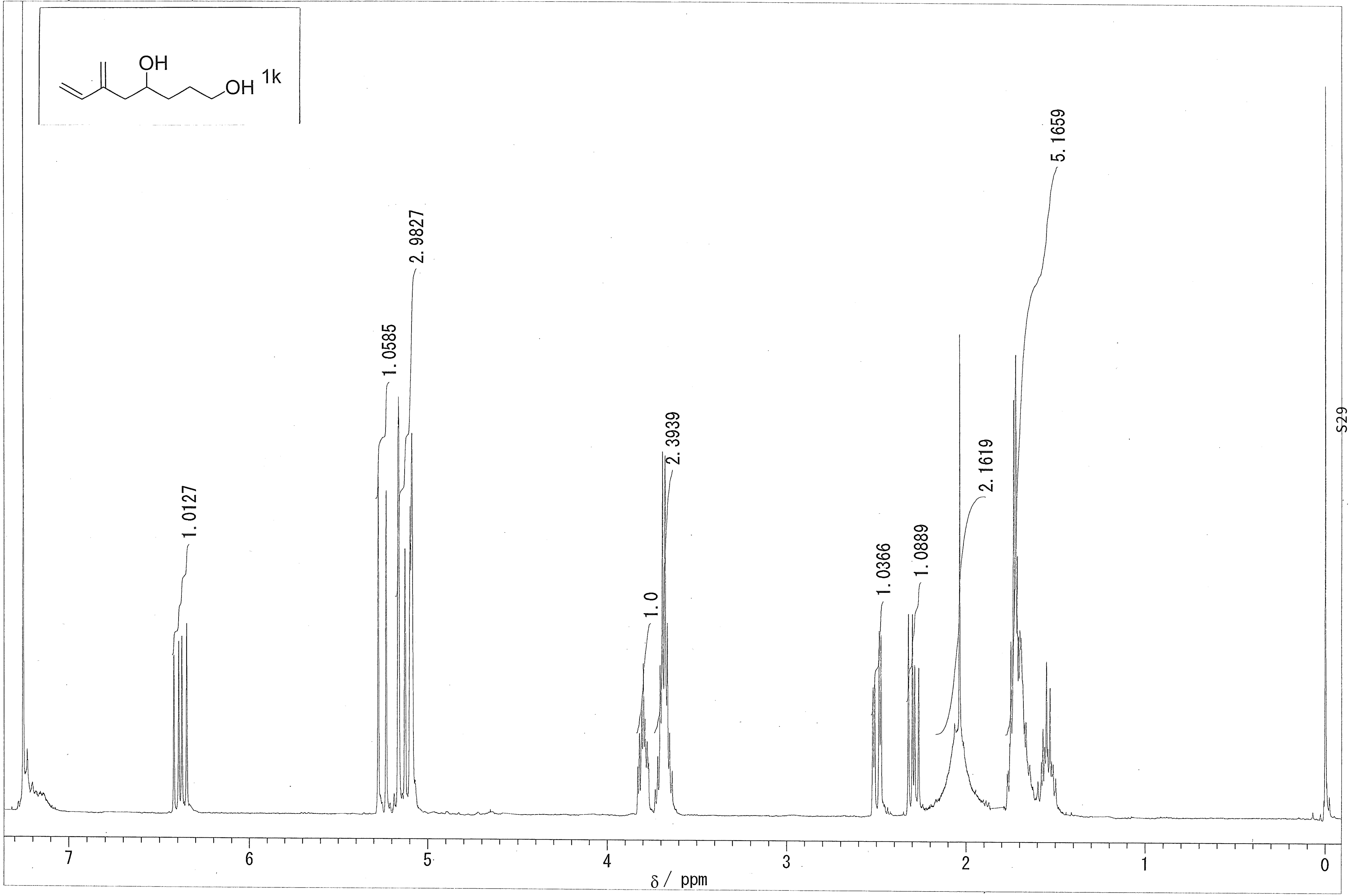
cyclohexanecarboxaldehyde, 1H



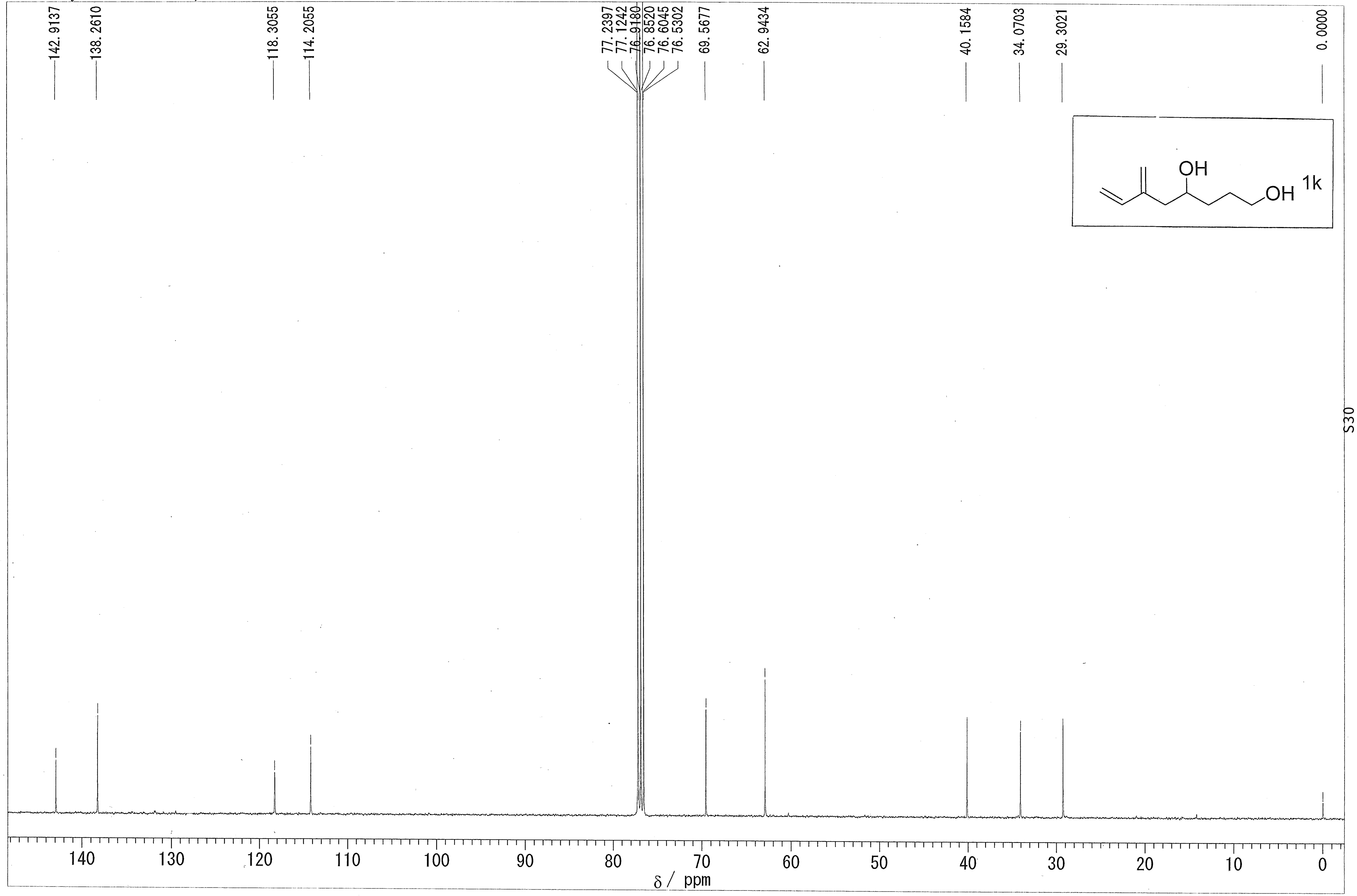
cyclohexanecarboxaldehyde, 13C

