SUPPLEMENTARY MATERIALS

for
the communication
entitled

An Intramolecular Formal *Oxa*-[3 + 3] Cycloaddition Approach to the ABD System of Phomactin A.

authored by

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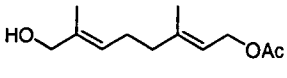
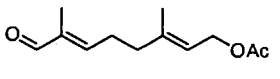
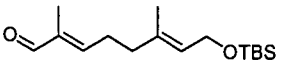
General Procedures. Column chromatography was performed on Bodman silica gel (60 Å, 230-400 mesh). THF was distilled over sodium/benzophenone under nitrogen. Dichloromethane, toluene, acetonitrile, diisopropyl amine, triethylamine and benzene were distilled from calcium hydride under nitrogen. Methanol was distilled from magnesium and stored under nitrogen over 3 Å molecular sieves. *N,N*-dimethylformamide was distilled under vacuum from calcium hydride and stored over 4 Å molecular sieves. Flasks were flame dried under vacuum and purged with nitrogen before use. TLC plates were silica (Whatman, polyester backed) and were visualized with UV (254 nm) and either anisaldehyde or permanganate stains. IR spectra were recorded on NaCl plates using a Midac M2000 FTIR. 500 MHz ^{1}H spectra were recorded on a Varian Inova spectrometer; 300 MHz spectra were recorded on a Varian Unity or Varian Inova instruments and are referenced to TMS at δ 0.00 ppm or $CHCl_3$ at 7.26 ppm. ^{13}C spectra were recorded on a Varian Inova spectrometers at 125 and 75 MHz and are referenced to the center chloroform peak at δ 77.23 ppm. Electrospray mass spectra were recorded on a Bruker Biotof II ESI-TOF/MS using either PPG or PEG standards as high resolution calibrants. Unless noted, all reagents (Acros, TCI, Aldrich) were used as received.



(*E*)-8-Hydroxygeranyl acetate (S-1).[1] Geranyl acetate (4.76 g, 24.25 mmol) was taken up in CH_2Cl_2 (50 mL) and *tert*-butylhydroperoxide (70% aqueous solution, 6.64 mL, 48.50 mmol) was added along with solid SeO_2 (269.1 mg, 2.43 mmol, CAUTION!!! HIGHLY TOXIC!!!). The biphase was stirred at room temperature for 36 h. The mixture was then transferred into a 600 mL beaker with MeOH (50 mL) and cooled to 0 °C. Small portions of solid $NaBH_4$ was slowly and cautiously added until foaming ceased and the mixture no longer tested positive to KI/starch paper. Water (100 mL) was added and the mixture was extracted with $CHCl_3$ (4 x 40 mL), washed with brine (50 mL), and concentrated to give a crude syrup. The aqueous waste was placed in a special container for selenium wastes. Kugelrohl distillation of the undesired lower boiling fractions afforded a syrup which was chromatographed (gradient elution, 30-50% EtOAc/hexanes) to afford alcohol **S-1** (3.50 g, 68%) as a colorless oil. R_f = 0.05 (10% EtOAc/Hexanes); ^{1}H NMR (300 MHz, $CDCl_3$) δ (ppm) 5.35 (mq, 2 H, *J* = 6.9 Hz), 5.07 (d, 2 H, *J* = 7.2 Hz), 3.98 (s, 2 H), 2.20-2.13 (m, 2 H), 2.10-2.05 (m, 2 H), 2.05 (s, 3 H), 1.70 (s, 3 H), 1.66 (s, 3 H), 1.60 (br, 1 H).

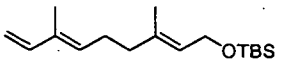


(*E*)-8-Oxo-geranyl acetate (S-2).[1] Alcohol **S-1** (3.50 g, 16.49 mmol) was taken up in CH_2Cl_2 (70 mL) and pyridine (5.33 mL, 65.95 mmol). Dess-Martin periodinane (10.49 g, 24.73 mmol) was then added in small portions over 2 min. After 30 min at room temperature, 2-propanol (2 mL) was added and most of the solvent was removed *in vacuo*. The residue was taken up in 10% EtOAc/hexanes and filtered through a 5 cm x 5 cm pad of silica. Evaporation of solvents followed by exposure to high vacuum (*ca.* 0.2 mmHg) for several hours afforded pure enal **S-2** (3.09 g, 89%) as a fragrant, clear, and colorless oil. R_f = 0.14 (10% EtOAc/hexanes); ^{1}H NMR (300 MHz, $CDCl_3$) δ (ppm) 9.40 (s, 1 H), 6.46 (mt, 1 H, *J* = 7.2 Hz), 5.39 (mt, 1 H, *J* = 6.0 Hz), 4.60 (d, 2 H, *J* = 7.2 Hz), 2.50 (brq, 2 H, *J* = 7.2 Hz), 2.24 (brt, 2 H, *J* = 7.5 Hz), 2.06 (s, 3 H), 1.75 (ms, 6 H).

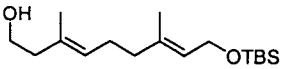


8-(*tert*-Butyl-dimethyl-silyloxy)-2,6-dimethyl-octa-2(*E*),6(*E*)-dien-1-al (S-3).[1] Enal **S-2** (3.09 g, 14.70 mmol) was taken up in MeOH (15 mL) and the solution was cooled to 0 °C. Powdered K_2CO_3 (203.1 mg, 1.47 mmol) was added. The initially colorless solution took on a yellow color, and the mixture stirred for 1 h. After this time, the reaction was poured into water (50 mL) and extracted with $CHCl_3$ (5 x 20 mL). The combined extracts were washed with brine (2 x 35 mL), dried (Na_2SO_4) and concentrated *in vacuo*. The crude alcohol was used without further purification. $R_f = 0.10$ (30% EtOAc/hexanes).

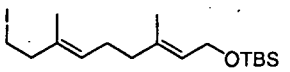
The crude alcohol was then taken up in CH_2Cl_2 (15 mL) and imidazole (2.00 g, 29.39 mmol) was added. TBSCl (1 M in CH_2Cl_2, 15.0 mL) was then added, and a exotherm was noted, along with formation of an off-white precipitate. After 15 min at room temperature, the mixture was filtered through a coarse-fritted funnel to remove the salt. Water (50 mL) was added and the organic layer drained. The aqueous phase was extracted with CH_2Cl_2 (2 x 30 mL) and the combined extracts were washed with water (1 x 30 mL), brine (1 x 30 mL), and dried (Na_2SO_4). Concentration of the solvents afforded crude enal **S-3** (3.86 g, 93% over 2 steps) which was not purified further. $R_f = 0.26$ (5% EtOAc/hexanes); ^{1}H NMR (300 MHz, $CDCl_3$) δ (ppm) 9.38 (s, 1 H), 6.47 (mt, 1 H, J = 7.2 Hz), 5.35 (mt, 1 H, J = 6.3 Hz), 4.20 (dd, 2 H, J = 0.9, 6.3 Hz), 2.48 (brq, 2 H, J = 7.8 Hz), 2.20 (brt, 2 H, J = 7.2 Hz), 1.74 (s, 3 H), 1.65 (s, 3 H), 0.90 (s, 9 H), 0.07 (s, 6 H).



1-(*tert*-Butyl-dimethyl-silyloxy)-3,7-dimethyl-2(*E*),6(*E*),8-nonatriene (S-4). Methyltriphenylphosphonium bromide (5.37 g, 15.03 mmol) was placed in a 100 mL flask and THF (30 mL) was added. The mixture was cooled to 0 °C and *n*-butyllithium (2.38 M in hexanes, 6.03 mL, 14.35 mmol) was slowly dripped in. The solution became bright yellow in color, and after 30 min nearly all of the solid had dissolved. At this time, enal **S-3** (3.86 g, 13.67 mmol) was dissolved in THF (15 mL) and added to the ylide solution over 1 min. The instantaneous formation of an off-white precipitate was noted, and as the reaction was warmed to room temperature, the color changed to a dull-orange. After 1 h, the stirbar was removed and the volume of solvent was reduced by 75% *in vacuo*. The thick mixture was poured into hexanes (200 mL) and vigorously stirred with a glass rod until all the precipitate became a powdery slurry. The phoshpine waste was filtered off, and the solvent removed. Addition of fresh hexanes (200 mL) induced the formation of additional precipitate and the mixture was placed in the freezer for 2 h. During this time long white needles of triphenylphosphine oxide formed. These were filtered off, the solvent removed, and the residue subjected to flash chromatography (0-10% MTBE/hexanes) to afford diene **S-4** (3.07 g, 80%) as a clear, colorless oil. $R_f = 0.25$ (hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 6.37 (dd, 1 H, J = 11.0, 17.0 Hz), 5.48 (t, 1 H, J = 7.5 Hz), 5.33 (mt, 1 H, J = 6.0 Hz), 5.09 (d, 1 H, J = 17.5 Hz), 4.93 (d, 1 H, J = 10.5 Hz), 4.21 (d, 2 H, J = 6.0 Hz), 2.27 (brq, 2 H, J = 7.5 Hz), 2.08 (brt, 2 H, J = 7.5 Hz), 1.75 (d, 3 H, J = 1.0 Hz), 1.64 (s, 3 H), 0.91 (s, 9 H), 0.08 (s, 6 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 141.7, 136.6, 134.3, 132.8, 125.0, 110.7, 60.5, 39.3, 26.7, 26.2, 18.7, 16.6, 11.9, -4.8; IR (neat) cm^{-1} 3090 (w), 2955 (s), 2930 (s), 2857 (s), 1642 (w), 1607 (m); CI-MS (*m/z*) 298.3 $(M+NH_4)^+$ (100); HRMS calcd for $C_{17}H_{36}ONSi$ $(M+NH_4)^+$ 298.2566; found 298.2541.



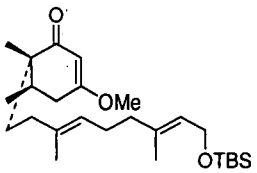
9-(*tert*-Butyl-dimethyl-silyloxy)-3,7-dimethyl-3(*E*),7(*E*)-nonadien-1-ol (S-5). A slurry of Cy_2BH was prepared by the dropwise addition of cyclohexene (2.44 mL, 24.05 mmol) to a solution of borane methylsulfide complex (10 M, 1.20 mL, 12.03 mmol) in THF (30 mL) at 0 °C. After about 15 minutes, a large amount of white precipitate was noted, and stirring was continued for an additional 45 min. After this time, diene **S-4** from above (3.07 g, 10.93 mmol) in THF (15 mL) was added *via* cannula at 0 °C. The reaction was then allowed to warm to room temperature, during which time the solution became clear and colorless. Stirring was continued for 2 h after the diene addition. After this time, the solution was cooled to 0 °C and NaOH (2.62 g, 65.60 mmol) in water (20 mL) was cautiously added, followed by H_2O_2 (30%, 4.10 mL, 32.80 mmol). A condenser was fitted to the flask, and the resulting mixture was heated to 50 °C by means of an oil bath for 2 h. At the end of this time, the mixture was poured into a separatory funnel and the organic phase was removed. The organic phase was concentrated *in vacuo* and combined with the aqueous phase. Extraction of this mixture with MTBE (5 x 35 mL) was followed by washing the combined extracts with water (2 x 25 mL), brine (1 x 25 mL), and drying with Na_2SO_4. Removal of solvent followed by flash chromatography (gradient elution, 15-40% EtOAc/hexanes) afforded alcohol **S-5** (2.74 g, 84%) as a clear, colorless oil. R_f = 0.17 ($CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 5.30 (mt, 1 H, *J* = 6.5 Hz), 5.21 (mt, 1 H, *J* = 7.0 Hz), 4.18 (d, 2 H, *J* = 6.5 Hz), 3.64 (t, 2 H, *J* = 5.5), 2.24 (t, 2 H, *J* = 6.5 Hz), 2.16 (brq, 2 H, *J* = 7.0 Hz), 2.04 (brt, 2 H, 7.5 Hz), 1.63 (s, 6 H), 1.56 (br, 1 H), 0.90 (s, 9 H), 0.07 (s, 6 H); ^{13}C NMR 136.9, 131.7, 127.7, 124.9, 60.5, 60.1, 42.9, 39.5, 26.4, 26.2, 18.7, 16.5, 15.9, -4.9; IR (neat) cm^{-1} 3367 (br), 2857 (s), 1669 (w), 1471 (s); CI-MS (*m/z*) 299.2 $(M+H)^+$ (100); HRMS calcd for $C_{17}H_{38}O_2NSi$ $(M+NH_4)^+$ 316.2672; found 316.2647.



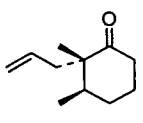
9-Iodo-1-(*tert*-butyl-dimethyl-silyloxy)-3,7-dimethyl-nona-2(*E*),6(*E*)-diene (11). Alcohol **S-5** (1.65 g, 5.53 mmol) was taken up in CH_2Cl_2 (22 mL) and triethylamine (2.31 ml, 16.58 mmol) was added along with DMAP (15.0 mg). Freshly crystallized TsCl (1.05 g, 5.53 mmol) was added in one portion, and the resulting solution was stirred at room temperature for 3 h. After this time, the solution was diluted with CH_2Cl_2 (80 mL), poured into a separatory funnel, and washed successively with 1 M HCl (1 x 50 mL), water (2 x 50 mL), and brine (1 x 50 mL). The organic layer was then dried with Na_2SO_4 and concentrated *in vacuo*. Filtration of the residue through a 10 cm x 2 cm column of silica eluting with 10% EtOAc followed by concentration afforded the tosylate (**S-6**) (2.40 g, 96%) as a clear, colorless oil. R_f = 0.35 (10% EtOAc/hexanes); ^{1}H NMR (300 MHz, $CDCl_3$) δ (ppm) 7.80 (d, 2 H, *J* = 8.4 Hz), 7.35 (d, 2 H, *J* = 7.8 Hz), 5.29 (mt, 1 H, *J* = 6.3 Hz), 5.13 (mt, 1 H, *J* = 5.7 Hz), 4.20 (d, 2 H, *J* = 6.6 Hz), 4.08 (t, 2 H, *J* = 6.9 Hz), 2.46 (s, 3 H), 2.31 (t, 2 H, *J* = 7.2 Hz), 2.11-2.02 (m, 2 H), 2.00-1.95 (m, 2 H), 1.62 (s, 3 H), 1.53 (s, 3 H), 0.91 (s, 9 H), 0.08 (s, 6 H).

The tosylate **S-6** (2.40 g, 5.30 mmol) was taken up in acetone (11 mL) and NaI (1.59 g, 10.60 mmol) was added. A condenser was fitted to the flask and the mixture was vigorously stirred and heated to 50 °C by means of an oil bath. A light yellow color formed and after about 5 min a precipitate of NaOTs began to form. TLC indicated

complete consumption of the starting material after 2 h. The mixture was cooled and filtered through a medium fritted funnel. The acetone was removed *in vacuo* and the residue taken up in hexanes (50 mL). The solution was washed with water (3 x 35 mL), a solution of 10% $Na_2S_2O_3$ (1 x 20 mL), brine (1 x 30 mL), and finally dried over Na_2SO_4. Concentration and flash chromatography (gradient elution, 0-5% EtOAc/hexanes) afforded iodide **11** (1.93 g, 89%)as a clear, pale yellow oil which was quite stable when stored over copper shot in the dark at -10 °C. R_f = 0.60 (5% EtOAc/hexanes); ^{1}H NMR (300 MHz, $CDCl_3$) δ (ppm) 5.32 (mt, 1 H, *J* = 6.0 Hz), 5.20 (mt, 1 H, *J* = 6.9 Hz), 4.21 (dd, 2 H, *J* = 0.6 Hz, 6.3 Hz), 3.22 (t, 2 H, *J* = 7.5 Hz), 2.53 (t, 2 H, *J* = 7.2 Hz), 2.16-2.02 (m, 4 H), 1.63 (brs, 3 H), 1.61 (brs, 3 H), 0.91 (s, 9 H), 0.08 (s, 6 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ (ppm) 136.4, 133.6, 126.9, 124.5, 60.2, 43.7, 39.0, 26.0, 25.9, 18.4, 16.3, 15.3, 5.1, -5.1; IR (neat) cm^{-1} 2954 (vs), 2928 (vs), 2856 (vs), 1670 (w); ESI-MS (*m/z*) 431.1 $(M+Na)^+$ (100); HRMS calcd for $C_{17}H_{33}OSiINa$ $(M+Na)^+$ 431.1243; found 431.1230.

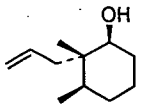


(±)-6α-[9-(*tert*-Butyl-dimethyl-silyloxy)-3,7-dimethyl-nona-3(*E*),7(*E*)-dienyl]-3-methoxy-5,6β-dimethyl-cyclohex-2-enone (12). Diisopropyl amine (55 μL, 0.389 mmol) was added to a flask containing THF (1.0 mL) and the solution was cooled to 0 °C. *n*-Butyllithium (2.38 M, 157 μL, 0.373 mmol) was added and the solution stirred for 30 min. After this time, the solution was cooled to -78 °C and a solution of (±)-3-methoxy-5,6-dimethyl-cyclohex-2-enone (50.0 mg, 0.324 mmol) and HMPA (113 μL, 0.648 mmol) in THF (2.0 mL) was added to the LDA solution over a period of 45 min using a syringe pump. After the addition was completed, the solution was stirred at -78 °C for an additional 30 min, after which time a solution of iodide **11** (119.2 mg, 0.292 mmol) in THF (1.0 mL) was added in a dropwise manner *via* syringe. The resulting solution was stirred for 15 minutes, then placed in an acetonitrile/CO_2 bath for 1 h, and finally allowed to warm to room temperature and stir overnight. The next day, the solution was poured into water (10 mL) and extracted with hexanes (4 x 10 mL). The organic extracts were washed with brine (1 x 15 mL) and dried over Na_2SO_4. Concentration *in vacuo* and flash chromatography (gradient elutant, 10-30% EtOAc/hexanes) afforded a 2.3:1 mixture of methyl diastereomers (23.9 mg, 17%) as a clear, colorless oil. The major diastereomer was determined by a ^{1}H NOESY spectrum to be the isomer with *cis* methyl groups. Repeated MPLC of the mixture afforded a sample of the major isomer (> 15:1) which was partially characterized. **12:** R_f = 0.18 (20% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 5.30 (mt, 1 H, *J* = 6.0 Hz), 5.28 (s, 1 H), 5.10 (mt, 1 H, *J* = 7.0 Hz), 4.19 (d, 2 H, *J* = 6.5 Hz), 2.40 (dt, 1 H, *J* = 8.5, 13.0 Hz), 2.27-2.21 (m, 2 H), 2.10-2.05 (m, 2 H), 2.02-1.96 (m, 3 H), 1.83 (dt, 1 H, *J* = 5.0, 13.0 Hz), 1.76 (dt, 1 H, *J* = 4.5, 13.0 Hz), 1.62 (s, 3 H), 1.55 (s, 3 H), 1.36 (ddd, 1 H, *J* = 5.5, 11.5, 17.0 Hz), 0.98 (d, 3 H, *J* = 6.0 Hz), 0.96 (s, 3 H), 0.90 (s, 9 H), 0.07 (s, 6 H).

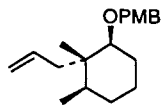


(±)-2α-Allyl-2,3β-dimethyl-cyclohexanone (14).[2] Prepared as previously reported and isolated as an 11:1 mixture of diastereomers. R_f = 0.42 (10% EtOAc in hexanes. ^{1}H NMR (300 MHz, $CDCl_3$) δ (ppm) 5.72 (dddd, 1 H, *J* = 6.0, 8.4, 10.7, 16.6 Hz), 5.07-4.99 (m, 2 H), 2.52 (tdd, 1 H, *J* = 1.5, 6.0, 13.8 Hz), 2.45-2.30 (m, 2 H), 2.17 (tdd, 1 H, *J* = 0.9, 8.4, 14.1 Hz), 2.00-1.90 (m, 1 H), 1.85-1.75 (m, 1

1.85-1.75 (m, 1 H), 1.75-1.65 (m, 1 H), 1.65-1.55 (m, 1 H), 1.10-0.95 (m, 1 H), 1.00 (s, 3 H), 0.90 (d, 3 H, J = 6.9 Hz).

