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Supporting Information

C–H Oxidation of Ingenanes Enables Potent and Selective Protein Kinase C Isoform Activation

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SUPPORTING INFORMATION

Part 1: Experimental Procedures and Characterization Data

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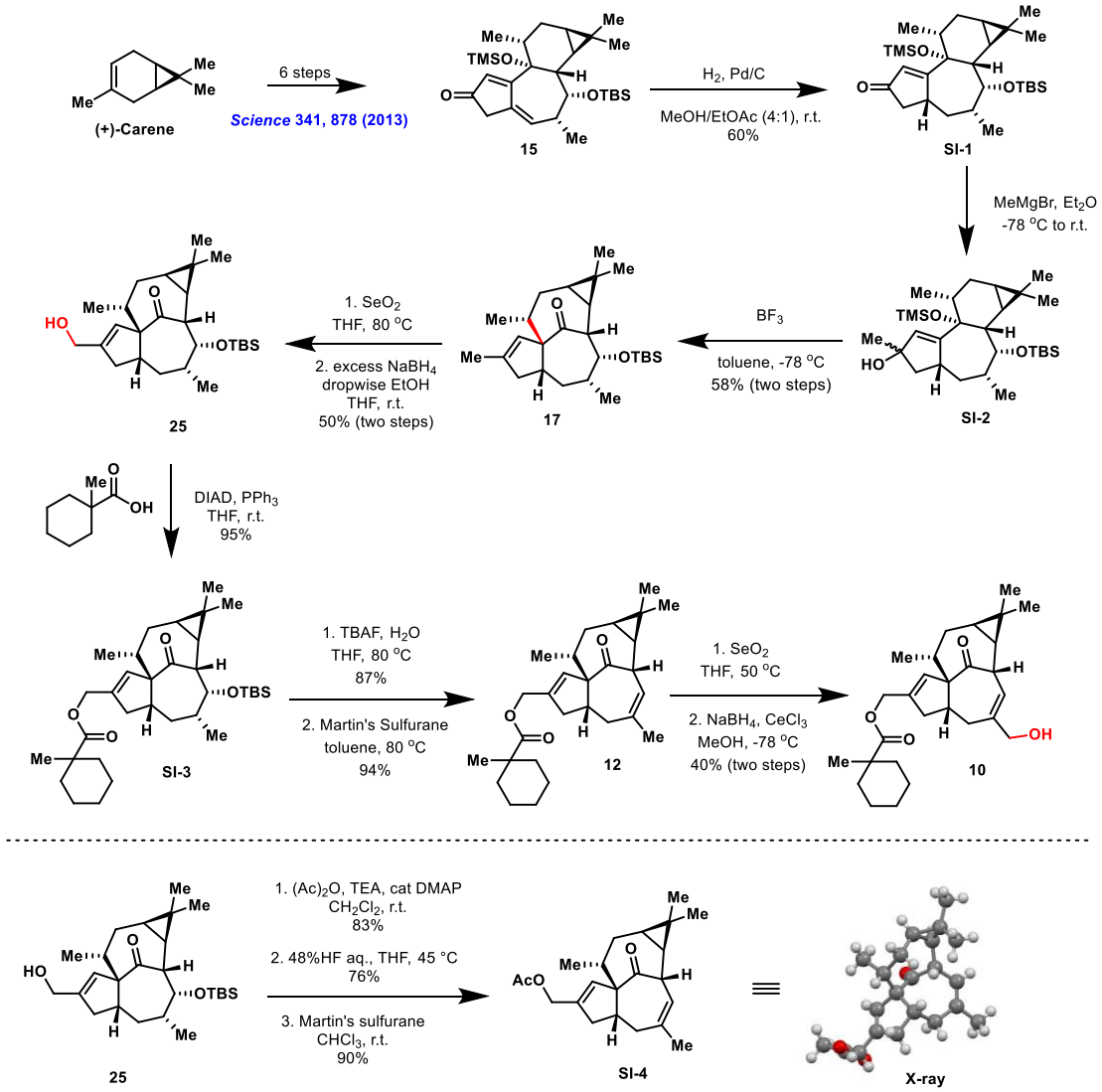
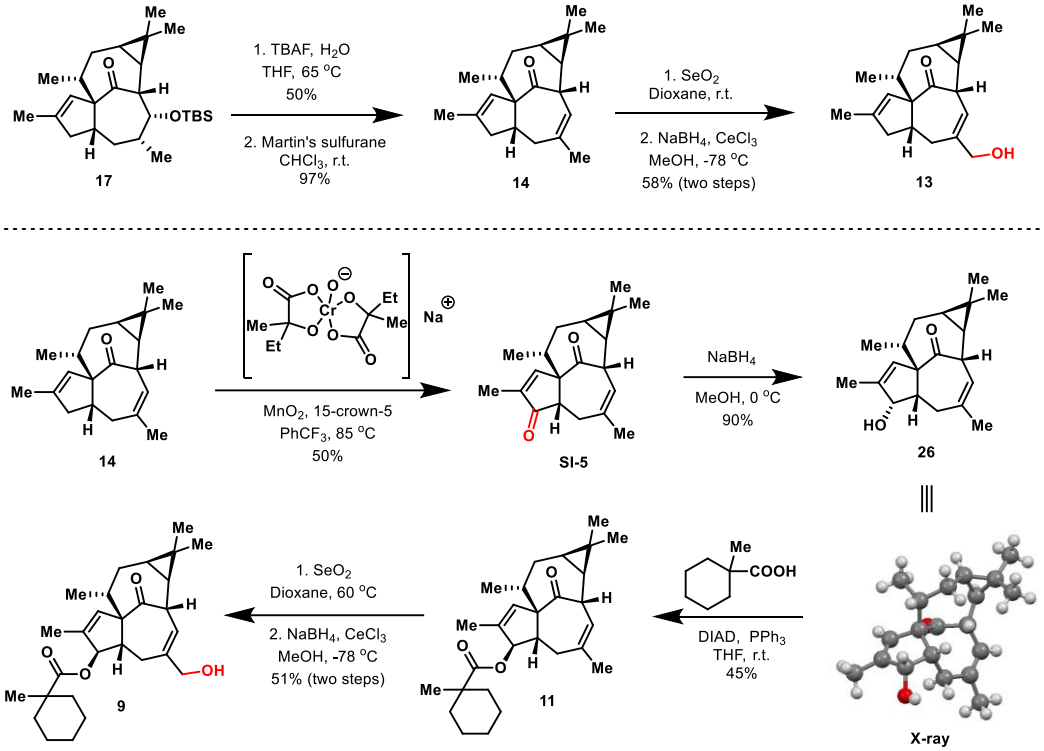
General Procedures: All reactions were carried out under an argon atmosphere with dry solvents using anhydrous conditions unless otherwise stated. Dry diethyl ether (Et_2O), dichloromethane (CH_2Cl_2), acetonitrile (CH_3CN), toluene (PhMe), tetrahydrofuran (THF), methanol (MeOH), and triethylamine (Et_3N) were obtained by passing these previously degassed solvents through activated alumina columns. Reagents were purchased at the highest commercial quality and used without further purification, unless otherwise stated. Yields refer to chromatographically and spectroscopically (^1H NMR) homogeneous materials, unless otherwise stated. Reactions were monitored by thin-layer chromatography (TLC) carried out on 0.25 mm E. Merck silica gel plates (60F-254) using UV light as visualizing agent and an acidic mixture of anisaldehyde, phosphomolybdic acid, or ceric ammonium molybdate, or basic aqueous potassium permanganate ($KMnO_4$), and heat as developing agents. E. Merck silica gel (60, particle size 0.0430−0.663 mm) was used for flash column chromatography. Preparative thin layer chromatography (PTLC) separations were carried out on 0.25 or 0.50 mm E. Merck silica gel plates (60F-254). Concentration of organic solvents was performed on a rotary evaporator under reduced pressure followed by further evacuation using a two-stage mechanical pump. NMR spectra were recorded on Bruker DRX-600, DRX-500 and AMX-400 instruments and calibrated using residual undeuterated solvent as an internal reference ($CHCl_3$ @ δ 7.26 ppm ^1H NMR, δ 77.16 ppm ^{13}C NMR; Benzene @ δ 7.16 ppm ^1H NMR, δ 128.06 ppm ^{13}C NMR). The following abbreviations (or combinations thereof) were used to explain ^1H NMR multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, p = quintet, m = multiplet, br = broad. High-resolution mass spectra (HRMS) were recorded on Agilent 6230 TOF LC/MS mass spectrometer by electrospray ionization time of flight reflectron experiments. IR spectra were recorded on a Perkin Elmer Spectrum BX FTIR spectrometer. Optical rotation were obtained on a Perkin-Elmer 341 polarimeter at 20 °C, measured at 589 nm. Melting points were recorded on a Fisher-Johns 12-144 melting point apparatus and are reported uncorrected.

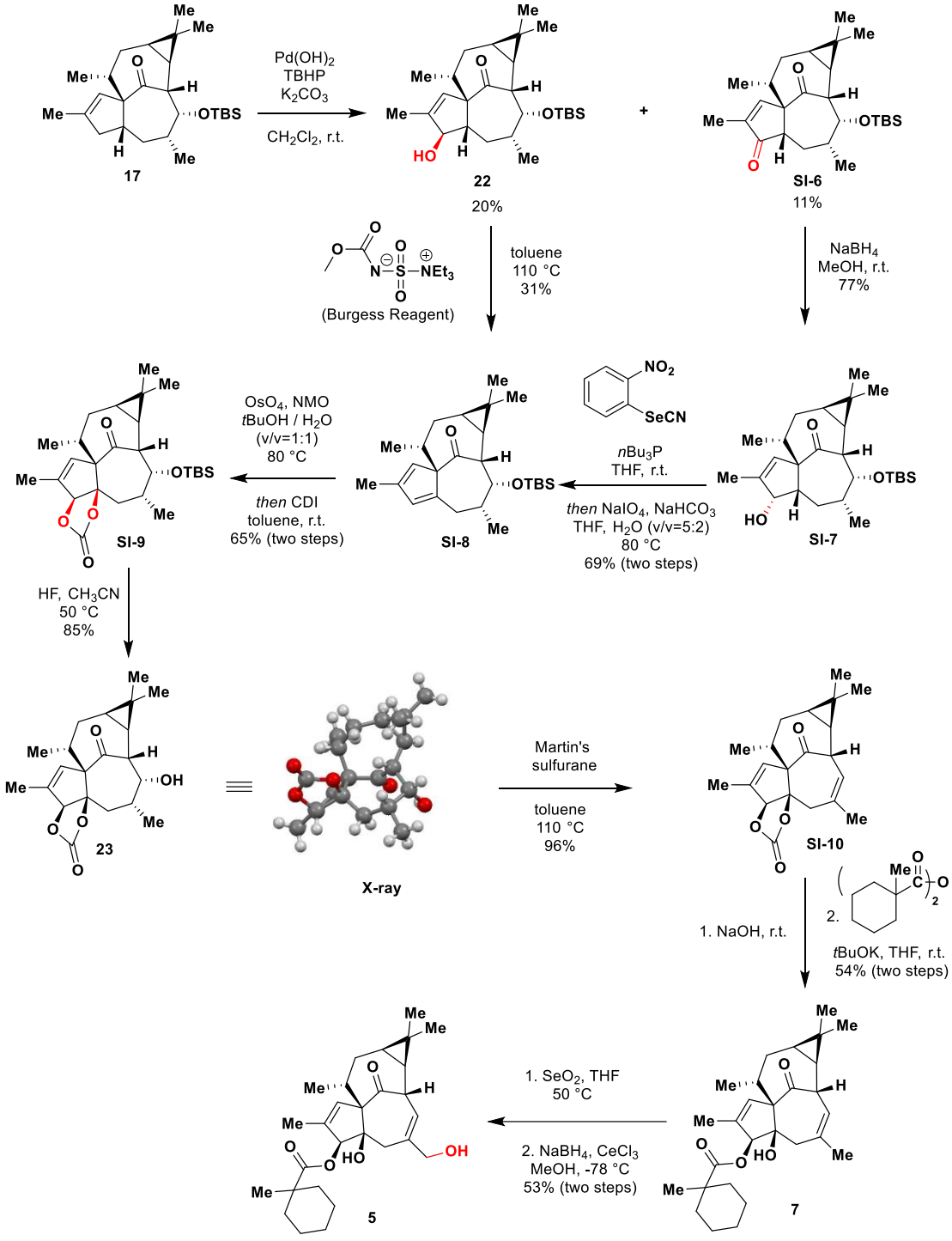
Scheme 1: Synthesis of **10**



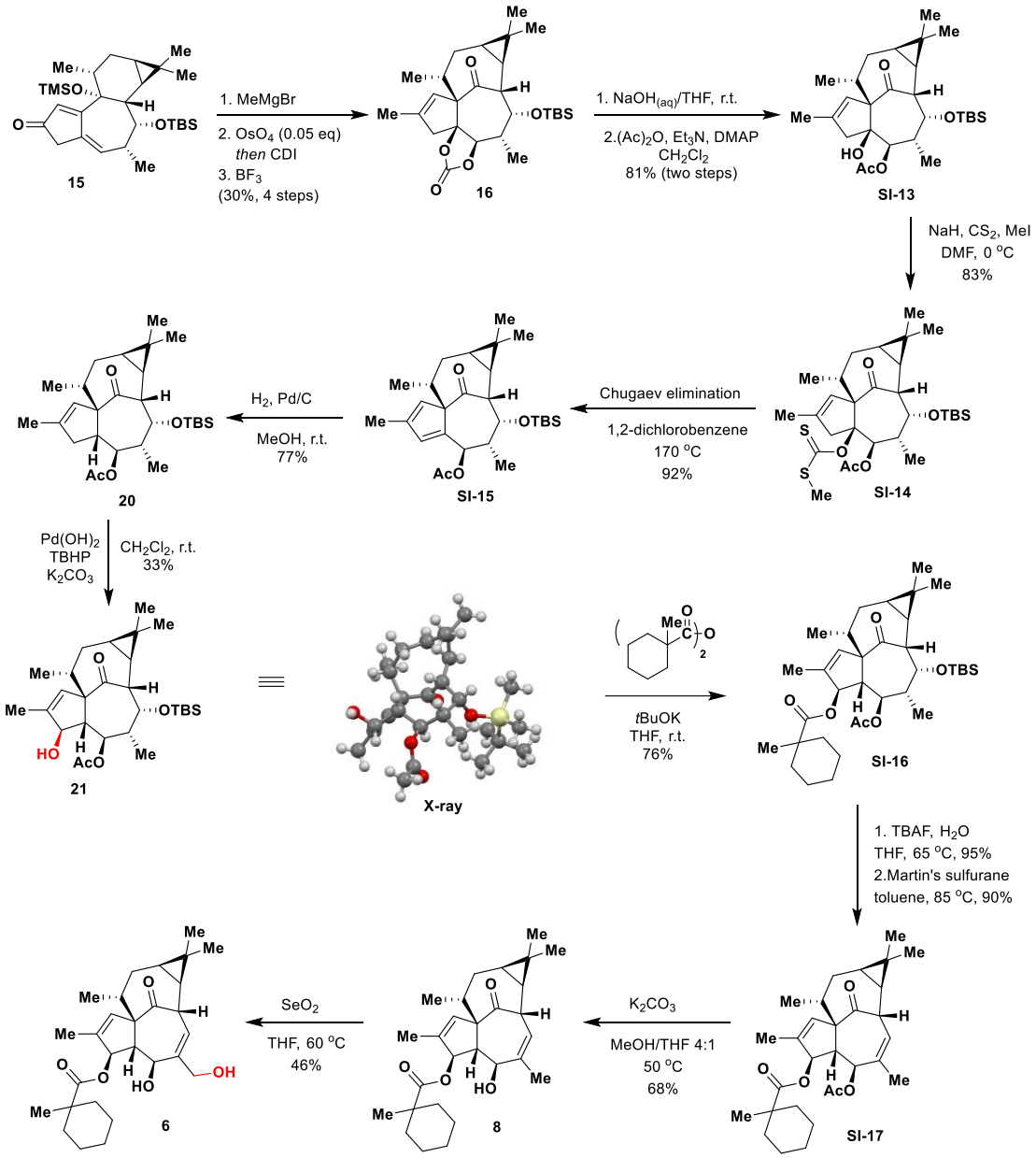
Scheme 2: Synthesis of **9** and **13**



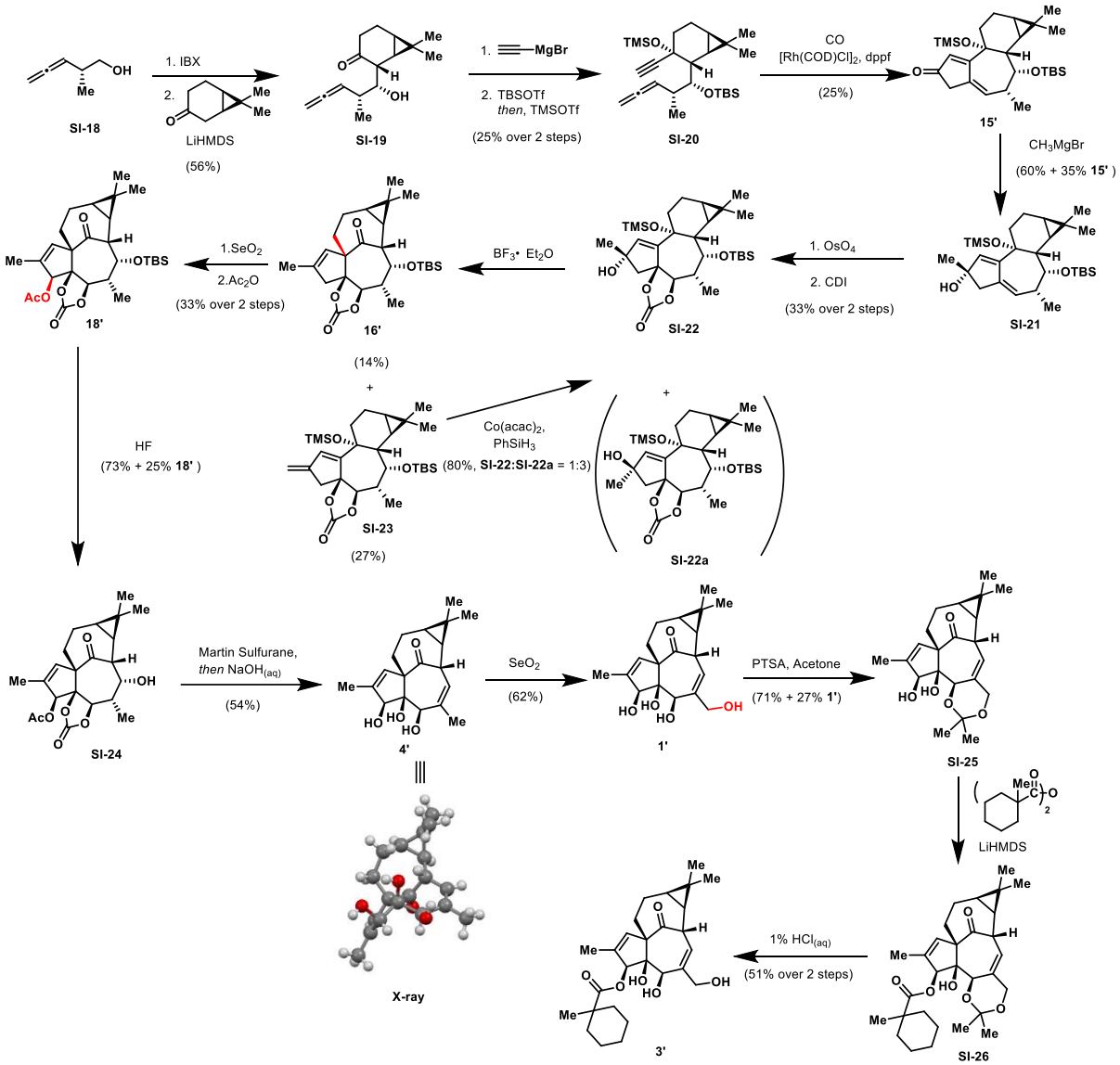
Scheme 3: Synthesis of **5**



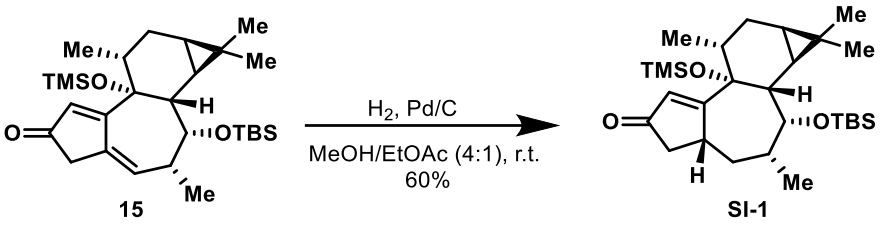
Scheme 4: Synthesis of **6**



Scheme 5: Synthesis of **3'**



Experimental Procedures



Synthesis of **SI-1**: To a solution of **15** (2.5 g, 5.12 mmol, 1.0 equiv) in MeOH (40 mL) and EtOAc (10 mL) was added 10% Pd/C (542 mg, 0.51 mmol, 0.1 equiv). $H_{2(g)}$ was bubbled into this solution at room temperature. The reaction mixture was stirred at room temperature for 30 min. Then, the solvent was concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 10:1 → 5:1) afforded **SI-1** (1.5 g, 60%) as a colorless crystalline solid.

Physical state: colorless crystalline solid

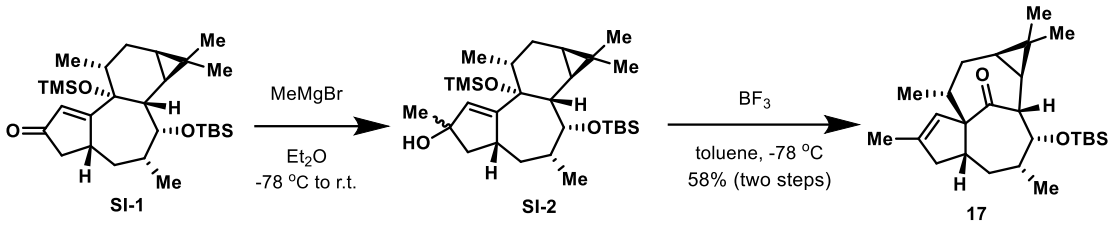
$\boldsymbol{R_f}$ = 0.5 (Hex/EtOAc = 5:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{28}H_{51}O_3Si_2$, $[M+H]^+$, 491.3377; found, 491.3376

$\boldsymbol{[\alpha]_D}$= +43.9° (*c* = 0.8, EtOAc)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 6.03 (s, 1H), 3.77 (s, 1H), 2.75 – 2.62 (m, 2H), 2.12 (d, *J* = 17.0 Hz, 1H), 1.76 – 1.32 (m, 7H), 1.10 (s, 3H), 0.96 (s, 3H), 0.93 (d, *J* = 6.7 Hz, 3H), 0.87 (s, 9H), 0.84 – 0.72 (m, 2H), 0.62 (d, *J* = 6.9 Hz, 3H), 0.25 (s, 9H), 0.15 (s, 3H), 0.06 (s, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 208.4, 192.1, 128.5, 83.0, 80.0, 52.0, 47.3, 44.0, 42.6, 41.9, 41.2, 28.9, 27.0, 26.9, 26.1, 21.9, 21.5, 19.2, 18.9, 17.6, 15.9, 5.1, -0.8, -4.1.



