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SUPPORTING INFORMATION FOR

[3,3]-sigmatropic rearrangement mediated synthesis of chiral building blocks for the preparation of Gemini and its analogs

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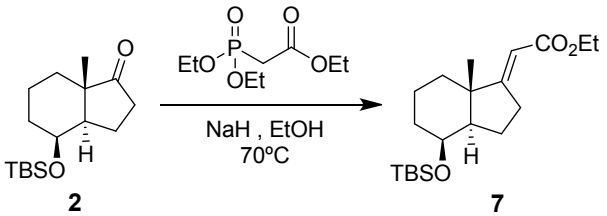
Experimental procedure

General: Solvents were purified and dried by standard procedures before use. Melting points are uncorrected. ^{1}H NMR and ^{13}C NMR spectra were recorded with a Bruker ARX-400 spectrometer (400 MHz for ^{1}H NMR, 100.61 MHz for ^{13}C NMR) using TMS as internal standard (Chemical shifts in δ values, J in Hz). Flash chromatography (FC) was performed on silica gel (Merck 60, 230-400 mesh); analytical TLC was performed on plates precoated with silica gel (Merck 60 F254, 0.25mm); mass spectra (FAB, EI) were recorded using FISONS VG and electron spray ionization (ESI-MS) spectroscopy was recorded using Bruker FTMS APEXIII. Melting points were obtained in open capillary tubes and are not corrected. Optical rotations were obtained using a Jasco P-2000 polarimeter. IR spectra were recorded with a JASCO FT/I(*R*)-6100 spectrophotometer.

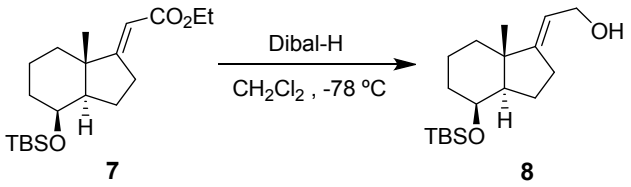
Preparation of (E)-2-((4S,7aS)-4-(tert-butyldimethylsilyloxy)-7a-methyloctahydro-1H-inden-1-ylidene)ethanol (7)



To a solution of ketone **2** (3 g, 11 mmol) and ethyl 2-(diethoxyphosphoryl)acetate (11.8 mL, 56 mmol) was added NaH (60%, 4.5 g, 113 mmol) in EtOH (70 mL). The reaction mixture was heated at 70 ºC for 16 h. Brine and EtOAc were then added and the mixture extracted with CH_2Cl_2 (2x100 mL). The organic layers were dried over Na_2SO_4, filtered and evaporated. The residue was chromatographed on silica gel using 1% EtOAc/Hexane as eluent, affording ester **7** (3.7 g, 94%) as a colorless liquid.

Rf: 0.64 (10% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**2951.52, 2929.34, 2856.06, 2770.24, 1713.44, 1470.46;**[α]$^{30}_{D}$=** +19.8 (c 2.3, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):** 5.42 (1H, m, H-20), 4.076 (3H, m, C**H**$_2$-OEt, H-8), 2.77 (2H, m, 2H-16), 1.72 (4H, m), 1.49 (2H, m), 1.32 (1H, m), 1.21 (3H, t, J = 7.12 Hz, C**H**$_3$-OEt), 1.21 (2H, m), 1.01 (3H, s, CH_3-18), 0.84 (9H, s, CH_3-*t*Bu), -0.02 (6H, s, 2CH_3-Si); **^{13}C-NMR ($CDCl_3$, δ):**176.8 (C-17), 167.3 (C=O), 107.5 (CH-20), 69.1 (CH-8), 59.2 (CH_2-OEt), 50.4 (CH-14), 45.6 (C-13), 36.0 (CH_2), 34.3 (CH_2), 29.5 (CH_2), 25.7 (CH_3-*t*Bu), 23.4 (CH_2), 21.0 (CH_3-18), 17.9 (C-*t*Bu), 17.4 (CH_2), 14.3 (CH_3-OEt), -4.9 (CH_3-Si), -5.2 (CH_3-Si); **MS (FAB$^+$) [m/z, (%)]:**353 (M^++1, 59), 352 (M^+, 25)**,** 285 (32), 248 (29); **HRMS (FAB$^+$):** calcd for $C_{20}H_{37}O_3Si$ 353.2429, found 353.2425.

Preparation of (E)-2-((4S,7aS)-4-(tert-butyldimethylsilyloxy)-7a-methyloctahydro-1H-inden-1-ylidene)ethanol (8)

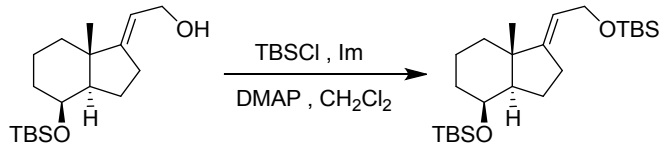


7 **8**

To a solution of ethyl ester **7** (4.3 g, 12 mmol) in CH_2Cl_2 (180 mL) at -78 ºC was added Dibal-H (1.0 M, 37 mL, 37 mmol). The reaction was stirred at the same temperature for 12 h.The reaction was diluted with ^{t}BuOMe (120 mL), H_2O (15 mL) and stirred until a white gel was formed. H_2O (15 mL) and NaOH (4.0 N, 15 mL) were added. When a white solid was formed, Na_2SO_4 and silica-gel were added and stirred for 30 min. The mixture was filtered and evaporated. The crude was chromatographed on silica gel using 3% EtOAc/Hexane as eluent, affording alcohol **8** (3.8 g, 99%) as a colorless liquid. Rf: 0.2 (10% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**3420.35, 2999.31, 2930.41, 2884.99, 2857.01, 1363.43, 1027.87;**[α]$^{24}_{D}$** = +21 (c 1, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):** 5.12 (1H, m, H-20), 4.02 (3H, m, H-8, 2H-22), 2.26 (2H, m, 2H-16), 1.74 (4H, m), 1.47 (2H, m), 1.36 (1H, m), 1.20 (2H, m), 0.962 (3H, s, CH_3-18), 0.85 (9H, s, CH_3-*t*Bu), -0.01

(3H, s, CH_3-Si), -0.02 (3H, s, CH_3-Si); **^{13}C-NMR ($CDCl_3$, δ):**155.9 (C-17), 114.5 (C-20), 69.1 (CH-8), 59.8 (CH_2-22), 50.9 (CH-14), 43.4 (C-13), 36.5 (CH_2), 34.6 (CH_2), 25.7 (CH_3-*t*Bu), 25.2 (CH_2), 23.3 (CH_2), 21.4 (CH_3-18), 17.9 (C-*t*Bu), 17.5 (CH_2), -4.9 (CH_3-Si), -5.3 (CH_3-Si); **MS (FAB$^+$) [m/z, (%)]:**310 (M^+, 29), 309 (M^+-1, 100), 209 (32), 185 (25); **HRMS (FAB$^+$)** calcd for $C_{18}H_{33}O_2Si$ 309.2325, found 309.2323.

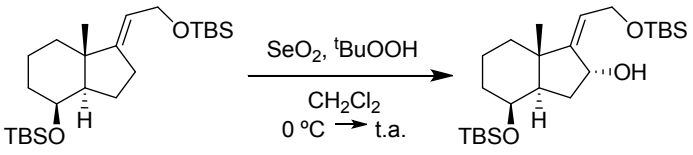
Preparation of tert-butyl((E)-2-((4S,7aS)-4-(tert-butyldimethylsilyloxy)-7a-methyl octahydro-1H-inden-1-ylidene)ethoxy)dimethylsilane (9)



8 **9**

To a solution of allylic alcohol **8** (2.0 g, 6.4 mmol) in CH_2Cl_2 (15 mL) were added Imidazole (820 mg, 12 mmol), DMPA (80 mg, 0.6 mmol) and TBSCl (1.07 g, 7.09 mmol). The mixture was stirred for 10 min. H_2O (15 mL) was added and the product extracted with CH_2Cl_2 (3x10 mL). The combined organic phases were washed with brine (2 x 20 mL), dried, filtered and evaporated to give a residue which was chromatographed on silica gel using 5% EtOAc/Hexane as eluent, affording compound **9** (2.4 g, 87%)as a colorless liquid; Rf: 0.75 (10% EtOAc/Hexane);**IR (NaCl,cm^{-1}):**2998.75, 2930.29, 2885.23, 2860.10, 1363.52;**[α]$^{22}_D$**=+22.4 (c 2.8, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):**5.07 (1H, m, H-20), 4.13 (3H, m, H-8, 2H-22), 2.25 (2H, m, H-16), 1.79 (4H, m), 1.50 (2H, m), 1.38 (1H, m), 1.23 (2H, m), 0.99 (3H, s, CH_3-18), 0.89 (9H, s, CH_3-*t*Bu), 0.88 (9H, s, CH_3-*t*Bu), 0.05 (6H, s, CH_3-Si), 0.02 (3H, s, CH_3-Si), 0.015 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):**153.4 (C-17), 115.6 (CH-20), 69.3 (CH-8), 61.5 (CH_2-22), 51.4 (CH-14), 43.4 (C-13), 36.9 (CH_2), 35.1 (CH_2), 26.4 (CH_3-*t*Bu), 26.1 (CH_3-*t*Bu), 25.3 (CH_2), 23.9 (CH_2), 21.8 (CH_3-18), 18.4 (C-*t*Bu), 18.0 (C-*t*Bu), 17.9 (CH_2), -4.4 (CH_3-Si), -4.5 (CH_3-Si), -4.5 (CH_3-Si), -4.7 (CH_3-Si);**MS (FAB$^+$) [m/z, (%)]:**424.27 (M^++1, 16), 423.27 (M^+,11), 367 (16), 293 (53), 291 (44), 235 (17), 171 (18);**HRMS (FAB$^+$)** calcd for $C_{24}H_{48}O_2Si_2$ 424.3134, found 424.3193.

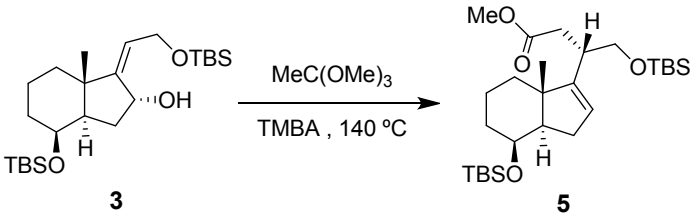
Preparation of (2R,4S,7aS,Z)-4-(tert-butyldimethylsilyloxy)-1-(2-(tert-butyl dimethylsilyloxy)ethylidene)-7a-methyloctahydro-1H-inden-2-ol (3)



9 **3**

To a suspension of SeO_2(42 mg, 0.38 mmol) in CH_2Cl_2 (6 mL) was added a 70% aqueous solution of ^tBuOOH (208 µL, 1.5 mmol) at 0 ºC and the mixture stirred for 1h. Then, a solution of compound **9** (324 mg, 0.76mmol) in CH_2Cl_2 (5 mL) was added and stirred at r.t. for 24 h. NaOH (1.0 N, 20 mL) was added and the product extracted with CH_2Cl_2 (3 x 20 mL). The combined organic phases were dried, filtered and evaporated to give a residue which was chromatographed on silica gel using 2% EtOAc/Hexane as eluent, affording compound **3** (300 mg, 90%) as a colorless liquid; Rf: 0.37 (10% EtOAc/Hexane);**IR (NaCl, cm^{-1}):** 3375.84, 2998.92, 2931.33, 2885.25, 2861.28, 1251.28;**$[\alpha]^{21}_D$**= -4.3 (c 1.4, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):**5.26 (1H, t, J=5.2 Hz, H-20), 4.80 (1H, d, J=6.54 Hz, H-16), 4.26 (1H, dd, J = 13.5, J = 5.7 Hz, H-22), 4.21 (1H, dd, J = 13.5,J= 6.1 Hz, H-22), 4.10 (1H, br s , H-8), 3.64 (1H, br s, O**H**), 1.99 (1H, dt, J = 13.2, J = 6.7 Hz), 1.75 (4H, m), 1.46 (3H, m), 1.26 (1H, m), 0.97 (3H, s, CH_3-18), 0.89 (9H, s, CH_3-*t*Bu), 0.86 (9H, s, CH_3-*t*Bu), 0.096 (3H, s, CH_3-Si), 0.082 (3H, s, CH_3-Si), 0.005 (3H, s, CH_3-Si), 0.001 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):** 160.3 (CH-17), 117.5 (CH-20), 69.9 (CH-8), 69.1 (CH-16), 61.2 (CH_2-22), 47.9 (CH-14), 44.6 (C-13), 37.0 (CH_2), 34.4 (CH_2), 34.0 (CH_2), 25.8 (CH_3-*t*Bu), 25.7 (CH_3-*t*Bu), 23.0 (CH_3-18), 18.2 (C-*t*Bu), 17.9 (C-*t*Bu), 17.5 (CH_2), -4.8 (CH_3-Si), -5.1 (CH_3-Si), -5.2 (CH_3-Si), -5.3 (CH_3-Si); **MS (FAB$^+$) [m/z, (%)]:**440.29 (M^+, 12), 439.29 (M^+-1, 9), 424 (49), 423 (100, M^+-OH), 309 (51), 291 (55), 289 (23), 251 (32), 177 (37);**HRMS (FAB$^+$)** calcd for $C_{24}H_{48}O_3Si_2$ 440.3105, found 440.3111.

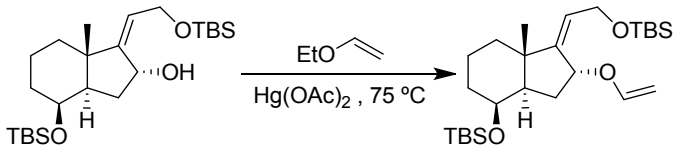
Preparation of (3S)-methyl 4-(tert-butyldimethylsilyloxy)-3-((3aS,7S)-7-(tert-butyldimethylsilyloxy)-3a-methyl-3a,4,5,6,7,7a-hexahydro-1H-inden-3-yl) butanoate (5)



3 **5**

To a solution of allylic alcohol **3** (737 mg, 1.7 mmol) in $MeC(OMe)_3$(10 mL) was added TMBA (30 mg, 0,2 mmol) and then the mixture was stirred at 120 ºC for 6h in a sealed tube. After that, the solvent was removed under reduced pressure and the crude was chromatographed on silica gel using 1% EtOAc/Hexane as eluent, providing compound **5** (690 mg, 83%) as a colorless liquid; Rf: 0.7 (10% EtOAc/Hexane);**IR (NaCl, cm^{-1}):** 2951.52, 2931.33, 2885.25, 2861.28, 1743.33, 1314.45, 864.98;**$[\alpha]^{23}_D$=** +36 (c 2.4, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):**5.44 (1H, s, H-16), 4.07 (1H, s ancho, H-8), 3.64 (1H, m, H-21), 3.60 (3H, s, CH_3-OMe), 3.45 (1H, t, J=9.1 Hz, H-21), 2.66 (1H, m, H-20), 2.61 (1H, d, J = 6.34 Hz, H-22), 2.35 (1H, dd, J = 14.34, J = 6.34 Hz, H-22), 2.20 (1H, m), 1.87 (2H, m), 1.74 (1H, m), 1.66 (1H, m), 1.61-1.4 (4H, m), 1.29 (1H, m), 0.99 (3H, s, CH_3-18), 0.88 (18H, s, CH_3-*t*Bu), 0.034 (6H, s, CH_3-Si), 0.018 (3H, s, CH_3-Si), 0.009 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):** 173.4 (C=O), 154.8 (C-17), 123.5 (CH-16), 68.9 (CH-8), 66.5 (CH_2-21), 54.5 (CH-14), 51.2 (CH_3-OMe), 46.8 (C-13), 37.5 (CH_2), 36.4 (CH-20), 35.2 (CH_2), 34.5 (CH_2), 31.1 (CH_2), 25.9 (CH_3-*t*Bu), 25.7 (CH_3-*t*Bu), 19.4 (CH_3-18), 18.3 (C-*t*Bu), 18.6 (C-*t*Bu), 17.9 (CH_2), -4.8 (CH_3-Si), -5.2 (CH_3-Si), -5.41 (CH_3-Si), -5.43 (CH_3-Si); **MS (FAB$^+$) [m/z, (%)]:**495 (M^+-1, 19), 481(12), 439 (100), 173 (35), 171 (29);**HRMS (FAB$^+$)** calcd for $C_{27}H_{52}O_4Si_2$ 495.3404, found 495.3414.

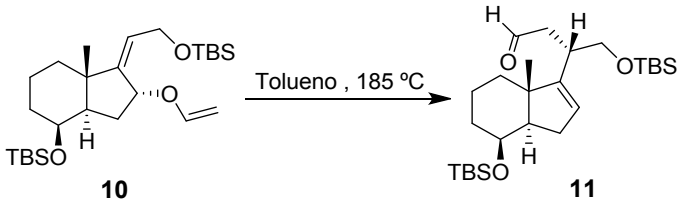
Preparation of tert-butyl((Z)-2-((2R,3aR,4S,7aS)-4-((tert-butyldimethylsilyl)oxy)-7a-methyl-2-(vinyloxy)octahydro-1H-inden-1-ylidene)ethoxy)dimethylsilane (10)



3 **10**

To a solution of allylic alcohol **3** (65 mg, 0.14 mmol) in ethyl vinyl ether (10 mL) was added $Hg(OAc)_2$ (15 mg, 0.048 mmol) and then the mixture was stirred at 75 ºC for 2d in a sealed tube.The solvent was evaporated and the crude was chromatographed on silica gel using 1% EtOAc/Hexane as eluent, affording **10** (58 mg, 85%) as a colorless liquid and recovering part of the starting material **101** (10 mg, 15%); Rf: 0.72 (10% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**2951.82, 2930.85, 2884.95, 2861.28, 1648.25, 975.49; **[α]$^{22}_{D}$=** -30 (c 1, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):**6.36 (1H, dd, J=14.3, 6.8 Hz, H-1'), 5.36 (1H, ddd, J=7.6 Hz, J = 4.2 Hz, J = 1.8 Hz, H-20), 4.82 (1H, d, J = 6.1 Hz, H-16), 4.29 (1H, dd, J = 13.6 Hz, J = 4.2 Hz, H-22), 4.24 (1H, dd, J = 14.3, J = 1.7 Hz, H-2'), 4.16 (1H, dd, J = 13.6 Hz, J = 7.9 Hz, H-22), 4.09 (1H, br s, H-8), 4.06 (1H, dd, J = 6.8, J = 1.7 Hz, H-2'), 1.97 (1H, dt, J = 14.9, J = 6.4 Hz), 1.83 (2H, m), 1.73 (1H, m), 1.61 (2H, m), 1.55-1.24 (3H, m), 1.02 (3H, s, CH_3-18), 0.90 (9H, s, CH_3-*t*Bu), 0.89 (9H, s, CH_3-*t*Bu), 0.06 (6H, s, CH_3-Si), 0.03 (3H, s, CH_3-Si), 0.02 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):** 151.6 (C-17), 150.2 (CH-1'), 123.2 (CH-20), 88.4 (CH_2-2'), 76.8 (CH-16), 68.9 (CH-8), 61.2 (CH_2-22), 48.7 (CH-14), 43.5 (C-13), 36.8 (CH_2), 34.4 (CH_2), 31.3 (CH_2), 26.0 (CH_3-*t*Bu), 25.8 (CH_3-*t*Bu), 22.9 (CH_3-18), 18.4 (C-*t*Bu), 17.9 (C-*t*Bu), 17.5 (CH_2), -4.8 (CH_3-Si), -4.9 (CH_3-Si), -5.0 (CH_3-Si), -5.1 (CH_3-Si); **MS (ESI) [m/z, (%)]:**489 (M^++Na, 33), 426 (M^+-$OCHCH_2$, 100), 291 (20);**HRMS (ESI)** calcd for $C_{26}H_{50}NaO_3Si_2$, 489.3190, found 489.3189.

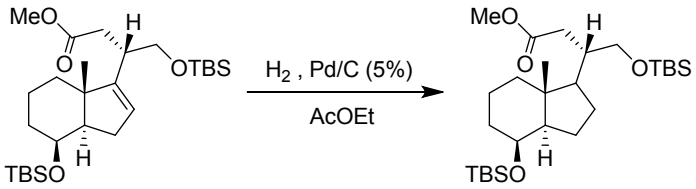
Preparation of (S)-4-((tert-butyldimethylsilyl)oxy)-3-((3aS,7S,7aR)-7-((tert-butyldimethylsilyl)oxy)-3a-methyl-3a,4,5,6,7,7a-hexahydro-1H-inden-3-yl)butanal (11)



10 **11**

A solution of compound **10** (50 mg, 0.11 mmol) in toluene (1 mL) was heated at 185 ºC for 1h in a sealed tube.The solvent was evaporated and the crude was chromatographed on silica gel using 1% EtOAc/Hexane as eluent, affording **11** (45 mg, 90%) as a colorless liquid. Rf: 0.52 (10% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**2951.75, 2930.99, 2884.95, 2862.38, 1723.67, 1315.01; **$[\alpha]^{22}_{D}$**= +30 (c 1.8, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):**9.62 (1H, t, J=2.26 Hz, CHO), 5.36 (1H, s, H-16), 4.05 (1H, s, H-8), 3.66 (1H, 1H, dd, J = 9.7, J = 3.9 Hz, H-21), 3.22 (1H, t, J = 9.3 Hz, H-21), 2.75 (1H, m, H-20), 2.68 (1H, dd, J = 6.7, J = 2.3 Hz, H-22), 2.41 (1H, ddd, J = 15.33, J = 7.36, J = 2.51 Hz, H-22), 2.20 (1H, t, J = 13.2 Hz), 1.85 (2H, m), 1.75 (1H, d, J = 12.15 Hz), 1.67 (1H, d, J = 13.2 Hz), 1.58 (1H, dd, J = 11.02, J = 6.22 Hz), 1.45 (2H, m), 1.28 (1H, dt, J = 12.7, J = 3.1 Hz), 1.00 (3H, s, CH_3-18), 0.85 (9H, s, CH_3-*t*Bu), 0.84 (9H, s, CH_3-*t*Bu), -0.007 (12H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):** 202.9 (C=O), 154.2 (C-17), 124.3 (CH-16), 68.8 (CH-8), 66.9 (CH_2-21), 54.4 (CH-14), 47.4 (CH_2), 46.8 (C-13), 35.3 (CH_2), 35.2 (CH-20), 34.4 (CH_2), 31.1 (CH_2), 25.8 (CH_3-*t*Bu), 25.7 (CH_3-*t*Bu), 19.3 (CH_3-18), 18.2 (C-*t*Bu), 17.9 (C-*t*Bu), 17.8 (CH_2), -4.8 (CH_3-Si), -5.2 (CH_3-Si), -5.4 (CH_3-Si), -5.42 (CH_3-Si); **MS (ESI) [m/z, (%)]:**467 (M^++1, 33), 466 (M^+, 9), 465 (M^+-1, 100), 337 (29), 209 (18);**HRMS (ESI)** calcd for $C_{26}H_{49}O_3Si_2$ 465.3214, found 465.3214.

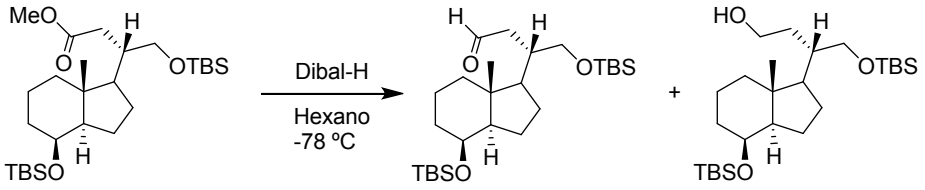
Preparation of (3S)-methyl 4-(tert-butyldimethylsilyloxy)-3-((4S,7aR)-4-(tert-butyldimethylsilyloxy)-7a-methyloctahydro-1H-inden-1-yl)butanoate (12)



5 **12**

To a solution of compound **5** (6.9 g, 13.8 mmol) in EtOAc (165 mL) was added Pd/C (5%) (826 mg) and the mixture was stirred for 13 h under atmosphere of H_2.The mixture was filtered through celite and the filtrate concentrated under vacuo to give pure **12** (6.8 g, 98%) as a colourless liquid.Rf: 0.71 (10% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**2952.01, 2929.82, 2883.54, 2857.02, 1740.92, 1252.54, 1089.1; **[α]$^{24}_{D}$=** +20.4 (c 2.4, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):**3.98 (1H, br s, H-8), 3.62 (3H, s, CH_3-OMe), 3.60 (1H, dd, J = 9.9 Hz, J = 3.3 Hz, H-21), 3.51 (1H, dd, J = 9.9, J = 5.6 Hz, H-21), 2.56 (1H, dd, J = 15.8 Hz, J = 3.6 Hz, H-22), 2.38 (1H, dd, J = 15.8 Hz, J = 9.1 Hz, H-22), 1.93 (1H, m), 1.79 (3H, m), 1.66 (1H, m), 1.55 (1H, m), 1.44-1.21 (6H, m), 1.12 (1H, m), 0.94 (3H, s, CH_3-18), 0.88 (9H, s, CH_3-*t*Bu), 0.87 (9H, s, CH_3-*t*Bu), -0.001 (9H, s, CH_3-Si), -0.01 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):** 173.8 (C=O), 69.2 (CH-8), 64.1 (CH_2-21), 52.7 (CH-17), 51.1 (CH_3-OMe), 50.5 (CH-14), 41.8 (C-13), 40.4 (CH_2), 39.2 (CH-20), 34.6 (CH_2), 34.3 (CH_2), 26.2 (CH_2), 25.9 (CH_3-*t*Bu), 25.8 (CH_3-*t*Bu), 22.8 (CH_2), 18.3 (C-*t*Bu), 18.0 (C-*t*Bu), 17.6 (CH_2), 14.1 (CH_3-18), -4.8 (CH_3-Si), -5.2 (CH_3-Si), -5.60 (CH_3-Si), 5.61 (CH_3-Si); **MS (ESI) [m/z, (%)]:**499 (M^++1, 100), 358 (25);**HRMS (ESI)** calcd for $C_{27}H_{55}O_4Si_2$, 499.6590, found 499.6588.

Preparation of (3S)-4-(tert-butyldimethylsilyloxy)-3-((4S,7aR)-4-(tert-butyldimethylsilyloxy)-7a-methyloctahydro-1H-inden-1-yl)butanal (18) and (3S)-4-(tert-butyldimethylsilyloxy)-3-((4S,7aR)-4-(tert-butyldimethylsilyloxy)-7a-methyloctahydro-1H-inden-1-yl)butan-1-ol (13)



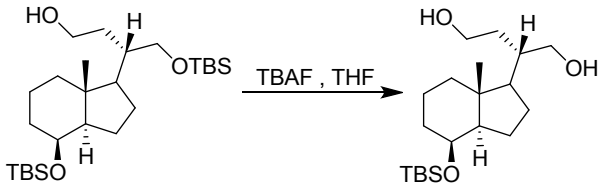
To a solution of ester **12** (650 mg, 1.31 mmol) in CH_2Cl_2 (50 mL) at -78 ºC was added Dibal-H (2.62 mL of a 1 M solution hexane, 2.62 mmol). The reaction was stirred at the same temperature for 30 min. Then, The reaction was diluted with ^{t}BuOMe (7.91 mL), and H_2O (0.98 mL) and the mixture stirred until a white gel was formed. H_2O (0.98 mL) and NaOH (4.0 N, 0.98 mL) were added. When the white solid appeared, Na_2SO_4 was added and the solvent removed under reduced pressure. The residue was chromatographed on silica gel using 5% EtOAc/Hexane as eluent, affording aldehyde **18** (125 mg, 20%) and alcohol **13** (450 mg, 73%).

Compound **18**.Colorless liquid. Rf: 0.71 (10% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**2952.97, 2929.82, 2883.54, 2857.02, 1726.94, 1471.94, 853.50; **[α]$^{22}_D$**=+23.6 (c 1.7, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):**9.73 (1H, d, J = 3.4 Hz, C**H**O), 3.99 (1H, br s , CH-8), 3.67 (1H, dd, J = 9.6 Hz, J = 3.7 Hz, H-21), 3.40 (1H, dd, J = 9.6 Hz, J = 7.3 Hz, H-21), 2.57 (1H, m, H-22), 2.38 (1H, ddd, J = 16.4 Hz, J = 9.0 Hz, J = 3.4 Hz, H-22), 2.09 (1H, m), 1.37-1.53 (5H, m), 1.43-1.20 (6H, m), 1.13 (1H, t, J = 12.5 Hz), 0.95 (3H, s, CH_3-18), 0.87 (9H, s, CH_3-^{t}Bu), 0.85 (9H, s, CH_3-^{t}Bu), 0.011 (3H, s, CH_3-Si), -0.001 (6H, s, CH_3-Si), 0.014 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):**202.8 (C=O), 69.1 (CH-8), 65.6 (CH_2-21), 52.7 (CH-14), 50.8 (CH-17), 45.9 (CH_2), 42.1 (C-13), 40.6 (CH_2), 39.1 (CH-20), 34.2 (CH_2), 26.6 (CH_2), 25.8 (CH_3-^{t}Bu), 25.8 (CH_3-^{t}Bu), 22.9 (CH_2), 18.2 (C-^{t}Bu), 17.9 (C-^{t}Bu), 17.5 (CH_2), 14.2 (CH_3-18), -4.8 (CH_3-Si), -5.2 (CH_3-Si), -5.6 (CH_3-Si), -5.6 (CH_3-

Si);**MS (ESI) [m/z, (%)]:**467 (M^+-1, 100);**HRMS (ESI)** calcd for $C_{26}H_{51}O_3Si_2$ 467.3367, found 467.3366

Compound **13**. Colorless liquid.Rf: 0.37 (10% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**3361.81, 2953.45, 2929.34, 2883.54, 2857.02, 1253.02, 835.50; **[α]$^{23}_D$**=+24.56 (c 1.32, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):**4.00 (1H, br s , CH-8), 3.70 (2H, dd, J = 10.0 Hz, J = 1.9 Hz, H-21, OH), 3.61 (1H, m, H-23), 3.45 (1H, dd, J = 10.0, J = 6.6 Hz, H-21), 3.21 (1H, t, J = 5.4 Hz, H-23), 1.89 (2H, m), 1.76 (2H, m), 1.70-1.49 (4H, m), 1.40-1.20 (6H, m), 1.13 (1H, m), 0.94 (3H, s, CH_3-18), 0.90 (9H, s, CH_3-*t*Bu), 0.88 (9H, s, CH_3-*t*Bu), 0.07 (6H, s, CH_3-Si), 0.01 (3H, s, CH_3-Si), 0.001 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):**69.3 (CH-8), 66.1 (CH_2-21), 60.8 (CH_2-23), 52.8 (CH-14), 51.1 (CH-17), 42.1 (C-13), 41.3 (CH-20), 40.6 (CH_2), 34.9 (CH_2), 34.3 (CH_2), 26.8 (CH_2), 25.8 (CH_3-*t*Bu), 25.8 (CH_3-*t*Bu), 22.9 (CH_2), 18.2 (C-*t*Bu), 17.9 (C-*t*Bu), 17.6 (CH_2), 13.9 (CH_3-18), -4.8 (CH_3-Si), -5.2 (CH_3-Si), -5.4 (CH_3-Si), -5.5 (CH_3-Si);**MS (ESI) [m/z, (%)]:**471 (M^++1, 100), 472 (M^++2, 25);**HRMS (ESI)** calcd for $C_{26}H_{55}O_3Si_2$ 471.3684, found 471.3674.