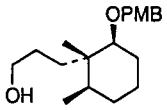


(±)-2α-Allyl-2,3β-dimethyl-cyclohexane-1β-ol (S-7). Lithium aluminium hydride (12.55 g, 0.331 mol) was cautiously added to a 2 L flask equipped with a mechanical stirrer and a thermometer which contained 0.80 L of diethyl ether held at 0 °C. When the addition was complete, the slurry was stirred an additional 15 min, and then cooled to -78 °C using acetone/CO_2. Ketone **14** (50.0 g, 0.301 mol) in ether (0.20 L) was then added *via* cannula over a period of 20 min, while the reaction temperature was maintained below -60 °C. When the addition was complete, the slurry was stirred an additional 1 h at -78 °C after which time ethyl acetate (100 mL) was slowly added. The mixture was stirred an additional 15 min after which time methanol (50 mL) was slowly added. After 15 min the mixture was warmed to 0 °C and 3 *N* HCl was added until all the solids dissolved (*ca.* 200 mL). Water (200 mL) was added, and the mixture poured into a separatory funnel. The ether layer was removed, and the aqueous phase extracted with MTBE (3 x 200 mL). The combined organic extracts were then washed with water (1 x 200 mL), brine (1 x 200 mL), and finally dried over Na_2SO_4. Evaporation of solvent followed by flash chromatography (gradient elution 5 to 20% MTBE in hexanes) afforded the alcohol **S-7** (35.46 g, 70%) as a clear, colorless oil. R_f = 0.17 (10% EtOAc in hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 5.91 (m, 1H), 5.09 (m, 2H), 3.48 (ddd, 1 H, J = 4.5, 4.5, 11.5 Hz); 2.35 (dd, 1 H, J = 8.0, 14.5 Hz), 2.04 (dd, 1 H, J = 8.0 Hz, 14.0 Hz), 1.69-1.63 (m, 2 H), 1.46 (m, 1 H), 1.40 (m, 1 H), 1.34 (m, 1 H), 1.28 (ddd, 1 H, J = 4.5, 4.5, 12.5 Hz), 1.21 (ddd, 1 H, J = 3.5, 12.0, 12.0 Hz), 0.85 (d, 3 H, J = 7.0 Hz), 0.78 (s, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 135.5, 117.4, 74.3, 42.3, 41.1, 36.1, 30.7, 30.2, 24.3, 15.4, 12.5; IR (neat) cm^{-1} 3435 (br), 3073 (m), 2932 (vs), 2859 (vs), 1729 (w), 1637 (mw), 1613 (mw), 1513 (s); CI-MS (*m/z*) 186.2 $(M+NH_4)^+$ (100); HRMS calcd for $C_{11}H_{24}ON$ $(M+NH_4)^+$ 186.1858; found 186.1847.

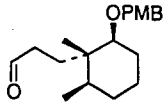


(±)-1-(2α-Allyl-2,3β-dimethyl-cyclohexyl-1β-oxymethyl)-4-methoxy-benzene (S-8). Alcohol **S-7** (4.42 g, 26.3 mmol) was placed in a 100 mL flask with a magnetic stir bar and dissolved in DMF (30 mL). Sodium hydride (60% in mineral oil, 1.37 g, 34.1 mmol) was added in one portion. Vigorous foaming ensued, and the solution turned cloudy. After 1 h, the flask was swirled by hand to ensure complete incorporation of reagents, and PMBCl (4.64 mL, 34.1 mmol) was added. The solution became very hot within 2 min and the reaction was completed within 0.5 h. The solution was poured into water (200 mL) and extracted with hexanes (4 x 35 mL). The combined organic extracts were washed with water (50 mL), brine (50 mL), and dried over Na_2SO_4. Evaporation of solvent followed by flash chromatography (gradient elution 5 to 10% EtOAc in hexanes) afforded ether **S-8** (6.68 g, 88%) as a clear, colorless oil. R_f = 0.44 (10% EtOAc in hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.27 (d, 2 H J = 8.5 Hz), 6.87 (d, 2 H, J = 8.5 Hz), 5.76 (m, 1 H), 5.00 (m, 2 H), 4.55 (d, 1 H, J = 11.0 Hz), 4.32 (d, 1 H, J = 11.5 Hz), 3.80 (s, 3 H), 3.16 (dd, 1 H, J = 5.0, 12.0 Hz), 2.52 (dd, 1 H, J = 8.0, 14.5 Hz), 1.99 (dd, 1 H, J = 7.0, 14.5 Hz), 1.91 (m, 1 H), 1.68 (m, 1 H), 1.44-1.30 (m, 3 H), 1.24-1.16 (m, 2 H), 0.82 (d, 3 H, J = 6.5 Hz), 0.81 (s, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 135.4, 132.0, 129.0, 117.1, 113.9, 112.6, 80.8,

70.6, 55.5, 42.4, 40.3, 35.8, 30.3, 26.2, 24.2, 15.3, 14.0; IR (neat) cm^{-1} 2974 (m), 2931 (s), 1613 (mw), 1514 (vs); CI-MS (*m/e*) 289.2 $(M+H)^+$ (5), 121.1 (100); HRMS calcd for $C_{19}H_{29}O_2$ $(M+H)^+$ 289.2168; found 289.2167.

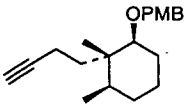


(±)-3-[2β-(4-Methoxy-benzyloxy)-1β,6β-dimethyl-cyclohexyl]-propan-1-ol (S-9). To a 100 mL flask, THF (46.0 mL) was added and the flask was lowered into an ice water bath. Borane methylsulfide complex (10 M, 1.16 mL, 11.58 mmol) was added. Alkene **S-8** from above (6.68 g, 23.16 mmol) in THF (23.0 mL) was slowly added *via* cannula. The flask was slowly allowed to come to room temperature over a period of 2 h. At this time, the solution was again cooled to 0 °C and sodium hydroxide (5.56g, 139.0 mmol) in water (20 mL) was cautiously added. When all of the base had been added, hydrogen peroxide (30%, 8 M, 23.16 mL, 185.3 mmol) was slowly added. A condenser was attached and the reaction was brought to reflux by means of an oil bath. After 2 hours at reflux, the mixture was cooled and most of the THF removed under reduced pressure. The remains were poured into a separatory funnel. Water (100 mL) was added, and the mixture was extracted with MTBE (6 x 35 mL). The combined extracts were washed with brine and dried over Na_2SO_4. The crude material was suitable for the next step, but an analytical sample was chromatographed with 30% EtOAc/hexanes. **S-9:** R_f = 0.20 (30% EtOAc/hexanes); ^1H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.26 (d, 2 H, *J* = 9.0 Hz), 6.87 (d, 2 H, *J* = 9.0 Hz), 4.57 (d, 1 H, *J* = 11.0 Hz), 4.30 (d, 1 H, *J* = 12.0 Hz), 3.81 (s, 3 H), 3.50 (t, 2 H, *J* = 5.5 Hz), 3.15 (dd, 1 H, *J* = 4.5, 12.0 Hz), 1.94 (m, 1 H), 1.74-1.65 (m, 2 H), 1.46-1.30 (m, 4 H), 1.28-1.18 (m, 5 H), 0.80 (s, 3 H), 0.78 (d, 3 H, *J* = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 159.2, 131.8, 129.4, 113.8, 80.1, 70.5, 64.2, 55.5, 41.1, 35.6, 31.5, 30.2, 26.1, 24.3, 19.4, 15.2, 14.5; IR (neat) cm^{-1} 3397 (br), 2945 (s), 2891 (s), 1612 (m), 1512 (s); CI-MS (*m/e*) 307.2 $(M+H)^+$ (4), 121.1 (100), HRMS calcd for $C_{19}H_{31}O_3$ $(M+H)^+$ 307.2273; found 307.2249.



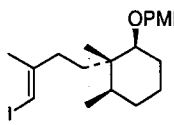
(±)-3-[2β-(4-Methoxy-benzyloxy)-1β,6β-dimethyl-cyclohexyl]-propionaldehyde (15). (Note: Immediately after use, all glassware in this procedure was submerged in a bucket containing dilute NaOCl for a minimum of 30 min in order to minimize the unpleasant odor produced.) A 500 mL flask was charged with dichloromethane (175 mL) and oxalyl chloride (7.04 mL, 80.7 mmol). The solution was cooled to -78 °C and DMSO (11.95 mL, 0.168 mol) in dichloromethane (35 mL) was added *via* a dropping funnel over a period of 10 min. The resulting yellow solution was stirred an additional 5 min and alcohol **S-9** from above (21.50 g, 70.2 mmol) in dichloromethane (40 mL) was added over 5 min *via* cannula. The solution was stirred for 20 min at -78 °C and then triethylamine (49.0 mL, 0.351 mol) was added over 5 min *via* dropping funnel. The mixture was then warmed to 0 °C, and water (200 mL) was added. The mixture was extracted with dichloromethane (3 x 100 mL) and the combined extracts were washed with 100 mL portions of 1% HCl until the water layer remained acidic to litmus. The organic phase was then washed with water (100 mL), brine (100 mL), and dried with Na_2SO_4. Concentration and flash chromatography (gradient elution, 5-20% EtOAc in cyclohexane) afforded aldehyde **15** (16.02 g, 75%) as a clear, colorless oil. R_f = 0.61 (30% EtOAc/cyclohexane); ^1H NMR (500 MHz, $CDCl_3$) δ (ppm) 9.57 (t, 1 H *J* = 2.0 Hz), 7.23 (d, 2 H, *J* = 9.0 Hz), 6.86 (d, 2 H, *J* = 9.0 Hz), 4.57 (d, 1 H, *J* = 12.0 Hz), 4.24 (d, 1 H, *J* = 11.5 Hz), 3.79 (s, 3 H), 3.03 (dd, 1 H, *J* = 4.5, 11.0 Hz), 2.19 (m, 1

H), 2.02-1.89 (m, 3 H), 1.72 (m, 1 H), 1.48-1.31 (m, 3 H), 1.28-1.15 (m, 3 H), 0.83 (s, 3 H), 0.77 (d, 3 H, J = 6.5 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 203.4, 159.3, 131.4, 129.6, 113.9, 79.6, 69.9, 55.5, 40.8, 38.1, 35.9, 30.1, 27.7, 25.8, 24.1, 15.2, 14.1; IR (neat) cm^{-1} 2933 (vs), 2863 (vs), 2718 (m), 1726 (vs), 1613 (s), 1586 (m), 1515 (vs); CI-MS (*m/e*) 322.3 $(M+NH_4)^+$ (1), 167.2 (21), 121.1 (100); HRMS calcd for $C_{19}H_{29}O_3$ $(M+H)^+$ 305.2117; found 305.2107.



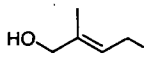
(±)-1-(2α-But-3-ynyl-2,3β-dimethyl-cyclohexyl-1β-oxymethyl)-4-methoxy-benzene (16). Aldehyde **15** (4.52 g, 14.85 mmol) was placed in a 100 mL flask along with dichloromethane (50 mL) and triphenylphosphine (7.79 g, 29.70 mmol). The solution was cooled to 0 °C and carbon tetrabromide (7.39 g, 22.28 mmol) was added in small portions. The reaction was allowed to warm to room temperature over 15 min and was then poured into cold hexanes (400 mL). The liquid was decanted, and the resultant reddish sludge was stirred with more hexanes (100 mL) and this process repeated another 2 times or until the sludge solidified. The combined organic phases were filtered and reduced to 10% of the orgional volume. Water (200 mL) and hexanes (300 mL) were added and the organic layer was then washed with brine (50 mL) and dried over Na_2SO_4 in the refrigerator overnight. The following morning, large white needles were observed to have formed. The solids were filtered off, and the solution evaporated under reduced pressure to afford a clear, colorless oil (6.70g, 98%) which was used without further purification. R_f = 0.61 (10% EtOAc/cyclohexane).

The crude dibromide (6.70 g, 14.55 mmol) was taken up in THF (60 mL) and the solution was cooled to -78 °C. *n*-Butyllithium (2.38 M in hexanes, 15.60 mL. 37.13 mmol) was slowly added, and the solution became dark in color. After 1 h at -78 °C, the solution was warmed to room temperature and quenched by the addition of water (5 mL). Most of the THF was removed under vacuum and the remaining mixture was partitioned between water (35 mL) and hexanes (75 mL). The water layer was discarded, and the organic phase washed with brine (1 x 30 mL) and dried over Na_2SO_4. Removal of solvents and flash chromatography (gradient elution, 0-10% EtOAc/hexanes) afforded alkyne **16** (3.52g, 81%) as a waxy white solid. R_f = 0.45 (10% EtOAc/cyclohexane); MP = 35.5-38 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.27 (d, 2 H, J = 9.5 Hz), 6.88 (d, 2 H, J = 9.0 Hz), 4.57 (d, 1 H, J = 11.5 Hz), 4.32 (d, 1 H, J = 11.0 Hz), 3.81 (s, 3 H), 3.08 (dd, 1 H, J = 4.5, 11.5 Hz), 2.08-2.00 (m, 2 H), 1.96-1.84 (m, 3 H), 1.70 (m, 1 H), 1.49 (m, 1 H), 1.40-1.16 (m, 5 H), 0.80 (d, 3 H, J = 6.5 Hz), 0.79 (s, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ (ppm) 159.1, 131.4, 129.4, 113.9, 85.8, 79.7, 70.3, 67.9, 55.5, 41.2, 35.6, 34.9, 30.1, 25.9, 24.1, 15.3, 14.0, 12.5; IR (neat) cm^{-1} 3304 (vs), 2958 (vs), 2907 (vs), 2863(vs), 2116 (m), 1612 (s), 1586 (m), 1513 (vs); CI-MS (*m/e*) 318.3 $(M+NH_4)^+$ (1), 263.1 (8), 121.1 (100); HRMS calcd for $C_{20}H_{29}O_2$ $(M+H)^+$ 301.2168; found 301.2193.



(±)-1-[2α-(4-Iodo-3-methyl-but-3(*E*)-enyl)-2,3β-dimethyl-cyclohexyl-1β-oxymethyl]-4-methoxy-benzene (17). Cp_2ZrCl_2 (3.51 g, 12.01 mmol) was placed in a dry flask with a magnetic stir bar, and the flask was evacuated and flushed with nitrogen 3 times. CH_2Cl_2 (100 mL) was then added, and finally a solution of $AlMe_3$ (2.0 M in hexanes, 120 mL, 240.0 mmol) was added *via*

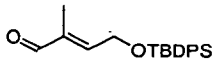
syringe. This mixture was stirred at room temperature for 1 h during which time all of the solids dissolved and the solution became bright yellow in color. After 1 h, alkyne **16** (12.01 g, 39.98 mmol) was added in CH_2Cl_2 (40 mL). The resulting solution was stirred overnight. The next morning, iodine (30.50 g, 120.2 mmol) was placed in a pear-shaped flask with a magnetic stir bar, and THF (50 mL) was added. This mixture was stirred until all of the iodine dissolved. The flask containing the zirconium was then placed in an acetonitrile/CO_2 bath and cooled to -45 °C. After cooling for 5 min, the iodine solution was added *via* cannula transfer. The solution was stirred at low temperature for 10 min after the addition was completed, and then the cooling bath was removed. When the temperature of the flask reached room temperature, the contents were slowly (CAUTION!! there is excess $AlMe_3$ which reacts quite violently with water) poured into a 2 L beaker containing 1 M HCl (300 mL) that was cooled to 0 °C by means of an ice bath. When all of the reaction had been quenched, the mixture was stirred and more acid was added until there was no longer a solid precipitate. The mixture was then separated, and the water layer extracted with hexanes (2 x 100 mL). The combined extracts were then washed with water (1 x 100 mL), brine (1 x 100 mL), and dried over Na_2SO_4. Removal of solvents *in vacuo* followed by flash chromatography (gradient elution 0-10% MTBE/hexanes) afforded iodide **17** (12.03 g, 68%) as a clear, colorless oil which was observed to be quite stable in the refrigerator for several months. R_f = 0.55 (10% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.25 (d, 2 H, J = 9.0 Hz), 6.88 (d, 2 H, J = 9.0 Hz), 5.78 (brd, 1 H, J = 1.0 Hz), 4.59 (d, 1 H, J = 11.5 Hz), 4.30 (d, 1 H, J = 12.0 Hz), 3.82 (s, 3 H), 3.15 (dd, 1 H, J = 4.0, 11.5 Hz), 2.04 (dt, 1 H, J = 3.5, 13.0 Hz), 2.00-1.82 (m, 3 H), 1.80 (s, 3 H), 1.76-1.71 (m, 1 H), 1.44-1.34 (m, 3 H), 1.32-1.18 (m, 3 H), 0.82 (s, 3 H), 0.81 (d, 3 H, J = 6.5 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 159.1, 149.0, 131.4, 129.2, 113.8, 79.9, 74.2, 70.2, 55.4, 41.2, 35.5, 33.7, 32.8, 30.1, 25.9, 24.4, 24.1, 15.2, 14.4; IR (neat) cm^{-1} 3060 (w), 2935 (vs), 2859 (s), 1613 (s), 1586 (m), 1513 (vs); ESI-MS (*m/e*) 465.2 (M+Na)+ (100), 339.3 $(M+Na-I)^+$ (34); HRMS calcd for $C_{21}H_{31}O_2INa$ $(M+Na)^+$ 465.1266; found 465.1266.



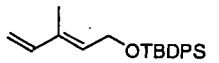
4-(*tert*-Butyl-diphenyl-silyloxy)-2-methyl-but-2(*E*)-en-1-ol (S-10). Prenyl alcohol (5.90 mL, 58.05 mmol) was placed in a 250 mL flask along with imidazole (9.88 g, 145.1 mmol) and CH_2Cl_2 (60 mL). TBDPSCl (15.40 mL, 59.21 mmol) was then added in one portion. A white precipitate formed, and the reaction became warm. After 20 min, hexanes (200 mL) was added and the reaction stirred an additional 20 min. After this time, the mixture was filtered through a coarse fritted funnel to remove imidazolium chloride, and the filtrate was placed in a separatory funnel with an additional 200 mL of hexanes. The organic layer was washed with water (4 x 100 mL), brine (1 x 100 mL) and dried over Na_2SO_4. Removal of solvents *in vacuo* afforded the crude silicon ether (18.95 g, 100%) which was used without further purification. R_f = 0.53 (5% EtOAc/cyclohexane).

The crude silicon ether was taken up in CH_2Cl_2 (100 mL) and *tert*-butylhydroperoxide (70% aqueous solution, 19.90 mL, 145.0 mmol) was added along with solid SeO_2 (1.29 g, 11.63 mmol, CAUTION!!! HIGHLY TOXIC!!!). Most of the solid eventually dissolved and the biphase was stirred rapidly with a large magnetic stir bar for 2 d at ambient temperature. When unlocked ^{1}H NMR analysis of the organic layer indicated no further change in the product distribution, the reaction was poured into

a 2 L beaker and placed into an ice bath. Methanol (100 mL) was added, and solid $NaBH_4$ was slowly and cautiously added until foaming ceased, and the reaction no longer darkened KI/starch paper. Water (400 mL) was then added, and the mixture was extracted with $CHCl_3$ (5 x 100 mL). The aqueous phase was placed in a specially labeled waste container for selenium. The organic phase was washed with water (1 x 100 mL), brine (1 x 100 mL), and dried over Na_2SO_4. The solvent was removed under reduced pressure, and the remaining oil was placed under high vacuum (*ca.* 0.2 mmHg) for several hours; alternatively, Kugelrohr distillation at the same pressure (*ca.* 50 °C oven temperature) was an excellent way to rapidly remove undesired lower boiling components. The remaining yellow oil was then chromatographed (20% EtOAc/cyclohexane) to afford alcohol **S-10** (14.41 g, 73%) as a clear, colorless oil. R_f = 0.43 (30% EtOAc/cyclohexane); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.70-7.67 (m, 4 H), 7.44-7.36 (m, 6 H), 5.61 (brt, 1 H, *J* = 6.5 Hz), 4.27 (d, 2 H, *J* = 6.5 Hz), 3.96 (brd, 2 H, *J* = 4), 1.48 (s, 3 H), 1.30 (brt, 1 H, *J* = 5.5 Hz), 1.05 (s, 9 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 136.4, 135.8, 134.1, 129.8, 127.8, 125.1, 68.5, 61.0, 27.0, 19.4, 14.0; IR (neat) cm^{-1} 3350 (br), 3071 (m), 3049 (m), 2931 (s), 2858 (vs), 1589 (w), 1472 (s); ESI-MS (*m/e*) 363.2 $(M+Na)^+$ (100); HRMS calcd for $C_{21}H_{28}O_2SiNa$ $(M+Na)^+$ 363.1756; found 363.1761.