Synthesis of **17**: To a solution of **SI-1** (1.5 g, 3.06 mmol, 1.0 equiv) in Et_2O (50 mL) was added methylmagnesium bromide (3 M in Et_2O, 1.53 mL, 4.59 mmol, 1.5 equiv) over 5 min at −78 °C. The reaction mixture was stirred at this temperature for 15 min before warming to 0 °C. After another 30 min of stirring, the reaction mixture was carefully quenched with water (100 mL). The mixture was extracted with Et_2O (3 × 100 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure to afford crude **SI-2** (1.5 g) as a light yellow foam. To a solution of crude **SI-2** (1.5 g) in toluene (50 mL) was added $BF_3{\cdot}Et_2O$ (3.76 mL, 29.6 mmol, 9.7 equiv) over 5 min at −78 °C. After 15 min, a 1:1 mixture of Et_3N/MeOH (24.6 mL) was slowly added, then the solution was allowed warm to room temperature. The solvent was concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 50:1 → 30:1) afforded **17** (745.4 mg, 58%, two steps) as a white foam.

Physical state: white foam

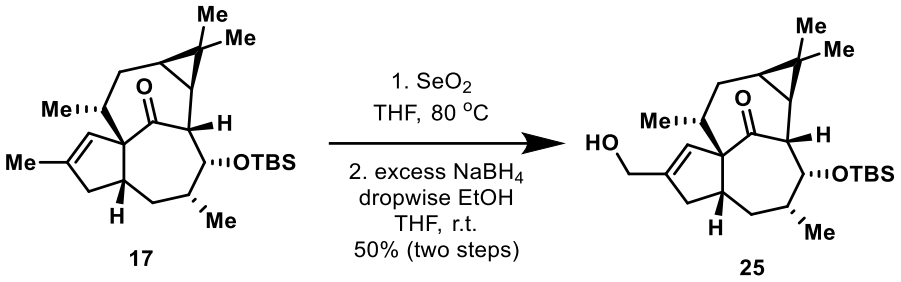
$\boldsymbol{R_f}$ = 0.22 (Hex/EtOAc = 50:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{26}H_{45}O_2Si$, $[M+H]^+$, 417.3189; found, 417.3185

$\boldsymbol{[\alpha]_D}$= +21.2° (*c* = 0.65, EtOAc)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 5.61 (s, 1H), 3.83 (d, *J* = 3.8 Hz, 1H), 2.72 (dd, *J* = 16.2, 7.3 Hz, 1H), 2.51 (d, *J* = 12.2 Hz, 1H), 2.21 (dd, *J* = 10.6, 7.4 Hz, 1H), 1.90 – 1.74 (m, 3H), 1.70 (d, *J* = 1.4 Hz 3H), 1.72 – 1.64 (m, 3H), 1.11 (d, *J* = 15.0 Hz, 1H), 1.08 (s, 3H), 1.04 (s, 3H), 0.94 (s, 9H), 0.90 (d, *J* = 7.0 Hz, 3H), 0.89 – 0.83 (m, 1H), 0.86 (d, *J* = 6.6 Hz, 3H), 0.67 (td, *J* = 8.8, 5.9 Hz, 1H), 0.15 (s, 3H), 0.03 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 208.0, 139.2, 125.0, 76.4, 73.6, 52.1, 45.6, 45.2, 45.1, 40.7, 38.7, 29.9, 28.8, 26.2, 24.4, 23.6, 23.3, 19.8, 18.5, 17.3, 16.6, 15.8, -3.7, -4.6.



Synthesis of **25**: To a solution of **17** (384 mg, 0.92 mmol, 1.0 equiv) in THF (5 mL) was added SeO_2 (307 mg, 2.74 mmol, 3.0 equiv). The flask was sealed with a plastic cap and the suspension was stirred at 80 °C for 10 h. After cooling to room temperature, the reaction mixture was filtered through a plug of silica gel (hexanes/EtOAc = 1:1) to provide a clear yellow solution. A yellow oil was obtained after concentration *in vacuo*, and followed by dissolution in THF (5 mL). To this solution, excess $NaBH_4$ (350 mg, 9.21 mmol, 10.0 equiv) was added, then EtOH (0.54 mL, 9.21 mmol, 10.0 eq.) was slowly added at room temperature. When the reaction was completed (monitored by TLC), water (5 mL) was slowly added to quench the excess $NaBH_4$. The reaction mixture was extracted with EtOAc (3 × 10 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 4:1 → 3:1) afforded **25** (197.7 mg, 50%) as a pale yellow oil.

Physical state: pale yellow oil

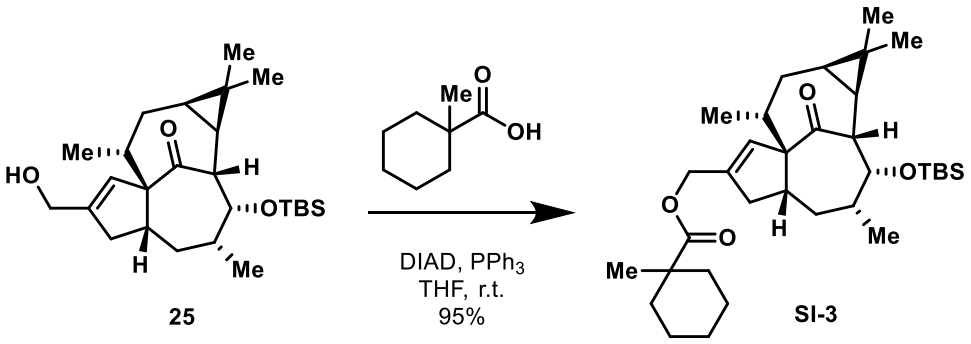
$\boldsymbol{R_f}$ = 0.2 (Hex/EtOAc = 4:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{26}H_{45}O_3Si$, $[M+H]^+$, 433.3138; found, 433.3132

$\boldsymbol{[\alpha]_D}$= +26.5° (*c* = 0.43, EtOAc)

^{1}H NMR (500 MHz, Chloroform-*d*) δ 6.14 – 5.68 (m, 1H), 4.15 (d, *J* = 5.3 Hz, 2H), 3.85 (d, *J* = 3.9 Hz, 1H), 2.76 (ddd, *J* = 15.9, 7.0, 3.9 Hz, 1H), 2.52 (d, *J* = 12.2 Hz, 1H), 2.30 (dd, *J* = 10.8, 7.4 Hz, 1H), 1.94 – 1.76 (m, 4H), 1.74 – 1.62 (m, 2H), 1.40 (t, *J* = 6.2 Hz, 1H), 1.14 (dd, *J* = 15.4, 2.0 Hz, 1H), 1.09 (s, 3H), 1.05 (s, 3H), 0.94 (s, 9H), 0.93 (d, *J* = 6.9 Hz, 3H), 0.90 – 0.85 (m, 1H), 0.87 (d, *J* = 6.7 Hz, 3H), 0.68 (td, *J* = 9.0, 6.1 Hz, 1H), 0.15 (s, 3H), 0.03 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 207.5, 143.0, 125.9, 76.0, 73.5, 62.4, 52.3, 45.23, 45.21, 40.6, 40.5, 38.5, 30.0, 28.8, 26.2, 24.4, 23.7, 23.3, 19.7, 18.5, 16.5, 15.8, -3.7, -4.6.



Synthesis of **SI-3**: To a solution of **25** (65.3 mg, 0.15 mmol, 1.0 equiv) in THF (3 mL) was added 1-methylcyclohexanecarboxylic acid (42.6 mg, 0.30 mmol, 2.0 equiv) and triphenylphosphine (119.0 mg, 0.45 mmol, 3.0 equiv) at room temperature. Then, DIAD (0.09 mL, 0.45 mmol, 3.0 equiv) was slowly added over 1 min. The reaction mixture was stirred at room temperature for another 5 min before water (5 mL) was added. The mixture was then extracted with Et_2O (3 × 10 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 30:1) afforded **SI-3** (79.8 mg, 95%) as a pale yellow oil.

Physical state: pale yellow oil

$\boldsymbol{R_f}$ = 0.5 (10:1 Hex/EtOAc; anisaldehyde)

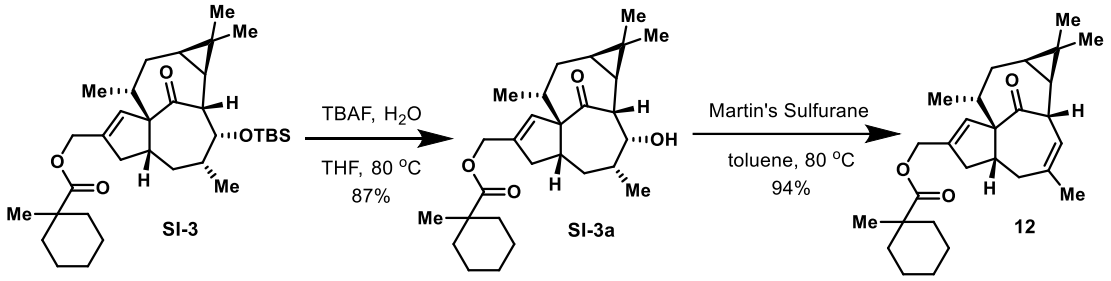
HRMS (***m*/*z***): calcd for $C_{34}H_{56}NaO_4Si$, $[M+Na]^+$, 579.3846; found, 579.3852

$[\alpha]_D$= +23.2° (*c* = 0.34, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.95 (s, 1H), 4.61 (s, 2H), 3.85 (d, *J* = 3.7 Hz, 1H), 2.75 (dd, *J* = 16.0, 6.9 Hz, 1H), 2.51 (d, *J* = 12.2 Hz, 1H), 2.37 – 2.18 (m, 1H), 2.03 (d, *J* = 13.2 Hz, 2H), 1.94 – 1.86 (m, 1H), 1.83 (d, *J* = 16.2 Hz, 1H), 1.83 – 1.78 (m, 2H), 1.75 – 1.62 (m, 2H), 1.54 – 1.46 (m, 2H), 1.35 (q, *J* = 10.7 Hz, 2H), 1.30 – 1.18 (m, 4H), 1.15 (s, 3H), 1.12 (d, *J* = 15.3 Hz, 1H), 1.09 (s, 3H), 1.04 (s, 3H), 0.94 (s,

9H), 0.91 (d, *J* = 7.0 Hz, 3H), 0.88 (d, *J* = 9.0 Hz, 1H), 0.87 (d, *J* = 6.9 Hz, 3H), 0.71 – 0.64 (m, 1H), 0.15 (s, 3H), 0.03 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 207.2, 177.6, 138.2, 128.4, 76.1, 73.5, 62.8, 52.3, 45.2, 45.1, 43.5, 41.1, 40.5, 38.5, 35.7, 30.0, 28.8, 26.2, 25.8, 24.5, 23.7, 23.4, 23.2, 19.7, 18.5, 16.5, 15.8, -3.7, -4.6.



Synthesis of **12**: To a solution of **SI-3** (79.8 mg, 0.14 mmol, 1.0 equiv) in THF (3 mL) was added TBAF (1 M, 0.72 mL, 0.72 mmol, 5.0 equiv) and H_2O (13 mg, 0.72 mmol, 5 equiv) at room temperature. The flask was sealed with a plastic cap and the reaction mixture was heated to 80 °C. After 10 h, the reaction mixture was cooled to room temperature, then water (5 mL) was added. The mixture was extracted with Et_2O (3 × 10 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 10:1) afforded **SI-3a** (54.9 mg, 87%).

To a solution of **SI-3a** (54.9 mg, 0.129 mmol, 1.0 equiv) in toluene (2 mL) was added Martin's sulfurane (110 mg, 0.163 mmol, 1.3 equiv) at room temperature. The solution was stirred at 80 °C for 10 min. Toluene was then removed under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1) afforded **12** (49.3 mg, 94%) as a colorless oil.

Physical state: colorless oil

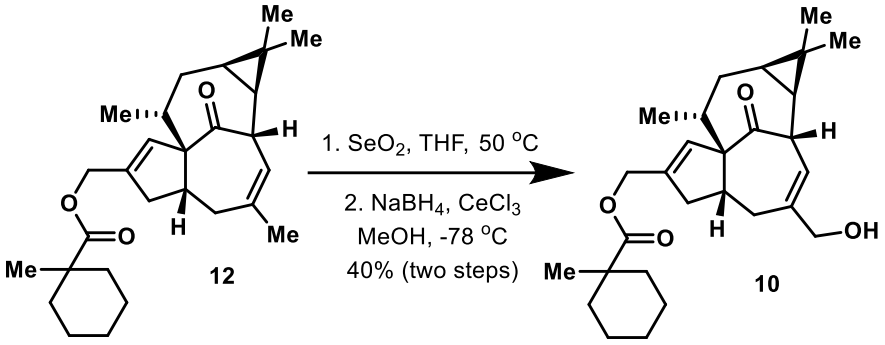
$\boldsymbol{R_f}$ = 0.2 (Hex/EtOAc = 20:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{28}H_{40}NaO_3$, $[M+Na]^+$, 447.2875; found, 447.2875

[α]$_D$= +5.6° (*c* = 0.18, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.93 (s, 1H), 5.63 (s, 1H), 4.63 (s, 2H), 3.62 (d, *J* = 12.0 Hz, 1H), 2.78 – 2.63 (m, 2H), 2.17 – 2.08 (m, 2H), 2.08 – 2.00 (m, 3H), 1.87 (dt, *J* = 15.7, 5.4 Hz, 1H), 1.80 – 1.70 (m, 2H), 1.58 (s, 3H), 1.52 – 1.47 (m, 2H), 1.41 – 1.32 (m, 2H), 1.30 – 1.18 (m, 4H), 1.17 (s, 3H), 1.10 (s, 3H), 1.05 (s, 3H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.87 (dd, *J* = 12.1, 8.3 Hz, 1H), 0.71 (td, *J* = 8.7, 6.4 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 208.9, 177.6, 139.3, 137.8, 126.1, 122.0, 76.3, 62.8, 45.4, 43.5, 43.1, 43.0, 38.4, 38.2, 35.7, 30.7, 28.8, 25.8, 24.4, 23.7, 23.5, 23.4, 23.1, 16.8, 15.6.



Synthesis of **10**: To a solution of **12** (5.5 mg, 0.013 mmol, 1.0 equiv) in THF (2 mL) was added SeO_2 (7.3 mg, 0.065 mmol, 5.0 equiv) at room temperature. The flask was sealed with a plastic cap and the suspension was stirred at 50 °C for 1 h. After cooling to room temperature, the reaction mixture was filtered through a plug of silica gel (hexanes/EtOAc = 1:1) to provide a clear yellow solution. A yellow oil was obtained after concentration *in vacuo*, and followed by dissolution in MeOH (2 mL). After cooling to –78 °C, $CeCl_3 \cdot 7H_2O$ (24 mg, in 0.5 mL MeOH, 0.065 mmol, 5.0 equiv) was added, then $NaBH_4$ (4.9 mg, 0.129 mmol, 10.0 equiv) was slowly added to the flask. After stirring for 10 min at –78 °C, H_2O (2 mL) was carefully added to quench this reaction followed by dilution with Et_2O (5 mL). The mixture was extracted with Et_2O (5 × 2 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 2:1) afforded **10** (2.3 mg, 40%) as a colorless oil.

Physical state: colorless oil

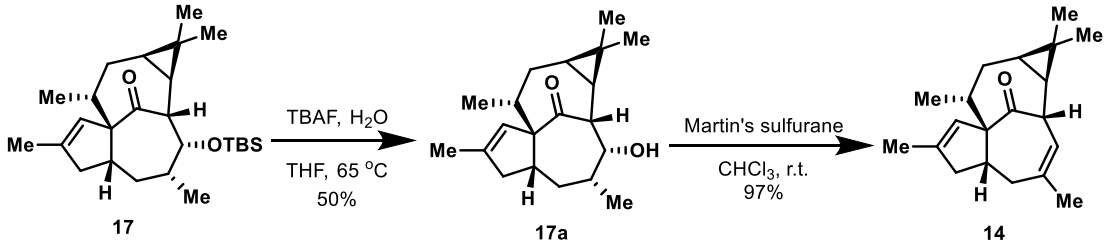
R_f = 0.16 (Hex/EtOAc = 3:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{28}H_{40}NaO_4$, $[M+Na]^+$, 463.2824; found, 463.2815

$[\alpha]_D$= −4.2° (*c* = 0.19, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.94 (s, 1H), 5.91 (s, 1H), 4.63 (s, 2H), 3.88 (q, *J* = 13.0 Hz, 2H), 3.67 (d, *J* = 11.8 Hz, 1H), 2.77 – 2.64 (m, 2H), 2.25 (d, *J* = 16.9 Hz, 1H), 2.21 – 2.12 (m, 1H), 2.12 – 1.98 (m, 3H), 1.89 (dt, *J* = 15.8, 5.6 Hz, 1H), 1.82 (d, *J* = 15.0 Hz, 1H), 1.75 (ddd, *J* = 15.6, 8.9, 2.4 Hz, 1H), 1.60 – 1.54 (m, 2H), 1.41 – 1.31 (m, 2H), 1.31 – 1.19 (m, 4H), 1.17 (s, 3H), 1.10 (s, 3H), 1.06 (s, 3H), 0.97 (d, *J* = 7.0 Hz, 3H), 0.91 (dd, *J* = 12.0, 8.4 Hz, 1H), 0.78 – 0.69 (m, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 208.6, 177.5, 141.1, 139.6, 125.7, 123.7, 76.3, 67.3, 62.7, 45.4, 43.5, 42.8, 38.5, 38.3, 38.2, 35.7, 30.8, 28.7, 25.8, 23.8, 23.6, 23.4, 23.0, 17.0, 15.6.



Synthesis of **14**: To a solution of **17** (496 mg, 1.19 mmol, 1.0 equiv) in THF (5 mL) was added TBAF (1 M, 5.95 mL, 5.95 mmol, 5.0 equiv) and H_2O (53 mg, 2.94 mmol, 2.5 equiv) at room temperature. The flask was sealed with a plastic cap and the reaction mixture was heated to 65 °C. After stirring for 2 days, the reaction mixture was cooled to room temperature then water (5 mL) was added. The mixture was extracted with Et_2O (3 × 10 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 10:1) afforded **17a** (178.3 mg, 50%).

To a solution of **17a** (178.3 mg, 0.59 mmol, 1.0 equiv) in $CHCl_3$ (3 mL) was added Martin's sulfurane (540 mg, 0.80 mmol, 1.4 equiv) at room temperature. The reaction mixture was stirred at room temperature for 30 min. Then, $CHCl_3$ was removed under

reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 30:1 → 20:1) afforded **14** (162.6 mg, 97%) as a pale yellow oil.

Physical state: pale yellow oil

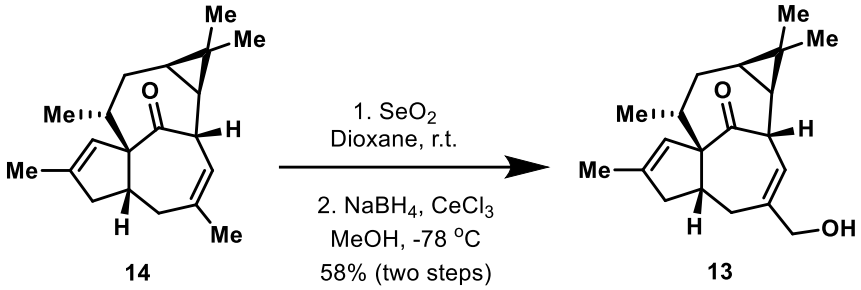
R_f = 0.5 (Hex/EtOAc = 10:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{20}H_{29}O$, $[M+H]^+$, 285.2218; found, 285.2211

$[\alpha]_D$= +0.7° (*c* = 0.42, EtOAc)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 5.62 (s, 1H), 5.58 (s, 1H), 3.63 (d, *J* = 10.2 Hz, 1H), 2.69 – 2.60 (m, 2H), 2.11 – 2.08 (m, 2H), 2.05 – 1.96 (m, 1H), 1.84 (dt, *J* = 15.7, 5.6 Hz, 1H), 1.76 – 1.69 (m, 1H), 1.74 (s, 3H), 1.61 (d, *J* = 14.9 Hz, 1H), 1.58 (s, 3H), 1.09 (s, 3H), 1.05 (s, 3H), 0.95 (d, *J* = 7.1 Hz, 3H), 0.86 (dd, *J* = 12.1, 8.4 Hz, 1H), 0.70 (td, *J* = 8.6, 6.2 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 209.8, 140.4, 137.9, 122.6, 122.0, 76.6, 45.3, 43.4, 42.4, 38.4, 30.7, 28.8, 24.5, 23.6, 23.5, 23.1, 17.5, 16.9, 15.6.



Synthesis of **13**: To a solution of **14** (46 mg, 0.16 mmol, 1.0 equiv) in dioxane (2 mL) was added SeO_2 (36 mg, 0.32 mmol, 2.0 equiv) at room temperature. The flask was sealed with a plastic cap and the suspension was stirred at room temperature for 1 h. The reaction mixture was filtered through a plug of silica gel (hexanes/EtOAc = 1:1) to provide a clear yellow solution. A yellow oil was obtained after concentration *in vacuo*, and followed by dissolution in MeOH (2 mL). After cooling to –78 °C, $CeCl_3 \cdot 7H_2O$ (301.5 mg, 0.81 mmol, in 2 mL MeOH, 5.0 equiv) was added, then $NaBH_4$ (31 mg,

0.81 mmol, 5.0 eq.) was slowly added to the flask. After stirring for 10 min at –78 °C, H_2O (5 mL) was carefully added to quench this reaction followed by dilution with Et_2O (10 mL). The mixture was extracted with Et_2O (3 × 10 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 3:1) afforded **13** (28.3 mg, 58%) as a pale yellow oil.