(2S)-2-((3aR,4S,7aR)-4-((tert-butyldimethylsilyl)oxy)-7a-methyloctahydro-1H-inden-1-yl)butane-1,4-diol (14)

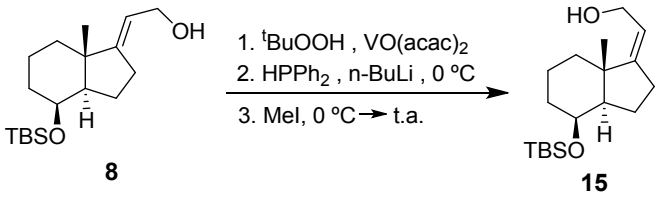


13 **14**

To a solution of **13** (35 mg, 0.074 mmol) in THF (1 mL) was added TBAF (150 µL of a 1 M solution in THF, 0.15 mmol) and the mixture was stirred at room temperature for 12 h. Then the solvent was removed under reduced pressure and the crude was chromatographed on silica gel using 50% EtOAc/Hexane as eluent, giving compound **14** (21 mg, 96%) as a white solid. m.p: 115 ºC; Rf: 0.1 (50% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**3277.43, 2997.80, 2936.09, 2857.51,

1251.58, 1021.12; **$[\alpha]^{24}_D$**=+21.14 (c 1.37, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):**4.00 (1H, s ancho, H-8), 3.78 (1H, m, H-23), 3.71 (1H, dd, J=11.1 Hz, 2.6 Hz, H-21), 3.66 (1H, m, H-23), 3.52 (1H, dd, J = 11.1 Hz, 5.9 Hz, H-21), 3.11 (2H, br s, OH), 1.93-1.72 (4H, m), 1.72-1.46 (4H, m), 1.46-1.20 (6H, m), 1.14 (1H, m), 0.92 (3H, s, CH_3-18), 0.88 (9H, s, CH_3-*t*Bu), 0.01 (3H, s, CH_3-Si), -0.01 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):**69.2 (CH-8), 65.1 (CH_2-21), 60.5 (CH_2-23), 52.8 (CH-14), 50.4 (CH-17), 42.1 (C-13), 41.1 (CH-20), 40.7 (CH_2), 34.3 (CH_2), 34.0 (CH_2), 26.7 (CH_2), 25.8 (CH_3-*t*Bu), 22.8 (CH_2), 18.0 (C-*t*Bu), 17.6 (CH_2), 13.9 (CH_3-18), -4.8 (CH_3-Si), -5.2 (CH_3-Si);**MS (ESI) [m/z, (%)]:**357 (M^++1, 100), 356 (M^+, 24), 339 (M^+-OH, 36);**HRMS (ESI)** calcd for $C_{20}H_{41}O_3Si$ 357.2747, found 357.2745.

Preparation of (Z)-2-((4S,7aS)-4-(tert-butyldimethylsilyloxy)-7a-methyloctahydro-1H-inden-1-ylidene)ethanol(15)



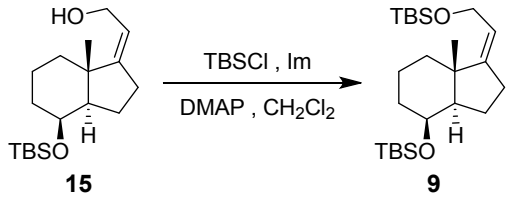
8 **15**

To a solution of allylic alcohol **8** (1.8 g, 5.8 mmol) in toluene (20 mL) was added $VO(acac)_2$ (catalytic) and ^{t}BuOOH (1.16 mLof a 5.5 M solution in decane, 6.4 mmol) at -20 ºC and the mixture was stirred at the same temperature for 24 h. A saturated aqueous solution of $NaHCO_3$ (20 mL) was added and the product extracted with CH_2Cl_2 (2 x 30 mL). The combined organic layers were dried over Na_2SO_4, filtered and evaporated. The crude (2.5 g) was directly used in the next step.

To a solution of $HPPh_2$ (2.6 mL, 15.1 mmol) in THF (15 mL) was added n-BuLi (2.5 M, 6.03 mL, 15.1 mmol) at 0 ºC. After 4 h at 0 ºC, a solution of the above obtained crude (2.5 g) in THF (15 mL) was added and stirring continued for 1 h. Finally, MeI (1.7 mL) was added and the mixture stirred for 4 h at room temperature. H_2O (100 mL) was added and the product extracted with Et_2O (3 x

30 mL). The combined organic layers were dried over Na_2SO_4, filtered and evaporated. The crude was chromatographed on silica gel using 4% EtOAc/Hexane as eluent, providing compound **15** (981 mg, 55%) as a colorless liquid.Rf: 0.28 (30% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**3416.91, 2999.96, 2931.83, 2884.24, 2856.99, 1362.58, 1027.89; **[α]$^{25}_{D}$**=-3.14 (c 0.92, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):**5.23 (1H, tt, J = 7.2 Hz, J = 1.9 Hz, H-20), 4.29 (1H, dd, J = 12.2 Hz, J = 7.3 Hz, H-22), 4.15 (1H, dd, J = 12.2 Hz, J = 7.3 Hz, H-22), 4.08 (1H, br s, H-8), 2.45 (1H, dd, J = 17.0 Hz, J = 9.1Hz, H-16), 2.23 (1H, dd, J = 17.0 Hz, J = 9.1Hz, H-16), 1.87 (1H, m), 1.70 (3H, m), 1.58-1.33 (5H, m), 1.12 (3H, s, CH_3-18), 0.89 (9H, s, CH_3-^{t}Bu), 0.03 (3H, s, CH_3-Si), 0.02 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):**154.6 (C-17), 117.9 (CH-20), 69.5 (CH-8), 58.6 (CH_2-22), 52.3 (CH-14), 44.5 (C-13), 38.1 (CH_2), 34.2 (CH_2), 30.5 (CH_2), 25.7 (CH_3-^{t}Bu), 23.5 (CH_2), 20.4 (CH_3-18), 17.9 (CH_2), 17.8 (C-^{t}Bu), -4.8 (CH_3-Si), -5.1 (CH_3-Si);**MS (ESI) [m/z, (%)]:**310 (M^+, 20), 309 (M^+-1, 100), 209 (21);**HRMS (ESI)** calcd for $C_{18}H_{33}O_2Si$ 309.2332, found 309.2329.

Preparation of tert-butyl((Z)-2-((4S,7aS)-4-(tert-butyldimethylsilyloxy)-7a-methyl octahydro-1H-inden-1-ylidene)ethoxy)dimethylsilane(9)

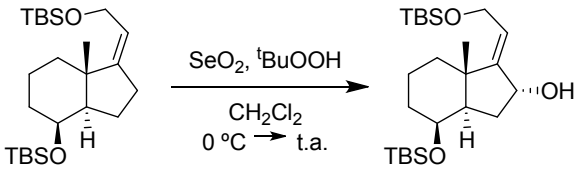


15 **9**

To a solution of allylic alcohol **15** (980 mg, 3.2 mmol) in CH_2Cl_2 (10 mL) were added Imidazole (431 mg, 6.3 mmol), DMPA (30 mg, 0.2 mmol) and TBSCl (523 mg, 3.5 mmol). The mixture was stirred for 1 h. H_2O (10 mL) was added and the product extracted with CH_2Cl_2 (3 x 10 mL). The combined organic phases were washed with brine (2 x 20 mL), dried, filtered and evaporated to give a residue which was chromatographed on silica gel using 5% EtOAc/Hexane as eluent, affording compound **9** (1.2 g, 91%)as a colorless liquid; Rf: 0.72 (10% EtOAc/Hexane);**IR (NaCl,cm^{-1}):**2998.69, 2931.89, 2885.86, 2861.02, 1362.14;**[α]$^{22}_{D}$**=+6.13 (c 0.92, $CHCl_3$);**^{1}H-NMR ($CDCl_3$,**

δ):5.13 (1H, tt, J = 6.2 Hz, J = 1.8 Hz, H-20), 4.36 (1H, dd, J = 12.7 Hz, J = 6.0 Hz, H-22), 4.27 (1H, dd, J = 12.7 Hz, J = 6.0 Hz, H-22), 4.09 (1H, br s, H-8), 2.45 (1H, dd, J = 17.0 Hz, J = 9.8 Hz, H-16), 2.21 (1H, m, H-16), 2.07 (1H, m), 1.88 (1H, m), 1.71 (2H, m), 1.57-1.35 (5H, m), 1.13 (3H, s, CH_3-18), 0.93 (9H, s, CH_3-*t*Bu), 0.91 (9H, s, CH_3-*t*Bu), 0.09 (6H, s, CH_3-Si), 0.043 (3H, s, CH_3-Si), 0.039 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):**151.3 (C-17), 119.2 (CH-20), 69.6 (CH-8), 59.5 (CH_2-22), 52.3 (CH-14), 44.3 (C-13), 37.8 (CH_2), 34.2 (CH_2), 30.3 (CH_2), 26.1 (CH_3-*t*Bu), 25.8 (CH_3-*t*Bu), 23.6 (CH_2), 19.8 (CH_3-13), 18.4 (C-*t*Bu), 18.1 (C-*t*Bu), 17.8 (CH_2), -4.8 (CH_3-Si), -4.9 (CH_3-Si), -5.0 (CH_3-Si), -5.1 (CH_3-Si);**MS (FAB$^+$) [m/z, (%)]:**424.27 (M^+, 26), 423.27 (M^+-1, 15), 367 (26), 293 (43), 291 (39), 235 (19), 171 (28);**HRMS (FAB$^+$)** calcd for $C_{24}H_{48}O_2Si_2$ 424.3132, found 424.3188.

Preparation of (2R,4S,7aS,E)-4-(tert-butyldimethylsilyloxy)-1-(2-(tert-butyl dimethylsilyloxy)ethylidene)-7a-methyloctahydro-1H-inden-2-ol (4)

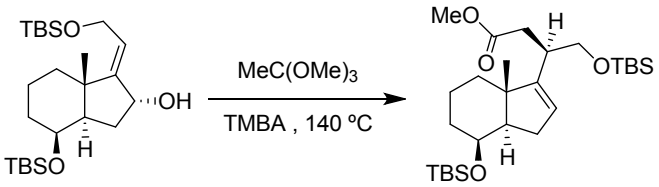


9 **4**

To a suspension of SeO_2(159 mg, 1.4 mmol) in CH_2Cl_2(8 mL) was added a 70% aqueous solution of ^{t}BuOOH (786 µL, 5.7 mmol) at 0 ºC and the mixture stirred for 1h. Then, a solution of compound **9** (1.2 g, 2.9 mmol) in CH_2Cl_2 (13 mL) was added and stirred at r.t. for 24 h. NaOH (1.0 N, 30 mL) was added and the product extracted with CH_2Cl_2 (3 x 30 mL). The combined organic phases were dried, filtered and evaporated to give a residue which was chromatographed on silica gel using 1% EtOAc/Hexane as eluent, affording compound **4** (993 mg, 79%) as a colorless liquid; Rf: 0.32 (10% EtOAc/Hexane);**IR (NaCl, cm^{-1}):** 3391.14, 2998.68, 2931.98, 2884.45, 2861.57, 1250.73;**[α]$^{23}_D$=** -19.2 (c 1.9, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):**5.53 (1H, m, H-20), 4.50 (1H, d, J = 6.3 Hz, H-16), 4.36 (2H, d, J = 5.7 Hz, 2H-22), 4.10 (1H, br s,), 2.05-1.35 (9H, m), 1.10 (3H, s,

CH_3-18), 0.91 (9H, s, CH_3-*t*Bu), 0.89 (9H, s, CH_3-*t*Bu), 0.08 (6H, s, CH_3-Si), 0.03 (3H, s, CH_3-Si), 0.02 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):** 155.2 (C-17), 124.0 (CH-20), 72.7 (CH-16), 69.2 (CH-8), 59.3 (CH_2-22), 48.7 (CH-14), 44.5 (C-13), 37.9 (CH_2), 34.5 (CH_2), 34.1 (CH_2), 25.9 (CH_3-*t*Bu), 25.6 (CH_3-*t*Bu), 20.4 (CH_3-13), 18.2 (C-*t*Bu), 17.8 (C-*t*Bu), 17.6 (CH_2), -4.9 (CH_3-Si), -5.17 (CH_3-Si), -5.17 (CH_3-Si), -5.2 (CH_3-Si); **MS (FAB$^+$) [m/z, (%)]:**440.29 (M^+, 16), 439.29 (M^+-1, 12), 424 (53), 423 (M^+-OH, 100), 309 (56), 291 (59), 289 (31);**HRMS (FAB$^+$)** calcd for $C_{24}H_{48}O_3Si_2$ 440.3098, found 440.3091.

Preparation of (3R)-methyl 4-(tert-butyldimethylsilyloxy)-3-((3aS,7S)-7-(tert-butyldimethylsilyloxy)-3a-methyl-3a,4,5,6,7,7a-hexahydro-1H-inden-3-yl)butanoate (6)



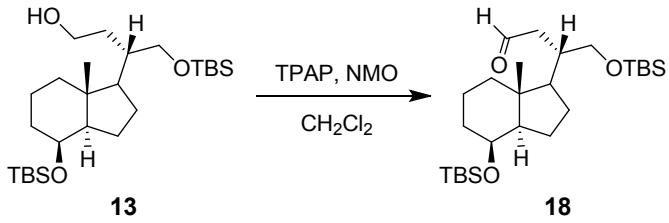
4 **6**

To a solution of allylic alcohol **4** (993 mg, 2.25 mmol) in $MeC(OMe)_3$(20 mL) was added TMBA (40 mg, 0.2 mmol) and then the mixture was stirred at 140 ºC for 6 h in a sealed tube. After that, the solvent was removed under reduced pressure and the crude was chromatographed on silica gel using 1% EtOAc/Hexane as eluent, providing the compound **6** (1.05 g, 95%).

Compound **6**.Colorless liquid.Rf: 0.72 (10% EtOAc/Hexane);**IR (NaCl, cm^{-1}):** 2951.82, 2930.98, 2885.31, 2861.35, 1751.62, 1313.87, 864.73;**[α]$^{22}_D$=** +5.5 (c 1.6, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):** 5.39 (1H, s, H-16), 4.06 (1H, br s, CH-8), 3.63 (1H, dd, J = 9.8 Hz, J = 3.9 Hz, H-21), 3.59 (3H, s, CH_3-OMe), 3.18 (1H, t, J = 9.1 Hz, H-21), 2.77 (1H, dd, J = 14.9 Hz, J = 5.6 Hz, H-20), 2.69 (1H, d, J = 6.34 Hz, H-22), 2.37 (1H, dd, J = 14.9 Hz, J = 6.8 Hz, H-22), 2.20 (1H, m), 1.86 (2H, m), 1.75 (1H, m), 1.68 (1H, d, J = 13 Hz), 1.58 (1H, dd, J = 11.1Hz, J = 6.2 Hz), 1.46 (2H, m), 1.26 (2H, m), 0.98 (3H, s, CH_3-18), 0.86 (18H, s, CH_3-*t*Bu), 0.04 (12H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):** 173.2 (C=O), 154.1 (C-17), 123.6 (CH-

16), 68.7 (CH-8), 66.2 (CH_2-21), 54.6 (CH-14), 51.1 (CH_3-OMe), 46.7 (C-13), 37.1 (CH-20), 36.4 (CH_2), 35.6 (CH_2), 34.6 (CH_2), 30.9 (CH_2), 25.9 (CH_3-^{t}Bu), 25.7 (CH_3-^{t}Bu), 18.9 (CH_3-18), 18.6 (C-^{t}Bu), 18.1 (CH_2), 17.9 (C-^{t}Bu), -4.9 (CH_3-Si), -5.2 (CH_3-Si), -5.39 (CH_3-Si), -5.41 (CH_3-Si); **MS (ESI) [m/z, (%)]:**495 (M^+-1, 15), 481(17), 439 (100), 173 (25), 171 (27), 159 (34);**HRMS (ESI)** calcd for $C_{27}H_{52}O_4Si_2$ 496.3404, found 496.3394.

Preparation of (3S)-4-(tert-butyldimethylsilyloxy)-3-((4S,7aR)-4-(tert-butyldimethylsilyloxy)-7a-methyloctahydro-1H-inden-1-yl)butanal (18)

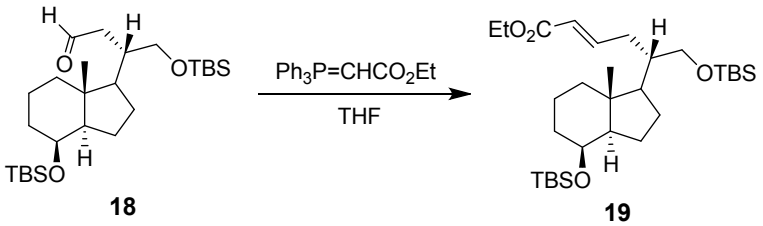


13 **18**

To a solution of compound **13** (780mg, 1.66mmol) in CH_2Cl_2 (15 mL) were added 4Å molecular sieves (500mg), NMO (583mg, 4.98mmol) and a catalytic amount of TPAP (3 mg). The resulting greenish solution was stirred at room temperature for 2 h. The solvent was rotatory evaporated to afford a residue which was chromatographed on silica gel using 5% EtOAc/Hexane as eluent, affording aldehyde **18** (705mg, 90%).

This compound was characterized in a previous reaction.

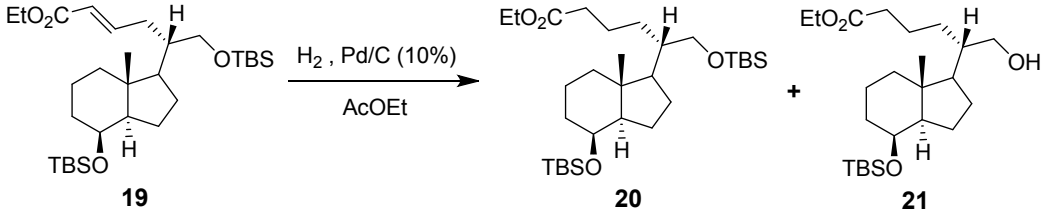
Preparation of (5R,E)-ethyl 6-(tert-butyldimethylsilyloxy)-5-((3aS,7S)-7-(tert-butyldimethylsilyloxy)-3a-methyl-3a,4,5,6,7,7a-hexahydro-1H-inden-3-yl)hex-2-enoate (19)



18 **19**

To a solution of aldehyde **18** (700 mg, 1.49 mmol) in THF (15 mL), was added PPh_3CHCO_2Et (1g, 2.99 mmol). The reaction was heated for 2 days at rt.The solvent was evaporated and the residue was chromatographed on silica gel using 5% EtOAc/Hexane as eluent, affording alkene **19** (720mg, 90%) as a colorless liquid. Rf: 0.74 (10% EtOAc/Hexane);**IR (NaCl, cm^{-1}):** 2953.45, 2929.82, 2884.50, 2857.02, 1723.57, 1653.18, 1254.95, 853.99;**$[\alpha]^{24}_D$**= +10.6 (c 1.4, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):**6.98 (1H, ddd, J = 15.3 Hz, J = 7.8 Hz, J = 7.3 Hz, CH-23), 5.81 (1H, d, J = 15.3 Hz, CH-24), 4.17 (2H, q, J = 7.1 Hz, O**C**H_2CH_3), 3.99 (1H, br s, CH-8), 3.55 (1H, dd, J = 10.0 Hz, J = 3.2 Hz, H-21), 3.40 (1H, dd, J = 10.0 Hz, J = 5.8 Hz, H-21), 2.49 (1H, m, H-22), 2.31 (1H, m, H-22), 1.90-1.47 (6H, m), 1.42-1.25 (7H, m), 1.28 (3H, t, J = 7.1 Hz, OCH_2C**H**$_3$), 0.93 (3H, s, CH_3-18), 0.89 (9H, s, CH_3-*t*Bu), 0.88 (9H, s, CH_3-*t*Bu), 0.01 (9H, s, CH_3-Si), -0.01 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):** 166.6 (C=O), 148.3 (CH-23), 122.4 (CH-24), 69.3 (CH-8), 63.2 (CH_2-21), 59.9 (O**C**H_2CH_3), 52.7 (CH-14), 50.3 (CH-17), 42.1 (C-13), 41.9 (CH-20), 40.6 (CH_2), 34.3 (CH_2), 32.4 (CH_2), 26.3 (CH_2), 25.9 (CH_3-*t*Bu), 25.8 (CH_3-*t*Bu), 22.8 (CH_2), 18.2 (C-*t*Bu), 18.0 (C-*t*Bu), 17.6 (CH_2), 14.2 (CH_3-18), 14.1 (OCH_2**C**H_3), -4.8 (CH_3-Si), -5.2 (CH_3-Si), -5.5 (CH_3-Si), -5.6 (CH_3-Si); **MS (ESI) [m/z, (%)]:**539 (M^++1, 40), 407 (M^+-OTBS, 45), 215 (100), 200 (96);**HRMS (FAB$^+$)** calcd for $C_{30}H_{59}O_4Si_2$ 539.3946, found 539.3946.

Preparation of (5S)-ethyl 6-((tert-butyldimethylsilyl)oxy)-5-((3aR,4S,7aR)-4-((tert-butyldimethylsilyl)oxy)-7a-methyloctahydro-1H-inden-1-yl)hexanoate (20) and (5S)-ethyl 5-((3aR,4S,7aR)-4-((tert-butyldimethylsilyl)oxy)-7a-methyloctahydro-1H-inden-1-yl)-6-hydroxyhexanoate (21)



19 20 21

To a solution of compound **19** (652 mg, 1.21 mmol) in AcOEt (15 mL) was added Pd/C (10%) (36 mg) and the mixture was stirred for 20h under atmosphere of H_2.The mixture was filtered through celite and the filtrate concentrated under vacuo. The crude was chromatographed on silica gel using 5% EtOAc/Hexane as eluent, affording compound **20** (280 mg, 43%) and alcohol **21** (250 mg, 48%).

Compound **20**.Colorless liquid.Rf: 0.74 (10% EtOAc/Hexane);**IR (NaCl, cm^{-1}):** 2953.39, 2929.82, 2884.49, 2856.99, 1723.64, 1253.94, 853.98;**$[\alpha]^{24}_D$**= +19.8 (c 1.4, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):**4.11 (2H, q, J = 7.1 Hz, OC**H**$_2$$CH_3$), 3.99 (1H, s ancho, CH-8), 3.61 (1H, m, H-21), 3.42 (1H, dd, J = 10.0 Hz, J = 5.7 Hz, H-21), 2.25 (2H, t, J =7.5 Hz, H-24), 1.91-1.12 (17H, m), 1.24 (3H, t, J = 7.2 Hz, OCH_2C**H**$_3$), 0.90 (3H, s, CH_3-18), 0.88 (9H, s, CH_3-*t*Bu), 0.87 (9H, s, CH_3-*t*Bu), 0.01 (6H, s, CH_3-Si), -0.001 (3H, s, CH_3-Si), -0.02 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):** 173.9 (C=O), 69.4 (CH-8), 63.1 (CH_2-21), 60.1 (O**C**H_2CH_3), 52.8 (CH-14), 50.6 (CH-17), 42.0 (C-13), 41.7 (CH-20), 40.4 (CH_2), 34.9 (CH_2), 34.4 (CH_2), 28.8 (CH_2), 26.3 (CH_2), 25.9 (CH_3-*t*Bu), 25.8 (CH_3-*t*Bu), 22.9 (CH_2), 21.6 (CH_2), 18.2 (C-*t*Bu), 18.0 (C-*t*Bu), 17.7 (CH_2), 14.2 (CH_3-18), 13.9 (OCH_2**C**H_3), -4.8 (CH_3-Si), -5.2 (CH_3-Si), -5.4 (CH_3-Si), -5.5 (CH_3-Si); **MS (ESI) [m/z, (%)]:**540 (M^+, 100), 322 (49), 298 (38);**HRMS (ESI)** calcd for $C_{30}H_{60}O_4Si_2$ 540.4029, found 540.4025.

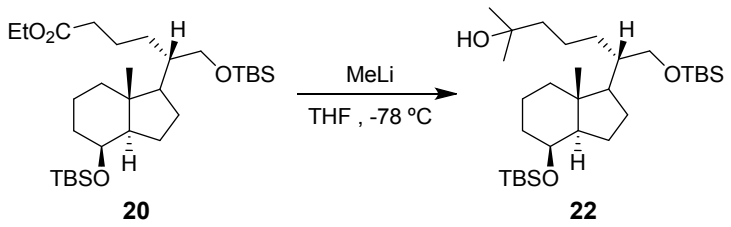
Compound **21**. Colorless liquid. Rf: 0.40 (30% EtOAc/Hexane);**IR (NaCl, cm^{-1}):** 3392.66, 2953.29, 2929.82, 2884.59, 2857.51, 1734.17, 1251.18;**$[\alpha]^{24}_D$**= +14.6 (c 0.6, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):** 4.10 (2H, q, J = 7.1 Hz, OC**H**$_2$$CH_3$), 3.97 (1H, br s, CH-8), 3.68 (1H, dd, J = 11.1 Hz, J = 3.0 Hz, H-21), 3.50 (1H, dd, J = 11.1Hz, J = 5.4 Hz, H-21), 2.28 (2H, t, J = 6.9 Hz, H-24), 2.02 (1H, m), 1.89-1.12 (16H, m), 1.23 (3H, t, J = 7.1 Hz, OCH_2C**H**$_3$), 0.89 (3H, s, CH_3-18), 0.86 (9H, s, CH_3-*t*Bu), -0.02 (3H, s, CH_3-Si), -0.03 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):** 174.1 (C=O), 69.2 (CH-8), 62.9 (CH_2-21), 60.3 (O**C**H_2CH_3), 52.8 (CH-14), 50.4 (CH-17), 42.1 (C-13), 41.6 (CH-20), 40.4 (CH_2), 34.3 (CH_2), 28.2 (CH_2), 26.4 (CH_2), 25.7 (CH_3-*t*Bu), 22.8 (CH_2), 20.8 (CH_2), 17.9 (CH_2), 17.6 (C-*t*Bu), 14.2 (CH_3-18), 13.9 (OCH_2**C**H_3), -4.8 (CH_3-Si), -5.2 (CH_3-Si); **MS (ESI) [m/z,**

(%)]:427 (M^++1, 100), 409 (M^+ - OH, 27), 277 (50), 215 (22);**HRMS (ESI)** calcd for $C_{24}H_{47}O_4Si$ 427.3226, found 427.3238.

General method for the preparation of compound 22 and 23:

To a solution of ester **20** or **21** (0.50 mmol) in THF (5 mL) was added MeLi·LiBr (2.53 mmol of a 1.5 M solution in Et_2O) at -78 ºC and the mixture was stirred for 30 min. Then, H_2O (20 mL) was added and the product extracted with CH_2Cl_2 (3x15 mL). The combined organic phases were dried, filtered and evaporated to give a residue which was chromatographed on silica gel using 15% EtOAc/Hexane as eluent.

Preparation of (6S)-7-((tert-butyldimethylsilyl)oxy)-6-((3aR,4S,7aR)-4-((tert-butyldimethylsilyl)oxy)-7a-methyloctahydro-1H-inden-1-yl)-2-methylheptan-2-ol (22)

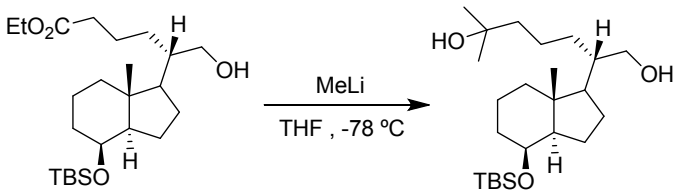


20 **22**

Compound **22**.Rf: 0.33 (10% AcOEt/Hexano); **IR (NaCl,cm^{-1}):**3392.17, 2953.93, 2929.34, 2884.02, 2857.02, 1252.54, 853.50.;**[α]$^{24}_D$**=+13.8 (c 2.6, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):**3.98 (1H, br s, CH-8), 3.61 (1H, dd, J = 9.9 Hz, J = 2.8 Hz, H-21), 3.42 (1H, dd, J = 9.9 Hz, J = 5.1 Hz, H-21), 1.89 (1H, m), 1.73 (3H, m), 1.58-1.15 (15H, m), 1.19 (6H, s, CH_3-26, CH_3-27), 0.90 (3H, s, CH_3-18), 0.88 (9H, s, CH_3-^{t}Bu), 0.87 (9H, s, CH_3-^{t}Bu), 0.01 (6H, s, CH_3-Si), -0.00 (3H, s, CH_3-Si), -0.02 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):**71.1 (C-25), 69.4 (CH-8), 63.2 (CH_2-21), 52.9 (CH-14), 50.7 (CH-17), 44.6 (CH_2), 42.1 (C-13), 41.9 (CH-20), 40.5 (CH_2), 34.4 (CH_2), 29.7 (CH_2), 29.2 (CH_3-26 o CH_3-27), 29.1 (CH_3-26 o

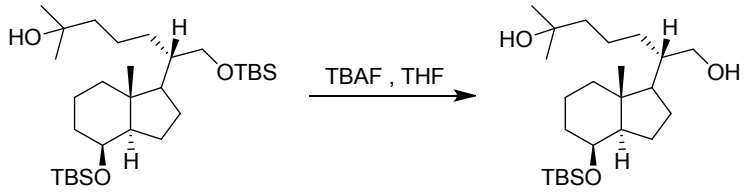
CH_3-27), 26.4 (CH_2), 25.9 (CH_3-*t*Bu), 25.8 (CH_3-*t*Bu), 22.9 (CH_2), 20.5 (CH_2), 18.2 (C-*t*Bu), 17.9 (CH_2), 17.7 (C-*t*Bu), 14.0 (CH_3-18), -4.8 (CH_3-Si), -5.2 (CH_3-Si), -5.4 (CH_3-Si), -5.5 (CH_3-Si);**MS (ESI) [m/z, (%)]:**527 (M^++1, 100),509 (M^+-OH, 36), 471 (50), 215 (79);**HRMS (ESI)** calcd for $C_{30}H_{63}O_3Si_2$ 527.4310, found 527.4320.

Preparation of (2S)-2-((3aR,4S,7aR)-4-((tert-butyldimethylsilyl)oxy)-7a-methyloctahydro-1H-inden-1-yl)-6-methylheptane-1,6-diol (23)



Compound **23**. White solid, m.p.= 113 ºC; Rf: 0.22 (50% AcOEt/Hexano); **IR (NaCl,cm^{-1}):**3366.14, 2953.64, 2929.82, 2884.05, 2858.47, 1252.60;**[α]$^{23}_D$**=+5.7 (c 0.6, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):**3.97 (1H, br s, CH-8), 3.67 (1H, dd, J=11.0, 2.8 Hz, H-21), 3.47 (1H, dd, J=11.0, 5.2 Hz, H-21), 2.27 (2H, br s, 2O**H**), 1.88 (1H, m), 1.77 (2H, m), 1.64 (1H, m), 1.56-1.14 (15H, m), 1.17 (6H, s, CH_3-26, CH_3-27), 0.90 (3H, s, CH_3-18), 0.86 (9H, s, CH_3-*t*Bu), -0.02 (3H, s, CH_3-Si), -0.03 (3H, s, CH_3-Si);**^{13}C-NMR ($CDCl_3$, δ):**70.9 (C-25), 69.3 (CH-8), 62.9 (CH_2-21), 52.8 (CH-14), 50.6 (CH-17), 43.9 (CH_2), 42.0 (C-13), 41.9 (CH-20), 40.4 (CH_2), 34.3 (CH_2), 29.4 (CH_2), 29.3 (CH_3-26 o CH_3-27), 29.2 (CH_3-26 o CH_3-27), 26.5 (CH_2), 25.7 (CH_3-*t*Bu), 22.8 (CH_2), 20.2 (CH_2), 17.9 (CH_2), 17.6 (C-*t*Bu), 13.8 (CH_3-18), -4.8 (CH_3-Si), -5.2 (CH_3-Si);**MS (ESI) [m/z, (%)]:**435 (M^+ + Na, 100), 395 (21);**HRMS (ESI)** calcd for $C_{24}H_{48}NaO_3Si_2$ 435.3264, found 435.3262.

