SUPPORTING INFORMATION

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Experimental part

All reactions were performed under nitrogen atmosphere with oven (80ºC) or flame-dried glassware. All solvents were distilled prior to use; diethyl ether and tetrahydrofuran were dried by distilling over sodium benzophenone ketyl. Toluene, acetonitrile, dichloromethane and dimethylformamide were distilled over calcium hydride. Cesium carbonate and sodium iodide were flame-dried under reduced pressure before use. Materials were detected by visualization under ultraviolet lamp and/or by spraying with a solution of phosphomolybdic acid (10% in ethanol) or an aqueous solution of $KMnO_4$ (1% w/w) followed by heating on a hot plate. For the NMR spectra assignments, the following abbreviations were used: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet and br, broad. Chemical shifts are reported in δ values relative to the solvent used ($CHCl_3$: 7.26 ppm for ^{1}H NMR and 77.0 ppm for ^{13}C NMR) as internal standard. Where necessary COSY, NOESY and J-resolved correlation experiment were performed.

Alcohol 5.
To a solution of but-3-yn-1-ol (1 mL, 13.2 mmol) in CH_2Cl_2 (60 mL) at 0^{o}C, was added *p*-toluenesulfonic acid (29.3 mg, 0.15 mmol) followed by 3,4-dihydro-2H-pyrane (1.55 mL, 17 mmol). The solution was stirred overnight at room temperature. $NaHCO_3$ (32 mg) and sat. $NaHCO_3$ (25 mL) were introduced and the mixture was stirred for 15 min, followed by extraction with CH_2Cl_2 (3 x 60 mL). The organic layer was dried over $MgSO_4$, the solvent was evaporated *in vacuo*, and the residue was chromatographed on silica gel with 5% EtOAc in hexane to give **5** as an oil (1.75 g, 86%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 4.65 (1H, t, J=3.5Hz, OC<u>H</u>O) ; 3.92-3.80 (2H, m, $CH_2C\underline{H_2}O$) ; 3.60-3.45 (2H, m, $CH_2C\underline{H_2}O$) ; 2.50 (2H, td, J=7Hz, 3Hz, $OCH_2C\underline{H_2}$) ; 1.95 (1H, t, J=2.5Hz, <u>H</u>C C) ; 1.85-1.50 (6H, m, C<u>H$_2$</u> THP). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 98.57, 81.27, 69.17, 65.38, 61.99, 30.41, 25.32, 19.82, 19.26. IR (film, ν cm^{-1}): 3294, 2943, 2873, 2359, 2120, 1441, 1201. MS $(MH)^+$: 153. HRMS calcd: 153.0915 $(MH)^+$; found: 153.0918.

Chlorohydrine 6
A solution of allyl chloride (3 mL, 36.8 mmol) in CH_2Cl_2 (20 mL) at –78^{o}C was treated with ozone. The mixture was quenched with dimethyl-sulfide (37 mL) at –78^{o}C and was warmed to room temperature over 2 h. The chloroacetaldehyde was purified by distillation (bp.≈ 80^{o}C).

To a solution of alkynol **5** (1.55 g, 10.09 mmol) in THF (25 mL) at –40^{o}C, was added *n*-BuLi (8.53 mL, 11.09 mmol). After 10 min, the mixture was cooled to –60^{o}C. Chloroacetaldehyde (1.11 g, 14.25 mmol) was added dropwise via a cannula at –60^{o}C, and the mixture was warmed to room temperature and stirred for 2h. Sat. NH_4Cl (25 mL) was then added and the compound was extracted with Et_2O (3 x 25 mL). The organic layer was dried

over $MgSO_4$ and the residue was chromatographed on silica gel with 20% EtOAc in hexane to give **6** as an oil (1.4 g, 60%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 4.60 (1H, m, OC<u>H</u>O) ; 4.50-4.45 (1H, m, OC<u>H</u>C C) ; 3.85-3.75 (2H, m, C<u>H$_2$</u>O) ; 3.65-3.45 (4H, m, C<u>H$_2$</u>Cl, C<u>H$_2$</u>O) ; 3.30 (1H, d, J=5.5Hz, O<u>H</u>) ; 2.50 (2H, td, J=7Hz, 2Hz, C CC<u>H$_2$</u>) ; 1.80-1.45 (6H, m, C<u>H$_2$</u> THP). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 98.68, 83.83, 78.72, 65.68, 62.42, 62.15, 48.98, 30.40, 25.28, 20.09, 19.23. IR (film, ν cm^{-1}): 3383, 2944, 2661, 2231, 1201. MS (M-H) $^+$: 231. HRMS calcd: 231.0788 $(M-H)^+$; found: 231.0792.

Alcohol 7

To a solution of chlorohydrin **6** (0.64 g, 2.77 mmol) in THF (28 mL) at 0^{o}C, 2,6-lutidine (0.42 mL, 3.6 mmol) and triisopropylsilane triflate (0.9 mL, 3.33 mmol) were added. The mixture was stirred for 45 min at 0^{o}C, quenched with sat. NH_4Cl (25 mL) then extracted with Et_2O (3 x 25 mL). The organic layer was dried over $MgSO_4$ and the residue was chromatographed on silica gel with 20% Et_2O in hexanes to give **7** (1.05 g, 98%) as an oil.
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 4.65-4.55 (2H, m, OC<u>H</u>O et OC<u>H</u>C C) ; 3.90-3.75 (2H, m, C<u>H$_2$</u>O) ; 3.65-3.45 (4H, m, C<u>H$_2$</u>Cl, C<u>H$_2$</u>O); 2.50 (2H, td, J=7Hz, 2Hz, C CC<u>H$_2$</u>) ; 1.85-1.50 (6H, m, C<u>H$_2$</u> THP) ; 1.30-1.10 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 98.26, 83.03, 79.63, 65.13, 63.82, 61.50, 48.66, 30.33, 25.35, 19.96, 19.06, 17.74, 12.17, 12.13, 12.08. IR (film, ν cm^{-1}): 2944, 2867, 2363, 2229, 1464, 1201. MS $(M - C_3H_7)^+$: 345. HRMS calcd: 345.1653 $(M - C_3H_7)^+$; found: 345.1657.

Alkene 8

To a solution of alkyne **7** (1.5 g, 3.87 mmol) in Et_2O (40 mL), Lindlar catalyst (250 mg) was added under H_2. The mixture was stirred for 4 h at room temperature and filtered through Celite with Et_2O. The organic layer was dried over $MgSO_4$ and evaporated *in vacuo* to give the alkene **8** (1.48 g, 98%) as an oil.
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 5.60-5.40 (2H, m, <u>H</u>C=C<u>H</u>); 4.70 (1H, td, J=6.5Hz, 6Hz, C<u>H</u>OTIPS) ; 4.60-4.55 (1H, m, OC<u>H</u>O) ; 3.90-3.70 (2H, m, C<u>H$_2$</u>O) ; 3.55-3.35 (4H, m, C<u>H$_2$</u>Cl, C<u>H$_2$</u>O) ; 2.45-2.35 (2H, m, C<u>H$_2$</u>-CH=) ; 1.85-1.50 (6H, m, C<u>H$_2$</u> THP) ; 1.12-0.91 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 132.30, 128.45, 98.88, 69.24, 66.52, 62.23, 48.97, 30.58, 28.94, 25.41, 19.52, 17.94, 12.20. IR (film, ν cm^{-1}): 2944, 2867, 1654, 1464. MS $(M - C_3H_7)^+$: 347.
HRMS calcd: 347.1809 $(M - C_3H_7)^+$; found: 347.1818.

Alcohol 9

To a solution of alcohol **8** (1.5 g, 3.84 mmol) in MeOH (39 mL) was added *p*-Toluenesulfonic acid (73 mg, 0.38 mmol). The solution was stirred for 1 h at room temperature and was quenched with sat. $NaHCO_3$ (30 mL). The mixture was extracted with Et_2O (3 x 30 mL). The organic layer was dried over $MgSO_4$, the solvent was evapored *in vacuo*, and the residue was chromatographed on silica gel with 30% EtOAc in hexanes to give **9** (0.88 g, 75%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 5.60-5.50 (2H, m, C<u>H</u>=C<u>H</u>) ; 4.69 (1H, AB<u>X</u>, J_{AX}=6.5Hz, J_{BX}=5.5Hz, C<u>H</u>OTIPS) ; 3.70 (2H, td, J=6.5Hz, 1Hz, C<u>H$_2$</u>OH) ; 3.55(1H, A<u>B</u>X, J_{AB}=11Hz, J_{BX}=5.5Hz, C<u>H</u>HCl) ; 3.40 (1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=6.5Hz, CH<u>H</u>Cl) ; 2.40 (2H, m, C<u>H$_2$</u>CH=CH) ; 1.10-0.85 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 133.07, 128.22, 69.05, 61.83, 48.74, 31.60, 17.87, 12.20. IR (film, ν cm^{-1}): 3333, 2944, 2866, 1654, 1094. MS $(M-C_3H_7)^+$: 263. HRMS calcd: 263.1234 $(M - C_3H_7)^+$; found: 263.1239.

Mesylate 10

To a solution of alcohol **9** (1.74 g, 5.68 mmol) in CH_2Cl_2 (56 mL) at 0°C were added triethylamine (1.15 mL, 7.95 mmol), methanesulfonyl chloride (0.53 mL, 6.81 mmol) and 4-dimethylaminopyridine (69 mg, 0.57 mmol). After stirring for 30 min at 0°C, the mixture was quenched with sat NH_4Cl (50 mL), then extracted with CH_2Cl_2 (3 x 50 mL). The organic layer was dried over $MgSO_4$ and the solvent was evaporated *in vacuo*. The residue was chromatographed on silica gel with 20% EtOAc in hexanes to give **10** (2.13 g, 98%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 5.60-5.55 (2H, m, C<u>H</u>=C<u>H</u>) ; 4.65 (1H, AB<u>X</u>, J_{AX}=7Hz, J_{BX}=5.5Hz, C<u>H</u>OTIPS) ; 4.25 (2H, t, J=6.5Hz, C<u>H</u>$_2$OSO$_2$) ; 3.55(1H, A<u>B</u>X, J_{AB}=11Hz, J_{BX}=5.5Hz, C<u>H</u>HCl) ; 3.40 (1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=7Hz, CH<u>H</u>Cl) ; 3.00 (3H, s, C<u>H</u>$_3$) ; 2.60-2.55 (2H, td, J=6.5Hz, 6Hz, C<u>H</u>$_2$CH=CH) ; 1.20-0.90 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 134.13, 125.85, 68.90, 68.58, 48.53, 37.33, 28.30, 17.86, 12.24. IR (film, ν cm^{-1}): 2945, 2867, 1464, 1177. MS (M – C_3H_7)$^+$: 341. (M – CH_2Cl)$^+$: 335. HRMS calcd: 341.1009 (M – C_3H_7)$^+$; found: 341.1016.

Malonate 11

To a solution of sodium hydride in a mixture of THF and DMF (1/1, 76 mL) at 0°C, dimethyl-malonate was added dropwise. The resulting mixture was stirred at room temperature 20 min then the mesylate **10** (2.49 g, 7.63 mmol) and potassium iodide (2.53 g, 15.27 mmol) were added. The solution was stirred at 80°C for 3 h. The mixture was quenched at room temperature with sat NH_4Cl (70 mL) and extracted with a mixture of Et_2O and hexane (1/1, 3 x 70 mL). The organic layer was dried over $MgSO_4$, the solvent was removed, and the residue was chromatographed on silica gel with 20% Et_2O in hexane yielded **11** (2.56 g, 80%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 5.50-5.25 (2H, m, C<u>H</u>=C<u>H</u>) ; 4.65 (1H, AB<u>X</u>, J_{BX}=6Hz, J_{AX}=6.5Hz, C<u>H</u>OTIPS) ; 3.75 (6H, s, C<u>H</u>$_3$O) ; 3.50 (1H, A<u>B</u>X, J_{AB}=11Hz, J_{BX}=6Hz, C<u>H</u>HCl) ; 3.40 (1H, t, J=7Hz, C<u>H</u>CO$_2$Me) ; 3.35 (1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=6.5Hz, CH<u>H</u>Cl) ; 2.15-2.05 (2H, m, C<u>H</u>$_2$-CH=CH) ; 2.00-1.95 (2H, m, C<u>H</u>$_2$CH) ; 1.10-0.85 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 169.37, 131.96, 130.18, 68.95, 52.34, 50.83, 48.68, 28.38, 25.81, 17.84, 12.18. IR (film, ν cm^{-1}): 2946, 2807, 1755, 1738, 1469, 1434, 1249. MS (M – C_3H_7)$^+$: 377. (M – CH_2Cl)$^+$: 371. HRMS calcd: 377.1551 (M – C_3H_7)$^+$; found: 377.1556.

Ether 13

To a solution of the iodoalcohol **12** (1.32 g, 7.16 mmol) in CH_2Cl_2 (50 mL), were added *p*-toluenesulfonic acid (181 mg, 0.72 mmol) and 3,4-dihydro-*2H*-pyran (1 mL, 10.97 mmol) at room temperature. The solution was stirred overnight in the dark. The mixture was quenched with saturated aqueous $NaHCO_3$ (50 mL) and extracted with Et_2O (3 x 50 mL). The organic layer was dried over $MgSO_4$, the solvent was removed, and the residue was chromatographed on silica gel with 20% Et_2O in hexanes to give **13** (1.82 g, 95%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.48 (1H, ddd, J=8Hz, 6Hz, 5Hz, C<u>H</u>=CHI) ; 6.40 (1H, dt, J=8Hz, 1.5Hz, CH=C<u>H</u>I) ; 4.65 (1H, m, OC<u>H</u>O) ; 4.28 (1H, complex system AB appearing as a ddd, J_{AB}=13.5Hz, J=5Hz, J=1.5Hz, C<u>H</u>HOTHP) ; 4.12 (1H, complex system AB appearing as a ddd, J_{AB}=13.5Hz, J=6Hz, J=1.5Hz, CH<u>H</u>OTHP) ; 3.90-3.85 (1H, m, C<u>H</u>HO THP) ; 3.55-3.50 (1H, m, CH<u>H</u>O THP) ; 1.85-1.5 (6H, m, C<u>H</u>$_2$THP). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 138.29, 98.42, 82.79, 69.99, 62.2, 30.49, 25.36, 19.34. IR (film, ν cm^{-1}): 2945, 2865, 1612, 1447.
MS (M – OTHP)$^+$: 167 HRMS calcd: 166.9358 (M – OTHP)$^+$; found: 166.9363.

Ether 15

To the compound **14** (2.29 g, 6.17 mmol) in CH_2Cl_2 (40 mL), imidazole (1.05 g, 15.43 mmol) and *t*-butyldimethylsilyl chloride (1.12 g, 7.4 mmol) were added at 0°C. After stirring for 1 h at room temperature, water was added (40 mL), and the solution was extracted with CH_2Cl_2 (3 x 40 mL).). The organic layer was dried over $MgSO_4$, the solvent was removed and the residue was chromatographed on silica gel with 10% Et_2O in hexane yielding **15** as an oil (2.65 g, 93%).

^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.17 (1H, A**B**X, J_{AB}=19Hz, J_{AX}=1.5Hz, CH=C**H**Sn) ; 6.05 (1H, A**B**X, J_{AB}=19Hz, J_{BX}=4Hz, C**H**=CHSn) ; 4.20 (2H, AB**X**, J_{BX} =4Hz, J_{AX} 1.5Hz, C**H**$_2$OTBDMS) ; 1.60-1.43 (6H, m, C**H**$_2$Sn) ; 1.40-1.25 (6H, m, C**H**$_2$C**H**$_2$Sn) ; 1.00-0.75 (24H, m, C**H**$_3$C**H**$_2$C**H**$_2$C**H**$_2$Sn, C(C**H**$_3$)$_3$) ; 0.05 (6H, s, C**H**$_3$Si). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 147.25, 126.77, 66.69, 28.94, 27.21, 25.92, 13.67, 9.36, -5.17. IR (film, ν cm^{-1}): 2928, 2855, 1463, 1361, 1253, 1093. MS $(M - C_4H_9)^+$: 405. HRMS calcd: 405.1636 $(M - C_4H_9)^+$; found: 405.1639.

Diene 18

To a solution of the alcohol **12** (0.82 g, 4.39 mmol) in N,N-dimethylformamide (45 mL), the compound **15** (2.79 g, 5.75 mmol) was added and the mixture was degassed. *Bis*-acetonitrile palladium-chloride (57 mg, 0.22 mmol) was added and the mixture was degassed again. The solution was stirred for 3 h at room temperature, quenched with saturated NH_4Cl (50 mL) and extracted with a mixture of Et_2O and hexane (1/1, 3 x 50 mL). The organic layer was dried over $MgSO_4$, the solvent was removed and the residue was chromatographed on silica gel with 20% Et_2O in hexane to yield **18** as an oil (0.8 g, 80%).

^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.55 (1H, dd, J=15Hz, 11Hz, CH=C**H**CH=CH) ; 6.10 (1H, t, J=11Hz, CH=CHC**H**=CH) ; 5.80 (1H, dt, J=15Hz, 5Hz, C**H**=CHCH=CH) ; 5.58 (1H, m, CH=CHCH=C**H**) ; 4.30 (2H, td, J=6Hz, 1Hz, C**H**$_2$OH) ; 4.25 (2H, dd, J=4.5Hz, 1.5Hz, C**H**$_2$OTBDMS) ; 1.30-0.90 (9H, m, (C**H**$_3$)$_3$C) ; 0.05 (6H, s, C**H**$_3$Si). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 134.63, 129.85, 129.25, 124.08, 63.28, 58.61, 25.89, 18.37, -5.27. IR (film, ν cm^{-1}): 3345, 2929, 2857, 1656, 1613, 1471. MS $(M - C_4H_9)^+$: 171; $(M - H_2O)^+$: 210. HRMS calcd: 171.0841 $(M - C_4H_9)^+$; found: 171.0846; calcd: 210.1440 $(M - H_2O)^+$; found: 210.1447.

Diene 19

To a solution of alcohol **18** (0.50 g, 2.2 mmol) in N,N-dimethylformamide (20 mL) at 0°C were added 2,4,6-collidine (1.16 mL, 8.78 mmol) methanesulfonyle chloride (0.68 mL, 8.78 mmol) and dry lithium chloride (372 mg, 8.78 mmol). The solution was stirred at 0°C for 3 h and water (20 mL) was added. The mixture was extracted with hexane and ether (1/1, 3 x 30 mL). The organic layer was dried over $MgSO_4$, the solvent was removed, and the residue was chromatographed on silica gel with 20% Et_2O in hexanes yielding **19** as an oil (0.43 g, 80%).

^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.55 (1H, dd, J=15Hz, 11Hz, CH=C**H**CH=CH); 6.10 (1H, t, J=11Hz, CH=CHC**H**=CH) ; 5.90 (1H, dt, J=15Hz, 4.5Hz, C**H**=CHCH=CH) ; 5.60 (1H, dt, J=11Hz, 8Hz, CH=CHCH=C**H**) ; 4.30 (2H, dd, J=4.5Hz, 1Hz, C**H**$_2$OTBDMS) ; 4.21 (2H, d, J=8Hz, C**H**$_2$Cl) ; 1.30-0.90 (9H, m, (C**H**$_3$)$_3$C) ; 0.05 (6H, s, C**H**$_3$Si). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 136.47, 132.27, 124.96, 122.92, 63.15, 39.51, 25.89, 18.35, -5.27. IR (film, ν cm^{-1}): 2955, 2857, 1651, 1613, 1471. MS $(M - C_4H_9)^+$: 189; $(M - Cl)^+$: 211. HRMS calcd: 189.0502 $(M - C_4H_9)^+$; found: 189.0502.

triene 20

To a solution of sodium hydride (215 mg, 5.38 mmol) in N,N-dimethylformamide and tetrahydrofuran (1/1, 40 mL) at 0°C, the compound **11** (2.16 g, 5.13 mmol) was added dropwise via a cannula. The mixture was stirred at room temperature during 20 min, cooled at 0°C and the diene **17** (1.22 g, 5.65 mmol) in tetrahydrofuran (5 mL) was added dropwise via a cannula. The solution was stirred at room temperature for 17 h and quenched with sat. NH_4Cl (40 mL). The mixture was extracted with hexane and ether (1/1, 3 x 30 mL). The organic layer was dried over $MgSO_4$, the solvent was removed, and the residue was chromatographed on silica gel with toluene yielding **20** as an oil (2.68 g, 87%).

^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.40 (1H, dd, J=15Hz, 11Hz, CH=C<u>H</u>CH=CH); 6.05 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.60-5.40 (4H, m, C<u>H</u>=CHCH=C<u>H</u>, C<u>H</u>=C<u>H</u>); 4.65-4.60 (2H, m, C<u>H</u>OTIPS, OC<u>H</u>O); 4.30 (1H, complex A<u>B</u>, J_{AB}=13Hz, J=6.5Hz, C<u>H</u>HOTHP); 4.20 (1H, complex <u>A</u>B, J_{AB}=13Hz, J=7Hz, CH<u>H</u>OTHP); 3.90-3.80 (1H, m, C<u>H</u>HO THP); 3.75 (6H, s, C<u>H$_3$</u>O); 3.55-3.50 (2H, m, C<u>H</u>HCl, CH<u>H</u>O THP); 3.35 (1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=6.5Hz, CH<u>H</u>Cl); 2.70 (2H, d, J=7.5Hz, CC<u>H$_2$</u>CH=CHCH=CH); 2.00-1.45 (10H, m, C<u>H$_2$</u>); 1.10-0.90 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 171.22, 131.45, 130.82, 130.60, 129.13, 126.61, 97.72, 69.09, 62.63, 62.10, 57.53, 53.41, 52.38, 48.72, 36.47, 32.45, 30.56, 25.41, 23.12, 19.39, 17.92, 12.22. IR (film, ν cm^{-1}): 2947, 2867, 1732, 1655, 1454, 1441. MS $(M - C_3H_7)^+$: 557.

HRMS calcd: 557.2701 $(M - C_3H_7)^+$; found: 557.2708.

Triene 21

The same method was applied from **11** (1.53 g, 3.62 mmol) and **19** (0.98 g, 3.99 mmol) and gave **21** as an oil (2.2 g, 96%).

^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.50 (1H, dd, J=15Hz, 11Hz, CH=C<u>H</u>CH=CH); 6.10 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.80 (1H, dt, J=15Hz, 5Hz, C<u>H</u>=CHCH=CH); 5.50-5.30 (2H, m, CH=CHCH=C<u>H</u>, C<u>H</u>=CH); 5.20 (1H, dt, J=8Hz, 7.5Hz, CH=C<u>H</u>); 4.60 (1H, AB<u>X</u>, J_{AX}=6.5Hz, J_{BX}=6Hz, C<u>H</u>OTIPS); 4.20 (2H, d, J=5Hz, C<u>H$_2$</u>OTBDMS); 3.70 (3H, s, C<u>H$_3$</u>O); 3.68 (3H, s, C<u>H$_3$</u>O); 3.45 (1H, A<u>B</u>X, J_{AB}=11Hz, J_{BX}=6Hz, C<u>H</u>HCl); 3.35(1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=6.5Hz, CH<u>H</u>Cl); 2.80 (2H, d, J=8Hz, CC<u>H$_2$</u>CH=CH); 2.00-1.90 (4H, m, C<u>H$_2$</u>C<u>H$_2$</u>); 1.10-0.90 (21H, m, TIPS); 0.9 (9H, s, (C<u>H$_3$</u>)$_3$C); 0.05 (6H, s, C<u>H$_3$</u>Si). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 171.35, 134.45, 131.58, 131.49, 130.59, 124.25, 123.67, 69.08, 63.46, 57.33, 52.4, 52.34, 48.79, 32.25, 30.91, 25.86, 23.15, 17.90, 12.23, -5.28. IR (film, ν cm^{-1}): 2949, 2865, 1738, 1654, 1463, 1254. MS $(M - C_3H_7)^+$: 587. HRMS calcd: 587.2991 $(M - C_3H_7)^+$; found: 587.2980.

Alcohol 22

To a solution of THP ether **20** (2.68 g, 4.46 mmol) in methanol (50 mL), *para*-toluene-sulfonic acid (42 mg, 0.23 mmol) was added. The mixture was stirred for 2 h at room temperature, and quenched with $NaHCO_3$ sat (30 mL). The methanol was removed in vacuo and extracted with ether (3 x 45 mL). The organic layer was dried over $MgSO_4$, the solvent was removed, and the residue was chromatographed on silica gel with 20% Et_2O in hexanes yielding **22** as an oil (1.72 g, 75%).

^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.35 (1H, dd, J=14.5Hz, 11Hz, CH=C<u>H</u>CH=CH); 6.00 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.60-5.30 (4H, m, CH=CHCH=C<u>H</u>, C<u>H</u>=CH); 4.60 (1H, AB<u>X</u>, J_{AX}=6.5Hz, J_{BX}=6Hz, C<u>H</u>OTIPS); 4.30 (2H, dd, J=7Hz, 1Hz, C<u>H$_2$</u>OH) ; 3.70 (6H, s, C<u>H$_3$</u>O) ; 3.50 (1H, A<u>B</u>X, J_{AB}=11Hz, J_{BX}=6Hz, C<u>H</u>HCl); 3.35 (1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=6.5Hz, CH<u>H</u>Cl); 2.70 (2H, d, J=7.5Hz, CC<u>H$_2$</u>CH=CH); 2.00-1.85 (4H, m, C<u>H$_2$</u>C<u>H$_2$</u>); 1.10-0.90 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 171.28, 131.51, 130.60, 130.12, 129.43, 129.06, 128.81,

69.12, 58.71, 52.46, 48.72, 36.43, 32.49, 23.13, 17.95, 17.90, 12.24. IR (film, ν cm^{-1}): 3367, 2947, 2866, 1731, 1654, 1454. MS $(M - C_3H_7)^+$: 473. HRMS calcd: 473.2126 $(M - C_3H_7)^+$; found: 473.2119.

Chloride 23

To a solution of alcohol **22** (1.73 g, 3.34 mmol) in tetrahydrofuran (59 mL) at –20°C were added triphenylphosphine (1.75 g, 6.64 mmol) and hexachloroacetone (0.76 mL, 5 mmol). After 5 min, the solution was quenched with sat. NH_4Cl (50 mL) and extracted with ether (3 x 40 mL). The organic layer was dried over $MgSO_4$, the solvent was removed and the residue was chromatographed on silica gel with 20% Et_2O in hexane yielding **23** as an oil (1.78 g, 98%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.35 (1H, dd, J=15Hz, 11Hz, CH=C<u>H</u>CH=CH); 6.10 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.65 (1H, dt, J=15Hz, 7.5Hz, C<u>H</u>=CHCH=CH); 5.55 (1H, dt, J=10.5Hz, 8Hz, CH=CHCH=C<u>H</u>); 5.50-5.30 (2H, m, C<u>H</u>=C<u>H</u>); 4.60 (1H, AB<u>X</u>, J_{AX}=6.5Hz, J_{BX}=6Hz, C<u>H</u>OTIPS); 4.15 (2H, d, J=8Hz, $C\underline{H_2}Cl$); 3.70 (6H, s, $C\underline{H_3}O$); 3.50 (1H, A<u>B</u>X, J_{AB}=11Hz, J_{BX}=6Hz, CHC<u>H</u>HCl); 3.35 (1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=6.5Hz, CHCH<u>H</u>Cl); 2.75 (2H, d, J=7.5Hz, $CC\underline{H_2}CH$=CH); 2.00-1.85 (4H, m, $C\underline{H_2}C\underline{H_2}$); 1.10-0.90 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 171.20, 132.29, 131.57, 131.21, 130.54, 127.87, 125.02, 69.13, 52.52, 48.72, 39.31, 36.56, 32.60, 23.15, 17.95, 17.90, 12.25. IR (film, ν cm^{-1}): 2949, 2867, 1785, 1731, 1651, 1453, 1201. MS $(M - C_3H_7)^+$: 491. HRMS calcd: 491.1787 $(M - C_3H_7)^+$; found: 491.1792.

Substituted malonate 24

To a solution of NaH (267 mg, 6.67mmol) in N,N-dimethylformamide and tetrahydrofuran (1/1, 65 mL) at 0°C was added dropwise the dimethylmalonate (0.76 mL, 6.68 mmol). The mixture was stirred at room temperature during 20 min and a solution of the allyl chloride **23** (1.78 g, 3.34 mmol) and potassium iodide (1.1 g, 6.67 mmol) in tetrahydrofuran (5 mL) was added dropwise at 0°C. The mixture was stirred at room temperature for 2h, quenched with sat. NH_4Cl (50 mL) and extracted with ether and hexane (1/1, 3 x 50 mL). The organic layer was dried over $MgSO_4$, the solvent was removed, and the residue was chromatographed on silica gel with 20% Et_2O in hexane yielding **24** as an oil (1.89 g, 90%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.35 (1H, dd, J=15Hz, 11Hz, CH=C<u>H</u>CH=CH); 6.00 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.65-5.25 (4H, m, C<u>H</u>=CHCH=C<u>H</u>, C<u>H</u>=C<u>H</u>); 4.60 (1H, AB<u>X</u>, J_{AX}= 6.5Hz, J_{BX}=6Hz, C<u>H</u>OTIPS); 3.72 (12H, s, $C\underline{H_3}O$); 3.50 (1H, A<u>B</u>X, J_{AB}=11Hz, J_{BX}=6Hz, C<u>H</u>HCl); 3.40 (1H, t, J=7.5Hz, $C\underline{H}(CO_2CH_3)_2$); 3.35 (1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=6.5Hz, CH<u>H</u>Cl); 2.70-2.60 (4H, m, $CC\underline{H_2}CH$=CH); 2.00-1.80 (4H, m, $C\underline{H_2}C\underline{H_2}$); 1.10-0.90 (21H, m, TIPS. ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 171.27, 169.13, 131.46, 130.80, 130.60, 128.87, 128.73, 125.55, 69.09, 57.59, 52.49, 52.43, 51.45, 48.76, 36.49, 32.47, 27.09, 23.14, 17.99, 12.23. IR (film, ν cm^{-1}): 2951, 2867, 1731, 1435. MS $(M - C_3H_7)^+$: 587. HRMS calcd: 587.2443 $(M - C_3H_7)^+$; found: 587.2446.

chlorohydrine 25

To a solution of silyl ether **24** (0.69 g, 1.1 mmol) in tetrahydrofuran (12 mL) at –20°C was added 1 M tetra-*n*-butylammonium fluoride (2.75 mL, 2.75 mmol). The solution was stirred at –20°C during 2 h. The solution was quenched with sat. NH_4Cl (20 mL) and extracted with ether (3 x 20 mL). The organic layer was dried over $MgSO_4$, the solvent was removed and the residue was chromatographed on silica gel with 40% Et_2O in hexane yielding **25** as an oil (0.42 g, 80%).

^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.39 (1H, dd, J=15Hz, 11Hz, CH=C<u>H</u>CH=CH); 6.00 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.65-5.35 (3H, m, C<u>H</u>=CHCH=CH, C<u>H</u>=C<u>H</u>); 5.28 (1H, td, J=7.5Hz, 7Hz, CH=CHCH=C<u>H</u>); 4.55 (1H, m, C<u>H</u>OH); 3.73 (12H, s, C<u>H$_3$</u>O); 3.50 (2H, m, C<u>H$_2$</u>Cl); 3.40 (1H, t, J=7.5Hz, C<u>H</u>(CO_2CH_3)$_2$); 2.80-2.70 (4H, m, CC<u>H$_2$</u>CH=CH); 2.20-1.90 (4H, m, C<u>H$_2$</u>C<u>H$_2$</u>). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 171.30, 169.22, 132.92, 130.71, 129.08, 128.99, 128.62, 125.59, 67.59, 57.32, 52.53, 51.47, 51.35, 49.02, 36.34, 32.22, 27.06, 22.82. IR (film, ν cm^{-1}): 2951, 2867, 1731, 1435. MS $(M - OCH_3)^+$: 443; $(M - Cl)^+$: 439. HRMS calcd: 443.1473 $(M - OCH_3)^+$; found: 443.1465.

Chloroketone 26

To a solution of chlorohydrine **25** (124 mg, 0.26 mmol) in dichloromethane (6 mL) was added diisopropylamine (37 μL, 0.26 mmol) and Dess-Martin reagent (382 mg, 0.78 mmol). The mixture was stirred at room temperature during 20 min. The solution was quenched with 10% NaS_2O_3 (10 mL), extracted with dichloromethane (3 x 15 mL). The organic layer was dried over $MgSO_4$, the solvent was removed, and the residue was chromatographed on Florisil (treated with Et_3N) with 40% Et_2O in hexane yielding **26** as an oil (104 mg, 85%).
^{1}H NMR (300 MHz, CD_2Cl_2, δ ppm): 6.40 (1H, ddd, J=15Hz, 11Hz, 1Hz, CH=C<u>H</u>CH=CH); 6.35-6.20 (2H, m, C<u>H</u>=C<u>H</u>); 6.00 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.55 (1H, dt, J=15Hz, 8Hz, C<u>H</u>=CH-CH=CH); 5.30 (1H, dt, J=11Hz, 8Hz, CH=CHCH=C<u>H</u>); 4.15 (2H, s, C<u>H$_2$</u>Cl); 3.70 (6H, s, OC<u>H$_3$</u>); 3.68 (6H, s, OC<u>H$_3$</u>); 3.40 (1H, t, J=7.5Hz, C<u>H</u>(CO_2CH_3)$_2$); 2.75-2.70 (4H, m, CH=CHCH=CHC<u>H$_2$</u>); 2.60-2.55 (2H, m, CH=CHC<u>H$_2$</u>); 2.00-1.95 (2H, m, CH=CHCH$_2$C<u>H$_2$</u>). ^{13}C NMR (75 MHz, CD_2Cl_2, δ ppm): 191.63, 171.09, 169.08, 150.02, 130.59, 129.11, 128.75, 125.73, 123.17, 57.44, 52.32, 51.42, 49.29, 35.92, 31.36, 27.02, 24.43. IR (film, ν cm^{-1}): 3008, 2956, 2848, 1730, 1695, 1621, 1435. MS $(M)^+$: 472; $(M - HCl)^+$: 436. HRMS calcd: 472.1500 $(M)^+$; found: 472.1507; calcd: 436.1733 $(M - HCl)^+$; found: 436.1739.