Physical state: pale yellow oil

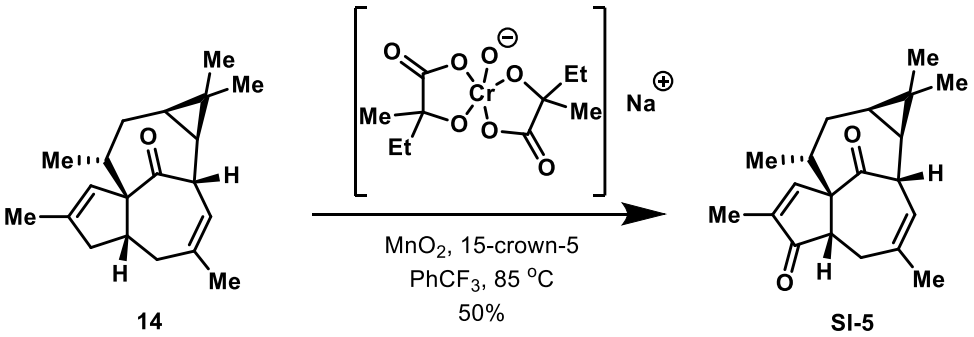
$\boldsymbol{R_f}$ = 0.4 (Hex/EtOAc = 2:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{20}H_{29}O_2$, $[M+H]^+$, 301.2168; found, 301.2166

$[\alpha]_D$= −5.0° (*c* = 0.18, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.92 (s, 1H), 5.57 (s, 1H), 3.96 – 3.83 (m, 2H), 3.67 (d, *J* = 12.0 Hz, 1H), 2.73 – 2.57 (m, 2H), 2.29 – 2.12 (m, 2H), 2.07 – 2.02 (m, 1H), 1.87 (dt, *J* = 15.8, 5.7 Hz, 1H), 1.76 – 1.71 (m, 1H), 1.74 (s, 3H), 1.67 (d, *J* = 15.2 Hz, 1H), 1.09 (s, 3H), 1.06 (s, 3H), 0.96 (d, *J* = 7.1 Hz, 3H), 0.90 (dd, *J* = 12.0, 8.4 Hz, 1H), 0.73 (td, *J* = 8.6, 6.2 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 209.4, 141.3, 140.7, 123.8, 122.4, 76.7, 67.4, 45.2, 43.2, 42.4, 38.5, 38.4, 30.8, 28.8, 23.7, 23.6, 22.9, 17.5, 17.1, 15.6.



Synthesis of **SI-5**: To a flame-dried 25 mL flask equipped with a stir bar were added **14** (21.3 mg, 0.075 mmol, 1.0 equiv), Cr(V) reagent (124.1 mg, 0.384 mmol, 5.0 equiv) and manganese (IV) oxide (324.6 mg, 49.8 equiv). The flask was evacuated and filled

with argon, followed by addition of α,α,α-trifluorotoluene (5 mL) and 15-crown-5 (74 μL). The vial was sealed with a septum and heated at 85 °C for 24 h. The reaction mixture was filtered through a two-layered plug of silica and Celite® (hexanes/EtOAc = 1:1) to provide a clear yellow solution, which was concentrated *in vacuo* to a yellow oil. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1 → 10:1) afforded **SI-5** (11.1 mg, 50%) as a pale yellow oil.

Physical state: pale yellow oil

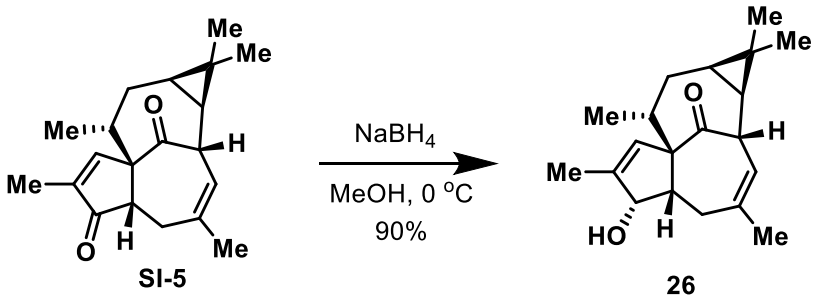
$\boldsymbol{R_f}$ = 0.4 (Hex/EtOAc = 5:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{20}H_{27}O_2$, $[M+H]^+$, 299.2011; found, 299.2011

$[\alpha]_D$= +74.6° (*c* = 0.26, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-d) δ 7.51 (s, 1H), 5.67 (s, 1H), 3.61 (d, *J* = 10.1 Hz, 1H), 2.71 (dd, *J* = 12.4, 4.0 Hz, 1H), 2.43 (dd, *J* = 18.3, 3.8 Hz, 1H), 1.98 (ddt, *J* = 9.4, 6.6, 2.6 Hz, 1H), 1.95 – 1.85 (m, 2H), 1.85 – 1.74 (m, 1H), 1.81 (d, *J* = 1.5 Hz, 3H), 1.61 (s, 3H), 1.11 (s, 3H), 1.07 (s, 3H), 0.99 (d, *J* = 6.9 Hz, 3H), 0.96 (dd, *J* = 11.9, 8.5 Hz, 1H), 0.78 – 0.73 (m, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 207.8, 206.2, 155.4, 140.7, 136.0, 122.1, 70.5, 52.8, 45.6, 42.9, 39.5, 31.6, 28.8, 24.2, 23.8, 23.5, 23.3, 17.8, 15.5, 10.7.



Synthesis of **26**: To a solution of **SI-5** (11.1 mg, 0.037 mmol, 1.0 equiv) in MeOH (1 mL) at 0 °C was slowly added $NaBH_4$ (7.1 mg, 0.187 mmol, 5.0 equiv). The reaction mixture was stirred at 0 °C for 5 min before quenching with H_2O (2 mL). The mixture was extracted with Et_2O (3 × 5 mL) and the combined organic layers were dried over

$MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 5:1) afforded **26** (10.1 mg, 90%) as a colorless crystalline solid.

Physical state: colorless crystalline solid

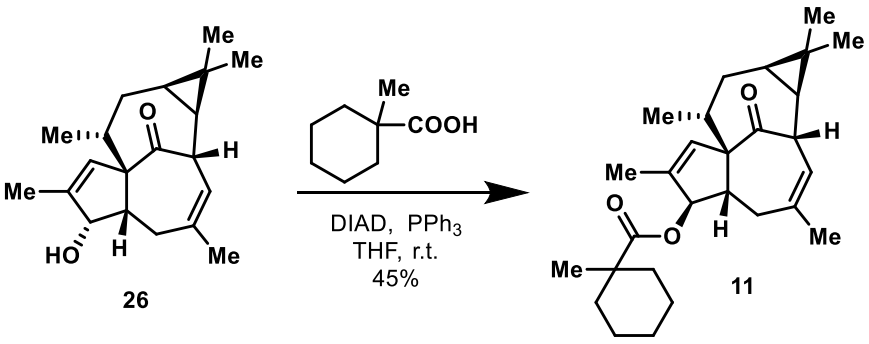
R_f = 0.2 (Hex/EtOAc = 5:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{20}H_{29}O_2$, $[M+H]^+$, 301.2168; found, 301.2168

[α]$_D$= −5.6° (*c* = 0.18, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.77 – 5.70 (m, 1H), 5.66 (dq, *J* = 4.8, 1.5 Hz, 1H), 4.72 – 4.65 (m, 1H), 3.67 (d, *J* = 11.8 Hz, 1H), 2.75 (ddd, *J* = 10.3, 6.2, 3.9 Hz, 1H), 2.53 (dd, *J* = 17.9, 3.7 Hz, 1H), 2.11 (td, *J* = 6.8, 3.1 Hz, 1H), 1.95 (dd, *J* = 17.8, 10.6 Hz, 2H), 1.85 (dt, *J* = 15.8, 6.3 Hz, 1H), 1.82 – 1.76 (m, 1H), 1.79 (t, *J* = 1.3 Hz, 3H), 1.66 (s, 3H), 1.12 (s, 3H), 1.04 (s, 3H), 0.94 (dd, *J* = 11.8, 8.5 Hz, 2H), 0.89 (d, *J* = 7.0 Hz, 3H), 0.68 (q, *J* = 7.4 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 210.1, 142.5, 137.9, 125.0, 122.2, 78.6, 73.1, 48.3, 45.0, 37.5, 33.7, 31.3, 28.8, 24.9, 23.9, 23.34, 23.26, 17.2, 15.6, 13.9.



Synthesis of **11**: To a solution of **26** (7.0 mg, 0.023 mmol, 1.0 equiv) in THF (1 mL) was added 1-methylcyclohexanecarboxylic acid (16.6 mg, 0.116 mmol, 5.0 equiv) and triphenylphosphine (30.6 mg, 0.116 mmol, 5.0 equiv) at room temperature. Then, DIAD (23 μL, 0.116 mmol, 5.0 equiv) was slowly added over 1 min. The reaction mixture was stirred at room temperature for 5 min before water (5 mL) was added. The

mixture was extracted with Et_2O (3 × 10 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 50:1 → 30:1) afforded **11** (4.4 mg, 45%) as a colorless oil.

Physical state: colorless oil

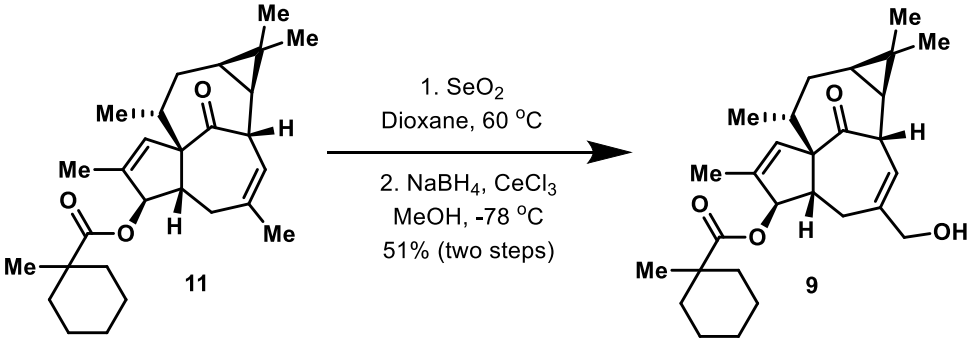
$\boldsymbol{R_f}$ = 0.2 (Hex/EtOAc = 20:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{28}H_{40}NaO_3$, $[M+Na]^+$, 447.2875; found, 447.2884

$\boldsymbol{[\alpha]_D}$= +16.4° (*c* = 0.44, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.04 (s, 1H), 5.62 (s, 1H), 4.82 (s, 1H), 3.51 (d, *J* = 11.7 Hz, 1H), 2.47 (s, 1H), 2.45 (dd, *J* = 15.9, 3.4 Hz, 1H), 2.18 – 2.08 (m, 1H), 2.01 (d, *J* = 12.3 Hz, 2H), 1.96 – 1.87 (m, 1H), 1.82 (dt, *J* = 15.7, 5.8 Hz, 1H), 1.77 (d, *J* = 1.3 Hz, 3H), 1.67 (ddd, *J* = 15.7, 9.1, 2.6 Hz, 1H), 1.59 (s, 4H), 1.58 – 1.51 (m, 2H), 1.38 – 1.19 (m, 6H), 1.14 (s, 3H), 1.07 (s, 3H), 1.04 (s, 3H), 1.01 (d, *J* = 7.1 Hz, 3H), 0.85 (dd, *J* = 12.1, 8.4 Hz, 1H), 0.69 (td, *J* = 8.8, 6.3 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 208.3, 178.1, 138.0, 136.9, 131.8, 122.2, 85.9, 75.4, 49.3, 45.4, 43.4, 41.4, 40.0, 35.7, 30.5, 28.8, 25.8, 24.3, 23.5, 23.44, 23.40, 22.9, 16.7, 15.6, 15.3.



Synthesis of **9**: To a solution of **11** (4.0 mg, 0.0094 mmol, 1.0 equiv) in THF (1 mL) was added SeO_2 (5.2 mg, 0.0465 mmol, 4.9 equiv) at room temperature. The flask was sealed with a plastic cap and the suspension was stirred at 60 °C for 1 h. After cooling to room temperature, the reaction mixture was filtered through a plug of silica gel

(hexanes/EtOAc = 1:1) to provide a clear yellow solution. A yellow oil was obtained after concentration *in vacuo*, and followed by dissolution in MeOH (1 mL). After cooling to –78 °C, $CeCl_3 \cdot 7H_2O$ (17.6 mg, in 0.5 mL MeOH, 0.0472 mmol, 5.0 equiv) was added, then $NaBH_4$ (1.8 mg, 0.0474 mmol, 5.0 equiv) was slowly added to the flask. After stirring for 10 min at –78 °C, H_2O (5 mL) was carefully added to quench this reaction, followed by dilution with Et_2O (5 mL). The mixture was extracted with Et_2O (3 × 5 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 2:1) afforded **9** (2.1 mg, 51%) as a colorless oil.

Physical state: colorless oil

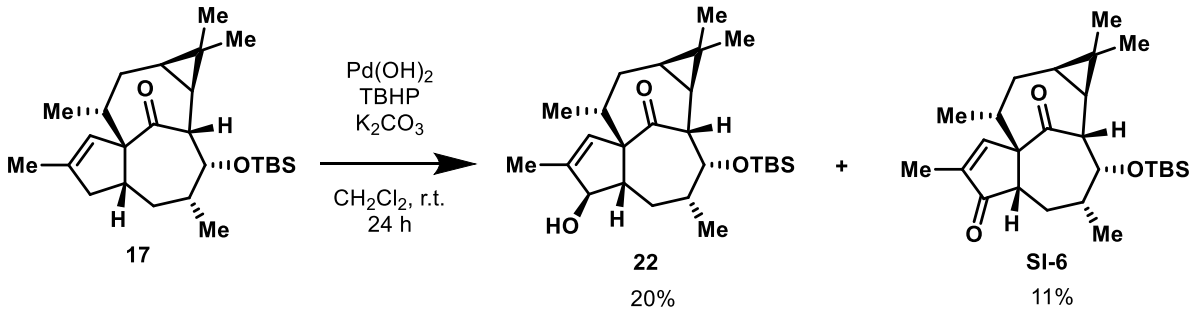
$\boldsymbol{R_f}$ = 0.25 (Hex/EtOAc = 2:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{28}H_{40}NaO_4$, $[M+Na]^+$, 463.2824; found, 463.2822

$\boldsymbol{[\alpha]_D}$= +20.0° (*c* = 0.21, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.02 (s, 1H), 5.94 (s, 1H), 4.89 (s, 1H), 3.91 (s, 2H), 3.56 (d, *J* = 11.6 Hz, 0H), 2.58 (dd, *J* = 18.1, 3.0 Hz, 1H), 2.47 (dd, *J* = 12.5, 3.3 Hz, 1H), 2.20 – 2.13 (m, 1H), 2.04 – 1.97 (m, 3H), 1.85 (dt, *J* = 15.8, 5.8 Hz, 1H), 1.77 (d, *J* = 1.3 Hz, 3H), 1.69 (ddd, *J* = 16.0, 8.9, 2.7 Hz, 1H), 1.60 – 1.55 (m, 2H), 1.39 – 1.19 (m, 6H), 1.15 (s, 3H), 1.08 (s, 3H), 1.05 (s, 3H), 1.01 (d, *J* = 7.1 Hz, 3H), 0.90 (dd, *J* = 12.0, 8.4 Hz, 1H), 0.73 (td, *J* = 8.5, 6.3 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 207.9, 140.3, 138.4, 131.4, 123.7, 85.6, 75.3, 67.1, 49.2, 45.2, 43.4, 41.3, 35.6, 35.2, 30.6, 28.7, 25.8, 23.6, 23.5, 23.4, 22.8, 16.8, 15.6, 15.3.



Synthesis of **22** and **SI-6**: To a solution of **17** (519.0 mg, 1.247 mmol, 1.0 equiv) in CH_2Cl_2 (8 mL) was added 20% $Pd(OH)_2$ on carbon (66 mg, 0.125 mmol, 0.1 equiv) and K_2CO_3 (43 mg, 0.312 mmol, 0.25 equiv) at room temperature. The mixture was cooled to 0 °C, and TBHP (5.5 M in decane, 1.13 mL, 6.215 mmol, 5.0 equiv) was added with vigorous stirring. Then, the reaction mixture was allowed to warm to room temperature. After 24 h, the reaction mixture was filtered through a plug of silica gel (CH_2Cl_2). The solvent was removed under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1 → 5:1) afforded **22** (105.1 mg, 20%) and **SI-6** (60 mg, 11%).

Spectroscopic data for **22**:

Physical state: colorless oil

$\boldsymbol{R_f}$ = 0.25 (Hex/EtOAc = 5:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{26}H_{44}NaO_3Si$, $[M+Na]^+$, 455.2957; found, 455.2959

$\boldsymbol{[\alpha]_D}$= +49.4° (*c* = 0.34, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.98 (d, *J* = 1.7 Hz, 1H), 3.96 (s, 1H), 3.85 (d, *J* = 3.9 Hz, 1H), 2.51 (d, *J* = 12.2 Hz, 1H), 2.15 (dd, *J* = 10.6, 1.8 Hz, 1H), 2.09 – 2.02 (m, 1H), 1.87 – 1.80 (m, 2H), 1.80 (d, *J* = 1.5 Hz, 3H), 1.78 – 1.73 (m, 1H), 1.35 – 1.29 (m, 1H), 1.27 (dd, *J* = 15.6, 3.4 Hz, 1H), 1.09 (s, 3H), 1.04 (s, 3H), 0.97 (d, *J* = 7.1 Hz, 3H), 0.93 (s, 9H), 0.88 (d, *J* = 6.9 Hz, 3H), 0.86 (dd, *J* = 12.2, 8.6 Hz, 1H), 0.67 (td, *J* = 9.2, 6.2 Hz, 1H), 0.14 (s, 3H), 0.03 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 206.6, 140.5, 132.0, 87.9, 75.0, 73.7, 54.1, 52.2, 44.9, 42.1, 38.2, 30.0, 28.7, 26.2, 24.3, 23.6, 23.0, 19.8, 18.4, 16.3, 15.7, 14.9, -3.7, -4.6.

Spectroscopic data for **SI-6**:

Physical state: colorless crystalline solid

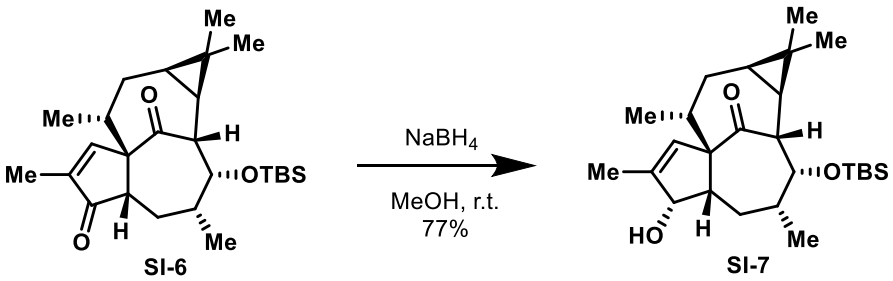
$\boldsymbol{R_f}$ = 0.33 (Hex/EtOAc = 10:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{26}H_{42}NaO_3Si$, $[M+Na]^+$, 453.2801; found, 453.2809

$[\alpha]_D$= +98.2° (*c* = 0.17, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.59 (s, 1H), 3.87 (d, *J* = 3.6 Hz, 1H), 2.57 (d, *J* = 12.1 Hz, 1H), 2.38 (d, *J* = 10.8 Hz, 1H), 1.92 – 1.81 (m, 3H), 1.79 – 1.76 (m, 1H) 1.77 (d, *J* = 1.5 Hz, 3H), 1.59 (dq, *J* = 15.2, 1.6 Hz, 1H), 1.27 (dt, *J* = 15.0, 11.4 Hz, 1H), 1.11 (s, 3H), 1.06 (s, 3H), 1.01 – 0.96 (m, 1H), 0.95 (d, *J* = 6.7 Hz, 3H), 0.93 (s, 9H), 0.90 (d, *J* = 6.9 Hz, 3H), 0.73 (td, *J* = 8.2, 5.8 Hz, 1H), 0.15 (s, 3H), 0.03 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 209.7, 204.6, 158.5, 140.4, 73.0, 69.9, 55.1, 52.7, 44.5, 42.8, 36.9, 31.1, 28.8, 26.1, 24.7, 23.6, 23.4, 19.5, 18.4, 17.3, 15.7, 10.6, -3.7, -4.5.



Synthesis of **SI-7**: To a solution of **SI-6** (60.0 mg, 0.14 mmol, 1.0 equiv) in MeOH (2 mL) at room temperature was slowly added $NaBH_4$ (26.5 mg, 0.70 mmol, 5.0 equiv). After stirring at room temperature for 5 min, the reaction mixture was diluted with Et_2O (5 mL), followed by quenching with H_2O (5 mL). The mixture was extracted with Et_2O (3 × 5 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 5:1) afforded **SI-7** (47.2 mg, 77%) as a white foam.

Physical state: white foam

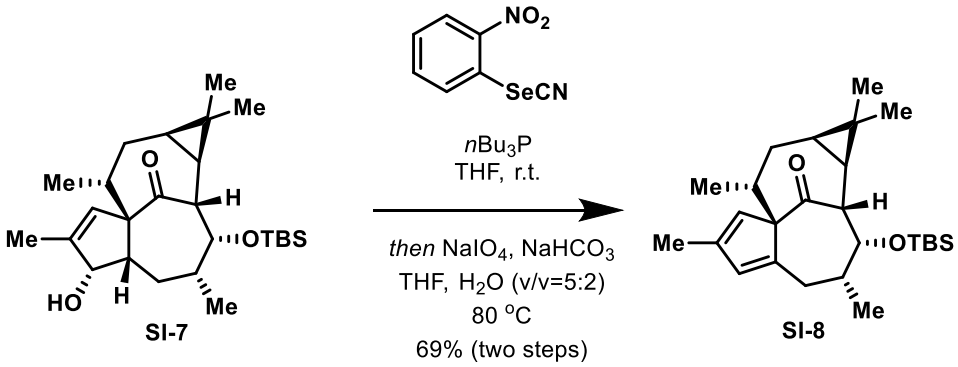
R_f = 0.4 (Hex/EtOAc = 4:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{26}H_{44}NaO_3Si$, $[M+Na]^+$, 455.2957; found, 455.2956

$[\alpha]_D$= +20.5° (*c* = 0.2, CH_2Cl_2)

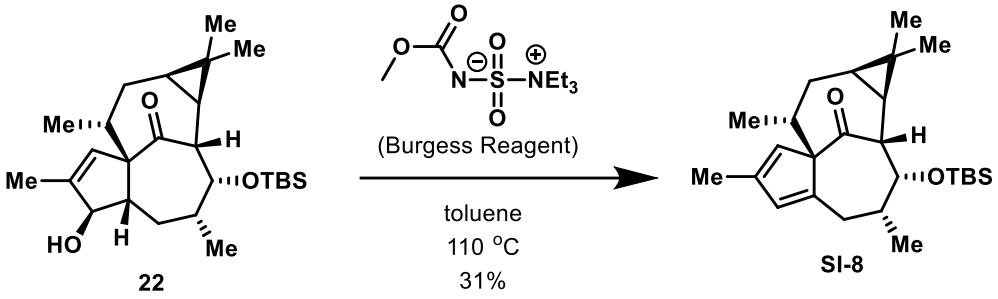
^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.86 (t, *J* = 1.8 Hz, 1H), 4.77 (s, 1H), 3.88 (d, *J* = 3.9 Hz, 1H), 2.52 (d, *J* = 12.2 Hz, 1H), 2.43 (dd, *J* = 10.9, 6.7 Hz, 1H), 1.88 (ddd, *J* = 7.1, 4.5, 2.8 Hz, 1H), 1.82 (ddd, *J* = 15.6, 6.0, 4.5 Hz, 1H), 1.75 – 1.68 (m, 3H), 1.72 (t, *J* = 1.5 Hz, 3H), 1.34 – 1.23 (m, 2H), 1.09 (s, 3H), 1.04 (s, 3H), 0.94 (s, 9H), 0.92 (d, *J* = 6.8 Hz, 3H), 0.89 (d, *J* = 7.3 Hz, 3H), 0.88 – 0.85 (m, 1H), 0.66 (ddd, *J* = 9.7, 8.6, 6.1 Hz, 1H), 0.15 (s, 3H), 0.03 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 206.5, 140.6, 127.3, 77.5, 73.8, 73.0, 52.2, 49.9, 45.0, 38.2, 30.2, 28.7, 28.4, 26.2, 24.4, 23.8, 23.1, 19.9, 18.4, 16.8, 15.8, 13.6, -3.7, -4.6.