Preparation of (2S)-2-((3aR,4S,7aR)-4-((tert-butyldimethylsilyl)oxy)-7a-methyloctahydro-1H-inden-1-yl)-6-methylheptane-1,6-diol (23)

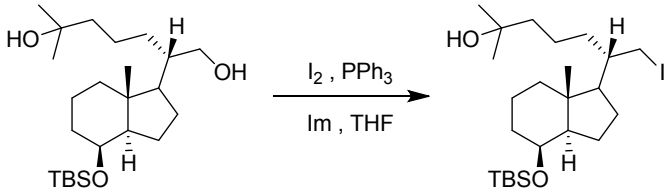


22 **23**

To a solution of silylated alcohol **22** (209 mg, 0.39 mmol) in THF (5 mL) was added TBAF (780 µL of a 1 M solution in THF, 0.78mmol) and the solution was stirred for 2 h.The solvent was rotatory evaporated to afford a residue which was chromatographed on silica gel using 40% EtOAc/Hexane as eluent, affording compound **23** (153 mg, 94%).

This compound was characterized in the previous experiment.

Preparation of (6S)-6-((3aR,4S,7aR)-4-((tert-butyldimethylsilyl)oxy)-7a-methyloctahydro-1H-inden-1-yl)-7-iodo-2-methylheptan-2-ol (24)

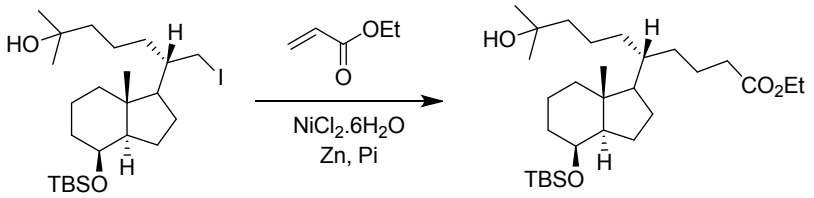


23 **24**

To a solution of **23** (370 mg, 0.90 mmol) in THF (10 mL) were added PPh_3 (283 mg, 1.08 mmol), Imidazole (184 mg, 2.7 mmol) and when the mixture was completely dissolved, I_2 (251 mg, 0.99 mmol) was added at 0ºC. The solution was stirred till room temperature for 20 min and then a saturated aqueous solution of $NaHCO_3$ (10 mL) was added. The resulting mixture was extracted with EtOAc (3x15 mL) and the organics were washed with a 10% aqueous solution of $Na_2S_2O_4$ (50 mL) and brine (50 mL), dried over Na_2SO_4 and the solvent removed under reduced pressure. The residue was chromatographed on silica gel using 5% EtOAc/Hexane as eluent, affording **24** (436 mg, 93%) as a colorless liquid; Rf: 0.80 (50% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**3392.66, 2953.64, 2930.31, 2884.78, 2858.47, 1251.58; **$[\alpha]^{24}_D$**=+15.40 (c 1.13, $CHCl_3$; **^{1}H-NMR ($CDCl_3$, δ):**3.98 (1H, s ancho, CH-8), 3.41 (1H, dd, J = 9.9 Hz, J = 2.8

Hz, H-21), 3.24 (1H, dd, J = 9.9 Hz, J = 3.8 Hz, H-21), 1.89 (1H, m), 1.79 (2H, m), 1.69-1.12 (16H, m), 1.21 (6H, s, CH_3-26, CH_3-27), 0.95 (3H, s, CH_3-18), 0.87 (9H, s, CH_3-*t*Bu), -0.00 (3H, s, CH_3-Si), -0.02 (3H, s, CH_3-Si); **^{13}C-NMR ($CDCl_3$, δ):**70.9 (C-25), 69.2 (CH-8), 54.2 (CH-17), 52.8 (CH-14), 43.7 (CH-20), 41.9 (C-13), 40.5 (CH_2), 39.9 (CH-20), 34.2 (CH_2), 32.6 (CH_2), 29.3 (CH_3-26 o CH_3-27), 29.2 (CH_3-26 o CH_3-27), 26.4 (CH_2), 25.7 (CH_3-*t*Bu), 22.7 (CH_2), 20.5 (CH_2), 18.4 (CH_2), 17.9 (C-*t*Bu), 17.6 (CH_2), 14.8 (CH_3-18), -4.8 (CH_3-Si), -5.2 (CH_3-Si); **MS (ESI) [m/z, (%)]:**505 (M^+ - OH), 373 (89), 242 (46), 215 (100); **HRMS (ESI)** calcd for $C_{24}H_{46}IOSi$ 505.2357, found 505.2346.

Preparation of (5R)-ethyl 5-((3aR,4S,7aR)-4-((tert-butyldimethylsilyl)oxy)-7a-methyloctahydro-1H-inden-1-yl)-9-hydroxy-9-methyldecanoate (25)

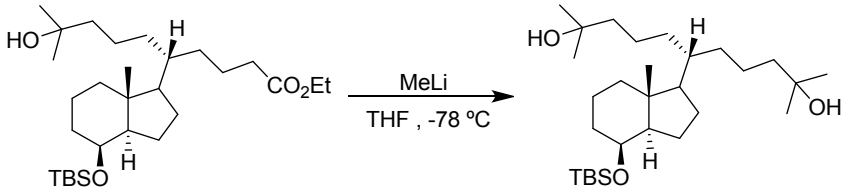


24 **25**

To a solution of Zn (784 mg, 12 mmol) in pyridine (15 mL) was added $NiCl_2 \cdot 6H_2O$ (569 mg, 2.4 mmol), ethyl acrylate (1.3 mL, 12 mmol) and the mixture was heated at 65 ºC till a brown-red colour. After 30 min at the same conditions, the mixture was cooled to 0 ºC and a solution of compound **24** (420 mg, 0.80 mmol) in pyridine (8 mL) was added and the mixture stirred for 90 min. The mixture was allowed to reach room temperature before adding EtOAc (20 mL) and the resultant suspension was filtered over celite. The solution was washed with $CuSO_4$ (10%, 3x20 mL), H_2O (2 x 20 mL) and brine (15 mL). The organic phase was dried over Na_2SO_4 and the solvent removed under reduced pressure. The residue was chromatographed on silica gel using 15% EtOAc/Hexane as eluent, affording **25** (370 mg, 92%) as a colorless liquid; Rf: 0.46 (50% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**3447.13, 2954.02, 2931.75, 2860.40, 1738.51, 1251.58, 1164.31; **$[\alpha]^{24}_D$**=+21.43 (c 1.20, $CHCl_3$); **^{1}H-NMR**

($CDCl_3$, δ):4.09 (2H, q, J=7.1 Hz, OC**H**$_2$CH$_3$), 3.96 (1H, br s, CH-8), 2.23 (2H, m, 2H-24), 1.86 (1H, m), 1.82-1.06 (22H, m), 1.23 (3H, t, J = 7.1Hz, OCH$_2$C**H**$_3$), 1.18 (6H, s, CH$_3$-26, CH$_3$-27), 0.87 (3H, s, CH$_3$-18), 0.86 (9H, s, CH$_3$-*t*Bu), -0.02 (3H, s, CH$_3$-Si), -0.04 (3H, s, CH$_3$-Si); **^{13}C-NMR ($CDCl_3$, δ):**173.9 (C=O), 70.9 (C-25), 69.3 (CH-8), 60.1 (O**C**H$_2$CH$_3$), 52.9 (CH-17), 52.8 (CH-14), 44.3 (CH$_2$), 42.1 (C-13), 40.3 (CH$_2$), 38.4 (CH-20), 34.7 (CH$_2$), 34.0 (CH$_2$), 30.9 (CH$_2$), 30.0 (CH$_2$), 29.2 (CH$_3$-26 o CH$_3$-27), 29.1 (CH$_3$-26 o CH$_3$-27), 26.7 (CH$_2$), 25.7 (CH$_3$-*t*Bu), 22.8 (CH$_2$), 20.7 (CH$_2$), 19.7 (CH$_2$), 17.9 (C-*t*Bu), 17.6 (CH$_2$), 14.2 (CH$_3$-18), 13.7 (OCH$_2$**C**H$_3$), -4.8 (CH$_3$-Si), -5.2 (CH$_3$-Si); **MS (ESI) [m/z, (%)]:**519 (M^+ + Na, 75), 479 (72), 447 (100), 215 (83); **HRMS (ESI)** calcd for $C_{29}H_{56}NaO_4Si$, 519.3840, found 519.3839.

Preparation of 6-((3aR,4S,7aR)-4-((tert-butyldimethylsilyl)oxy)-7a-methyloctahydro-1H-inden-1-yl)-2,10-dimethylundecane-2,10-diol (26)

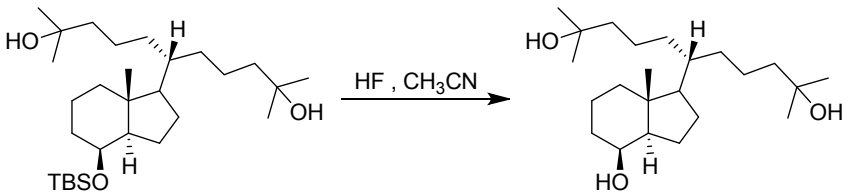


25 **26**

To a solution of ester **25** (140 mg, 0.28 mmol) in THF (3 mL) was added MeLi·LiBr (1.3 mL of a 1.5 M solution in Et_2O, 1.97 mmol) at -78 ºC and the mixture was stirred for 15 min. H_2O (20 mL) was added and the product extracted with CH_2Cl_2 (3 x 15 mL). The combined organic phases were dried, filtered and evaporated to give a residue which was chromatographed on silica gel using 30% EtOAc/Hexane as eluent, affording **26** (135mg, 99%) as a colorless liquid; Rf: 0.32 (50% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**3420.14, 2963.09, 2931.69, 2874.38, 1377.41; **[α]$^{23}_D$**=+1.7 (c 0.5, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):**3.96 (1H, br s, CH-8), 1.86 (1H, m), 1.79-1.10 (24H, m), 1.18 (12H, s, CH$_3$-26, CH$_3$-27, CH$_3$-4', CH$_3$-5'), 0.88 (3H, s, CH$_3$-18), 0.86 (9H, s, CH$_3$-*t*Bu), -0.02 (3H, s, CH$_3$-Si), -0.03 (3H, s, CH$_3$-Si); **^{13}C-NMR ($CDCl_3$, δ):**70.9 (C-25 ó C-3'), 69.4 (CH-8), 53.1 (CH-14 ó CH-17), 53.0 (CH-14 ó CH-17), 44.4 (CH$_2$), 44.3 (CH$_2$), 42.1 (C-13), 40.3 (CH$_2$), 38.5 (CH-20), 34.4 (CH$_2$), 31.2 (CH$_2$), 31.1

(CH_2), 29.3 (CH_3-4' o CH_3-5'), 29.2 (CH_3-26 o CH_3-27), 29.1 (CH_3-26 o CH_3-27), 26.8 (CH_2), 25.7 (CH_3-*t*Bu), 22.9 (CH_2), 19.9 (CH_2), 19.7 (CH_2), 17.9 (C-*t*Bu), 17.7 (CH_2), 13.8 (CH_3-18), -4.8 (CH_3-Si), -5.2 (CH_3-Si); **MS (ESI) [m/z, (%)]:**505 (M^+ + Na, 100), 447 (39), 315 (65), 215 (58); **HRMS (ESI)** calcd for $C_{29}H_{58}NaO_3Si$, 505.4047, found 505.4046.

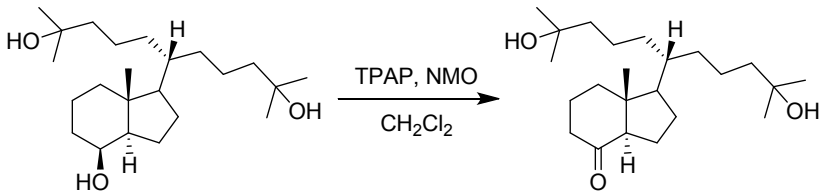
Preparation of 6-((3aR,4S,7aR)-4-hydroxy-7a-methyloctahydro-1H-inden-1-yl)-2,10-dimethylundecane-2,10-diol (27)



26 **27**

To a solution of compound **26** (115 mg, 0.24 mmol) in CH_3CN (5 mL) was added, dropwise, a 48 % aqueous solution of HF and the reaction was followed by TLC. A satured solution of $NaHCO_3$ (10 mL) was added and the product extracted with EtOAc (2 x 10mL). The organic layer was dried over Na_2SO_4, filtered and evaporated. The crude was chromatographed on silica gel using 60% EtOAc/Hexane as eluent, affording **27** (77 mg, 89%) as a colorless liquid; Rf: 0.17 (50% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**3402.24, 2962.99, 2930.31, 2874.85, 1378.14; **[α]$^{25}_D$**=+1.20 (c 0.64, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):**4.07 (1H, br s, CH-8), 1.93 (1H, m), 1.80 (2H, m), 1.67-1.12 (22H, m), 1.21 (12H, s, CH_3-26, CH_3-27, CH_3-4', CH_3-5'), 0.92 (3H, s, CH_3-18); **^{13}C-NMR ($CDCl_3$, δ):**71.1 (C-25 ó C-3'), 69.4 (CH-8), 52.9 (CH-14 ó CH-17), 52.6 (CH-14 ó CH-17), 44.5 (CH_2), 44.4 (CH_2), 41.9 (C-13), 40.1 (CH_2), 38.6 (CH-20), 33.6 (CH_2), 31.2 (CH_2), 31.0 (CH_2), 29.3 (CH_3-4' o CH_3-5'), 29.2 (CH_3-26 o CH_3-27), 29.1 (CH_3-26 o CH_3-27), 26.7 (CH_2), 22.4 (CH_2), 20.0 (CH_2), 19.8 (CH_2), 17.5 (CH_2), 13.6 (CH_3-18); **MS (ESI) [m/z, (%)]:**391 (M^+ + Na, 100), 315 (34); **HRMS (ESI)** calcd for $C_{23}H_{44}NaO_3$ 391.3182, found 391.3177.

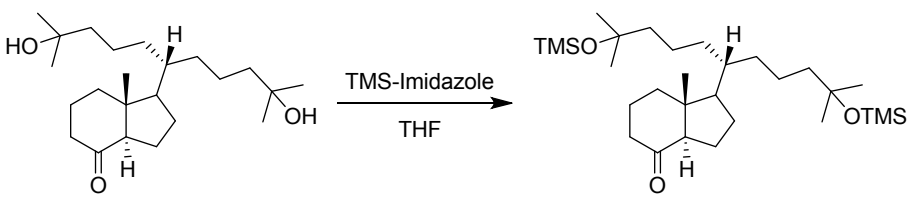
Preparation of (3aR,7aR)-1-(2,10-dihydroxy-2,10-dimethylundecan-6-yl)-7a-methylhexahydro-1H-inden-4(2H)-one (28)



27 **28**

To a solution of compound **27** (58 mg, 0.16 mmol) in CH_2Cl_2 (3 mL) were added 4Å molecular sieves (50mg), NMO (55 mg, 0.47 mmol) and a catalytic amount of TPAP (5 mg). The resulting greenish solution was stirred at room temperature for 12 h. The solvent was rotatory evaporated to afford a residue which was chromatographed on silica gel using 60% EtOAc/Hexane as eluent, affording ketone **28** (55 mg, 95%) as a colorless liquid. Rf: 0.52 (10% MeOH/CH_2Cl_2);**IR (NaCl, cm^{-1}):** 3398.29, 2960.20, 2874.86, 1725.78, 1457.92, 1248.68, 1042.34;**$[\alpha]^{24}_D$=** -9.0 (c 1.3, $CHCl_3$);**^{1}H-NMR ($CDCl_3$, δ):**2.45 (1H, dd, J = 11.4Hz, J = 7.6 Hz, H-14), 2.24 (2H, m), 2.02 (2H, m), 1.96-1.23 (25H, m), 1.22 (6H, s, CH_3-26, CH_3-27 o CH_3-4', CH_3-5'), 1.21 (6H, s, CH_3-26, CH_3-27 o CH_3-4', CH_3-5'), 0.63 (3H, s, CH_3-18);**^{13}C-NMR ($CDCl_3$, δ):** 212.1 (C=O), 70.8 (C-25 ó C-3'), 61.8 (CH-14), 53.1 (CH-17), 49.9 (C-13), 44.3 (CH_2), 44.2 (CH_2), 40.8 (CH_2), 38.8 (CH-20), 38.5 (CH_2), 31.3 (CH_2), 31.2 (CH_2), 29.3 (CH_3-4' o CH_3-5'), 29.2 (CH_3-26 o CH_3-27), 29.1 (CH_3-26 o CH_3-27), 26.8 (CH_2), 23.9 (CH_2), 19.9 (CH_2), 19.7 (CH_2), 18.8 (CH_2), 12.5 (CH_3-18); **MS (ESI) [m/z, (%)]:**389 (M^+ + Na, 32), 349 (M^+ - OH, 100), 331 (56), 215 (31);**HRMS (ESI)** calcd for $C_{23}H_{42}NaO_3$, 389.3026, found 389.3028.

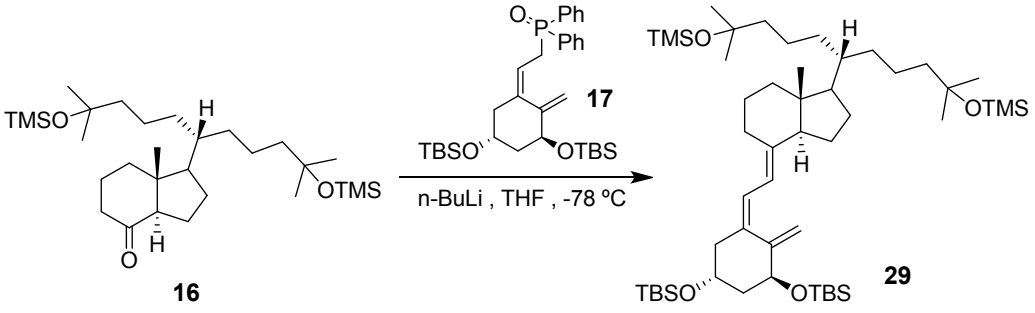
Preparation of (3aR,7aR)-7a-methyl-1-(2,2,4,4,12,12,14,14-octamethyl-3,13-dioxa-2,14-disilapentadecan-8-yl)hexahydro-1H-inden-4(2H)-one (16)



28 **16**

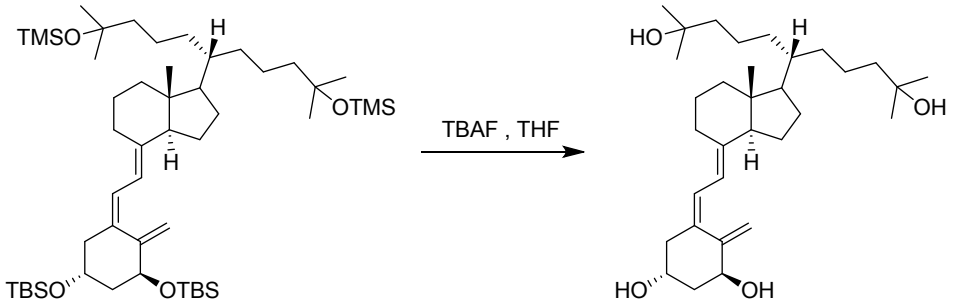
To a solution of compound **28** (39 mg, 0.11 mmol) in THF (2 mL) was added TMS-Imidazole (312 µL, 2.13 mmol) and the solution was stirred at room temperature for 40 h. H_2O (5 mL) was added and the product extracted with CH_2Cl_2 (3 x 5 mL). The organic layer was dried over Na_2SO_4, filtered and evaporated. The crude was chromatographed on silica gel using 5% EtOAc/Hexane as eluent, affording **16** (49 mg, 91%)as a colorless liquid; Rf: 0.66 (30% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**2960.29, 2874.86, 1717.69, 1457.82, 1248.68, 1042.34, 852.50; **[α]$^{25}_{D}$**=-6.2 (c 2.3, $CHCl_3$); **^{1}H-NMR ($CDCl_3$, δ):**2.45 (1H, dd, J = 11.4 Hz, J = 7.6 Hz, H-14), 2.24 (2H, m), 2.03 (2H, m), 1.95-1.22 (20H, m), 1.21 (6H, s, CH_3-26, CH_3-27 o CH_3-4', CH_3-5'), 1.20 (6H, s, CH_3-26, CH_3-27 o CH_3-4', CH_3-5'), 0.63 (3H, s, CH_3-18), 0.10 (9H, s, CH_3-Si), 0.10 (9H, s, CH_3-Si); **^{13}C-NMR ($CDCl_3$, δ):**212.1 (C=O), 73.9 (C-25 ó C-3'), 73.9 (C-25 ó C-3'), 61.9 (CH-14), 53.2 (CH-17), 49.9 (C-13), 45.3 (CH_2), 45.3 (CH_2), 40.9 (CH_2), 39.0 (CH-20), 38.7 (CH_2), 31.2 (CH_2), 31.1 (CH_2), 29.9 (CH_3-4' o CH_3-5'), 29.8 (CH_3-26 o CH_3-27), 29.7 (CH_3-26 o CH_3-27), 27.0 (CH_2), 24.1 (CH_2), 20.2 (CH_2), 19.7 (CH_2), 18.9 (CH_2), 12.5 (CH_3-18), 2.6 (CH_3-Si); **MS (ESI) [m/z, (%)]:**533 (M^+ + Na, 100), 511 (M^+ + 1, 36); **HRMS (ESI)** calcd for $C_{29}H_{58}NaO_3Si_2$, 533.3816, found 533.3814.

Preparation of 8-((3aS,7aR,E)-4-((Z)-2-((3S,5R)-3,5-bis((tert-butyldimethylsilyl)oxy)-2-methylenecyclohexylidene)ethylidene)-7a-methyloctahydro-1H-inden-1-yl)-2,2,4,4,12,12,14,14-octamethyl-3,13-dioxa-2,14-disilapentadecane (29)



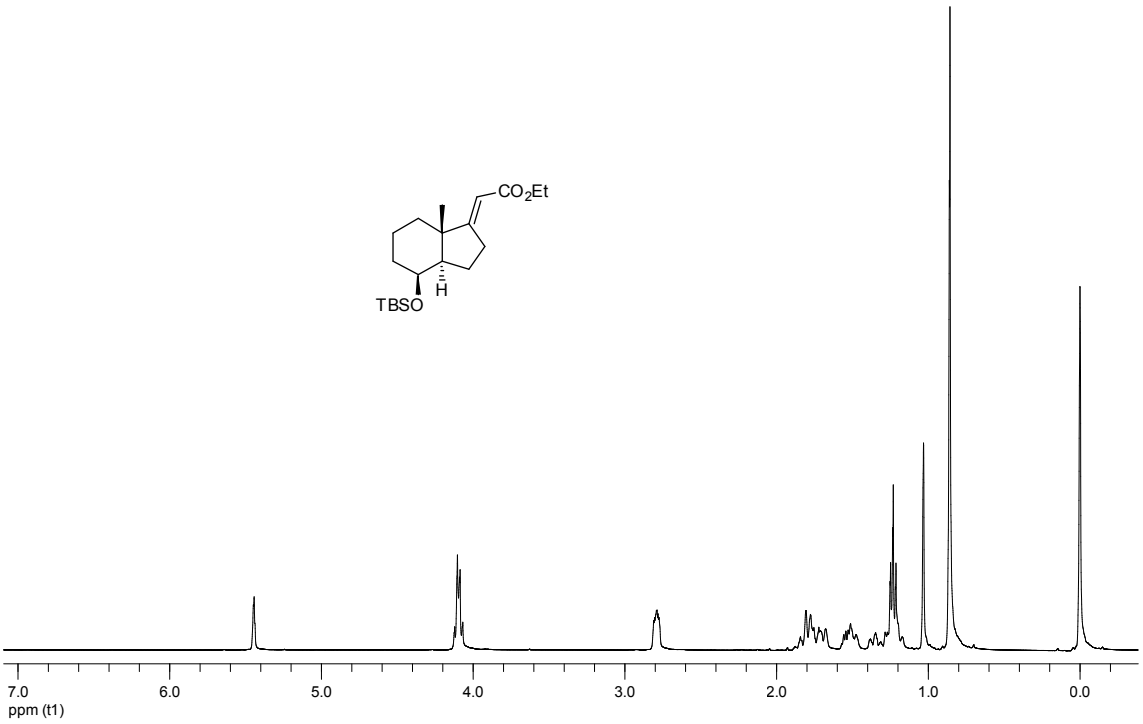
To a solution of phosphine oxide **17** (413 mg, 0.71 mmol) in THF (2 mL) was added dropwise *n*-BuLi (260 µL of a 2.5 M solution in THF, 0.65mmol) at -78 ºC and the mixture was stirred for 30 min. A solution of ketone **16** (52 mg, 0.1 mmol) in THF (2 mL) was added at the same conditions and stirred for 1 h. A saturated aqueous solution of NH_4Cl (5 mL) was added and the mixture was extracted with EtOAc (3x5 mL). The organic phase was dried over Na_2SO_4 and the solvent removed under reduced pressure. The residue was chromatographed on silica gel using 2% EtOAc/Hexane as eluent, affording **29** (81 mg, 91%) as a colorless liquid; Rf: 0.68 (10% EtOAc/Hexane); **IR (NaCl,cm^{-1}):**2961.20, 2875.86, 1684.32, 1634.85, 1495.56, 1265.34, 1085.32, 849.69; **$[\alpha]^{23}_D$**=-4.6 (c 0.9, $CHCl_3$; **^{1}H-NMR ($CDCl_3$, δ):**6.24 (1H, d, J = 11.2 Hz, H-6), 6.02 (1H, d, J = 11.2 Hz, H-7), 5.18 (1H, br s, H-19), 4.87 (1H, br s, H-19), 4.37 (1H, dd, J = 6.6 Hz, J = 3.5 Hz, H-1), 4.19 (1H, m, H-3), 2.83 (1H, m), 2.45 (1H, dd, J = 13.1Hz, J = 3.5 Hz), 2.22 (1H, dd, J = 13.1Hz, J = 7.4 Hz), 1.97 (2H, m), 1.82 (3H, m), 1.65 (2H, m), 1.58-1.21 (19H, m), 1.20 (12H, s, CH_3-26, CH_3-27, CH_3-4', CH_3-5'), 0.88 (18H, s, CH_3-Si), 0.53 (3H, s, CH_3-18), 0.10 (18H, s, CH_3-Si), 0.06 (12H, s, CH_3-Si); **^{13}C-NMR ($CDCl_3$, δ):**148. (C-10), 141.1 (C-8), 134.9 (C-5), 123.2 (CH-6), 117.8 (CH-7), 111.2 (CH_2-19), 74.1 (C-25), 74.0 (C-3'), 72.1 (CH-1), 67.5 (CH-3), 56.3 (CH-14), 53.0 (CH-17), 46.0 (CH_2), 45.8 (C-13), 45.4 (CH_2), 44.8 (CH_2), 40.3 (CH_2), 39.6 (CH-20), 31.4 (CH_2), 31.2 (CH_2), 29.9 (CH_3-4' o CH_3-5'), 29.9 (CH_3-26 o CH_3-27), 29.8 (CH_3-26 o CH_3-27), 28.9 (CH_2), 27.2 (CH_2), 25.8 (CH_3-*t*Bu), 25.8 (CH_3-*t*Bu), 23.5 (CH_2), 22.0 (CH_2), 20.3 (CH_2), 19.7 (CH_2), 18.2 (C-*t*Bu), 18.1 (C-*t*Bu), 12.0 (CH_3-18), 2.6 (CH_3-Si), -4.6 (CH_3-Si), -4.6 (CH_3-Si), -4.8 (CH_3-Si), -5.1 (CH_3-Si); **MS (ESI) [m/z, (%)]:**874 (M^+, 62), 873 (M^+ - 1, 100), 579 (36), 457 (22); **HRMS (ESI)** calcd for $C_{50}H_{97}NaO_4Si_4$ 873.6458, found 873.6455.