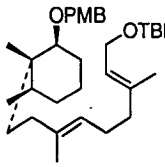


4-(*tert*-Butyl-diphenyl-silyloxy)-2-methyl-but-2(*E*)-enal (S-11). Alcohol **S-10** (14.41 g, 42.32 mmol) was taken up in CH_2Cl_2 (170 mL) and placed in a 500 mL flask equipped with a mechanical stirrer. MnO_2 (36.79 g, 0.423 mol) was then added in 3 portions, 5 min apart, and the reaction was stirred for 1.5 d at room temperature after which time TLC indicated consumption of starting alcohol. Filtration of the mixture through a 5 cm bed of Celite and concentration afforded aldehyde **S-11** (11.75 g, 82%) as a clear, colorless oil. R_f = 0.31 (10% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 9.40 (s, 1 H), 7.67 (dd, 4 H, *J* = 1.5, 7.5 Hz), 7.46-7.36 (m, 6 H), 6.59 (brt, 1 H, *J* = 5.5 Hz), 4.51 (dd, 2 H, *J* = 1.0, 5.5 Hz), 1.56 (brs, 3 H), 1.07 (s, 9 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 194.7, 152.6, 138.1, 135.7, 133.2, 130.1, 128.0, 61.5, 26.9, 19.3, 9.5; IR (neat) cm^{-1} 3072 (m), 3051 (m), 3016 (m), 2958 (s), 2932 (s), 2892 (ms), 2858 (s), 2714 (mw), 1691 (s), 1650 (m); ESI-MS (*m/e*) 361.2 (M+Na)+ (100); HRMS calcd for $C_{21}H_{26}O_2SiNa$ $(M+Na)^+$ 361.1600; found 361.1581.

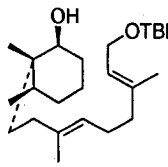


1-(*tert*-Butyl-diphenyl-silyloxy)-3-methyl-penata-2(*E*),4-diene (19). Methyltriphenylphosphonium bromide (1.52 g, 4.25 mmol) was placed in a 25 mL flask with THF (10 mL) and cooled to 0 °C. *n*-Butyllithium (2.38 M in hexanes, 1.71 mL, 4.06 mmol) was added in a dropwise manner. The bright yellow solution was stirred for 30 min, and then aldehyde **S-11** (1.25 g, 3.69 mmol) in THF (10 mL) was added *via* cannula. A white precipitate formed instantly, and the mixture was allowed to warm to room temperature over 1 h. The mixture was poured into 0 °C hexanes (100 mL) and mixed with a glass stirring rod until the solid was no longer sticky. Filtration through a coarse fritted funnel and washing with water (2 x 50 mL), brine (1 x 50 mL), drying (Na_2SO_4), and concentration afforded the crude diene which was subjected to flash chromatography (gradient, 0-10% MTBE/hexanes) to give pure diene **19** (1.17 g, 94%) as a clear, colorless oil. R_f = 0.61 (5% EtOAc/cyclohexane); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.76 (dd, 4 H, *J* = 1.5, 8.0 Hz), 7.49-7.42 (m, 6 H), 6.44 (dd,

1 H, J = 11.0, 17.0 Hz), 5.75 (t, 1 H, J = 6.0 Hz), 5.19 (d, 1 H, J = 17.5 Hz), 5.06 (d, 1 H, J = 11.0 Hz), 4.42 (d, 2 H, J = 6.5 Hz), 1.63 (s, 3 H), 1.12 (s, 9 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 141.2, 135.8, 134.6, 134.0, 131.8, 129.8, 127.9, 112.4, 61.3, 27.0, 19.4, 12.1; IR (neat) cm^{-1} 3071 (m), 3050 (m), 2957(s), 2931 (vs), 2891 (m), 2857 (vs), 1608 (m), 1589 (w), 1427 (s); ESI-MS (*m/z*) 359.2 $(M+Na)^+$ (100), 301.1 (61); HRMS calcd for $C_{22}H_{28}OSiNa$ $(M+Na)^+$ 359.1807; found 359.1786.

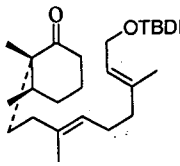


(±)-2α-[9-(*tert*-Butyl-diphenyl-siloxy)-3,7-dimethyl-nona-3(*E*),7(*E*)-dienyl]-2,3β-dimethyl-1-(4-methoxy-benzyloxy)-cyclohexane (20). A slurry of dicyclohexylborane was prepared by dropwise addition of cyclohexene (3.74 mL, 36.89 mmol) to a solution of borane methylsulfide complex (10 M, 1.85 mL, 18.44 mmol) in THF (40 mL) at 0 °C in a 100 mL pear-shaped flask. After about 15 min, a large amount of white precipitate formed and the mixture was allowed to warm to ambient temperature over 1 h. After this time, the mixture was again cooled to 0 °C and a solution of the above TBDPS-diene (6.04 g, 17.95 mol) in THF 15 mL was rapidly added *via* cannula. After about 5 min, all of the precipitate was gone, and the solution was clear and colorless. This solution was stirred for 2 h at ambient temperature. To a 250 mL flask was added iodide **17**, DMF (25 mL), and $PdCl_2(PPh_3)_2$ (559.8 mg, 0.798 mmol). The resulting solution was degassed by bubbling nitrogen through it for 10 min. After this time, the borane prepared above was transferred *via* cannula to the DMF solution, and immediately after this addition, aqueous K_3PO_4 (2 M, 10 mL) was added. After 15 min the solution had become a golden orange color, and stirring was continued for 12 h. The solution was then partitioned between water (200 mL) and hexanes (100 mL). Separation of the organic phase, followed by extraction of the aqueous phase (hexanes, 3 x 100 mL). The combined extracts were washed with water (1 x 100 mL), brine (1 x 100 mL), and dried (Na_2SO_4). Removal of solvents *in vacuo* afforded a dark brown oil which was subjected to flash chromatography (gradient elution, 5-15% EtOAc in hexanes) to afford the coupled product **20** (6.12 g, 94%) as a clear and colorless oil. R_f = 0.53 (10% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.69 (dd, 4 H, J = 1.5, 8.0 Hz), 7.41-7.35 (m, 6 H), 7.26 (d, 2 H, J = 9.0 Hz), 6.85 (d, 2 H, J = 9.0 Hz), 5.38 (brt, 1 H, J = 6.0 Hz), 5.09 (brt, 1 H, J = 6.0 Hz), 4.55 (d, 1 H, J = 11.0 Hz), 4.33 (d, 1 H, J = 11.0 Hz), 4.21 (d, 2 H, J = 6.5 Hz), 3.79 (s, 3 H), 3.19 (dd, 1 H, J = 4.5, 11.0 Hz), 2.06 (brq, 2 H, J = 7.0), 1.97 (bdd, 2 H, J = 6.5, 8.5 Hz), 1.90 (m, 1 H), 1.88-1.78 (m, 3 H), 1.70 (m, 1 H), 1.58 (s, 3 H), 1.44 (s, 3 H), 1.44-1.20 (m, 6 H), 1.04 (s, 9 H), 0.79 (d, 3 H, J = 6.0 Hz), 0.78 (s, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm)159.1, 137.4, 136.5, 135.8, 134.3, 131.9, 129.7, 129.2, 127.8, 124.2, 123.6, 113.8, 80.6, 70.8, 61.4, 55.4, 41.4, 39.8, 35.5, 34.4, 32.9, 30.2, 27.1, 26.7, 26.3, 24.3, 19.4, 16.6, 16.5, 15.2, 14.7; IR (neat) cm^{-1} 3071 (m), 3049 (m), 2936 (vs), 2857 (vs), 1613 (m), 1587 (m), 1513 (vs); ESI-MS (*m/z*) 675.4 $(M+Na)^+$ (100); HRMS calcd for $C_{43}H_{60}O_3SiNa$ $(M+Na)^+$ 675.4209; found 675.4214.

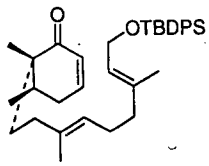


(±)-2α-[9-(*tert*-Butyl-diphenyl-silyloxy)-3,7-dimethyl-nona-3(*E*),7(*E*)-dienyl]-2,3β-dimethyl-cyclohexane-1β-ol (S-12). Diene **20** (6.13 g, 9.39 mmol) was placed in a flask with CH_2Cl_2 (40 mL) and water (10 mL). The biphase was cooled to 0 °C and solid DDQ (2.45 g, 10.80 mmol) was then added in small portions over 5 min. TLC

indicated consumption of the starting material after *ca.* 15 min. The mixture was filtered through a coarse fritted funnel to remove the off-white precipitate and then poured into 0.5 M NaOH (50 mL). The mixture was then extracted with hexanes (4 x 50 mL). The combined extracts were washed with water (1 x 50 mL), brine (1 x 50 mL), and dried over Na_2SO_4. Flash chromatography (gradient elution, 5-20% EtOAc in hexanes) afforded alcohol **S-12** (4.35 g, 87%) as a clear, colorless oil. R_f = 0.44 (20% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.69 (dd, 4 H, *J* = 1.5, 8.0 Hz), 7.43-7.35 (m, 6 H), 5.38 (brt, 1 H, *J* = 6.5 Hz), 5.13 (brt, 1 H, *J* = 6.5 Hz), 4.22 (d, 2 H, *J* = 6.5 Hz), 3.51 (brdd, 1 H, *J* = 4.0, 11.5 Hz), 2.06 (brq, 2 H, *J* = 7.0 Hz), 1.98 (brt, 2 H, *J* = 8.0 Hz), 1.94-1.86 (m, 2 H), 1.70-1.59 (m, 2 H), 1.62 (s, 3 H), 1.50-1.40 (m, 1 H), 1.44 (s, 3 H), 1.38-1.18 (m, 6 H), 1.04 (s, 9 H), 0.81 (d, 3 H, *J* = 7.0 Hz), 0.74 (s, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 137.3, 136.2, 135.8, 134.3, 129.7, 127.8, 124.2, 123.9, 73.2, 61.4, 41.3, 39.7, 35.1, 34.4, 32.6, 30.8, 30.1, 27.1, 26.6, 24.4, 19.4, 16.6, 16.5, 15.3, 13.6; IR (neat) cm $^{-1}$ 3450 (br), 2931 (vs), 2858(s), 1428 (m); ESI-MS (*m/z*) 555.4 $(M+Na)^+$ (100); HRMS calcd for $C_{35}H_{52}O_2SiNa$ $(M+Na)^+$ 555.3634; found 555.3655.



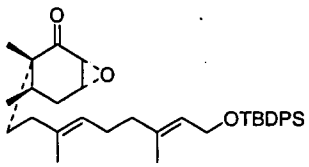
(±)-2α-[9-(*tert*-Butyl-diphenyl-silyloxy)-3,7-dimethyl-nona-3(*E*),7(*E*)- dienyl]-2,3β-dimethyl-cyclohexanone (S-13). Alcohol **S-12** (1.74 g, 3.27 mmol) was taken up in CH_2Cl_2 and NMO (535.6 mg, 4.57 mmol) was added. To this was added powdered 4 Å molecular sieves and TPAP (91.8 mg, 0.261 mmol). The black solution was stirred at ambient temperature for 3 h after which time it was filtered through a medium fritted funnel and most of the solvent was removed *in vacuo*. Filtration through silica eluting with 5% acetone/CH_2Cl_2 and evaporation of solvent afforded ketone **S-13** (1.58 g, 91%) as a clear, colorless oil. R_f = 0.48 (10% EtOAc/cyclohexane); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.69 (dd, 4 H, *J* = 1.5, 8.5 Hz), 7.42-7.35 (m, 6 H), 5.38 (brt, 1 H, *J* = 5.0 Hz), 5.12 (t, 1 H, *J* = 7.0 Hz), 4.22 (d, 2 H, *J* = 6.5 Hz), 2.36-2.33 (m, 2 H), 2.05 (brq, 2 H, *J* = 7.0 Hz), 1.98 (brt, 2 H, *J* = 8.5 Hz), 1.95-1.83 (m, 4 H), 1.79-1.68 (m, 3 H), 1.62 (s, 3 H), 1.60-1.50 (m, 2 H), 1.44 (s, 3 H), 1.04 (s, 9 H), 0.98 (s, 3 H), 0.90 (d, 3 H, *J* = 6.5 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 216.0, 137.3, 135.8, 135.7, 134.3, 129.7, 127.8, 124.2, 124.1, 61.4, 52.2, 39.7, 38.6, 38.5, 35.5, 34.4, 28.9, 27.1, 26.6, 24.0, 19.4, 19.3, 16.6, 16.3, 15.7; IR (neat) cm^{-1} 3071 (w), 2958 (s), 2930 (vs), 2857 (s), 1706 (vs), 1428 (s); ESI-MS (*m/z*) 553.4 $(M+Na)^+$ (100); HRMS calcd for $C_{35}H_{50}O_2SiNa$ $(M+Na)^+$ 553.3478; found 553.3479.



(±)-6α-[9-(*tert*-Butyl-diphenyl-silyloxy)-3,7-dimethyl-nona-3(*E*),7(*E*)-dienyl]-5β,6-dimethyl-cyclohex-2-enone (21). Diisopropylamine (189 μL, 1.35 mmol) was added to THF (3 mL) and the solution was cooled to 0 °C. *n*-Butyllithium (2.38 M in hexanes, 576 μL, 1.30 mmol) was then dripped in over 2 min. This solution was stirred for 30 min, and then cooled to -78 °C. Ketone **S-13** (571.2 mg, 1.08 mmol) was taken up in THF (4 mL) and HMPA (0.36 mL, 2.16 mmol) was added. This solution was slowly dripped *via* syringe into the LDA solution and then stirred for 45 min. After this time, PhSeBr (242.1 mg, 1.03 mmol) was taken up in THF (3 mL) and rapidly added to the

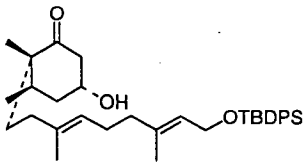
enolate solution at -78 °C. The color of the selenide was immediately dissipated. The solution was warmed after 5 min to room temperature, and poured into water (40 mL). The mixture was extracted with hexanes (4 x 30 mL) and the combined extracts were washed with brine (1 x 40 mL) and dried with Na_2SO_4. Concentration *in vacuo* and flash chromatography (gradient, 5-10% MTBE/hexanes) afforded the selenide as an impure mixture of isomers. $R_f = 0.61$ (10% EtOAc/cyclohexane).

The above selenide was dissolved in THF (10 mL) and the solution was cooled to 0 °C. Hydrogen peroxide (30% , 149 μL, 1.19 mmol) was then added, and the solution was allowed to warm to room temperature and stirred for a total of 3 h. Removal of solvent under reduced pressure afforded a slurry of product and selenous waste. Flash chromatography (gradient elutant, 5-10% EtOAc in cyclohexane) afforded enone **21** (194.2 mg, 34%) as a clear, colorless oil. $R_f = 0.32$ (10% EtOAc/cyclohexane); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.69 (dd, 4 H, *J* = 1.5, 8.0 Hz), 7.43-7.35 (m, 6 H), 6.79 (ddd, 1 H, *J* = 3.0, 5.0, 10.5 Hz), 5.92 (td, 1 H, *J* = 2.0, 10.0 Hz), 5.37 (brt, 1 H, *J* = 6.5 Hz), 5.11 (brt, 1 H, *J* = 6.5 Hz), 4.22 (d, 2 H, *J* = 6.5 Hz), 2.39 (dtd, 1 H, *J* = 1.5, 4.5, 18.5 Hz), 2.22 (m, 1 H), 2.13 (tdd, 1 H, *J* = 3.0, 9.0, 19.0 Hz), 2.05 (brq, 2 H, *J* = 7.0 Hz), 2.00-1.94 (m, 3 H), 1.84 (dt, 1 H, *J* = 4.5, 13.0 Hz), 1.80 (dt, 1 H, *J* = 4.5, 13.5 Hz), 1.61 (s, 3H), 1.43 (s, 3 H), 1.38 (ddd, 1 H, *J* = 5.0, 12.0, 16.5 Hz), 1.04 (s, 9 H), 0.96 (d, 3 H, *J* = 7.0 Hz), 0.96 (s, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 204.5, 147.5, 137.3, 135.8, 135.7, 134.3, 129.7, 129.0, 127.8, 124.2, 124.1, 61.4, 48.7, 39.7, 34.3, 34.1, 33.9, 31.8, 27.1, 26.6, 19.4, 18.3, 16.6, 16.3, 15.2; IR (neat) cm^{-1} 3071 (m), 3049 (m), 3033 (m), 2960 (vs), 2930 (vs), 2856 (vs), 1675 (vs); ESI-MS (*m/z*) 551.3 $(M+Na)^+$ (100); HRMS calcd for $C_{35}H_{48}O_2SiNa$ $(M+Na)^+$ 551.3321; found 551.3322.

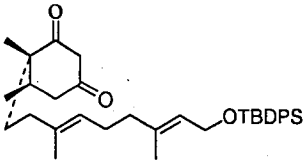


(±)-6α-[9-(*tert*-Butyl-diphenyl-silyloxy)-3,7-dimethyl-nona-3(*E*),7(*E*)-dienyl]-5β,6-dimethyl-2,3-α-epoxy-cyclohexanone (22). Enone **21** (194.2 mg, 0.367 mmol) was taken up in THF (1 mL), MeOH (1 mL) and water (0.25 mL). This solution was cooled to 0 °C and H_2O_2 (30%, 92 μL, 0.734 mmol) was added, followed by powdered K_2CO_3 (101.5 mg, 0.734 mmol). This mixture was stirred, and allowed to warm to room temperature for about 4 h. When TLC indicated consumption of starting enone, the mixture was poured into 0.1 M HCl (5 mL) and extracted with $CHCl_3$ (4 x 10 mL). The combined extracts were washed with water (1 x 10 mL), brine (1 x 10 mL), and finally dried over Na_2SO_4. Concentration of the extracts followed by flash chromatography (gradient elution, 5-10% EtOAc/cyclohexane) afforded epoxide **22** (188.1 mg, 94%) as a clear, colorless oil. The assignment of the α-epoxide was based on ^{1}H NOE studies. $R_f = 0.27$ (10% EtOAc/cyclohexane); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.69 (dd, 4 H, *J* = 1.5, 8.0 Hz), 7.43-7.35 (m, 6 H), 5.37 (brt, 1 H, *J* = 6.5 Hz), 5.10 (brt, 1 H, *J* = 6.5 Hz), 4.21 (d, 2 H, *J* = 6.5 Hz), 3.49 (t, 1 H, *J* = 3.0 Hz), 3.20 (d, 1 H, *J* = 3.5 Hz), 2.32 (ddddd, 1 H, *J* = 4.0, 7.0, 7.3, 7.3, 11.7 Hz), 2.17 (td, 1 H, *J* = 3.5, 14.5 Hz), 2.04 (brq, 2 H, *J* = 6.5 Hz), 2.00-1.87 (m, 4 H), 1.79 (ddd 1 H, *J* = 1.0, 12.5, 15.5 Hz), 1.66 (dt, 1 H, *J* = 3.5, 11.0 Hz), 1.58 (s, 3 H), 1.43 (s, 3 H), 1.38 (dt, 1 H, *J* = 4.5, 13.0 Hz), 1.04 (s, 9 H), 0.87 (s, 3 H), 0.87 (d, 3 H, *J* = 6.5 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 210.0, 137.3, 135.8, 135.3, 134.3, 129.7, 127.8, 124.4, 124.2, 61.4, 54.2, 53.9, 49.7, 39.6, 34.6, 34.5, 29.0, 27.1, 26.6, 25.1, 19.4, 19.2, 16.6, 16.2, 14.4; IR (neat) cm^{-1}

3070 (w), 3049 (w), 2960 (s), 2932 (vs),2857 (s), 1703 (s), 1673 (w); ESI-MS (*m/z*) 567.3 $(M+Na)^+$ (100); HRMS calcd for $C_{35}H_{48}O_3SiNa$ $(M+Na)^+$ 567.3270; found 567.3276.