Synthesis of **SI-8**: To a solution of **SI-7** (46.2 mg, 0.107 mmol, 1.0 equiv) in THF (2 mL) was added 1-nitro-2-selenocyanatobenzene (29.0 mg, 0.127 mmol, 1.2 equiv) at room temperature. *n*-Bu_3P (53 μL, 0.212 mmol, 2.0 equiv) was then slowly added at room temperature. After stirring for 30 min, the reaction mixture was filtered through a plug of silica gel (Hexanes/EtOAc = 10:1). The solvent was removed under reduced pressure. The crude residue was dissolved in THF (5 mL). To this solution was added H_2O (2 mL), $NaIO_4$ (228.9 mg, 1.070 mmol, 10.0 eq.) and Na_2CO_3 (53.0 mg, 0.639 mmol, 6.0 equiv). The flask was sealed with a plastic cap and the reaction mixture was stirred at 80 °C for 2 h. After filtration, the filtrate was extracted with Et_2O (3 × 5 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated

under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1) afforded **SI-8** (30.5 mg, 69%).



Synthesis of **SI-8**: To a solution of **22** (78.0 mg, 0.18 mmol, 1.0 equiv) in toluene (2 mL) was added Burgess reagent (56.0 mg, 0.24 mmol, 1.3 equiv) at room temperature under argon atmosphere. The reaction mixture was stirred at 110 °C for 1 min. Then, the solvent was removed under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1) afforded **SI-8** (23.3 mg, 31%).

Physical state: pale yellow foam

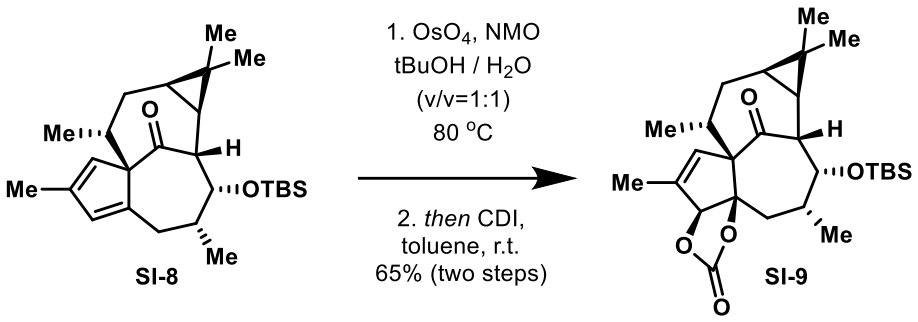
$\boldsymbol{R_f}$ = 0.5 (Hex/EtOAc = 10:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{26}H_{42}NaO_2Si$, $[M+Na]^+$, 437.2852; found, 437.2853

$\boldsymbol{[\alpha]_D}$= −54.7° (*c* = 0.17, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.98 (s, 1H), 5.92 (s, 1H), 4.09 (dd, *J* = 8.6, 3.8 Hz, 1H), 3.26 (dd, *J* = 11.5, 3.9 Hz, 1H), 2.71 (d, *J* = 14.5 Hz, 1H), 2.55 (h, *J* = 6.9 Hz, 1H), 2.48 (dd, *J* = 14.5, 5.3 Hz, 1H), 2.43 – 2.34 (m, 1H), 2.10 – 2.00 (m, 2H), 1.90 (d, *J* = 1.6 Hz, 3H), 1.21 (s, 3H), 1.11 (dd, *J* = 11.4, 9.1 Hz, 1H), 1.03 (s, 3H), 0.92 (s, 9H), 0.73 (dt, *J* = 8.7, 4.1 Hz, 1H), 0.66 (d, *J* = 7.5 Hz, 3H), 0.62 (d, *J* = 6.5 Hz, 3H), 0.06 (s, 2H), 0.03 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 208.0, 142.4, 142.3, 136.5, 130.5, 81.1, 71.6, 46.8, 37.7, 36.8, 33.4, 33.1, 29.0, 26.0, 24.8, 24.1, 21.4, 18.5, 18.4, 15.6, 15.4, 13.4, -4.6, -4.7.



Synthesis of **SI-9**: To a solution of **SI-8** (46.2 mg, 0.107 mmol, 1.0 equiv) in *t*-BuOH (1 mL) and H_2O (1 mL) was added OsO_4 (2.5 wt% in *t*-BuOH, 0.31 mL, 0.0214 mmol 0.2 equiv) and NMO (50% w/w in H_2O, 0.15 mL, 0.642 mmol, 6.0 equiv) at room temperature. The reaction mixture was stirred at 80 °C for 4 h. Saturated Na_2SO_3 (5 mL) was added, the mixture was extracted with Et_2O (3 × 5 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The crude product was dissolved in toluene (2 mL). To this solution was added *N*,*N*-carbonyldiimidazole (54 mg, 0.333 mmol, 3.1 equiv) at room temperature. The reaction mixture was stirred overnight at room temperature before quenching with H_2O (2 mL). The mixture was extracted with Et_2O (3 × 5 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1) afforded **SI-9** (38.8 mg, 65%) as a colorless oil.

Physical state: colorless oil

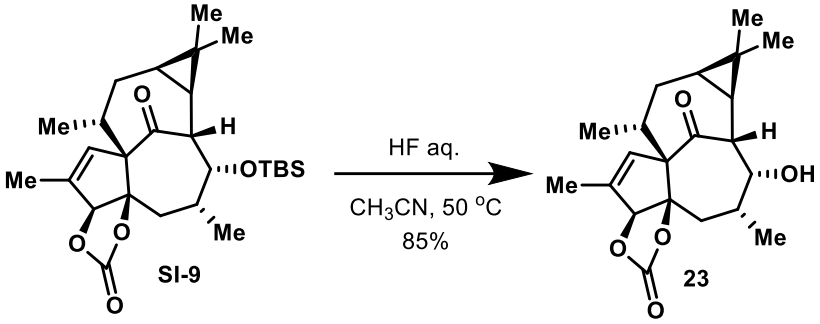
$\boldsymbol{R_f}$ = 0.2 (Hex/EtOAc = 20:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{27}H_{43}O_5Si$, $[M+H]^+$, 475.2880; found, 475.2882

$\boldsymbol{[\alpha]_D}$= +19.6° (*c* = 0.27, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.03 (d, *J* = 1.8 Hz, 1H), 4.55 (s, 1H), 3.86 (d, *J* = 3.3 Hz, 1H), 2.72 (d, *J* = 11.8 Hz, 1H), 2.30 – 2.20 (m, 1H), 2.21 – 2.11 (m, 1H), 2.01 (ddd, *J* = 15.9, 6.6, 2.7 Hz, 1H), 1.91 (dd, *J* = 15.5, 11.4 Hz, 1H), 1.87 (d, *J* = 1.6 Hz, 3H), 1.81 (ddd, *J* = 16.0, 7.6, 6.5 Hz, 1H), 1.61 (d, *J* = 15.6, 1H), 1.15 (s, 3H), 1.04 (s, 3H), 1.00 (dd, *J* = 11.8, 8.8 Hz, 1H), 0.94 (s, 9H), 0.93 (d, *J* = 6.6 Hz, 3H), 0.85 (d, *J* = 6.8 Hz, 3H), 0.67 (dt, *J* = 8.8, 6.5 Hz, 1H), 0.16 (s, 3H), 0.05 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 205.0, 154.4, 135.1, 134.7, 95.1, 90.0, 77.1, 72.7, 52.4, 41.7, 39.0, 31.2, 28.8, 26.1, 25.0, 23.6, 23.2, 19.8, 18.4, 15.7, 15.3, -3.6, -4.4.



Synthesis of **23**: A plastic Falcon® tube was charged with **SI-9** (38.8 mg, 0.082 mmol, 1.0 equiv) and CH_3CN (3 mL). 48% aqueous HF (0.15 mL, 3.60 mmol, 43.9 equiv) was added and mixture was heated to 50 °C. After stirring for 3 h, the reaction mixture was cooled to room temperature and quenched by the slow addition of saturated aqueous Na_2SO_3 (6 mL). The mixture was extracted with EtOAc (3 × 8 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 4:1) afforded **23** (25.0 mg, 85%) as a colorless crystalline solid.

Physical state: colorless crystalline solid

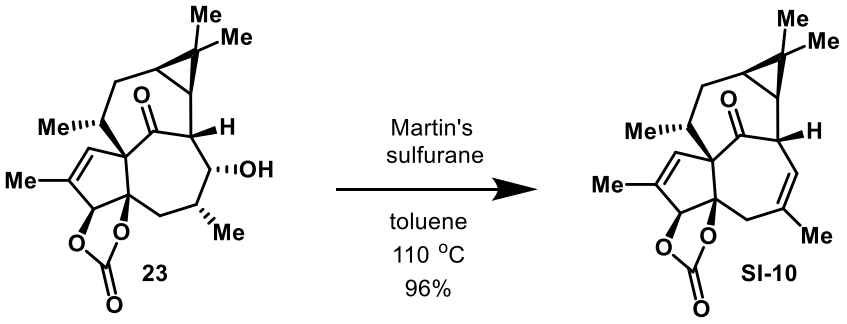
$\boldsymbol{R_f}$ = 0.25 (Hex/EtOAc = 3:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{21}H_{28}NaO_5$, $[M+Na]^+$, 383.1834; found, 383.1848

$[\alpha]_D$= +12.7° (*c* = 0.15, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.92 (d, *J* = 1.6 Hz, 1H), 4.58 (s, 1H), 3.87 (s, 1H), 3.19 (d, *J* = 7.8 Hz, 1H), 2.87 (dd, *J* = 11.3, 1.2 Hz, 1H), 2.34 (ddd, *J* = 9.6, 6.9, 2.5 Hz, 1H), 2.15 (dtq, *J* = 16.9, 6.9, 3.5 Hz, 1H), 2.08 – 1.99 (m, 1H), 1.90 (d, *J* = 1.5 Hz, 3H), 1.84 (ddd, *J* = 16.1, 9.6, 6.6 Hz, 1H), 1.75 (dd, *J* = 15.8, 11.3 Hz, 1H), 1.69 (dd, *J* = 15.6, 2.4 Hz, 1H), 1.18 (s, 3H), 1.11 (dd, *J* = 11.3, 8.9 Hz, 1H), 1.040 (s, 3H), 1.037 (d, *J* = 7.2 Hz, 3H), 0.81 (d, *J* = 6.8 Hz, 3H), 0.71 (ddd, *J* = 8.9, 6.5, 4.6 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 211.9, 154.0, 136.4, 133.1, 94.4, 89.4, 76.8, 72.2, 50.0, 41.7, 38.4, 37.6, 31.7, 29.0, 23.9, 23.7, 22.5, 19.3, 18.7, 15.4, 15.2.



Synthesis of **SI-10**: To a solution of **23** (23.0 mg, 0.064 mmol, 1.0 equiv) in toluene (2 mL) was added Martin's sulfurane (86.0 mg, 0.128 mmol, 2.0 equiv) at room temperature. The solution was heated to 110 °C for 10 min. Then, toluene was removed under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1) afforded **SI-10** (21.1 mg, 96%) as a colorless oil.

Physical state: colorless oil

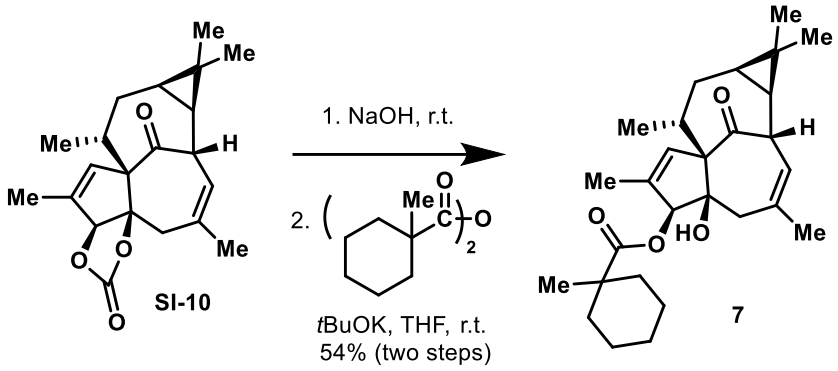
$\boldsymbol{R_f}$ = 0.25 (Hex/EtOAc = 5:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{21}H_{27}O_4$, $[M+H]^+$, 343.1909; found, 343.1902

$[\alpha]_D$= −2.8° (*c* = 0.18, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.10 (q, *J* = 1.6 Hz, 1H), 5.81 – 5.71 (m, 1H), 4.53 (s, 1H), 3.65 (d, *J* = 10.9 Hz, 1H), 2.65 (d, *J* = 18.3 Hz, 1H), 2.40 (d, *J* = 18.2, Hz, 1H), 2.25 (td, *J* = 6.8, 2.8 Hz, 1H), 2.14 (ddd, *J* = 16.1, 7.4, 2.9 Hz, 1H), 1.91 (d, *J* = 1.6 Hz, 3H), 1.84 (dt, *J* = 16.1, 6.5 Hz, 1H), 1.67 (s, 1H), 1.16 (s, 3H), 1.06 (s, 3H), 0.99 – 0.95 (m, 1H), 0.97 (d, *J* = 6.8 Hz, 3H), 0.72 (dt, *J* = 8.4, 7.1 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 206.3, 154.0, 135.1, 134.4, 132.9, 124.1, 92.4, 90.9, 77.8, 46.1, 44.9, 39.6, 31.4, 28.8, 24.1, 23.6, 23.5, 18.3, 15.6, 15.5.



Synthesis of **7**: To a solution of **SI-10** (4.2 mg, 0.0123 mmol, 1.0 equiv) in THF (0.5 mL) was added 10% $NaOH_{(aq)}$ (0.5 mL) at room temperature. After stirring for 1 h, the reaction mixture was quenched by saturated $NH_4Cl_{(aq)}$ (2 mL). The mixture was extracted with Et_2O (5 × 3 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The crude residue and 1-methylcyclohexane-1-carboxylic anhydride (32.7 mg, 0.123 mmol, 10.0 equiv) was dissolved in THF (2 mL). To this stirring solution was slowly added *t*-BuOK (6.9 mg, 0.0616 mmol, 5.0 equiv) at room temperature. The reaction mixture was stirred at room temperature for 2 min and quenched by the slow addition of H_2O (2 mL). The mixture was extracted with EtOAc (3 × 3 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 14:1) afforded **7** (2.9 mg, 54%) as a colorless oil.

Physical state: colorless oil

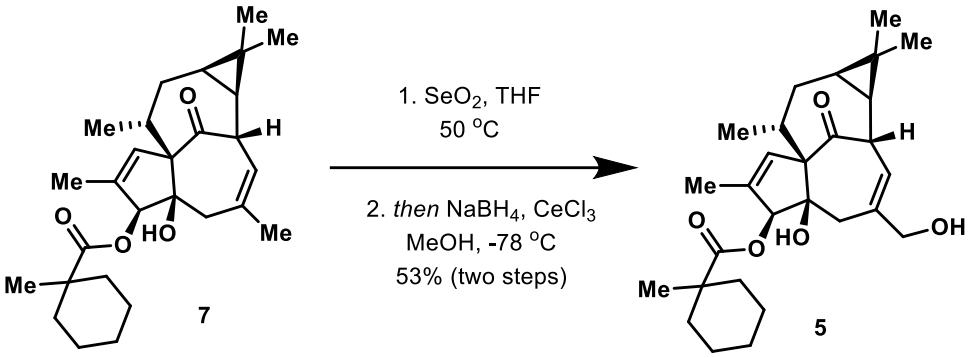
$\boldsymbol{R_f}$ = 0.2 (Hex/EtOAc = 14:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{28}H_{41}O_4$, $[M+H]^+$, 441.3005; found, 441.3010

$[\alpha]_D$= +67.2° (*c* = 0.25, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.99 (q, *J* = 1.6 Hz, 1H), 5.71 (s, 1H), 4.92 (s, 1H), 4.06(d, *J* = 1.6 Hz, 1H), 2.49 (s, 1H), 2.43 – 2.28 (m, 3H), 2.19 (ddd, *J* = 15.7, 7.9, 3.1 Hz, 1H), 2.09 – 1.98 (m, 2H), 1.81 – 1.72 (m, 1H), 1.76 (d, *J* = 1.5 Hz, 3H), 1.64 (s, 3H), 1.62 – 1.48 (m, 2H), 1.46 – 1.22 (m, 6H), 1.20 (s, 3H), 1.12 (s, 3H), 1.04 (s, 3H), 0.96 (d, *J* = 7.1 Hz, 3H), 0.91 (dd, *J* = 11.8, 8.4 Hz, 1H), 0.68 (td, *J* = 8.1, 6.2 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 209.5, 178.9, 136.1, 134.1, 132.6, 123.8, 85.8, 81.0, 75.1, 48.0, 44.2, 43.8, 37.4, 35.8, 35.7, 31.6, 28.8, 25.8, 24.8, 23.8, 23.7, 23.6, 23.39, 23.35, 18.3, 15.72, 15.67.



Synthesis of **5**: To a solution of **7** (2.0 mg, 0.0045 mmol, 1.0 equiv) in THF (1 mL) was added SeO_2 (2.5 mg, 0.023 mmol, 5.0 equiv) at room temperature. The flask was sealed with a plastic cap and the suspension was stirred at 50 °C for 1 h. After cooling to room temperature, the reaction mixture was filtered through a plug of silica gel (hexanes/EtOAc = 1:1) to provide a clear yellow solution. A yellow oil was obtained after concentration *in vacuo*, followed by dissolution in MeOH (1 mL). After cooling to –78 °C, $CeCl_3 \cdot 7H_2O$ (8.5 mg, in 0.5 mL MeOH, 0.023 mmol, 5.0 equiv) was added, then $NaBH_4$ (1.7 mg, 0.045 mmol, 10.0 equiv) was slowly added to the flask. After stirring for 10 min at –78 °C, H_2O (5 mL) was carefully added to quench this reaction, followed by dilution with Et_2O (5 mL). The mixture was extracted with Et_2O (3 × 5 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 2:1) afforded **5** (1.1 mg, 53%) as a colorless oil.

Physical state: colorless oil

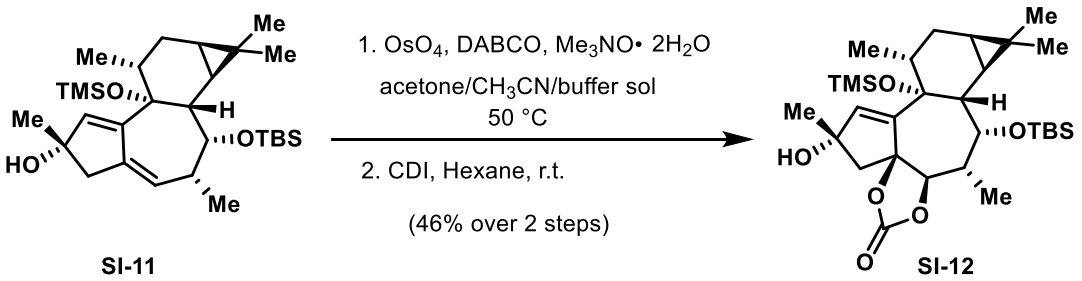
$\boldsymbol{R_f}$ = 0.2 (Hex/EtOAc = 2:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{28}H_{40}NaO_5$, $[M+Na]^+$, 479.2773; found, 479.2779

$[\alpha]_D$= +36.0° (*c* = 0.05, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.00 (q, *J* = 2.4 Hz, 1H), 5.98 (d, *J* = 1.7 Hz, 1H), 4.97 (s, 1H), 4.11 (d, *J* = 11.7 Hz, 1H), 3.93 (s, 2H), 2.56 (d, *J* = 17.1 Hz, 2H), 2.55 (s, 1H), 2.41 (td, *J* = 6.8, 3.0 Hz, 1H), 2.37 (d, *J* = 18.4 Hz, 1H), 2.18 (ddt, *J* = 17.0, 12.5, 9.1 Hz, 1H), 2.07 – 2.00 (m, 2H), 1.82 – 1.77 (m, 1H), 1.76 (d, *J* = 1.6 Hz, 3H), 1.62 – 1.56 (m, 2H), 1.44 – 1.27 (m, 6H), 1.20 (s, 3H), 1.12 (s, 3H), 1.05 (s, 3H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.96 – 0.93 (m, 1H), 0.71 (q, *J* = 7.6 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 209.1, 178.9, 137.7, 136.4, 132.4, 125.7, 85.8, 80.8, 75.1, 67.6, 44.2, 43.8, 43.4, 37.2, 35.8, 35.7, 31.7, 28.8, 25.8, 24.0, 23.6, 23.5, 23.39, 23.35, 18.5, 15.72, 15.70.