Alcohol 27

The same method as that used to prepare **22** was applied from **21** (2.2 g, 3.49 mmol) to give **27** as an oil (1.71 g, 95%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.50 (1H, dd, J=15Hz, 11Hz, CH=C<u>H</u>CH=CH); 6.10 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.85 (1H, dt, J=15Hz, 6Hz, C<u>H</u>=CHCH=CH); 5.45-5.20 (3H, m, CH=CHCH=C<u>H</u>, C<u>H</u>=C<u>H</u>); 4.60 (1H, AB<u>X</u>, J_{AX}=6.5Hz, J_{BX}=6Hz , C<u>H</u>OTIPS); 4.20 (2H, td, J=5Hz, 1Hz, C<u>H$_2$</u>OH); 3.70 (6H, s, C<u>H$_3$</u>O); 3.50 (1H, A<u>B</u>X, J_{AB}=11Hz, J_{BX}=6Hz, C<u>H</u>HCl); 3.35 (1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=6.5Hz, CH<u>H</u>Cl); 2.80 (2H, d, J=7Hz, CC<u>H$_2$</u>CH=CH); 2.00-1.85 (4H, m, C<u>H$_2$</u>C<u>H$_2$</u>); 1.10-0.90 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 171.38, 133.91, 131.52, 131.35, 130.60, 125.45, 124.54, 69.10, 63.19, 57.3, 52.5, 48.78, 32.18, 30.90, 23.14, 17.94, 12.24. IR (film, ν cm^{-1}): 3444, 2950, 2867, 1738, 1667, 1455. MS $(M - C_3H_7)^+$: 473. HRMS calcd: 473.2126 $(M - C_3H_7)^+$; found: 473.2135.

Chloride 28

The same method as that used to prepare **23** was applied from **27** (1.66 g, 3.21 mmol) to give **28** as an oil (1.68 g, 98%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.55 (1H, dd, J=15Hz, 11Hz, CH=C<u>H</u>CH=CH); 6.10 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.85 (1H, dt, J=15Hz, 7Hz, C<u>H</u>=CHCH=CH); 5.50-5.30 (3H, m, CH=CHCH=C<u>H</u>, C<u>H</u>=C<u>H</u>); 4.60 (1H, AB<u>X</u>, J_{AX}=6.5Hz, J_{BX}=6Hz, C<u>H</u>OTIPS); 4.10 (2H, d, J=7Hz, CH=CHC<u>H$_2$</u>Cl); 3.70 (6H, s, C<u>H$_3$</u>O); 3.50 (1H, A<u>B</u>X, J_{AB}=11Hz, J_{BX}=6Hz, C<u>H</u>HCl); 3.35 (1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=6.5Hz, CH<u>H</u>Cl); 2.80 (2H, d, J=8Hz, CC<u>H$_2$</u>CH=CH); 2.00-1.80 (4H, m, C<u>H$_2$</u>C<u>H$_2$</u>); 1.10-0.90 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 171.23, 131.57,

130.64, 130.50, 129.90, 128.64, 126.44, 69.09, 57.33, 52.53, 48.73, 44.89, 32.2, 30.94, 23.14, 17.92, 12.24. IR (film, ν cm^{-1}): 2951, 2867, 1794, 1654, 1458, 1201. MS $(M - C_3H_7)^+$: 491. HRMS calcd: 491.1787 $(M - C_3H_7)^+$; found: 491.1778.

Substituted malonate 29

The same method as that used to prepare **24** was applied from **28** (1.68 g, 3.15 mmol) to give **29** as an oil (1.41 g, 71%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.35 (1H, dd, J=15Hz, 11Hz, CH=C<u>H</u>CH=CH); 6.05 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.65 (1H, dt, J=15Hz, 7Hz, C<u>H</u>=CHCH=CH); 5.50-5.30 (2H, m, C<u>H</u>=C<u>H</u>); 5.20 (1H, br q, J=7.5Hz, CH=CH-CH=C<u>H</u>); 4.60 (1H, AB<u>X</u>, J_{AX}=6.5Hz, J_{BX}=6Hz, C<u>H</u>OTIPS); 3.75 (6H, s, C<u>H_3</u>O); 3.70 (6H, s, C<u>H_3</u>O); 3.50 (1H, A<u>B</u>X, J_{AB}=11Hz, J_{BX}=6Hz, C<u>H</u>HCl); 3.45 (1H, t, J=7.5Hz, C<u>H</u>$(CO_2CH_3)_2$); 3.35 (1H, <u>A</u>BX, J_{AB}=11Hz, J_{AX}=6.5Hz, CH<u>H</u>Cl); 2.80 (2H, d, J=8Hz, CC<u>H_2</u>CH=CH); 2.70 (2H, t, J=7.5Hz, C<u>H_2</u>CH$(CO_2Me)_2$); 2.00-1.90 (4H, m, C<u>H_2</u>C<u>H_2</u>); 1.05 (21H, m, TIPS). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 171.34, 169.10, 131.53, 130.74, 130.58, 130.20, 127.76, 123.65, 69.09, 57.32, 52.54, 52.46, 51.58, 48.79, 32.22, 32.04, 30.95, 23.15, 17.9, 12.24. IR (film, ν cm^{-1}): 2948, 2867, 1737, 1440, 1202. MS $(M - C_3H_7)^+$: 587. HRMS calcd: 587.2443 $(M - C_3H_7)^+$; found: 587.2446.

Chlorohydrine 30

The same method as that used to prepare **25** was applied from **29** (0.69 g, 1.1 mmol) to give **27** as an oil (0.44 g, 84%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.35 (1H, dd, J=15Hz, 11Hz, CH=C<u>H</u>CH=CH); 6.05 (1H, t, J=11Hz, CH=CHC<u>H</u>=CH); 5.65 (1H, dt, J=15Hz, 7Hz, C<u>H</u>=CHCH=CH); 5.50 (1H, m, CH=CHCH=C<u>H</u>); 5.45 (1H, dd, J=11Hz, 8Hz, CH=C<u>H</u>); 5.15 (1H, dt, J=11Hz, 7.5Hz, C<u>H</u>=CH); 4.55 (1H, m, C<u>H</u>OH); 3.70 (6H, s, OC<u>H_3</u>); 3.68 (6H, s, OC<u>H_3</u>); 3.50 (2H, m, C<u>H_2</u>Cl); 3.45 (1H, t, J=7.5Hz, C<u>H</u>$(CO_2Me)_2$); 2.80 (2H, d, J=7.5Hz, CC<u>H_2</u>CH=CH); 2.70 (2H, t, J=7Hz, C<u>H_2</u>CH$(CO_2Me)_2$); 2.11-1.90 (4H, m, C<u>H_2</u>C<u>H_2</u>). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 171.40, 169.13, 133.07, 131.57, 130.93, 129.02, 127.65, 123.67, 67.55, 57.14, 52.53, 52.54, 51.5, 49.16, 32.15, 31.98, 30.94, 22.93. IR (film, ν cm^{-1}): 3522, 3011, 2954, 2846, 1733, 1435. MS $(M - OCH_3)^+$: 443; $(M - Cl)^+$: 439. HRMS calcd: 443.1473 $(M - OCH_3)^+$; found: 443.1465.

Chloroketone 31

The same method as that used to prepare **26** was applied from **30** (122.5 mg, 0.26 mmol) to give **31** as an oil (105 mg, 85%).
^{1}H NMR (300 MHz, CD_2Cl_2, δ ppm): 6.40 (1H, ddd, J=15Hz, 11Hz, 1Hz, CH=C<u>H</u>CH=CH); 6.35-6.20 (2H, m, CH=CHC<u>H</u>=CH, COC<u>H</u>=CH); 6.05 (1H, t, J=11Hz, C<u>H</u>=CHCH=CH); 5.65 (1H, dt, J=15Hz, 7.5Hz, CH=CHCH=C<u>H</u>); 5.25 (1H, br q, J=9Hz, COCH=C<u>H</u>); 4.25 (2H, s, C<u>H_2</u>Cl); 3.71 (6H, s, O<u>CH_3</u>); 3.70 (6H, s, OC<u>H_3</u>); 3.45 (1H, t, J=7.5Hz, C<u>H</u>$(CO_2CH_3)_2$); 2.80 (2H, d, J=8Hz, CC<u>H_2</u>CH=CH); 2.75 (2H, t, J=7.5Hz, C<u>H_2</u>CH$(CO_2Me)_2$); 2.58 (2H, m, COCH=CHC<u>H_2</u>); 2.00-1.95 (2H, m, COCH=CHCH$_2$C<u>H_2</u>). ^{13}C NMR (75 MHz, CD_2Cl_2, δ ppm): 191.58, 171.15, 169.07, 150.07, 131.53, 130.81, 127.75, 123.76, 123.16, 57.25, 52.32, 51.50, 49.36, 41.13, 31.95, 31.28, 30.55, 24.55. IR (film, ν cm^{-1}): 3008, 2956, 2848, 1730, 1695, 1621, 1435. MS $(M)^+$: 472; $(M - HCl)^+$: 436. HRMS calcd: 472.1500 $(M)^+$; found: 472.1507; calcd: 436.1733 $(M - HCl)^+$; found: 436.1739.

Macrocycle 2

To a solution of cesium carbonate (581.8 mg, 1.50 mmol) and cesium iodide (392 mg, 1.50 mmol) in acetonitrile (67 mL) was added the chloroketone **26** (95.1 mg, 0.2 mmol) in

acetonitrile (1 mL). The solution was stirred at room temperature for 48 h in the dark. The mixture was filtered, the solvent was removed and the residue was chromatographed on silica gel with 40% Et_2O in hexane yielding **26** as an oil (26 mg, 30%).
^{1}H NMR (300 MHz, C_6D_6, 375K, δ ppm): 6.40 (1H, dd, J=15Hz, 11Hz, CH=CHCH=CH); 5.98 (1H, t, J=11Hz, CH=CHCH=CH); 5.72 (1H, d, J=11.5Hz, 7Hz, COCH=CH); 5.50-5.40 (2H, m, CH=CHCH=CH); 5.22 (1H, td, J=11.5Hz, 9Hz, COCH=CH); 3.40 (6H, s, OCH_3); 3.35 (6H, s, OCH_3); 3.17 (2H, s, $COCH_2$); 2.80 (2H, d, J=8Hz, CH=CHCH=CHCH_2); 2.40 (2H, br q, J=8.5Hz,, CH_2CH=CHCH=CH); 1.90-1.80 (4H, m, CH_2-CH_2). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 199.69, 170.60, 142.845, 132.5, 130.75, 130.10, 127.98, 125, 56.16, 54.5, 52.72, 44.38, 35.44, 31.66, 30.29, 29.68, 27.11, 22.1. IR ((CH_2Cl_2), ν cm^{-1}): 3003, 2955, 1734, 1695, 1628, 1444, 1266, 1221. MS $(M)^+$: 436. HRMS calcd: 436.1733 $(M)^+$; found: 436.1739. mp: 160-162^{0}C.

Macrocycle 3

To a solution of cesium carbonate (45 mg, 0.12 mmol) and cesium iodide (30 mg, 0.12 mmol) in acetonitrile (15 mL), the compound **31** (11 mg, 0.02 mmol) in acetonitrile (1 mL) was slowly added via a syringe pump over 10 h at 40^{o}C. The solution was stirred at 40^{o}C for an additional 12 h period. The mixture was filtered and the solvent was removed. The residue was chromatographed on silica gel with 40% Et_2O in hexane to yield **3** as an oil (1.8 mg, 17%).
^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 6.35 (1H, dd, J=15Hz, 11.5Hz, CH=CHCH=CH); 6.15-6.05 (2H, m, CH=CHCH=CH, COCH=CH); 5.75 (1H, dt, J=11.5Hz, 7Hz, CH=CHCH=CH); 5.65 (1H, dt, J=15Hz, 7Hz, CH=CH-CH=CH); 4.95 (1H, br q, J=9Hz, CH_2CH=CHCO); 3.80 (6H, s, OCH_3); 3.78 (6H, s, OCH_3); 3.15-1.8 (10H, br m, CH_2). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 200.75, 172.13, 172.04, 141.93, 132.69, 131.10, 130.20, 129.47, 125.55, 57.94, 53.99, 53.72, 45.63, 36.77, 31.75, 30.69, 30.44, 24.5. IR (film, ν cm^{-1}): 2955, 1732, 1698, 1633, 1436, 1270, 1223. MS $(M)^+$: 436. HRMS calcd: 436.1733. found: 436.1739.

Diels-Alder adduct 33 and its epimer 34

The macrocycle **2** (10 mg, 23 μmol) in toluene (2 mL) in a quartz tube was sealed *in vacuo* and heated in an oven for 2h at 220^{o}C. The solvent was removed and the residue was chromatographed on silica gel with 40% AcOEt in hexane. It was impossible to separate both compounds **33** and **34** at that stage, their relative population was evaluated by integration of the NMR signal corresponding to the alkene (1:1).
The mixture of the two tricycles was then treated with *para*-toluenesulfonic acid (catalytic) in toluene (3 mL) at reflux for 5h. The residue was purified on silica gel with 40% AcOEt in hexane to afford the tricycle **34** (9mg, 87%).
TAT tricycle **34**: ^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 5.45 (2H, s, CH=CH); 3.75 (6H, s, OCH_3); 3.74 (3H, s, OCH_3); 3.69 (3H, s, OCH_3); 2.90 (1H, dd, J=13Hz, 3Hz, CHHCO); 2.72 (1H, d, J=13Hz, CHHCO); 2.60-2.50 (2H, m, CH,); 2.45-2.30 (3H, m, COCHCHCH=CH, CH); 2.15 (1H, t, J=11Hz, CHCO, this coupling proves the TAT ring junction); 1.95-1.80 (2H, m, CH); 1.75 (1H, dt, J=14Hz, 4Hz, CH); 1.60-1.40 (3H, m, CH); 1.11-0.90 (2H, m, CH). ^{13}C NMR (75 MHz, $CDCl_3$, δ ppm): 206.68, 172.41, 171.62, 170.60, 170.41, 131.72, 128.51, 57.73, 55.63, 55.35, 53.21, 53.11, 52.7, 52.55, 46.25, 40.32, 38.55, 38.16, 37.89, 37.52, 36.93, 31.29, 29.69, 25.7, 22.68. IR (film, ν cm^{-1}): 2956, 2854, 1731, 1450, 1436, 1258. MS $(M)^+$: 436. HRMS calcd: 436.1733 $(M)^+$;found: 436.1730.
CST tricycle **33**: Only a few ^{1}H NMR signals could be attributed for this compound which could not be separated from its epimer **34**: ^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 5.66 (1H,

complex AB system appearing as a doublet of doublet, J_{AB}=10Hz, J=3.5Hz, C<u>H</u>=CH); 5.57 (1H, complex AB system appearing as a doublet of doublet, J_{AB}=10Hz, J=4Hz, CH=C<u>H</u>); 3.72 (3H, s, OC<u>H</u>$_3$).

Diels-Alder adduct 35 and its epimer 36

The macrocycle **3** (1.6 mg, 3.6 µmol) in toluene (2 mL) in a quartz tube was sealed *in vacuo* and heated in an oven for 2h at 160°C. The solvent was removed and the residue was chromatographed on silica gel with 40% AcOEt in hexane. It was impossible to separate both compounds **35** and **36** at that stage, their relative population was evaluated by integration of the NMR signal corresponding to the alkene (1:1).

The mixture of the two tricycles was then treated with *para*-toluenesulfonic acid (catalytic) in toluene (3 mL) at reflux for 5h. The final mixture still contained both compounds but with a different **36**/**35** ratio of 3:1 and with no significant total weight loss.

In a separate experiment a solution of 1M $SnCl_4$ (7.6 µL) was added to a solution of the macrocycle **3** (1.6 mg, 3.6 µL) in dichloromethane (1 mL) at 30°C, The solution was stirred at 30°C for 3.5 h and quenched with sat. $NaHCO_3$ (1 mL). The mixture was extracted with dichloromethane (3 x 5mL) and dried. Pure tricycle **35** was obtained after purification on silica gel with 40% AcOEt in hexane. (1.5 mg, 94%). Since the conditions had been sufficiently mild to avoid epimerization, 35 could be crystallized from pentane and ether and its structure proven crystal X-ray diffraction analysis.

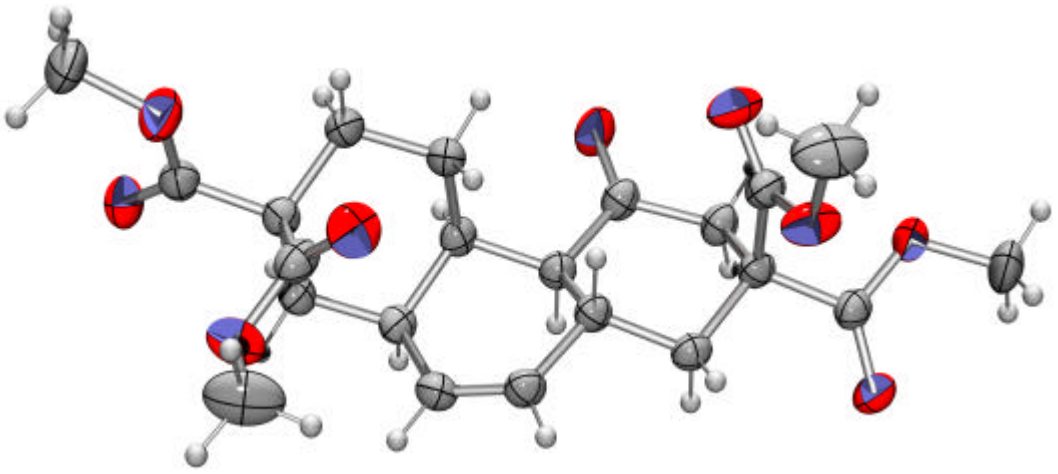
Finally, pure tricycle **35** was treated with *para*-toluenesulfonic acid (catalytic) in toluene (3 mL) at reflux for 5h. The solvent was removed and the residue was chromatographed on silica gel with 40% AcOEt in hexane. A 3:1 mixture of compounds **36** and **35** was obtained as previously observed.

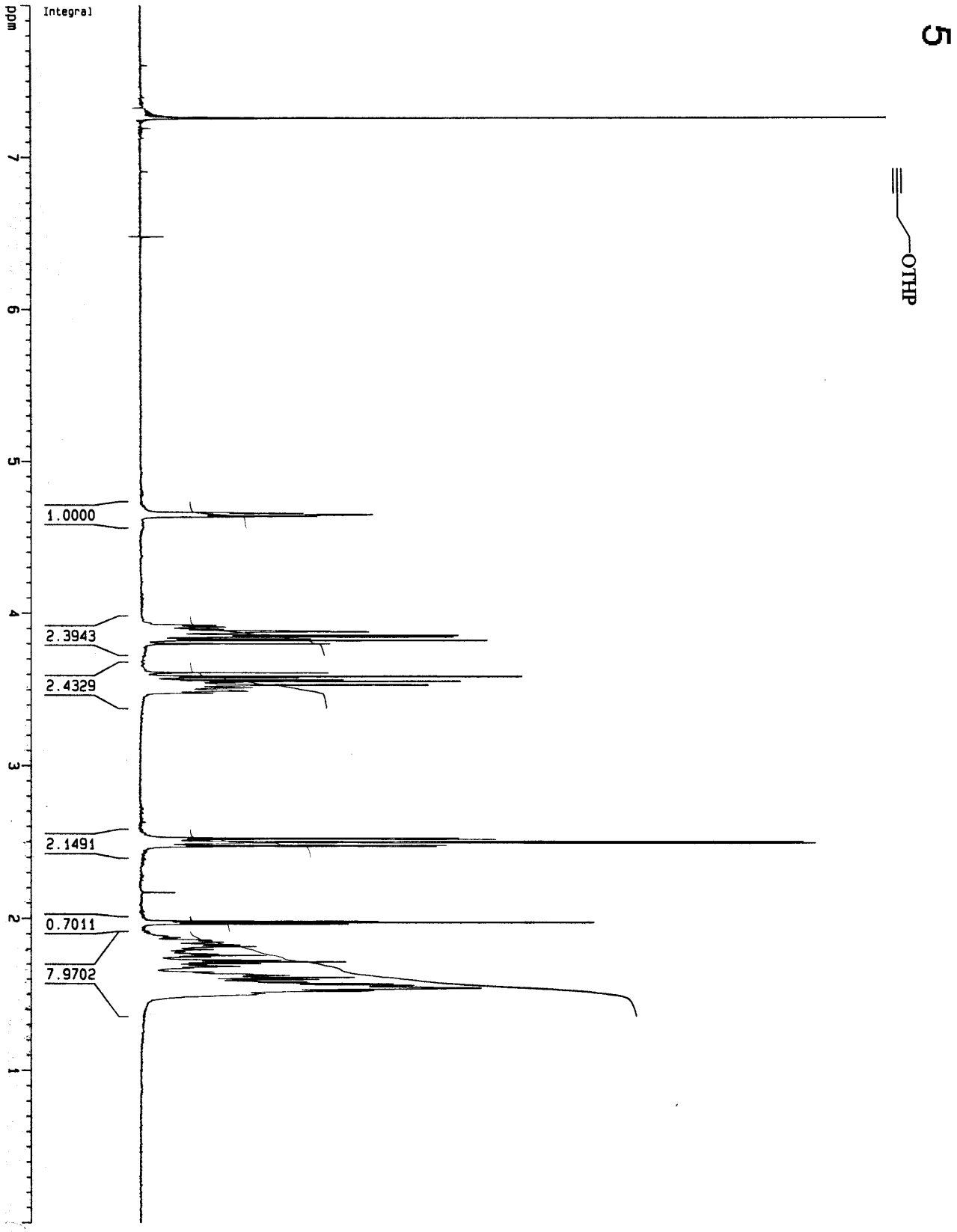
CST tricycle **35**: ^{1}H NMR (300 MHz, $CDCl_3$, δ ppm) : 5.45 (2H, s, C<u>H</u>=C<u>H</u>) ; 3.76 (3H, s, OC<u>H</u>$_3$) ; 3.75 (3H, s, OC<u>H</u>$_3$) ;3.69 (3H, s, OC<u>H</u>$_3$) ;3.67 (3H, s, OC<u>H</u>$_3$) ; 3.05 (1H, dd, J=15Hz, 2.5Hz, COC<u>H</u>) ; 2.60-1.95 (9H, m, C<u>H</u>) ; 1.70-1.30 (4H, m, C<u>H</u>).

IR (film, ν cm^{-1}) : 2922, 1734, 1437, 1257. SM $(M)^+$: 436. HRMS calcd: 436.1733 $(M)^+$; found: 436.1730. mp : 153-155°C

CAC tricycle **36**: Only a few ^{1}H NMR signals could be attributed for this compound which could not be separated from its epimer **35**: ^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 5.66 (1H, complex AB system appearing as a doublet of doublet, J_{AB}=9Hz, J=4Hz, C<u>H</u>=CH); 5.56 (1H, complex AB system appearing as a doublet of doublet, J_{AB}=9Hz, J=3.5Hz, CH=C<u>H</u>); 3.74 (6H, s, OC<u>H</u>$_3$); 3.72 (3H, s, OC<u>H</u>$_3$); 3.68 (3H, s, OC<u>H</u>$_3$).

ORTEP representation of **35**

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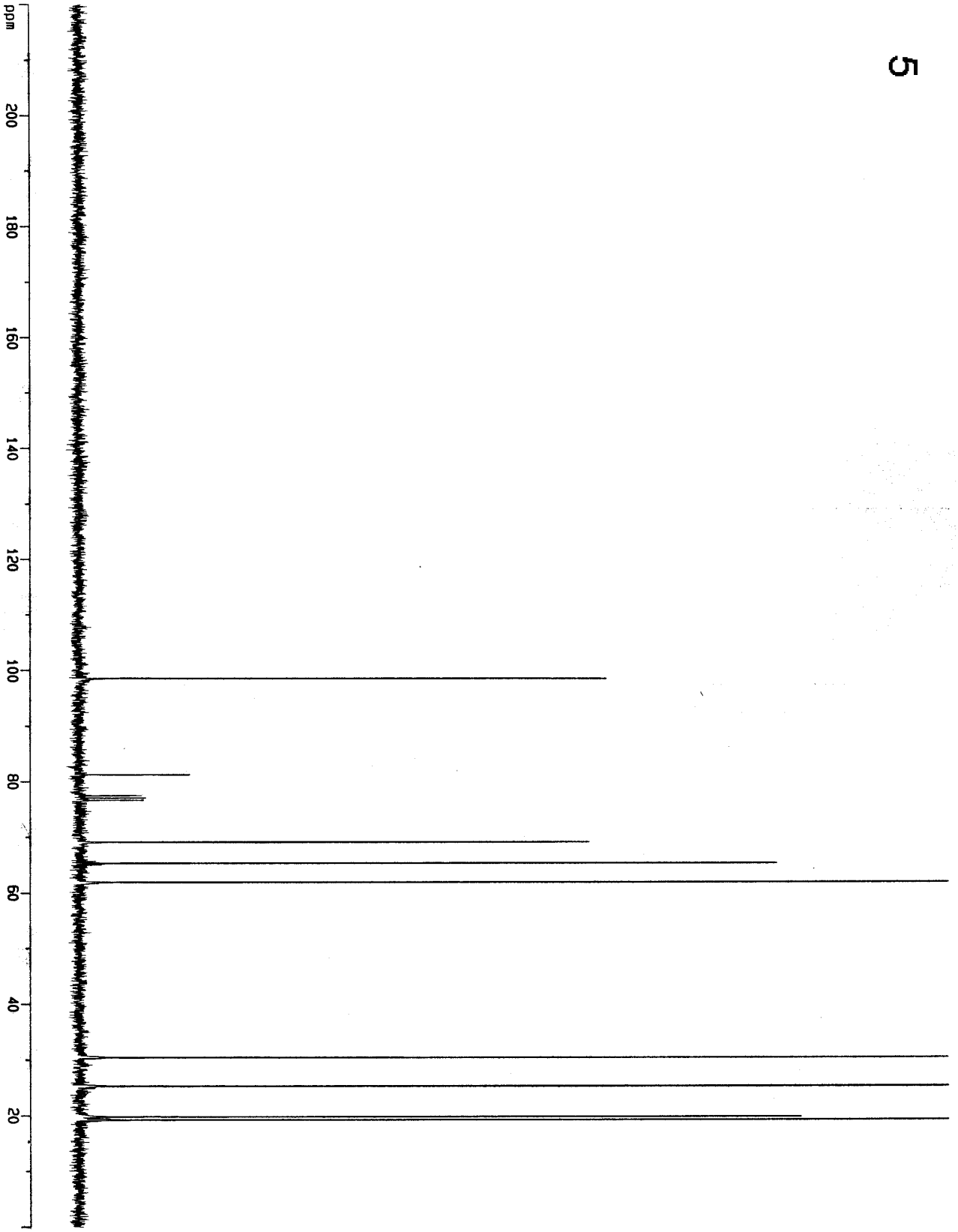

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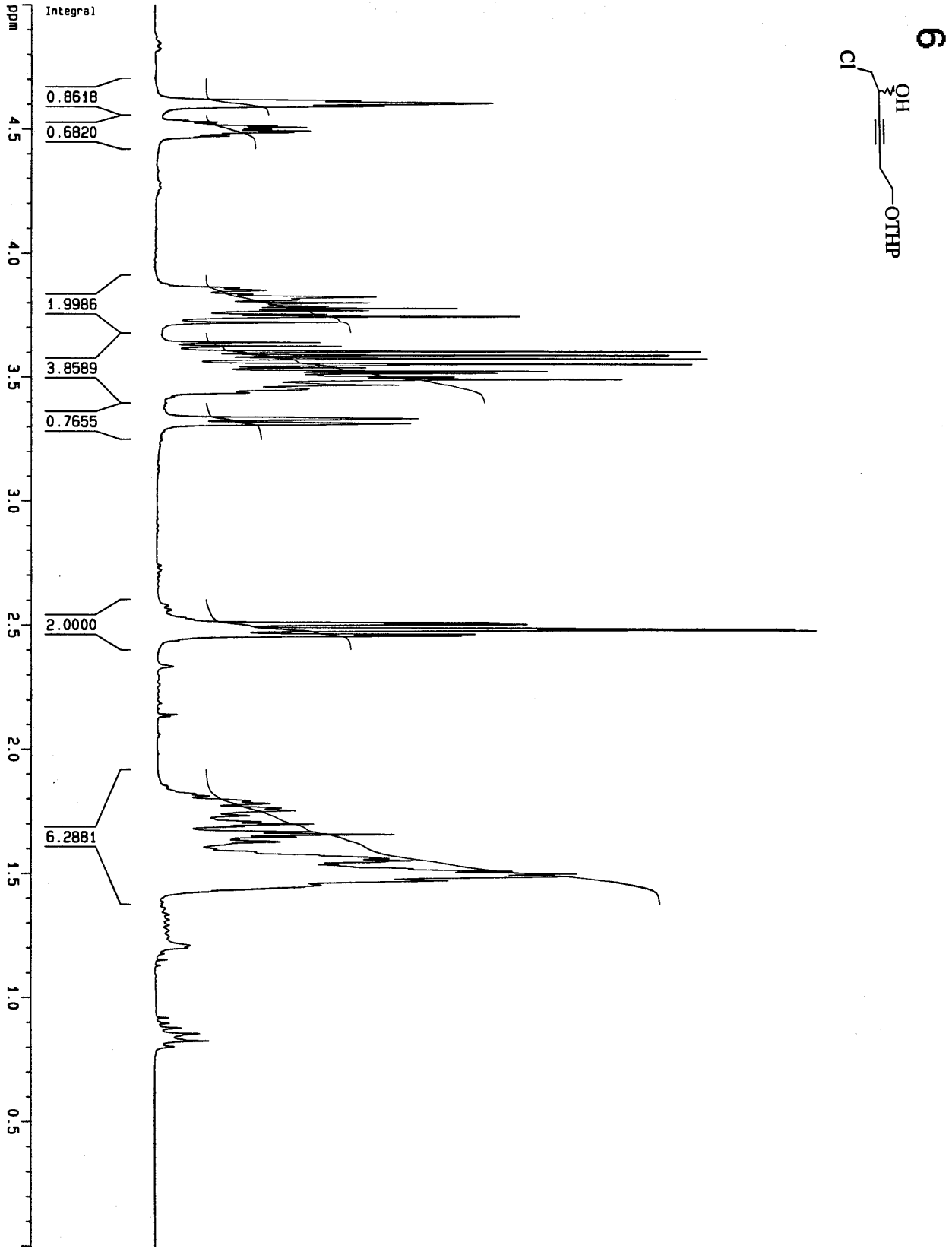
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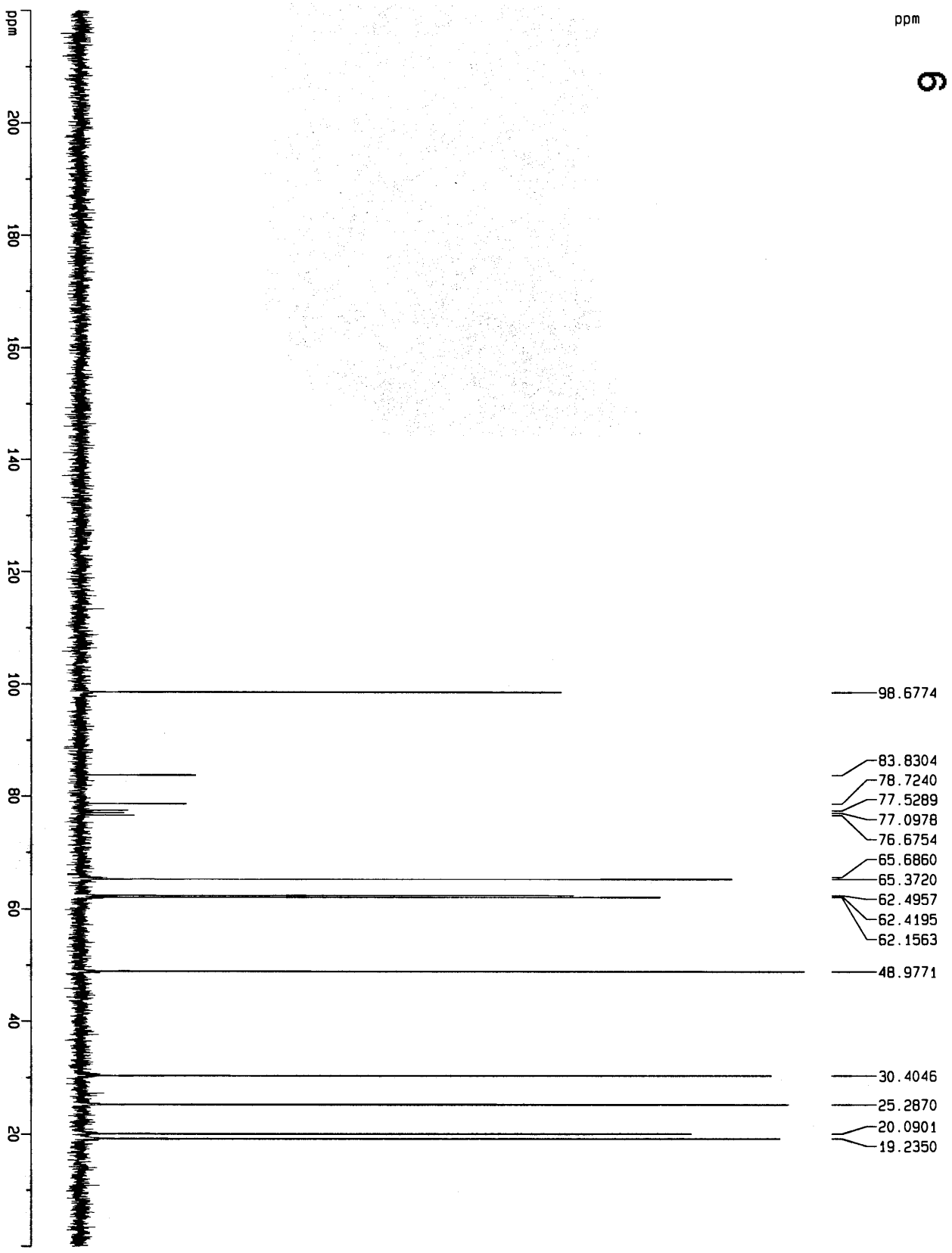
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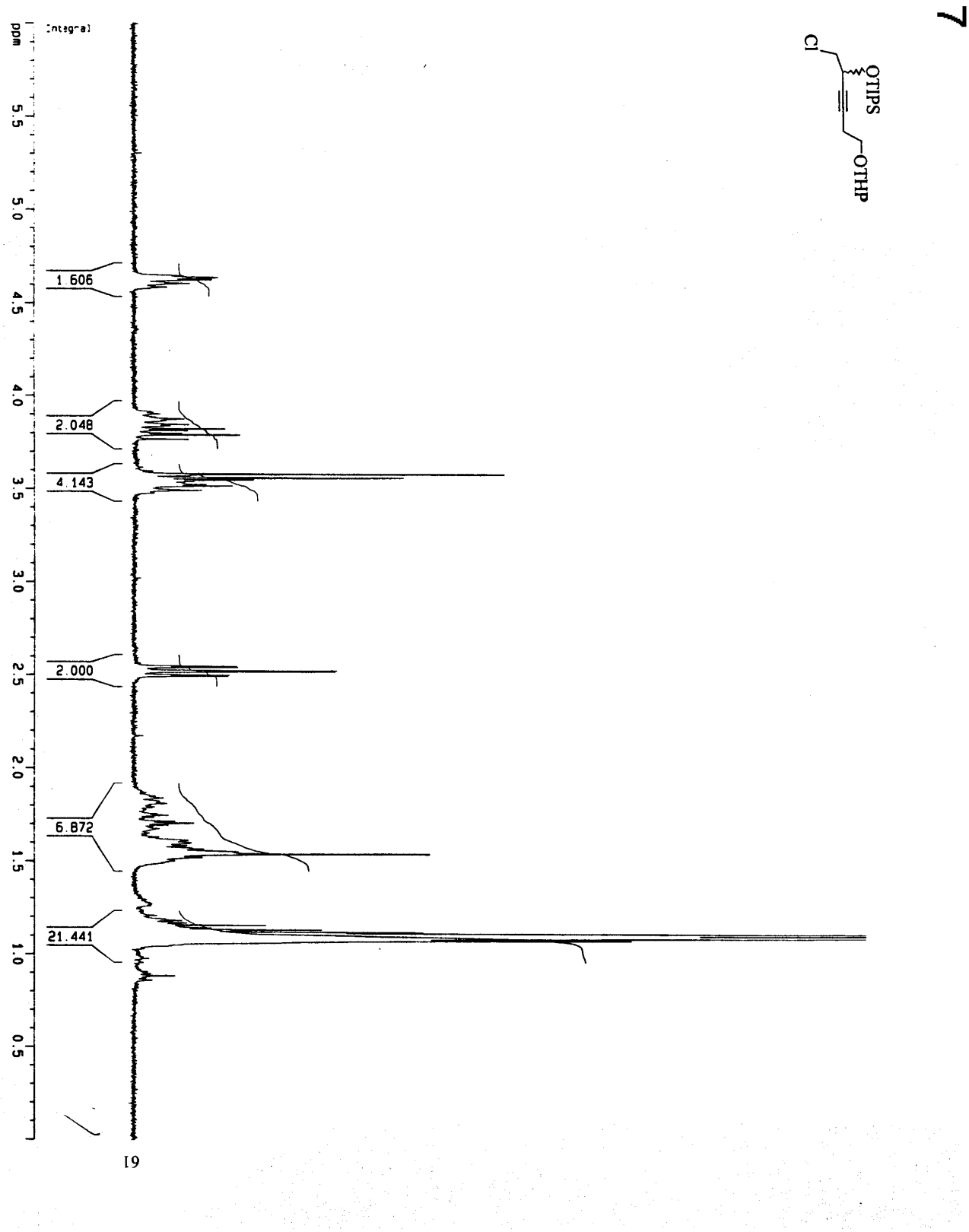
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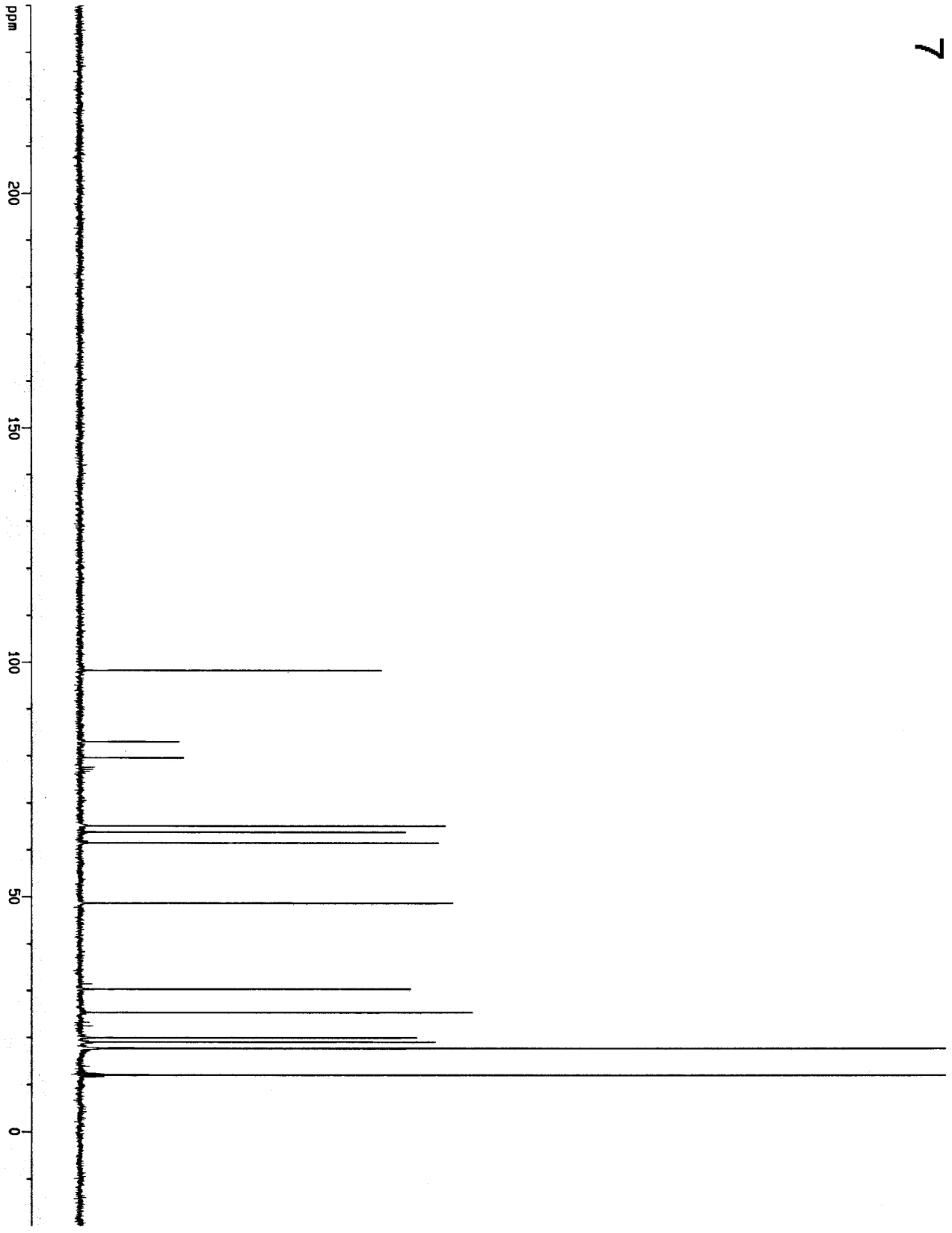