Preparation of (1R,3S,Z)-5-((E)-2-((3aS,7aR)-1-(2,10-dihydroxy-2,10-dimethylundecan-6-yl)-7a-methylhexahydro-1H-inden-4(2H)-ylidene)ethylidene)-4-methylenecyclohexane-1,3-diol (Gemini)



29 **Gemini**

To a solution of **29** (70 mg, 0.079 mmol) in THF (4 mL) was added TBAF (1.6 mL of a 1 M solution in THF, 1.6mmol) and the solution was stirred for 48 h. A saturated aqueous solution of NH_4Cl (5 mL) was added and the product extracted with EtOAc (2 x 5 mL). The organic phase was dried over Na_2SO_4 and the residue was chromatographed on silica gel using 5% MeOH/ CH_2Cl_2 as eluent, affording **Gemini** (38 mg, 95%) as a white solid; m.p: 86 ºC;Rf: 0.40 (AcOEt); **IR (NaCl,cm^{-1}):**3392.66,2960.27, 2928.862875.86, 1684.32, 1634.89, 1457.44; **[α]$^{24}_D$**=+12.86 (c 1.26, EtOH); **^{1}H-NMR (CDCl$_3$, δ):**6.35 (1H, d, J = 11.2 Hz, H-6), 6.01 (1H, d, J = 11.2 Hz, H-7), 5.31 (1H, br s, H-19), 4.98 (1H, br s, H-19), 4.41 (1H, dd, J = 7.8 Hz, J = 4.2 Hz, H-1), 4.20 (1H, m, H-3), 2.81 (1H, dd, J = 12.0, 3.4 Hz), 2.57 (1H, dd, J = 13.4 Hz, J = 2.9 Hz), 2.30 (1H, dd, J = 13.4 Hz, J = 6.4 Hz), 2.05-1.73 (10H, m), 1.65 (2H, m), 1.58-1.21 (14H, m), 1.20 (12H, s, CH_3-26, CH_3-27, CH_3-4', CH_3-5'), 0.52 (3H, s, CH_3-18); **^{13}C-NMR (CDCl$_3$, δ):**147.6 (C-10), 142.9 (C-8), 133.1 (C-5), 124.8 (CH-6), 117.1 (CH-7), 111.7 (CH_2-19), 71.1 (CH-1), 70.6 (C-25 ò C-3'), 66.7 (CH-3), 56.2 (CH-14), 52.9 (CH-17), 45.9 (C-13), 45.1 (CH_2), 44.4 (CH_2), 44.3 (CH_2), 42.7 (CH_2), 40.1 (CH_2), 39.4 (CH-20), 31.3 (CH_2), 31.2 (CH_2), 29.3 (CH_3-4' o CH_3-5'), 29.1 (CH_3-26 o CH_3-27), 29.1 (CH_3-26 o CH_3-27), 29.0 (CH_2), 27.1 (CH_2), 23.5 (CH_2), 22.1 (CH_2), 20.0 (CH_2), 19.7 (CH_2), 12.1 (CH_3-18); **MS (ESI) [m/z, (%)]:**525 (M^+ + Na, 100), 467 (52), 449 (25); **HRMS (ESI)** calcd for $C_{32}H_{54}NaO_4$ 525.3914, found 525.3910.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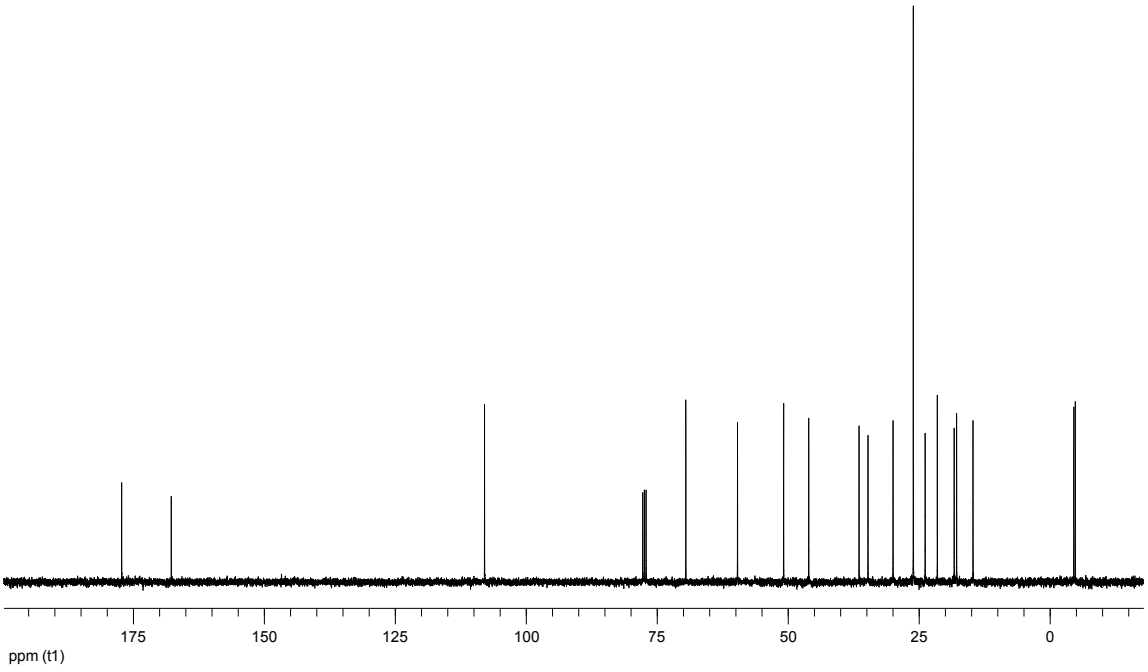
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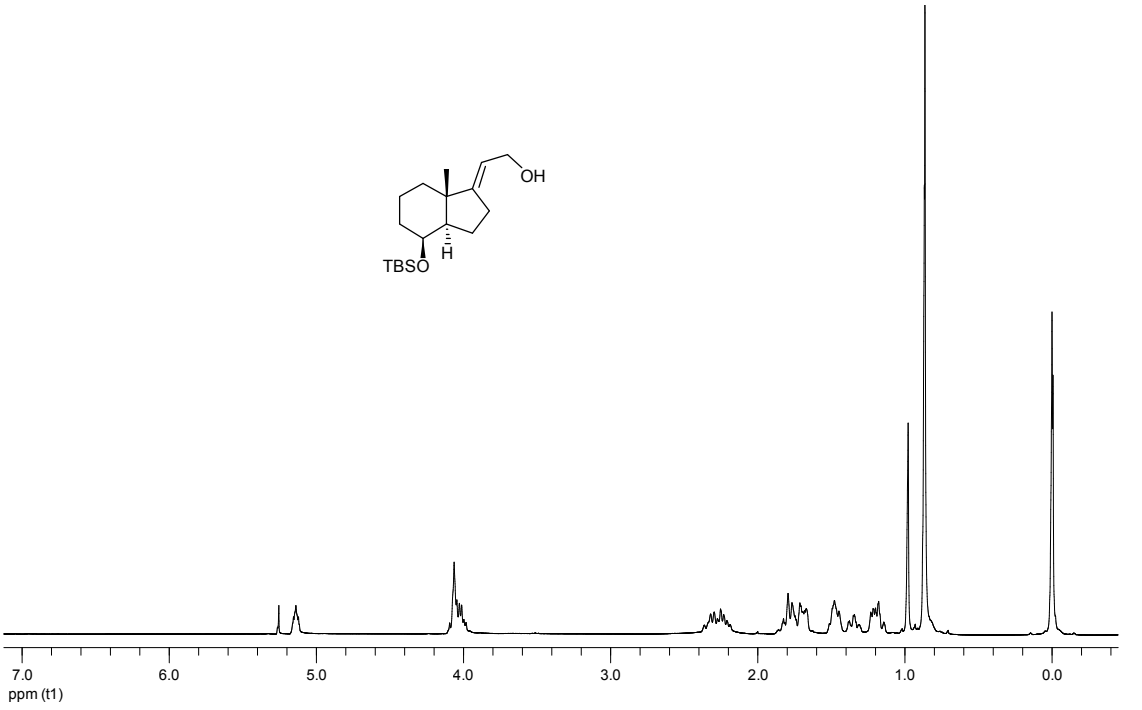
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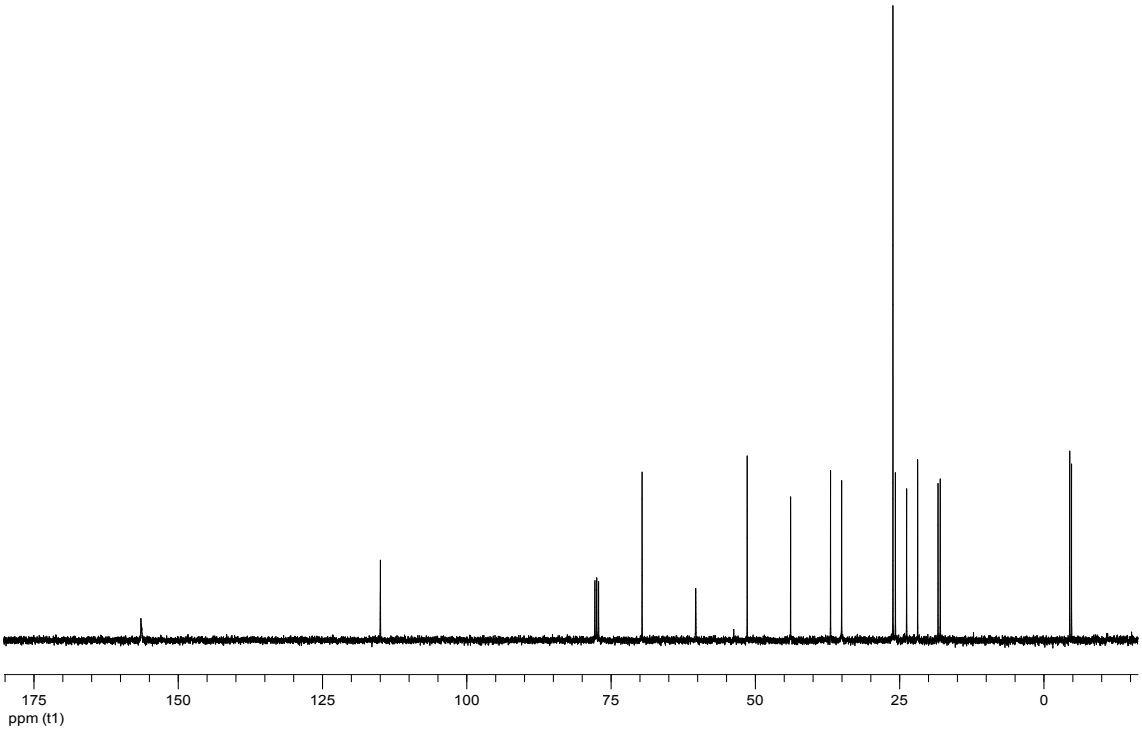
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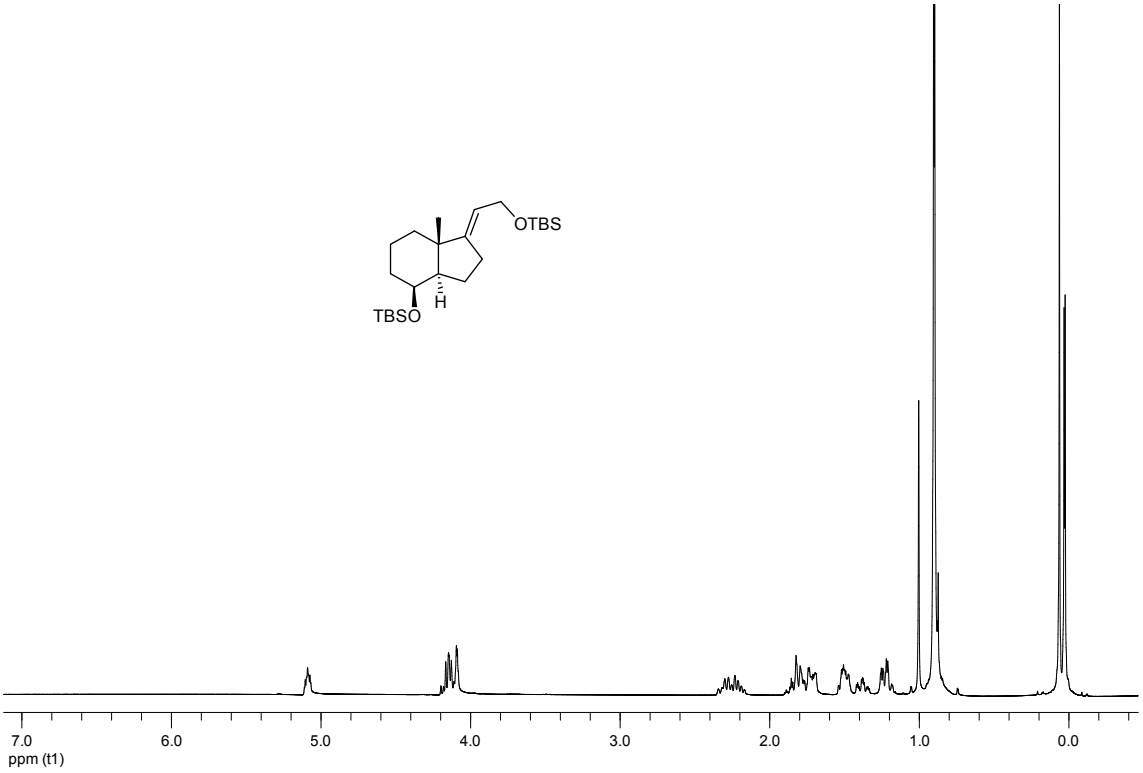
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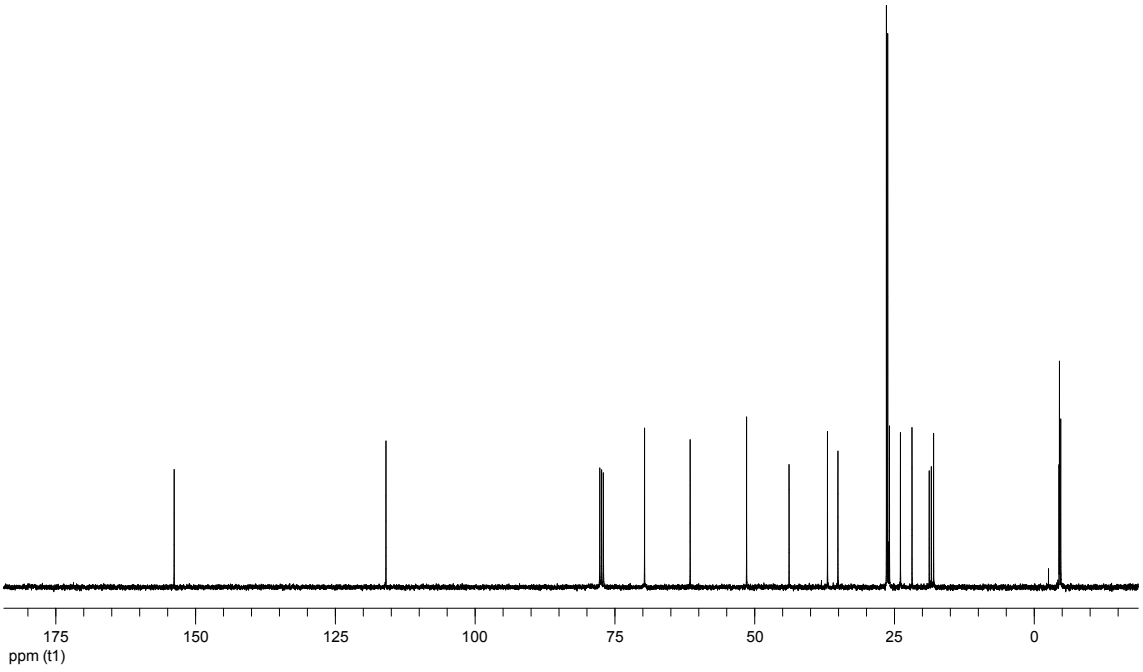
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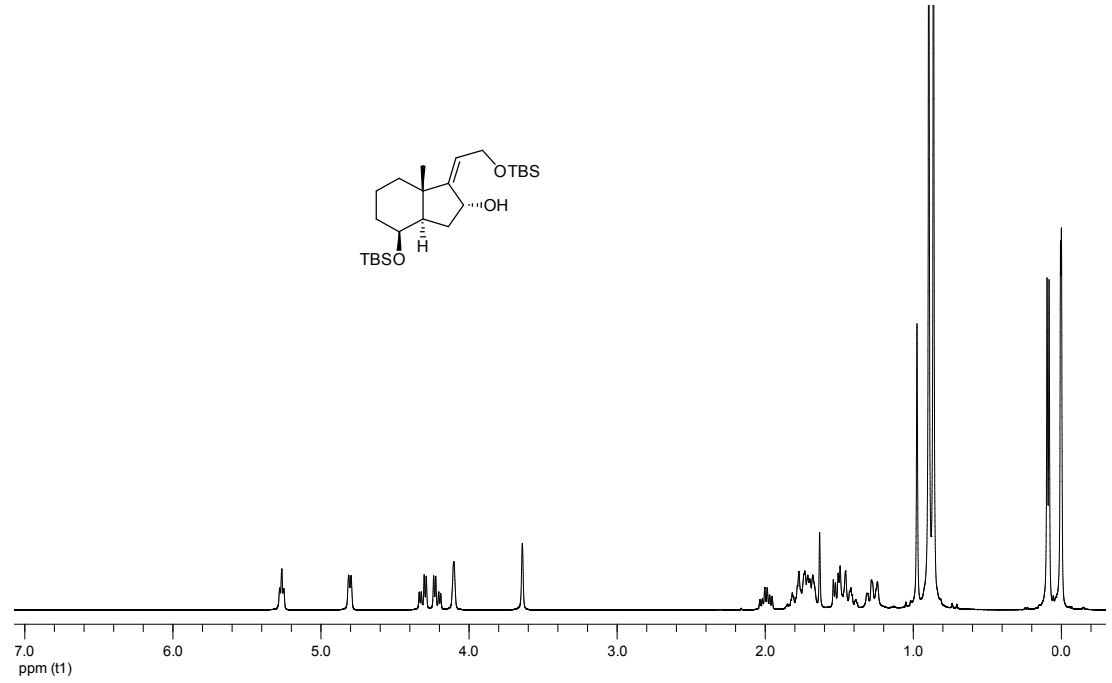
ppm (t1)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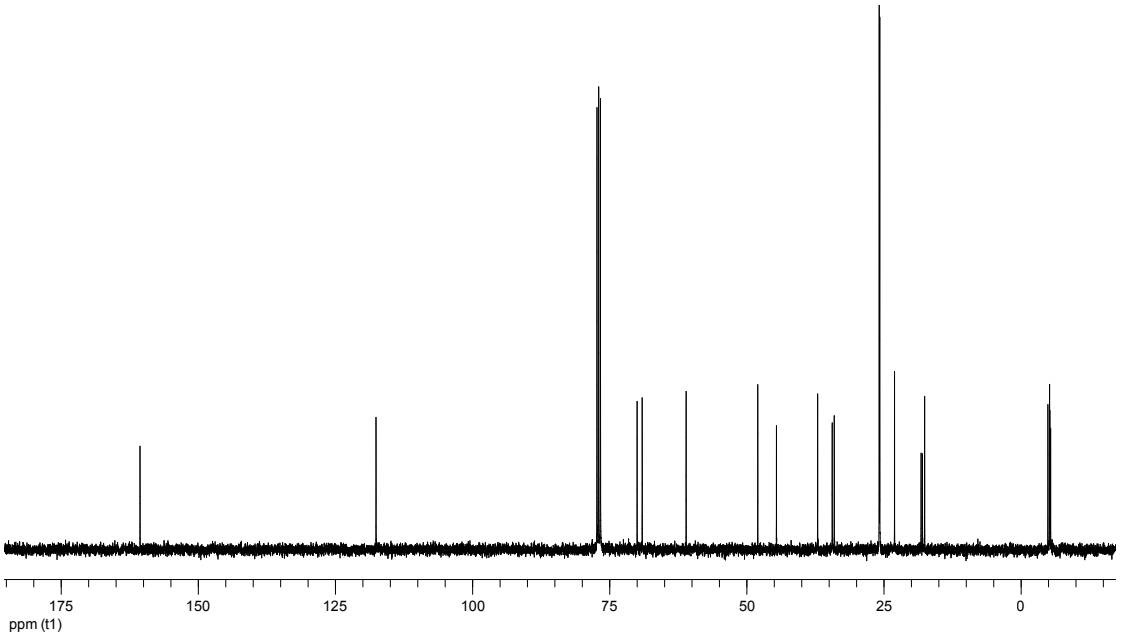
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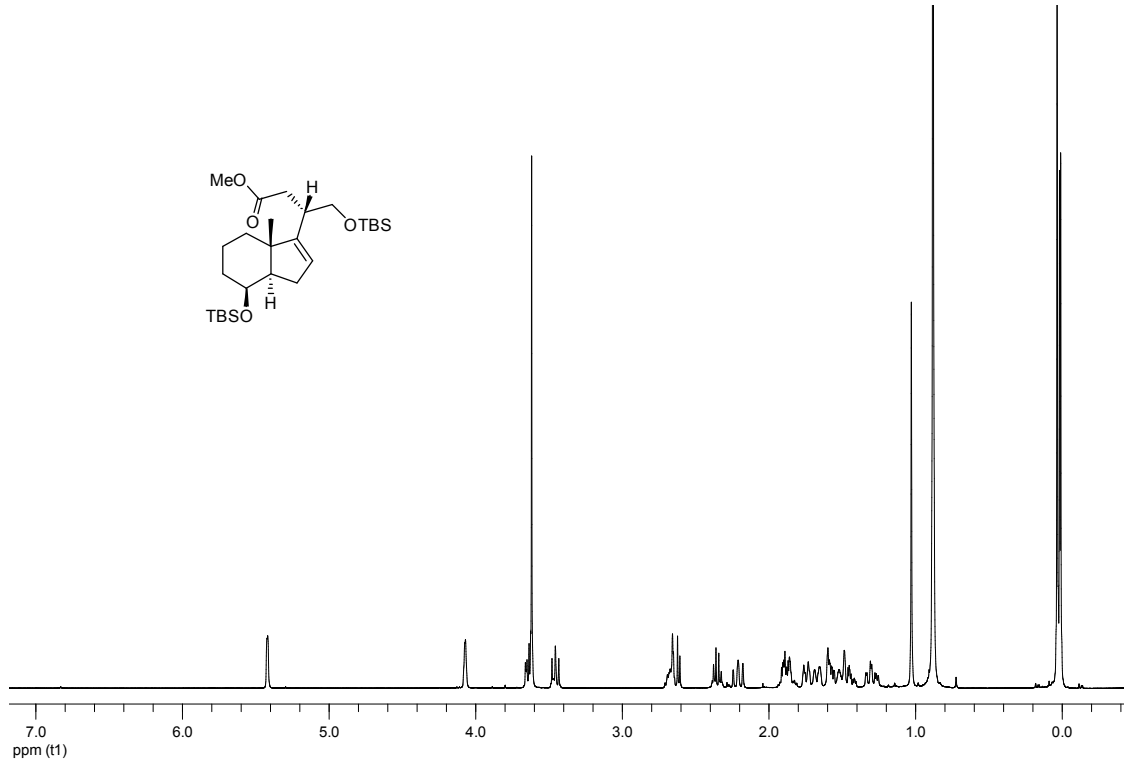
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OTBS
TBSO
H
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6.0
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4.0
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2.0
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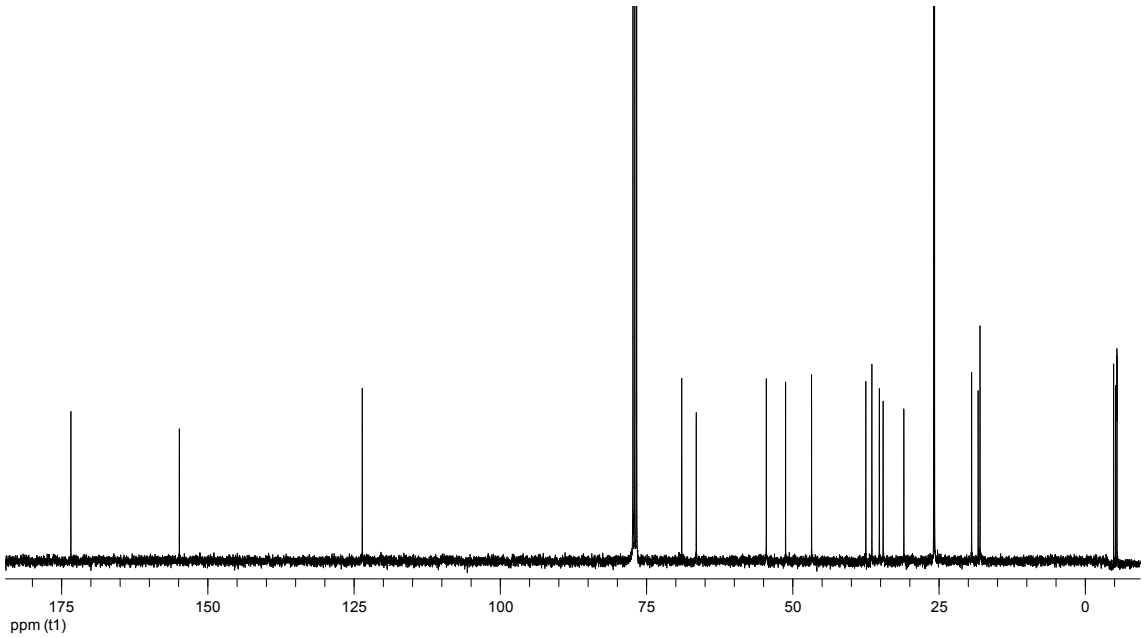
0.0
ppm (t1)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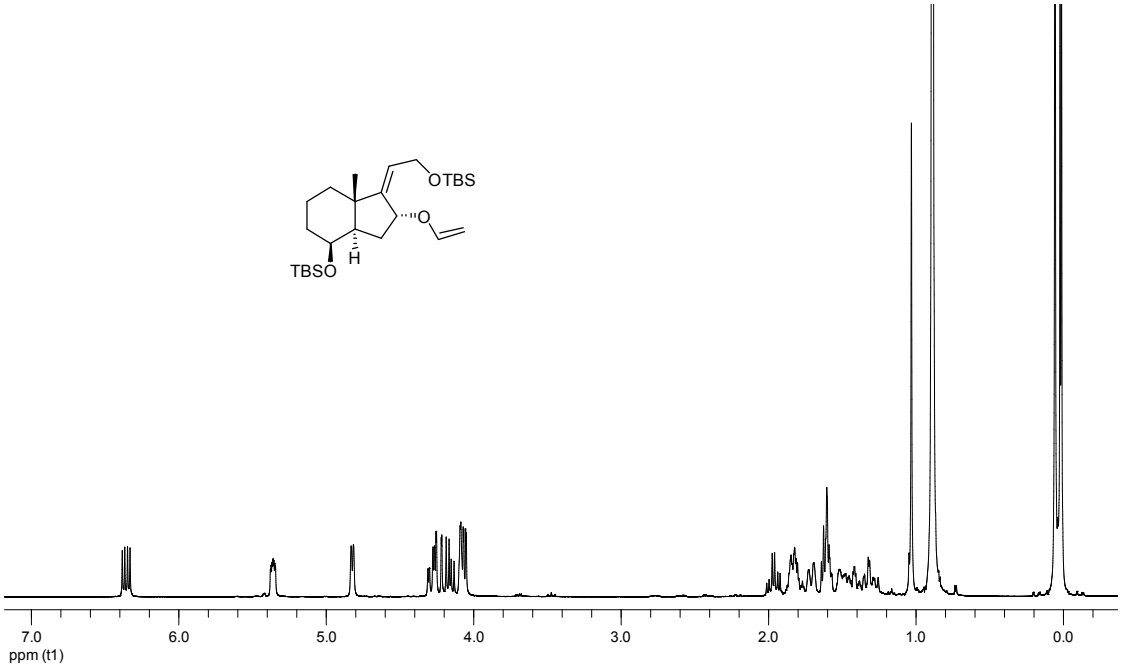
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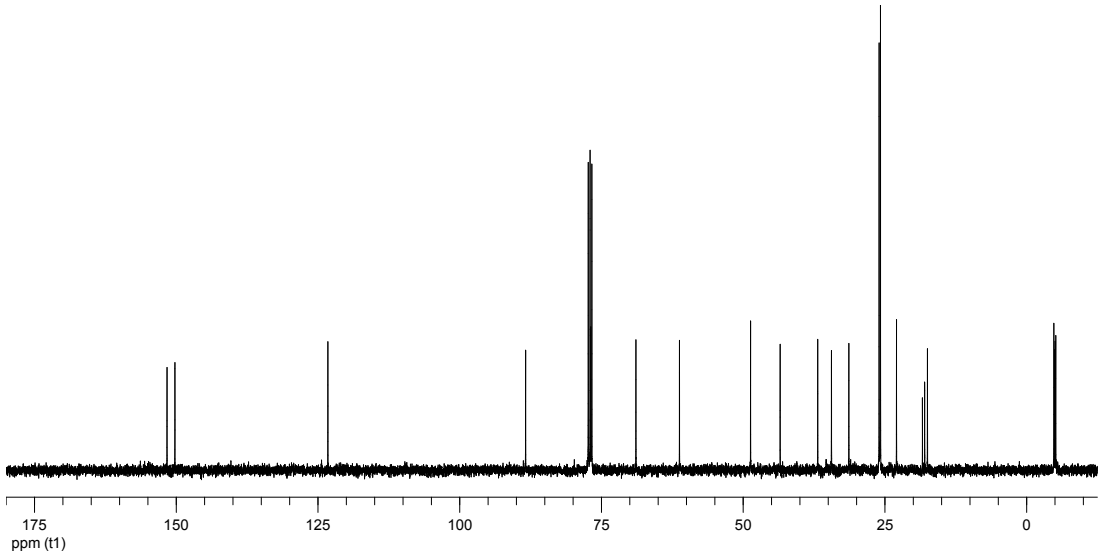
ppm (t1)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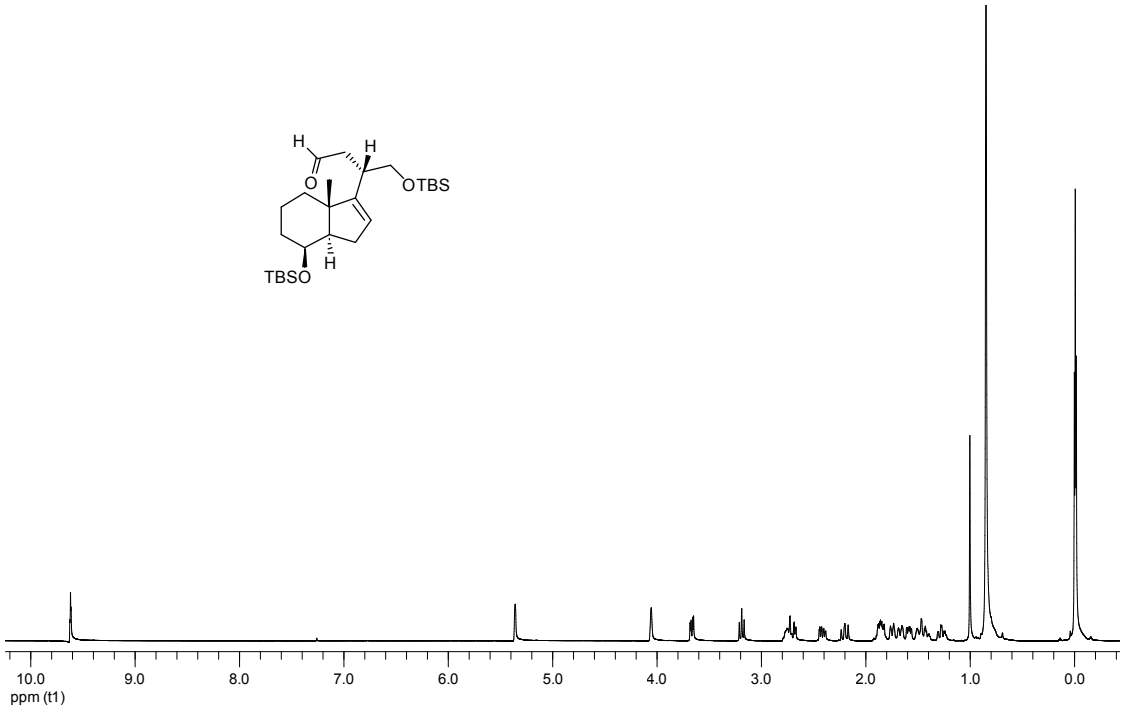
ppm (t1)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7.0
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5.0
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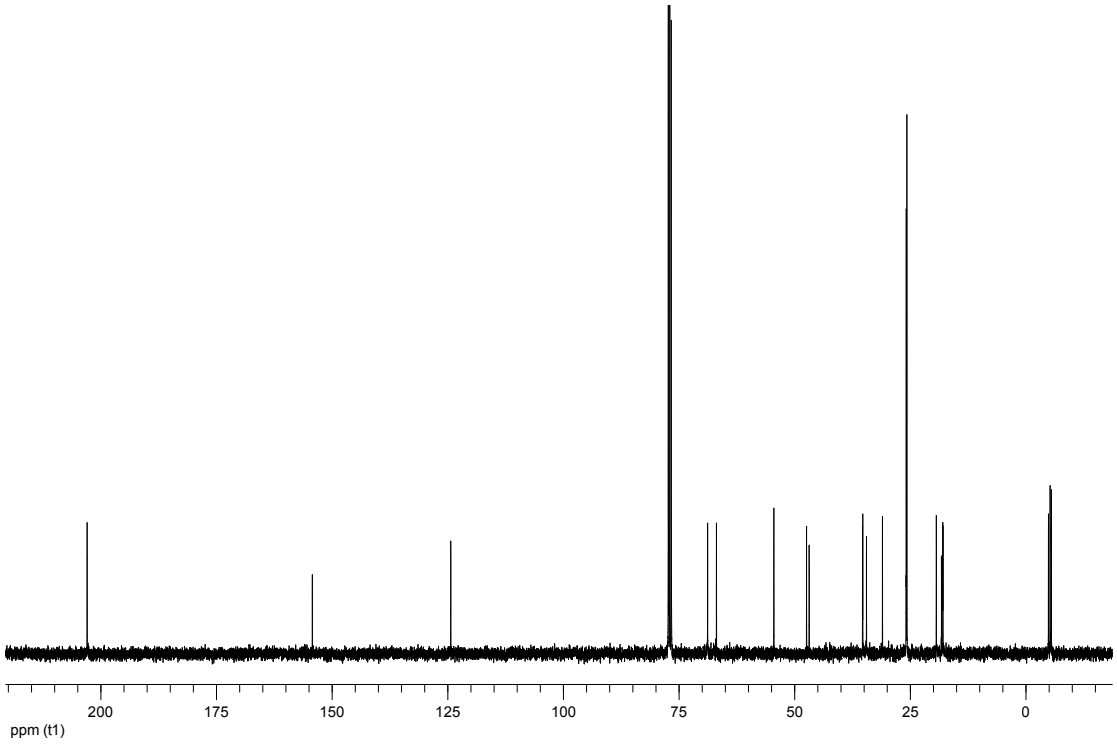
1.0
0.0
ppm (t1)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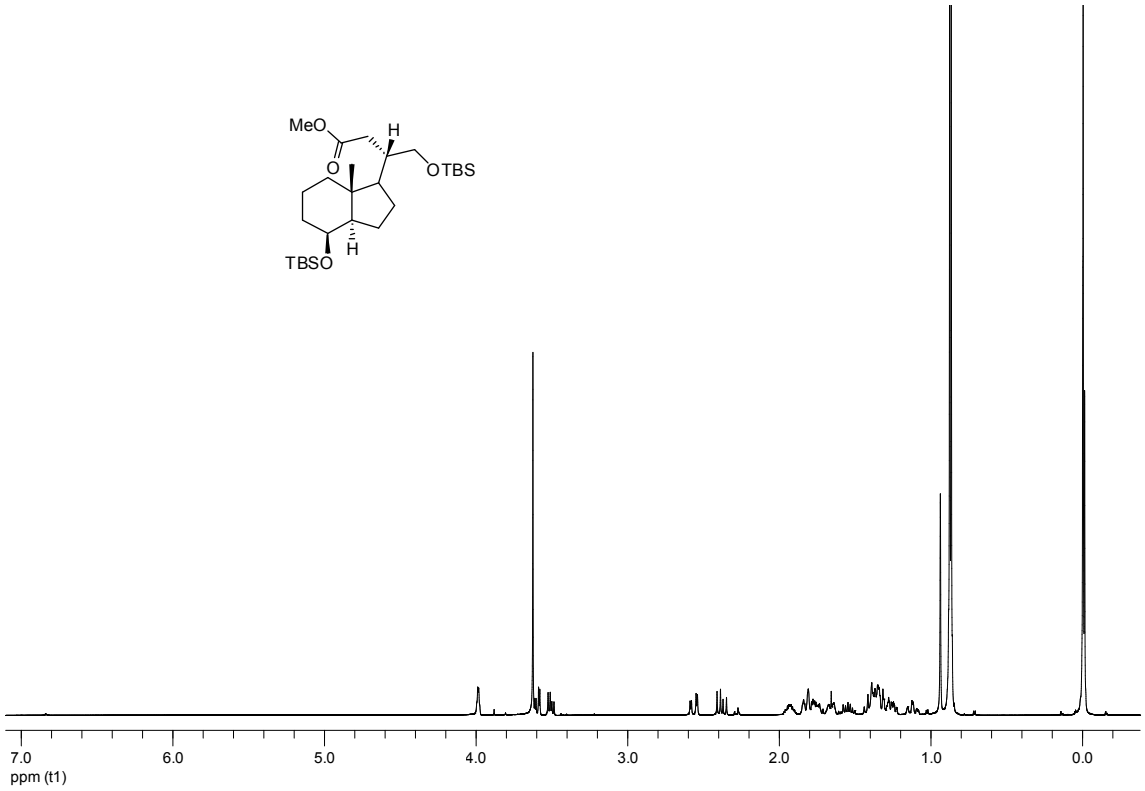
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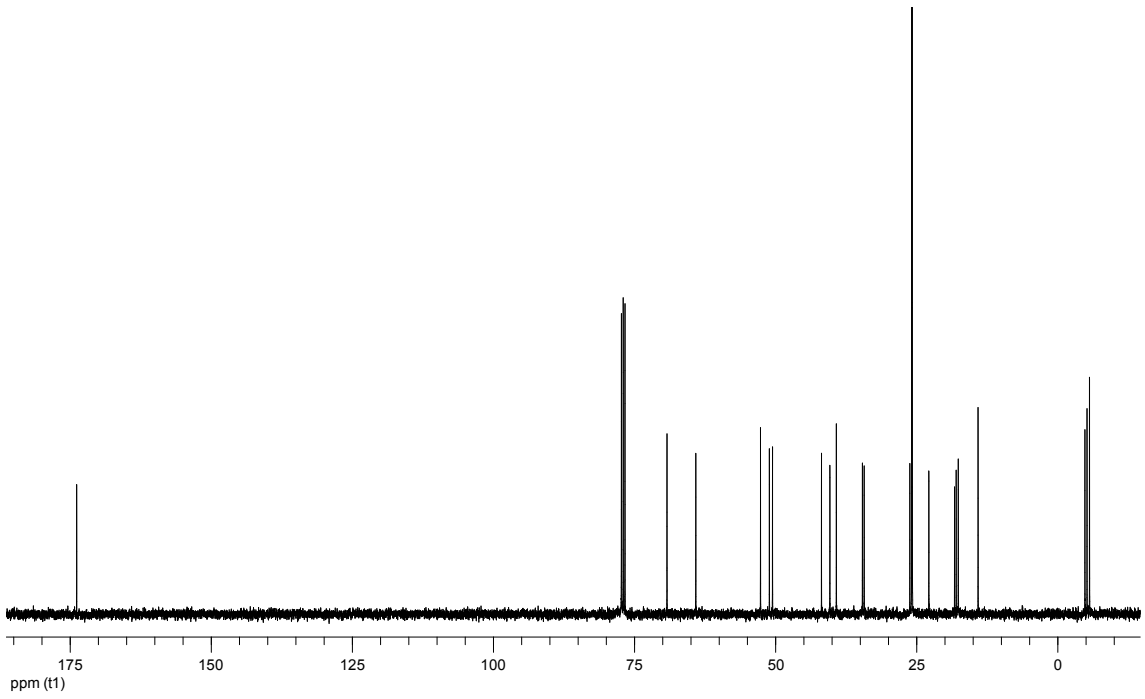
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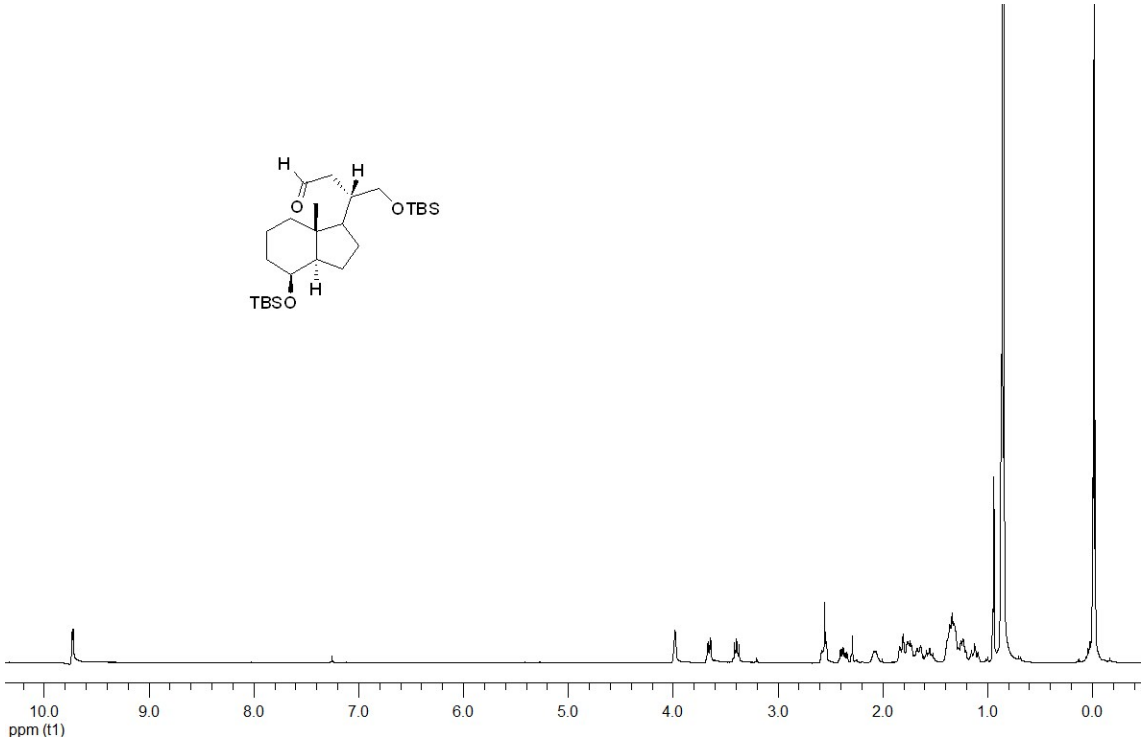
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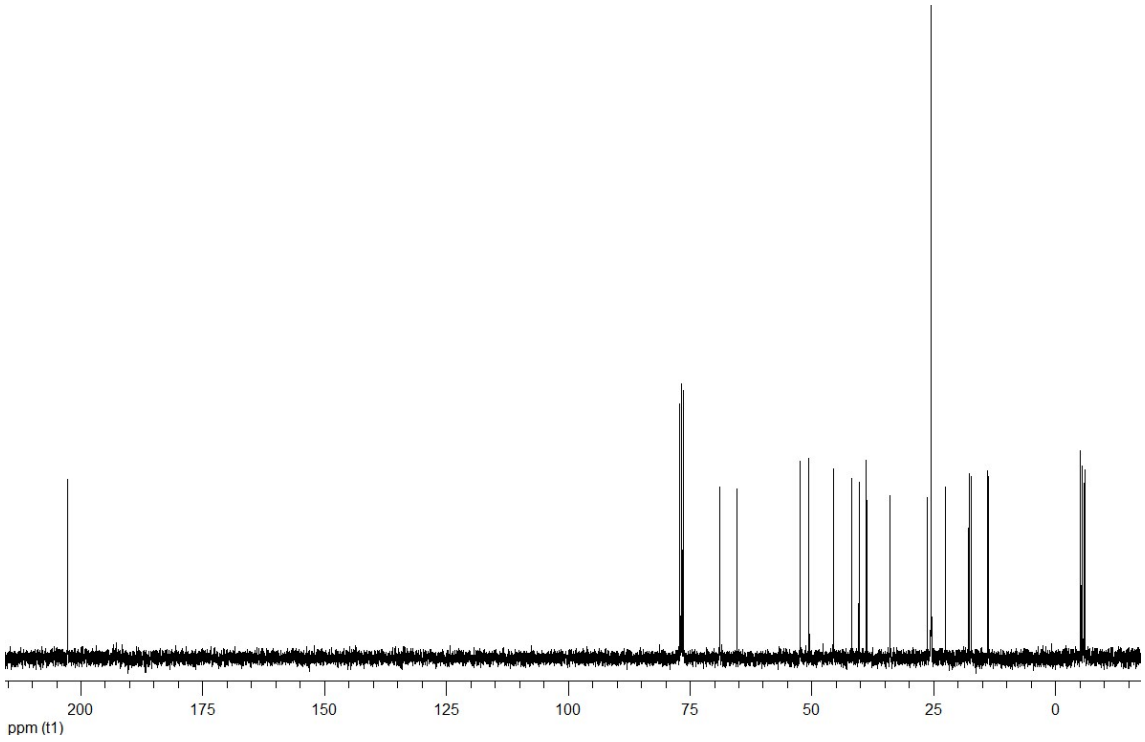
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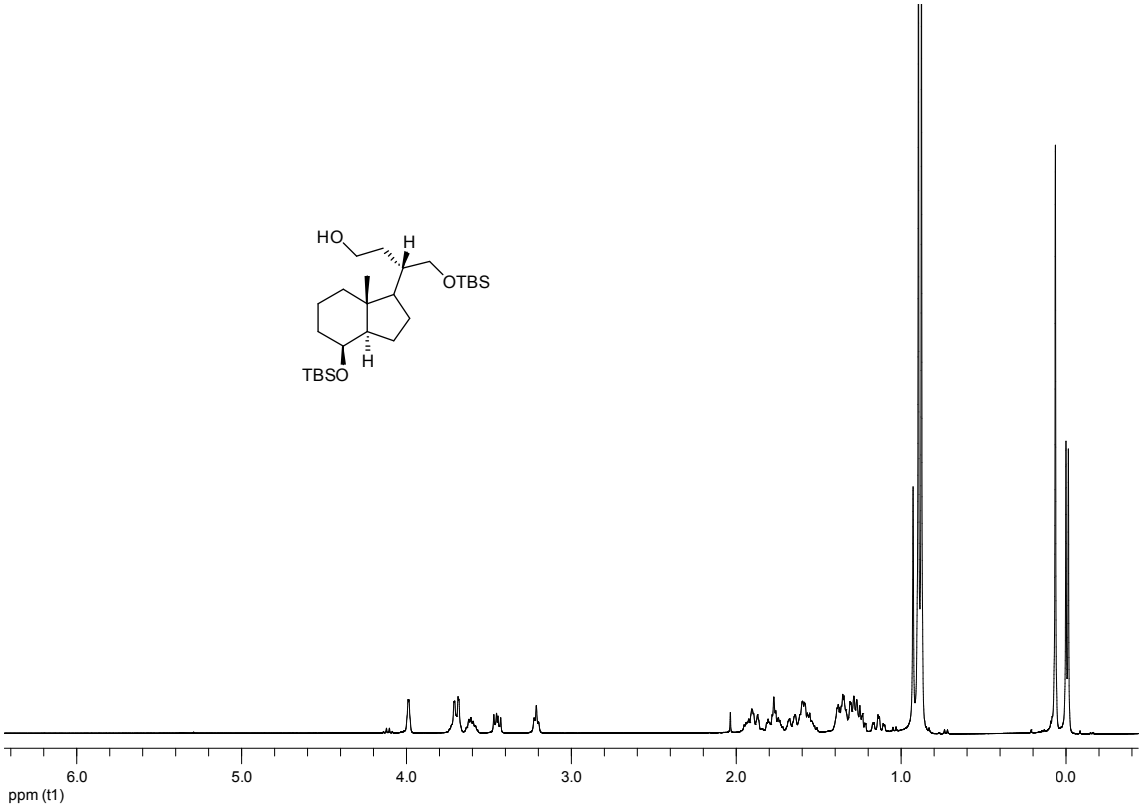
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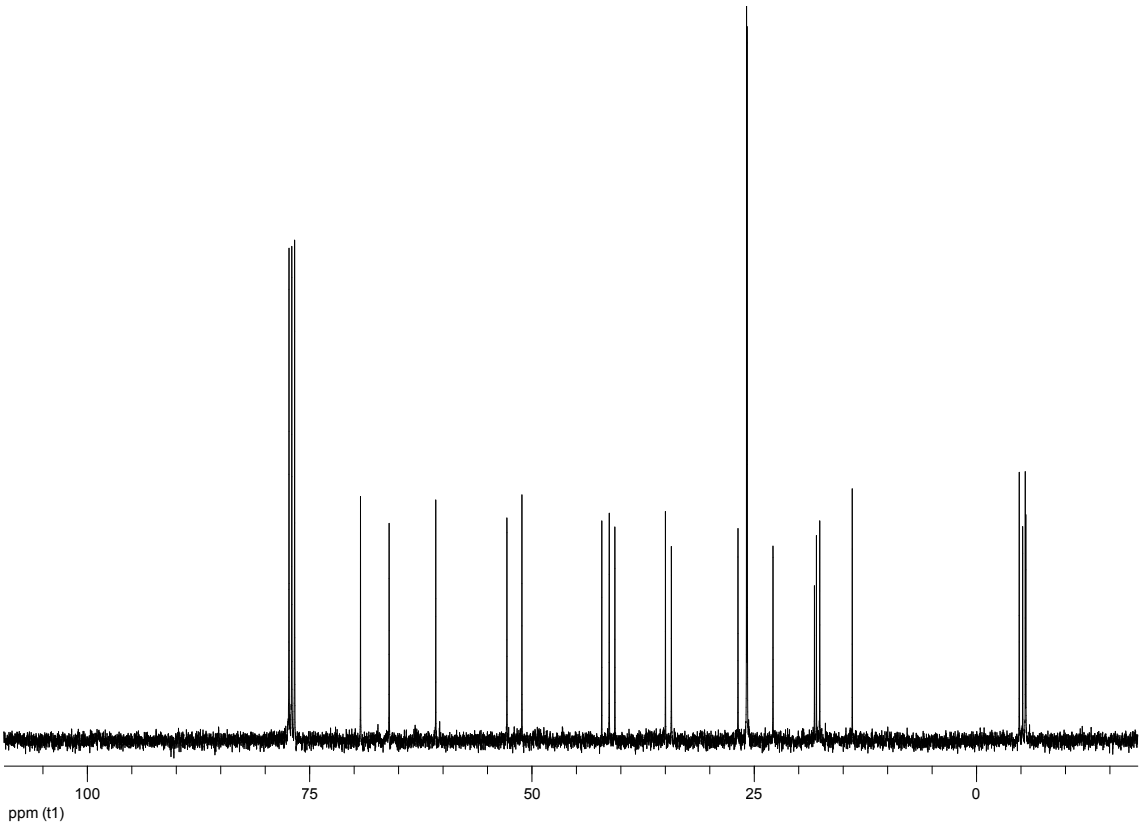
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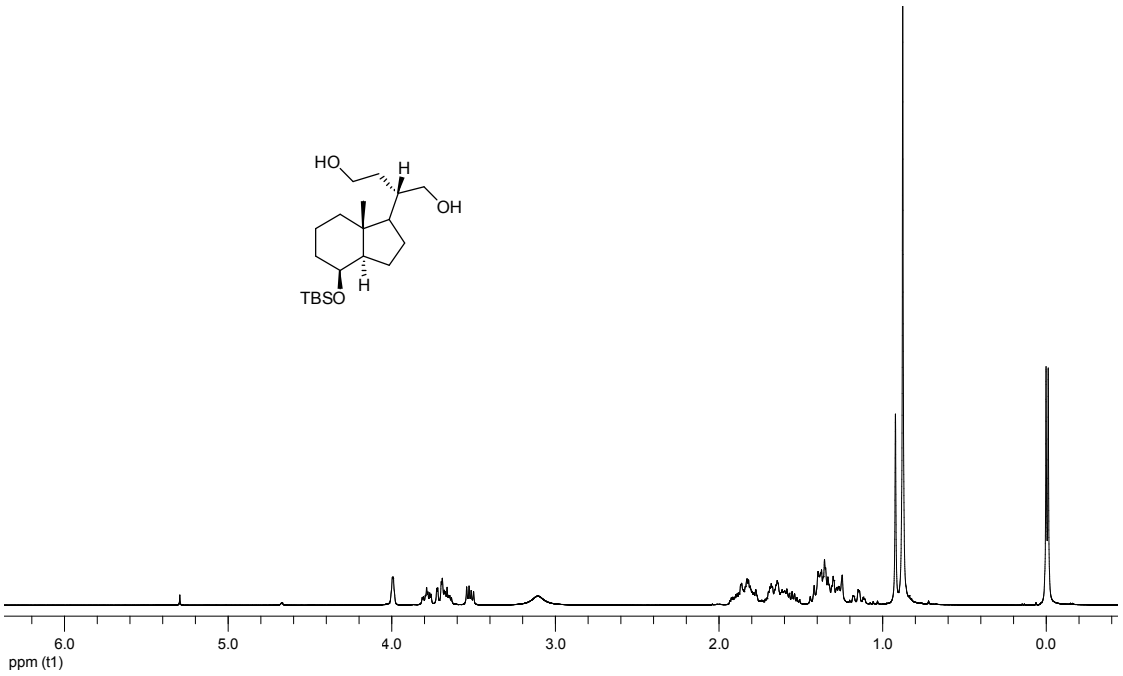
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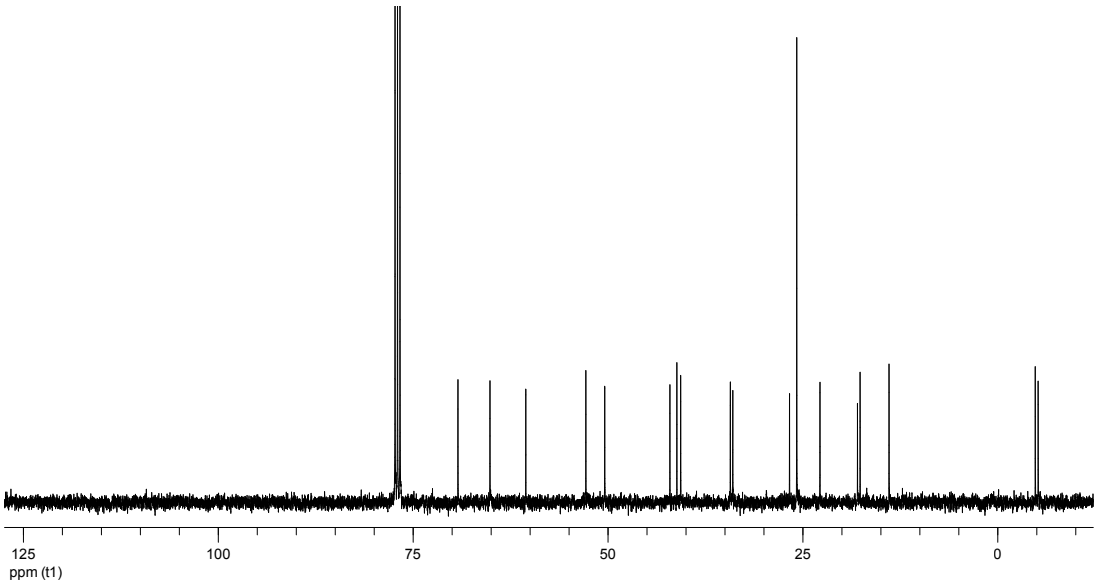
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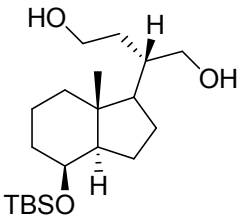
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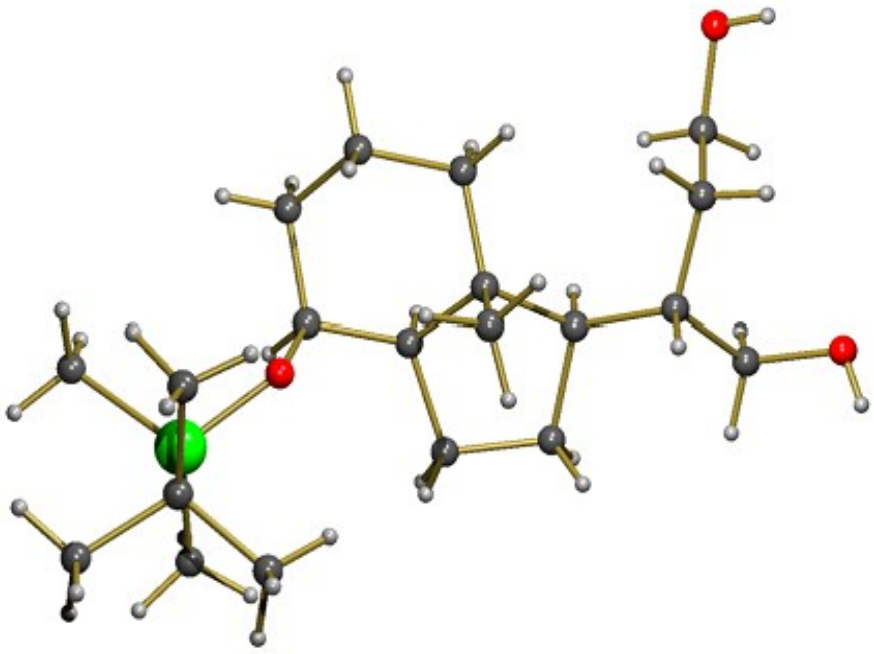