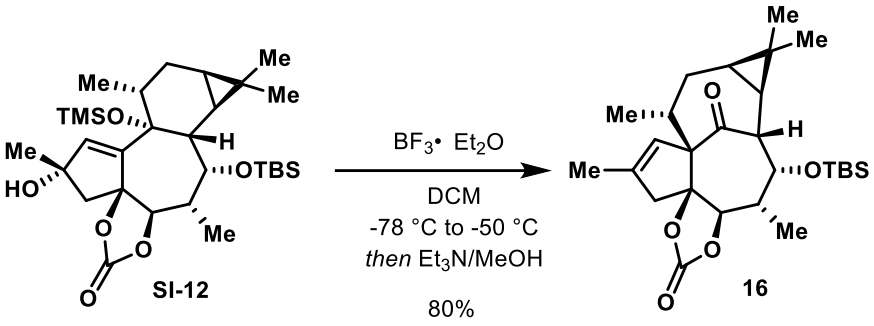
Synthesis of **SI-12**: A 100 mL round-bottomed flask was charged with **SI-11** (661 mg, 1.31 mmol, 1.0 equiv), $Me_3NO{\cdot}2H_2O$ (1455 mg, 13.1 mmol, 10 equiv) and DABCO (160 mg, 1.31 mmol, 1.0 equiv) in acetone/CH_3CN/*0.5 M buffer solution (26.2 mL, 0.05 M, **4:3:3**). Then, OsO_4 solution (2.5 wt. % in *tert*-butanol, 0.65 mL, 0.0655 mmol, 0.05 equiv) was added to this flask. The reaction mixture was stirred vigorously at 50 °C for 18 h, before quenching with saturated aqueous Na_2SO_3 (20 mL). (*After 15 h, the reaction was monitored by TLC every 3 h; when the conversion stopped, the reaction was quenched immediately to prevent further side reactions.) The reaction mixture was extracted with ether (3 × 20 mL). The combined organic layers were washed with brine and dried over Na_2SO_4, filtered and concentrated *in vacuo* to afford a crude diol (R_f = 0.33 (Hex/EtOAc = 7:3; anisaldehyde)).

[*0.5 M buffer solution: pH=3, Na_2HPO_4 (280 mg) and citric acid (840 mg) was dissolved in H_2O (10 mL).]

The crude diol was dissolved in hexanes (26.2 mL, 0.05 M) and *N*,*N*-carbonyldiimidazole (1.05 g, 6.5 mmol, 5.0 equiv) was added. The solution was stirred

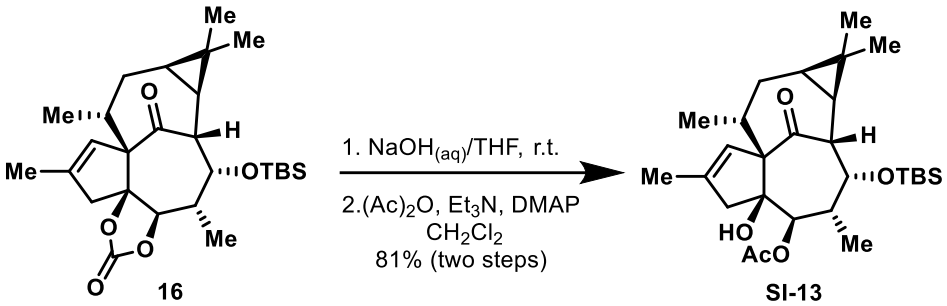
at room temperature for 11 h and quenched by water (20 mL). The aqueous layer was separated and extracted further with hexanes (2 × 30 mL). The combined organic layers were dried over Na_2SO_4, filtered and concentrated *in vacuo*. Purification of the crude product was accomplished by subjecting the crude solution to flash column chromatography (silica gel, column packed in hexanes, then hexanes/EtOAc = 20:1 → 9:1) afforded desired product **SI-12** (342 mg, 46% over 2 steps) as a white foam.

Spectral data were identical to those previously reported. [1]



Synthesis of **16**: To a solution of **SI-12** (191 mg, 0.338 mmol, 1.0 equiv) in CH_2Cl_2 (7 mL) was added $BF_3{\cdot}Et_2O$ (420 μL, 3.38 mmol, 10 equiv) dropwise at −78 °C. The reaction mixture was stirred at this temperature for 2 min before warming to −50 °C. After stirring for 30 min, a 1:1 mixture of Et_3N/MeOH (3 mL) was added at −40 °C. The solution was stirred for an additional 2 min and then saturated aqueous $NaHCO_3$ (5 mL) was added. The reaction mixture was warmed to room temperature and extracted with CH_2Cl_2 (3 × 25 mL). The combined organic layers were dried over Na_2SO_4, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, column packed in CH_2Cl_2, then hexanes/EtOAc = 20:1 → 10:1 → 5:1) afforded **16** (128 mg, 80%) as a white foam.

Spectral data were identical to those previously reported.[1]



Synthesis of **SI-13**: To a solution of **16** (590 mg, 1.24 mmol, 1 equiv) in THF (10 mL) was added 10% $NaOH_{(aq)}$ (10 mL). The reaction mixture was stirred vigorously at room temperature for 1 h. The reaction mixture was then extracted with Et_2O (3 × 20 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. The crude residue was dissolved in CH_2Cl_2 (5 mL). To this solution was added Ac_2O (0.14 mL, 1.49 mmol, 1.2 equiv), Et_3N (0.26 mL, 1.86 mmol, 1.5 equiv) and DMAP (15.0 mg, 0.123 mmol, 0.1 equiv) at room temperature. The reaction mixture was stirred at room temperature for 2 h before addition of saturated NH_4Cl (10 mL). The mixture was extracted with CH_2Cl_2 (3 × 10 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 5:1) afforded **SI-13** (490 mg, 81%) as a white solid.

Physical state: white solid

$\boldsymbol{R_f}$ = 0.51 (Hex/EtOAc = 7:3; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{28}H_{46}NaO_5Si$, $[M+Na]^+$, 513.3012; found, 513.3006

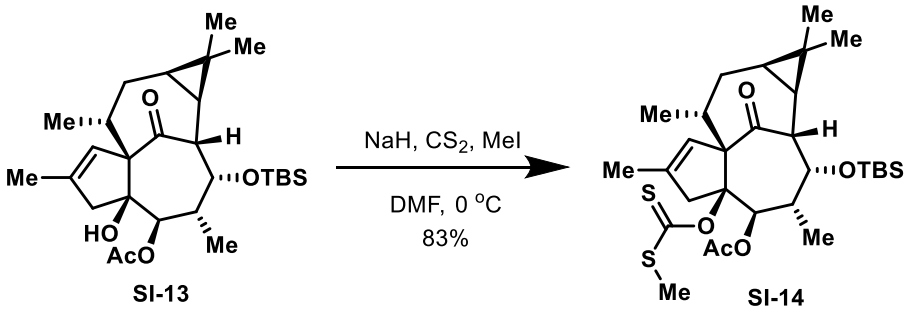
$\boldsymbol{[\alpha]_D}$= +47.7° (*c* = 0.7, CH_2Cl_2)

This compound shows two sets of NMR peaks due to restricted rotation (rotamers, ratio = 4 : 6)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.64 (s, 1H), 5.04 (s, 0.4H), 4.90 (d, *J* = 10.5 Hz, 0.6H), 3.89 (d, *J* = 10.7 Hz, 0.4H), 3.85 (d, *J* = 4.1 Hz, 1H), 3.19 (d, *J* = 12.0 Hz, 0.4H), 3.01 (d, *J* = 12.0 Hz, 0.6H), 2.90 (ddd, *J* = 10.8, 7.0, 4.0 Hz, 0.4H), 2.58 (d, *J* = 15.7 Hz, 0.4H), 2.52 – 2.39 (m, 1.6H), 2.39 – 2.31 (m, 0.6H), 2.29 – 2.20 (m, 1.4H), 2.17 – 2.12 (m, 0.6H), 2.11 (s, 1.2H), 2.09 (s, 1.8), 2.05 (brs, 0.6H), 1.72 (dq, *J* = 15.4, 5.1,

4.5 Hz, 1H), 1.67 (s, 1.2H), 1.60 (s, 1.8H), 1.09 (s, 3H), 1.03 (s, 3H), 0.94 (s, 9H), 0.93 – 0.84 (m, 7H), 0.62 (dq, *J* = 13.1, 6.7, 4.7 Hz, 1H), 0.17 (s, 1.2H), 0.16 (s, 1.8H), 0.06 (s, 1.2H), 0.04 (s, 1.8H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 207.2 , 206.2 , 174.1 , 169.3 , 136.0 , 135.2 , 125.8 , 125.7 , 86.7 , 86.1 , 85.6 , 74.9 , 73.8 , 72.7 , 72.1 , 49.3 , 48.8 , 48.1 , 46.6 , 42.9 , 40.5 , 35.8 , 35.5 , 30.4 , 28.71 , 28.65 , 26.22 , 26.20 , 24.9 , 24.4 , 24.2 , 23.12 , 23.05 , 21.2 , 20.7 , 18.5 , 17.4 , 17.3 , 17.2 , 17.1 , 16.5 , 15.90 , 15.85 , 15.7 , -3.50 , -3.52 , -4.5.



Synthesis of **SI-14** : To a stirred solution of **SI-13** (490 mg, 1.0 mmol, 1.0 equiv) in DMF (10 mL) was added NaH (60% in mineral oil, 80 mg, 2.0 mmol, 2.0 equiv) at 0 °C. After stirring for 15 min, CS_2 (0.6 mL, 10.0 mmol, 10 equiv) was added to the suspension at the same temperature. The reaction mixture was allowed warm to room temperature and stirred for 40 min. Then, MeI (0.62 mL, 10.0 mmol, 10 equiv) was added to the mixture. After stirring for 40 min at room temperature, the reaction mixture diluted with Et_2O (30 mL) and quenched by H_2O (30 mL). The mixture was extracted with Et_2O (3 × 30 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1) afforded **SI-14** (483.4 mg, 83%) as a pale yellow foam.

Physical state: pale yellow foam

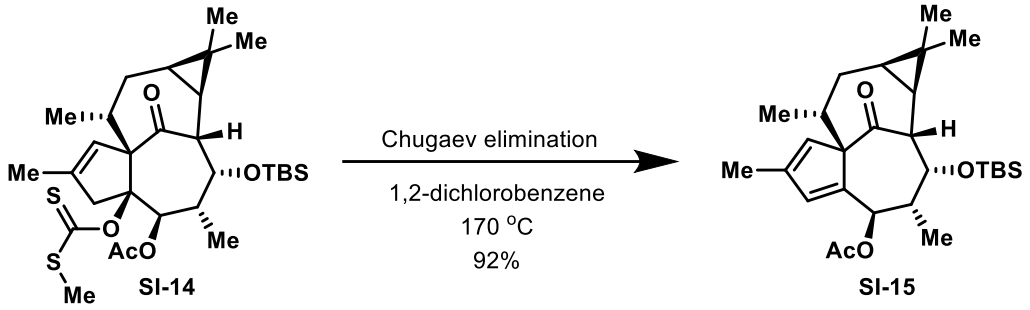
***R**f* = 0.62 (Hex/EtOAc = 4:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{30}H_{48}NaO_5S_2Si$, $[M+Na]^+$, 603.2610; found, 603.2606

[α]$_D$= +91.3° (*c* = 0.9, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.70 (s, 1H), 5.10 (d, *J* = 10.2 Hz, 1H), 3.86 (d, *J* = 3.5 Hz, 1H), 3.17 (d, *J* = 16.6 Hz, 1H), 2.93 (d, *J* = 16.4 Hz, 1H), 2.86 (d, *J* = 11.9 Hz, 1H), 2.55 (s, 3H), 2.39 – 2.18 (m, 3H), 2.06 (s, 3H), 1.85 (ddd, *J* = 15.9, 5.9, 3.6 Hz, 1H), 1.20 (s, 3H), 1.06 (s, 3H), 0.99 – 0.94 (m, 1H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.94 (s, 9H), 0.83 (d, *J* = 7.0 Hz, 3H), 0.72 – 0.65 (m, 1H), 0.16 (s, 3H), 0.02 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 212.6, 205.0, 169.0, 136.0, 124.7, 101.2, 77.2, 74.6, 72.0, 50.4, 43.7, 42.8, 36.2, 31.4, 28.7, 26.1, 25.4, 25.1, 22.8, 20.6, 20.5, 18.4, 17.3, 17.2, 16.2, 15.0, -3.5, -4.5.



Synthesis of **SI-15**: Compound **SI-14** (483.4 mg, 0.83 mmol, 1.0 equiv) was dissolved in degassed 1,2-dichlorobenzene (15 mL) under argon. The mixture was stirred at 170 °C for 5 min. After cooling to room temperature, the reaction mixture was passed through a short plug of silica gel, eluting with hexanes (to remove 1,2-dichlorobenzene), followed by 20:1 hexanes:EtOAc to afford **SI-15** (365.9 mg, 92%) as a pale yellow foam.

Physical state: pale yellow foam

R$_f$ = 0.55 (Hex/EtOAc = 8:2; anisaldehyde)

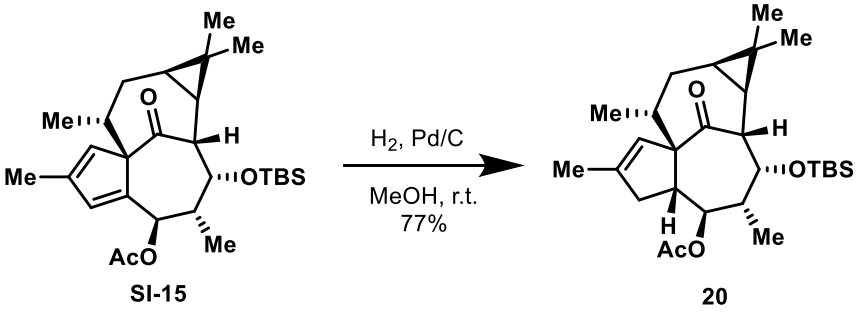
HRMS (***m*/*z***): calcd for $C_{28}H_{44}NaO_4Si$, $[M+Na]^+$, 495.2907; found, 495.2904

[α]$_D$= +3.6° (*c* = 0.89, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.22 (d, *J* = 1.4 Hz, 1H), 6.09 (s, 1H), 5.87 (d, *J* = 5.3 Hz, 1H), 4.17 (dd, *J* = 8.3, 3.8 Hz, 1H), 3.87 (dd, *J* = 11.3, 3.9 Hz, 1H), 2.94 (h,

J = 7.0 Hz, 1H), 2.70 – 2.59 (m, 1H), 2.06 (s, 3H), 2.03 (dt, *J* = 5.2, 2.9 Hz, 2H), 1.90 (d, *J* = 1.4 Hz, 3H), 1.26 (s, 3H), 1.16 (dd, *J* = 11.3, 9.3 Hz, 1H), 1.04 (s, 3H), 0.92 (s, 9H), 0.75 (dt, *J* = 8.4, 3.9 Hz, 1H), 0.64 (d, *J* = 7.6 Hz, 3H), 0.61 (d, *J* = 6.7 Hz, 3H), 0.08 (s, 3H), 0.03 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 207.5, 169.6, 141.4, 141.0, 138.3, 133.7, 82.9, 79.4, 69.5, 45.9, 40.8, 37.3, 33.0, 29.0, 25.9, 24.8, 24.1, 21.5, 21.2, 18.4, 18.3, 15.4, 15.1, 12.8, -4.6, -4.7.



SI-15 20

Synthesis of **20**: To a solution of **SI-15** (365.9 mg, 0.77 mmol, 1.0 equiv) in MeOH (10 mL) was added 10% Pd on carbon (82 mg, 0.077 mmol, 0.1 equiv). H_2 was bubbled into the stirring mixture for 20 s at room temperature. Then, the solvent was concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 80:1 → 50:1) afforded **20** (282.7 mg, 77%) as a colorless oil.

Physical state: colorless oil

***R*$_f$** = 0.5 (Hex/EtOAc = 10:1; anisaldehyde)

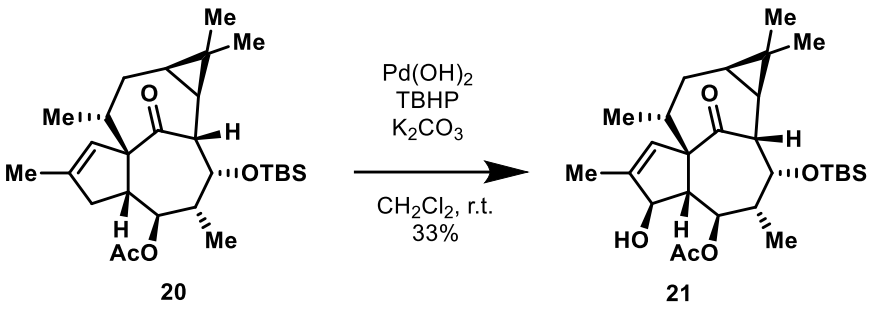
HRMS (***m*/*z***): calcd for $C_{28}H_{46}NaO_4Si$, $[M+Na]^+$, 497.3063; found, 497.3072

[*α*]$_D$= +25.8° (*c* = 0.12, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.66 (s, 1H), 4.70 (s, 1H), 3.88 (d, *J* = 4.3 Hz, 1H), 2.61 (d, *J* = 12.1 Hz, 1H), 2.56 – 2.44 (m, 2H), 2.05 (s, 3H), 2.04 – 1.97 (m, 2H), 1.89 (d, *J* = 16.2 Hz, 1H), 1.83 (dt, *J* = 15.7, 5.5 Hz, 1H), 1.68 (ddd, *J* = 14.8, 10.2, 5.5 Hz, 1H), 1.65 (s, 3H), 1.10 (s, 3H), 1.04 (s, 3H), 0.94 (s, 9H), 0.95 – 0.91 (m, 1H), 0.90

(d, *J* = 7.0 Hz, 3H), 0.88 (d, *J* = 6.9 Hz, 3H), 0.68 (td, *J* = 8.9, 6.1 Hz, 1H), 0.16 (s, 3H), 0.04 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 205.6, 169.0, 138.4, 124.2, 74.5, 73.8, 71.5, 51.0, 50.9, 49.2, 37.9, 36.9, 29.6, 28.1, 25.6, 23.7, 23.2, 22.8, 20.3, 17.8, 16.4, 15.6, 15.3, 15.2, -4.2, -5.2.



20 **21**

Synthesis of **21**: To a solution of **20** (282.7 mg, 0.60 mmol, 1.0 equiv) in CH_2Cl_2 (8 mL) was added 20% $Pd(OH)_2$ on carbon (15.9 mg, 0.03 mmol, 0.05 equiv) and K_2CO_3 (20.7 mg, 0.15 mmol, 0.25 equiv) at room temperature. The mixture was cooled to 0 °C, and TBHP (5.5 M in decane, 0.54 mL, 3.0 mmol, 5.0 equiv) was added with vigorous stirring. Then, the reaction mixture was allowed to warm to room temperature. After stirring for 24 h, the reaction mixture was filtered through a plug of silica gel (washed with CH_2Cl_2). The solvent was removed under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 3:1) afforded **21** (95 mg, 33%) as a colorless crystalline solid.

Physical state: colorless crystalline solid

***R*$_f$** = 0.1 (Hex/EtOAc = 3:1; anisaldehyde)

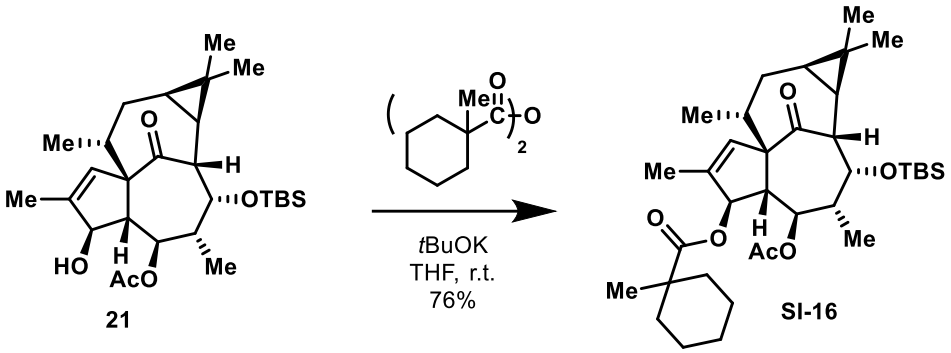
HRMS (***m*/*z***): calcd for $C_{28}H_{46}NaO_5Si$, $[M+Na]^+$, 513.3012; found, 513.3018

[α]$_D$= +32.9° (*c* = 0.14, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 5.89 (s, 1H), 4.71 (brs, 1H), 4.21 (s, 1H), 3.91 (d, *J* = 3.9 Hz, 1H), 2.69 (d, *J* = 11.7 Hz, 1H), 2.38 (s, 1H), 2.25 – 2.12 (m, 2H), 2.08 (s, 3H), 1.82 (dt, *J* = 15.8, 6.1 Hz, 1H), 1.79 – 1.73 (m, 1H), 1.76 (d, *J* = 1.1 Hz, 3H),

1.13 (s, 3H), 1.04 (s, 3H), 0.95 – 0.91 (m, 1H), 0.933 (s, 9H), 0.926 (d, *J* = 5.4 Hz, 3H), 0.86 (d, *J* = 7.1 Hz, 3H), 0.72 – 0.66 (m, 1H), 0.14 (s, 3H), 0.04 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 205.5, 169.3, 139.8, 129.7, 82.1, 75.8, 72.4, 70.9, 59.7, 50.4, 47.8, 42.5, 29.9, 28.1, 25.5, 23.5, 22.9, 22.8, 20.4, 17.8, 15.7, 15.0, 14.5, 14.0, -4.4, -5.2.



Synthesis of **SI-16**: Compound **21** (10.2 mg, 0.0208 mmol, 1.0 equiv) and 1-methylcyclohexane-1-carboxylic anhydride (55.4 mg, 0.208 mmol, 10.0 equiv) was dissolved in THF (2 mL). To this stirring solution was slowly added *t*-BuOK (11.7 mg, 0.104 mmol, 5.0 equiv) at room temperature. The reaction mixture was stirred at room temperature for 2 min and quenched by the slow addition of H_2O (2 mL). The mixture was extracted with EtOAc (3 × 3 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1) afforded **SI-16** (9.7 mg, 76%) as a colorless oil.