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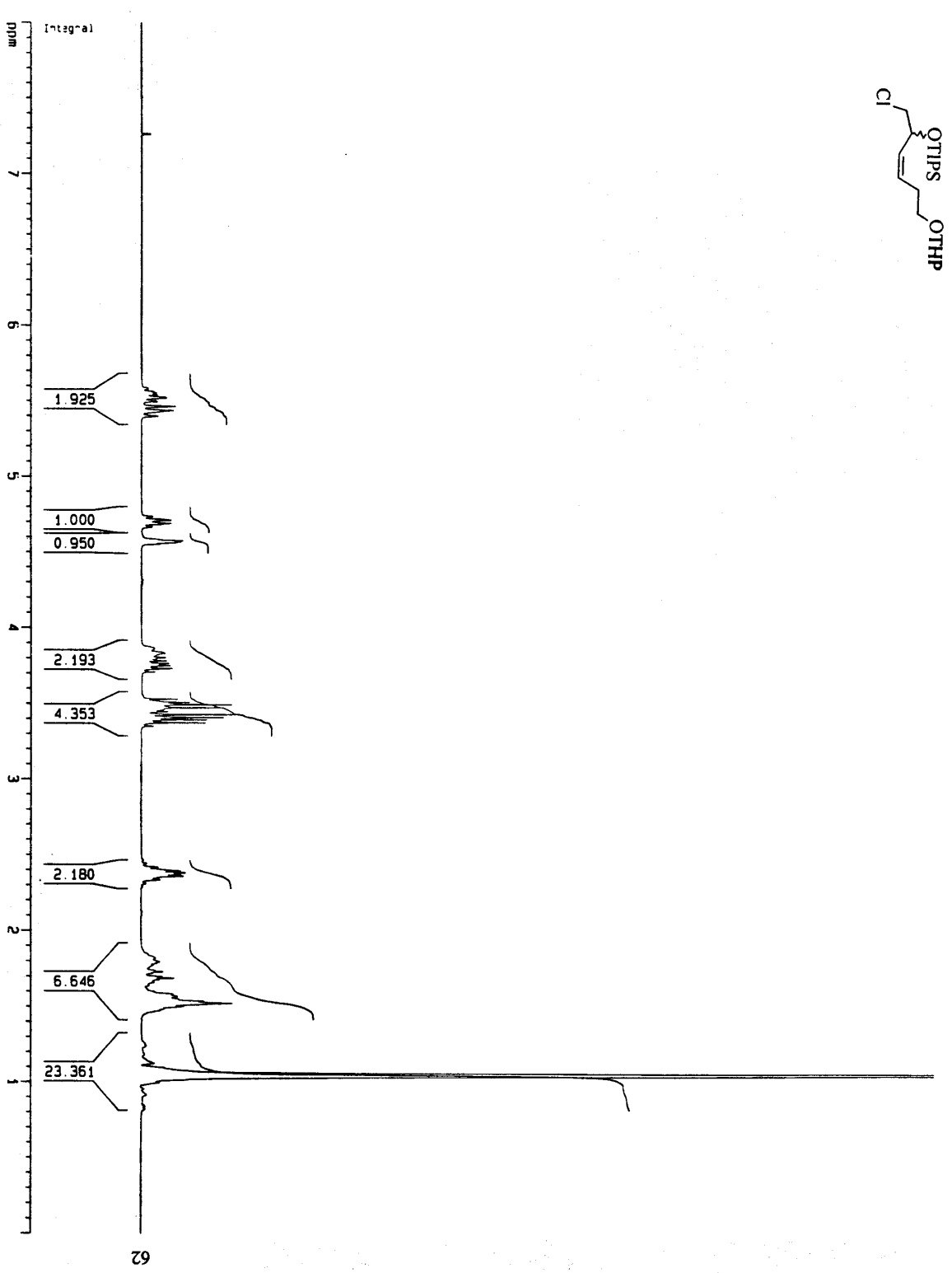
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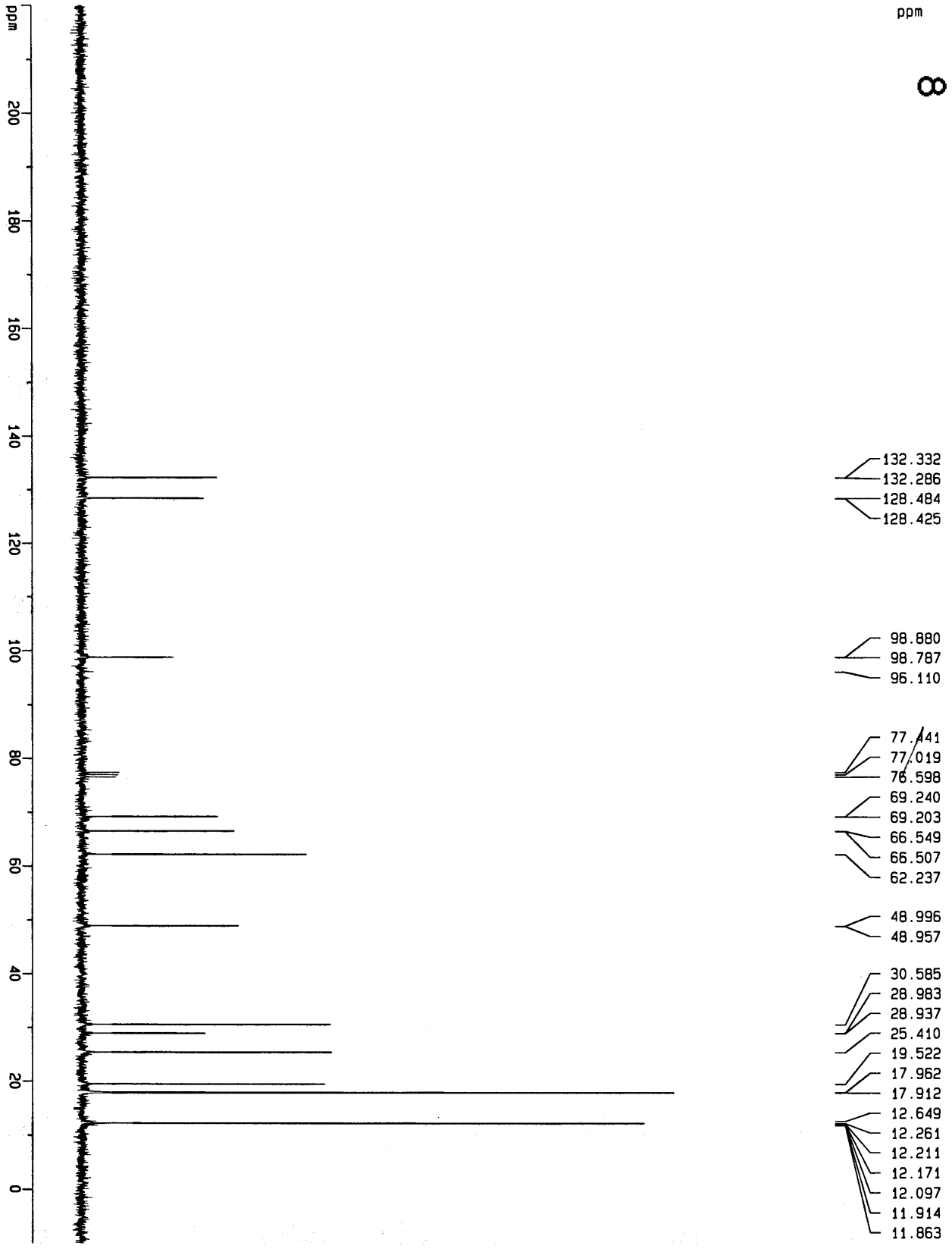
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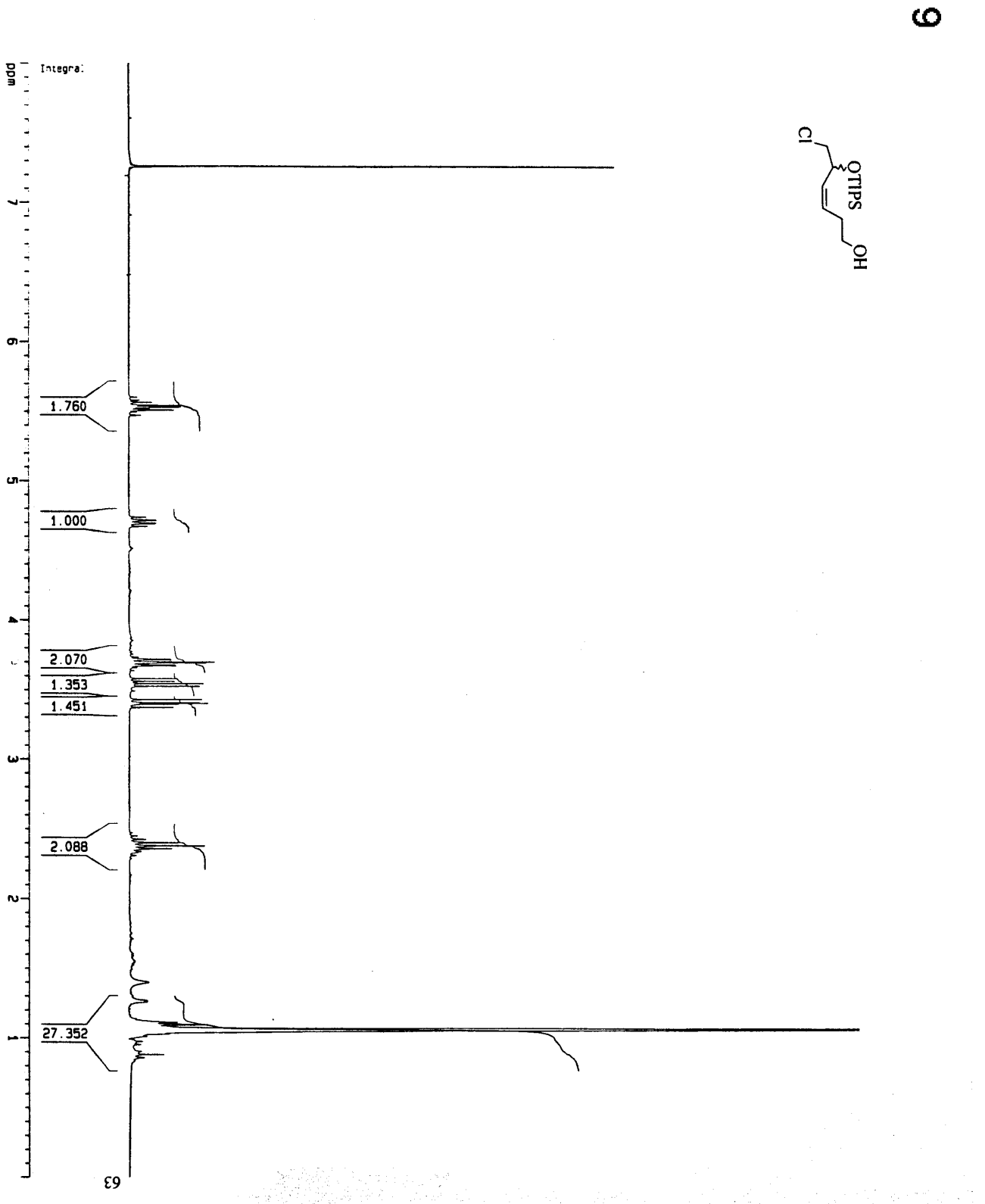
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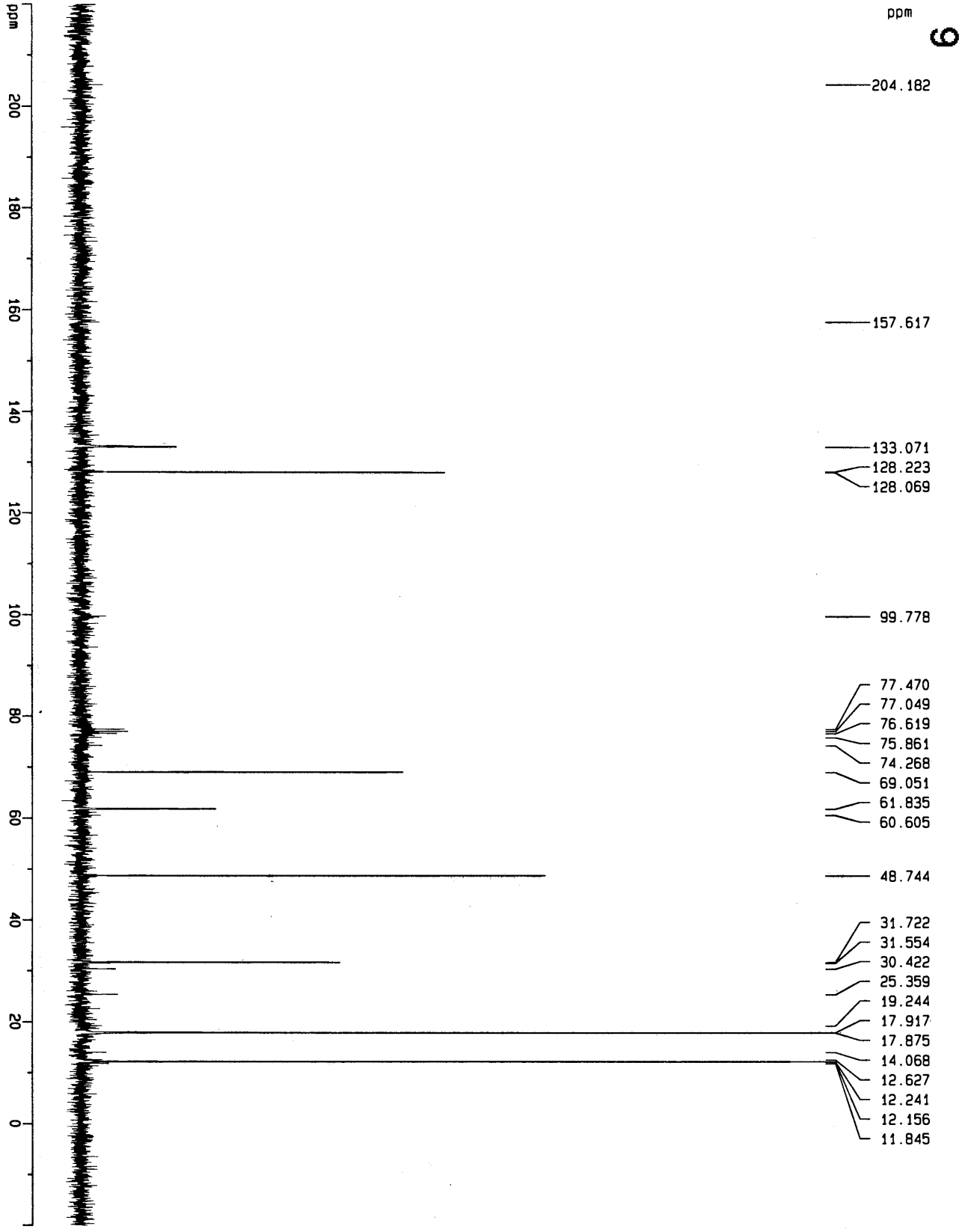
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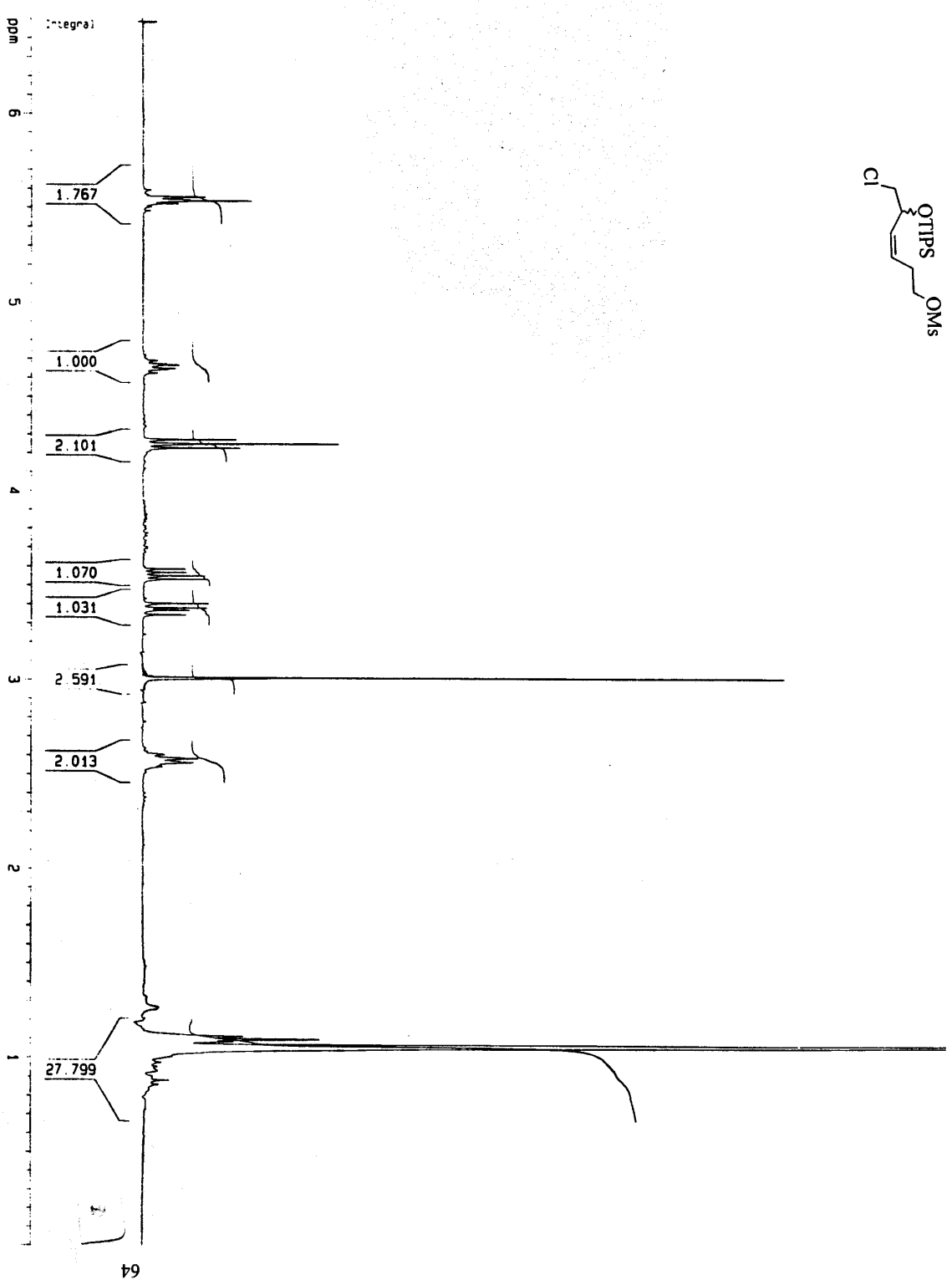
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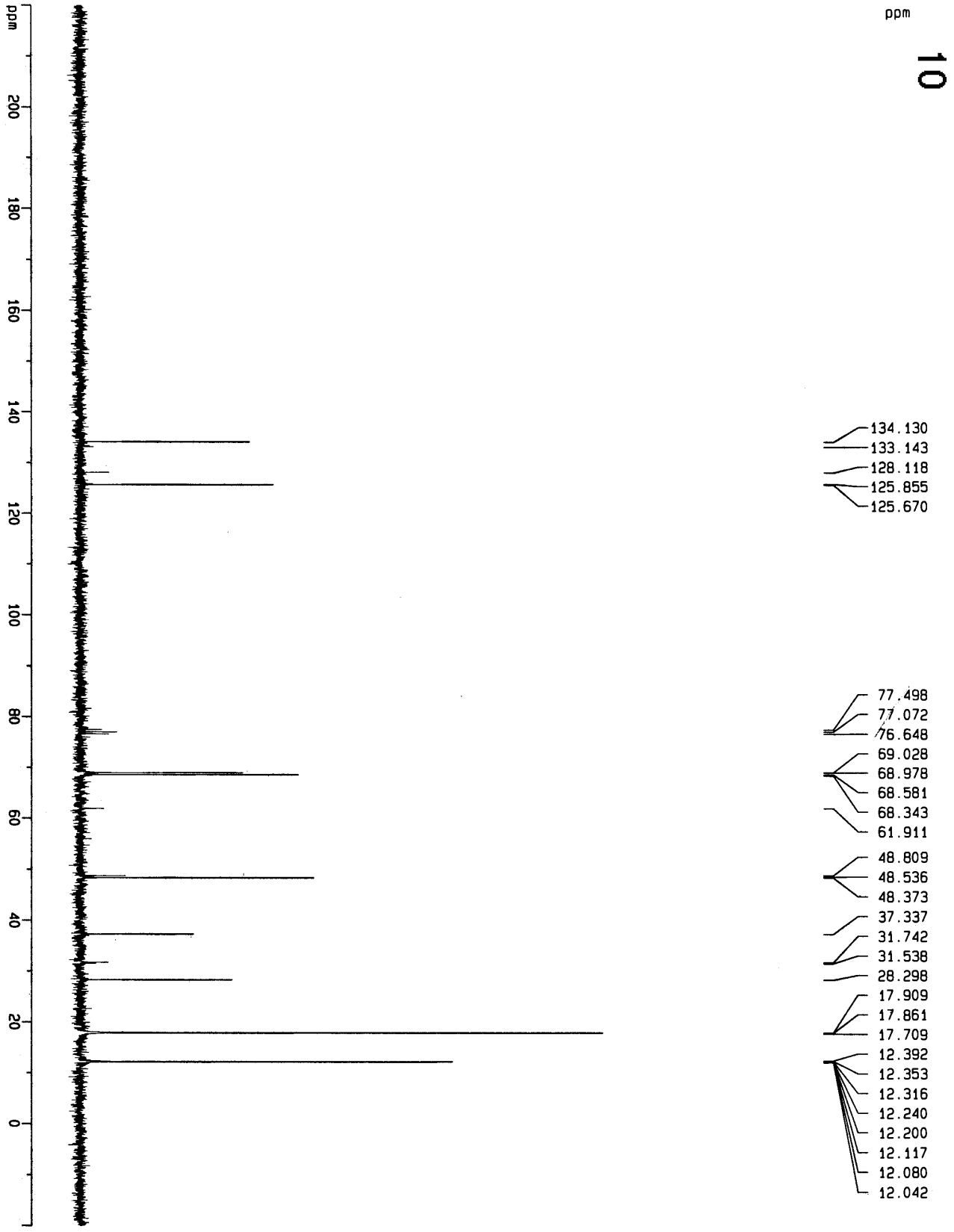
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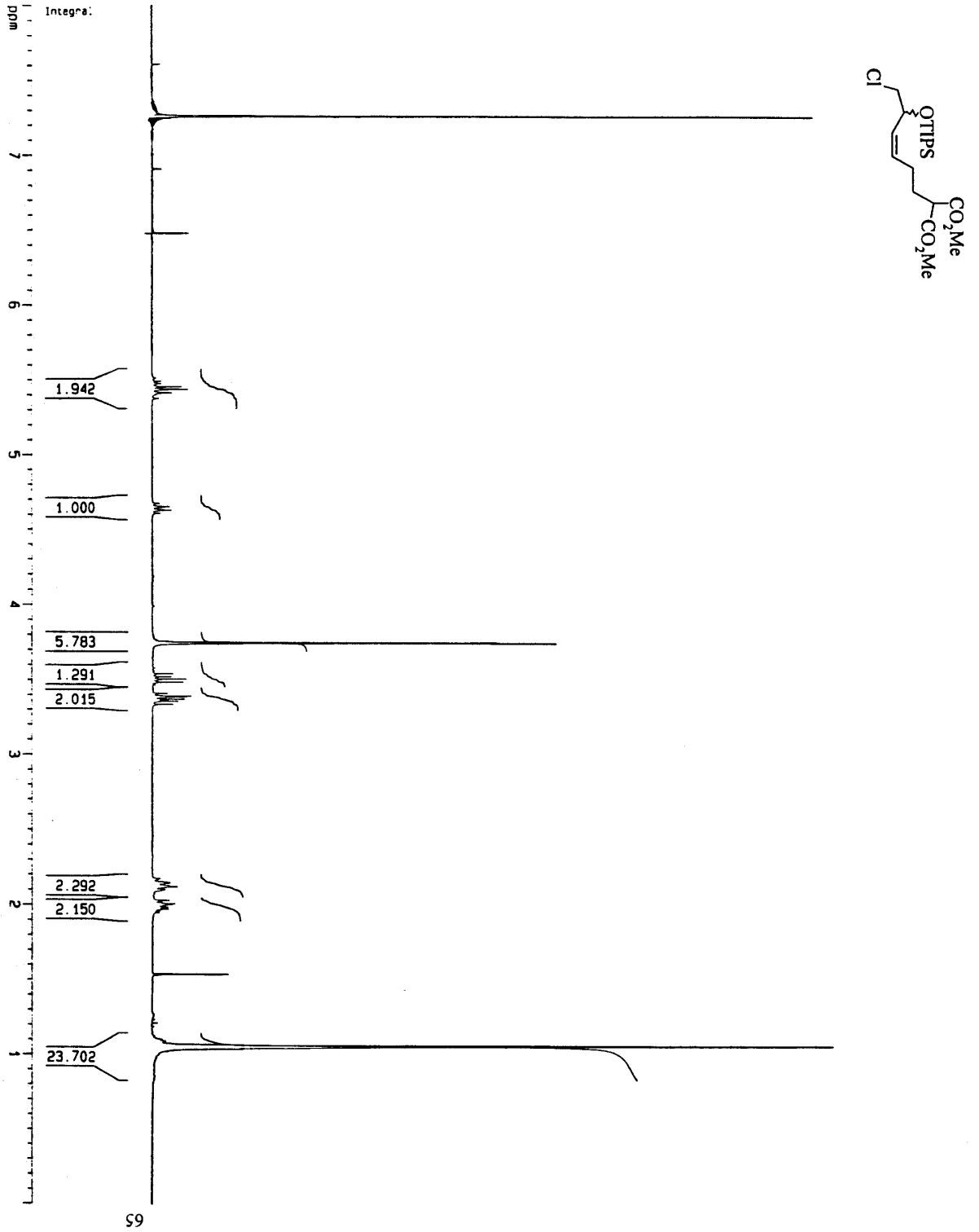
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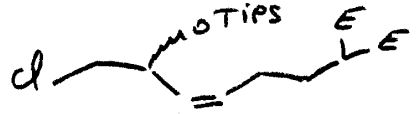