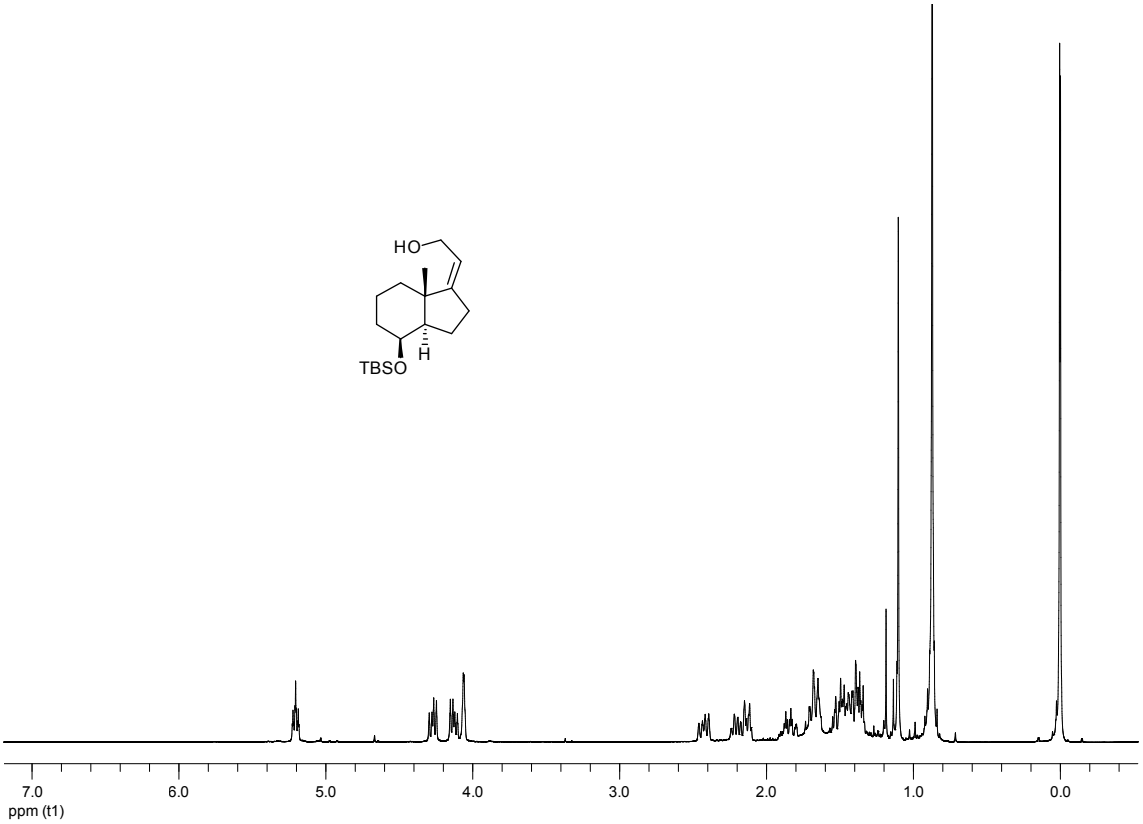
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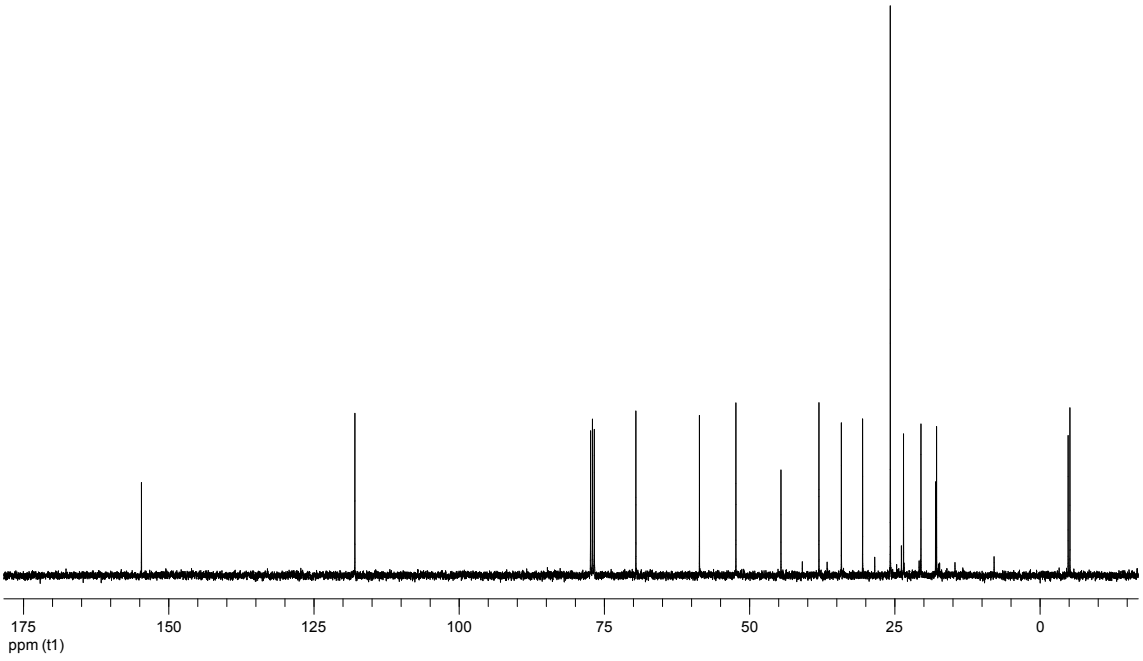
ppm (t1)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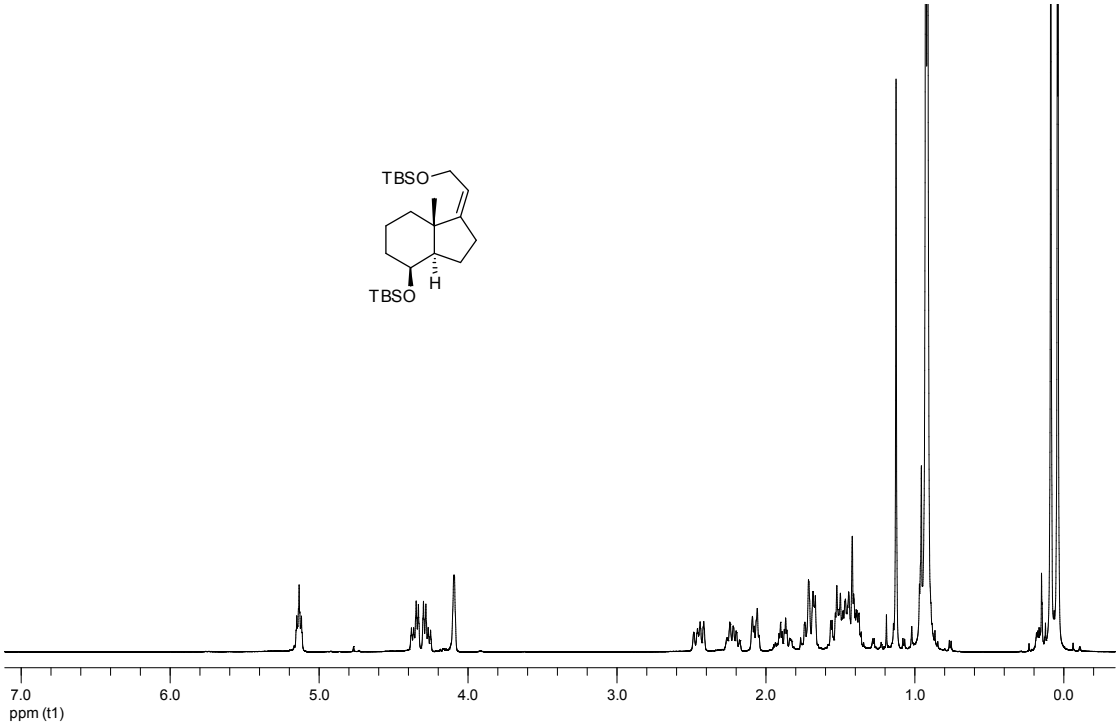
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TBSO
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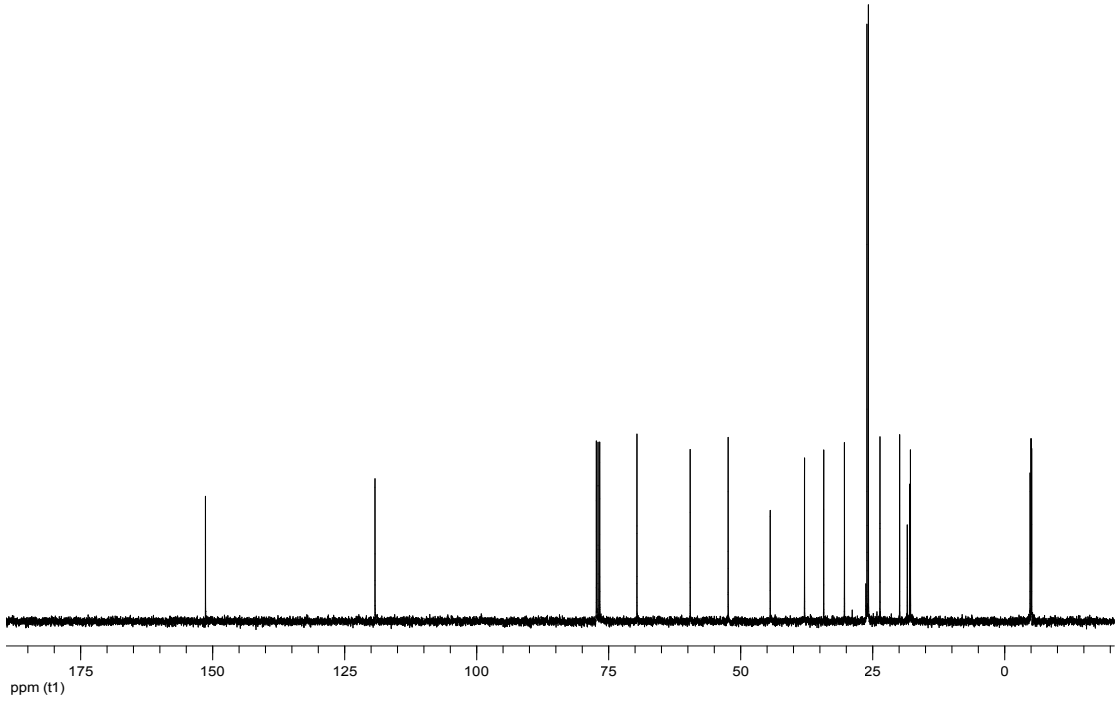
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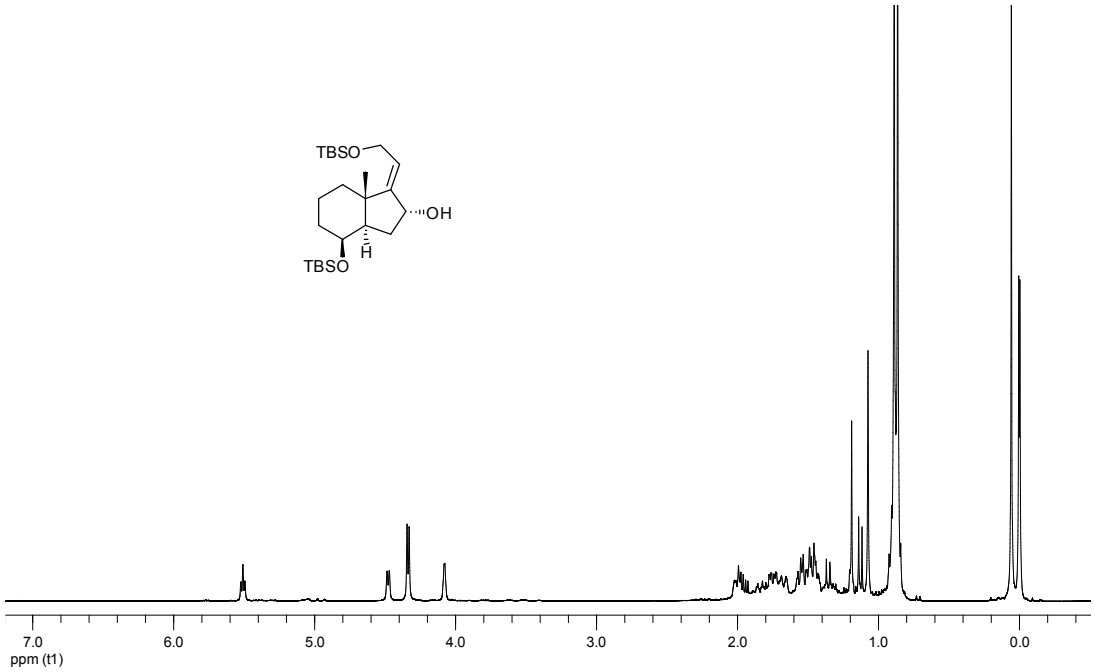
ppm (t1)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TBSO
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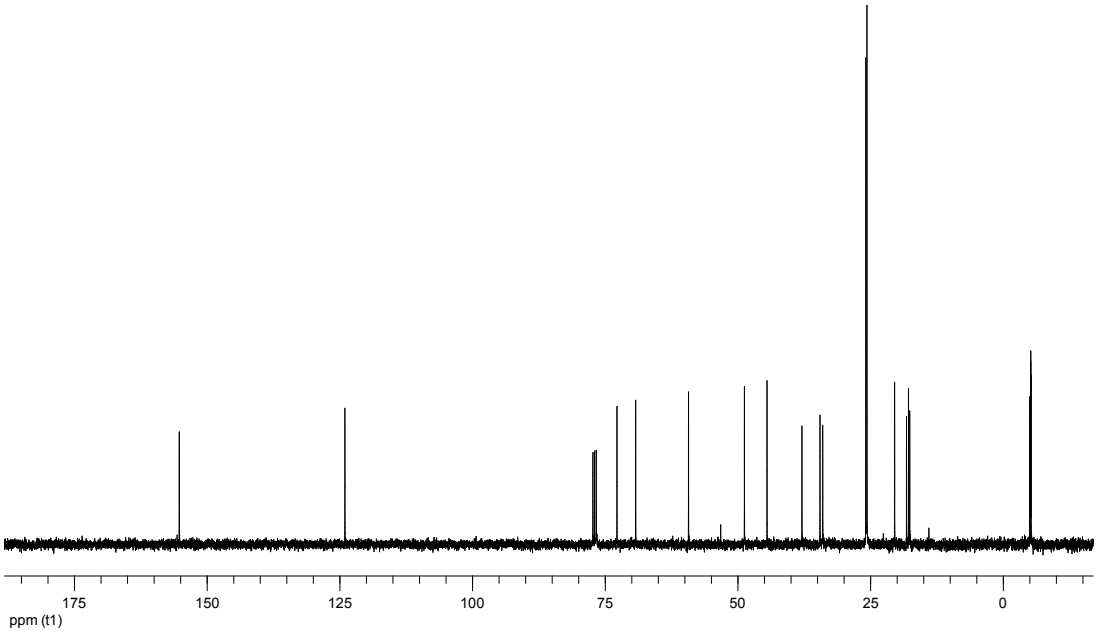
ppm (t1)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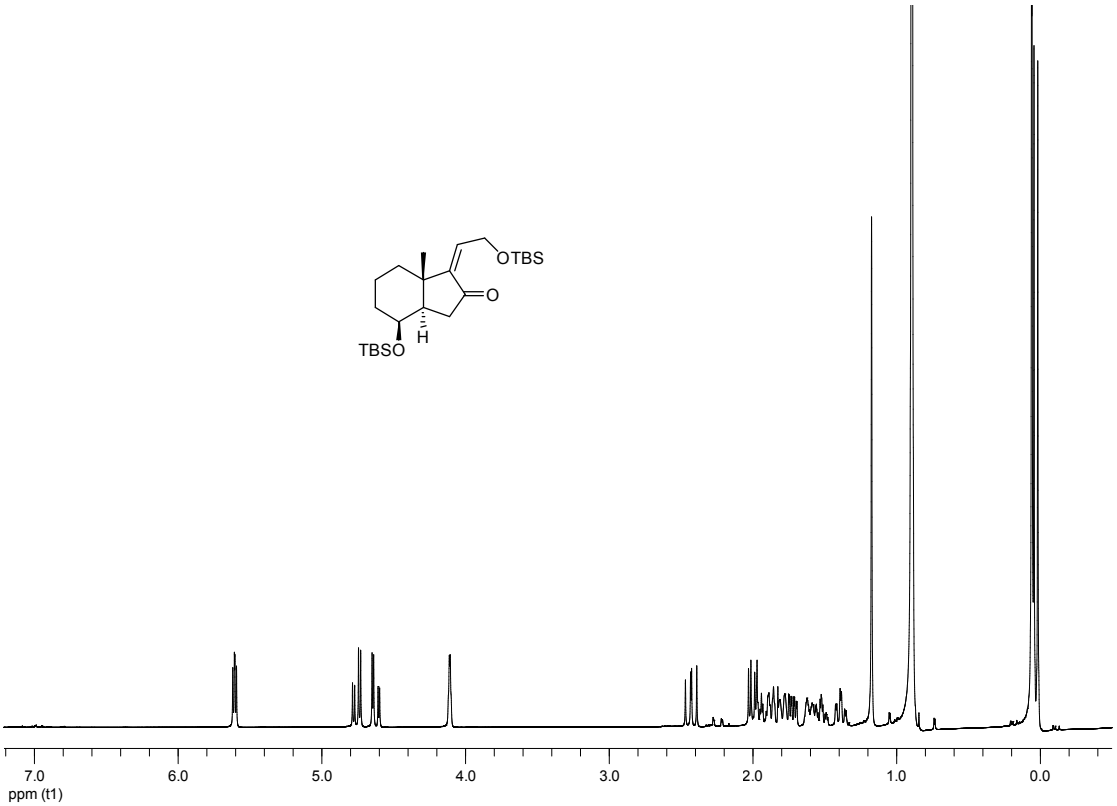
ppm (t1)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3.0
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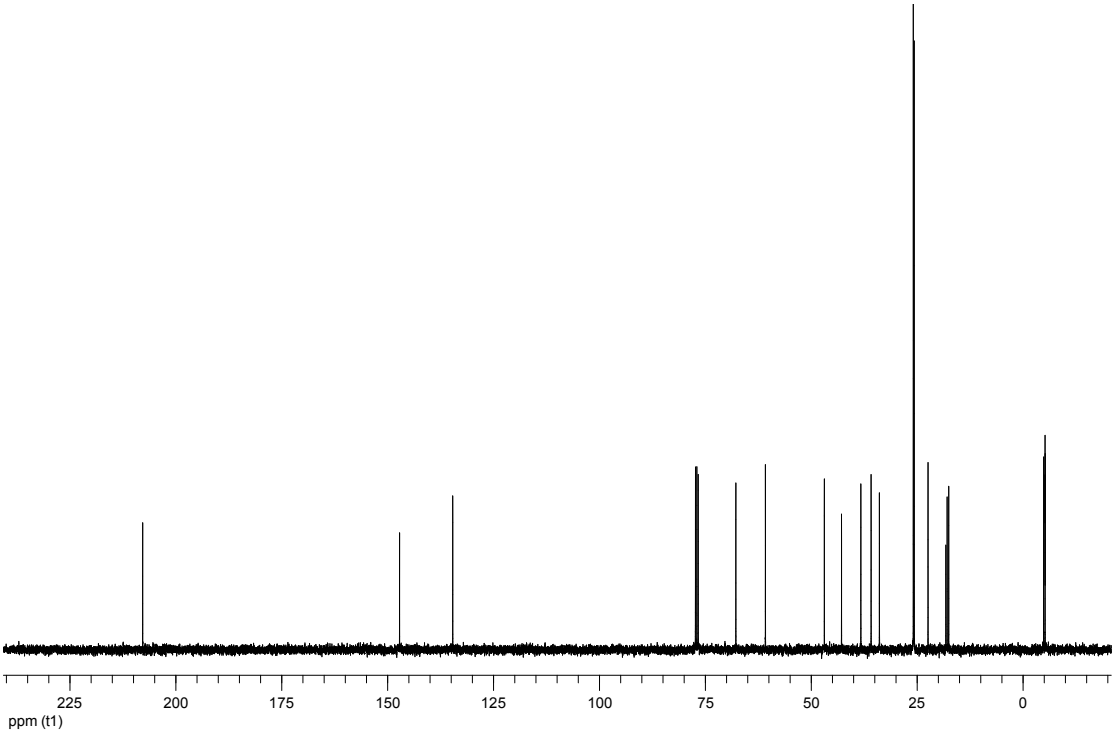
ppm (t1)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ppm (t1)