Physical state: colorless oil

***R*$_f$** = 0.17 (Hex/EtOAc = 20:1; anisaldehyde)

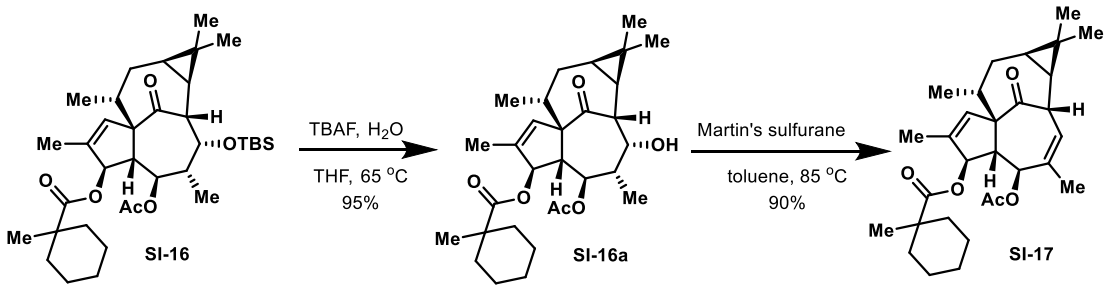
HRMS (***m*/*z***): calcd for $C_{36}H_{58}NaO_6Si$, $[M+Na]^+$, 637.3900; found, 637.3893

[α]$_D$= +100.0° (*c* = 0.17, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.03 (s, 1H), 5.37 (s, 1H), 4.64 (brs, 1H), 3.87 (d, *J* = 4.1 Hz, 1H), 2.58 (d, *J* = 11.9 Hz, 1H), 2.36 (s, 1H), 2.26 – 2.18 (m, 1H), 2.17 – 2.07 (m, 1H), 2.13 (s, 3H), 2.03 – 1.95 (m, 2H), 1.81 (dt, *J* = 15.8, 6.0 Hz, 1H), 1.70 –

1.63 (m, 1H), 1.66 (d, *J* = 1.2 Hz, 3H), 1.59 – 1.50 (m, 2H), 1.40 – 1.17 (m, 6H), 1.13 (s, 3H), 1.10 (s, 3H), 1.04 (s, 3H), 0.96 – 0.92(m, 1H), 0.94 (d, *J* = 7.2 Hz, 3H), 0.93 (s, 9H), 0.89 (d, *J* = 6.9 Hz, 3H), 0.68 (td, *J* = 8.5, 6.4 Hz, 1H), 0.15 (s, 3H), 0.04 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 205.2, 177.3, 170.0, 137.6, 132.8, 82.1, 74.3, 73.1, 71.9, 57.4, 51.6, 49.6, 43.3, 41.9, 35.7, 30.2, 28.7, 26.7, 26.1, 25.8, 24.3, 23.6, 23.4, 20.9, 18.4, 16.1, 15.8, 15.7, 14.9, -3.6, -4.5.



Synthesis of **SI-17**: To a solution of **SI-16** (6.6 mg, 0.0107 mmol, 1.0 equiv) in THF (1 mL) was added TBAF (1 M, 0.11 mL, 0.107 mmol, 10.0 equiv) and H_2O (2 μL, 0.107 mmol, 10.0 equiv) at room temperature. The flask was sealed with a plastic cap and the reaction mixture was heated to 65 °C. After stirring for 10 h, the reaction mixture was cooled to room temperature, then water (3 mL) was added. The mixture was extracted with Et_2O (5 × 3 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 5:1) afforded **SI-16a** (5.1 mg, 95%).

To a solution of **SI-16a** (5.1 mg, 0.0102 mmol, 1.0 equiv) in toluene (2 mL) was added Martin's sulfurane (8.9 mg, 0.0132 mmol, 1.3 equiv) at room temperature. The solution was stirred at 85 °C for 10 min. Toluene was then removed under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1) afforded **SI-17** (4.4 mg, 90%).

Physical state: colorless oil

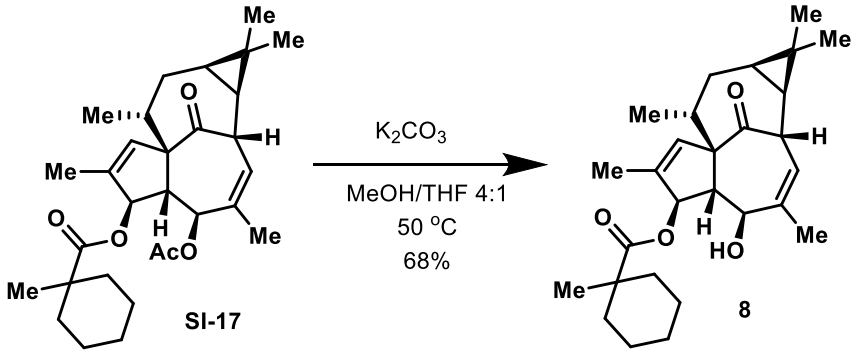
$\boldsymbol{R_f}$ = 0.3 (Hex/EtOAc = 10:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{30}H_{42}NaO_5$, $[M+Na]^+$, 505.2930; found, 505.2932

[α]D= −21.9° (*c* = 0.27, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.01 (s, 1H), 5.80 (d, *J* = 5.7 Hz, 1H), 5.24 (s, 1H), 4.86 (brs, 1H), 3.73 (dd, *J* = 11.4, 5.2 Hz, 1H), 2.82 (s, 1H), 2.32 – 2.24 (m, 1H), 2.18 (s, 3H), 2.00 (d, *J* = 12.7 Hz, 2H), 1.83 (dt, *J* = 15.8, 5.9 Hz, 1H), 1.77 – 1.71 (m, 1H), 1.74 (s, 3H), 1.62 (s, 3H), 1.60 – 1.50 (m, 2H), 1.39 – 1.16 (m, 6H), 1.141 (s, 3H), 1.138 (s, 3H), 1.05 (s, 3H), 0.99 (d, *J* = 7.0 Hz, 3H), 0.94 (dd, *J* = 11.8, 8.5 Hz, 1H), 0.70 (td, *J* = 8.4, 6.6 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 206.0, 177.1, 171.0, 138.7, 136.2, 131.0, 125.5, 81.6, 71.8, 55.9, 44.7, 43.4, 41.5, 35.7, 30.4, 28.7, 26.7, 25.8, 23.8, 23.5, 23.4, 22.8, 21.7, 21.3, 15.7, 15.5, 15.1.



Synthesis of **8**: To a solution of **SI-17** (4.2 mg, 0.0087 mmol, 1.0 equiv) in MeOH (0.8 mL) and THF (0.2 mL) was added K_2CO_3 (6.0 mg, 0.0435 mmol, 5.0 equiv) at room temperature. The reaction mixture was stirred for 2 h at 50 °C before quenching with saturated $NH_4Cl_{(aq)}$ (2 mL). The mixture was extracted with Et_2O (5 × 3 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 5:1) afforded **8** (2.6 mg, 68%) as a white foam.

Physical state: white foam

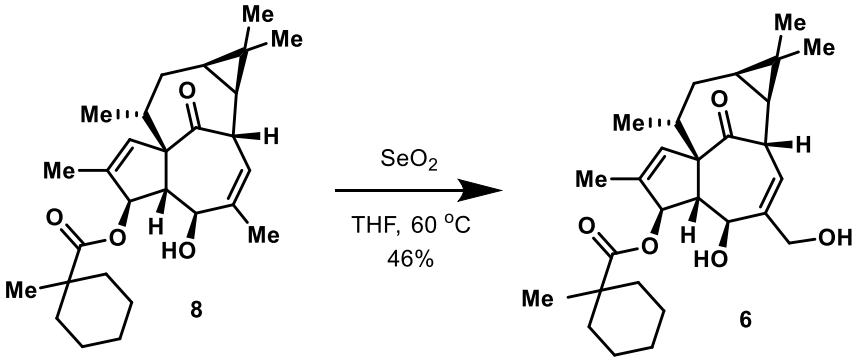
***R*$_f$** = 0.25 (Hex/EtOAc = 7:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{28}H_{40}NaO_4$, $[M+Na]^+$, 463.2824; found, 463.2825

[α]$_D$= +10.0° (*c* = 0.21, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.12 (s, 1H), 5.67 (d, *J* = 5.3 Hz, 1H), 5.20 (s, 1H), 3.83 (s, 1H), 3.72 (d, *J* = 9.9 Hz, 1H), 3.49 (dd, *J* = 11.6, 4.7 Hz, 1H), 2.52 (d, *J* = 10.0 Hz, 1H), 2.09 (ddd, *J* = 7.1, 4.6, 2.8 Hz, 1H), 2.06 – 1.97 (m, 2H), 1.84 – 1.80 (m, 1H), 1.80 (d, *J* = 1.1 Hz, 3H), 1.77 (s, 3H), 1.66 (ddd, *J* = 15.6, 9.0, 2.4 Hz, 1H), 1.60-1.51 (m, 2H), 1.42 – 1.20 (m, 6H), 1.16 (s, 3H), 1.08 (s, 3H), 1.04 (s, 3H), 1.00 (d, *J* = 7.0 Hz, 3H), 0.89 (dd, *J* = 11.9, 8.4 Hz, 1H), 0.69 (td, *J* = 8.7, 6.4 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 205.7, 179.6, 139.4, 137.2, 132.6, 122.1, 85.6, 76.0, 72.2, 59.0, 44.9, 43.5, 42.8, 35.6, 35.5, 30.2, 28.7, 25.8, 23.7, 23.42, 23.36, 23.1, 22.7, 21.8, 15.9, 15.6, 15.2.



Synthesis of **6**: To a solution of **8** (2.5 mg, 0.0057 mmol, 1.0 equiv) in THF (1 mL) was added SeO_2 (1.9 mg, 0.0171 mmol, 3.0 equiv) at room temperature. The flask was sealed with a plastic cap and the suspension was stirred at 60 °C for 1 h. The mixture was cooled to room temperature, then H_2O (2 mL) was added. The mixture was extracted with Et_2O (5 × 3 mL) and the combined organic layers were dried over $MgSO_4$, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 2:1) afforded **6** (1.2 mg, 46%) as a white foam.

Physical state: white foam

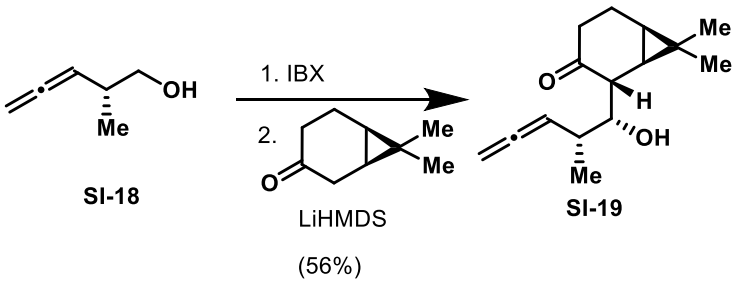
R$_f$ = 0.15 (Hex/EtOAc = 2:1; anisaldehyde)

HRMS (***m*/*z***): calcd for $C_{28}H_{40}NaO_5$, $[M+Na]^+$, 479.2773; found, 479.2767

[α]$_D$= +8.0° (*c* = 0.1, CH_2Cl_2)

^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.09 (d, *J* = 1.2 Hz, 1H), 5.98 (d, *J* = 4.5 Hz, 1H), 5.21 (s, 1H), 4.13 (d, *J* = 12.2 Hz, 1H), 4.05 (d, *J* = 12.3 Hz, 1H), 4.04 (d, *J* = 10.8 Hz, 1H), 3.55 (dd, *J* = 11.9, 5.1 Hz, 1H), 2.55 (d, *J* = 10.2 Hz, 1H), 2.14 – 2.07 (m, 1H), 2.07 – 1.96 (m, 2H), 1.84 (dt, *J* = 15.8, 5.9 Hz, 1H), 1.81 (d, *J* = 1.3 Hz, 3H), 1.69 (ddd, *J* = 15.9, 8.5, 2.4 Hz, 1H), 1.64-1.49 (m, 2H), 1.41 – 1.22 (m, 6H), 1.17 (s, 3H), 1.10 (s, 3H), 1.05 (s, 3H), 1.00 (d, *J* = 7.0 Hz, 3H), 0.94 (dd, *J* = 11.9, 8.4 Hz, 1H), 0.72 (td, *J* = 8.5, 6.3 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 205.5, 180.0, 141.6, 137.3, 132.3, 125.9, 85.3, 75.6, 72.2, 67.2, 58.7, 45.0, 43.6 , 42.8, 35.53, 35.50, 30.4, 28.7, 25.7, 23.7, 23.4, 22.6, 16.2, 15.7, 15.1.



Synthesis of **SI-19**: In a 3 L round-bottomed flask, **SI-18** (92 g, 941 mmol, 2.0 equiv) was dissolved in THF (1720 mL). IBX (395 g, 1411 mmol, 3.0 equiv) was added and the resulting suspension was stirred at 80 °C for 2 h. The mixture was then cooled to room temperature. After filtration, the filtered residue was washed with THF (573 mL). The filtrate (aldehyde in THF) was kept under argon atmosphere and dried over Na_2SO_4 30 min prior to use for the aldol reaction.

In a another 3 L round-bottomed flask was placed ketone[2] (65 g, 471 mmol, 1.0 equiv) in THF (143 mL) under argon and the solution was cooled to −78 °C. LiHMDS (1M in THF, 847 mL, 847 mmol, 1.8 equiv) was added dropwise under argon at −78 °C and the solution was stirred at −78 °C for 1 h. The aforementioned solution of aldehyde in THF was added dropwise over 50 min under argon at −78 °C. The mixture was stirred at −78 °C for 2 h then quenched by the addition of saturated aqueous NH_4Cl. The aqueous layer was separated and the aqueous layer was extracted with ethyl acetate. The combined organic fractions were dried with sodium sulfate, and concentrated under vacuum at 45 °C. Purification of the crude product by flash column chromatography afforded **SI-19** (68 g, 56%) as a colorless oil.

Physical state: colorless oil

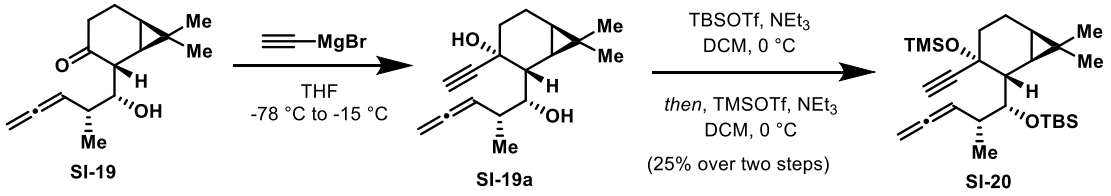
$\mathbf{R_f}$ = 0.26 (Hex/EtOAc = 9:1; anisaldehyde)

HRMS (*m/z*): calc. for $C_{15}H_{23}O_2$ $[M+H]^+$= 235.1698; found, 235.1697

$\mathbf{[\alpha]_D}$= +207.6° (*c* = 1.40, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.24 (p, *J* = 6.9 Hz, 1H), 4.69 (dt, *J* = 6.4, 3.0 Hz, 2H), 3.96-3.91 (m, 2H), 2.40-2.09 (m, 3H), 1.96 (t, *J* = 8.4 Hz, 1H), 1.85 (ddd, *J* = 14.9, 7.7, 2.2 Hz, 1H), 1.66-1.61 (m, 1H), 1.21 (d, *J* = 7.4 Hz, 3H), 1.15 (s, 3H), 1.11 (s, 3H), 0.92 (td, *J* = 9.1, 7.7 Hz, 1H), 0.41 (t, *J* = 8.3 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 219.9, 209.1, 86.5, 74.7, 71.8, 50.2, 41.3, 32.9, 27.9, 25.5, 23.3, 20.7, 19.7, 17.4, 14.9.



Synthesis of **SI-20**: In a 4 L round-bottomed flask, ethynylmagnesium bromide (0.5M in THF, 2321 mL, 1161 mmol, 4.0 equiv) was cooled to −78 °C. Compound **SI-19** (68 g, 290 mmol, 1.0 equiv) in THF (288 mL) was added over 35 min at −78 °C. The reaction mixture was stirred at this temperature for 10 min before warming to −15 °C. After stirring for 4 h at −15 °C, the reaction mixture was quenched by saturated aqueous NH_4Cl. The THF layer was then separated and distilled completely. The aqueous layer was extracted with EtOAc and the combined organic layers were filtered through silica gel and dried over Na_2SO_4, then the solution was concentrated under vacuum to provide crude **SI-19a** (77 g).

To a solution of crude **SI-19a** in CH_2Cl_2 (568 mL) was added distilled triethylamine (165 ml, 1183 mmol, 4.0 equiv). Then, TBSOTf (136 ml, 591 mmol, 2.0 equiv) was added dropwise at 0 °C. After 1.5 h, distilled triethylamine (165 mL, 1183 mmol, 4.0 equiv) and TMSOTf (108 mL, 591 mmol, 2.0 equiv) were added dropwise at 0 °C. The reaction mixture was stirred for a further 1.5 h. Then, the reaction was quenched by saturated aqueous $NaHCO_3$ (500 mL) and diluted with CH_2Cl_2 (500 mL). After separating the aqueous layer, the organic layer was washed again with saturated

aqueous $NaHCO_3$ (500 mL) and then with water (3 × 500 mL) (to remove triethylamine). All aqueous layers were extracted with ethyl acetate (3 × 700 mL). The combined organic layers were dried over Na_2SO_4, filtered and concentrated under reduced pressure**.** Purification of the crude product by flash column chromatography afforded **SI-20** (33 g, 25%) as a colorless oil.

Spectroscopic data for **SI-19a**:

Physical state: colorless oil

R_f = 0.19 (Hex/EtOAc = 4:1; anisaldehyde)

HRMS (*m/z*): calc. for $C_{17}H_{25}O_2$ $[M+H]^+$= 261.1855; found, 261.1856

$[\alpha]_D$= −27.8° (*c* = 0.80, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.54 – 5.02 (m, 1H), 4.73 (dt, *J* = 6.3, 2.9 Hz, 2H), 4.16-4.13 (m, 1H), 3.09 (s, 1H), 2.68 (s, 1H), 2.64-2.51 (m, 3H), 1.70 (dd, *J* = 14.9, 7.0 Hz, 1H), 1.59 – 1.47 (m, 2H), 1.35-1.28 (m, 1H), 1.08 (d, *J* = 6.6 Hz, 3H), 1.06 (s, 3H), 0.96 (s, 3H), 0.73 (t, *J* = 8.8 Hz, 1H), 0.38 (dd, *J* = 9.4, 5.2 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 209.3, 87.6, 86.6, 76.1, 75.1, 74.8, 67.0, 46.2, 38.9, 34.8, 28.8, 24.2, 21.6, 19.9, 17.6, 16.8, 15.4.

Spectroscopic data for **SI-20**:

Physical state: colorless oil

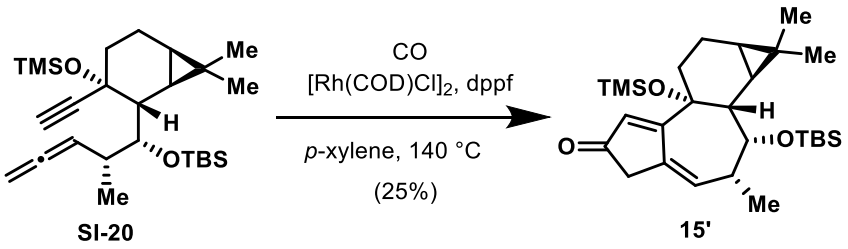
R_f = 0.66 (Hex; anisaldehyde)

HRMS (*m/z*): calc. for $C_{26}H_{46}NaO_2Si_2$ $[M+Na]^+$= 469.2934; found, 469.2943

$[\alpha]_D$= +25.8° (*c* = 0.58, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.49 (q, *J* = 7.0 Hz, 1H), 4.60-4.58 (m, 2H), 4.36 (dd, *J* = 4.0, 1.4 Hz, 1H), 3.04-3.00 (m, 1H), 2.51 (s, 1H), 1.88 – 1.79 (m, 2H), 1.50 – 1.42 (m, 1H), 1.38 (dd, *J* = 5.6, 3.8 Hz, 1H), 1.33 – 1.23 (m, 1H), 1.15 – 1.08 (m, 4H), 1.00 (s, 3H), 0.92 (s, 9H), 0.88 (s, 3H), 0.60 – 0.49 (m, 1H), 0.18 (s, 9H), 0.07 (s, 3H), 0.04 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 208.4, 93.5, 88.1, 76.4, 74.1, 73.5, 68.4, 49.2, 38.6, 35.6, 29.1, 26.0, 21.2, 18.5, 18.1, 18.1, 16.8, 15.8, 15.0, 1.7, -3.8, -4.6.



Synthesis of **15'**: A solution of **SI-20** (20 g, 44.8 mmol, 1.0 equiv) in anhydrous *p*-xylene (4454 mL) was degassed using carbon monoxide for 5 h. 1,5-cyclooctadienerhodium(I) chloride dimer (2.208 g, 4.48 mmol, 0.1 equiv) and dppf (4.89 g, 8.95 mmol, 0.2 equiv) were added. The reaction mixture was transferred into a preheated oil bath and stirred at 140 °C under 1 atm of CO for 18 h. The reaction mixture was cooled to room temperature and concentrated under reduced pressure. Purification of the crude product by flash column chromatography afforded **15'** (5.3 g, 25%) as a yellow solid.

Physical state: yellow solid (m.p. 101-104 °C)

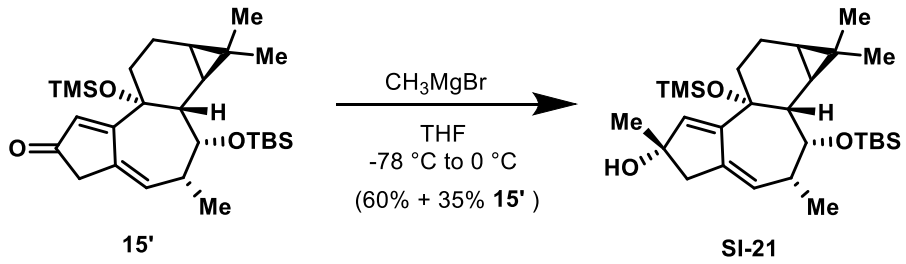
R_f = 0.38 (Hex/EtOAc = 10:1; anisaldehyde)

HRMS (*m/z*): calc. for $C_{27}H_{47}O_3Si_2$ $[M+H]^+$= 475.3064; found, 475.3065

$[\alpha]_D$= −118.6° (*c* = 0.86, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 6.06 (d, *J* = 1.6 Hz, 1H), 5.88 (d, *J* = 8.8 Hz, 1H), 4.12 (dd, *J* = 8.3, 3.1 Hz, 1H), 3.17 – 2.95 (ABq, *J* = 19.9, 2H), 2.59-2.53 (m, 1H), 2.08 – 1.84 (m, 2H), 1.71 – 1.53 (m, 2H), 1.42 (d, *J* = 7.4 Hz, 3H), 1.35 – 1.20 (m, 2H), 1.08 (s, 3H), 0.91 (s, 9H), 0.86 (s, 3H), 0.66 (td, *J* = 9.1, 1.5 Hz, 1H) 0.01 (s, 15H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 205.3, 176.9, 134.8, 133.3, 129.9, 73.5, 73.3, 48.2, 45.0, 43.8, 35.7, 28.4, 25.9, 22.6, 18.5, 17.9, 17.7, 16.4, 15.3, 12.6, 2.0, -4.2, -5.1.



Synthesis of **SI-21**: To a solution of **15'** (602 mg, 1.27 mmol, 1.0 equiv) in THF (64 mL, 0.02 M) was added methylmagnesium bromide (3.0 M in Et_2O, 2.5 mL, 7.62 mmol, 6.0 equiv) over 5 min at −78 °C. The reaction mixture was stirred at this temperature for 5 min before warming to 0 °C. After 15 min, the reaction mixture was cooled to −78 °C and carefully quenched by $NH_4Cl_{(aq)}$ (30 mL). The mixture was extracted with EtOAc (3 × 50 mL) and the combined organic layers were dried over Na_2SO_4, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1→4:1) afforded **SI-21** (373 mg, 60%) as a colorless foam and recovered **15'** (212 mg, 35%).