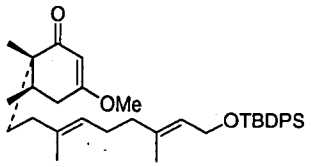


2α-[9-(*tert*-Butyl-diphenyl-silyloxy)-3,7-dimethyl-nona-3(*E*),7(*E*)-dienyl]-5α-hydroxy-2,3β-dimethyl-cyclohexanone (S-14). A solution of SmI_2 was prepared by the addition of freshly purified 1,2-diiodoethane (134.3 mg, 0.476 mmol) to a flask containing THF (2.0 mL) and Sm powder from a recently opened bottle (Strem, 40 mesh, 75.2 mg, 0.500 mmol). There was an instant reaction to give a pale blue color, and a greenish/yellow precipitate began to form. The contents were stirred at room temperature for 1 h, after which time an extremely dark blue color formed, and nearly all of the Sm had gone into solution. At times, the reaction may become quite vigorous, and cooling with a room temperature water bath may be advisable. After the hour had passed, the flask was cooled to -90 °C by means of a MeOH/N_2 slush. Epoxide **22** from above (129.8 mg, 0.238 mmol) was taken up in THF (1.0 mL) and anhydrous MeOH (0.5 mL). This solution was slowly dripped into the SmI_2 solution *via* syringe. After 5 min, the reaction was quenched at -90 °C with K_2CO_3 (50.0 mg) in water (1.0 mL) and warmed to room temperature. This caused a greenish/brown precipitate to form, and the reaction froze until it warmed up. The contents of the flask were filtered through a medium fritted funnel, and water (10 mL) was added. Extraction ($CHCl_3$, 3 x 20 mL), washing with brine (1 x 20 mL), drying with Na_2SO_4, concentration *in vacuo*, and flash chromatography (gradient elution, 20-50% EtOAc in hexanes) afforded recovered epoxide **22** (22.1 mg, 17%) and hydroxy-ketone **S-14** (102.9 mg, 79%) as a clear, colorless oil. R_f = 0.42 (50% EtOAc in hexanes); ^1H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.70-7.68 (m, 4 H), 7.43-7.36 (m, 6 H), 5.38 (brt, 1 H, *J* = 6.0 Hz), 5.11 (brt, 1 H *J* = 6.5 Hz), 4.26 (brm, 1 H), 4.22 (d, 1 H, *J* = 6.5 Hz), 2.69 (dd, 1 H, *J* = 4.5, 15.0 Hz), 2.44 (ddd, 1 H, *J* = 1.0, 6.5, 14.5 Hz), 2.27 (m, 1 H) 2.05 (brq, 2 H, *J* = 7.0 Hz), 1.98-1.90 (m, 4 H), 1.87-1.70 (m, 3 H), 1.62 (s, 3 H), 1.56 (dt, 1 H, *J* = 4.0, 13.0 Hz), 1.43 (s, 3 H), 1.04 (s, 9 H), 0.99 (s, 3 H), 0.90 (d, 3 H, *J* = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 213.9, 137.3, 135.8, 135.6, 134.3, 129.7, 127.8, 124.2, 124.1, 67.7, 61.4, 51.6, 47.0, 39.7, 36.9, 35.2, 34.2, 32.8, 27.0, 26.6, 19.4, 18.8, 16.6, 16.3, 15.8; IR (neat) cm^{-1} 3418 (br), 3071 (m), 3050 (m), 2960 (vs), 2931 (vs), 2857 (s), 1708 (vs); ESI-MS (*m/z*) 569.3 $(M+Na)^+$ (100); HRMS calcd for $C_{35}H_{50}O_3SiNa$ $(M+Na)^+$ 569.3427; found 569.3425.



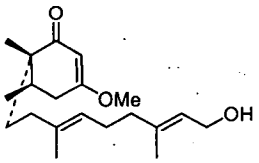
(±)-4α-[9-(*tert*-Butyl-diphenyl-silyloxy)-3,7-dimethyl-nona-3(*E*),7(*E*)-dienyl]-4,5β-dimethyl-cyclohexane-1,3-dione (23). Hydroxy-ketone **S-14** (89.7 mg, 0.164 mmol) was taken up in CH_2Cl_2 (2 mL) and PCC (106.1 mg, 0.492 mmol) was added in one portion. The reaction was monitored by TLC (developed two times with 30% EtOAc/hexanes) and when the starting material was *nearly* gone the mixture was loaded onto a short silica column packed with CH_2Cl_2. When the mixture was on the column, the solvent was changed to 10% EtOAc/hexanes and gradually increased to 10% MeOH/EtOAc in order to pull the strongly bound diketone off the silica. Concentration of the fractions containing diketone (conveniently found by the strong UV band of the enol form on silica) afforded **23** (72.4 mg, 81%) as a clear

colorless oil. R_f = 0.41 (50% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.69 (dd, 4 H, *J* = 1.5, 8.0 Hz), 7.43-7.36 (m, 6 H), 5.38 (brt, 1 H, *J* = 6.0 Hz), 5.13 (brt, 1 H, *J* = 6.5 Hz), 4.22 (d, 2 H, *J* = 6.5 Hz), 3.50 (d, 1 H, *J* = 17.5 Hz), 3.30 (dd, 1 H, *J* = 1.0, 17.5 Hz), 2.79 (dd, 1 H, *J* = 4.5, 16.5 Hz), 2.40 (ddd, 1 H, *J* = 1.0, 8.0, 17.0 Hz), 2.32-2.20 (m, 2 H), 2.06 (brq, 2 H, *J* = 7.0 Hz), 1.97 (brt, 2 H, *J* = 8.5 Hz), 1.94-1.84 (m, 3 H), 1.61 (s, 3 H), 1.44 (s, 3 H), 1.07 (s, 3 H), 1.04 (s, 9 H), 0.93 (d, 3 H *J* = 7.5 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 208.3, 204.5, 137.0, 135.8, 134.7, 134.2, 129.7, 127.8, 125.0, 124.3, 61.3, 56.3, 51.2, 44.8, 39.5, 35.5, 34.2, 32.4, 27.0, 26.5, 19.4, 18.2, 16.6, 16.3, 15.8; IR (neat) cm^{-1} 3071 (m), 3050 (m), 2960 (vs), 2931 (vs), 2857 (vs), 1706 (m), 1605 (vs), 1589 (vs); ESI-MS (*m/z*) 567.3 $(M+Na)^+$ (100); HRMS calcd for $C_{35}H_{48}O_3SiNa$ $(M+Na)^+$ 567.3270; found 567.3269.

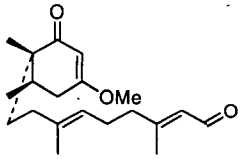


(±)-6α-[9-(*tert*-Butyl-diphenyl-silyloxy)-3,7-dimethyl-nona-3(*E*),7(*E*)-dienyl]-3-methoxy-5β,6-dimethyl-cyclohex-2-enone (24). To a solution of dione **23** (308.1 mg, 0.566 mmol) in acetone (4.0 mL) was added dimethylsulfate (107 μL, 1.13 mmol) and powdered K_2CO_3 (156.0 mg, 1.13 mmol). The solution was stirred for 1 h at which time TLC indicated complete conversion. Filtration through a cotton plug, concentration *in vacuo*, and flash chromatography (30% EtOAc/hexanes) afforded the desired isomer **24** (154.9 mg, 49%) along with the undesired isomer **25** (148.8 mg, 47%) as clear, colorless oils. **24:** R_f = 0.69 (50% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.70-7.68 (m, 4 H), 7.43-7.36 (m, 6 H), 5.37 (brt, 1 H, *J* = 6.5 Hz), 5.28 (s, 1 H), 5.10 (brt, 1 H, *J* = 6.5 Hz), 4.21 (d, 2 H, *J* = 5.5 Hz), 3.67 (s, 3 H), 2.39 (td, 1 H, *J* = 9.0, 12.5 Hz), 2.27-2.20 (m, 2 H), 2.07-2.01 (m, 2 H), 2.00-1.95 (m, 3 H), 1.83 (dt, 1 H, *J* = 5.0, 13.0 Hz), 1.77 (dt, 1 H, *J* = 4.5, 13.0 Hz), 1.61 (s, 3 H), 1.43 (s, 3 H), 1.36 (ddd, 1 H, *J* = 5.0, 12.0, 17.0 Hz), 1.04 (s, 9 H), 0.97 (d, 3 H, *J* = 6.5 Hz), 0.95 (s, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 204.2, 175.6, 137.3, 135.8, 135.7, 134.2, 129.7, 127.8, 124.1, 124.0, 101.3, 61.3, 55.7, 47.5, 39.6, 34.4, 34.2, 34.1, 32.8, 27.0, 26.6, 19.3, 18.8, 16.6, 16.3, 15.2; IR (neat) cm^{-1} 3070 (m), 3048 (m), 2961 (vs), 2934 (vs), 2855 (vs), 1656 (vs), 1619 (vs); ESI-MS (*m/z*) 581.3 $(M+Na)^+$ (100); HRMS calcd for $C_{36}H_{50}O_3SiNa$ $(M+Na)^+$ 581.3427; found 581.3430. **Undesired isomer (±)-25:** R_f = 0.53 (50% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 7.70-7.68 (m, 4 H), 7.43-7.36 (m, 6 H), 5.38 (brt, 1 H, *J* = 6.0 Hz), 5.36 (s, 1 H), 5.09 (brt, 1 H, *J* = 6.5 Hz), 4.22 (d, 2 H, *J* = 6.0), 3.67 (s, 3 H), 2.34-2.21 (m, 3 H), 2.06 (brq, 2 H, *J* = 7.0 Hz), 1.98 (brt, 2 H, *J* = 8.0 Hz), 1.94-1.83 (m, 2 H), 1.65-1.61 (m, 1 H), 1.59 (s, 3 H), 1.44 (s, 3 H), 1.52-1.46 (m, 1 H), 1.05 (s, 3 H), 1.04 (s, 3 H), 0.95 (d, 1 H, *J* = 6 Hz); ESI-MS (*m/z*) 581.3 $(M+Na)^+$ (100); HRMS calcd for $C_{36}H_{50}O_3SiNa$ $(M+Na)^+$ 581.3427; found 581.3420.

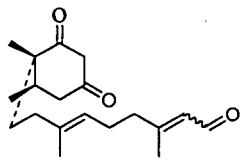
To recycle the undesired isomer **24** to diketone **23**, **24** (45.6 mg, 81.7 μmol) was taken up in THF (1.0 mL) and MeOH (0.4 mL). Five drops of a 1.0 M solution of KOH in H_2O was added, and the solution stirred at room temperature overnight. The following morning, TLC indicated consumption of the starting enone, and the solution was acidified with 1 M HCl (7 drops). Most of the solvent was blown off using a stream of nitrogen, and the residue was subjected to flash chromatography (gradient elution, 0 to 10% MeOH in EtOAc) to afford diketone **22** (34.7 mg, 78%).



(±)-6α-(9-Hydroxy-3,7-dimethyl-nona-3(*E*),7(*E*)-dienyl)-3-methoxy-5β,6-dimethyl-cyclohex-2-enone (S-15). Enone **24** (144.0 mg, 0.258 mmol) was taken up in THF (2.0 mL) and cooled to 0 °C. TBAF (THF solution, Aldrich, 1.0 M, 5% H_2O, 0.5 mL, 0.5 mmol) was then added, and the solution warmed to room temperature. After about 2 h, TLC indicated complete consumption of starting material. The THF was removed *in vacuo* and the residue was filtered through a 5 cm x 1 cm column of silica eluting with EtOAc to afford pure alcohol **S-15** (81.0 mg, 98%) as a clear, colorless oil. R_f = 0.29 (50% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 5.42 (mt, 1 H, *J* = 6.5 Hz), 5.29 (s, 1 H), 5.10 (brt, 1 H, *J* = 6.0 Hz), 4.15 (brt, 1 H, *J* = 5.5 Hz), 3.67 (s, 3 H), 2.41-2.35 (m, 1 H), 2.28-2.20 (m, 2 H), 2.12-2.07 (m, 2 H), 2.05-2.02 (m, 2 H), 1.98 (ddd, 1 H, *J* = 4.5, 12.0, 16.5 Hz), 1.83 (dt, 1 H, *J* = 5.0, 12.5 Hz), 1.75 (dt, 1 H, *J* = 4.0, 12.5 Hz), 1.67 (s, 3 H), 1.61 (s, 3 H), 1.42 (brt, 1 H, *J* = 5.5 Hz), 1.38 (ddd, 1 H, *J* = 5.0, 12.0, 17.5 Hz), 0.98 (d, 3 H, *J* = 7.0 Hz), 0.95 (s, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ (ppm) 204.4, 175.8, 139.4, 135.8, 123.9, 123.7, 101.3, 59.5, 55.7, 47.5, 39.6, 34.3, 34.2, 34.1, 32.7, 26.2, 18.7, 16.3, 16.2, 15.1; IR (neat) cm^{-1} 3414 (br), 2967 (s), 2933 (s), 1650 (s), 1613 (vs), 1456 (s); ESI-MS (*m/z*) 343.2 $(M+Na)^+$ (100), 197.0 (26); HRMS calcd for $C_{20}H_{32}O_3Na$ $(M+Na)^+$ 343.2249; found 343.2247.

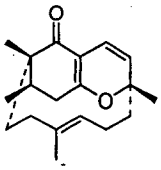


(±)-9-(4-Methoxy-1β,6β-dimethyl-2-oxo-cyclohex-3-enyl)-3,7-dimethyl-nona-2(*E*),6(*E*)-dienal (S-16). Alcohol **S-15** (81.0 mg, 0.253 mmol) was taken up in CH_2Cl_2 (2 mL) and Dess-Martin periodinane (122.5 mg, 0.506 mmol) was added. The initially clear solution rapidly became cloudy, and the starting material was consumed within 30 min. After this time, 2-propanol (5 drops) was added, and the mixture was filtered through a cotton plug and most of the solvent removed *in vacuo*. Flash chromatography (gradient elution, 30-70% EtOAc/hexanes) of the residue afforded enal **S-16** (72.6 mg, 97%) as a clear, colorless oil. R_f = 0.39 (50% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 9.99 (d, 1 H, *J* = 7.5 Hz), 5.88 (dd, 1 H, *J* = 1.0, 8.5 Hz), 5.29 (s, 1 H), 5.09 (t, 1 H, *J* = 6.5 Hz), 3.68 (s, 3 H), 2.41-2.36 (m, 1 H), 2.29-2.16 (m, 6 H), 2.17 (s, 3 H), 1.99 (dt, 1 H, *J* = 4.5, 12.0 Hz), 1.84 (dt, 1 H, *J* = 5.0, 13.5 Hz), 1.77 (dt, 1 H, *J* = 4.0, 12.5 Hz), 1.62 (s, 3 H), 1.36 (ddd, 1 H, *J* = 5.5, 11.5, 17.0 Hz), 0.98 (d, 3 H, *J* = 7.0 Hz), 0.96 (s, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 204.2, 191.4, 175.7, 164.1, 137.1, 127.5, 122.3, 101.2, 55.7, 47.5, 40.7, 34.2, 34.1, 34.0, 32.7, 25.8, 18.7, 17.7, 16.3, 15.1; IR (neat) cm^{-1} 2967 (m), 2938 (m), 2852 (m), 2770 (w), 1673 (vs), 1617 (vs); ESI-MS (*m/z*) 341.2 $(M+Na)^+$ (100) 247.1 (17); HRMS calcd for $C_{20}H_{30}O_3Na$ $(M+Na)^+$ 341.2093; found 341.2090.



(±)-9-(1β,2β-Dimethyl-4,6-dioxo-cyclohexyl)-3,7-dimethyl-nona-2,6(*E*)-dienal (7). Enal **S-16** (43.9 mg, 0.138 mmol) was taken up in THF (1.0 mL) and HCl (3 M, 5 drops) was added. This solution was stirred at room temperature until TLC indicated consumption of starting enone (about 1 h). After this time, most of the THF was removed *in vacuo* and the residue was filtered through a 3 cm x 1 cm column of silica eluting with 10% MeOH/EtOAc. Concentration of the filtrate afforded the diketone (39.1

mg, 93%) as a mixture (by 500 MHz ^{1}H NMR) of enolic and *E/Z* geometries. R_f = 0.18 (50% EtOAc/hexanes).



Tricycle 6. Enal **7** (39.1 mg, 0.128 mmol) was taken up in THF (200 mL) and piperidinium acetate (37.2 mg, 0.256 mmol) was added. The solution was stirred overnight at room temperature. The following morning the THF was removed *in vacuo* and the residue subjected to flash chromatography (5-15% EtOAc/hexanes) to afford the desired isomer **6** (8.4 mg, 23%) and a 4:1 unassignable mixture of **8** and **9** (19.4 mg, 53%) as clear, colorless oils. **6:** R_f = 0.41 (10% EtOAc/hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ (ppm) 6.45 (d, 1 H, *J* = 10.5 Hz), 5.15 (brd, 1 H, *J* = 10.5 Hz), 4.99 (d, 1 H, *J* = 10.5 Hz), 2.87 (dd, 1 H, *J* = 6.5, 20.0 Hz), 2.40-2.29 (m, 2 H), 2.12(m, 1 H), 2.10 (d, 1 H, *J* = 19.5 Hz), 2.06 (ddd, 1 H, *J* = 1.5, 7.5, 14.5 Hz), 1.94 (dt, 1 H, *J* = 3.5, 14.0 Hz), 1.94 (ddd, 1 H, *J* = 2.0, 4.0, 14.5 Hz), 1.89 (ddd, 1 H, *J* = 3.5, 12.5, 15.0 Hz), 1.80 (td, 1 H, *J* = 3.5, 14.5 Hz), 1.70 (ddd, 1 H, *J* = 3.0, 6.0, 15.0 Hz), 1.47 (s, 3 H), 1.38 (brm, 3 H), 1.07 (s, 3 H), 1.02 (d, 3 H, *J* = 7.0 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ (ppm) 198.6, 169.1, 134.6, 125.3, 119.8, 118.0, 116.0, 82.9, 47.1, 46.1, 39.5, 37.0, 35.7, 34.5, 31.3, 25.2, 24.6, 20.0, 16.1; IR (neat) cm^{-1} 2976 (m), 2929 (m), 2901 (m), 2835 (w), 1640 (vs), 1607 (s), 1449 1449 (m), 1416 (s); ESI-MS (*m/z*) 309.2 $(M+Na)^+$ (100), 197.0 (13); HRMS calcd for $C_{19}H_{26}O_2Na$ $(M+Na)^+$ 309.1830; found 309.1818.

References:

(1) Fairlamb, I. J. S.; Dickinson, J. M.; Pegg, M. *Tetrahedron Lett.* **2001**, *42*, 2205 - 2208.
(2) Warnhoff, E. W.; Martin, D. G.; Johnson, W. S. in *Org. Syntheses Coll. Vol. 4*, **1963**, 162-166.