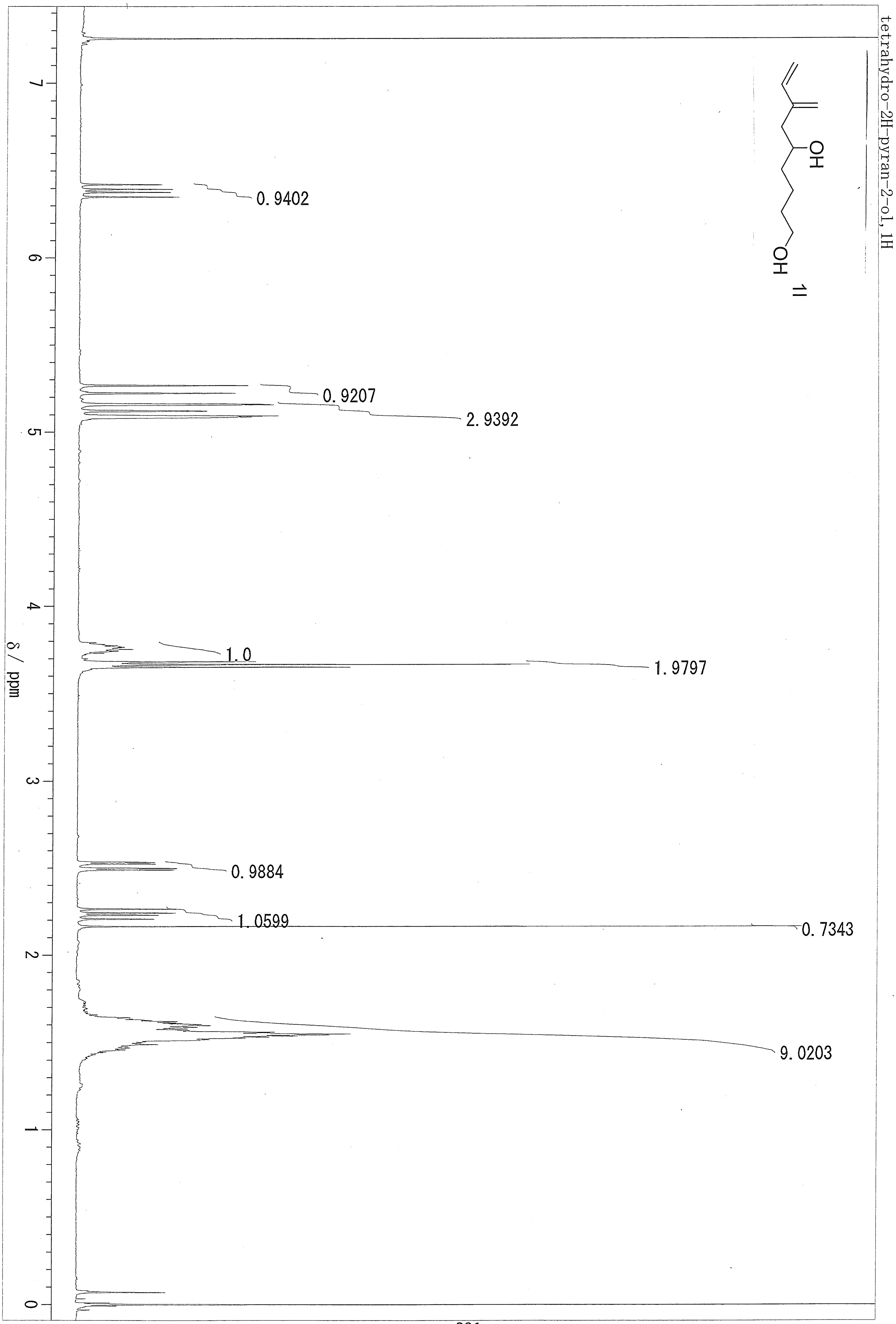


tetrahydrofuran-2-ol, 1H



tetrahydrofuran-2-ol, 13C




tetrahydro-2H-pyran-2-ol, 1H
OH
OH
1l
0.9402
0.9207
2.9392
1.0
1.9797
0.9884
1.0599
0.7343
9.0203
δ / ppm
7
6
5
4
3
2
1
0

tetrahydro-2H-pyran-2-ol, 13C