Physical state: colorless foam

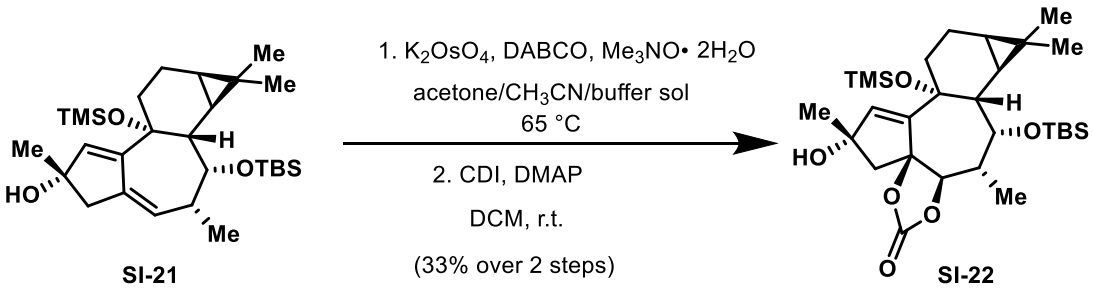
R_f = 0.50 (Hex/EtOAc = 4:1; anisaldehyde)

HRMS (*m/z*): calc. for $C_{28}H_{51}O_3Si_2$ $[M+H]^+$= 461.2718; found, 461.2722

$[\alpha]_D$= −131.3° (*c* = 0.75, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.67 (s, 1H), 5.47 (d, *J* = 8.4 Hz, 1H), 4.06 (dd, *J* = 8.4, 3.0 Hz, 1H), 2.64 (ABq, *J* = 14.4 Hz, 2H), 2.42 – 2.37 (m, 1H), 1.95 (dt, *J* = 14.9, 9.7 Hz, 1H), 1.82 (dd, *J* = 13.5, 9.7 Hz, 1H), 1.57 (dd, *J* = 14.9, 8.7 Hz, 1H), 1.42 (t, *J* = 8.0 Hz, 1H), 1.36 – 1.29 (m, 6H), 1.25 – 0.96 (m, 5H), 0.90 (s, 9H), 0.83 (s, 3H), 0.60 (t, *J* = 8.4 Hz, 1H), 0.05 (s, 9H), -0.01 (s, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 149.7, 139.3, 137.0, 125.3, 79.8, 73.9, 72.8, 52.2, 49.1, 44.0, 35.3, 28.5, 26.7, 25.9, 22.7, 18.7, 18.0, 17.5, 16.5, 15.4, 12.6, 2.3, -4.3, -5.1.



Synthesis of **SI-22**: A 100 mL round-bottomed flask was charged with **SI-21** (246 mg, 0.5 mmol, 1.0 equiv), $Me_3NO{\cdot}2H_2O$ (556 mg, 5.0 mmol, 10 equiv) and DABCO (305

mg, 5 mmol, 2.5 equiv) in acetone/CH_3CN/*0.5 M buffer solution (10.0 mL, 0.05 M, 4:3:3). Then, $K_2OsO_4 \cdot H_2O$ (18.4 mg, 0.05 mmol, 0.1 equiv) was added and the flask was sealed with a plastic cap and stirred vigorously at 65 °C. After 12 h, another portion of $K_2OsO_4 \cdot H_2O$ (18.4 mg, 0.05 mmol, 0.1 equiv) was added and stirred for 8 h before quenching with the addition of saturated aqueous Na_2SO_3 (10 mL). The reaction mixture was extracted with ether (3 × 20 mL). The combined organic layers were washed with brine and dried over Na_2SO_4, filtered and concentrated *in vacuo* to afford crude diol.

[*0.5 M buffer solution: pH=3, Na_2HPO_4 (280 mg) and citric acid (840 mg) was dissolved in H_2O (10 mL).]

The crude diol was dissolved in CH_2Cl_2 (10.0 mL, 0.05 M). *N*,*N*-Carbonyldiimidazole (305 mg, 2.5 mmol, 5.0 equiv) and DMAP (6.1 mg, 0.05 mmol, 0.1 equiv) were then added. The solution was stirred at room temperature for 7 h before quenching with water (20 mL). The aqueous layer was separated, then extracted further with hexane (2 × 30 mL). The combined organic layers were dried over Na_2SO_4, filtered and concentrated *in vacuo*. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1→15:1→9:1) afforded desired product **SI-22** (91 mg, 33% over 2 steps) as a colorless oil.

Physical state: colorless oil

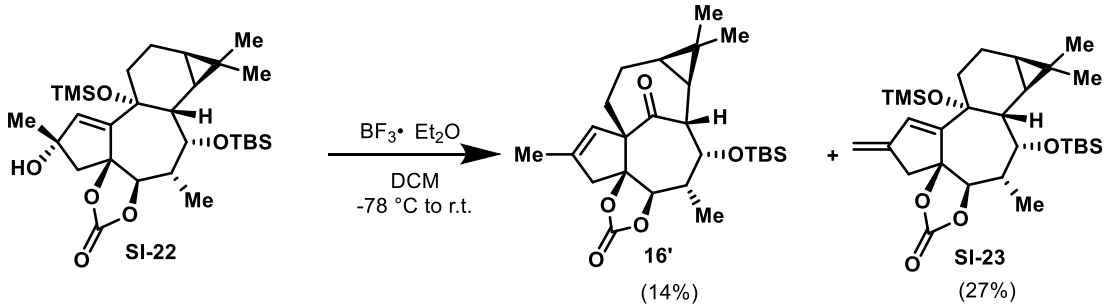
R_f = 0.32 (Hex/EtOAc = 7:3; anisaldehyde)

HRMS (*m/z*): calc. for $C_{29}H_{50}NaO_6Si_2$ $[M+Na]^+$= 573.3038; found, 573.3041

$[\alpha]_D$= +2.5° (*c* = 0.52, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.97 (s, 1H), 4.76 (d, *J* = 5.1 Hz, 1H), 4.23 (dd, *J* = 7.6, 4.8 Hz, 1H), 2.81-2.75 (m, 1H), 2.56 (d, *J* = 14.5 Hz, 1H), 2.33 (d, *J* = 14.5 Hz, 1H), 1.94-1.87 (m, 1H), 1.67 – 1.47 (m, 2H), 1.45 (s, 3H), 1.32 (ddd, *J* = 15.2, 10.8, 8.0 Hz, 1H), 1.24 – 1.20 (m, 1H), 1.15 (d, *J* = 7.7 Hz, 3H), 1.11 – 1.05 (m, 1H), 1.03 (s, 3H), 0.94 (s, 9H), 0.91 (s, 3H), 0.63 (t, *J* = 9.0 Hz, 1H), 0.21 (s, 9H), 0.07 (s, 3H), 0.06 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 153.7, 151.6, 140.7, 93.7, 87.2, 78.3, 75.3, 72.0, 57.1, 41.2, 41.1, 38.2, 28.9, 28.7, 26.0, 19.6, 19.1, 18.3, 17.4, 15.8, 15.1, 11.7, 2.9, -4.1, -5.1.



Synthesis of **16'** and **SI-23**: To a solution of **SI-22** (50 mg, 0.091 mmol, 1.0 equiv) in CH_2Cl_2 (3.7 mL, 0.025 M) was added $BF_3 \cdot Et_2O$ (112 μL, 3.38 mmol, 10 equiv) dropwise at −78 °C. The reaction mixture was stirred at this temperature for 2 min before warming to room temperature. After stirring for 5 min, the reaction was cooled to −78 °C and a 1:1 mixture of Et_3N/MeOH (0.5 mL) was added. The reaction mixture was warmed to room temperature and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 30:1→15:1) afforded **16'** (6.0 mg, 14%) and **SI-23** (12.9 mg, 27%).

Spectroscopic data for **16'**:

Physical state: colorless oil

R_f = 0.53 (Hex/EtOAc = 4:1; anisaldehyde)

HRMS (*m/z*): calc. for $C_{26}H_{41}O_5Si$ $[M+H]^+$= 461.2718; found, 461.2722

$[\alpha]_D$= +39.6° (*c* = 0.5; CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.44 (d, *J* = 1.7 Hz, 1H), 4.88 (d, *J* = 5.2 Hz, 1H), 4.20 (dd, *J* = 7.6, 3.8 Hz, 1H), 3.16 (d, *J* = 18.4 Hz, 1H), 2.88-2.82 (m, 1H), 2.62 (d, *J* = 18.2 Hz, 1H), 2.32 (dd, *J* = 11.4, 3.8 Hz, 1H), 2.20 – 1.99 (m, 2H), 1.71 (s, 3H), 1.56 – 1.43 (m, 2H), 1.10 (s, 3H), 1.04 (s, 3H), 1.00 – 0.92 (m, 10H) 0.85 (d, *J* = 8.0 Hz, 3H), 0.71 – 0.62 (m, 1H), 0.11 (s, 3H), 0.05 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 208.0, 153.2, 134.1, 127.2, 93.3, 91.4, 75.3, 67.4, 54.9, 49.2, 38.2, 36.6, 28.3, 25.7, 25.1, 24.9, 23.6, 23.3, 18.2, 16.2, 15.1, 9.5, -4.9, -4.9.

Spectroscopic data for **SI-23**:

Physical state: colorless foam

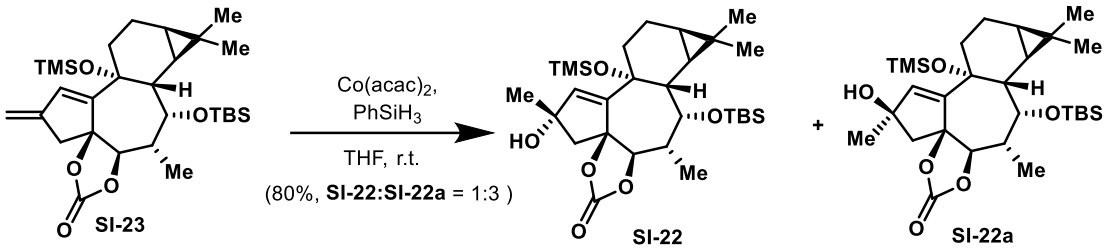
R_f = 0.65 (Hex/EtOAc = 4:1; anisaldehyde)

HRMS (*m/z*): calc. for $C_{29}H_{49}O_5Si_2$ $[M+H]^+$= 533.3118; found, 533.3121

$[\alpha]_D$= +18.0° (*c* = 1.0, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 6.42 (s, 1H), 5.03 (s, 1H), 4.90 (s, 1H), 4.70 (d, *J* = 5.2 Hz, 1H), 4.24 (dd, *J* = 7.8, 4.8 Hz, 1H), 3.20 (dt, *J* = 17.0, 2.2 Hz, 1H), 2.81 (dt, *J* = 17.0, 1.7 Hz, 1H), 2.78 – 2.72 (m, 1H), 1.94 – 1.87 (m, 1H), 1.67 – 1.48 (m, 2H), 1.40 – 1.35 (m, 1H), 1.25 – 1.23 (m, 1H), 1.09 (dd, *J* = 9.7, 6.1 Hz, 1H), 1.04 (s, 3H), 0.98 (d, *J* = 7.6 Hz, 3H), 0.93 – 0.92 (m, 12H), 0.65 – 0.62 (m, 1H), 0.21 (s, 9H), 0.07 (s, 3H), 0.05 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 155.9, 153.5, 144.9, 136.9, 106.9, 93.0, 87.7, 76.1, 72.0, 48.2, 41.1, 40.2, 37.6, 28.8, 26.0, 19.5, 19.1, 18.2, 17.4, 15.7, 15.2, 11.0, 2.8, -4.2, -5.1.



Synthesis of **SI-22** and **SI-22a**: To a solution of **SI-23** (87.5 mg, 0.16 mmol, 1 equiv) in THF (3.3 mL, 0.05 M) was added $Co(acac)_2$ (8.5 mg, 0.033 mmol, 0.2 equiv) and molecular sieves (4Å, 0.44 g, 5 wt equiv). $PhSiH_3$ (81 μL, 0.66 mmol, 4 equiv) was added slowly while bubbling O_2 through the stirred solution. Then, the reaction was stirred under O_2 atmosphere (no bubbling) at ambient temperature for 10 min. The suspension was then filtered through Celite® to remove the molecular sieves and the filtrate was concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 20:1→15:1→9:1→1:1) afforded a mixture of **SI-22** and **SI-22a** as a colorless oil [72.3 mg, 80% (**SI-22**:**SI-22a** = 1:3, the ratio was determined by ^{1}H NMR spectroscopy)].

Spectroscopic data for **SI-22a**:

Physical state: colorless oil

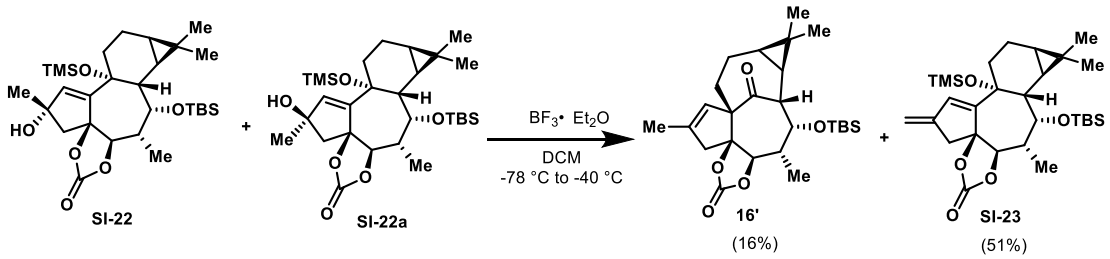
R_f = 0.27 (Hex/EtOAc = 7:3; anisaldehyde)

HRMS (*m/z*): calc. for $C_{29}H_{50}NaO_6Si_2$ $[M+Na]^+$= 573.3038; found, 573.3041

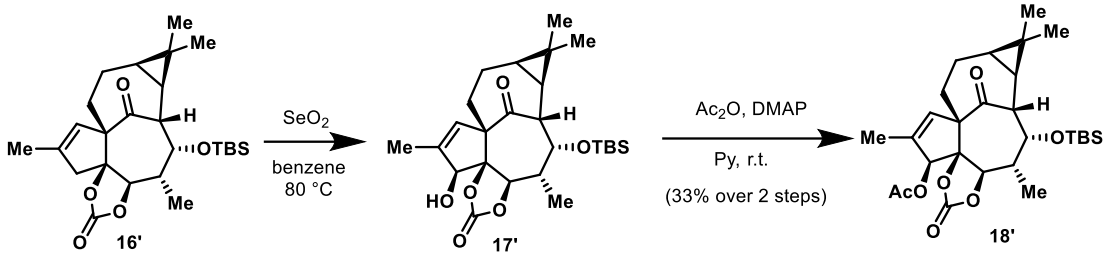
$[\alpha]_D$= +1.5° (*c* = 0.39, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 6.07 (s, 1H), 4.67 (d, *J* = 5.3 Hz, 1H), 4.22 (dd, *J* = 7.6, 4.8 Hz, 1H), 2.78 – 2.72 (m, 1H), 2.63 (d, *J* = 15.1 Hz, 1H), 2.34 (d, *J* = 15.1 Hz, 1H), 1.97 – 1.85 (m, 1H), 1.73 – 1.52 (m, 2H), 1.43 (s, 3H), 1.36 (ddd, *J* = 15.1, 11.0, 8.0 Hz, 1H), 1.22 (t, *J* = 5.4 Hz, 1H), 1.11 – 1.01 (m, 7H), 0.93 (s, 9H), 0.91 (s, 3H), 0.63 (t, *J* = 7.8 Hz, 1H), 0.20 (s, 9H), 0.07 (s, 3H), 0.06 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 153.4, 151.9, 141.6, 93.2, 86.6, 77.3, 75.2, 72.1, 57.8, 41.5, 41.1, 38.1, 28.9, 27.0, 26.0, 19.6, 19.0, 18.3, 17.4, 15.9, 15.1, 11.1, 2.9, -4.1, -5.1.



Synthesis of **16'** [synthesis via recovered **SI-22** and **SI-22a** (**SI-22 : SI-22a** = 1:3)]: To a solution of a mixture of **SI-22** and **SI-22a** (54 mg, 0.098 mmol, 1.0 equiv) in CH_2Cl_2 (3.9 mL, 0.025 M) was added $BF_3{\cdot}Et_2O$ (120 μL, 0.98 mmol, 10 equiv) dropwise at −78 °C. The reaction mixture was stirred at this temperature for 2 min before warming to −40 °C. After stirring for 5 min, the reaction was cooled to −78 °C and a 1:1 mixture of Et_3N/MeOH (0.5 mL) was added. The reaction mixture was warmed to room temperature and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 30:1→15:1) afforded **16'** (12.1 mg, 16%) and **SI-23** (26.8 mg, 51%).



Synthesis of **17'**: To a solution of **16'** (45.4 mg, 0.099 mmol, 1.0 equiv) in benzene (5 mL, 0.02 M) was added SeO_2 (55 mg, 0.49 mmol, 5.0 equiv). The flask was sealed with a plastic cap and the suspension was stirred at 80 °C for 21 h. The suspension was cooled to room temperature and was filtered through Celite®, washed with EtOAc, and then concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 9:1→4:1) afforded alcohol **17'** (22.0 mg, 47%) as a colorless oil.

Synthesis of **18'**: To a solution of **17'** (20.7 mg, 0.043 mmol, 1.0 equiv) in pyridine (1.4 mL, 0.03 M) was added Ac_2O (20 μL, 0.22 mmol, 5.0 equiv) and DMAP (20.7 mg, 4.3 μmol, 1.0 equiv). After stirring for 10 min, the mixture was quenched by saturated aqueous $NaHCO_3$ (2.0 mL) and then extracted with EtOAc (3 × 2 mL). The combined organic layers were washed with brine (2 mL), dried over Na_2SO_4, filtered and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, hexanes/EtOAc = 15:1→9:1) afforded **18'** (15.6 mg, 70%) as a colorless oil.

Spectroscopic data for **17'**:

Physical state: colorless oil

R_f = 0.43 (Hex/EtOAc = 7:3; anisaldehyde)

HRMS (*m/z*): calc. for $C_{26}H_{41}O_6Si$ $[M+H]^+$= 477.2667; found, 477.2665

$[\alpha]_D$= +92.2° (*c* = 0.37, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.63 – 5.58 (m, 1H), 4.99 (d, *J* = 5.1 Hz, 1H), 4.26 – 4.18 (m, 2H), 2.94-2.88 (m, 1H), 2.47 (dd, *J* = 11.4, 3.8 Hz, 1H), 2.15-2.06 (m, 2H), 1.79 (s, 3H), 1.62 – 1.47 (m, 2H), 1.12 (s, 3H), 1.05 (s, 3H), 0.97-0.92 (s, 10H), 0.85 (d, *J* = 8.0 Hz, 3H), 0.74 – 0.66 (m, 1H), 0.12 (s, 3H), 0.06 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 207.1, 152.8, 137.9, 129.3, 90.8, 89.1, 86.3, 73.1, 67.3, 49.9, 38.2, 37.8, 28.2, 25.7, 25.0, 24.7, 23.2, 23.1, 18.2, 15.1, 13.8, 10.2, -4.9.

Spectroscopic data for **18'**

Physical state: colorless oil

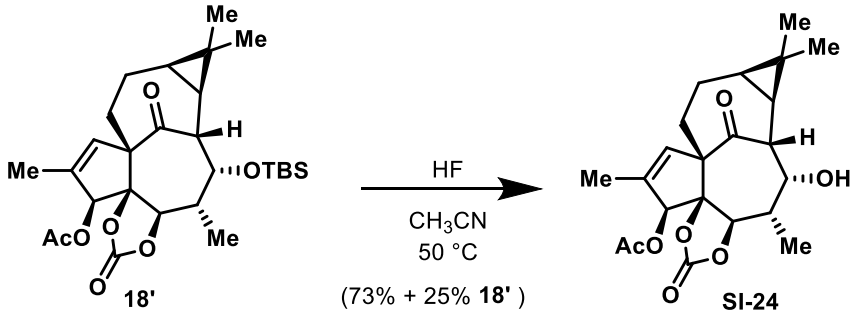
R_f = 0.54 (Hex/EtOAc = 4:1; anisaldehyde)

HRMS (*m/z*): calc. for $C_{28}H_{42}O_7Si$ $[M+H]^+$= 519.2772; found, 519.2763

$[\alpha]_D$= +42.9° (*c* = 0.17, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.91 (s, 1H), 5.35 (d, *J* = 4.9 Hz, 1H), 5.16 (s, 1H), 4.21 (dd, *J* = 7.5, 3.9 Hz, 1H), 2.90-2.84 (m, 1H), 2.22 (dd, *J* = 11.4, 4.0 Hz, 1H), 2.18 (s, 3H), 2.10 – 1.99 (m, 2H), 1.75 (s, 3H), 1.57 – 1.52 (m, 2H), 1.08 (s, 3H), 1.04 (s, 3H), 0.97 (dd, *J* = 11.3, 8.6 Hz, 1H), 0.94 (s, 9H), 0.81 (d, *J* = 8.0 Hz, 3H), 0.71 – 0.62 (m, 1H), 0.11 (s, 3H), 0.06 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 206.9, 172.3, 152.7, 133.4, 133.0, 90.8, 89.0, 88.9, 73.0, 67.1, 50.0, 38.7, 37.7, 28.2, 25.7, 25.2, 25.0, 23.4, 23.2, 20.5, 18.2, 15.1, 14.2, 9.6, -4.9.



Synthesis of **SI-24**: A plastic Falcon® tube was charged with **18'** (16.6 mg, 0.032 mmol, 1.0 equiv) and CH_3CN (0.64 mL, 0.05 M). 47% aqueous HF (70 µL, 1.92 mmol, 60 equiv) was added and the mixture was heated to 50 °C. After stirring for 16 h, the reaction was cooled to room temperature and quenched by the slow addition of saturated aqueous $NaHCO_3$ (4 mL). After dilution with EtOAc (5 mL), the organic layer was separated, then the aqueous layer was extracted with EtOAc (3 × 5 mL). The combined organic fractions were dried over Na_2SO_4, filtered, and concentrated *in vacuo*.

Purification of the crude product by flash column chromatography (silica gel, hex/EtOAc = 9:1→4:1→7:3) afforded recovered **18'** (4.1 mg, 25%) and **SI-24** (9.4 mg, 73%) as a colorless oil.