SUPPLEMENTARY ^{1}H NMR and SELECTED ^{13}C SPECTRA

for

the communication

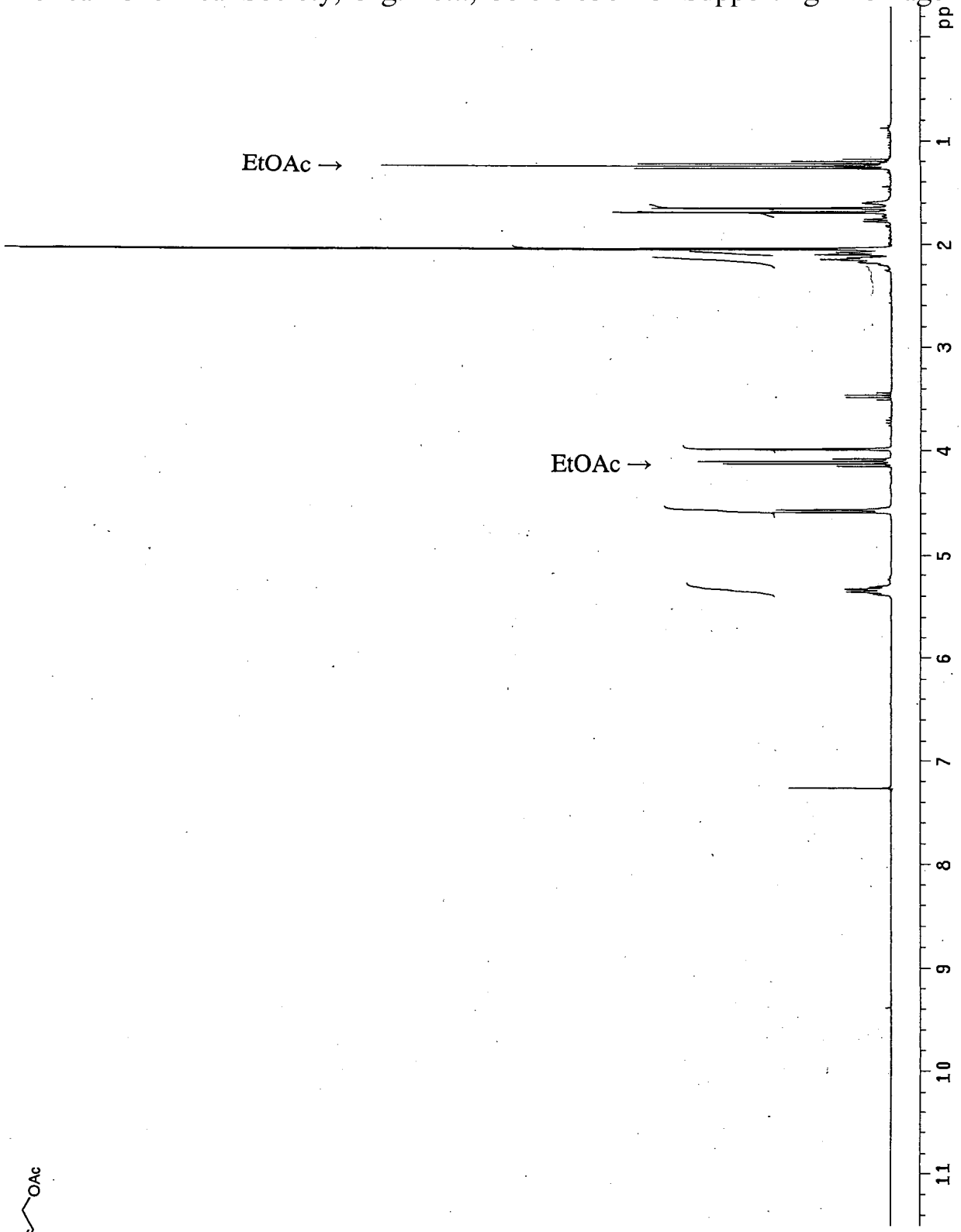
entitled

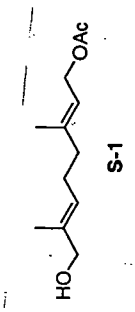
An Intramolecular Formal *Oxa*-[3 + 3] Cycloaddition Approach to the ABD System of Phomactin A.

authored by

Kevin P. Cole and Richard P. Hsung*

Department of Chemistry, University of Minnesota, Minneapolis, MN 55455





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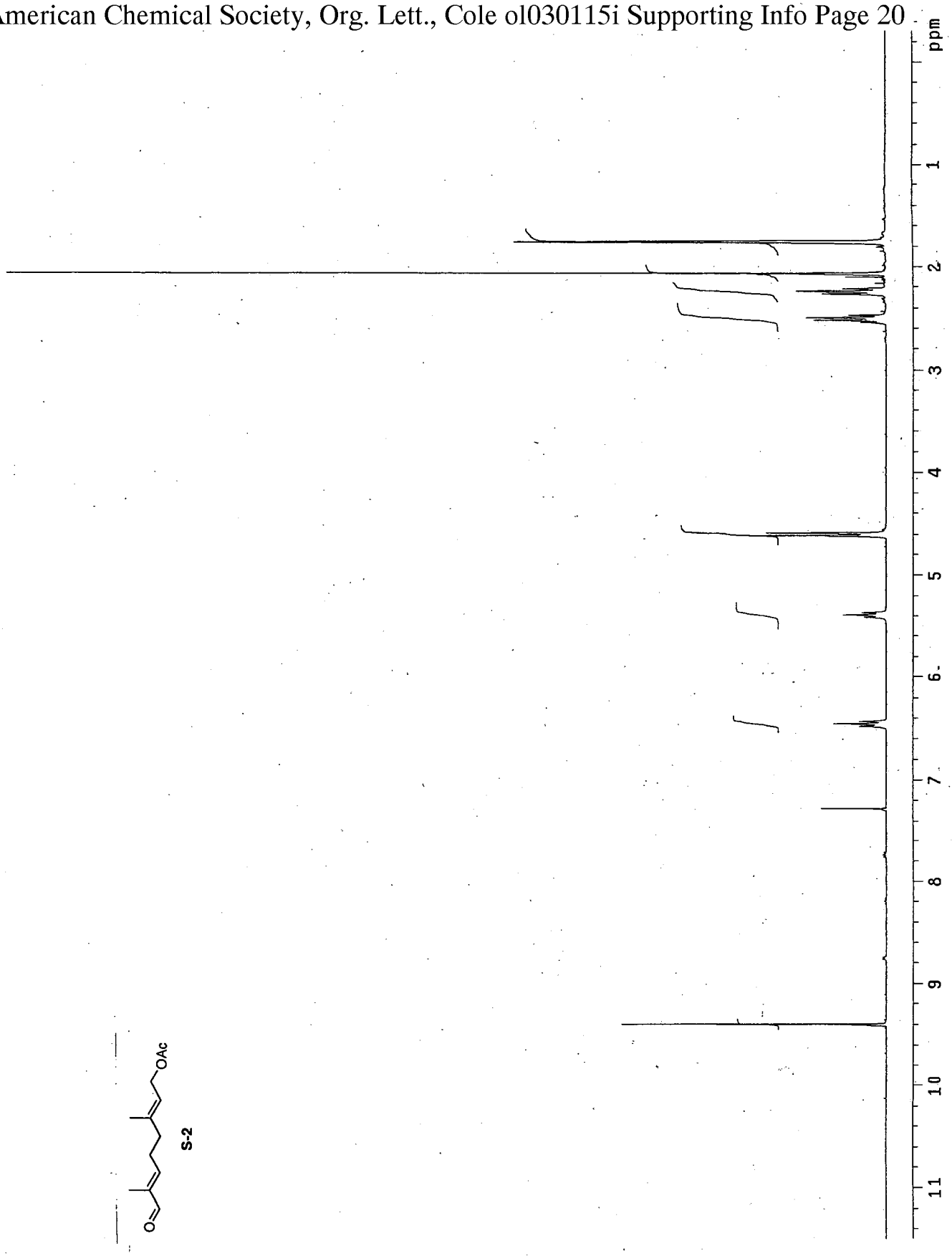
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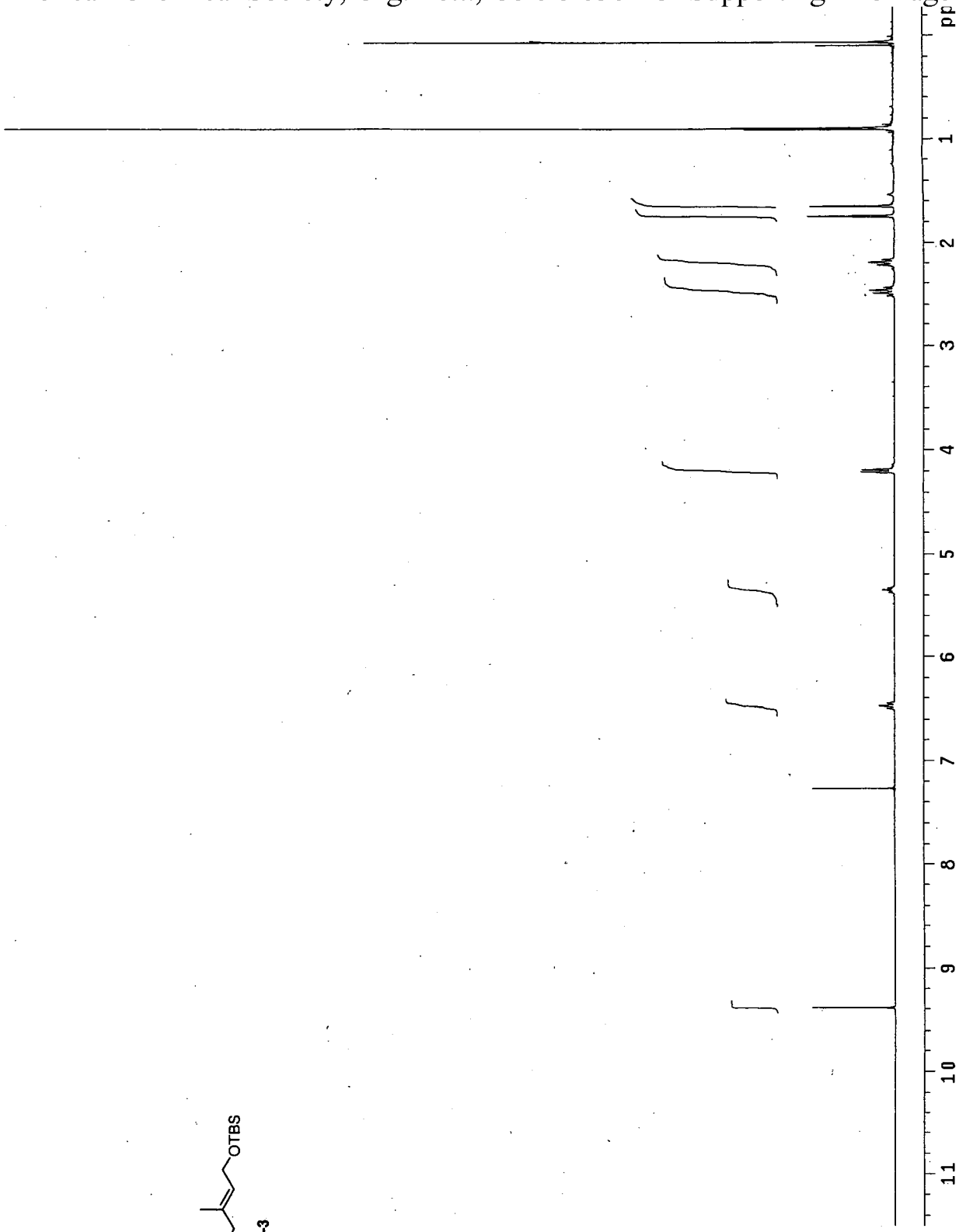