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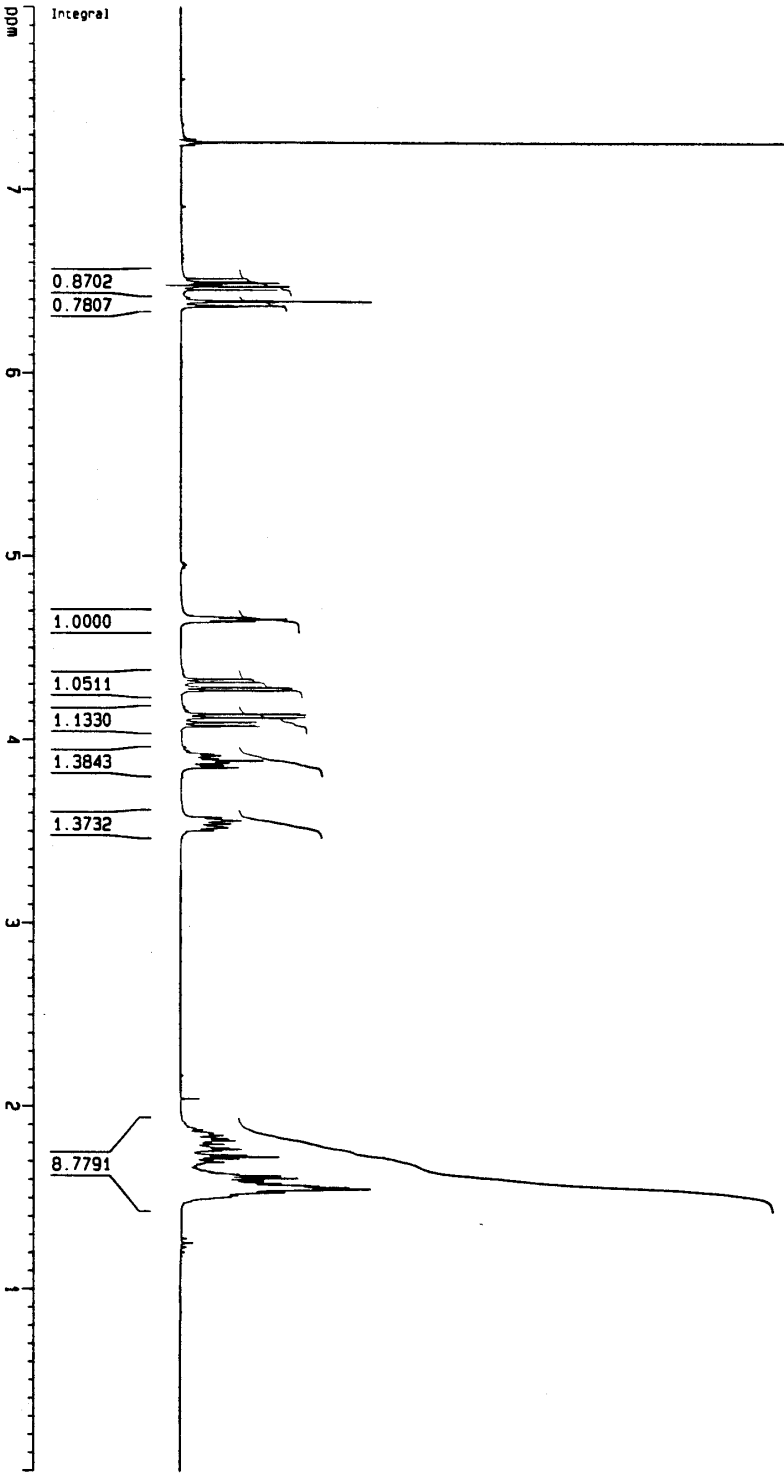
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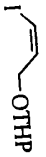
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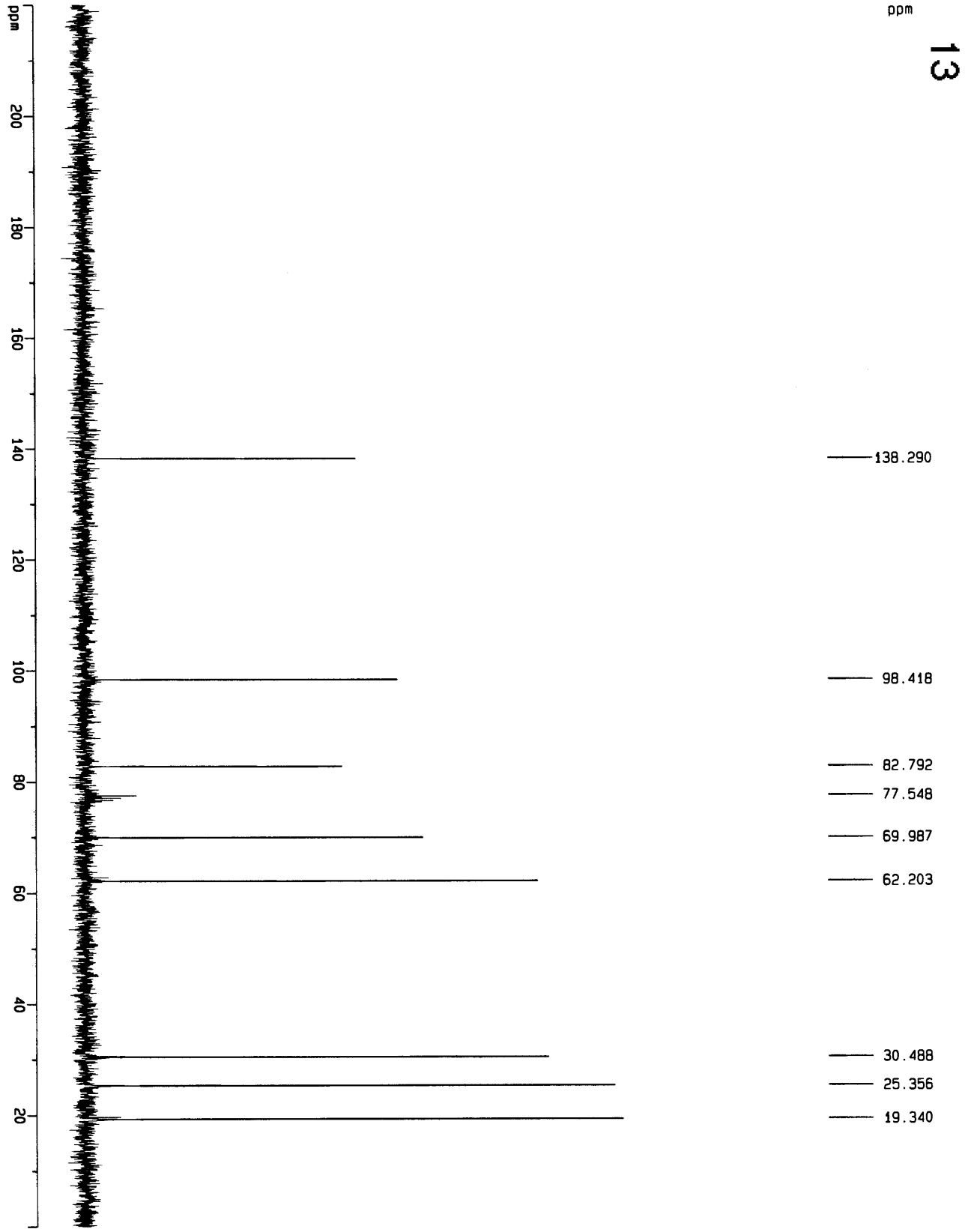
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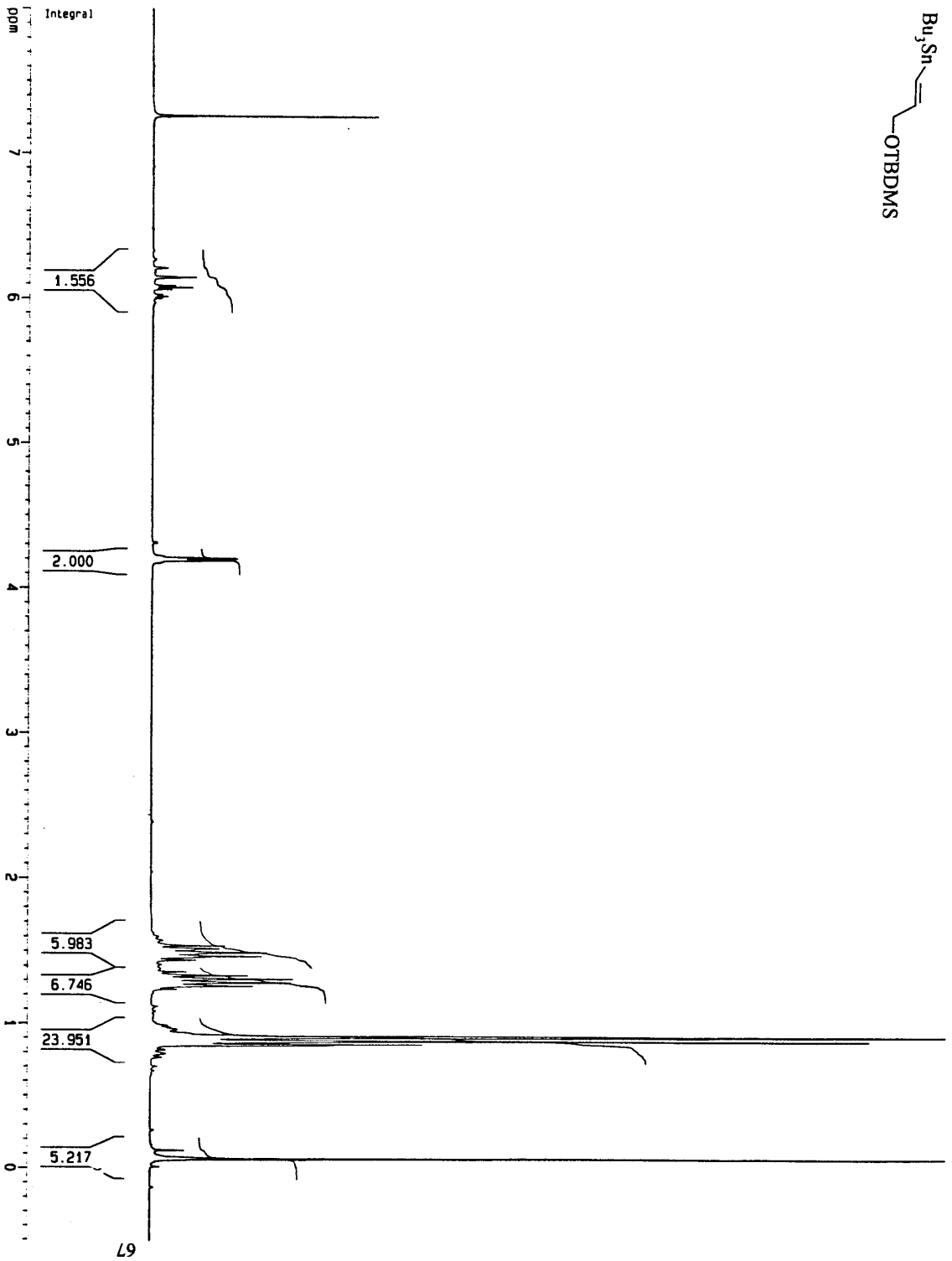

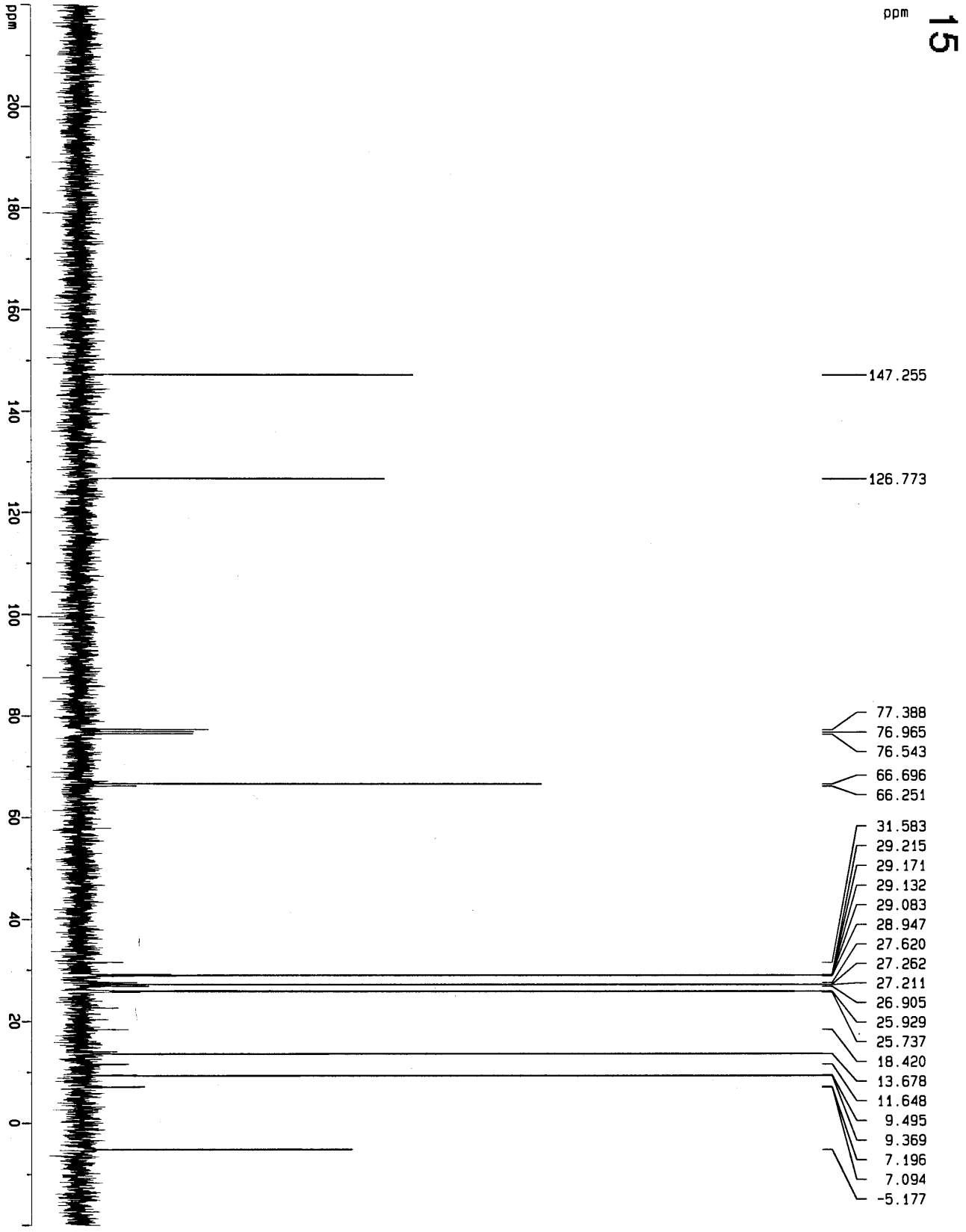
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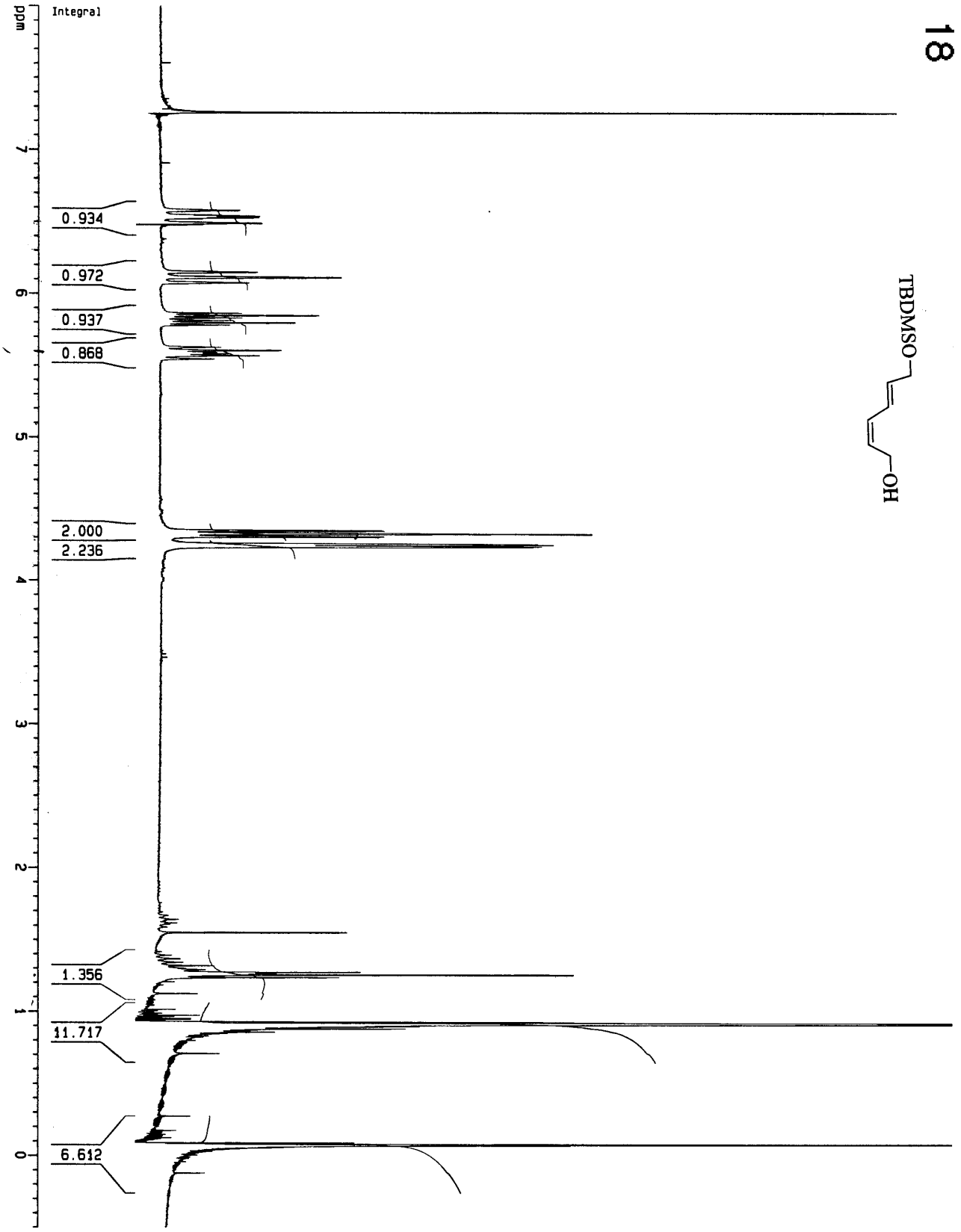
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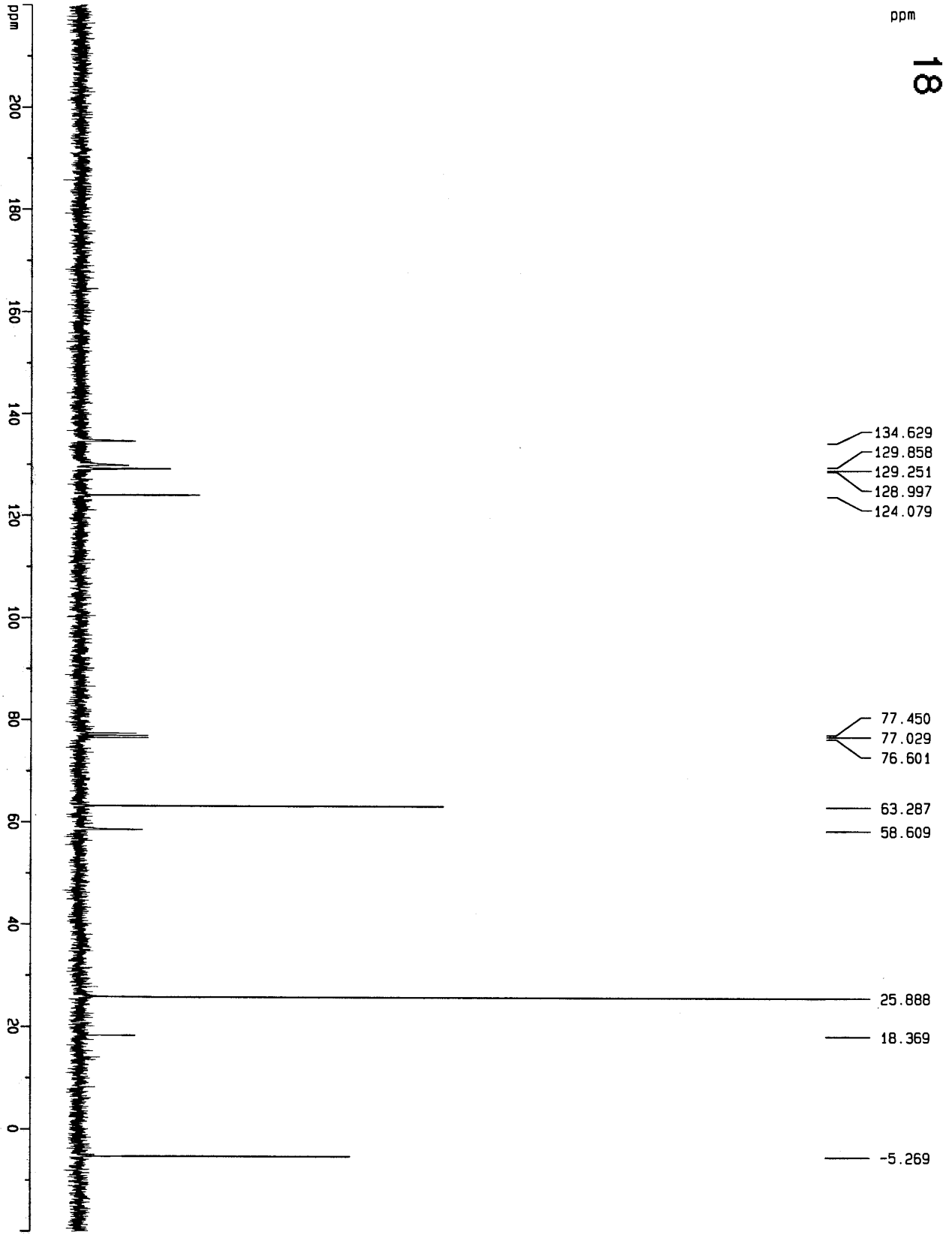
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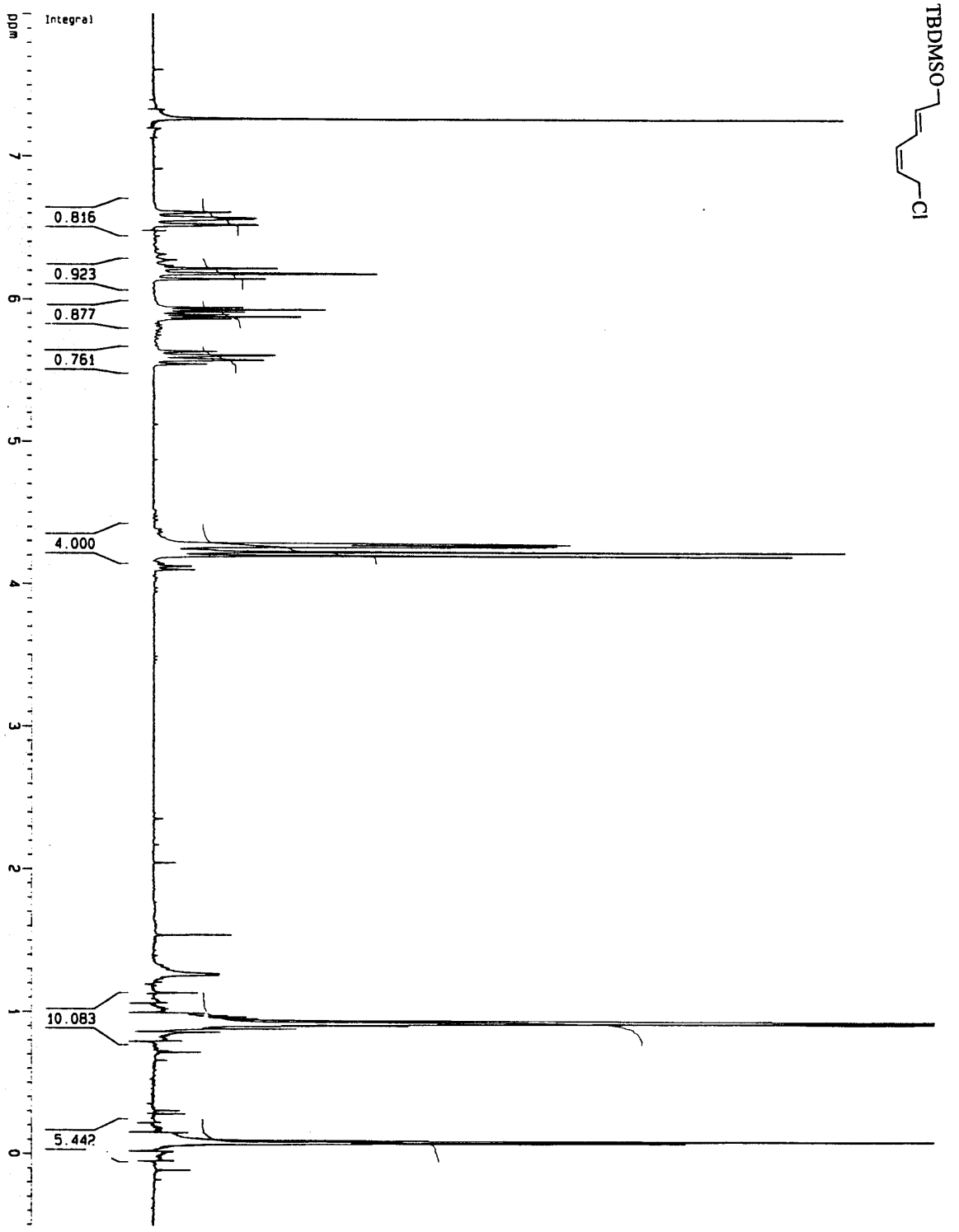

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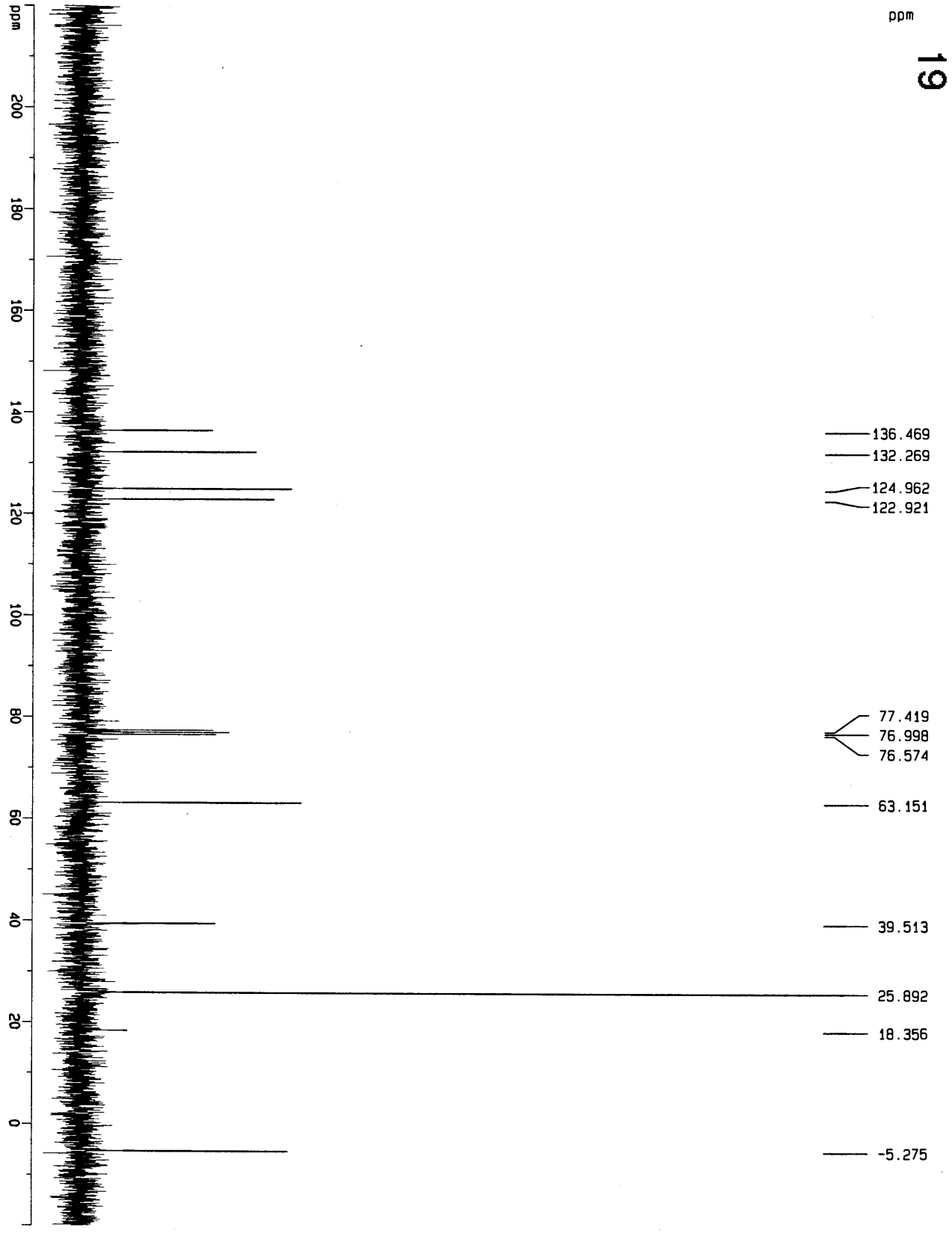
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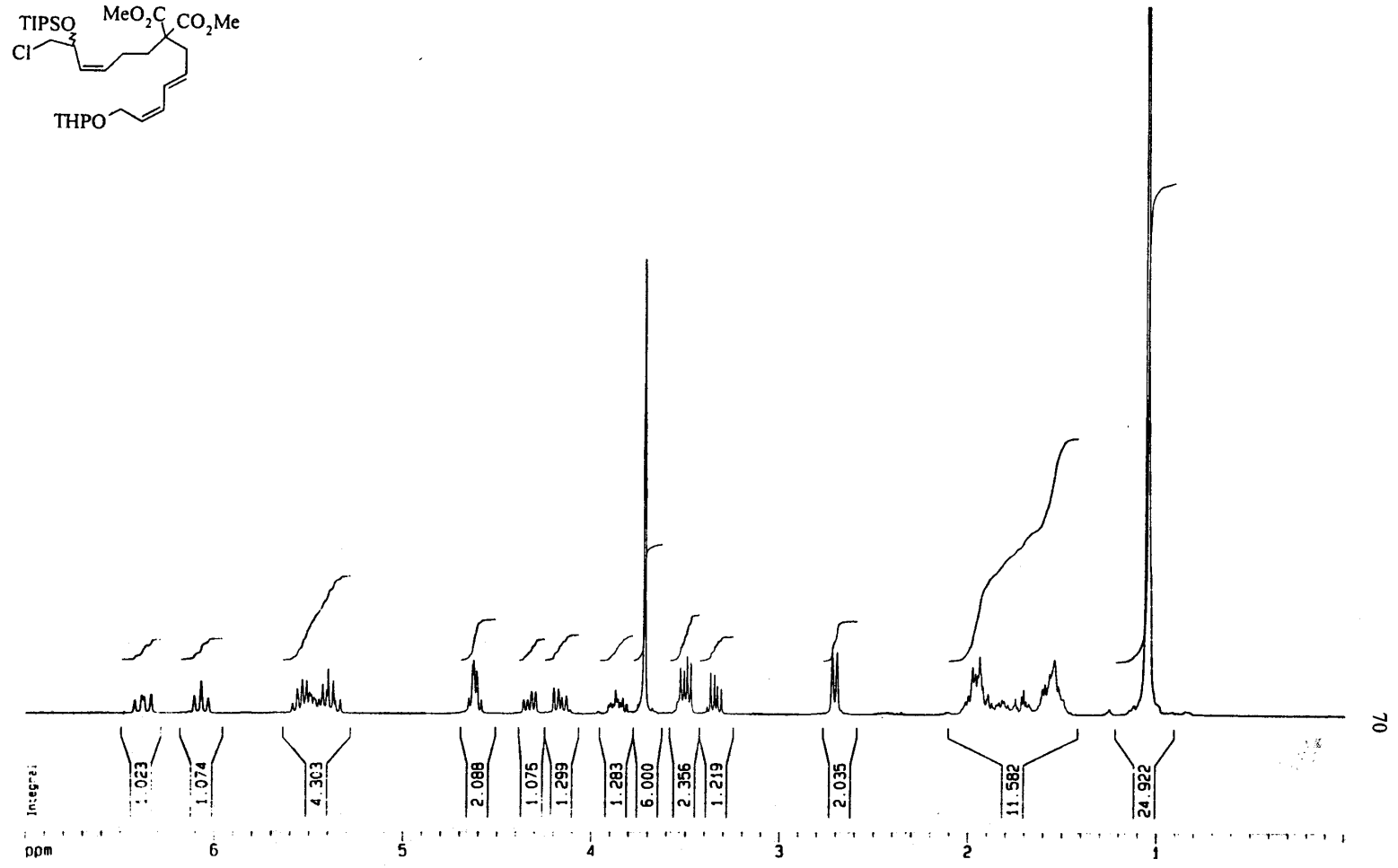
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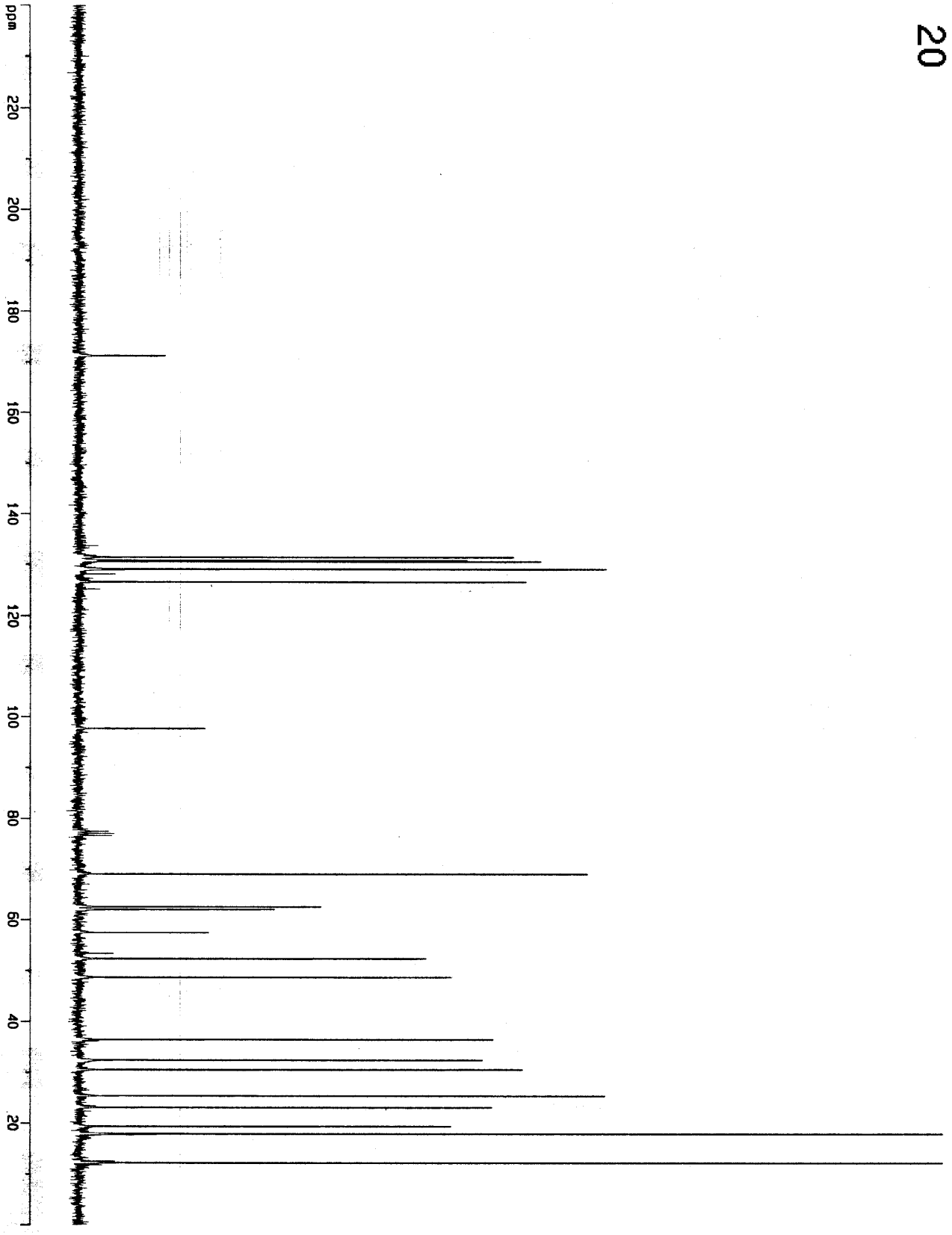