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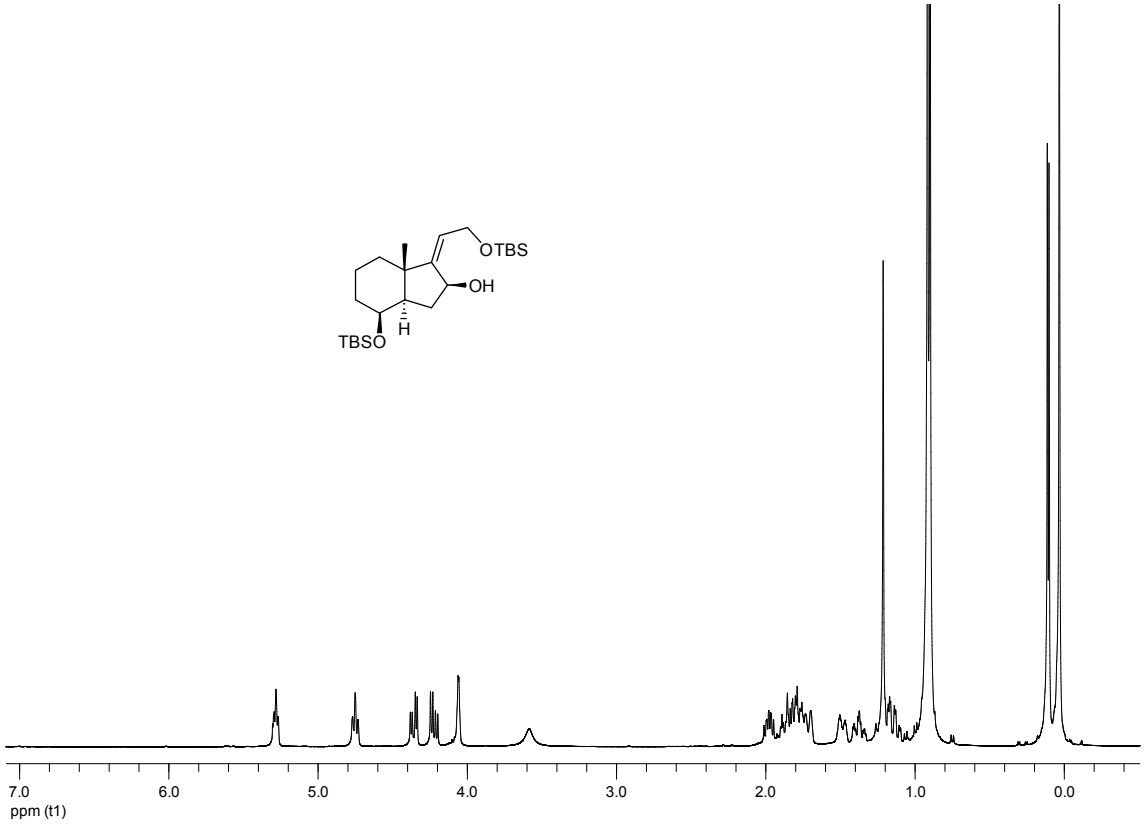
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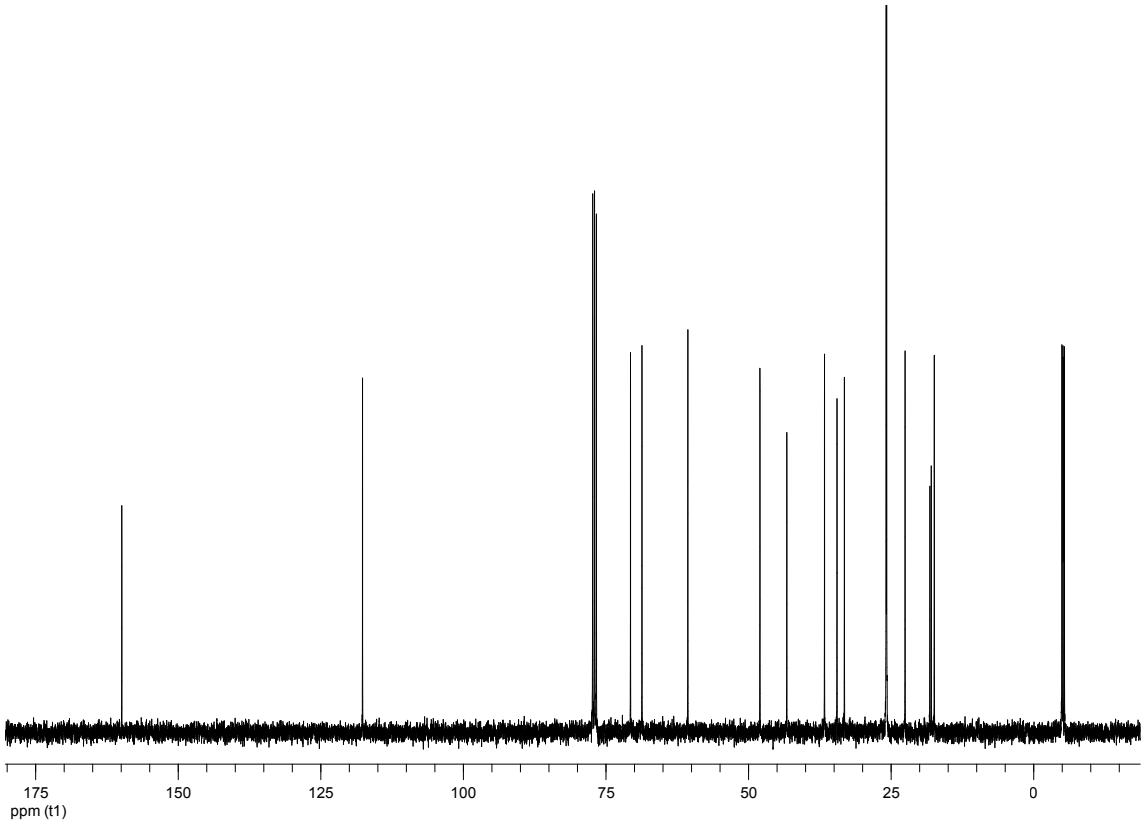
ppm (t1)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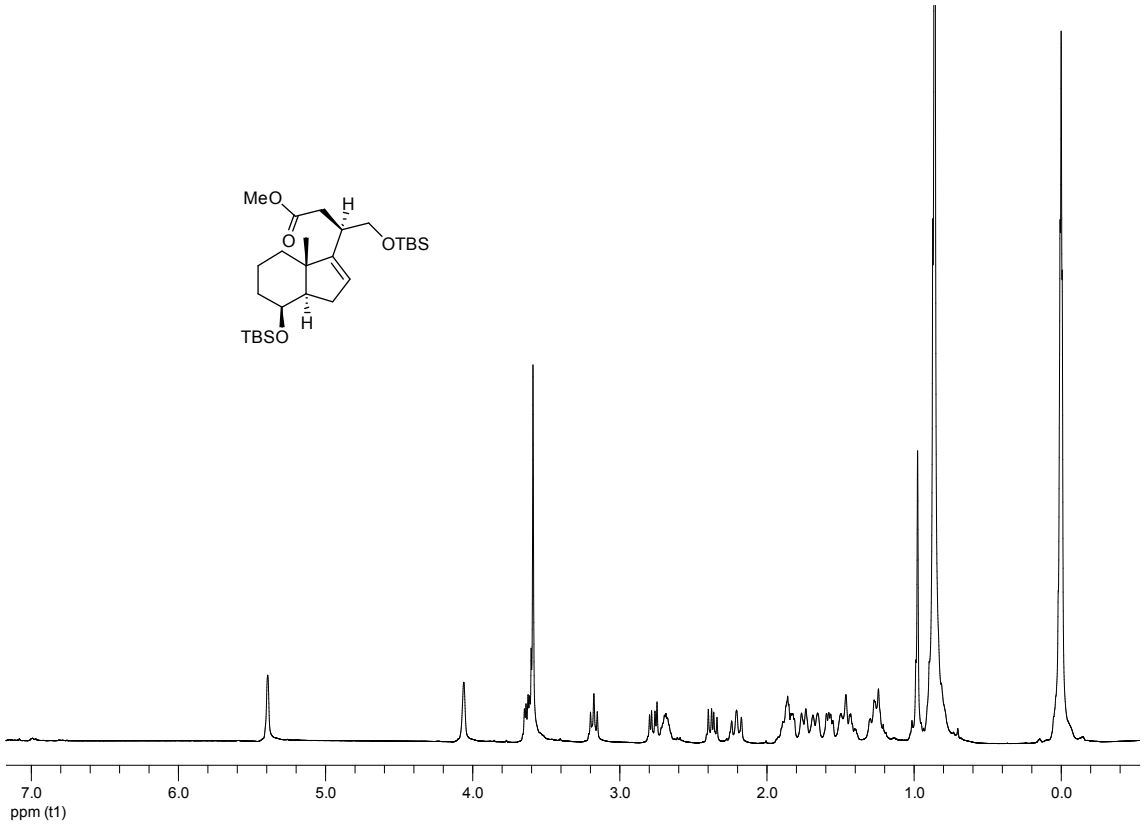
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OTBS
TBSO
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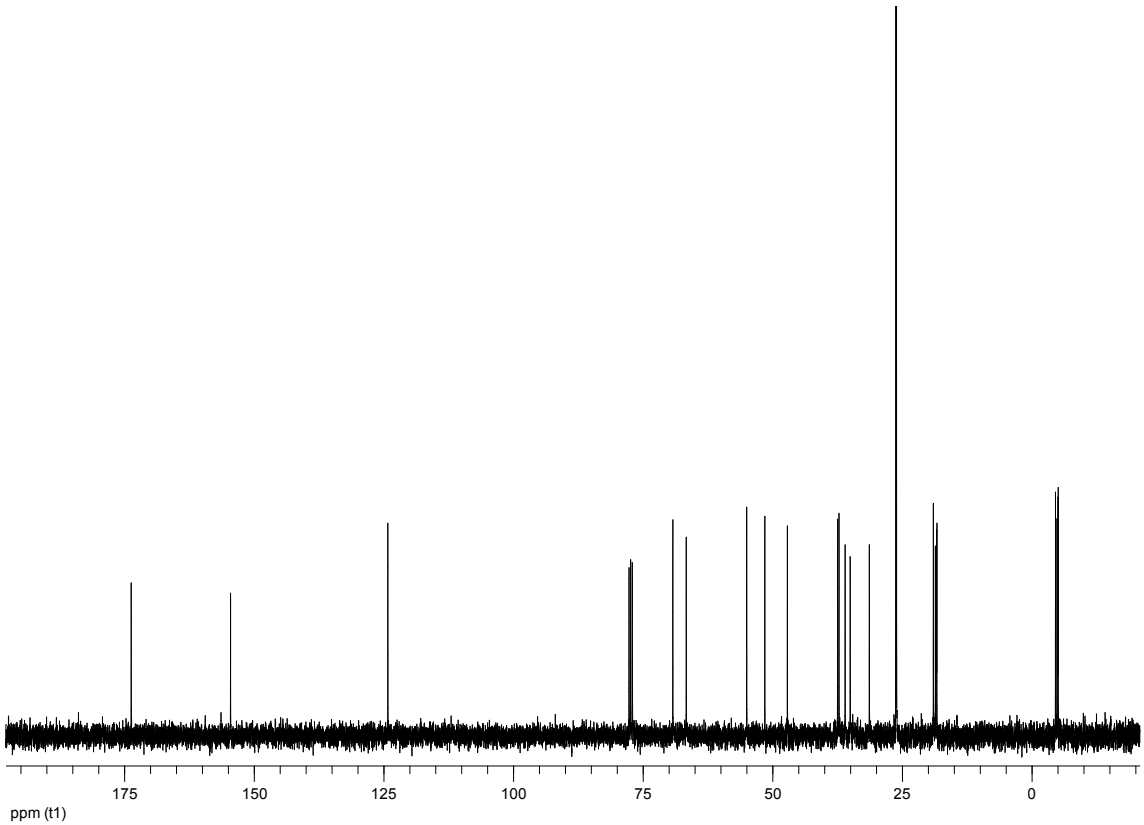
ppm (t1)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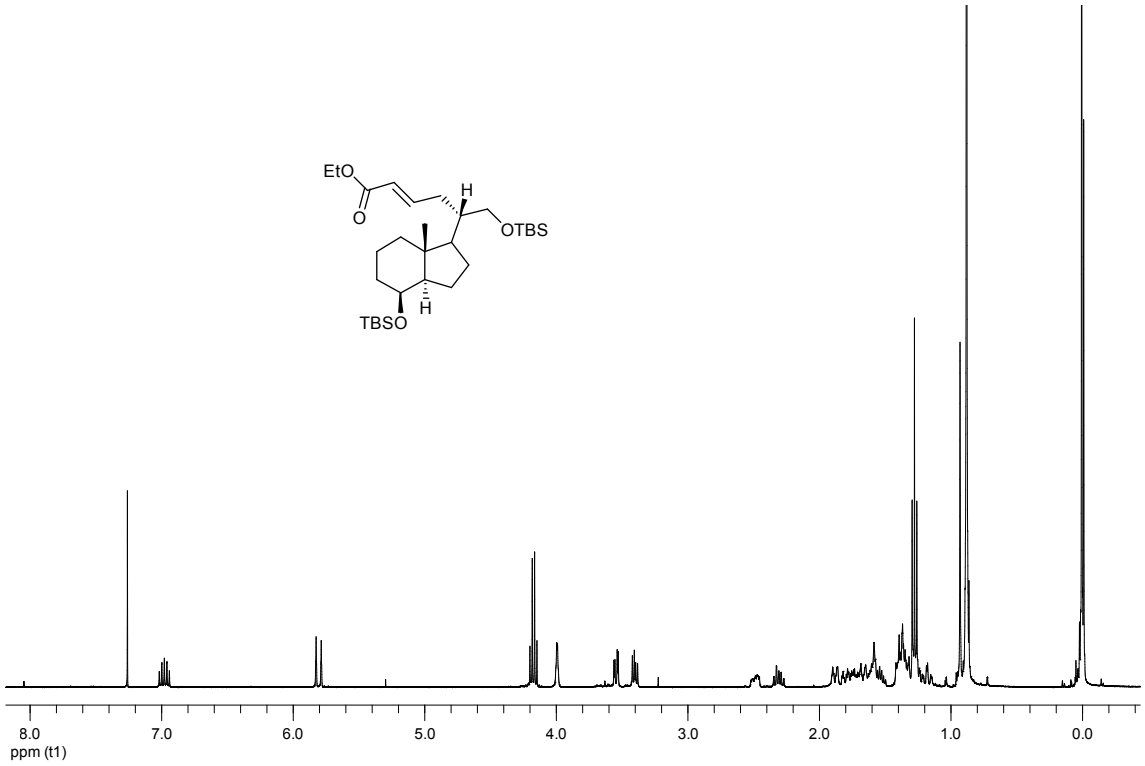
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OTBS
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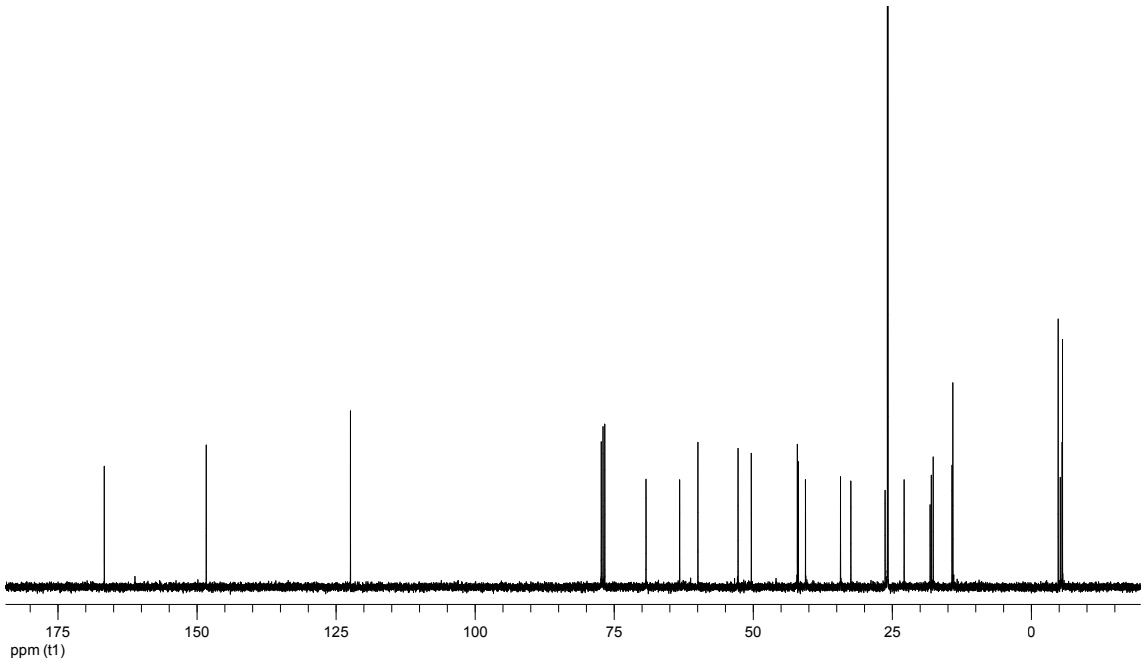
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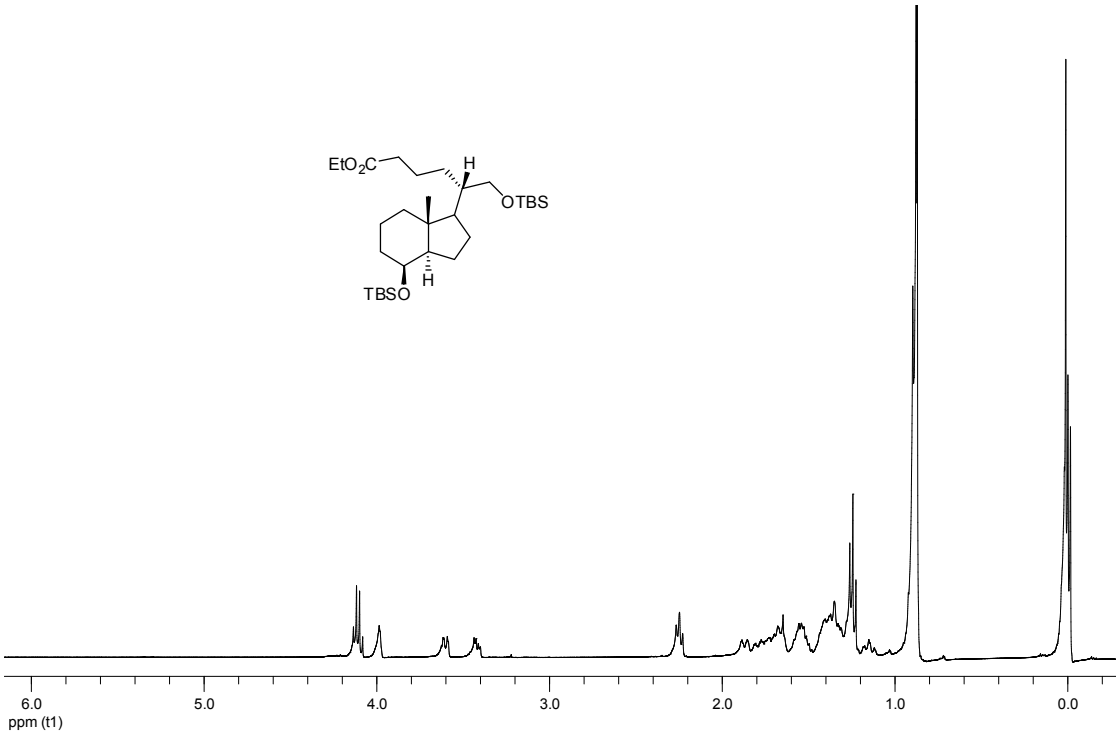
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TBSO
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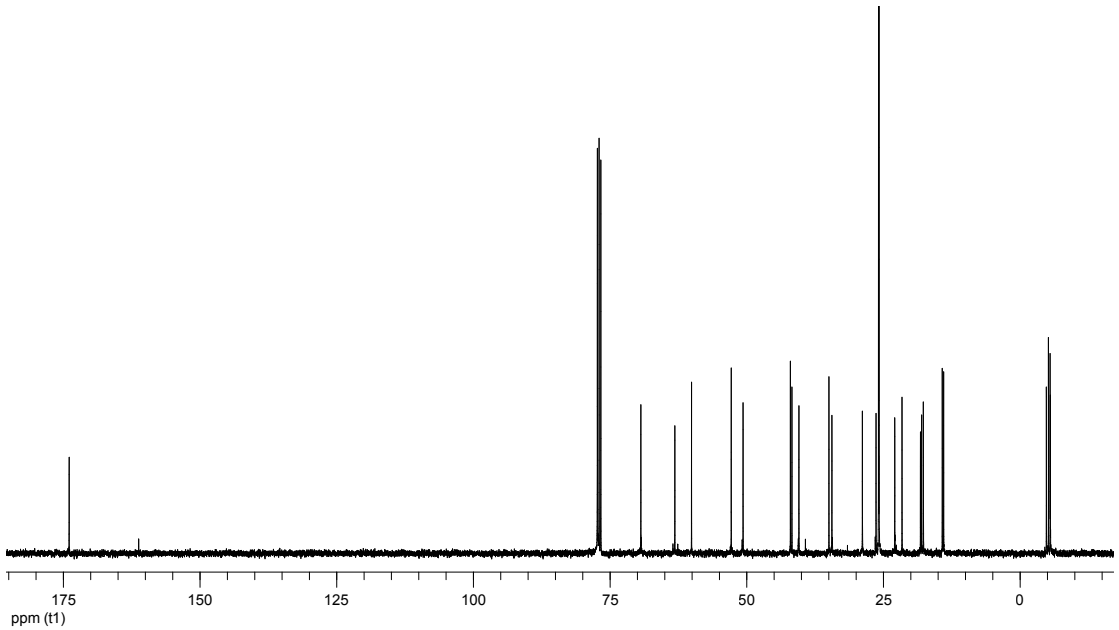
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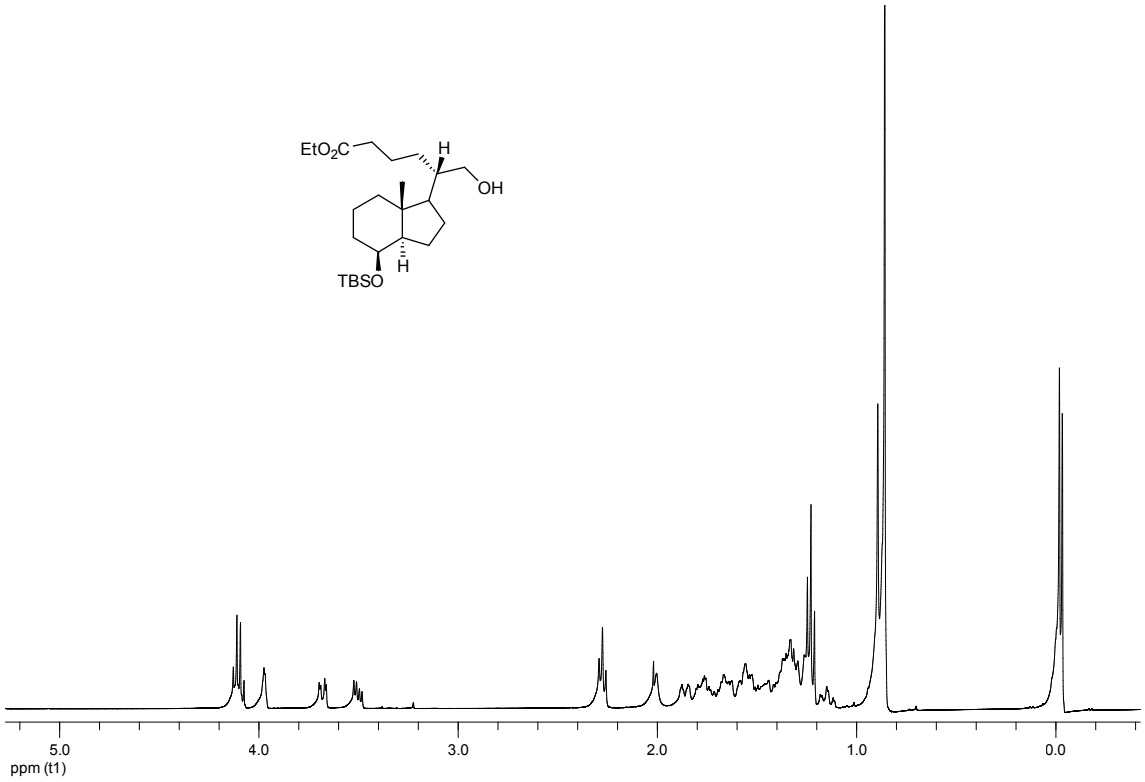
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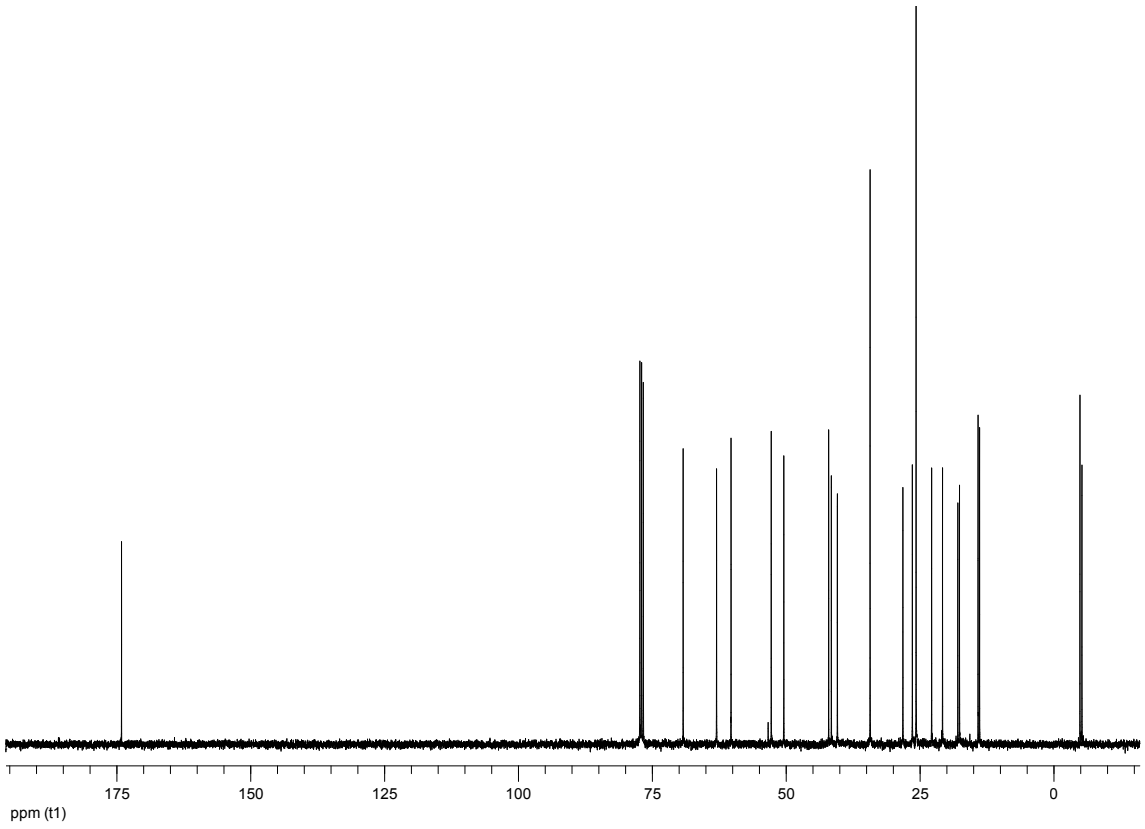
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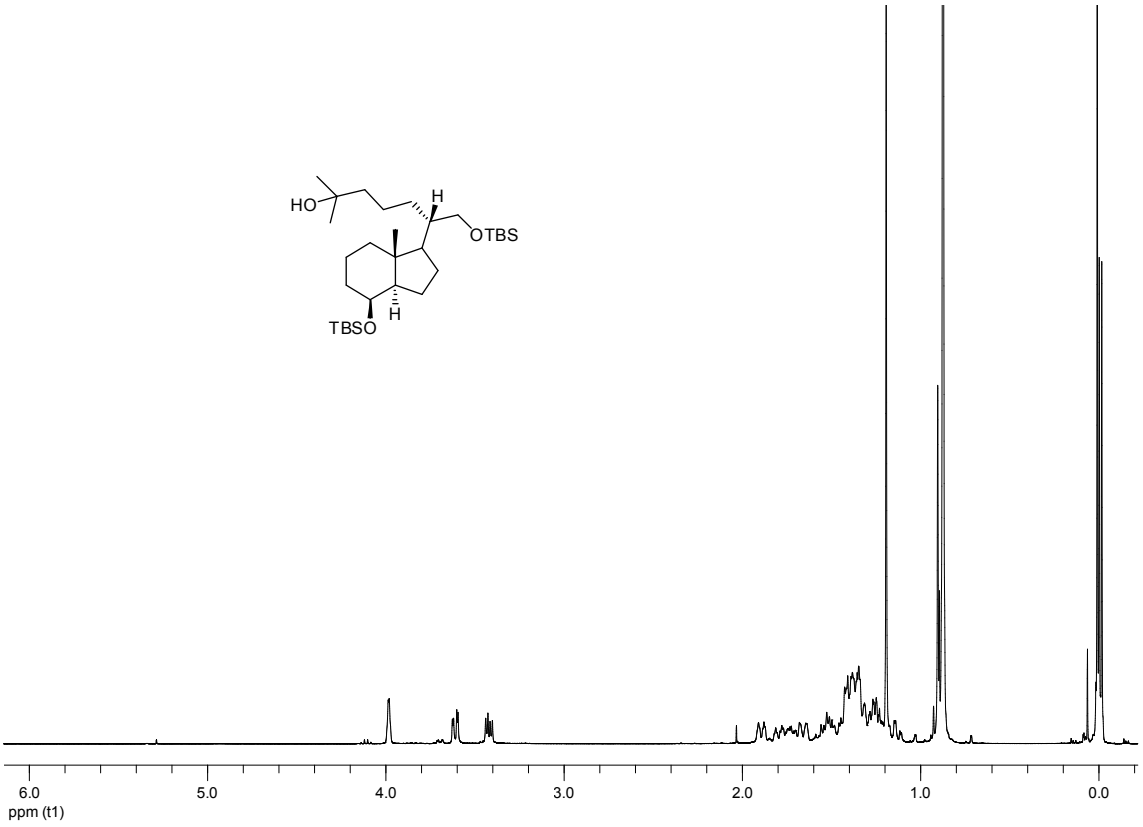
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TBSO
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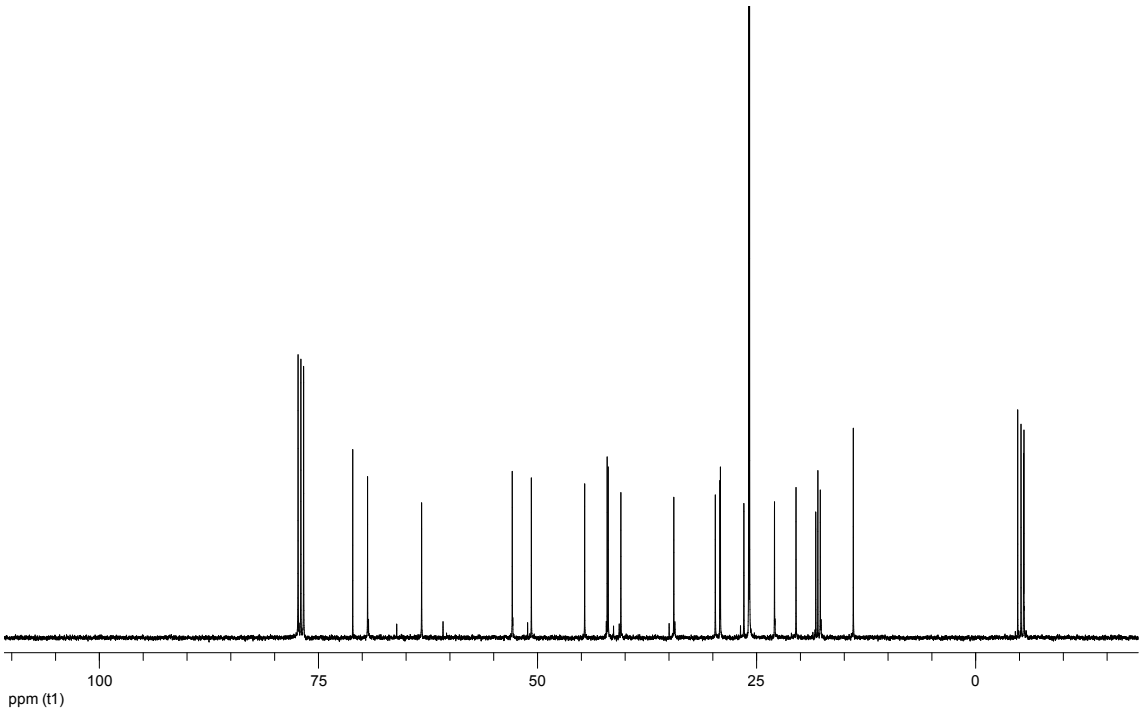
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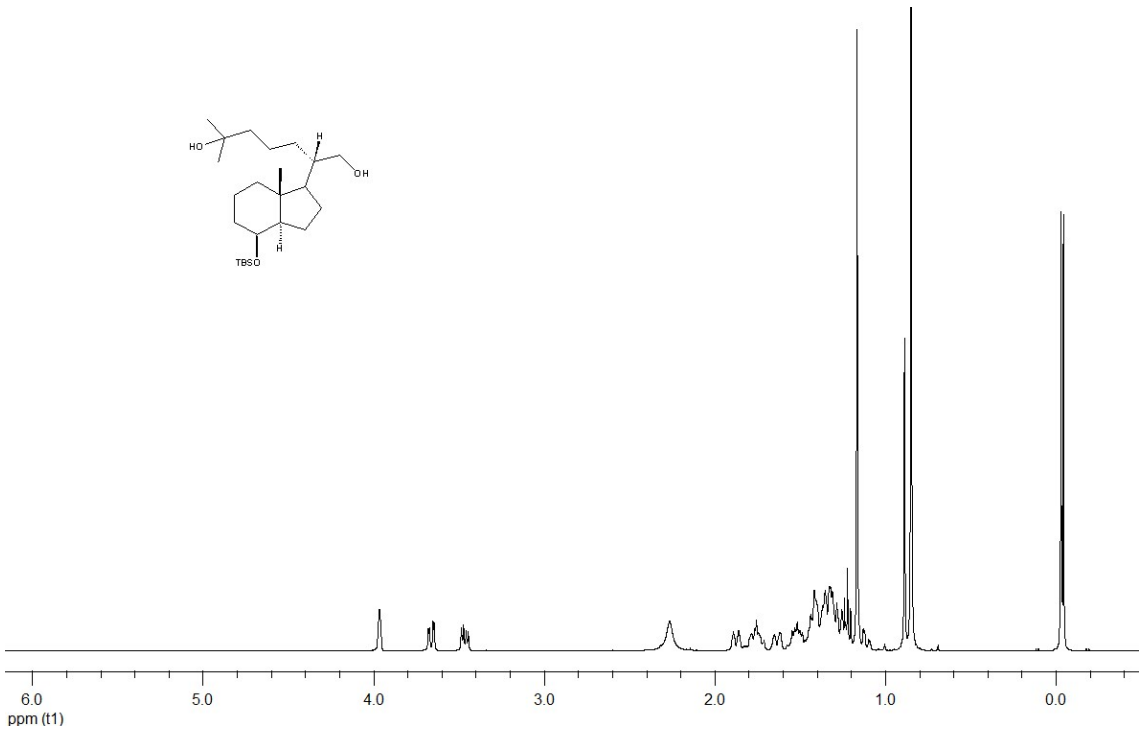
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OH
H
TBSO
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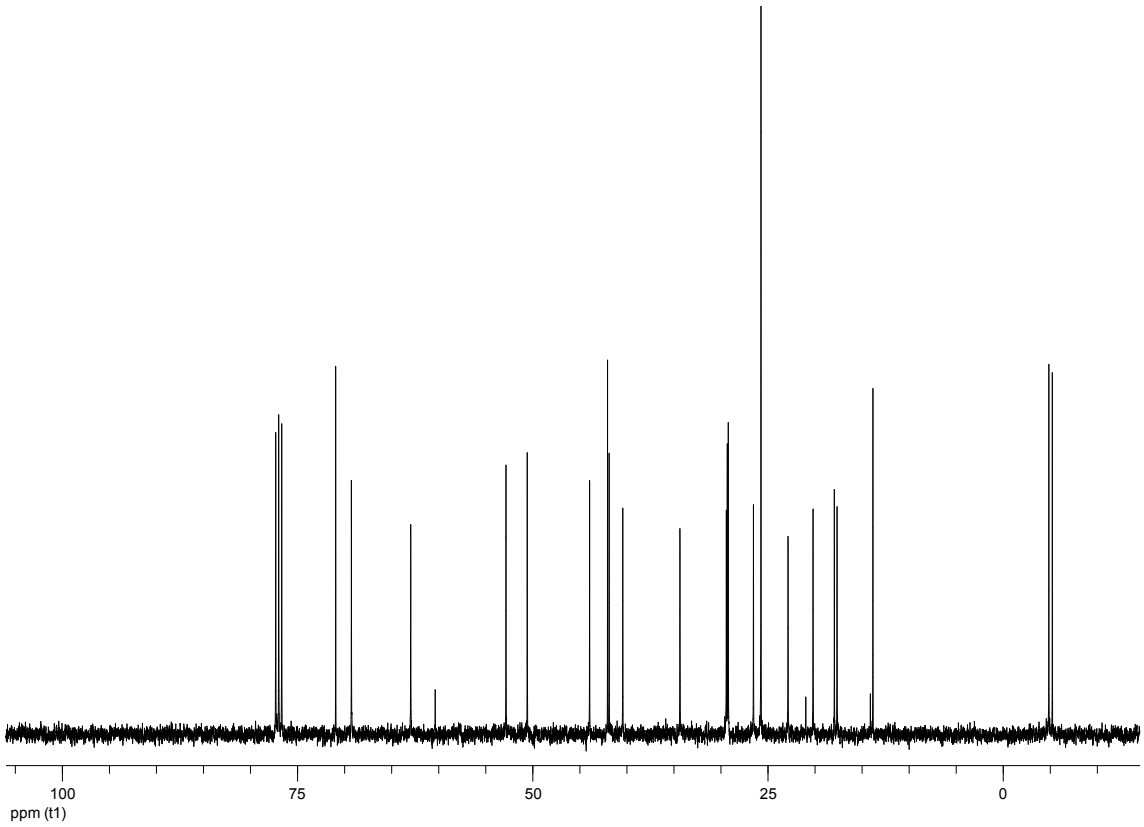
1.0
0.0