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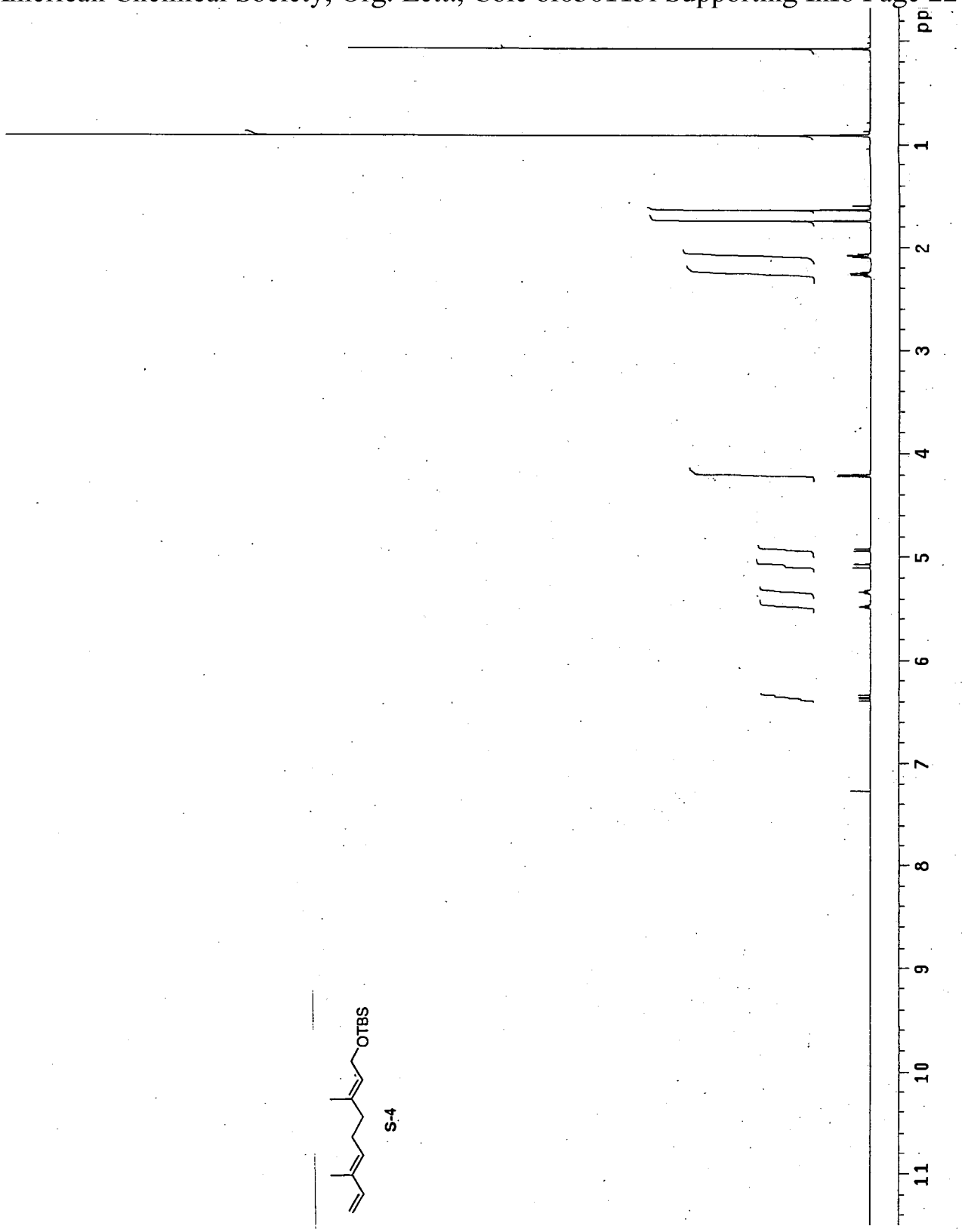
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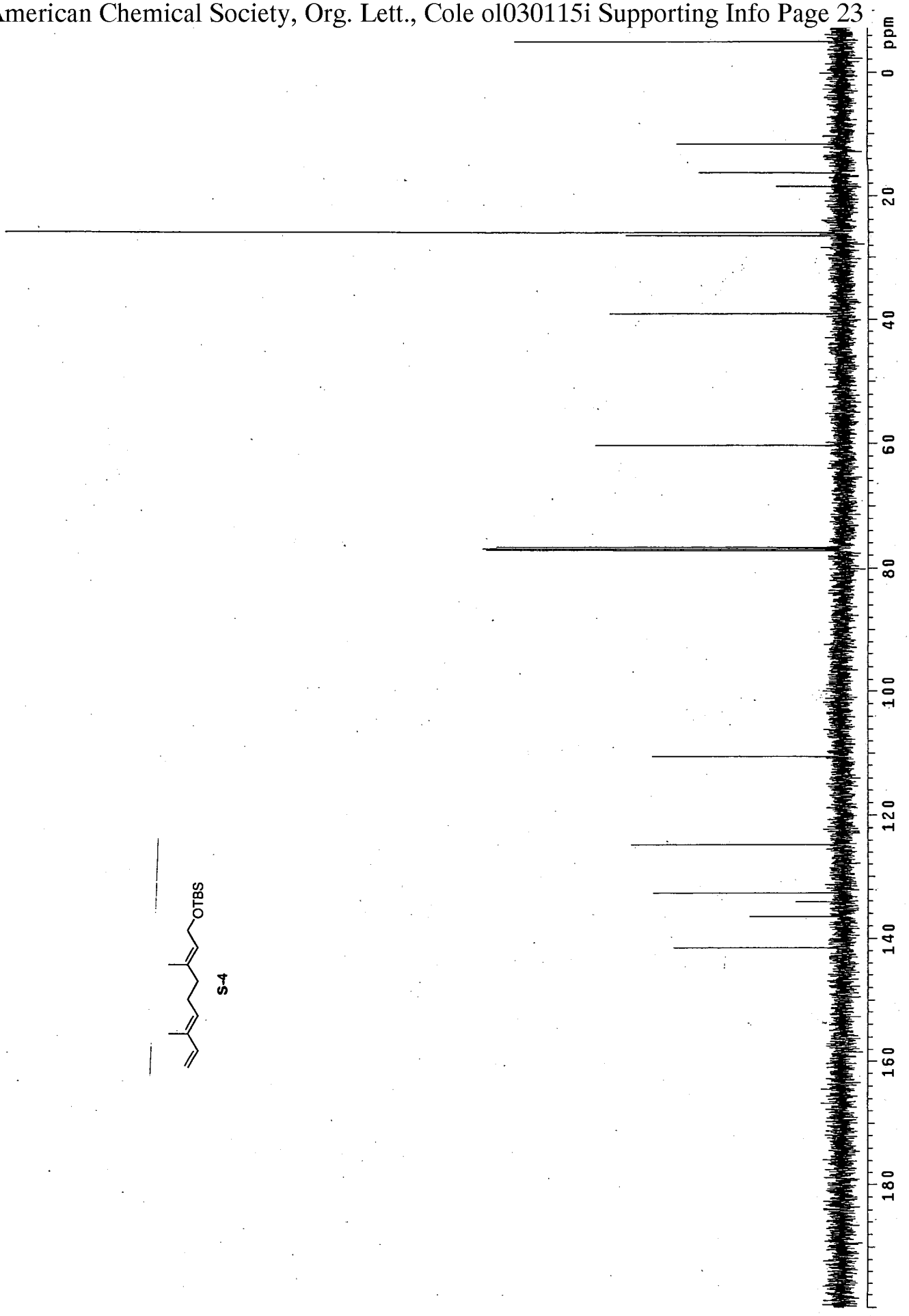
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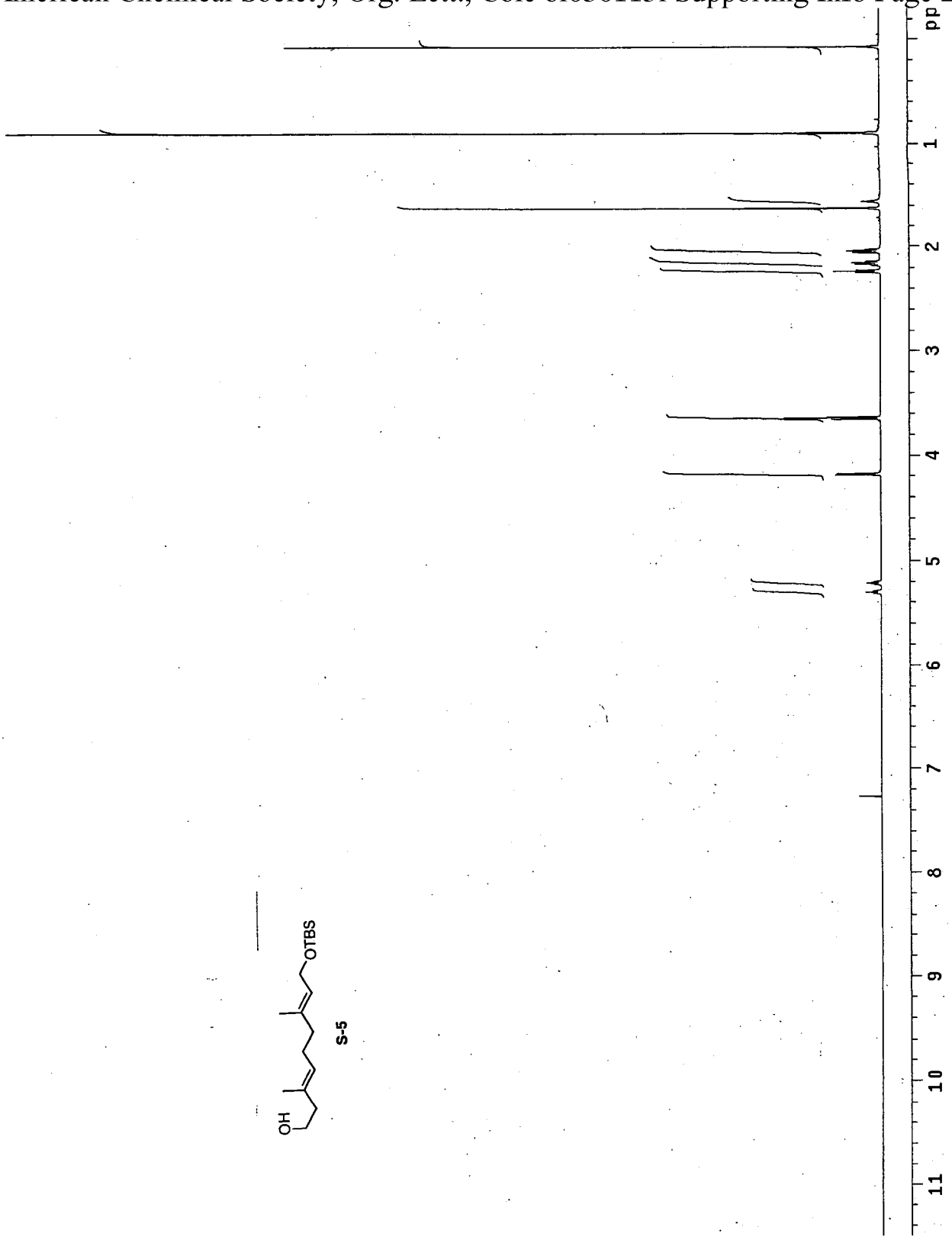
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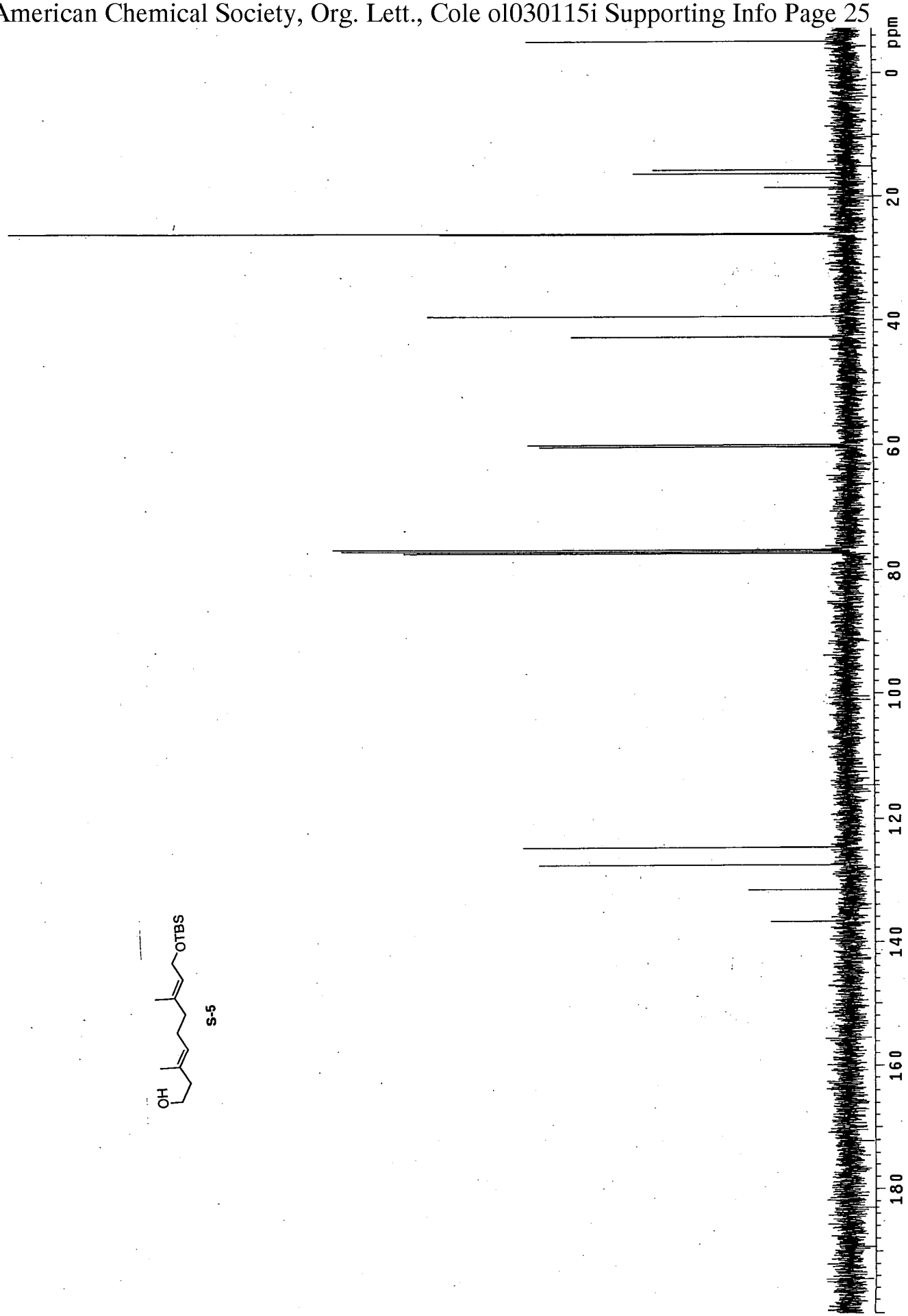
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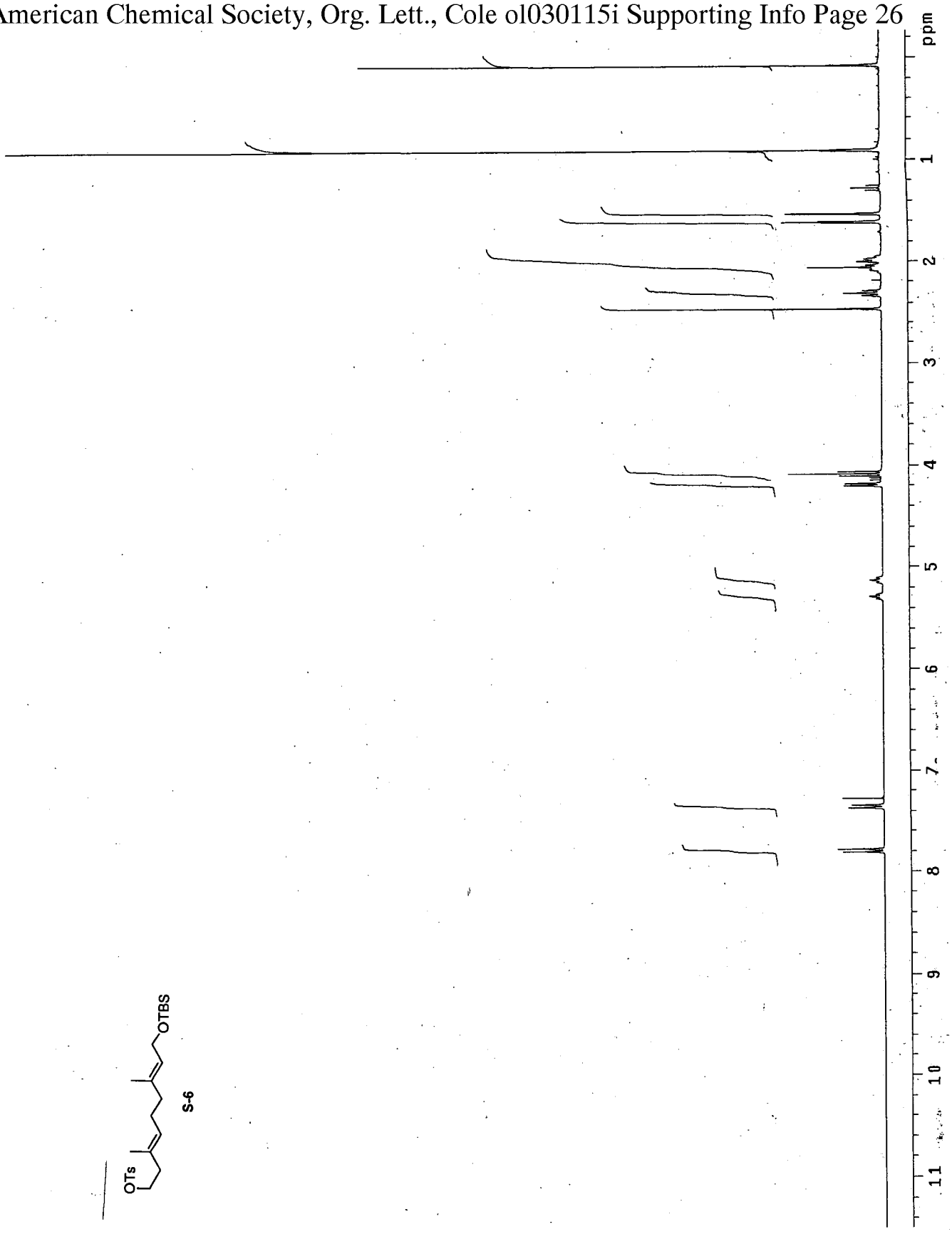
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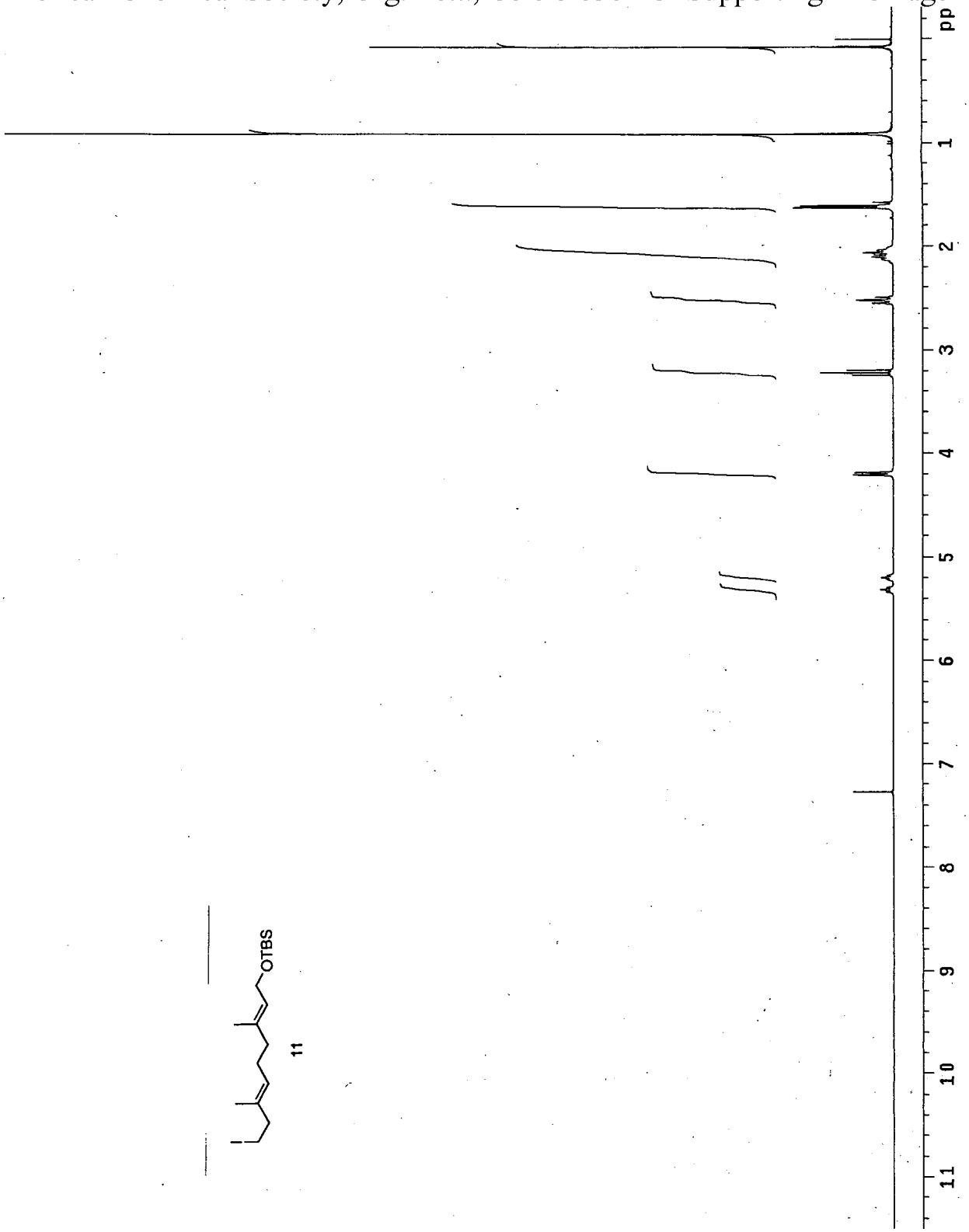
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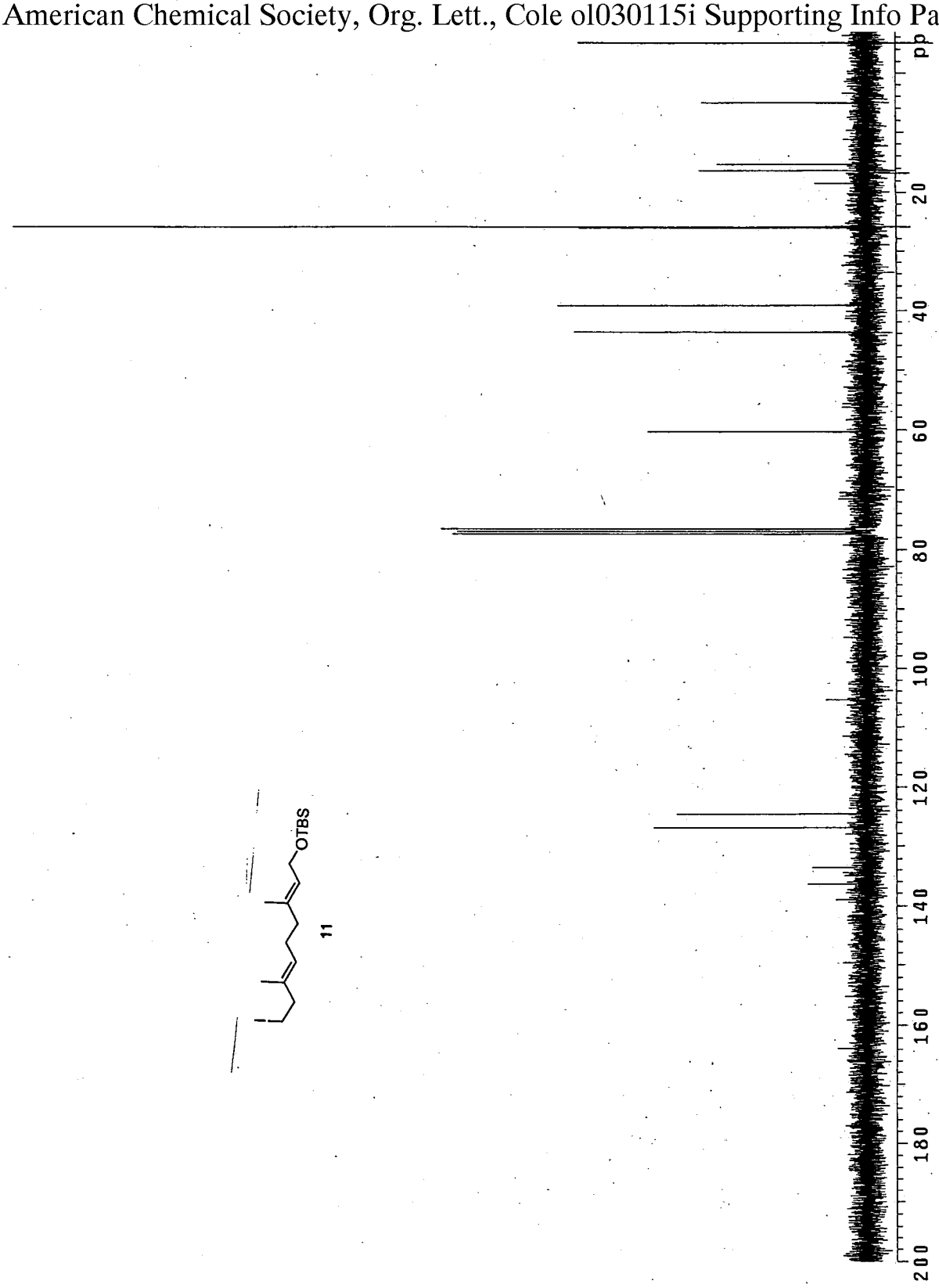
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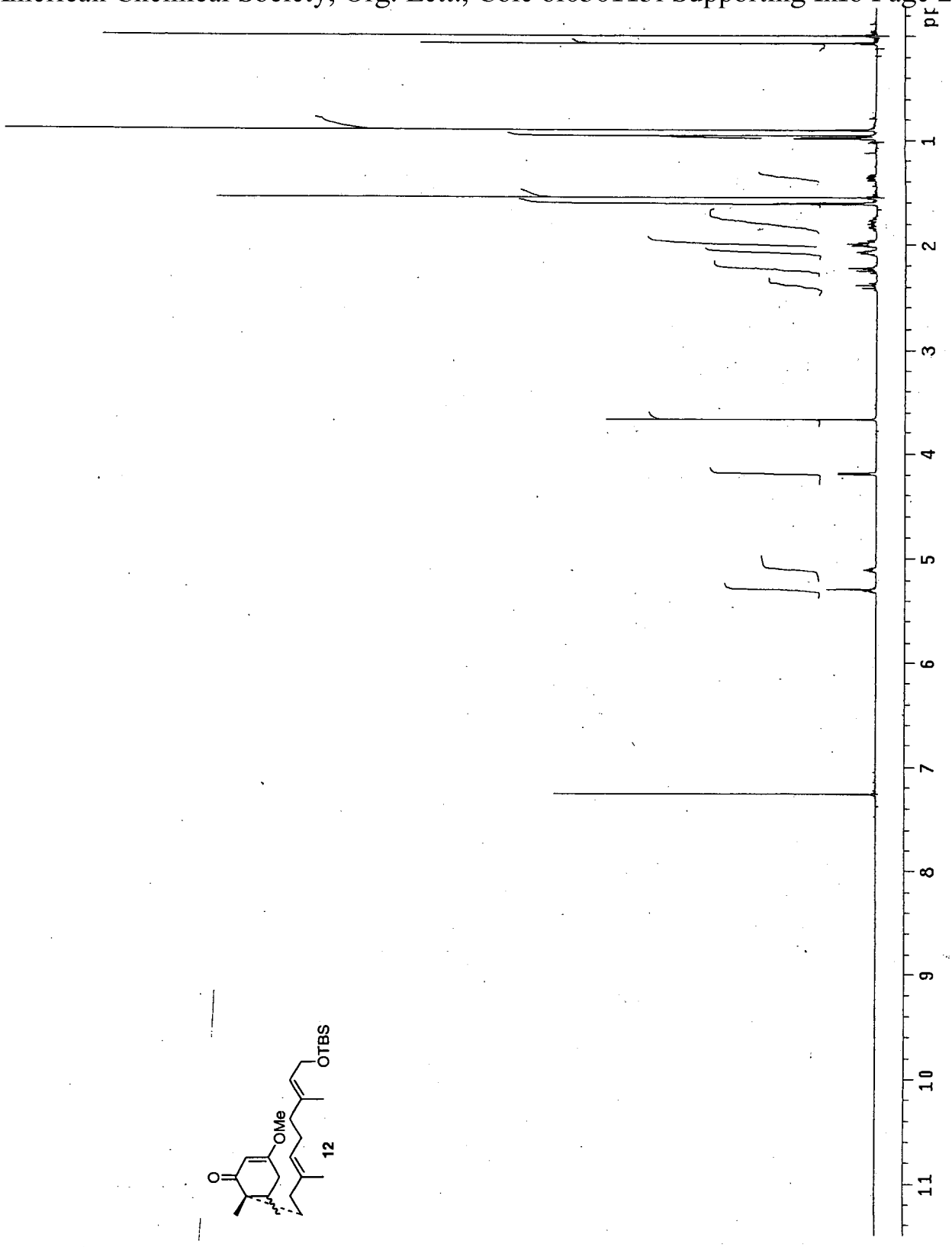
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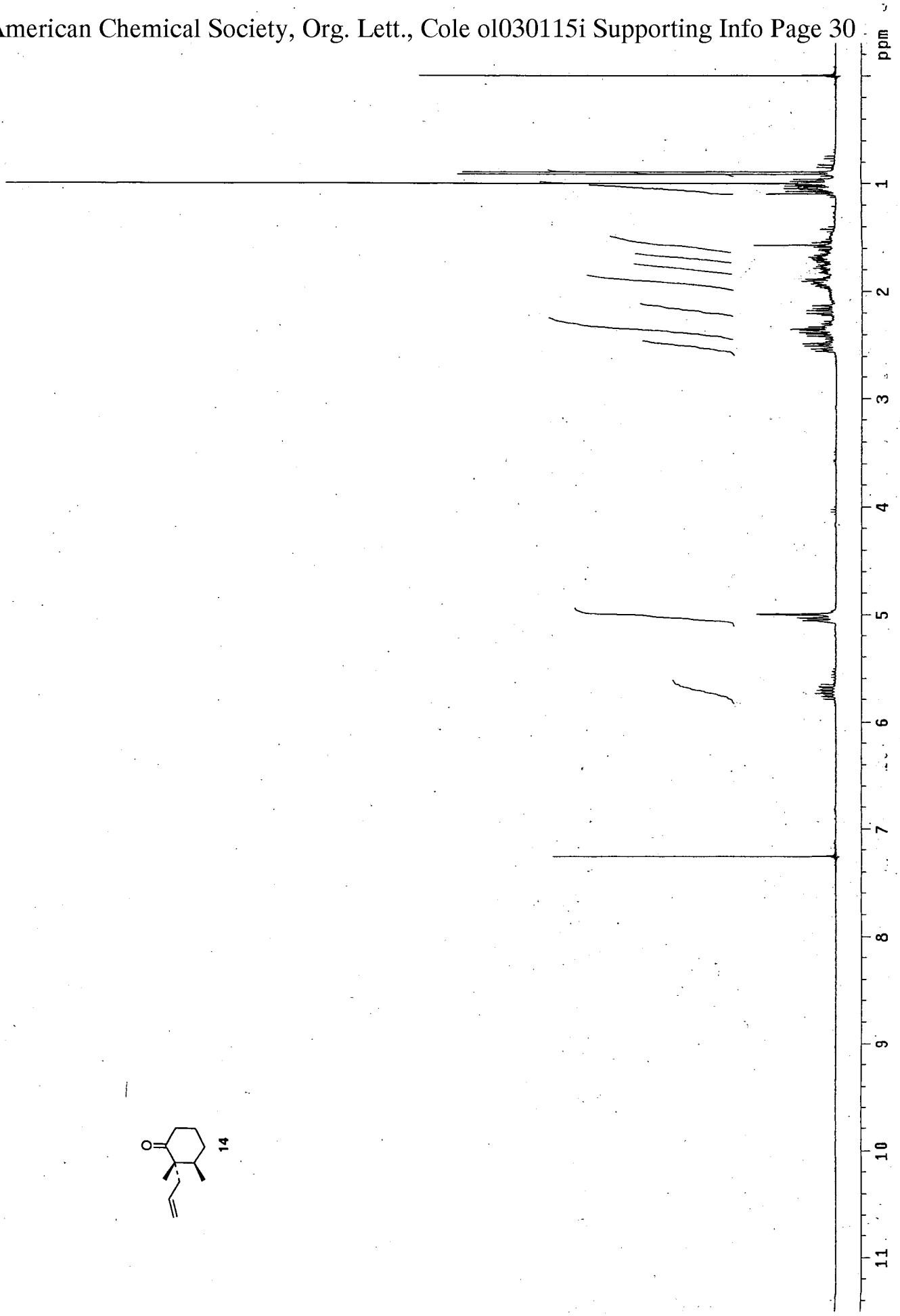