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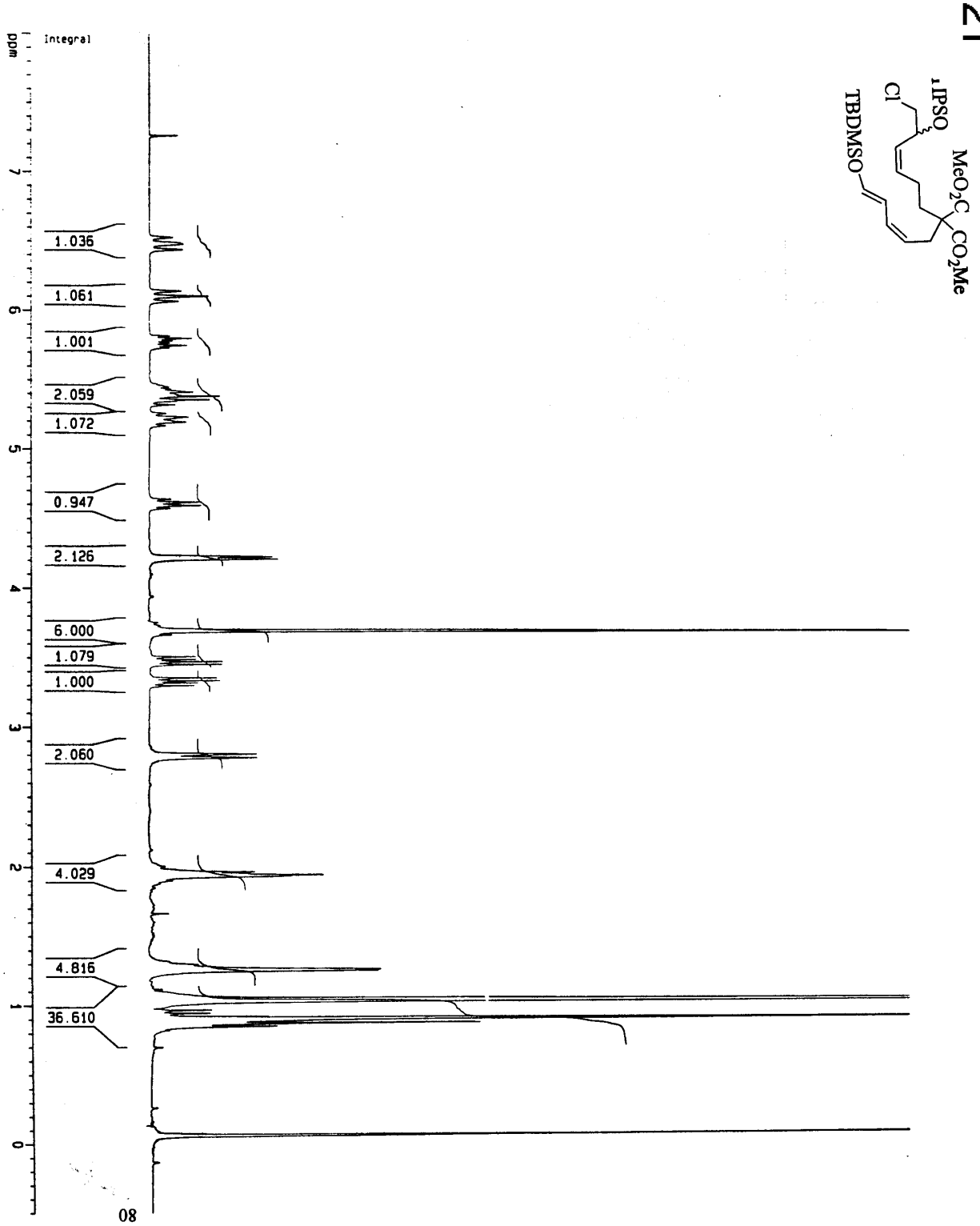
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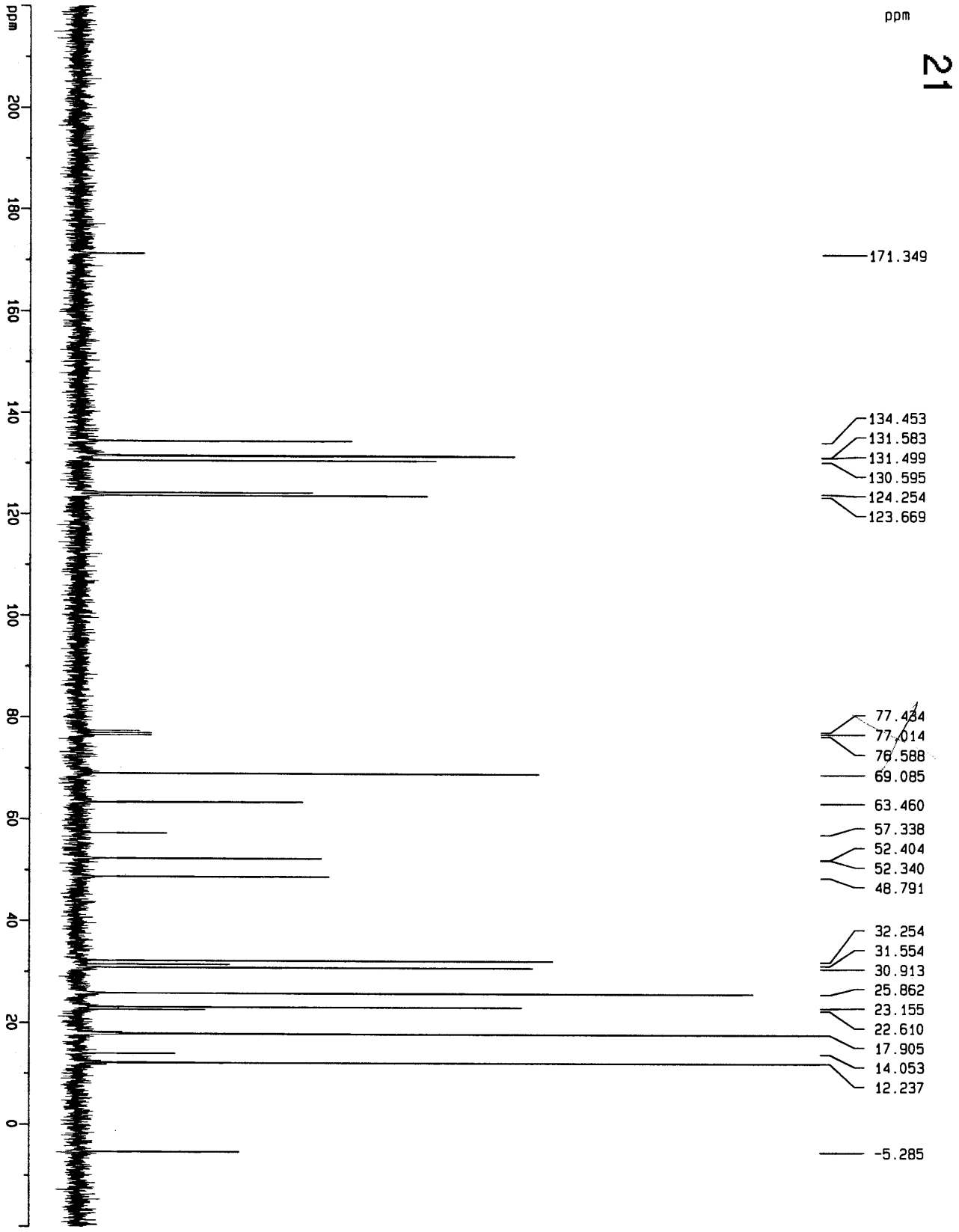
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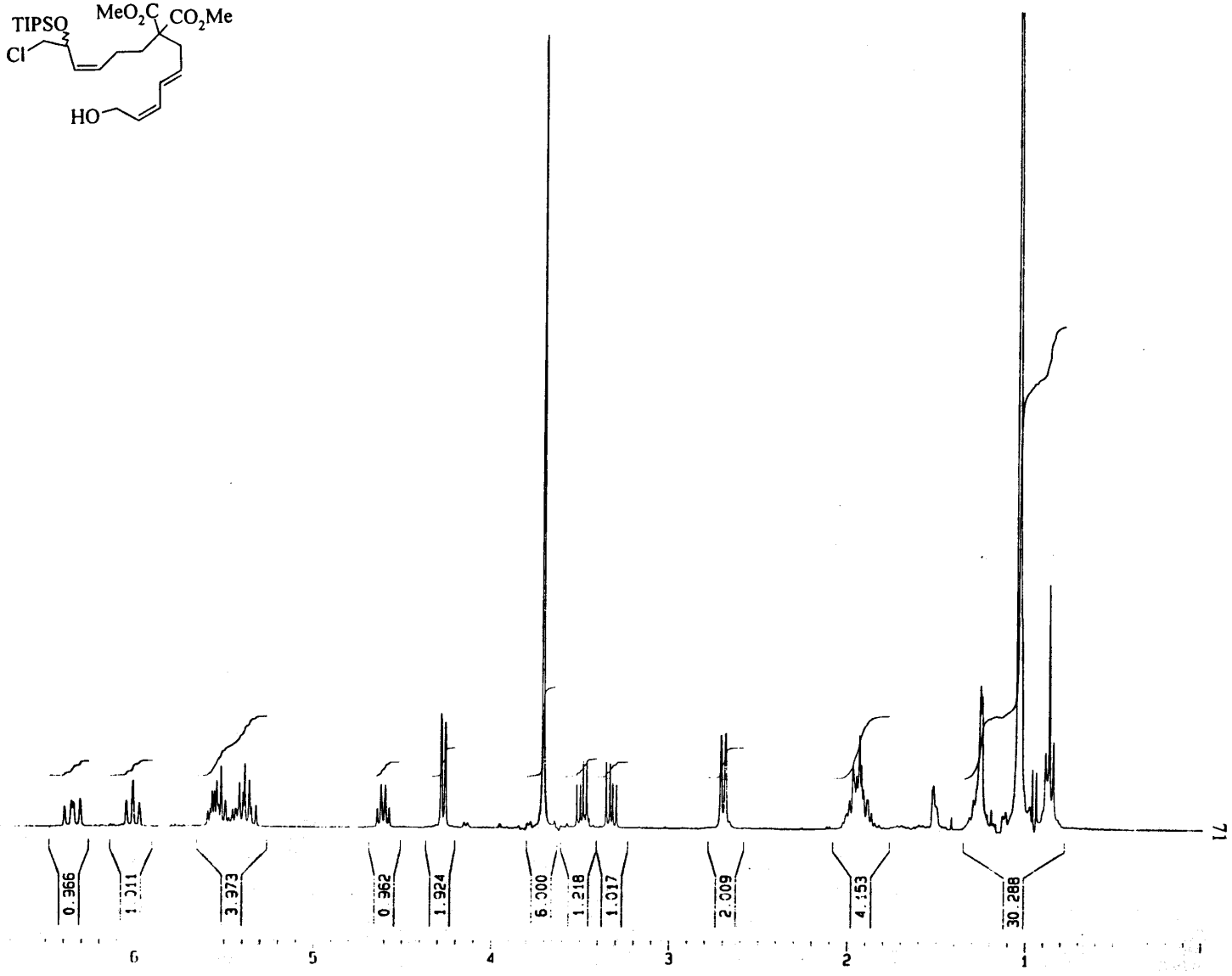
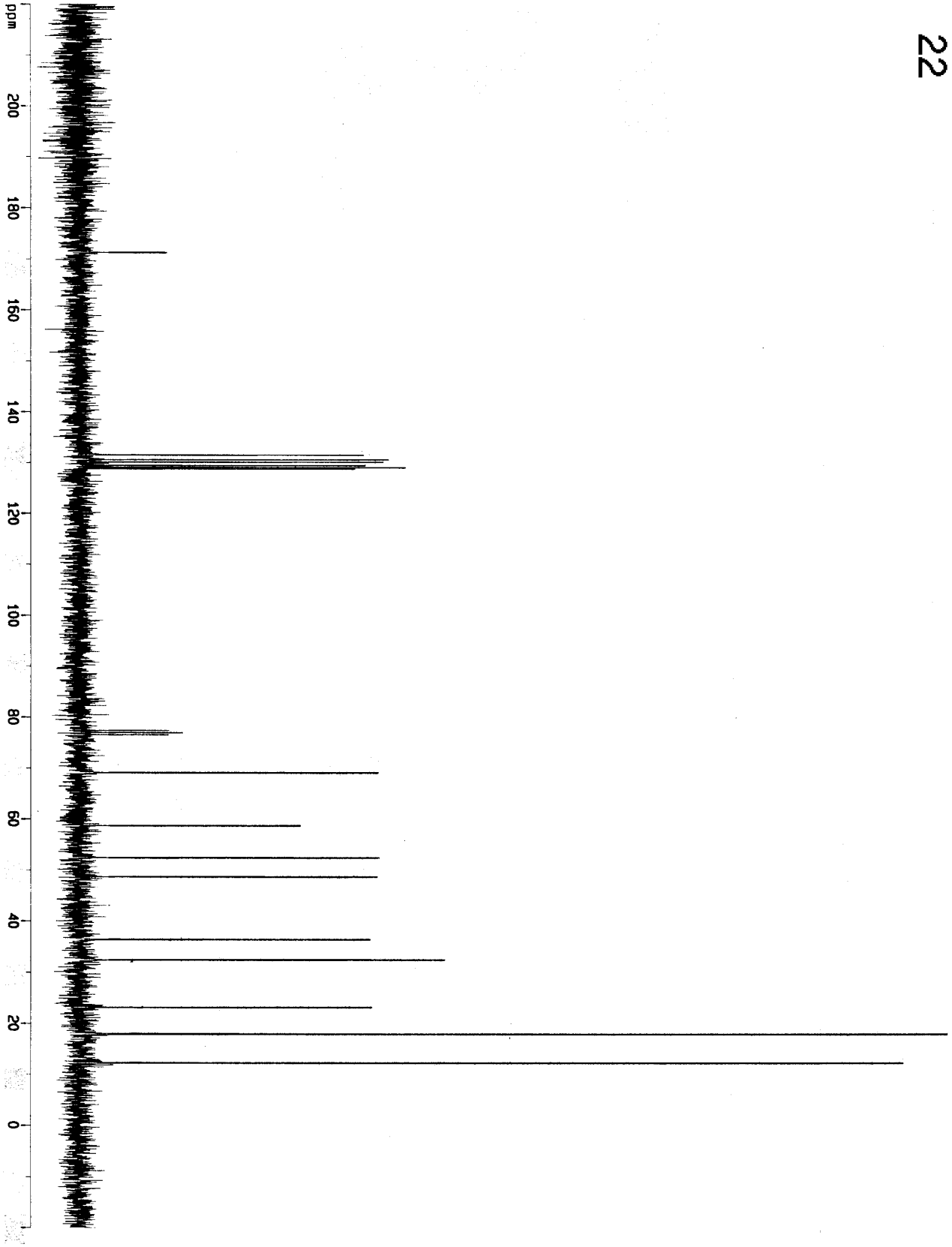
12.237
-5.285

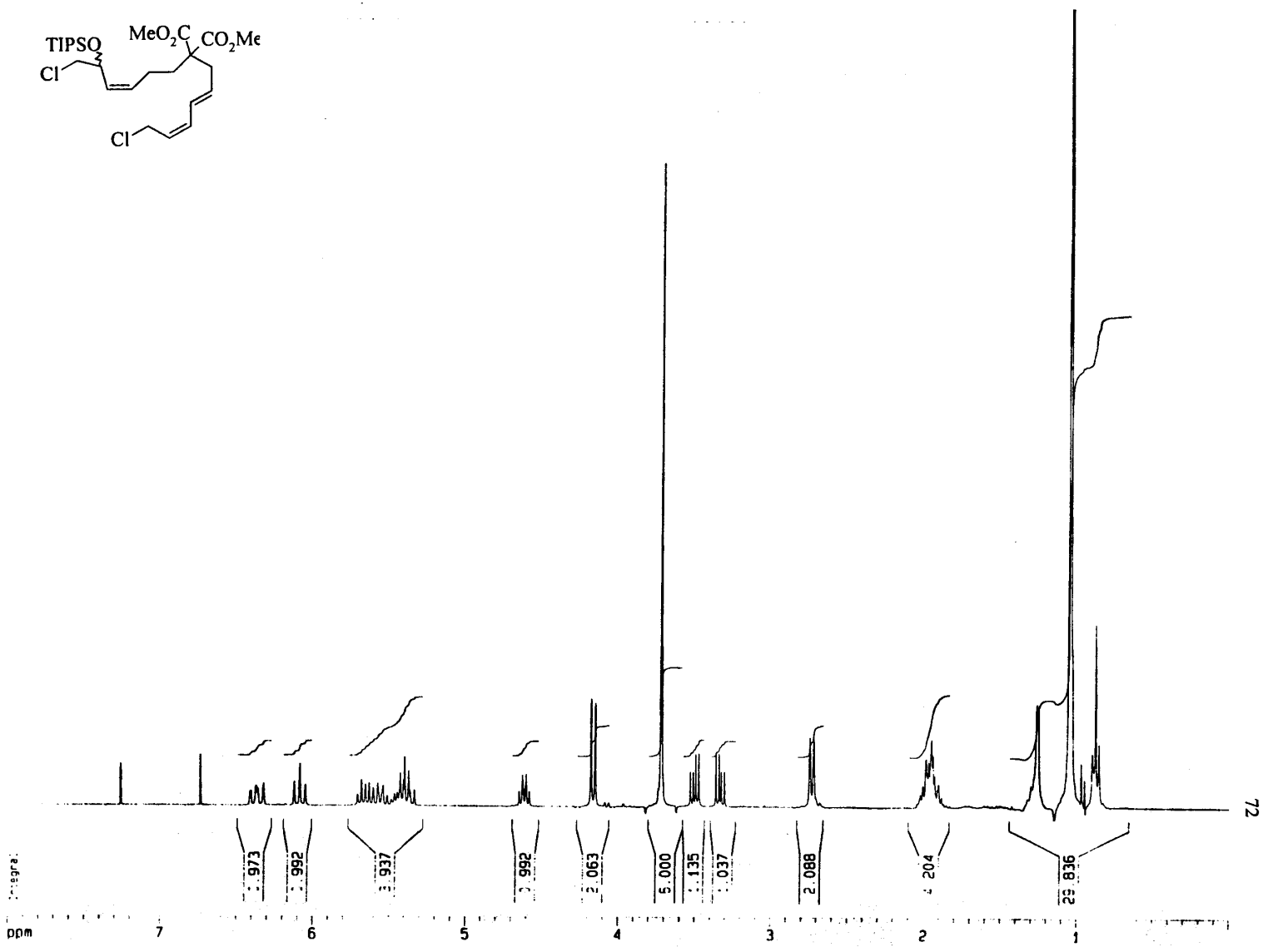
22


TIPSO
Cl
MeO2C
CO2Me
HO
0.966
1.011
3.973
0.962
1.924
6.000
1.218
1.017
2.009
4.153
30.288
ppm
6
5
4
3
2
1