ppm (t1)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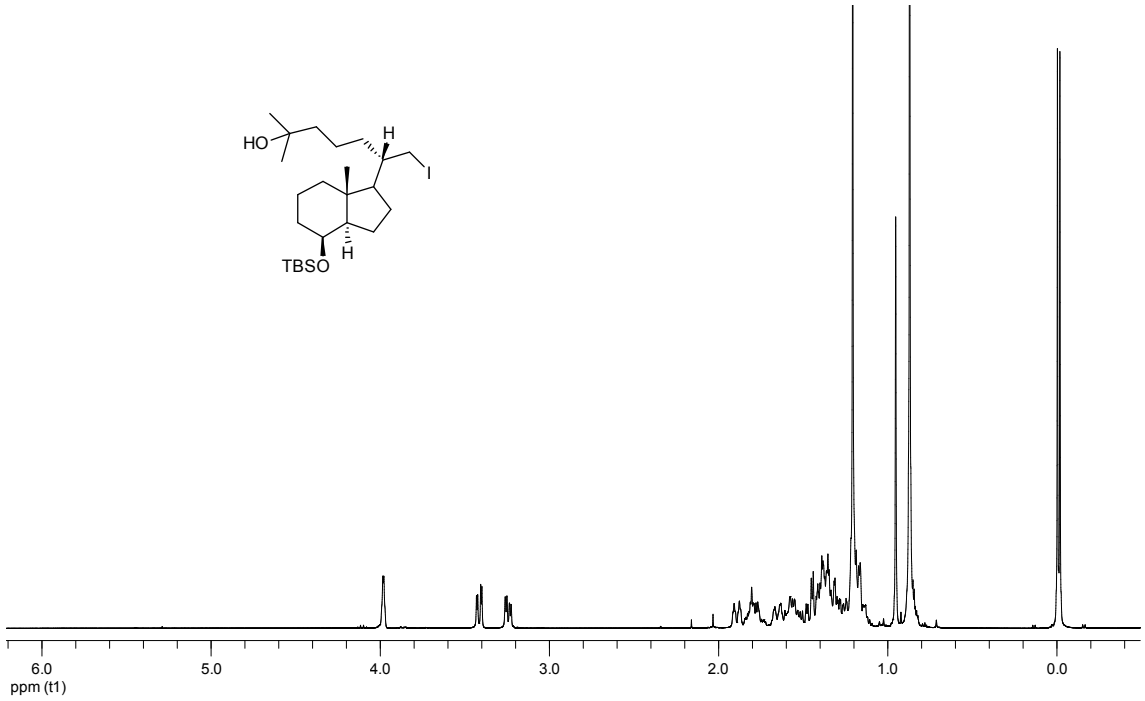
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TBSO
H
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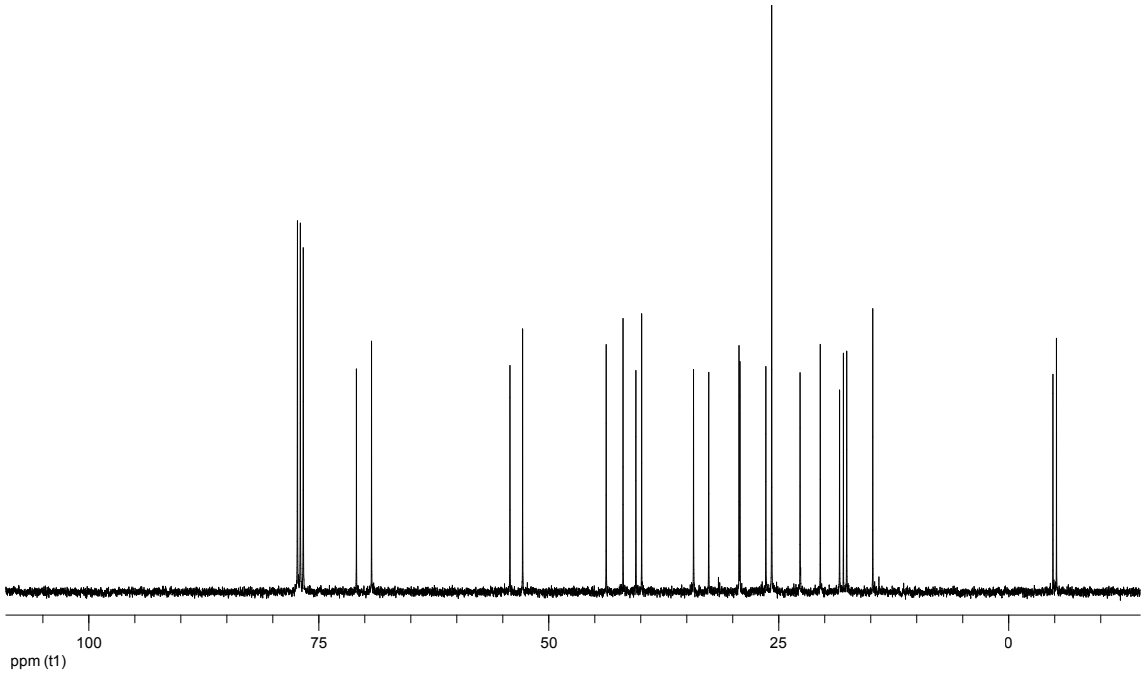
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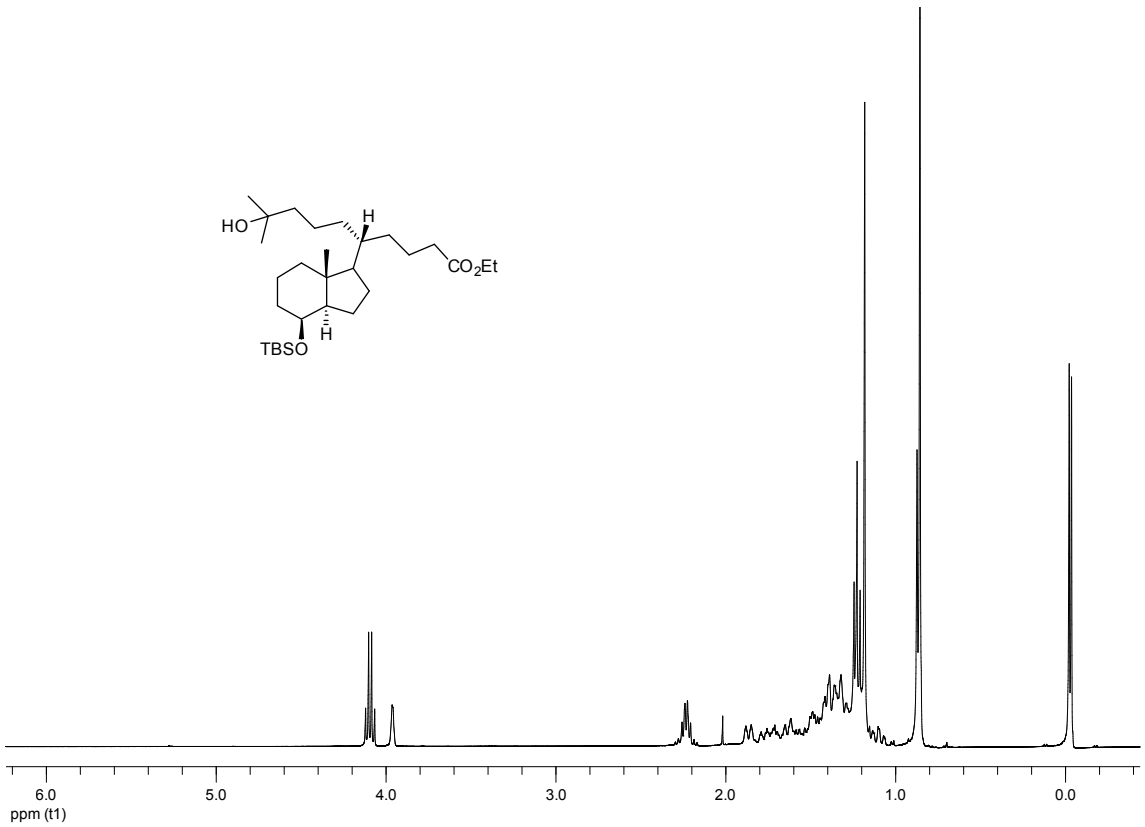
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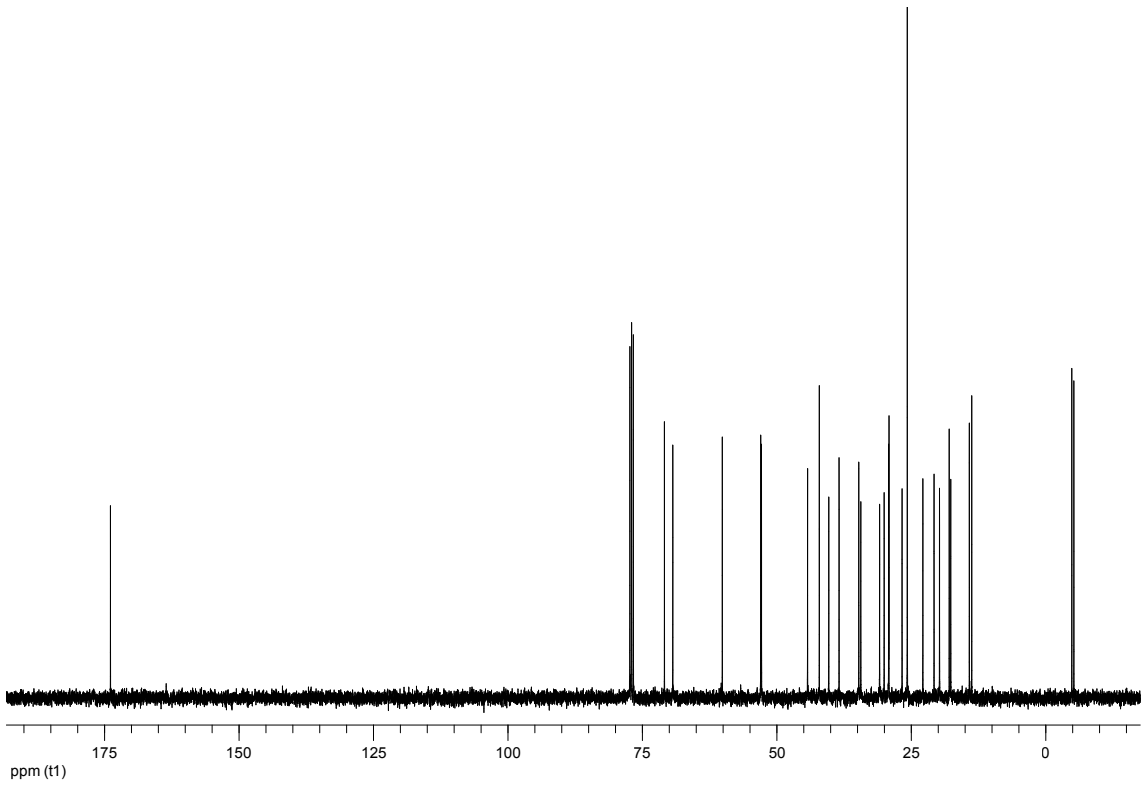
ppm (t1)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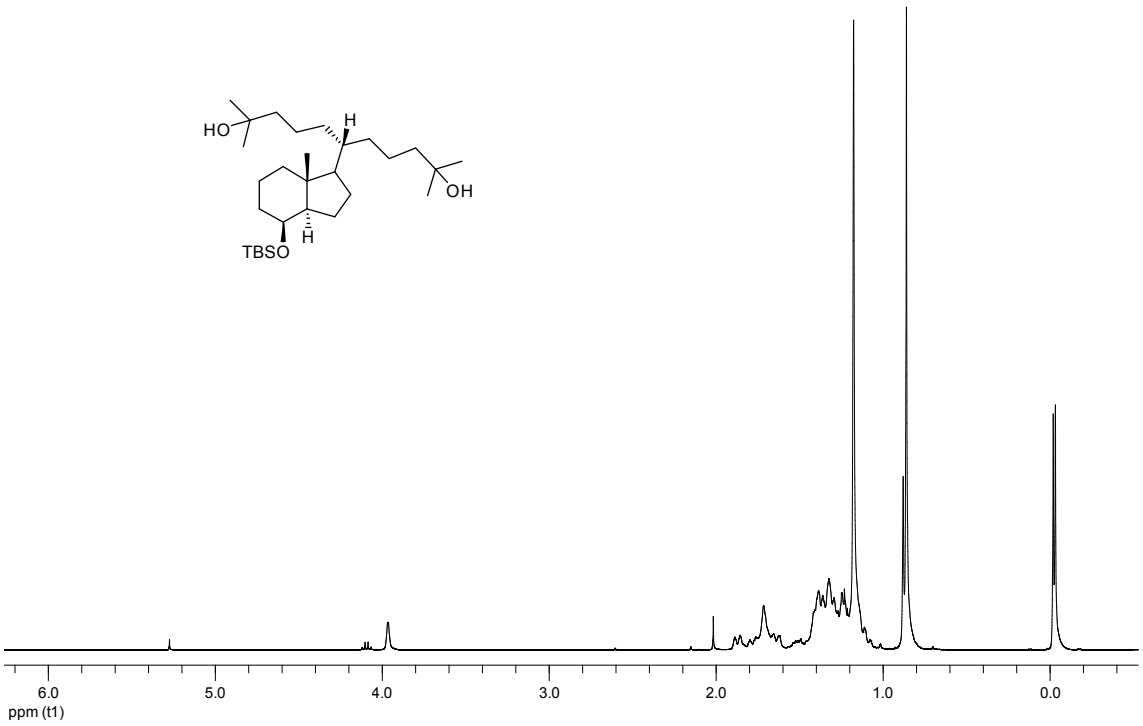
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OH
H
TBSO
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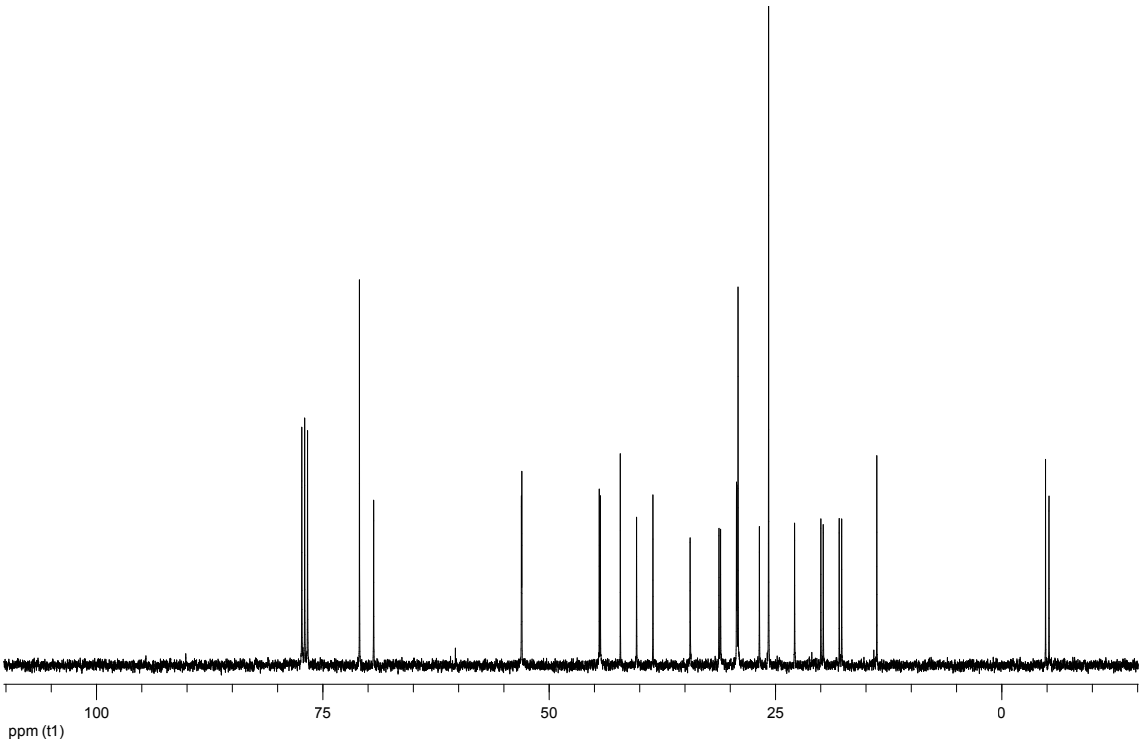
ppm (t1)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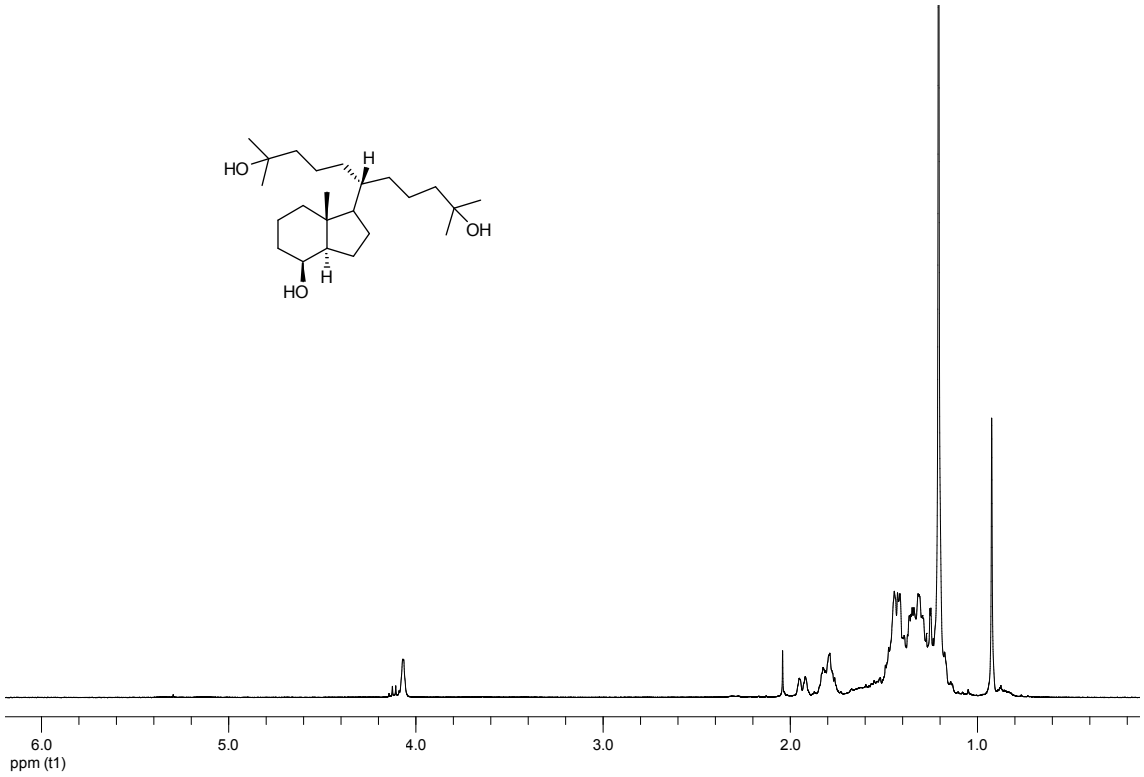
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OH
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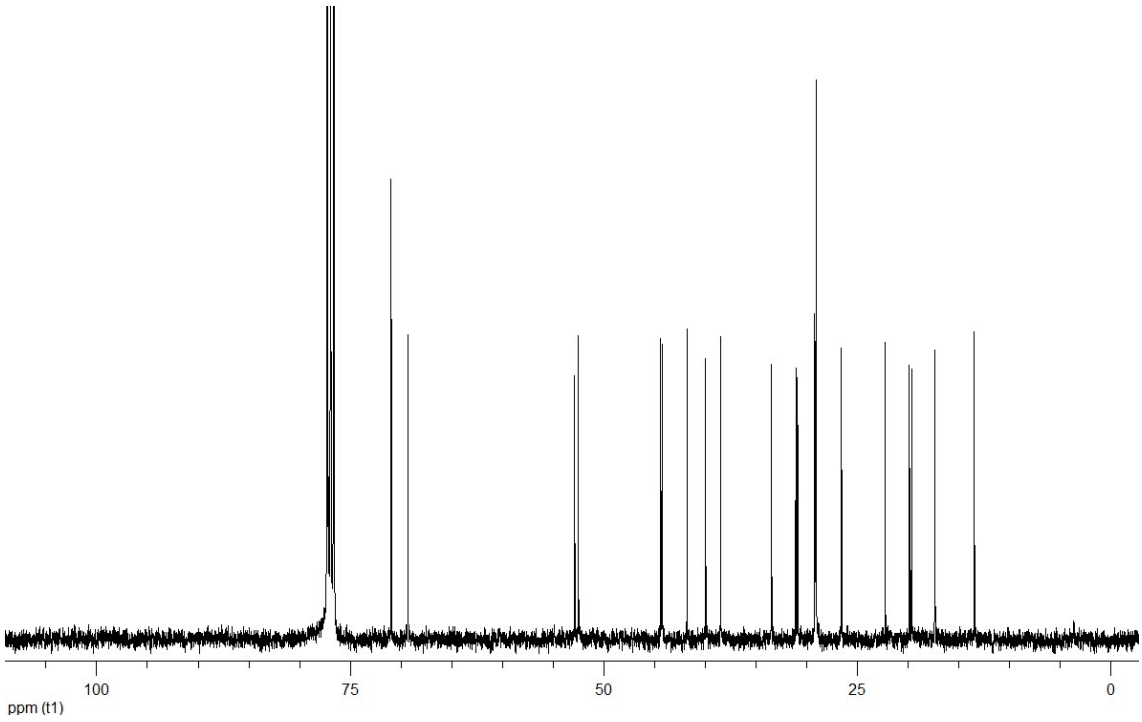
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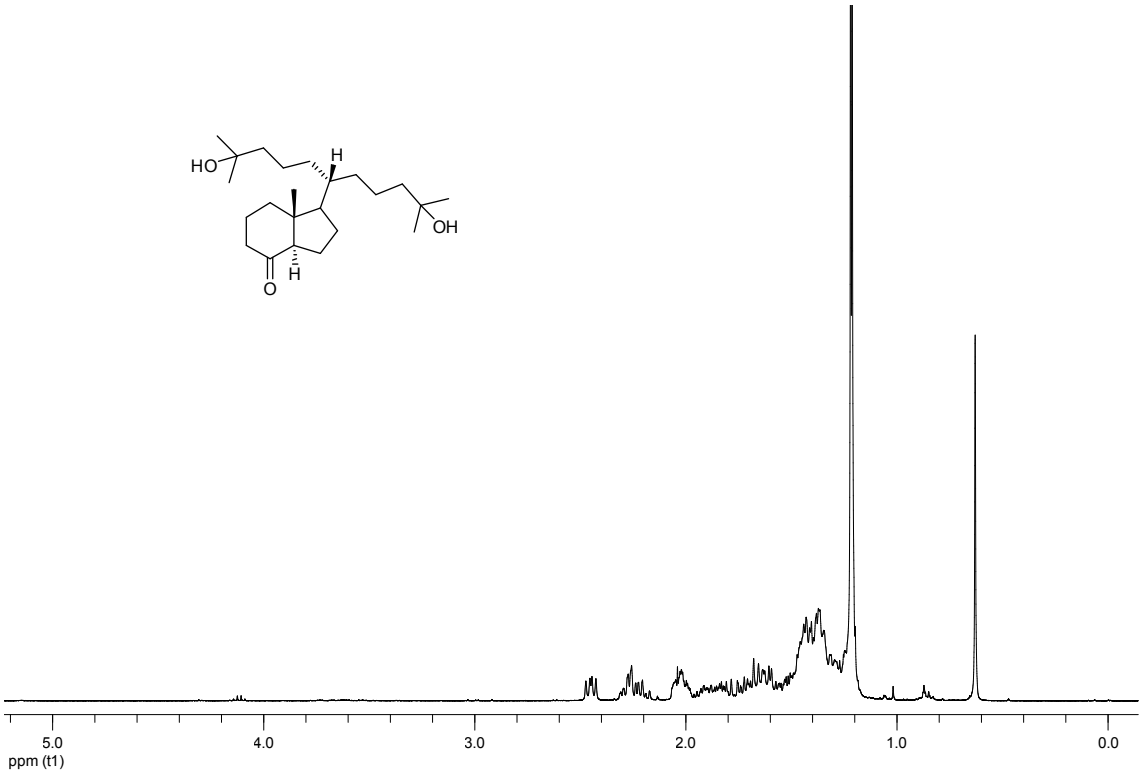
ppm (t1)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OH
H
O
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2.0
1.0
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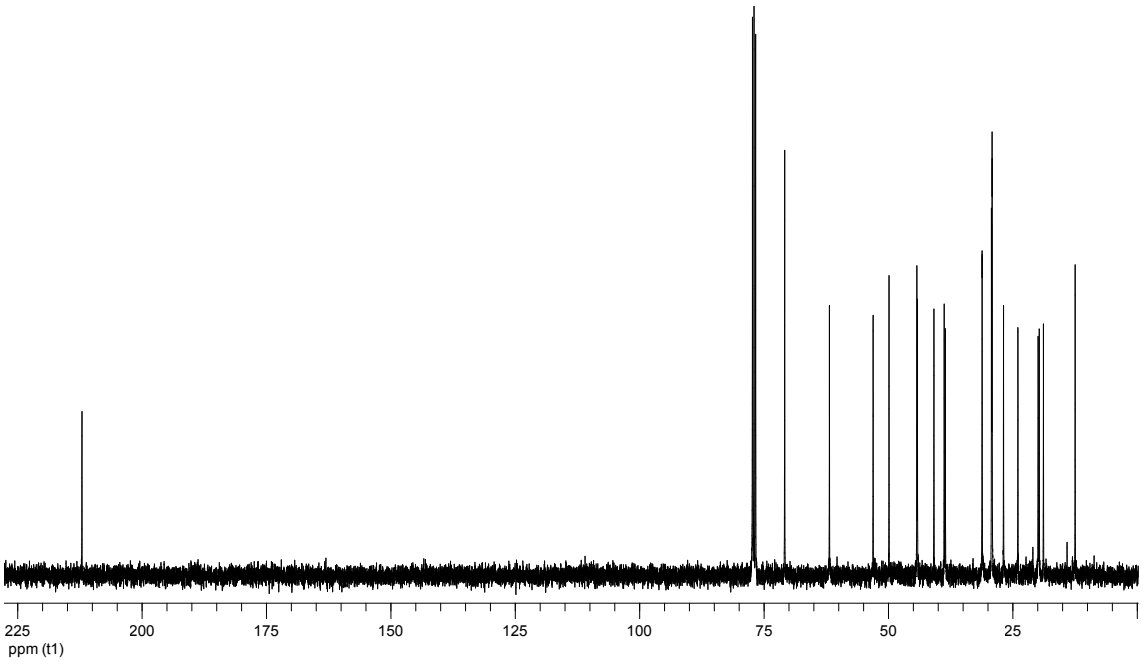
ppm (t1)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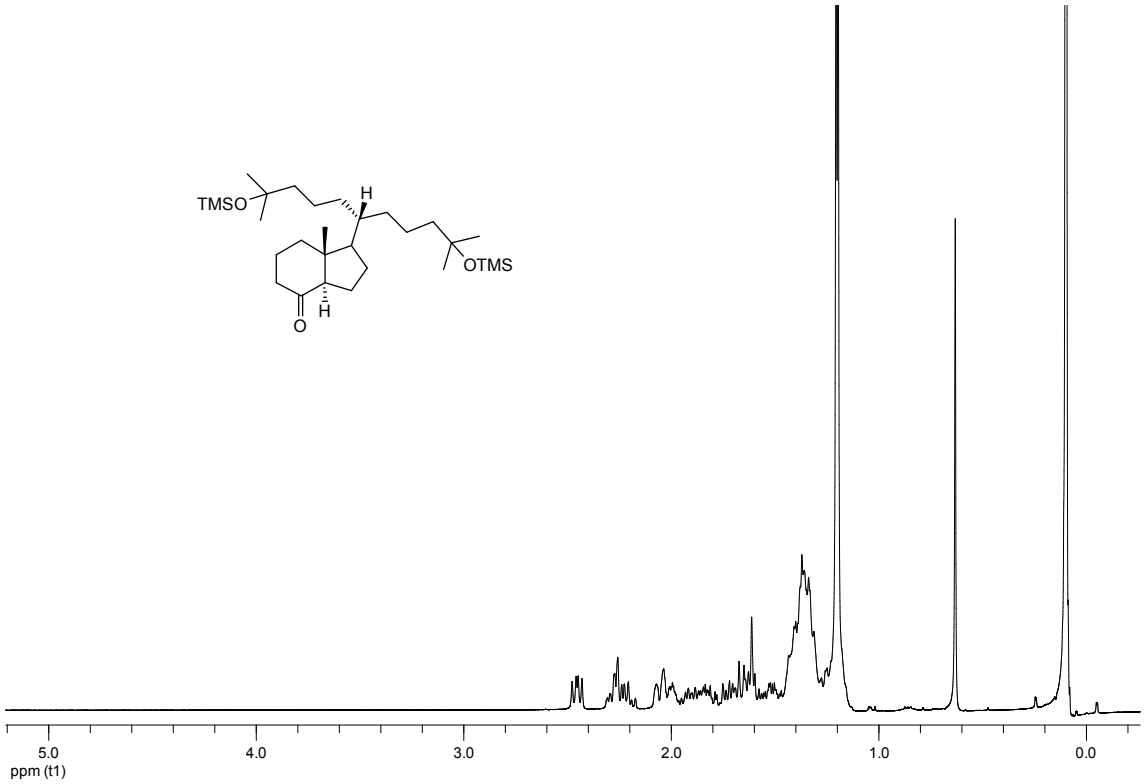
ppm (t1)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OTMS
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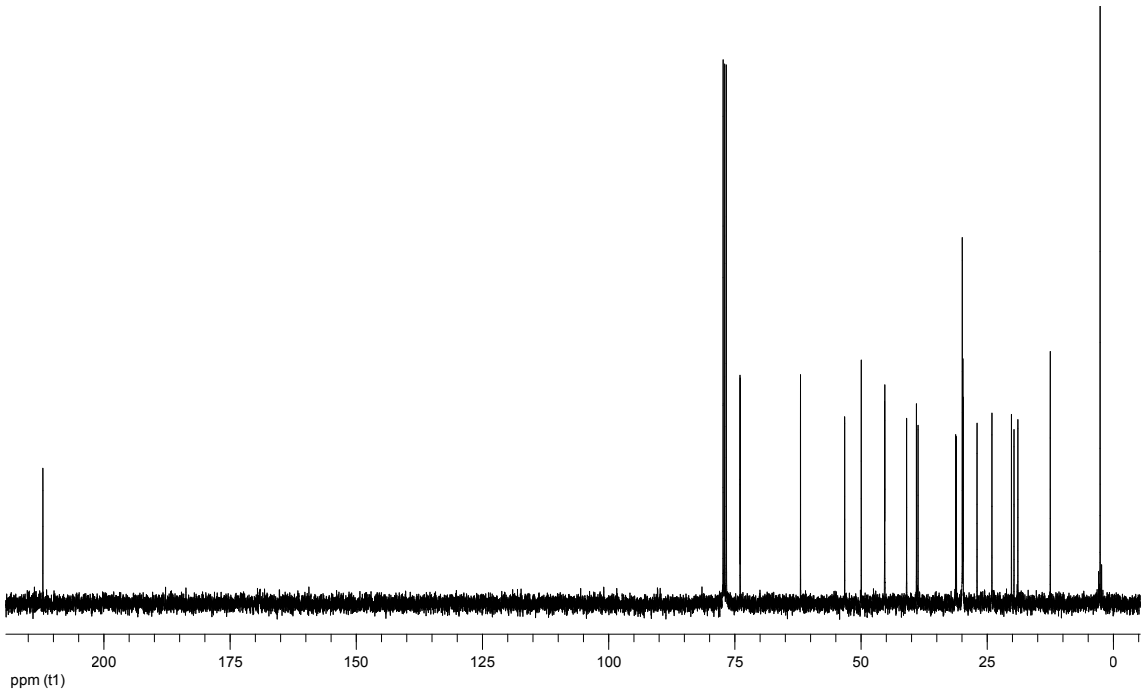
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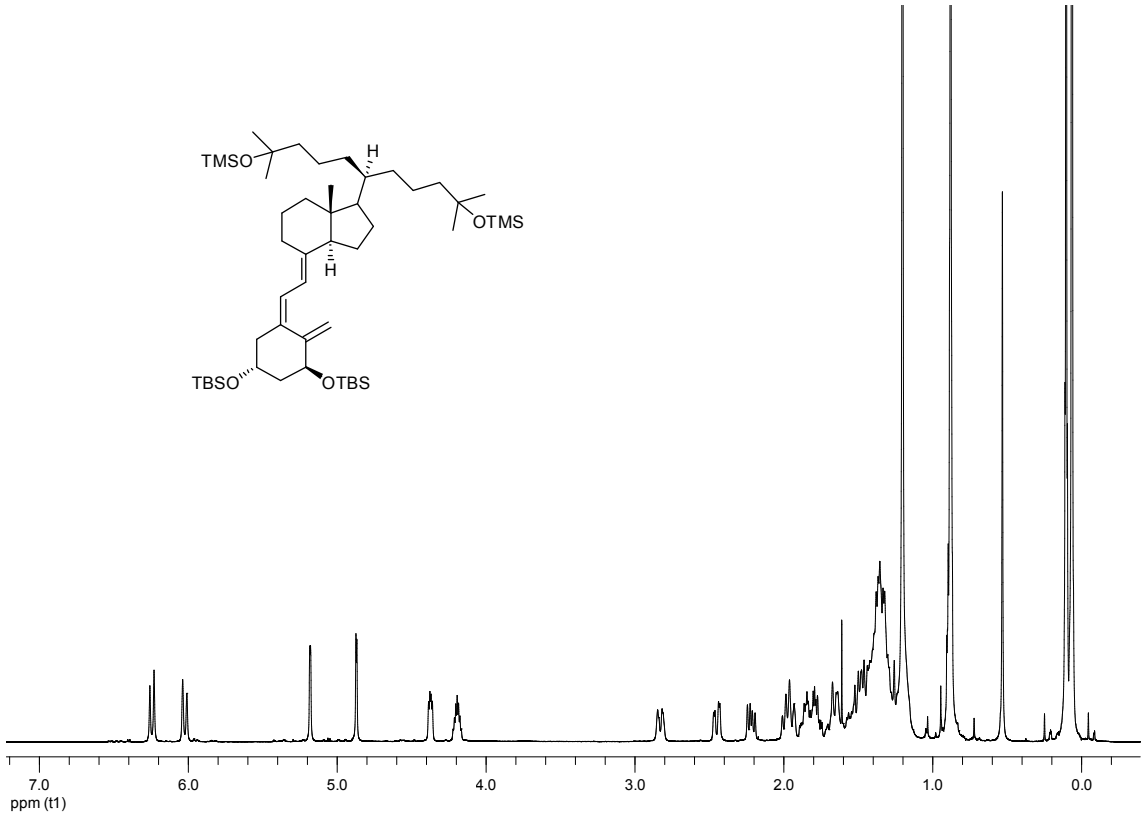
ppm (t1)