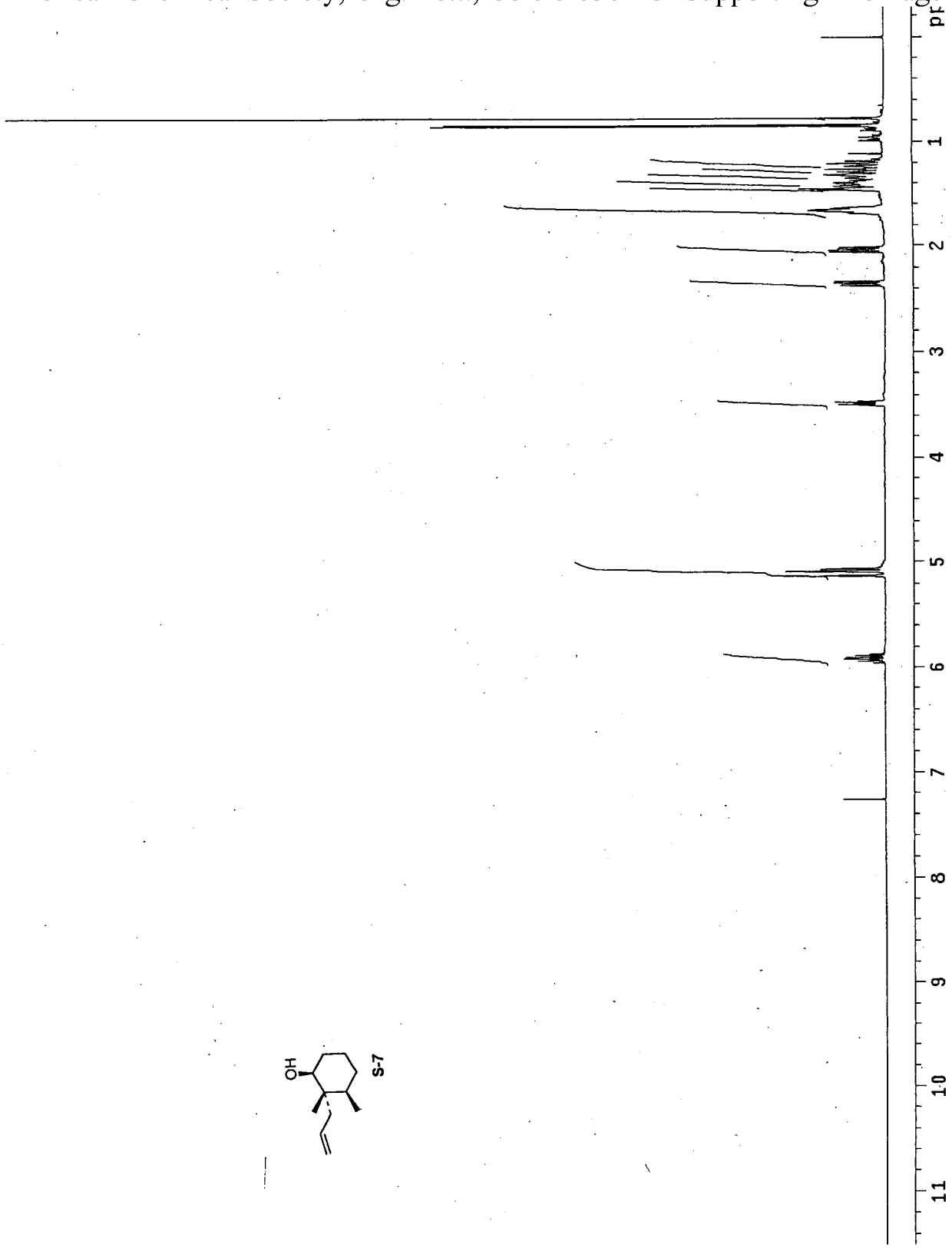
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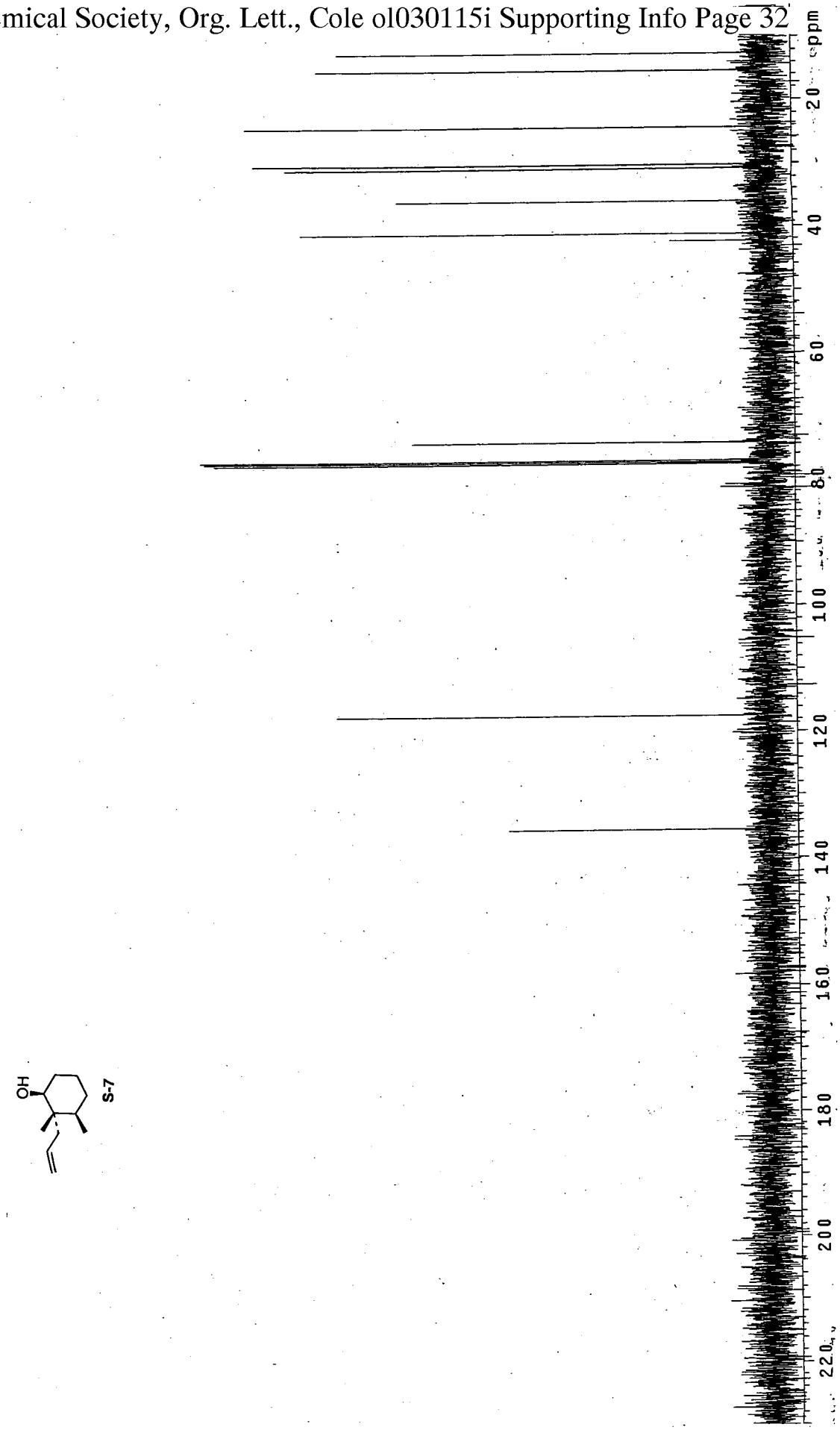

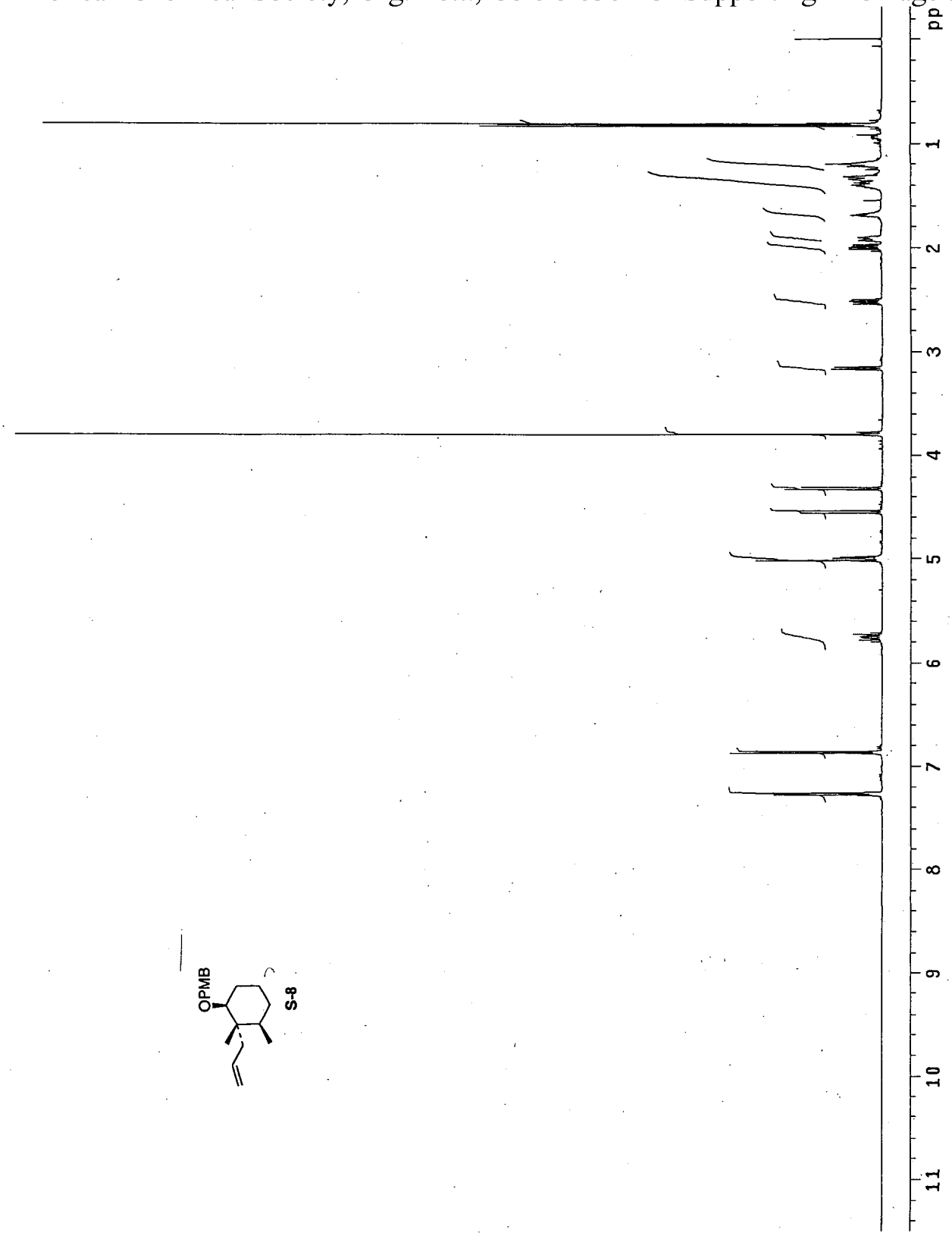
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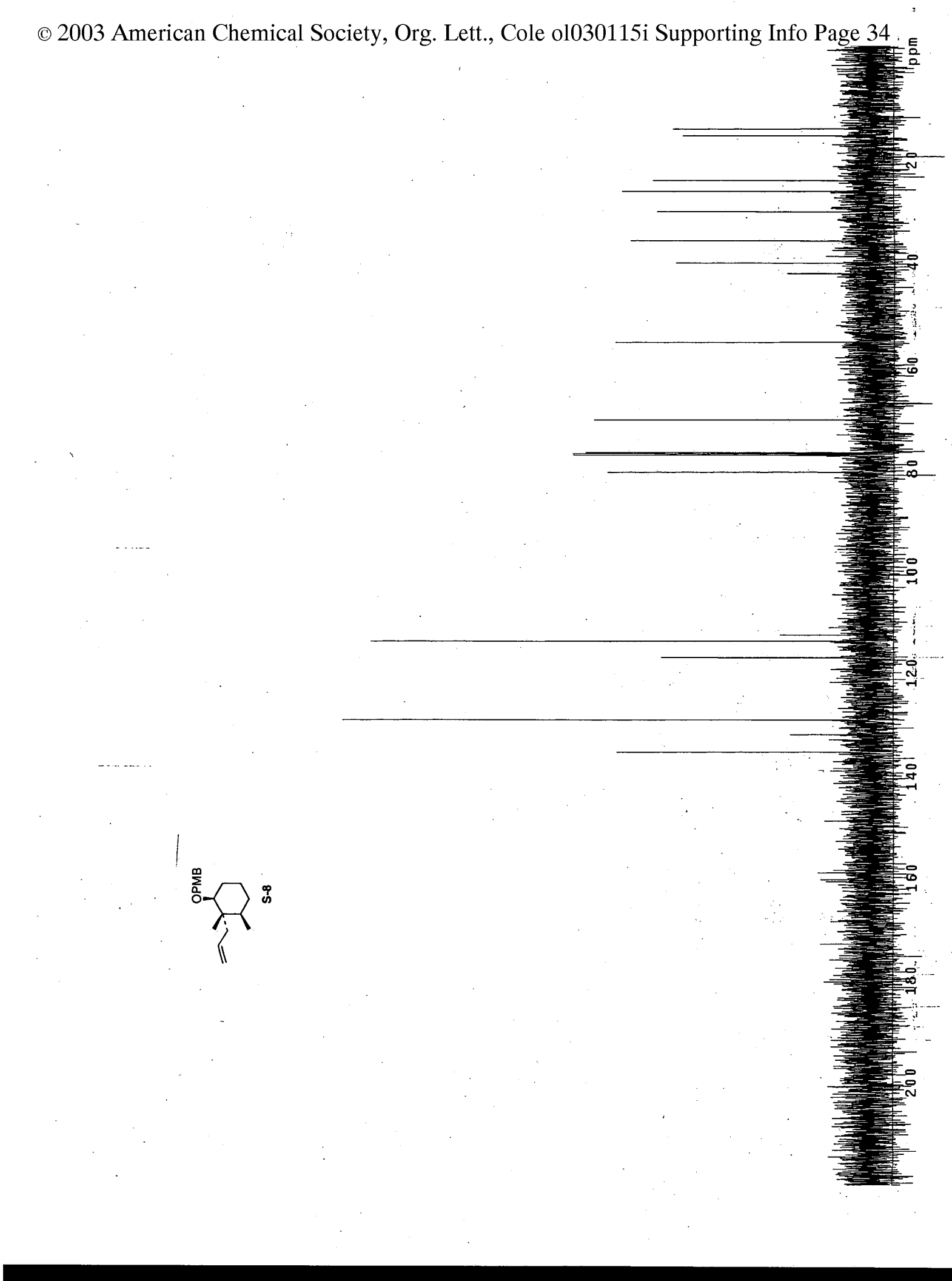
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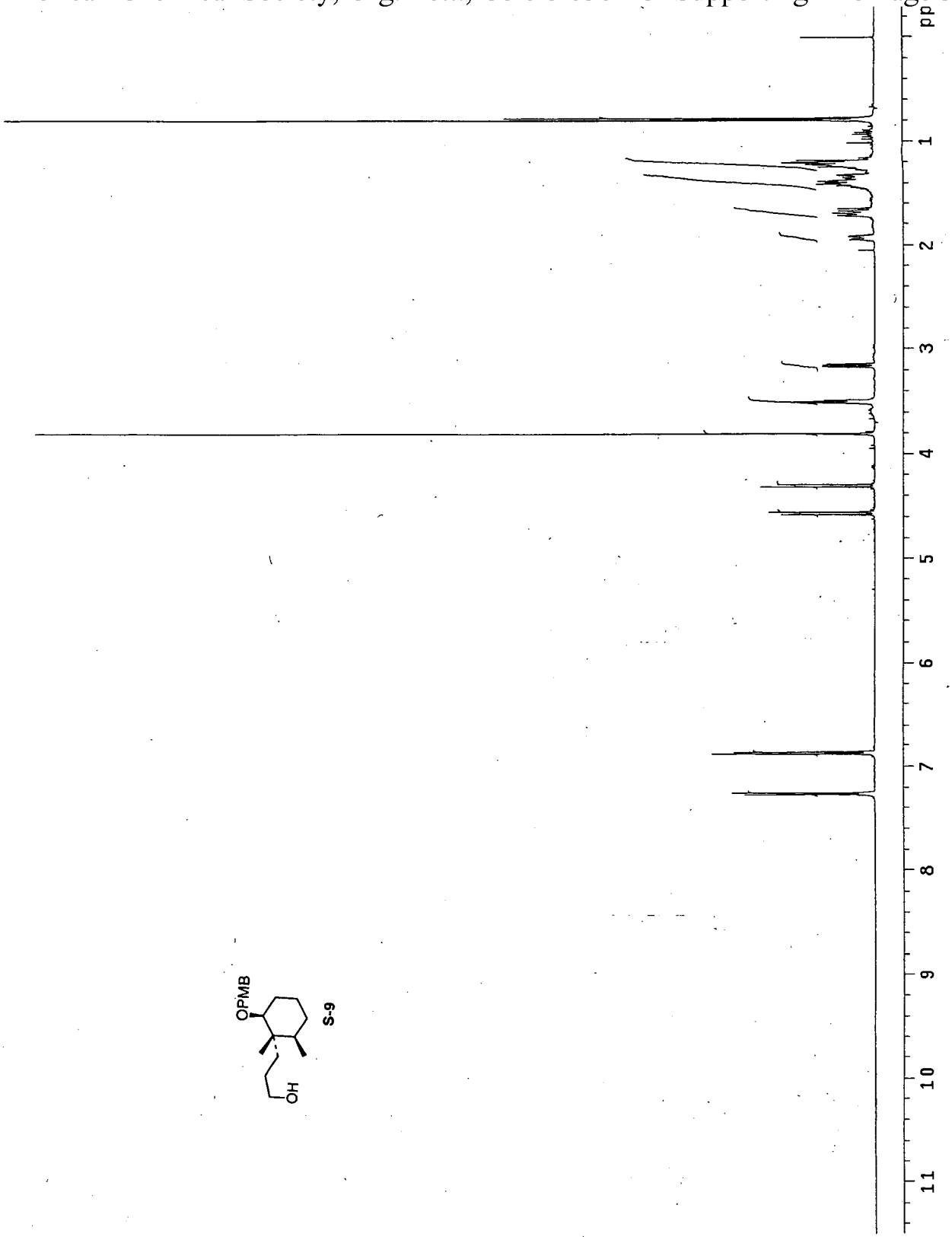