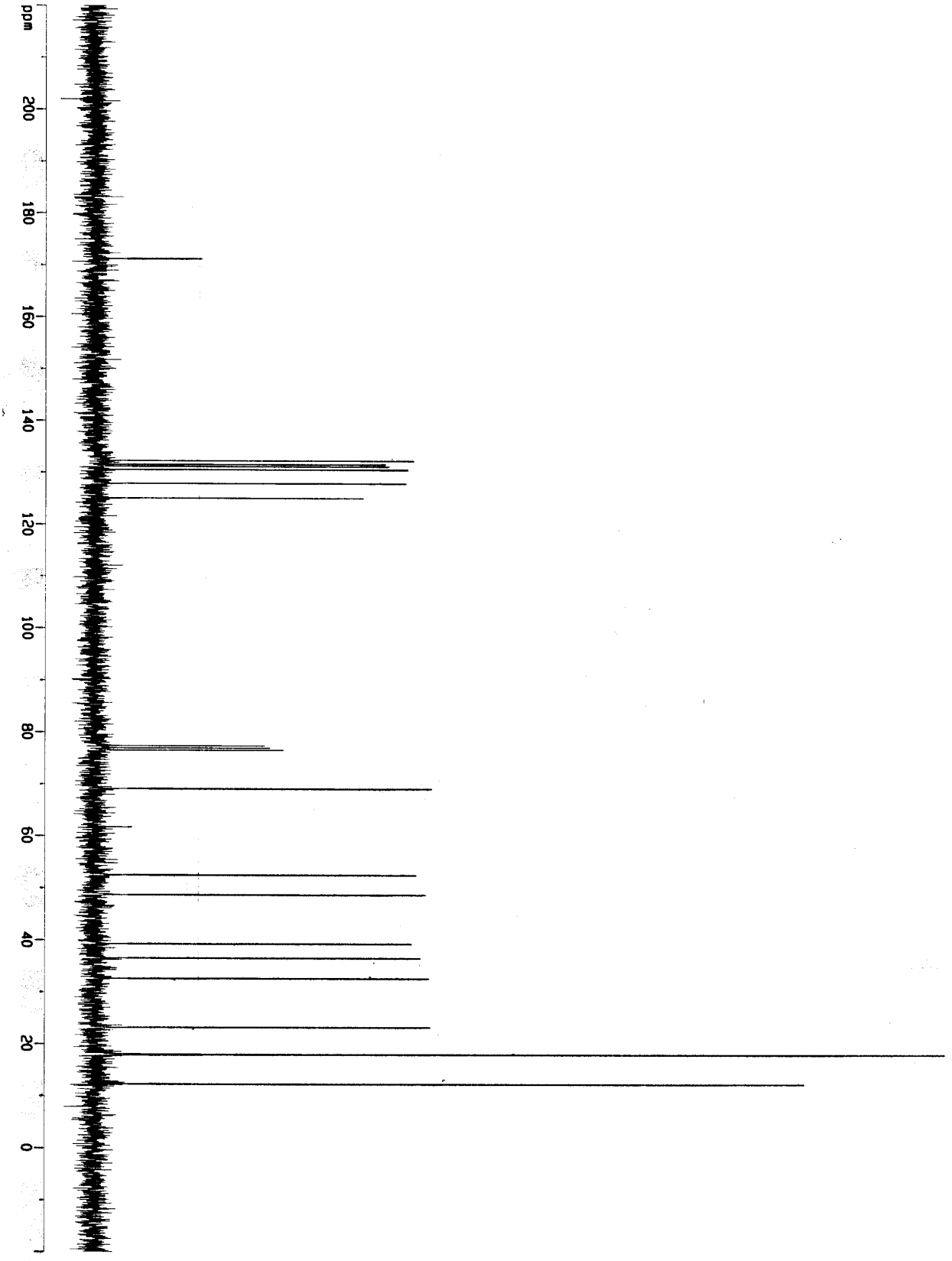
22



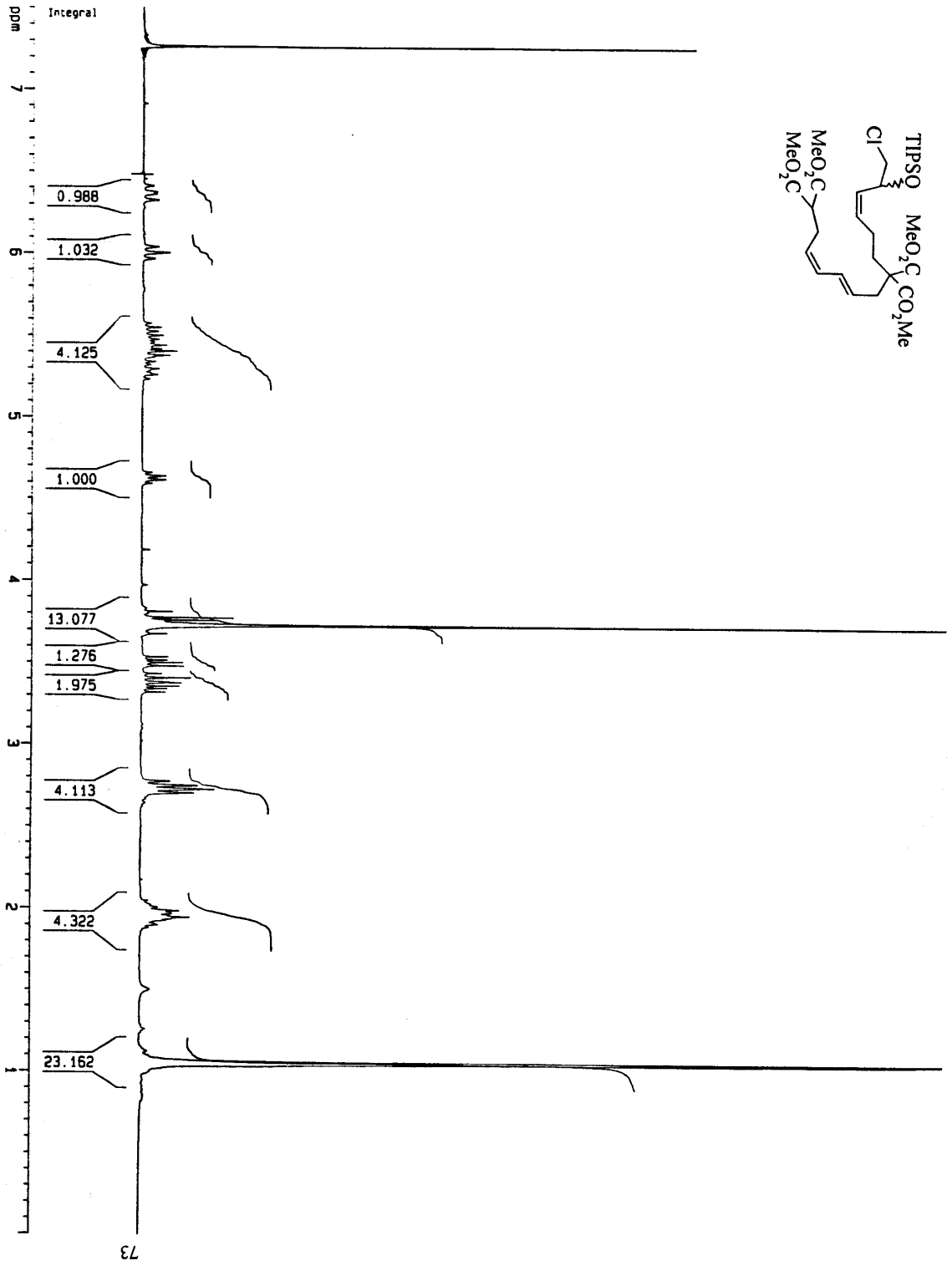
23

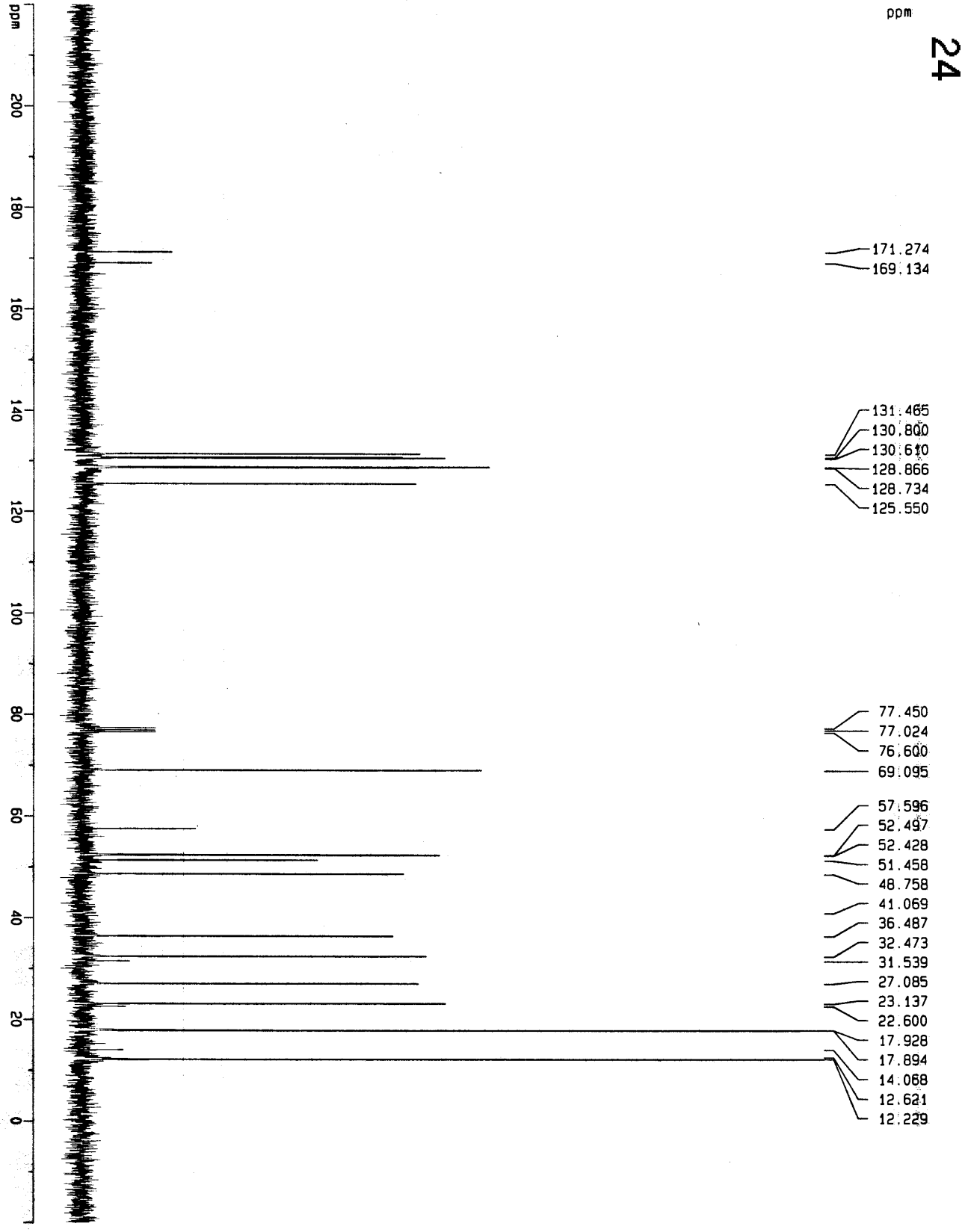


23

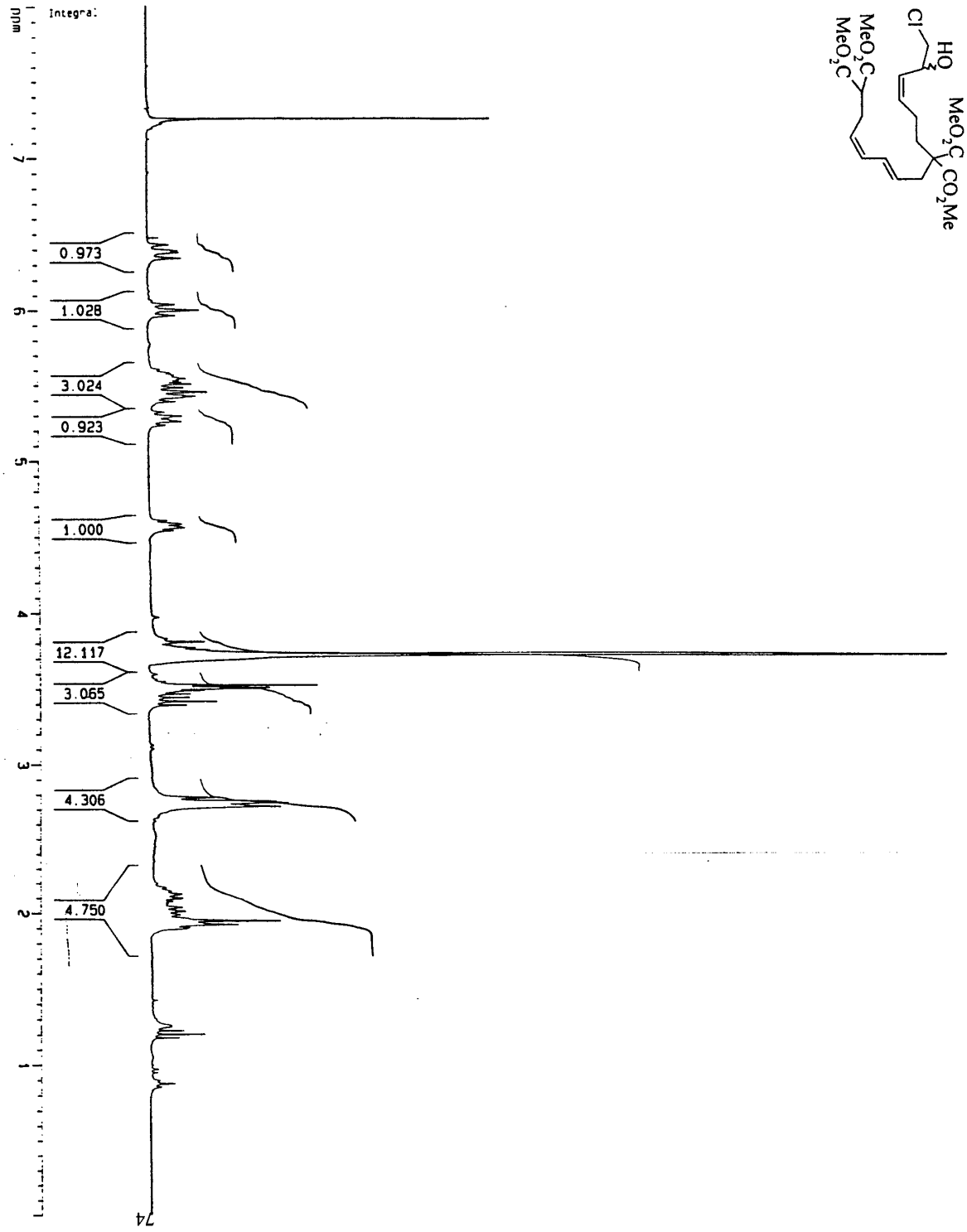


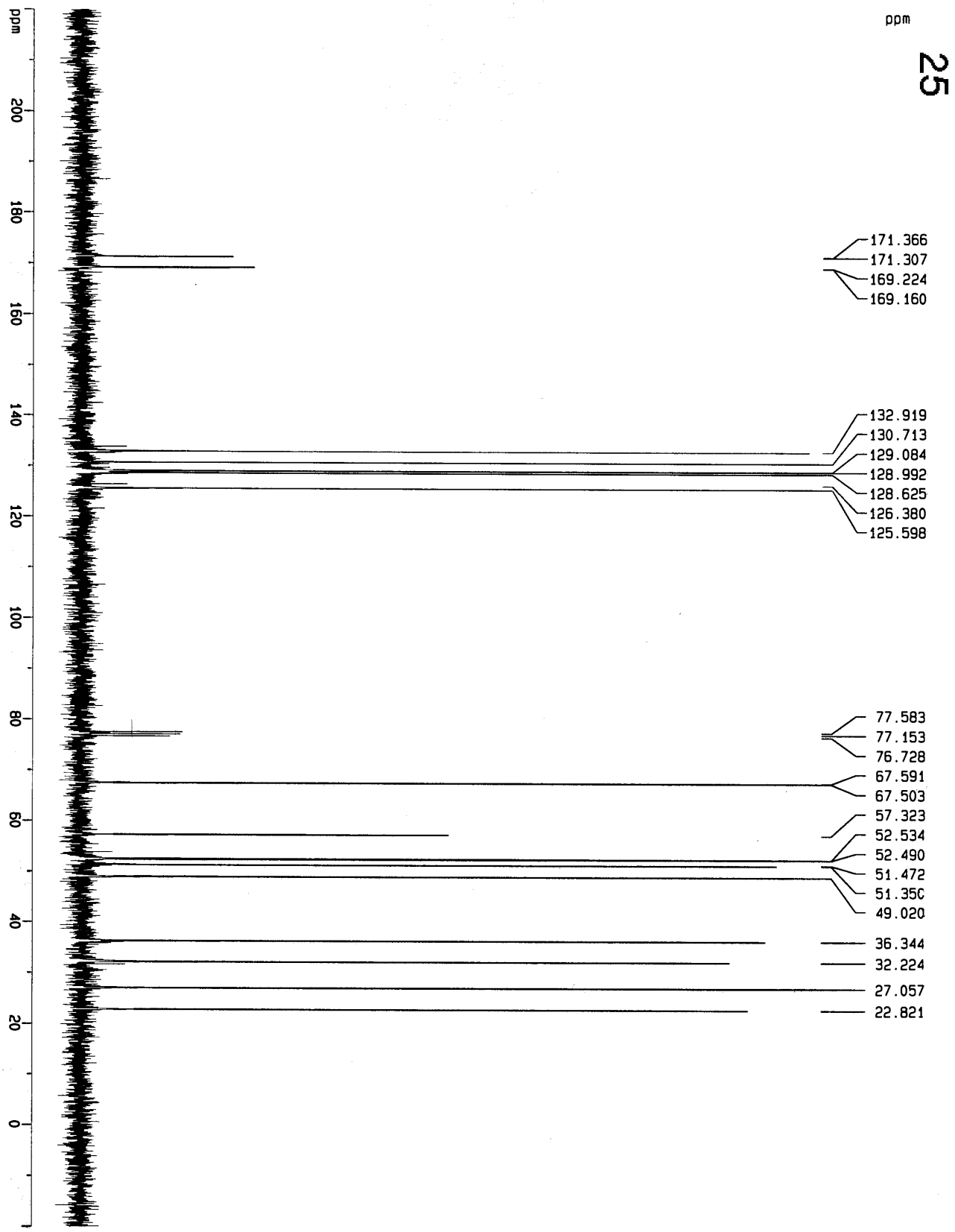
24

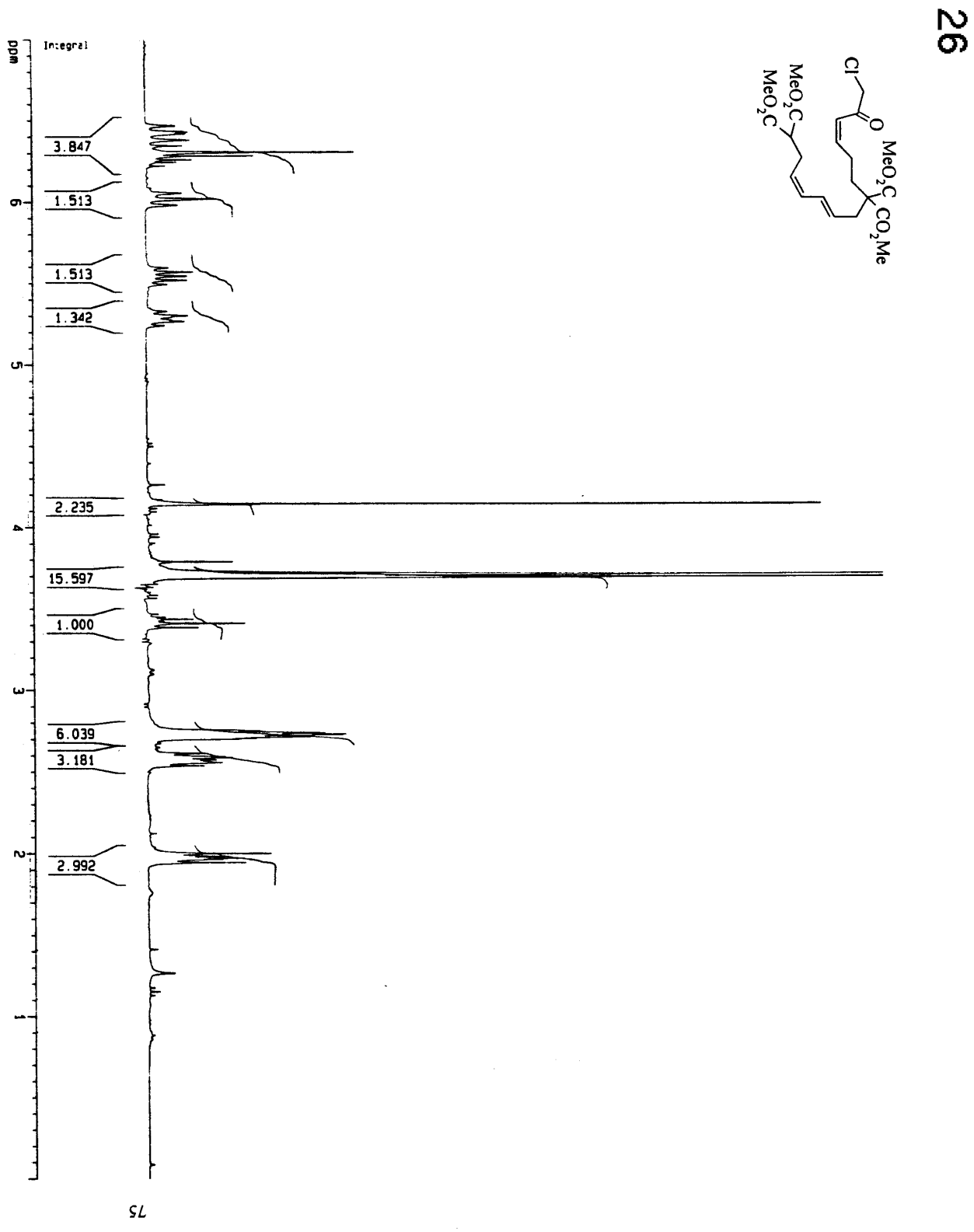

Integral
ppm
0.988
1.032
4.125
1.000
13.077
1.276
1.975
4.113
4.322
23.162
TIPSO
Cl
MeO2C
MeO2C
MeO2C
CO2Me

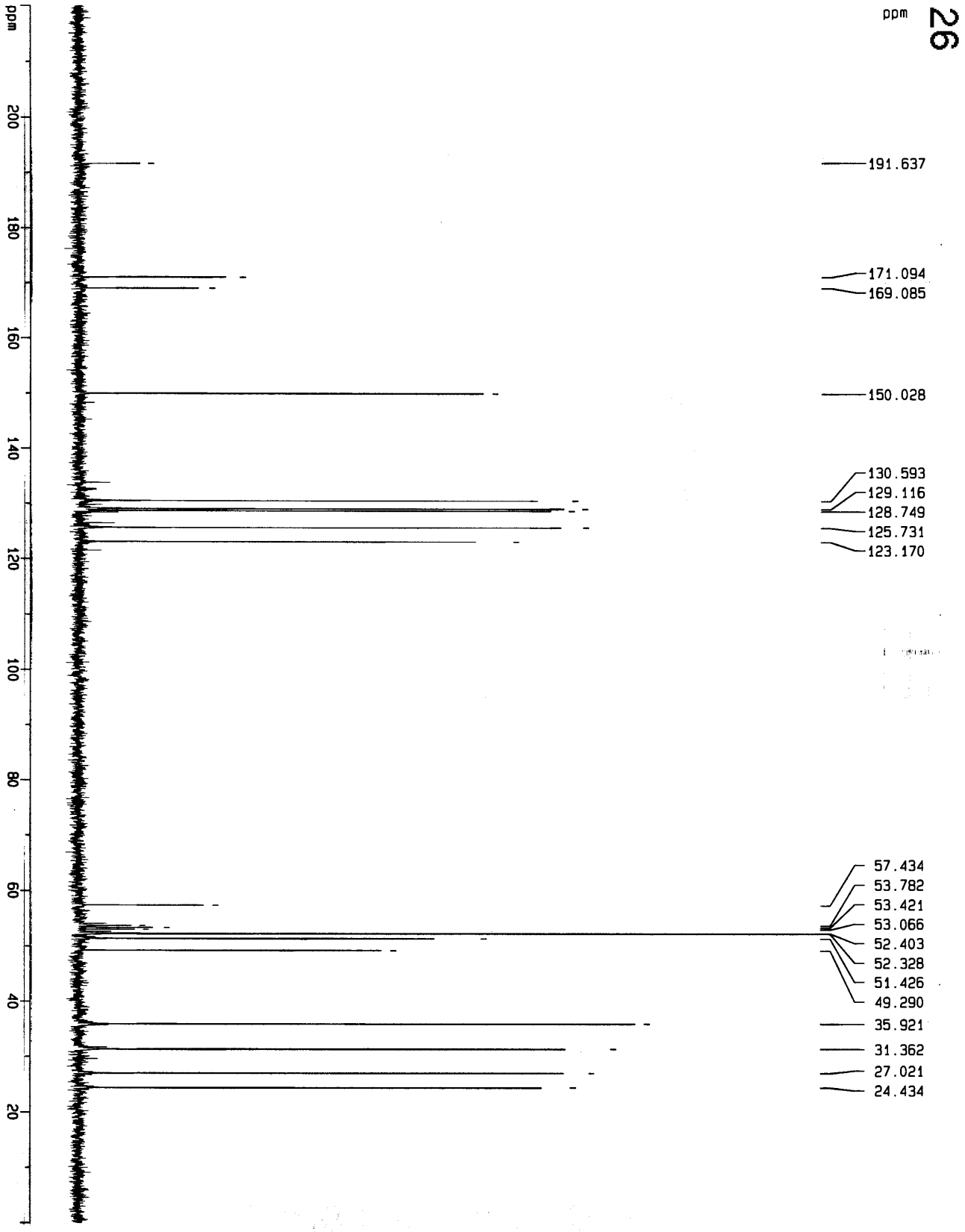

ppm
24
ppm
200
180
160
140
120
100
80
60
40
20
0
171.274
169.134
131.465
130.800
130.610
128.866
128.734
125.550
77.450
77.024
76.600
69.095
57.596
52.497
52.428
51.458
48.758
41.069
36.487
32.473
31.539
27.085
23.137
22.600
17.928
17.894
14.068
12.621
12.229

25

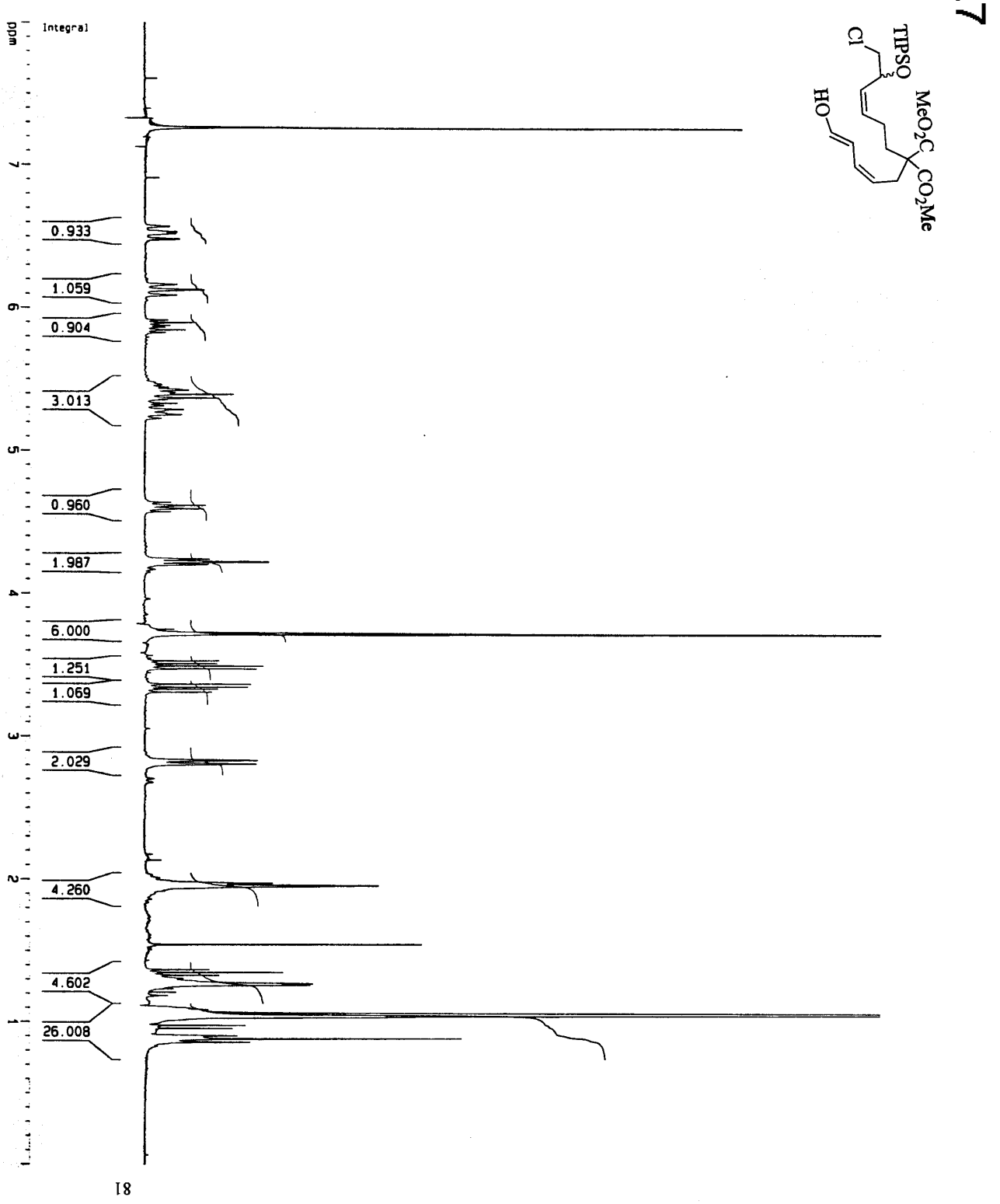

ppm
Integral
0.973
1.028
3.024
0.923
1.000
12.117
3.065
4.306
4.750
Cl
HO
MeO2C
MeO2C
MeO2C
CO2Me


ppm
25
ppm
200
180
160
140
120
100
80
60
40
20
0
171.366
171.307
169.224
169.160
132.919
130.713
129.084
128.992
128.625
126.380
125.598
77.583
77.153
76.728
67.591
67.503
57.323
52.534
52.490
51.472
51.350
49.020
36.344
32.224
27.057
22.821

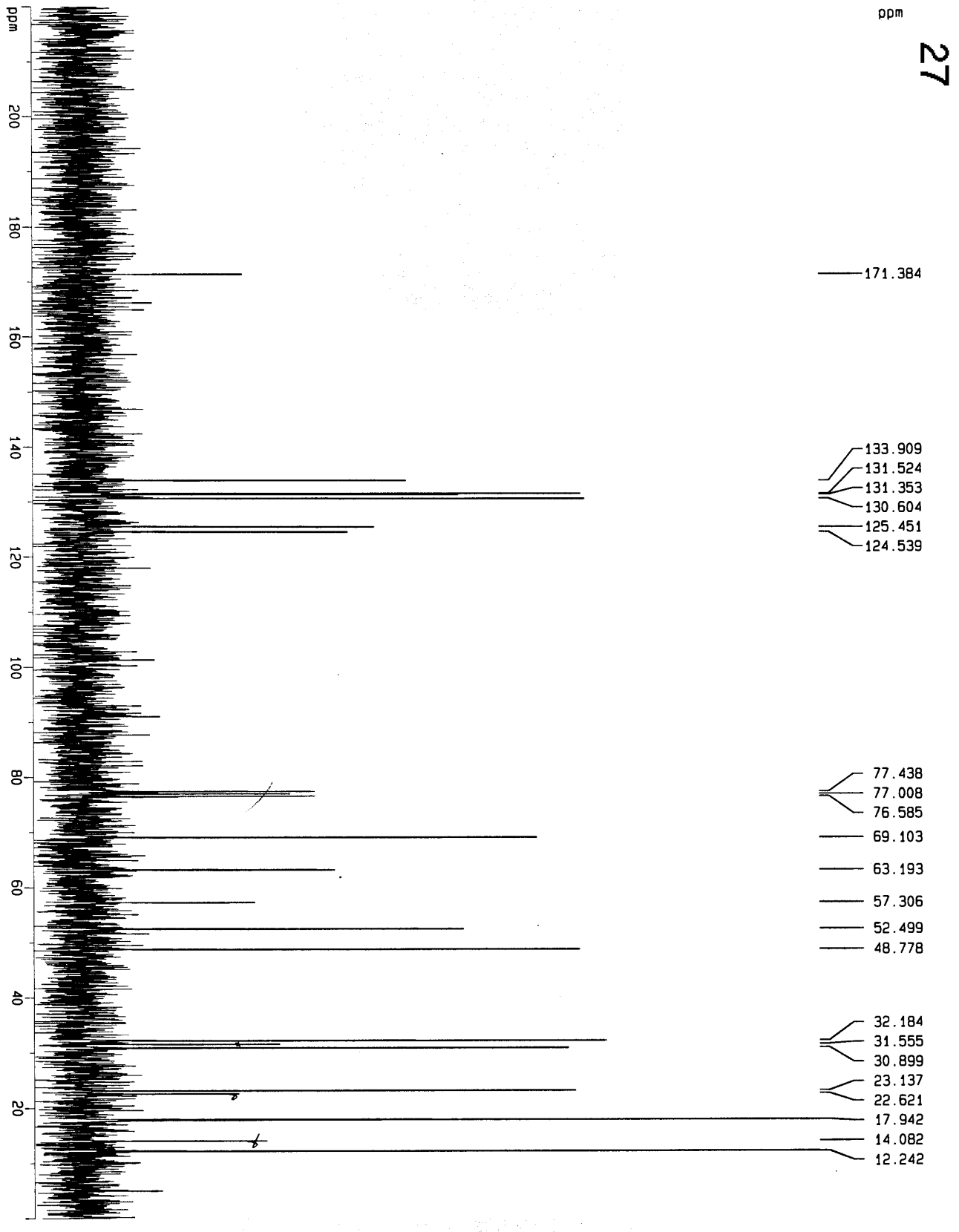

26
Integral
3.847
1.513
1.513
1.342
2.235
15.597
1.000
6.039
3.181
2.992
ppm
6
5
4
3
2
1
Cl
O
MeO2C
CO2Me
MeO2C
MeO2C
75


26
ppm
ppm
200
180
160
140
120
100
80
60
40
20
191.637
171.094
169.085
150.028
130.593
129.116
128.749
125.731
123.170
57.434
53.782
53.421
53.066
52.403
52.328
51.426
49.290
35.921
31.362
27.021
24.434

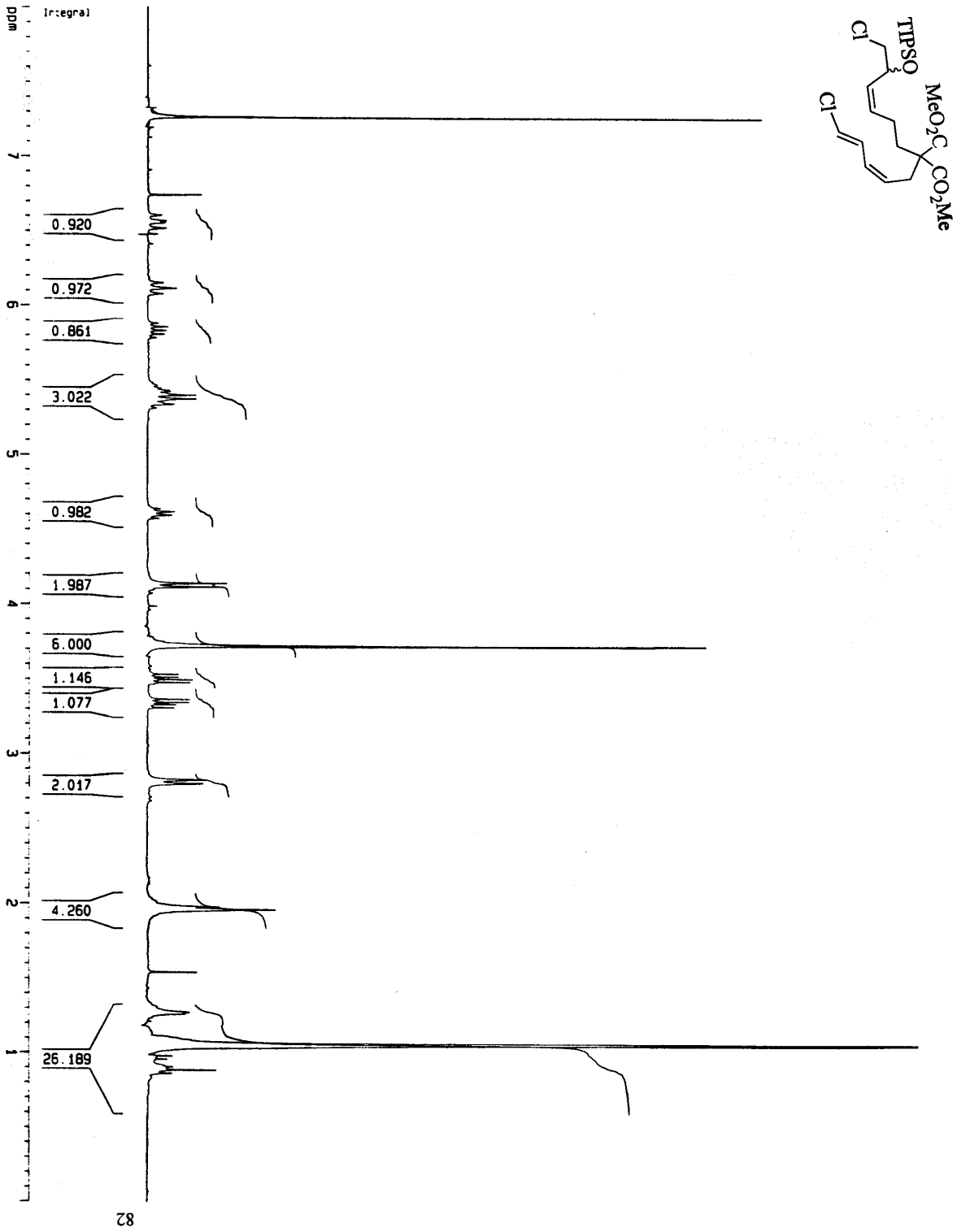
27

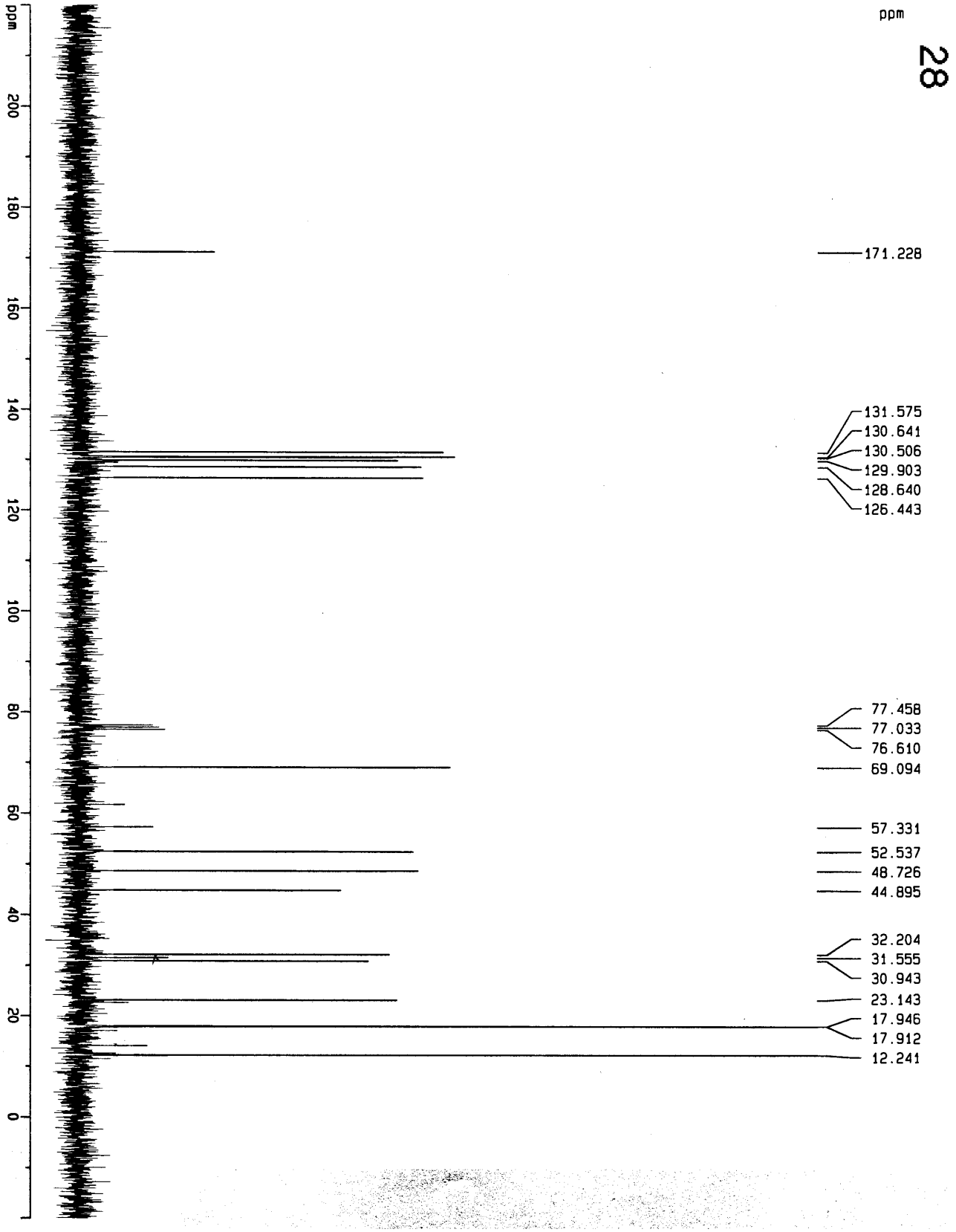

Integral
ppm
0.933
1.059
0.904
3.013
0.960
1.987
6.000
1.251
1.069
2.029
4.260
4.602
26.008
TIPSO
Cl
HO
MeO2C
CO2Me

18

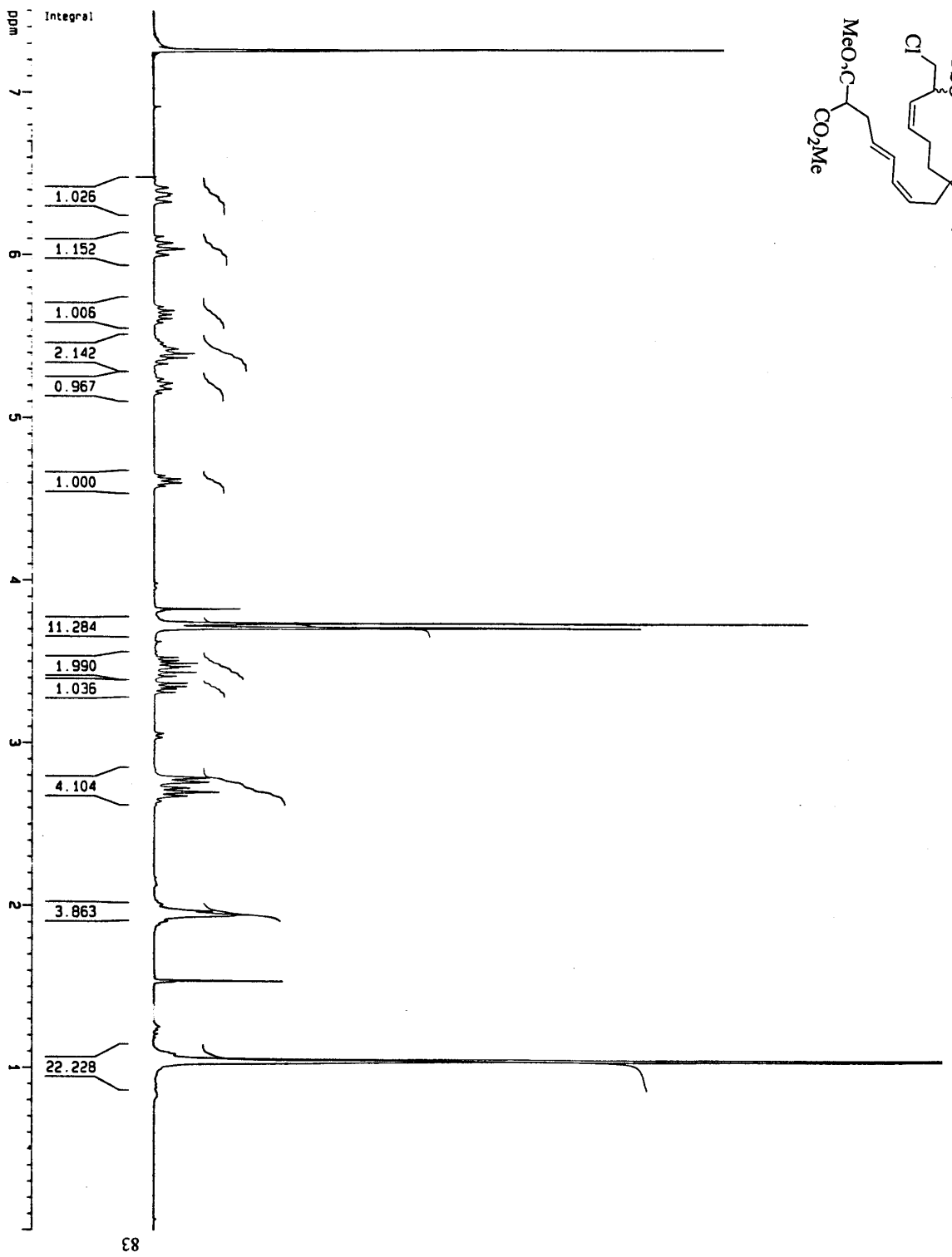

ppm
27
ppm
200
180
160
140
120
100
80
60
40
20
171.384
133.909
131.524
131.353
130.604
125.451
124.539
77.438
77.008
76.585
69.103
63.193
57.306
52.499
48.778
32.184
31.555
30.899
23.137
22.621
17.942
14.082
12.242

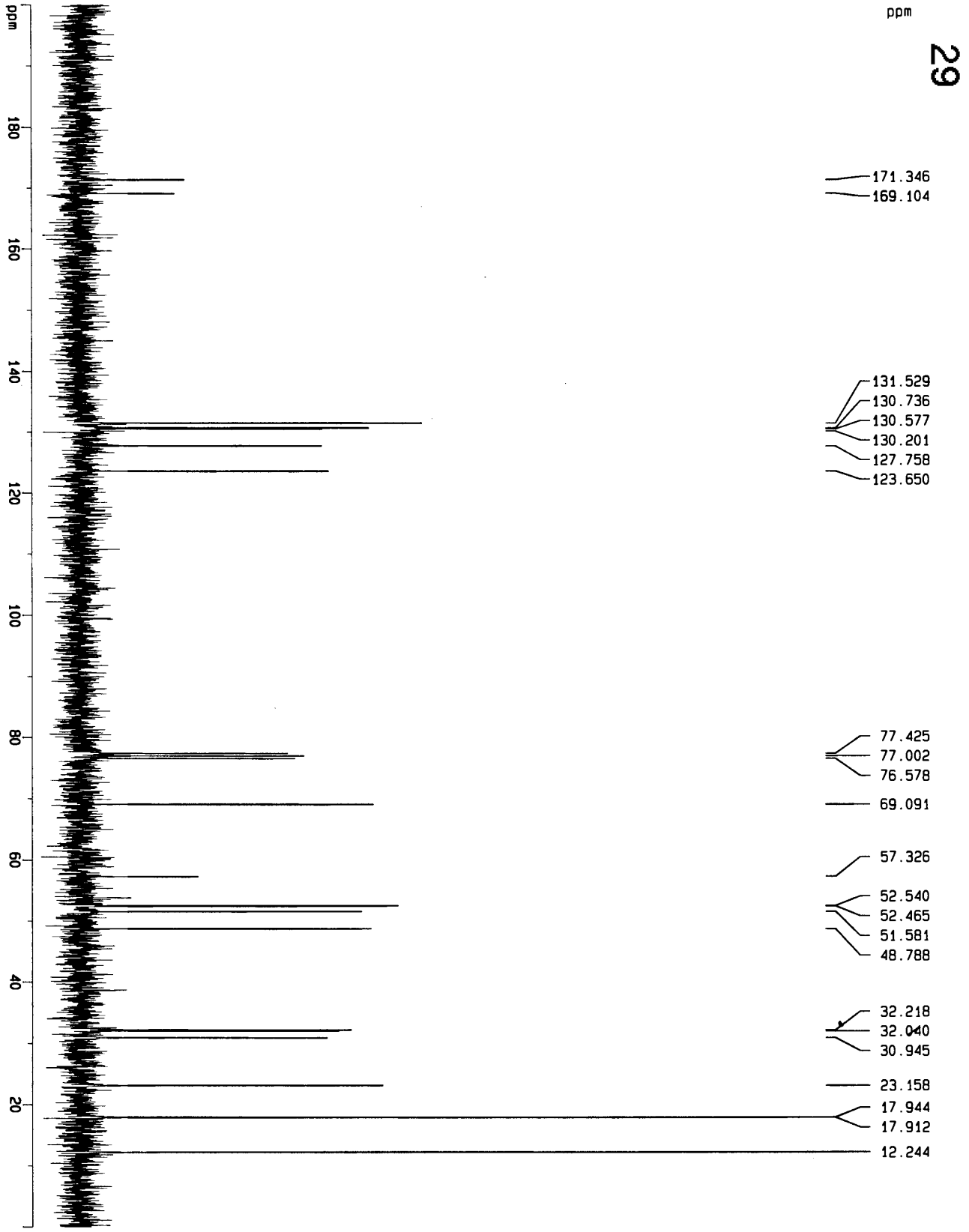
28


Integral
ppm
0.920
0.972
0.861
3.022
0.982
1.987
6.000
1.146
1.077
2.017
4.260
26.189
TIPSO
Cl
Cl
MeO2C
CO2Me