TMSO
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OTMS
H
TBSO
OTBS
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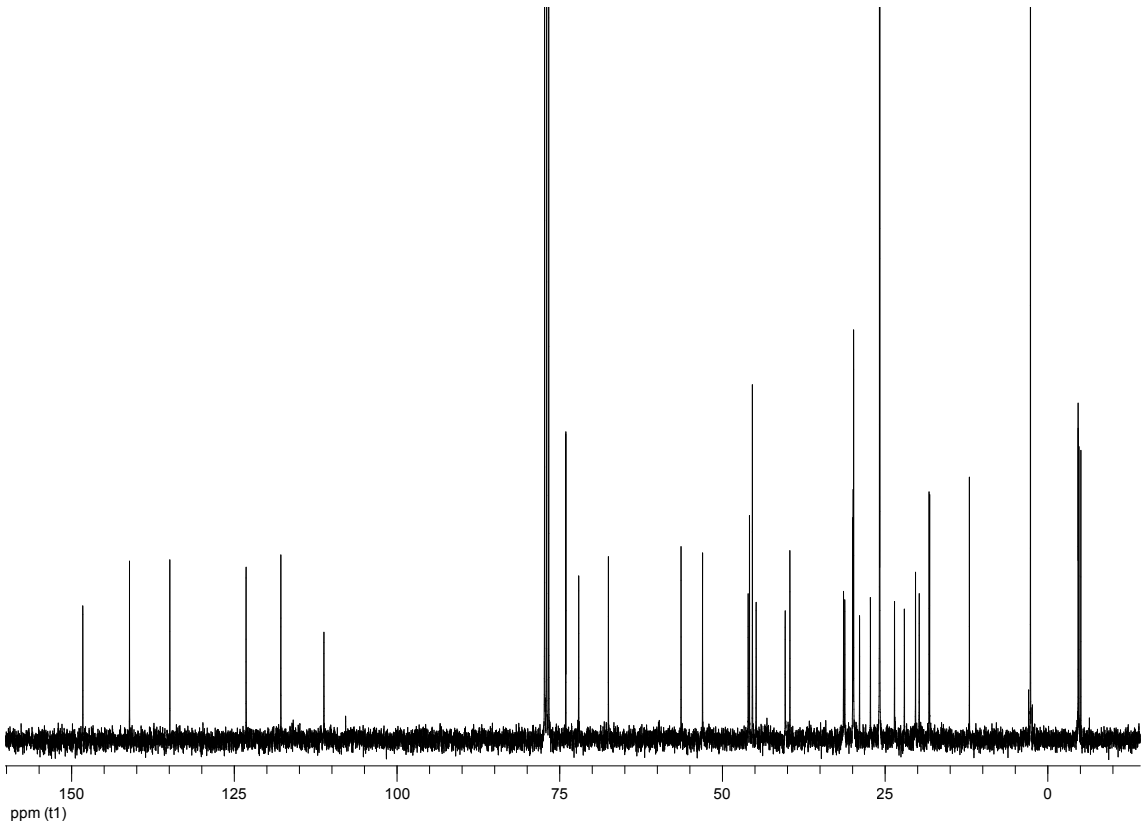
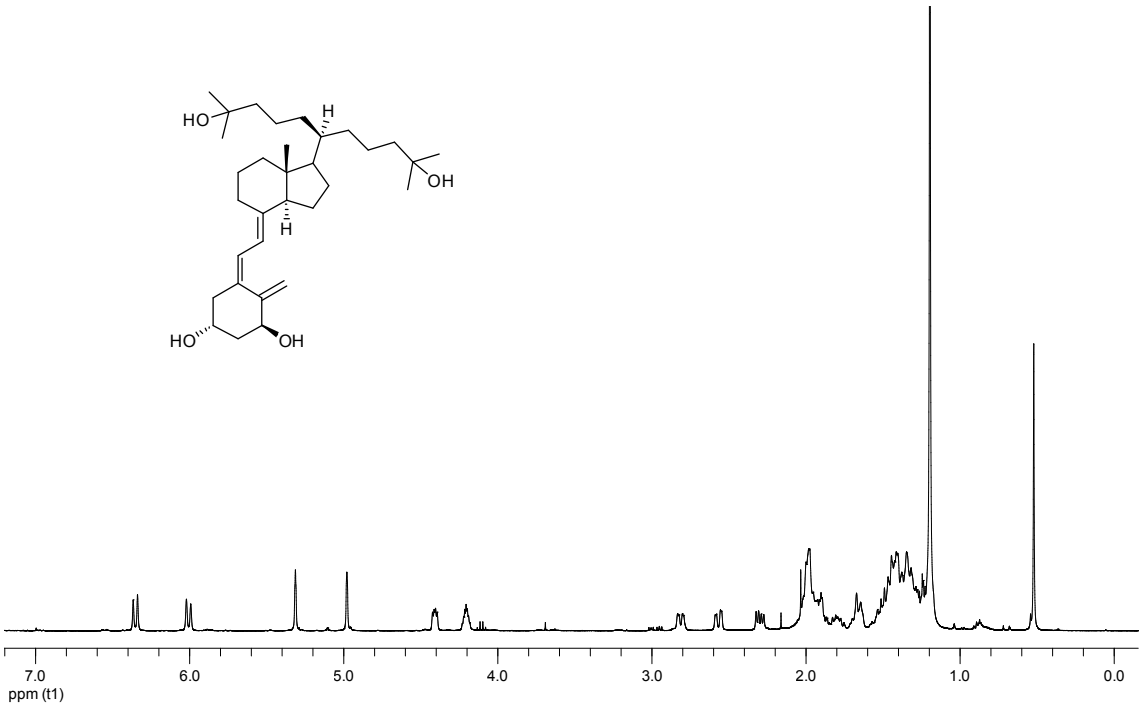
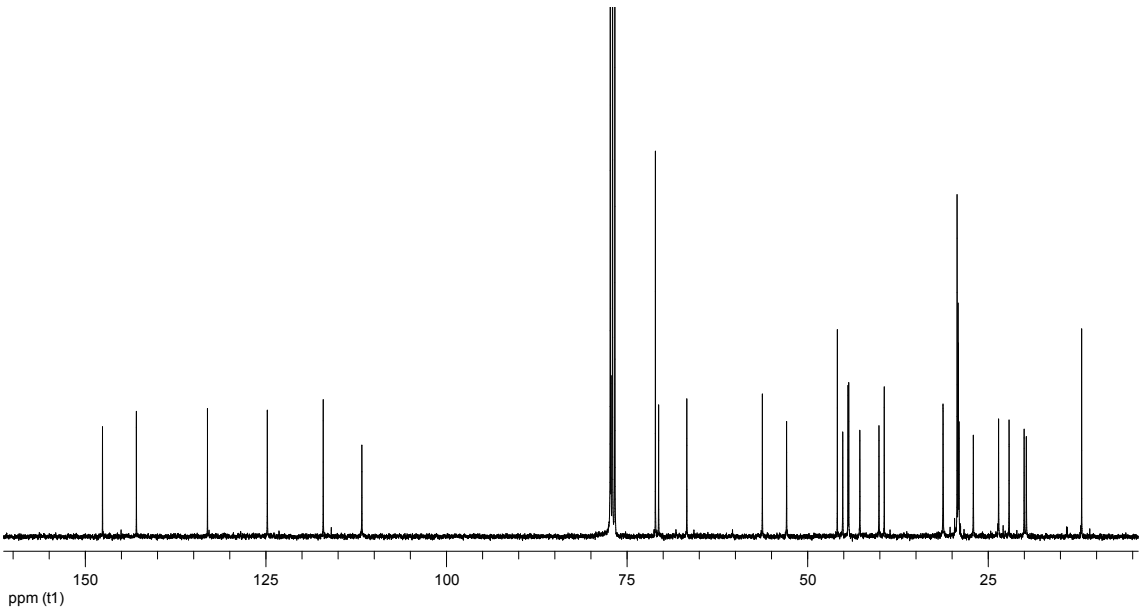
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)


150
125
100
75
50
25
0
ppm (t1)


HO
H
OH
H
HO
OH
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)


150
125
100
75
50
25
ppm (t1)