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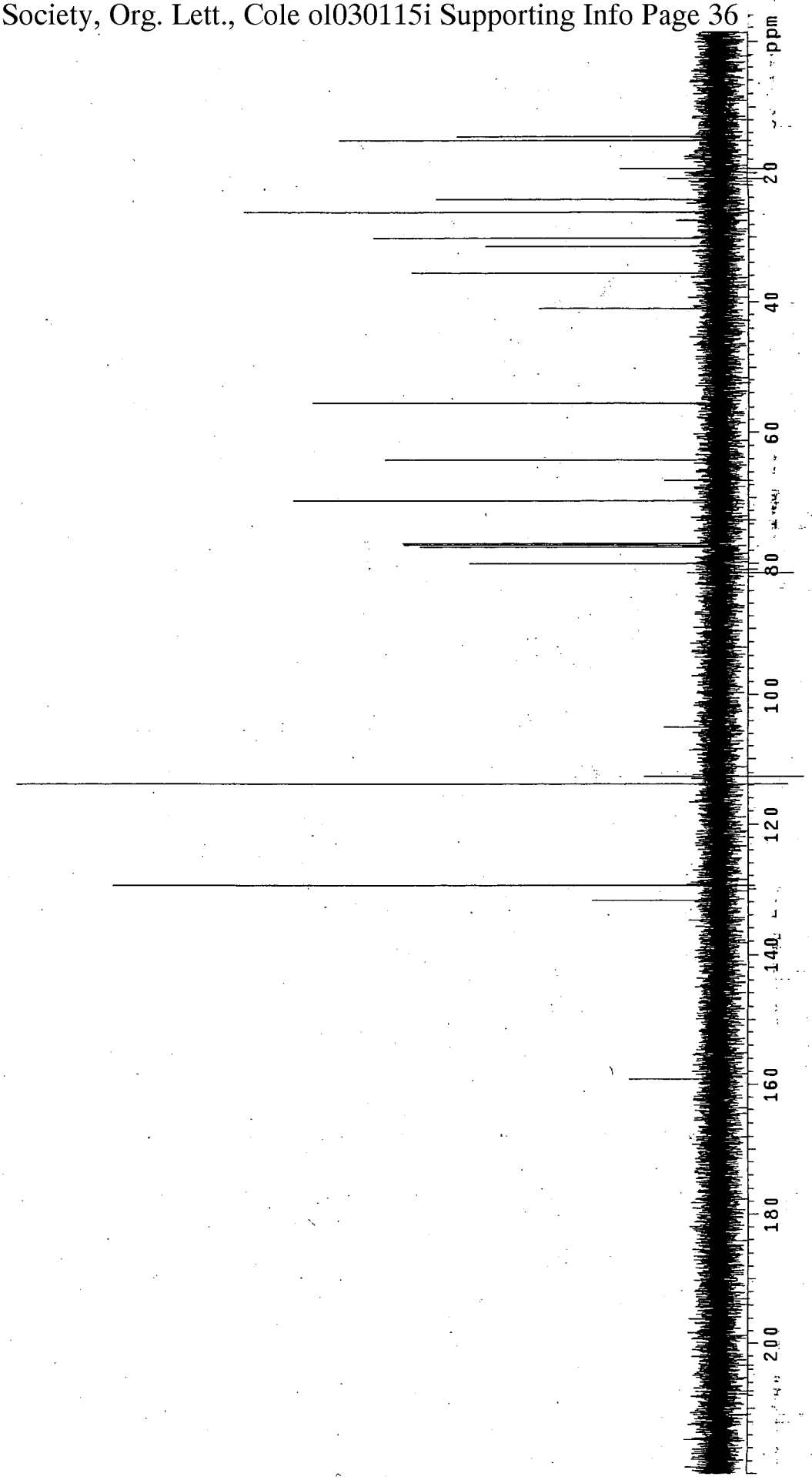
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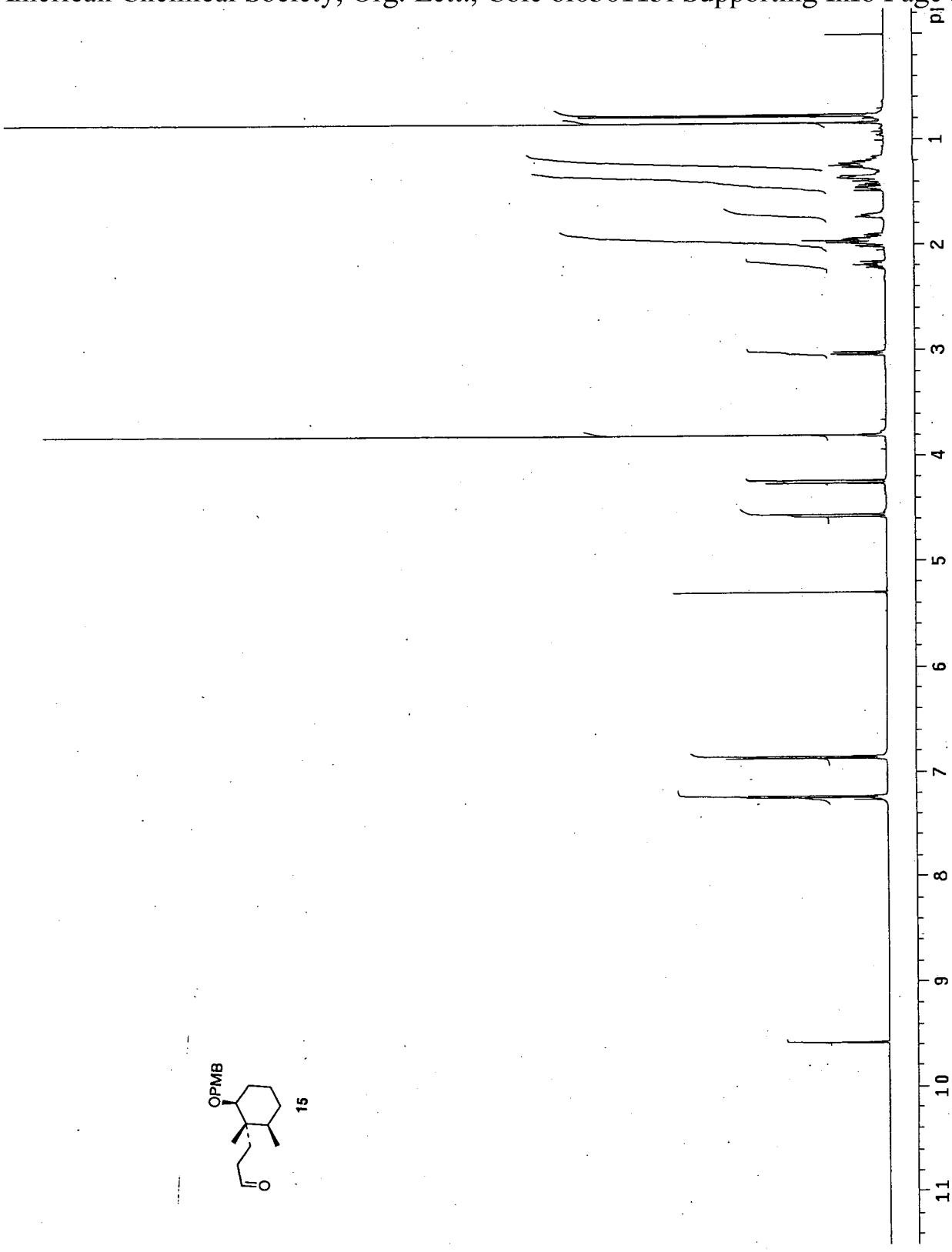
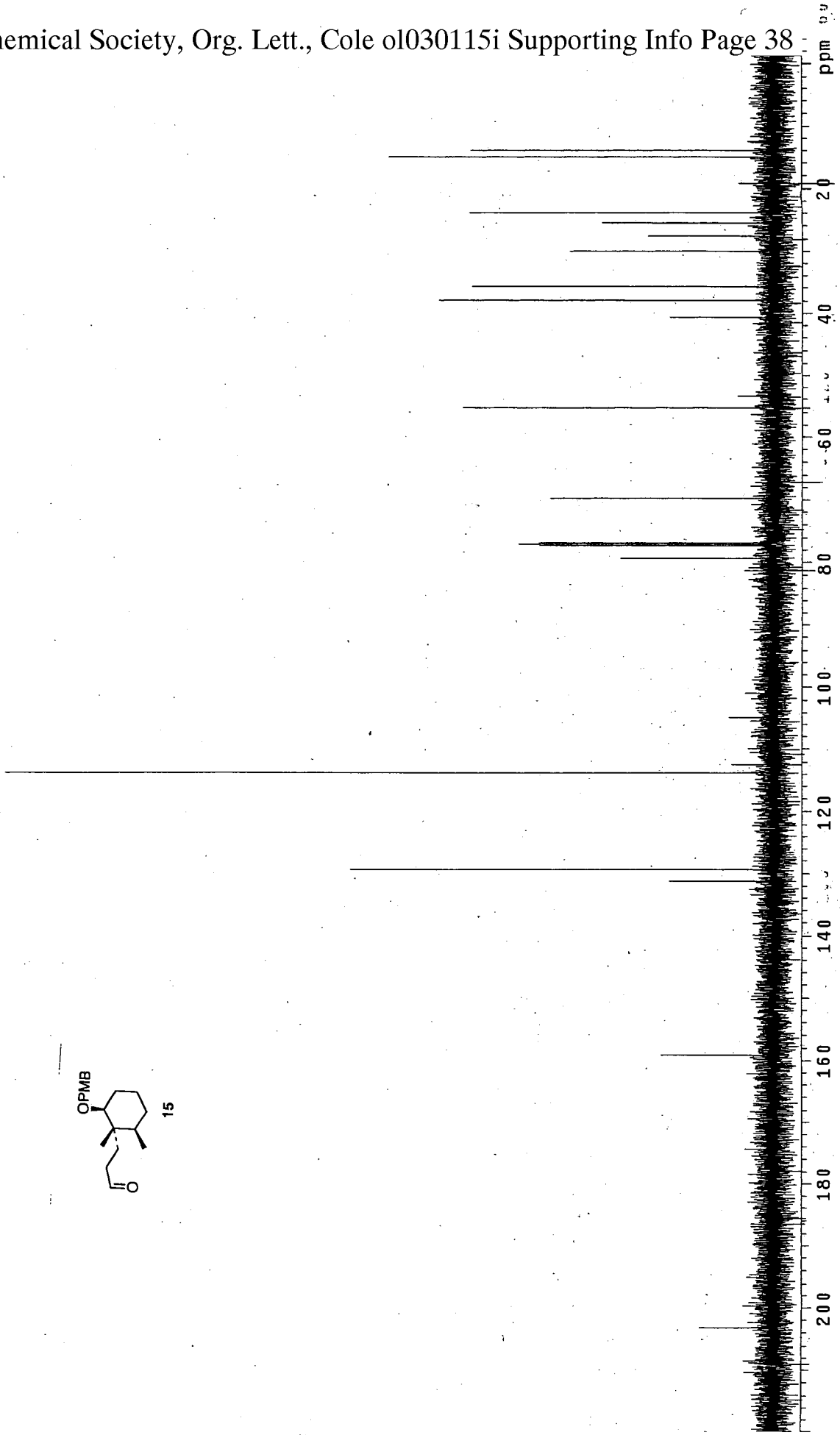
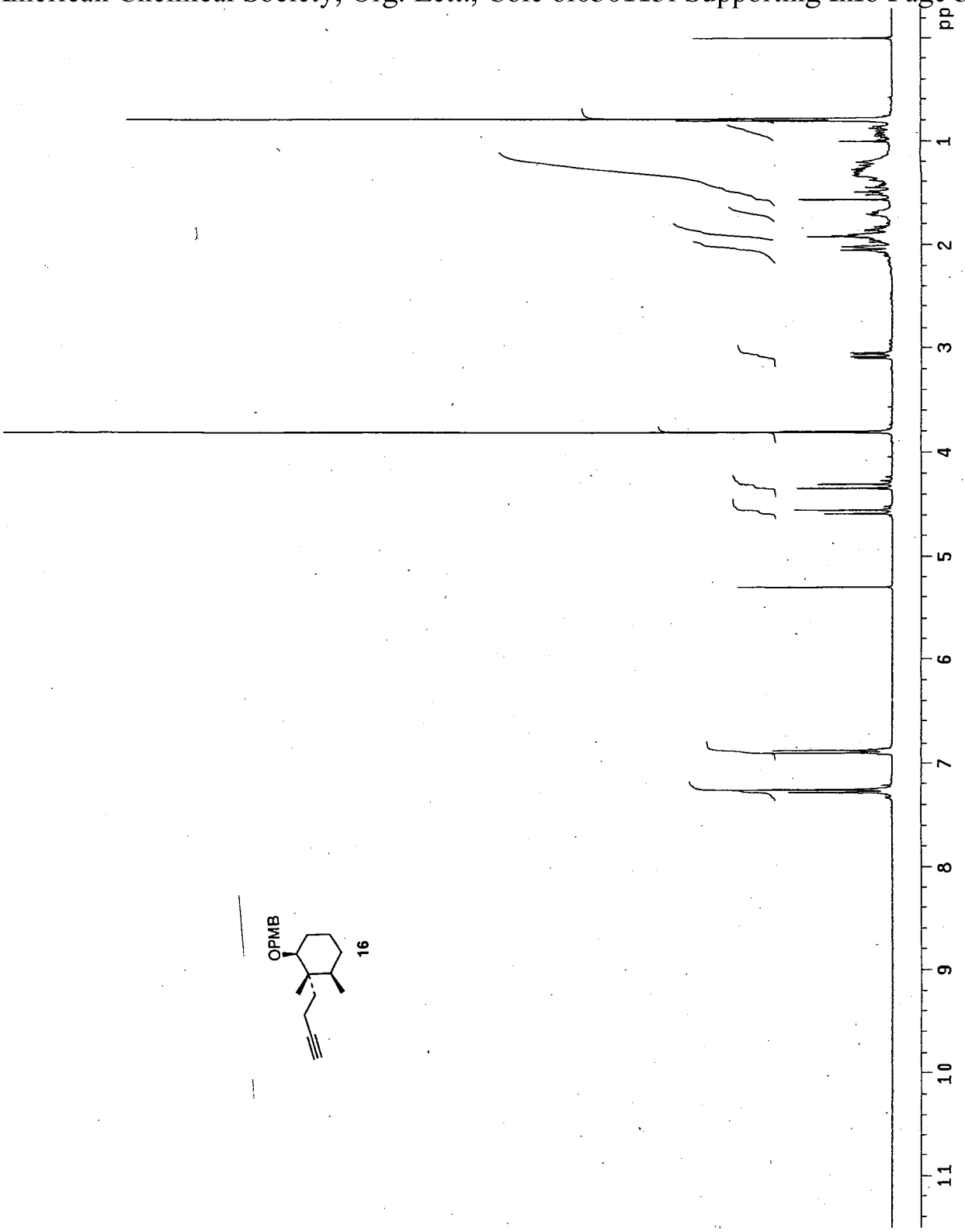
S-9


OPMB
15
O
ppm
1
2
3
4
5
6
7
8
9
10
11


OPMB
15
O
ppm
200
180
160
140
120
100
80
60
40
20


ppm
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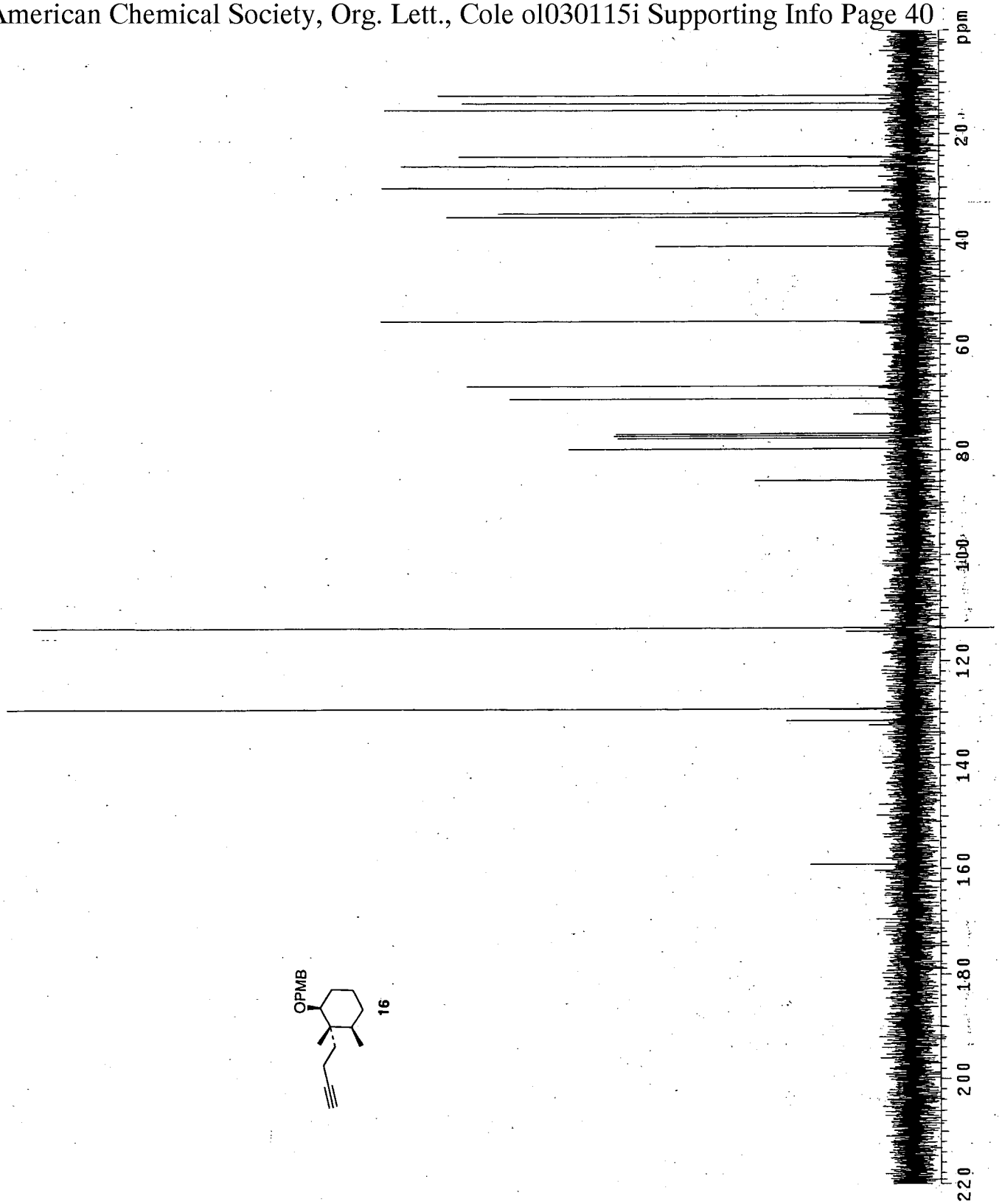
2
3
4
5
6
7
8
9
10
11
OPMB
16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200
180
160
140
120
100
80
60
40
20
OPMB
16