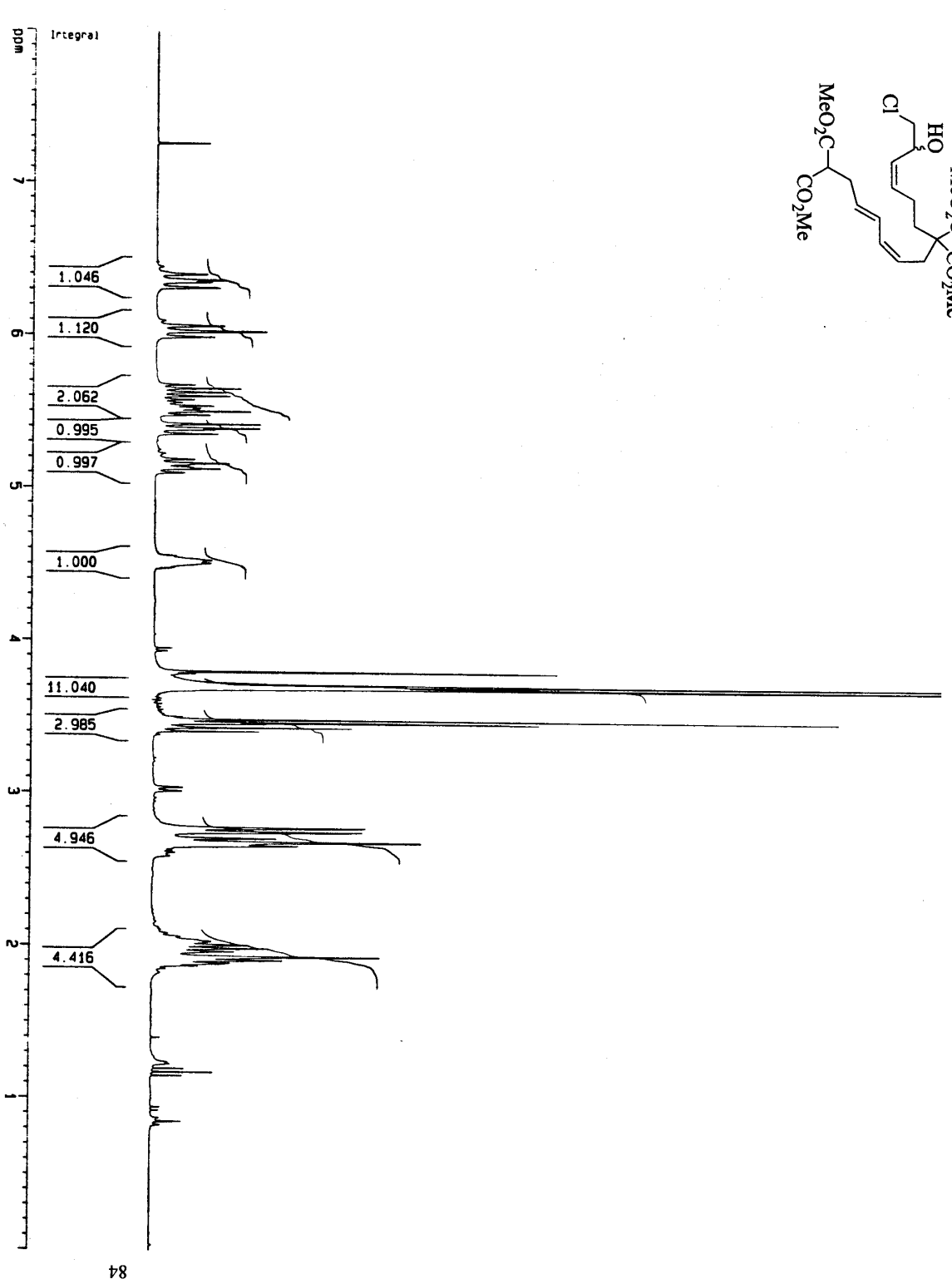

ppm
28
ppm
200
180
160
140
120
100
80
60
40
20
0
171.228
131.575
130.641
130.506
129.903
128.640
126.443
77.458
77.033
76.610
69.094
57.331
52.537
48.726
44.895
32.204
31.555
30.943
23.143
17.946
17.912
12.241

29

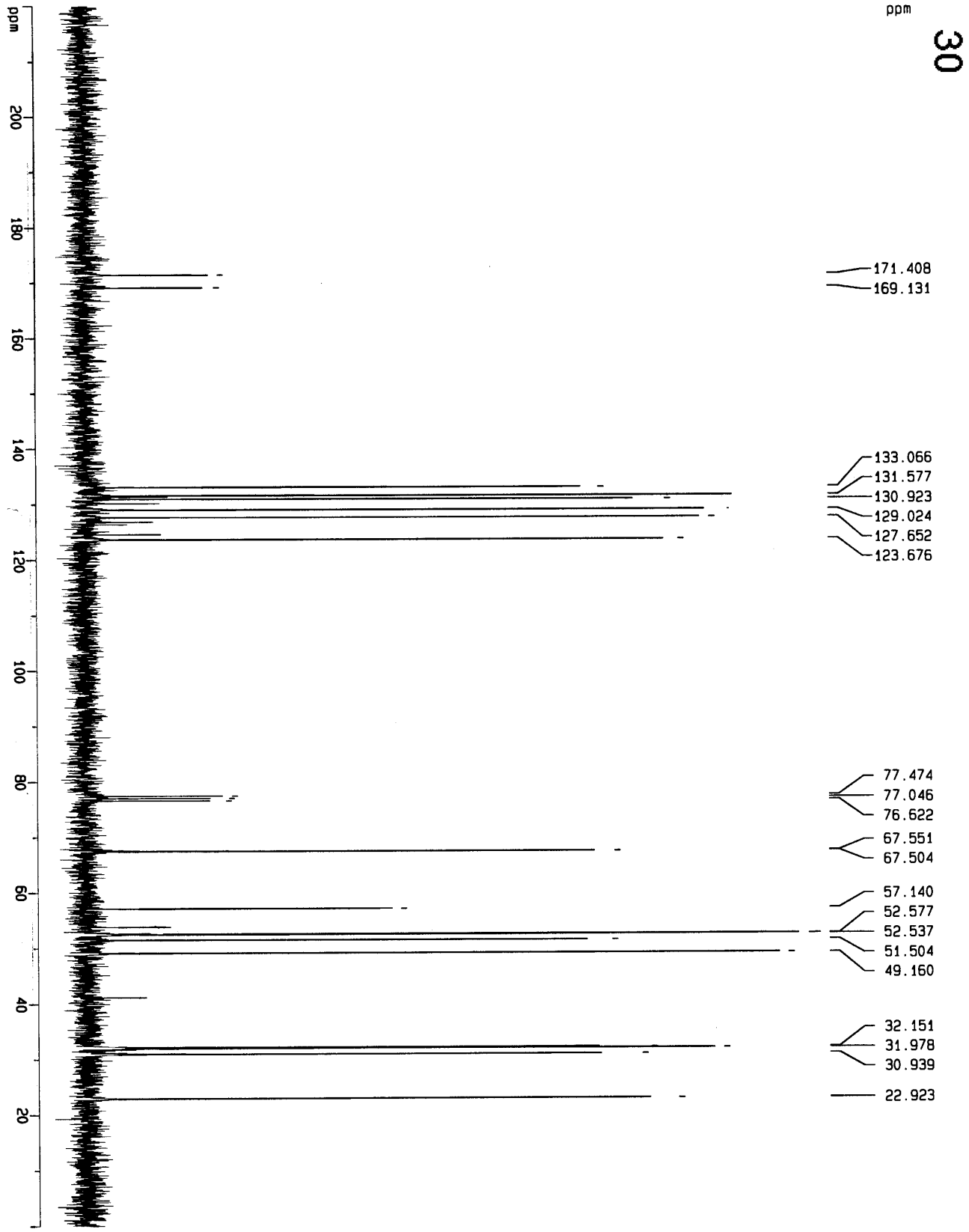

Integral
ppm
1.026
1.152
1.006
2.142
0.967
1.000
11.284
1.990
1.036
4.104
3.863
22.228
TIPSO
Cl
MeO2C
CO2Me
MeO2C
CO2Me


ppm
29
ppm
180
160
140
120
100
80
60
40
20
171.346
169.104
131.529
130.736
130.577
130.201
127.758
123.650
77.425
77.002
76.578
69.091
57.326
52.540
52.465
51.581
48.788
32.218
32.040
30.945
23.158
17.944
17.912
12.244

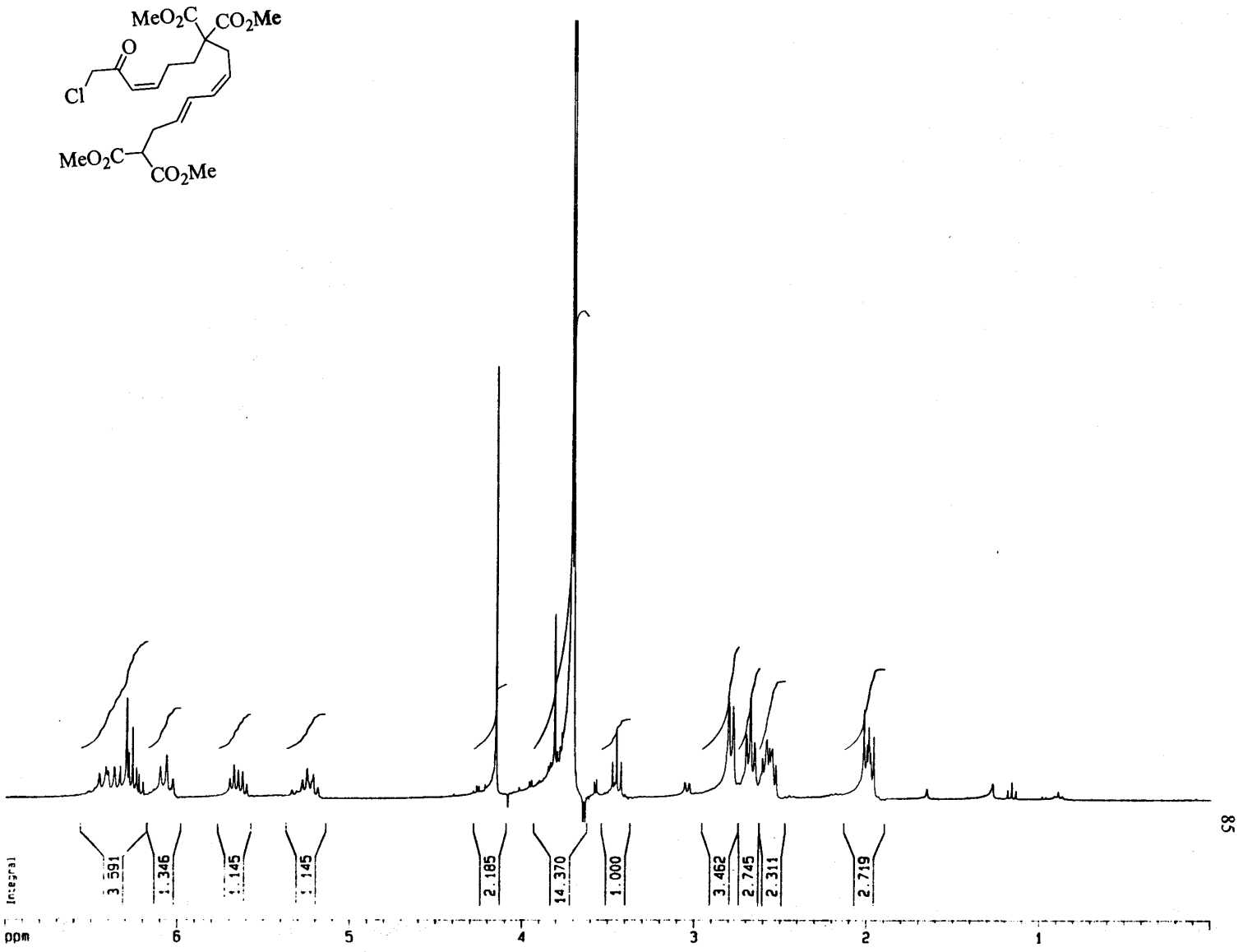
30

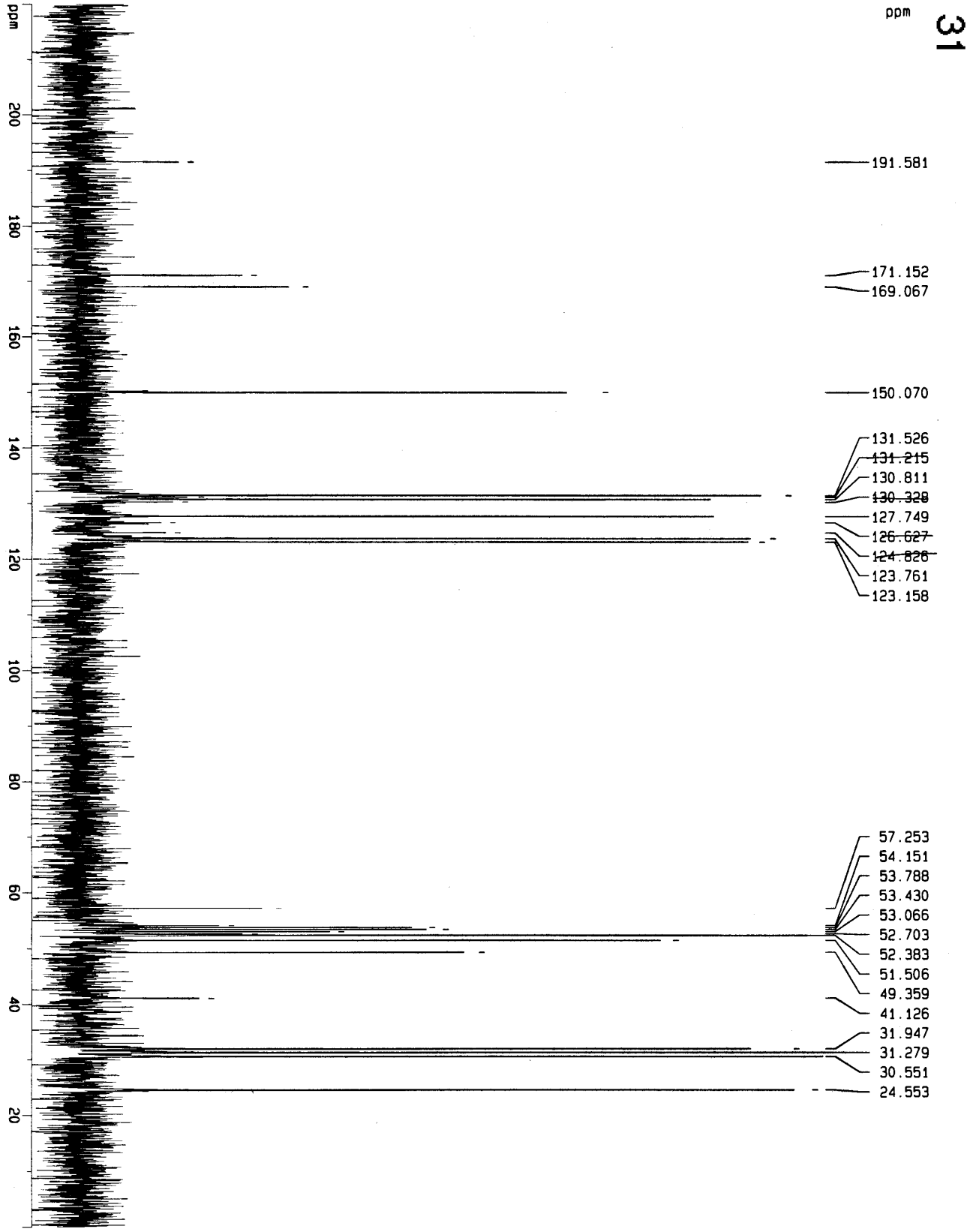

Integral
ppm
1.046
1.120
2.062
0.995
0.997
1.000
11.040
2.985
4.946
4.416
Cl
HO
MeO2C
CO2Me
MeO2C
CO2Me

84

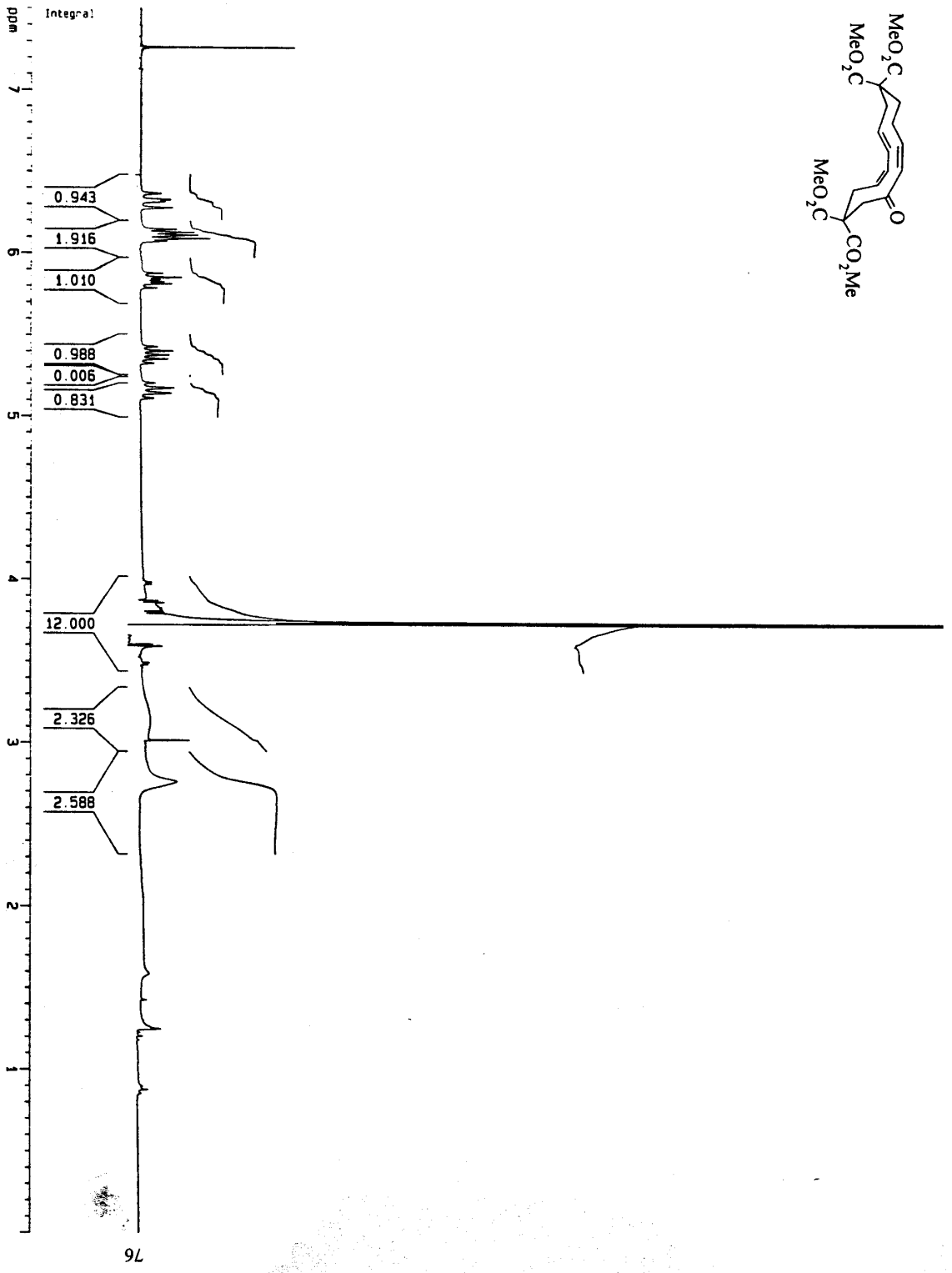

ppm
30
ppm
200
180
160
140
120
100
80
60
40
20
171.408
169.131
133.066
131.577
130.923
129.024
127.652
123.676
77.474
77.046
76.622
67.551
67.504
57.140
52.577
52.537
51.504
49.160
32.151
31.978
30.939
22.923

31


MeO2C
CO2Me
O
Cl
MeO2C
CO2Me
Integral
3.591
1.346
1.145
1.145
2.185
14.370
1.000
3.462
2.745
2.311
2.719
ppm
6
5
4
3
2
1
85

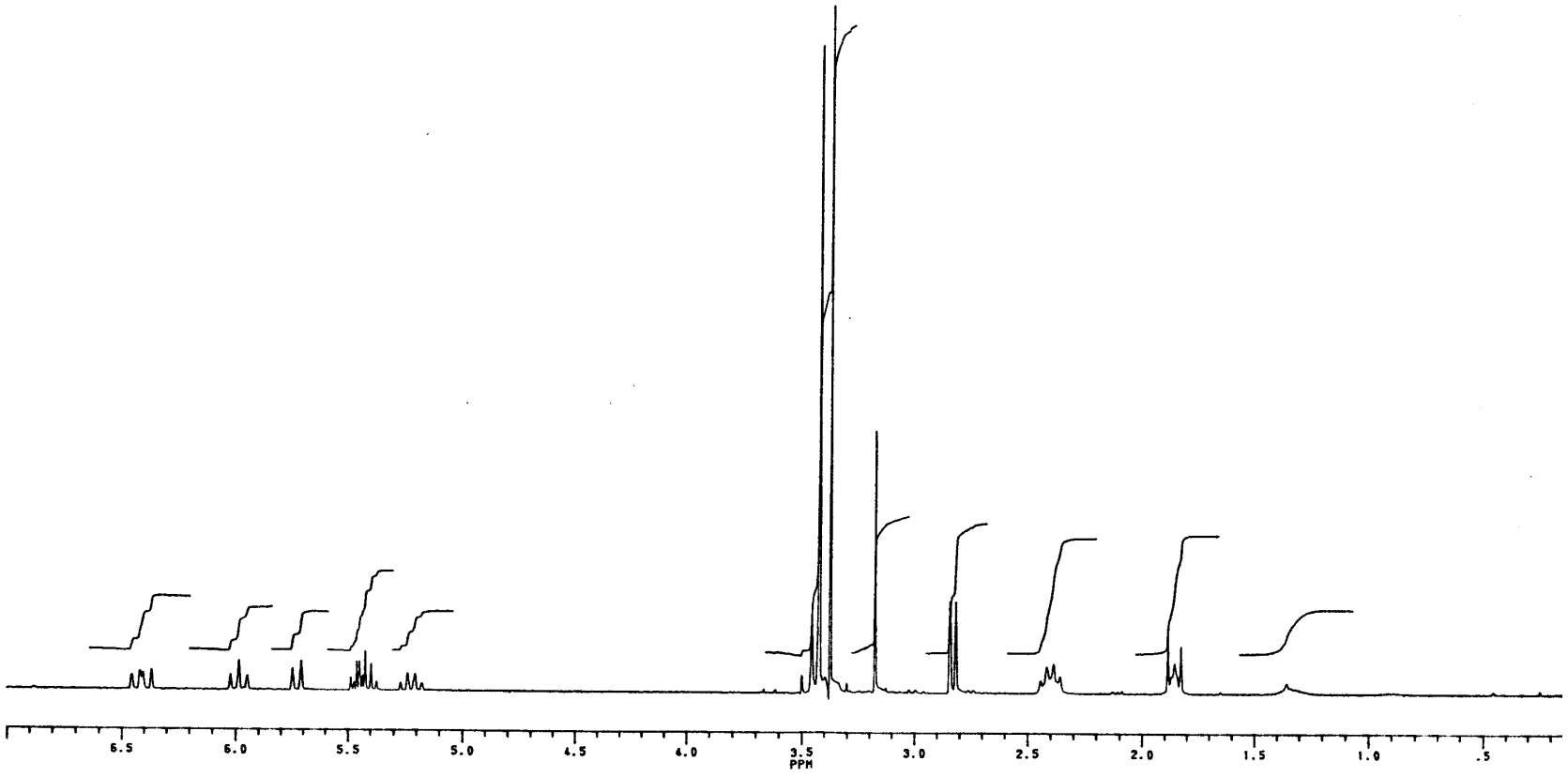

ppm
31
ppm
200
180
160
140
120
100
80
60
40
20
191.581
171.152
169.067
150.070
131.526
131.215
130.811
130.328
127.749
126.627
124.826
123.761
123.158
57.253
54.151
53.788
53.430
53.066
52.703
52.383
51.506
49.359
41.126
31.947
31.279
30.551
24.553

2

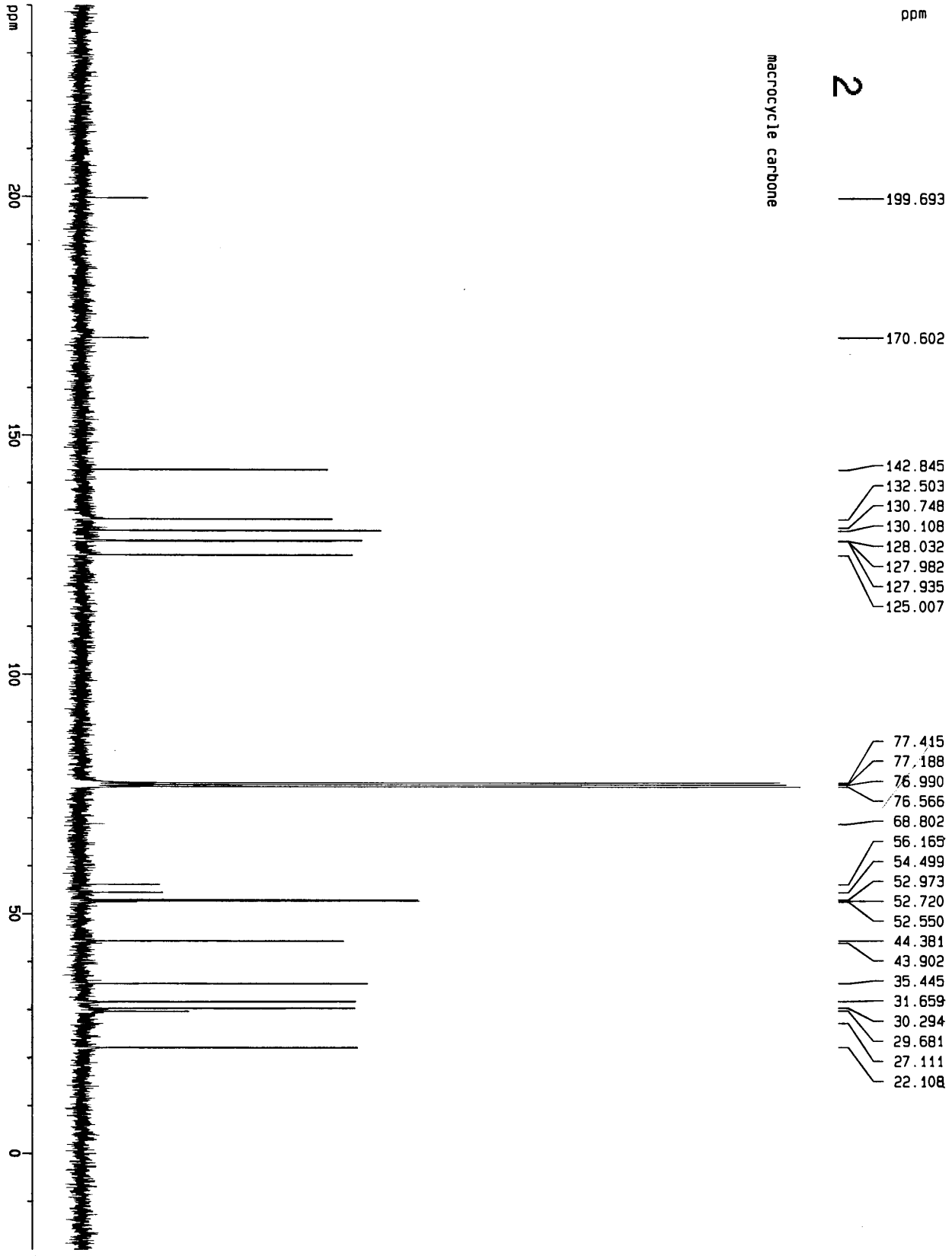

Integral
ppm
0.943
1.916
1.010
0.988
0.006
0.831
12.000
2.326
2.588
MeO2C
MeO2C
MeO2C
CO2Me
O

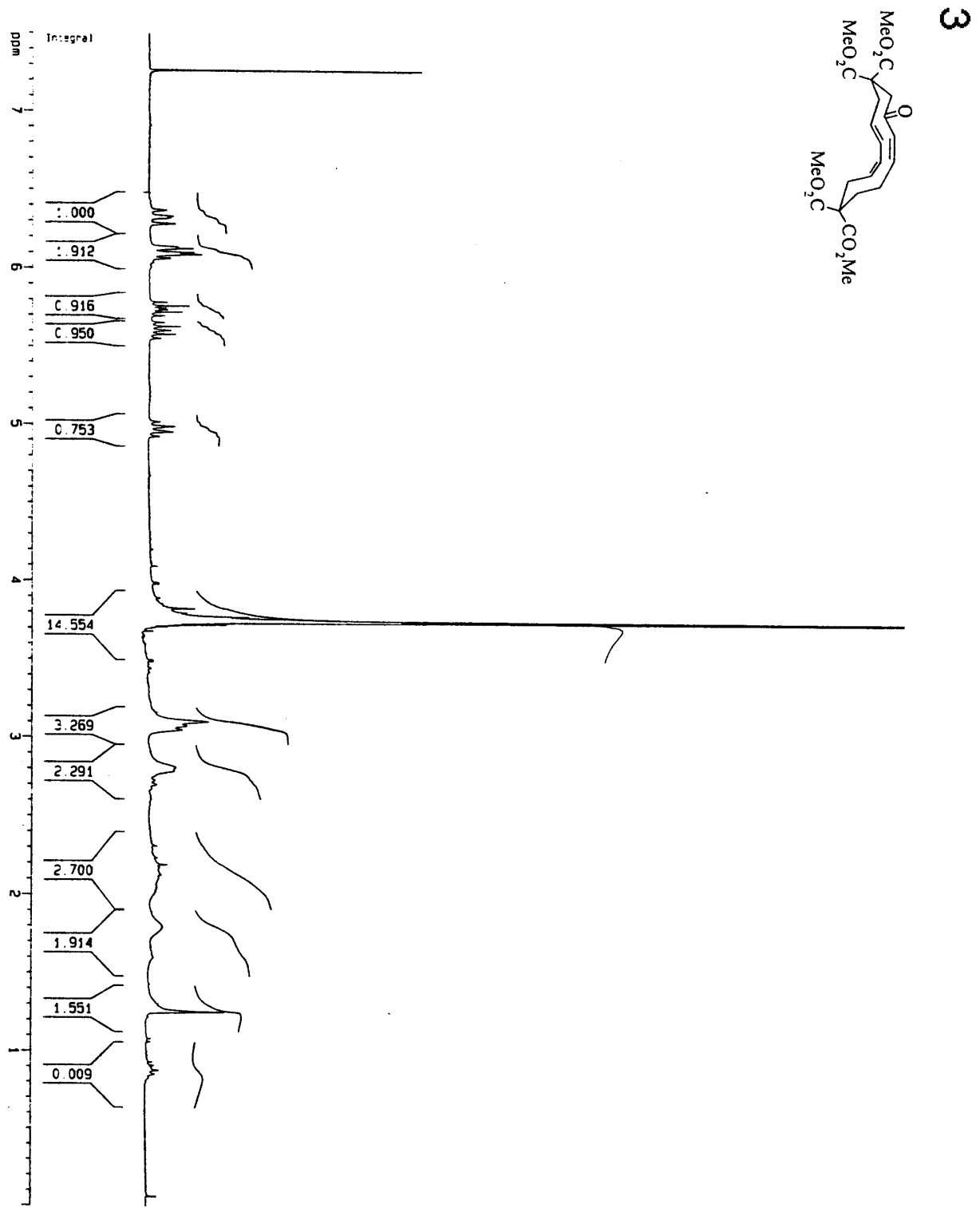
2

375K

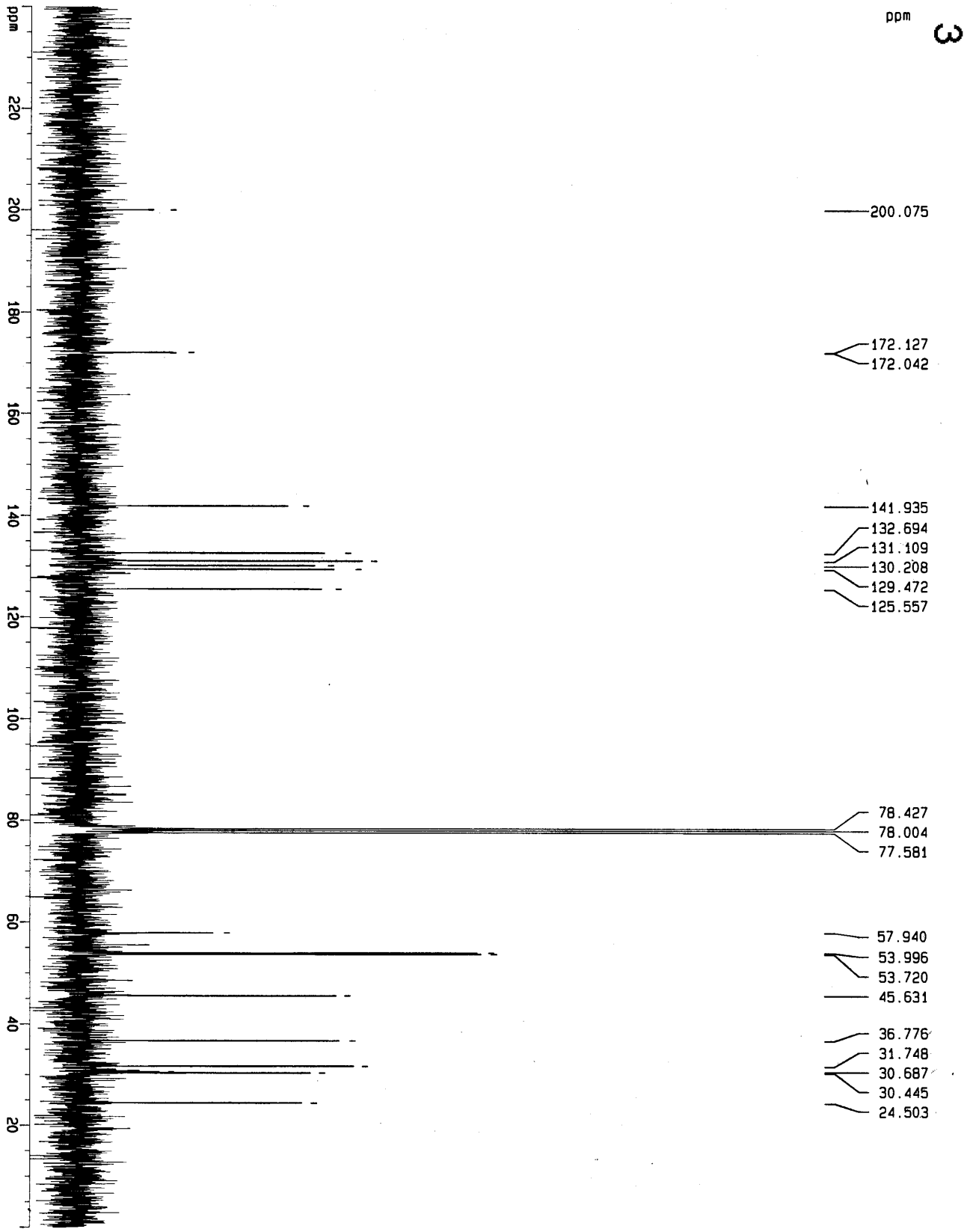


77

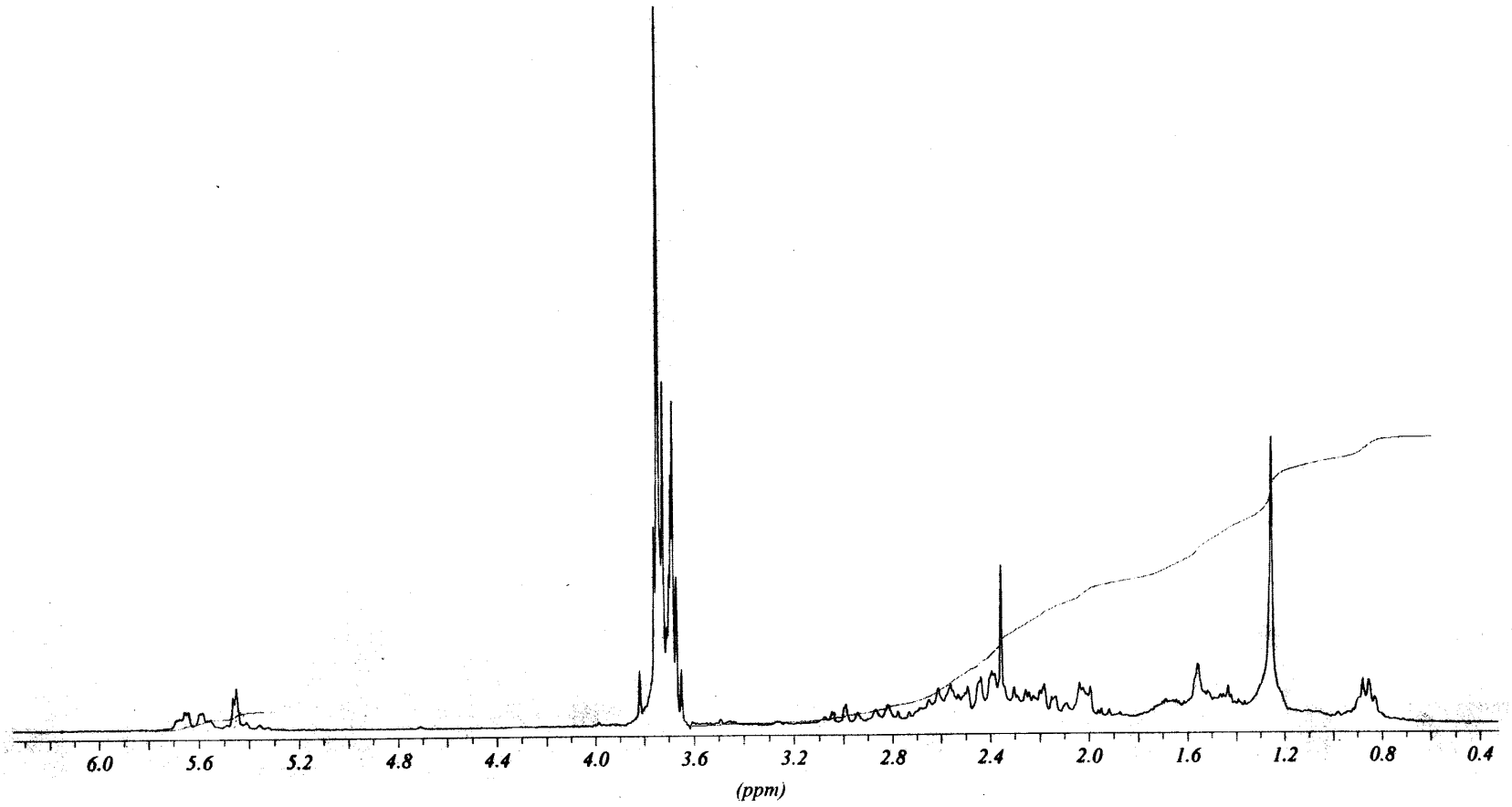

ppm
200
150
100
50
0
macrocycle carbone
2
ppm
199.693
170.602
142.845
132.503
130.748
130.108
128.032
127.982
127.935
125.007
77.415
77.188
76.990
76.566
68.802
56.165
54.499
52.973
52.720
52.550
44.381
43.902
35.445
31.659
30.294
29.681
27.111
22.108

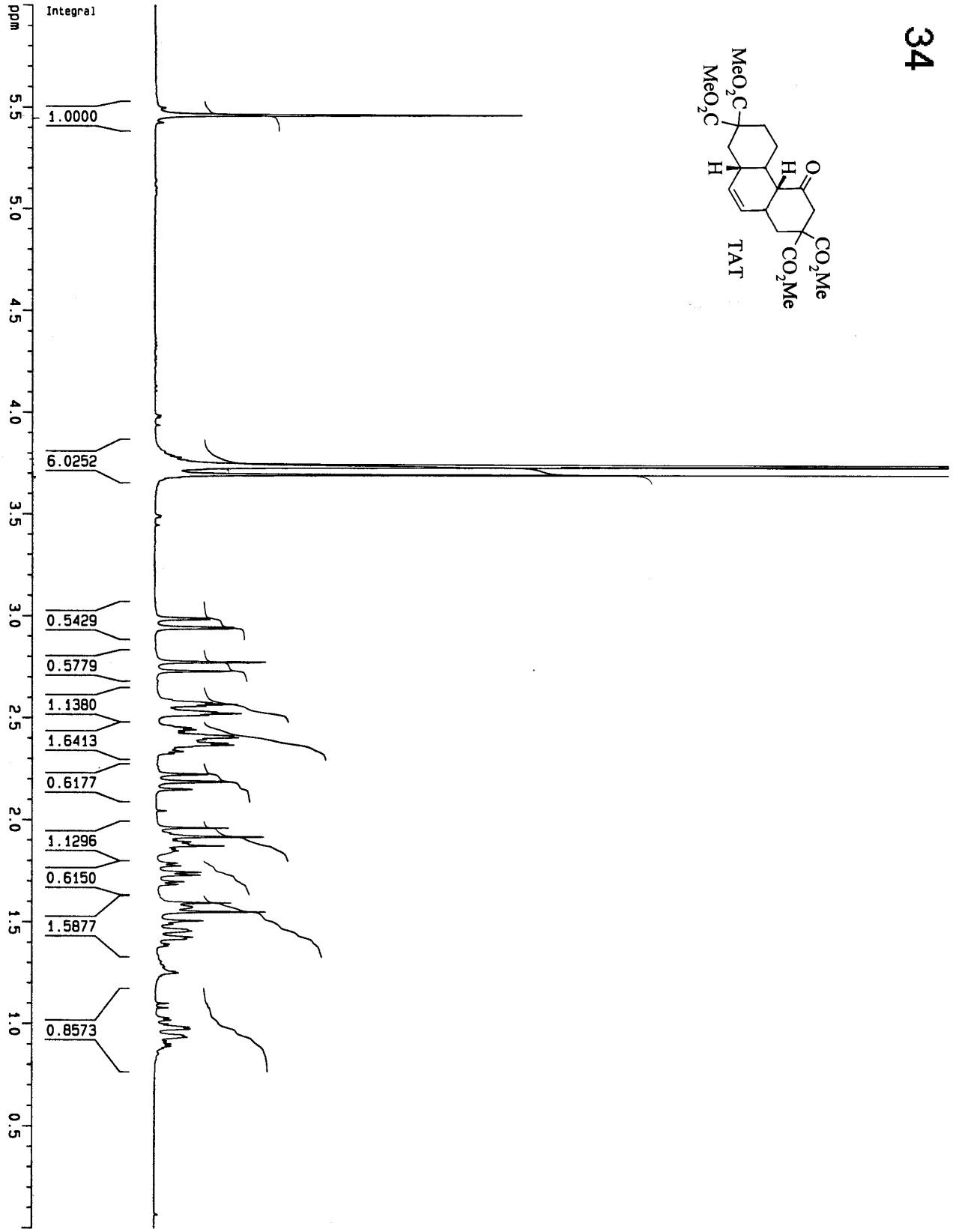

3
MeO2C
MeO2C
O
MeO2C
CO2Me
ppm
Integral
1.000
1.912
0.916
0.950
0.753
14.554
3.269
2.291
2.700
1.914
1.551
0.009

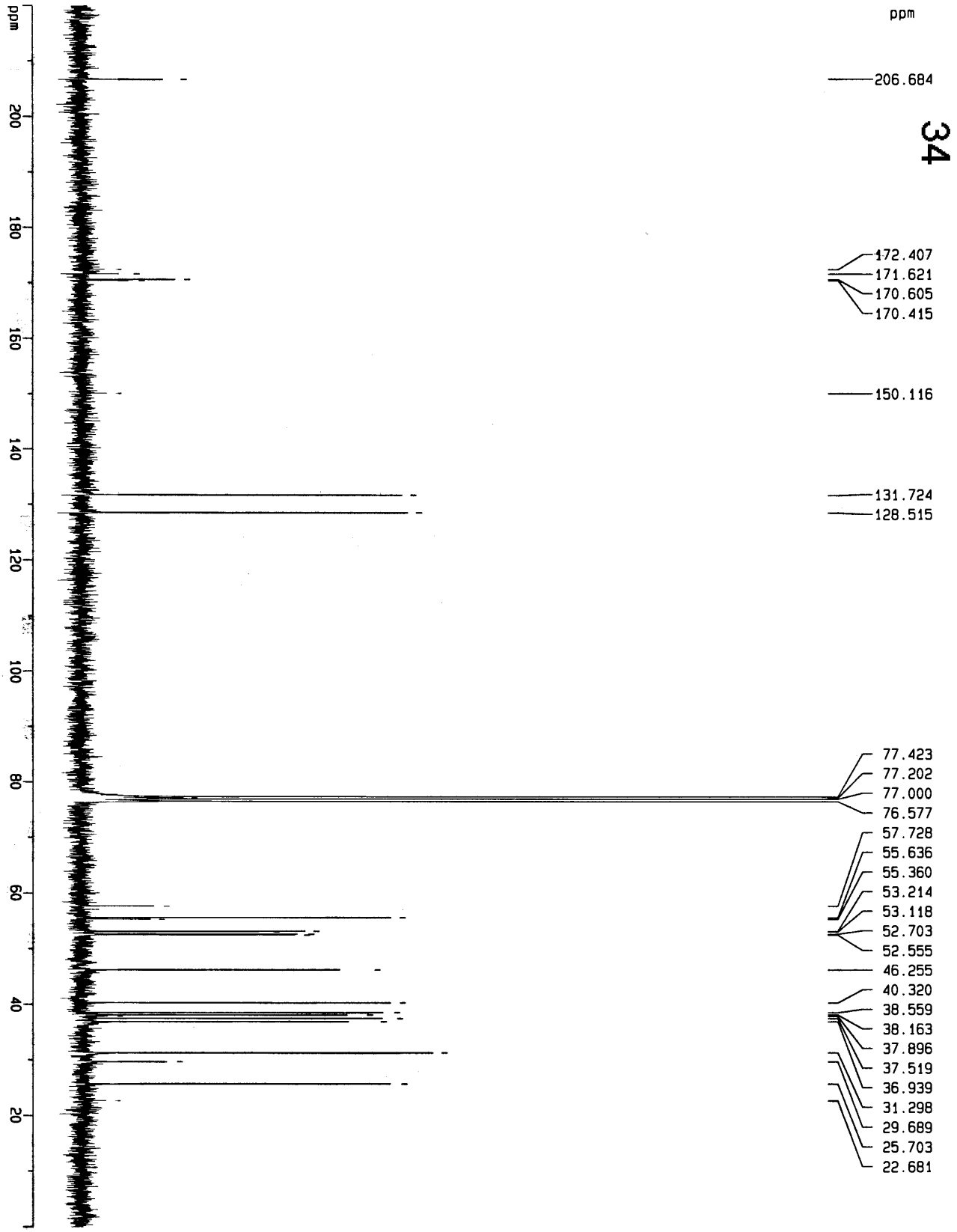
98


ppm
3
220
200
180
160
140
120
100
80
60
40
20
200.075
172.127
172.042
141.935
132.694
131.109
130.208
129.472
125.557
78.427
78.004
77.581
57.940
53.996
53.720
45.631
36.776
31.748
30.687
30.445
24.503

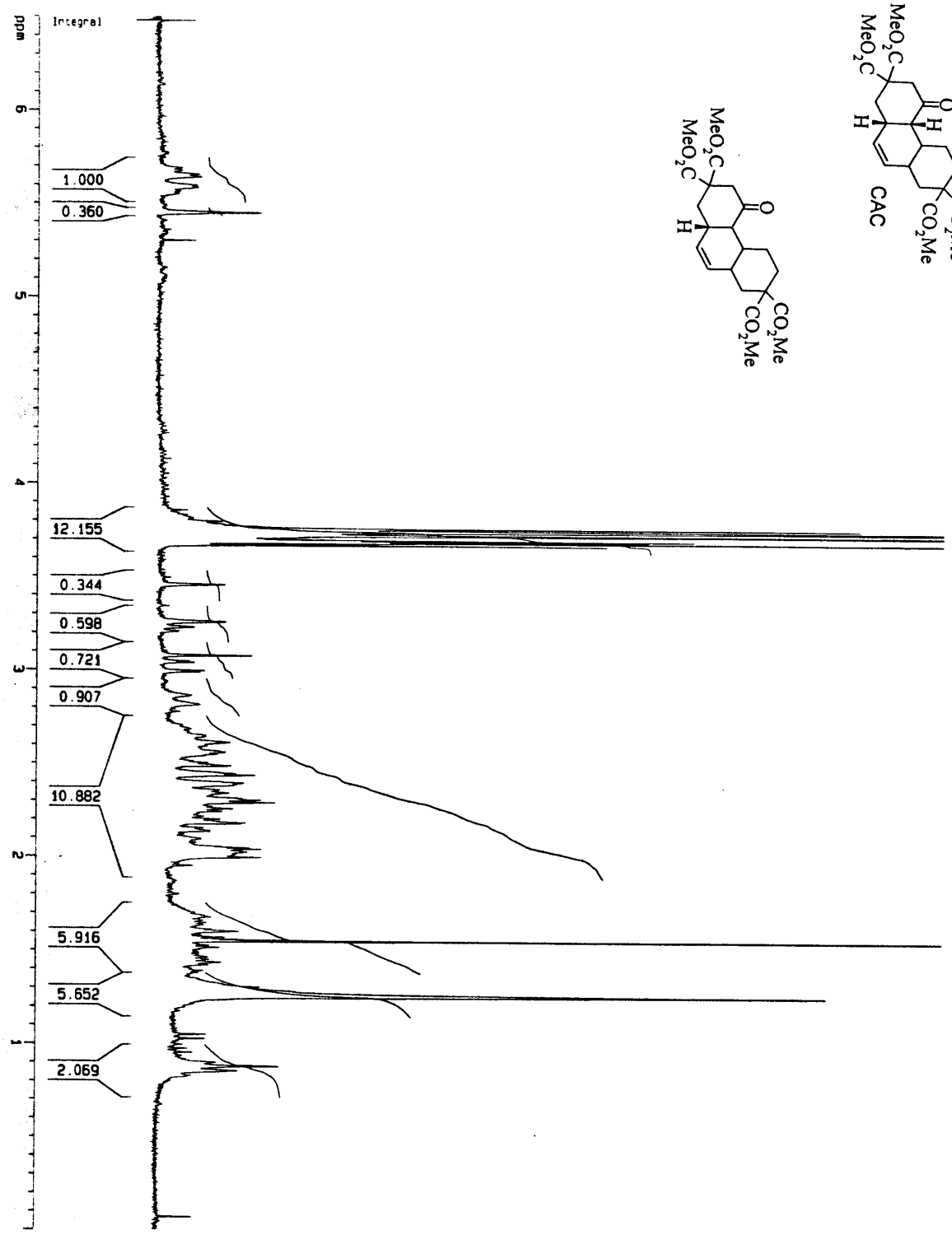
Mixture of 33 & 34




34
TAT
Integral
ppm
1.0000
6.0252
0.5429
0.5779
1.1380
1.6413
0.6177
1.1296
0.6150
1.5877
0.8573

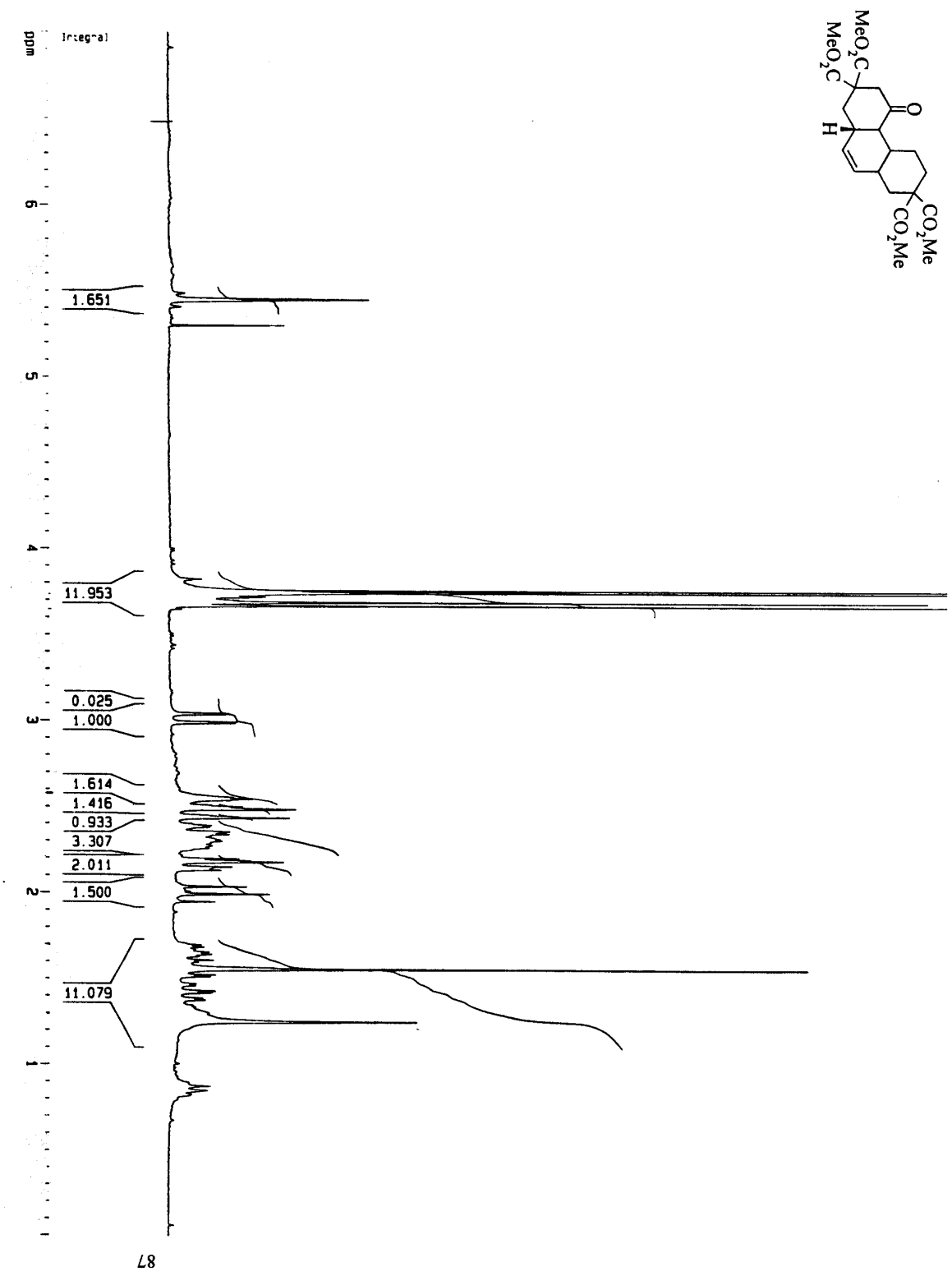

ppm
200
180
160
140
120
100
80
60
40
20
ppm
206.684
34
172.407
171.621
170.605
170.415
150.116
131.724
128.515
77.423
77.202
77.000
76.577
57.728
55.636
55.360
53.214
53.118
52.703
52.555
46.255
40.320
38.559
38.163
37.896
37.519
36.939
31.298
29.689
25.703
22.681

Mixture 35 & 36



06

35


MeO2C
MeO2C
O
H
CO2Me
CO2Me
ppm
Integral
1.651
11.953
0.025
1.000
1.614
1.416
0.933
3.307
2.011
1.500
11.079
87

```
36
mac M1 -539.9083443 au
C       2.502002   -1.685880     .660848
C       1.285935   -2.173190    -.084554
C        .040757   -1.891382     .260453
C      -1.137248   -2.288422    -.517118
C      -2.372984   -1.842348    -.349566
C      -2.860190    -.831744     .661430
C       3.325327    -.675054    -.182384
C       2.512115     .540904    -.669568
C       1.973562    1.431332     .476345
C       1.214982    2.613692    -.080914
C      -3.243866     .510608    -.016930
C      -2.037643    1.296258    -.571253
C      -1.161247    1.934307     .535899
C       -.088991    2.817698    -.060840
H       3.144585   -2.527073     .906719
H       2.202321   -1.229030    1.596475
H       1.477754   -2.748429    -.975648
H       -.129937   -1.313453    1.148837
H       -.950090   -2.991008   -1.310712
H      -3.136809   -2.206073   -1.015283
H      -3.745126   -1.231155    1.149734
H      -2.126513    -.655383    1.435069
H       3.727238   -1.194328   -1.047773
H       4.171117    -.334498     .407908
H       1.673670     .201718   -1.264327
H       3.142620    1.146959   -1.313858
H       1.342778     .845058    1.127318
H       2.812683    1.788077    1.068659
H       1.833316    3.345434    -.573717
H      -3.934602     .299088    -.827701
H      -3.774349    1.130605     .700094
H      -1.423283     .643753   -1.179333
H      -2.404607    2.089487   -1.216172
H       -.726315    1.161342    1.152060
H      -1.799330    2.539466    1.175442
H       -.467960    3.706602    -.537369
```

```
35
mac M2 -613.1917667 au
C      -2.641526    1.502524     .820158
C      -1.546995    2.077721    -.045785
C       -.260235    1.855371     .166602
C        .820687    2.326210    -.706147
C       2.108709    2.041361    -.567714
C       2.737970    1.212854     .527965
C      -3.530727     .490802     .047695
C      -2.732257    -.631769    -.643109
C      -1.984843   -1.570910     .340797
C      -1.103295   -2.503162    -.454380
C       3.304425    -.141559     .023703
C       2.290729   -1.025780    -.716559
C       1.106003   -1.483710     .114278
C        .212148   -2.442730    -.583565
O        .896285   -1.066564    1.240801
H      -3.279657    2.301273    1.188984
H      -2.202258    1.019907    1.684859
H      -1.865869    2.665804    -.891229
H        .021678    1.250280    1.004439
H        .515724    2.939847   -1.536535
H       2.797598    2.432776   -1.297014
H       3.565306    1.776211     .951780
H       2.041257    1.011165    1.321565
H      -4.090509    1.029668    -.711444
H      -4.253893     .061144     .734677
H      -2.005397    -.184873   -1.308884
H      -3.408801   -1.226020   -1.250771
H      -1.387533   -1.010158    1.036589
H      -2.711857   -2.149409     .903151
H      -1.631148   -3.231153   -1.047571
H       4.135616     .050465    -.647864
H       3.695119    -.683588     .877779
H       1.882782    -.488712   -1.568552
H       2.790955   -1.905716   -1.111671
H        .702889   -3.098892   -1.278296
```

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35
mac M3 -613.1894295 au
C      -2.131622    2.177379     .497735
C       -.852711    2.391678    -.275868
C        .306065    1.883899     .113136
C       1.572412    2.034824    -.608253
C       2.714505    1.431719    -.309545
C       2.974260     .456936     .815876
C      -3.153732    1.258769    -.229682
C      -2.551588     .003309    -.878313
C      -1.748958    -.898134     .040003
C      -1.249913   -2.131007    -.623348
C       3.347945    -.950012     .279400
C       2.199100   -1.630809    -.490299
C       1.059416   -2.143316     .429438
C       -.062434   -2.678276    -.426813
O      -1.498153    -.612892    1.197417
H      -2.613365    3.133806     .680097
H      -1.896421    1.732003    1.450435
H       -.916462    2.973687   -1.180970
H        .320151    1.301117    1.012506
H       1.549169    2.694404   -1.458702
H       3.571042    1.629037    -.931643
H       3.807228     .825896    1.408984
H       2.124372     .380519    1.478009
H      -3.650335    1.825152   -1.011504
H      -3.912902     .965989     .487297
H      -1.878698     .288800   -1.682374
H      -3.343419    -.587130   -1.331910
H      -1.914270   -2.559193   -1.351272
H       4.204883    -.850733    -.380217
H       3.654462   -1.578683    1.110194
H       1.787832    -.927287   -1.203357
H       2.594090   -2.471624   -1.053304
H        .691468   -1.363264    1.072747
H       1.445336   -2.942037    1.056313
H        .186508   -3.556069    -.999391
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36
ts M1 cbc -539.8272233 au
C         .575180    -.516288     .996893
C        1.156946    1.150597    -.348439
C        -.777528    -.464622    1.282119
C       -1.748811    1.332068     .282624
C        -.790430    2.252999     .634850
C         .561638    2.198328     .305557
C        1.222128   -1.652633     .214006
C        2.745897   -1.479296     .059944
C        2.667489    1.042193    -.444727
C        3.133414    -.349493    -.910532
C       -1.766123   -1.569208     .902540
C       -2.151039   -1.707787    -.583330
C       -2.007735     .780167   -1.111088
C       -2.890987    -.477598   -1.119128
H        1.229703    -.069779    1.720217
H         .630376     .611071   -1.101574
H       -1.037031     .027257    2.197598
H       -2.665679    1.390572     .850072
H       -1.045582    2.923162    1.438517
H        1.208861    2.885400     .825297
H         .780447   -1.754229    -.769571
H        1.032266   -2.589000     .737317
H        3.186028   -1.286686    1.034361
H        3.168933   -2.411178    -.303162
H        3.033300    1.784693   -1.151446
H        3.114722    1.270965     .517950
H        4.212415    -.337191   -1.029961
H        2.706170    -.559260   -1.887756
H       -2.680844   -1.407440    1.464061
H       -1.361631   -2.521660    1.241081
H       -1.272253   -1.886654   -1.189848
H       -2.788794   -2.581539    -.684361
H       -2.528725    1.568393   -1.652883
H       -1.102328     .581066   -1.658199
H       -3.784669    -.301168    -.526203
H       -3.215157    -.670150   -2.137421
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36
ts M1 bbc -539.8274153 au
C         .606252    -.628202     .905424
C        1.261816    1.101700    -.290965
C        -.772285    -.628924    1.068557
C       -1.650314    1.295301     .267228
C        -.688772    2.181019     .695568
C         .668474    2.116087     .420017
C        1.318492   -1.708914     .089335
C        2.846584   -1.526622     .029804
C        2.776226    1.002527    -.351991
C        3.273520    -.356599    -.870044
C       -1.646745   -1.670738     .371714
C       -3.079405   -1.193412     .074813
C       -1.866061     .715663   -1.122150
C       -3.103930    -.208842   -1.117177
H        1.188190    -.257280    1.727372
H         .752835     .657742   -1.117200
H       -1.156358    -.305905    2.016290
H       -2.583956    1.378786     .800440
H        -.972952    2.831776    1.504937
H        1.312228    2.753768    1.002652
H         .933190   -1.748831    -.923787
H        1.105951   -2.676674     .539777
H        3.232759   -1.373540    1.033631
H        3.291536   -2.442269    -.348045
H        3.151887    1.784995   -1.008594
H        3.192760    1.186022     .633725
H        4.356542    -.332117    -.940830
H        2.890231    -.521444   -1.873584
H       -1.690834   -2.546481    1.017644
H       -1.191894   -1.995283    -.555259
H       -3.710731   -2.046385    -.150984
H       -3.488978    -.724252     .962213
H       -2.030996    1.530330   -1.823266
H       -1.012697     .163194   -1.477388
H       -4.005911     .393575   -1.074257
H       -3.132075    -.767330   -2.047304
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35
ts M2 cbc -613.1095926 au
C       -.576543    -.664950    -.782657
C      -1.573994    1.062030     .109284
C        .743978    -.368065   -1.081275
C       1.329708    1.689839    -.231447
C        .283650    2.347408    -.834537
C      -1.071762    2.082334    -.659625
C      -1.072721   -1.707637     .220311
C      -2.608742   -1.844421     .190033
C      -3.045152     .688901     .061895
C      -3.336638    -.631992     .798139
C       1.976222    -.970795    -.529889
C       2.127856   -1.106393     .966857
C       1.484691    1.348860    1.244398
C       2.550686     .273667    1.521409
O       2.910827   -1.239901   -1.266747
H      -1.242654    -.563444   -1.618371
H      -1.085301     .788579    1.015741
H        .922852    -.015303   -2.076872
H       2.290085    1.830123    -.703023
H        .533533    2.932028   -1.702966
H      -1.741787    2.542878   -1.366166
H       -.768515   -1.472973    1.231807
H       -.633871   -2.670019    -.029085
H      -2.935906   -1.989659    -.835295
H      -2.890089   -2.734321     .744306
H      -3.628981    1.481109     .525553
H      -3.373332     .612414    -.970139
H      -4.406200    -.815376     .785016
H      -3.042915    -.528596    1.839450
H       1.216314   -1.422515    1.444654
H       2.906471   -1.832235    1.159561
H       1.799786    2.271154    1.729415
H        .558239    1.059255    1.707609
H       3.492478     .559308    1.064979
H       2.713184     .197559    2.590656
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35
ts M2 bbc -613.1128631 au
C        -.712980    -.508759   -1.015748
C       -1.317203     .942954     .336153
C         .687643    -.495737    -.996988
C        1.546675    1.705661    -.336420
C         .407847    2.358158    -.732079
C        -.892554    2.070650    -.349945
C       -1.484553   -1.722970    -.472118
C       -2.995715   -1.518950    -.309710
C       -2.815066     .829637     .604534
C       -3.307824    -.597030     .873724
C        1.455501   -1.100667     .070024
C        2.946127    -.842475     .028540
C        1.983201    1.298273    1.057206
C        3.196363     .336410    1.019070
O         .970510   -1.619516    1.075692
H       -1.159899    -.104985   -1.908111
H        -.697944     .476633    1.076256
H        1.225844    -.196194   -1.869255
H        2.397168    1.856948    -.984104
H         .507486    3.009167   -1.584456
H       -1.662436    2.650868    -.829642
H       -1.043169   -2.036874     .456610
H       -1.316448   -2.516996   -1.196817
H       -3.425054   -1.107499   -1.219864
H       -3.455832   -2.488501    -.146272
H       -3.050276    1.454999    1.463132
H       -3.359676    1.233452    -.243725
H       -4.377404    -.569216    1.056443
H       -2.833740    -.990489    1.767790
H        3.483431   -1.721086     .358889
H        3.271008    -.579497    -.967930
H        2.282766    2.209481    1.570985
H        1.191497     .853257    1.634012
H        4.089396     .876510     .726261
H        3.354047    -.062194    2.012173
```

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35
ts M3 cbc -613.1191519 au
C         .516354    -.315728    1.053305
C        1.078810    1.393323    -.430449
C        -.853494    -.338926    1.296149
C       -1.818425    1.320159     .300942
C        -.919107    2.319012     .626183
C         .419910    2.378362     .257519
C        1.268480   -1.249766     .226691
C        2.774978   -1.051464     .256334
C        2.589934    1.379327    -.543970
C        3.159752    -.022163    -.836022
C       -1.798063   -1.496922     .932791
C       -2.210910   -1.681574    -.537683
C       -2.069107     .776028   -1.101407
C       -2.961243    -.472833   -1.100509
O         .782040   -2.101164    -.507699
H        1.118492     .225319    1.751586
H         .571747     .794735   -1.151743
H       -1.124001     .104380    2.235417
H       -2.734988    1.345101     .870888
H       -1.208023    2.978089    1.427151
H        1.024077    3.113626     .761169
H        3.111173    -.703681    1.224292
H        3.243257   -2.001019     .032814
H        2.883138    2.045246   -1.353674
H        3.029929    1.768502     .368178
H        4.239604     .039288    -.910398
H        2.784628    -.381332   -1.788539
H       -2.697401   -1.373757    1.527725
H       -1.317852   -2.413763    1.258909
H       -1.325277   -1.880417   -1.117619
H       -2.848268   -2.559790    -.591217
H       -2.569005    1.572187   -1.649252
H       -1.161474     .551228   -1.634063
H       -3.861309    -.281979    -.521464
H       -3.272265    -.683165   -2.119087
```

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35
ts M3 bbc -613.1210002 au
C         .478747    -.299850    1.104325
C        1.083971    1.435600    -.373153
C        -.888369    -.281799    1.396440
C       -1.763350    1.365939     .430363
C        -.864915    2.384123     .711934
C         .469827    2.426233     .347887
C        1.134770   -1.140715     .117484
C        2.653601   -1.094170     .143047
C        2.591337    1.372716    -.523420
C        3.100536    -.034120    -.894500
C       -1.808796   -1.437283     .956202
C       -3.237864   -1.027254     .561834
C       -1.981497     .638950    -.896606
C       -3.242317    -.245573    -.773696
O         .570090   -1.761536    -.782666
H        1.139912     .152259    1.812560
H         .531040     .889438   -1.103995
H       -1.132589     .097210    2.372491
H       -2.688201    1.468557     .973017
H       -1.170276    3.086077    1.468496
H        1.093377    3.150978     .842542
H        3.032372    -.840718    1.123614
H        3.030986   -2.065085    -.150813
H        2.889207    2.066414   -1.307585
H        3.063978    1.702158     .395879
H        4.181861    -.020406    -.967507
H        2.703449    -.326242   -1.860152
H       -1.861528   -2.114302    1.805822
H       -1.344269   -1.965881     .142682
H       -3.846694   -1.919226     .461144
H       -3.681916    -.433723    1.353420
H       -2.116538    1.368078   -1.690349
H       -1.151700     .005572   -1.163140
H       -4.134175     .369712    -.837737
H       -3.263464    -.943931   -1.602661
```