Physical state: colorless oil

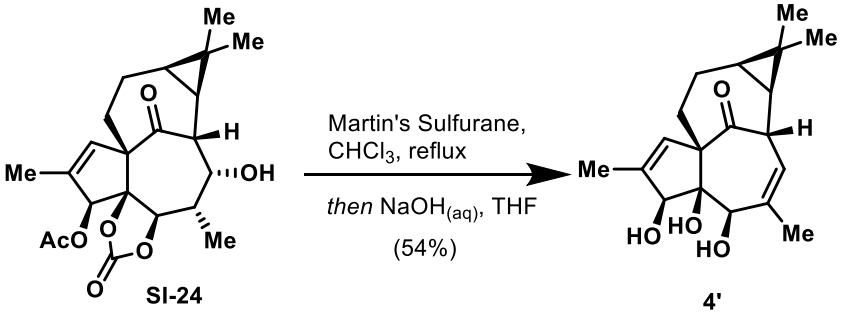
$\mathbf{R_f}$ = 0.32 (Hex/EtOAc = 3:2; anisaldehyde)

HRMS (*m/z*): calc. for $C_{22}H_{29}O_7$ $[M+H]^+$= 405.1913; found, 405.1920

$\mathbf{[\alpha]_D}$= +18.8° (*c* = 0.51, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.82 (s, 1H), 5.39 (d, *J* = 4.7 Hz, 1H), 5.15 (s, 1H), 4.18 (d, *J* = 8.2 Hz, 1H), 3.12 – 3.03 (m, 1H), 2.40 (dd, *J* = 11.3, 3.8 Hz, 1H), 2.18 (s, 3H), 2.16 – 2.01 (m, 2H), 1.77 (s, 3H), 1.65 – 1.51 (m, 2H), 1.09 (s, 3H), 1.06 (s, 3H), 0.95 (dd, *J* = 11.4, 8.5 Hz, 1H), 0.83 (d, *J* = 8.1 Hz, 3H), 0.74 – 0.70 (s, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 210.7, 172.2, 152.4, 134.0, 132.3, 91.0, 89.0, 88.4, 72.3, 67.4, 48.7, 37.7, 37.0, 28.4, 25.3, 25.1, 23.0, 22.3, 20.4, 14.9, 14.2, 9.7.



Synthesis of **4'**: To a solution of **SI-24** (19.1 mg, 0.047 mmol, 1.0 equiv) in $CHCl_3$ (200 μL) was added Martin's sulfurane (100 mg, 0.15 mmol, 3.2 equiv). The solution was heated to reflux for 1 h. Additional Martin's sulfurane (150 mg, 0.23 mmol, 4.8 equiv) was added portion-wise over 2 h until starting material was fully consumed. The $CHCl_3$ was removed under reduced pressure, then THF (500 μL) and 10% aqueous NaOH (500 μL) were added. The mixture was stirred for 1 h. EtOAc was added and the layers were separated. The aqueous layer was extracted with EtOAc (5 × 2 mL). The combined organic fractions were dried over Na_2SO_4, filtered, and concentrated to provide crude

product. The crude material was purified by column chromatography (Hex/EtOAc = 10:1 →5:1 →2:1 →1:1) to afforded **4'** (7.1 mg, 54%) as a white solid.

Physical state: white solid (m.p. = 192-195 °C, decomp.)

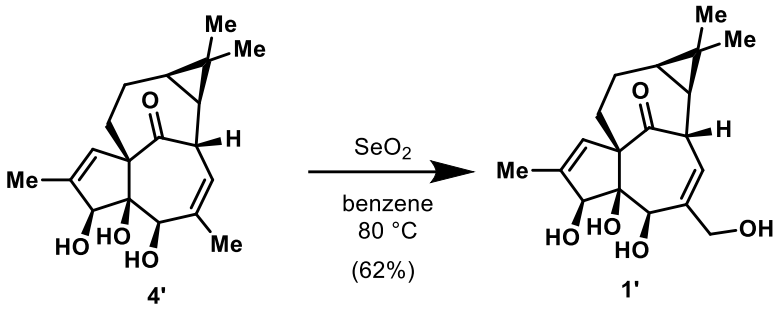
$\mathbf{R_f}$ = 0.38 (Hex/EtOAc = 1:1; anisaldehyde)

HRMS (*m/z*): calc. for $C_{19}H_{27}O_4$ $[M+H]^+$= 319.1904; found, 319.1904

$[\alpha]_D$= −10.0° (*c* = 0.2, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.83 (d, *J* = 1.7 Hz, 1H), 5.77 (dt, *J* = 4.9, 1.6 Hz, 1H), 4.44 (d, *J* = 4.4 Hz, 1H), 4.09 (s, 1H), 4.04 – 4.00 (m, 1H), 3.47 (d, *J* = 10.2 Hz, 1H), 2.53 (d, *J* = 11.4 Hz, 1H), 2.18 – 1.87 (m, 4H), 1.83 (d, *J* = 1.5 Hz, 3H), 1.78 (s, 3H), 1.63 (ddd, *J* = 14.2, 12.7, 3.8 Hz, 1H), 1.11 (s, 3H), 1.05 (s, 3H), 0.93 (dd, *J* = 12.0, 8.3 Hz, 1H), 0.69 – 0.62 (m, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 208.4, 138.3, 131.5, 123.2, 83.8, 81.6, 76.2, 69.3, 44.2, 37.0, 28.4, 25.5, 24.5, 23.5, 23.2, 22.1, 15.4, 15.1



Synthesis of **1'**: To a solution of **4'** (1.7 mg, 5.3μmol, 1.0 equiv) in benzene (1.2 mL, 0.005 M) was added SeO_2 (5.9 mg, 0.053 mmol, 10.0 equiv). The suspension was stirred at 80 °C for 9 h. After cooling to room temperature, the reaction mixture was filtered through Celite®, washed with EtOAc, and then concentrated under reduced pressure. Purification by PTLC (CH_2Cl_2/MeOH = 9:1) yielded **1'** (1.1 mg, 62%) as a colorless oil.

Physical state: colorless oil

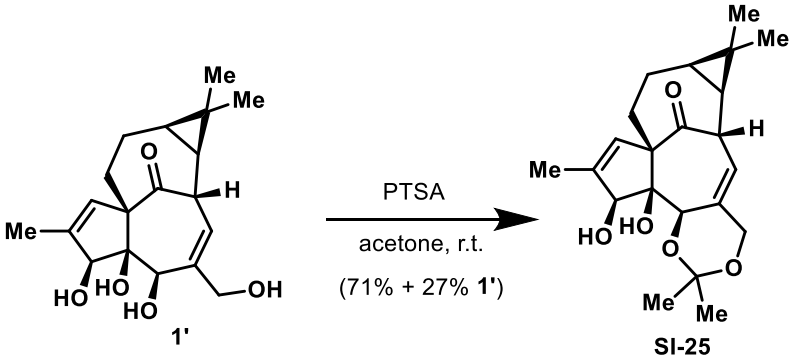
R_f = 0.38 (DCM/MeOH = 9:1; anisaldehyde)

HRMS (*m/z*): calc. for $C_{19}H_{26}NaO_5$ $[M+Na]^+$= 357.1678; found, 357.1670

$[\alpha]_D$= −12.7° (*c* = 0.11, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 6.07 (d, *J* = 4.8 Hz, 1H), 5.81 (d, *J* = 1.6 Hz, 1H), 4.43 (s, 1H), 4.22 – 4.08 (m, 3H), 3.85 (s, 1H), 2.10 – 1.89 (m, 4H), 1.83 (d, *J* = 1.5 Hz, 3H), 1.66-1.61 (m, 1H), 1.11 (s, 3H), 1.06 (s, 3H), 0.95 (dd, *J* = 12.0, 8.3 Hz, 1H), 0.71-0.67 (m, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 208.0, 140.4, 138.7, 130.9, 127.0, 83.7, 81.0, 75.2, 69.3, 67.1, 44.3, 36.7, 28.4, 25.6, 24.6, 23.2, 23.1, 15.5, 15.1.



Synthesis of **SI-25**:[3] Compound **1'** (1.5 mg, 4.5 μmol) was dissolved in a solution of *p*-toluenesulfonic acid monohydrate in acetone (0.2 mg/mL, 0.5 mL) and stirred at room temperature for 0.5 h. The reaction was quenched by few drops of saturated aqueous $NaHCO_3$ and concentrated under reduced pressure. The residue was dissolved in EtOAc (1.0 mL), washed with brine and concentrated to provide crude product. Purification by PTLC (Hex/EtOAc = 7:3) to afforded recovered **1'** (0.4 mg, 27%) and **SI-25** (1.2 mg, 71%) as a colorless oil.

Physical state: colorless oil

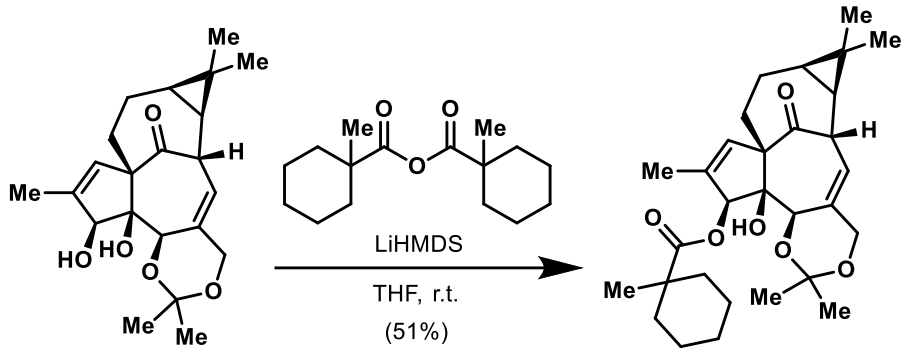
R_f = 0.71 (Hex/EtOAc = 7:3; anisaldehyde)

HRMS (*m/z*): calc. for $C_{22}H_{30}NaO_5$ $[M+Na]^+$= 397.1997; found, 397.1997

$[\alpha]_D$= −19.3° (*c* = 0.15, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.82 (dd, *J* = 3.9, 1.9 Hz, 1H), 5.79 (d, *J* = 1.6 Hz, 1H), 4.26 (s, 1H), 4.22 – 4.06 (m, 3H), 3.95 (s, 1H), 2.19 – 2.13 (m, 1H), 2.05 – 1.90 (m, 2H), 1.83 (d, *J* = 1.5 Hz, 3H), 1.66 – 1.57 (m, 1H), 1.42 (s, 3H), 1.35 (s, 3H), 1.11 (s, 3H), 1.05 (s, 3H), 0.92 (dd, *J* = 12.0, 8.3 Hz, 1H), 0.70-0.66 (m, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 208.5, 139.4, 136.1, 130.4, 122.0, 100.5, 82.8, 80.4, 73.6, 69.5, 64.1, 44.3, 35.7, 28.4, 26.6, 25.8, 24.5, 23.3, 23.2, 21.0, 15.5, 15.4.



SI-25 **SI-26**

Synthesis of **SI-26**: [3] To a solution of **SI-25** (1.5 mg, 4 μmol, 1.0 equiv) and 1-methylcyclohexane-1-carboxylic anhydride (3.2 mg, 12 μmol, 3.0 equiv) in THF (0.4 mL) was added a solution of LiHMDS in THF (1.0 M, 22 μL, 22 μmol, 5.0 equiv) at room temperature. The solution was stirred at room temperature for 10 min, diluted with Et_2O (1 mL), and washed with H_2O. The aqueous phase was extracted with Et_2O (3 × 1 mL). The combined organic phases were concentrated under reduced pressure. Purification by PTLC (Hex/EtOAc = 4:1) to afforded **SI-26** (1.1 mg, 51%) as a white oil.

Physical state: white oil

R_f = 0.63 (Hex/EtOAc = 7:3; anisaldehyde)

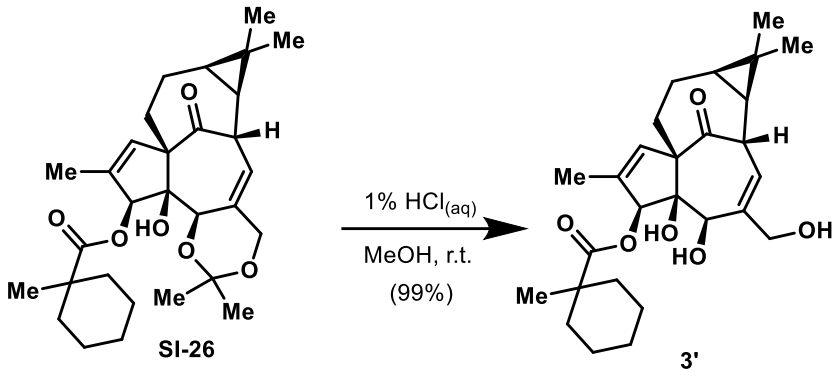
HRMS (*m/z*): calc. for $C_{30}H_{43}O_6$ $[M+H]^+$= 521.2879; found, 521.2875

$[\alpha]_D$= +2.4° (*c* = 0.21, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 5.91 (d, *J* = 1.6 Hz, 1H), 5.81 – 5.77 (m, 1H), 5.56 (s, 1H), 4.26 – 4.10 (m, 3H), 4.03 (s, 1H), 2.25 (dt, *J* = 14.3, 3.7 Hz, 1H), 2.11 – 1.86 (m,

3H), 1.73 (d, *J* = 1.6 Hz, 3H), 1.62 – 1.53 (m, 5H), 1.47 (s, 3H), 1.41 (s, 3H), 1,36-1.21 (m, 5H), 1.19 (s, 3H), 1.08 (s, 3H), 1.04 (s, 3H), 0.94 – 0.85 (m, 1H), 0.69-0.65 (m, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 208.7, 178.2, 136.4, 136.1, 132.9, 121.7, 100.3, 83.8, 81.8, 73.7, 68.9, 64.3, 44.0, 43.6, 35.7, 35.6, 35.4, 34.9, 28.4, 26.7, 26.0, 25.8, 25.6, 24.8, 23.3, 23.2, 23.1, 20.8, 15.6, 15.4.



Synthesis of **3'**:[3] A solution of **SI-26** (0.4 mg, 0.8 μmol) in methanol (0.2 mL), which contains 1 % of concentrated aqueous hydrochloric acid solution, was stirred at room temperature for 1 h. The solution was concentrated under reduced pressure. Purification by PTLC (Hex/EtOAc = 5:5) to afforded **3'** (0.4 mg, 99%) as a colorless oil.

Physical state: colorless oil

R_f = 0.33 (Hex/EtOAc = 1:1; anisaldehyde)

HRMS (*m/z*): calc. for $C_{27}H_{38}NaO_6$ $[M+Na]^+$= 481.2566; found, 481.2559

$[\alpha]_D$= +5.4° (*c* = 0.13, CH_2Cl_2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 6.07 (d, *J* = 4.0 Hz, 1H), 5.90 (d, *J* = 1.6 Hz, 1H), 5.43 (s, 1H), 4.18 – 4.12 (m, 3H), 4.08 (s, 1H), 2.15 (dt, *J* = 14.2, 3.8 Hz, 1H), 2.09 – 1.88 (m, 3H), 1.75 (d, *J* = 1.5 Hz, 3H), 1.67 – 1.24 (m, 10H), 1.21 (s, 3H), 1.08 (s, 3H), 1.05 (s, 3H), 0.93 (dd, *J* = 12.0, 8.3 Hz, 1H), 0.70-0.66 (m, 1H).

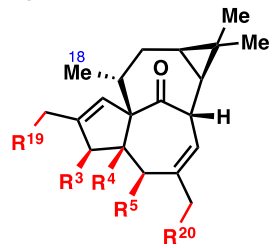
^{13}C NMR (151 MHz, $CDCl_3$) δ 207.6, 179.0, 139.1, 135.4, 132.8, 128.2, 84.5, 82.9, 77.0 (verify by HSQC), 68.7, 67.5, 43.8, 43.7, 36.0, 35.6, 35.6, 28.3, 25.8, 25.7, 24.8, 23.3, 23.3, 23.2, 23.1, 15.6, 15.2 (one signal does not appear due to incidental overlap).

Biological experiments:

Table S1. Biological testing of C20-hydroxylated ingenol analogs **5**, **6**, **9**, **10**, **13** and desmethyl compound **3'** compared to reference compound **3**, illuminating the minimally required functional groups on the ingenane core (N/A = not available; green = high potency; yellow = intermediate potency; red = low potency/inactive). This is the full table version of Table 1 (shown in the main text) including E_{max} values.

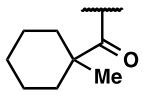
higher oxidation state; greater potency	EC_{50} PKCδ binding (nM)	E_{max} PKCδ (%)	EC_{50} IL-8 HEKa (nM)	E_{max} IL-8 HEKa (%)	EC_{50} ox burst hPMN (nM)	E_{max} ox burst hPMN (%)	EC_{50} PKCβII binding (nM)	E_{max} PKCβ (%)
3	11	98	8	87	7	114	0.2	46
5	80	89	26	83	7	106	0.8	86
6	154	86	35	111	9	108	0.2	71
9	1110	92	130	107	13	99	6	62
10	>10000	N/A	>19000	N/A	478	81	828	91
13	>10000	N/A	>10200	N/A	>10200	N/A	>10000	N/A
3' *	7	92	4	90	4	111	0.1	57

Ingenane structures:



	R^3	R^4	R^5	R^{19}	R^{20}
3	OR	OH	OH	H	OH
5	OR	OH	H	H	OH
6	OR	H	OH	H	OH
9	OR	H	H	H	OH
10	H	H	H	OR	OH
13	H	H	H	H	OH
3' *	OR	OH	OH	H	OH

R =



* = without C18-methyl group

Table S2. Expression of mRNA of classical and novel PKC isoforms in primary human keratinocytes and neutrophils, respectively. **(A)** Raw data (CT values) from quantitative PCR (qPRC). **(B)** Calculated relative expression normalized to PKCδ expression level (normalization was separately performed for each cell type)

A) Raw data (C_T values)	**Primary human keratinocytes (HeKa)**			**Primary human neutrophils (PMN)**	
Gene	**Donor 1**	**Donor 2**	**Donor 3**	**Donor 4**	**Donor 5**
PRKCalpha	30.07	29.69	30.38	34.00	34.00
PRKCbeta	35.21	36.94	35.97	25.00	26.50
PRKCgamma	40.00	40.00	40.00	40.00	40.00

PRKCdelta	28.56	28.77	28.91	30.26	30.00
PRKCeta	28.75	28.94	28.54	30.00	30.00
PRKCtheta	31.71	31.95	32.00	34.87	34.00
PRKCepsilon	32.00	32.51	31.14	36.00	34.00
GAPDH	21.94	22.87	21.81	30.40	30.00

B) Relative levels ($x = 2^{-\Delta\Delta C_T}$)	**Primary human keratinocytes (HeKa)**			**Primary human neutrophils (PMN)**	
Gene	**Donor 1**	**Donor 2**	**Donor 3**	**Donor 4**	**Donor 5**
PRKCalpha	0.35	0.53	0.36	0.08	0.06
PRKCbeta	0.01	0.00	0.01	38.26	11.32
PRKCgamma	nd	nd	nd	nd	nd
PRKCdelta	1.00	1.00	1.00	1.00	1.00
PRKCeta	0.88	0.89	1.29	1.20	1.00
PRKCtheta	0.11	0.11	0.12	0.04	0.06
PRKCepsilon	0.09	0.08	0.21	0.02	0.06

Methods

Neutrophil oxidative burst:

Primary human PMN's (polymorphonuclear leukocytes) were isolated and purified from fresh buffy coats by sequential sedimentation, density centrifugation and lysis of contaminating erythrocytes. Buffy coats were incubated with 2% methocel for 30-45 min to differentially sediment red blood cells. The leukocyte-rich supernatant was transferred to Lymphoprep™ tubes to remove mononuclear cells by density centrifugation (400xg, 30 min). The pellet was re-suspended and any remaining erythrocytes lysed using 0.2% NaCl for 30 sec before restoring isotonicity by the

addition of 1.2% NaCl. This step was repeated until the cell pellet appeared relatively free of red blood cells. Cells were re-suspended in DPBS (Dulbecco's Phosphate Buffered Saline; without Ca^{2+}, Mg^{2+}) and the concentration adjusted to 1.4x10^6 cells/ml in HBSS (Hanks Balanced Salt solution; with Ca^{2+}, Mg^{2+}) containing 0.1% BSA (Bovine Serum Albumin) and 5mM glucose just prior to assay initiation. Titrated reference and test compounds were pre-mixed with HE (hydroethidine; 10µM final assay concentration) before addition to 96-well plates containing 2.5x10^5 cells. Following 40 min incubation at RT, changes in the respiratory burst was estimated by measuring fluorescence at 579 nm (excitation: 485 nm) using an Envision plate reader.

Test compound titration curves were fitted to a four-parameter sigmoidal curve after normalizing the effect of the test compound to the effect of the positive control (5x10^-7 M ingenol mebutate). Relative EC50 is defined as the concentration of test compound producing an effect that is midway between the fitted top and bottom. Absolute EC50 is the concentration of test compound that provokes a response corresponding to 50% of the maximal effect associated with the positive control (5x10^-7 M ingenol mebutate). Results represent average of two independent determinations run in duplicate on individual plates.

HeKa cytokine release (IL-8):

Primary human epidermal keratinocytes (HeKa), were seeded (10.000 cells/well) in 96-well plates the day before the assay. Test compounds were diluted in DMSO (dimethyl sulfoxide) and further diluted in assay medium and pipetted into wells of 96 well-plates containing HeKa cells. The plates were incubated for 6h at 37°C in humidified air with 5% CO2. Plates were centrifuged briefly to spin down cells at 4°C, the supernatant was removed and analyzed by Meso Scale Discovery (MSD) 4-spot cytokine assay (Pro-inflammatory II Ultra Sensitive kit, MSD, MD, USA). The MSD assay employs a sandwich immunoassay format where capture antibodies are coated in a patterned array on the bottom of the wells of a 4-Spot- Multi-MSD plate. Standard samples were incubated in the MULTI-SPOT plates as well, and the cytokine (IL-8) binds to its corresponding capture antibody spot. The cytokine level was quantitated on a SECTORTM Imager using a cytokine-specific Detection Antibody labeled with MSD SULFO-TAGTM reagent.

Test compound titration curves were fitted to a four-parameter sigmoidal curve after normalizing the effect of the test compound to the effect of the positive control (1.5x10^-7 M PEP0005). Results represent average of two independent determinations run in duplicate on individual plates.

Human PKC delta (PKCδ) activation

The potency and efficacy of test compounds in stimulating human recombinant protein kinase C (PKC) delta isoform was determined by measuring phosphorylation of a PKC substrate peptide using 33P-ATP. Data points for the EC50 determinations were performed in duplicate. The assay was perfomed at Millipore (Dundee, UK).

Human PKC delta (PKCδ, Millipore cat# 14-504) was diluted in 20 mM HEPES, 0.03% Triton X-100. Amount of enzyme in each assay was 7.25 ng, final assay volume 25 µl. All compounds for testing were diluted to 1 mM in 100% DMSO as an intermediary dilution. The compounds were then diluted further to 50 µM, and then serially diluted in 100% DMSO in semi-logarithmic decrements for 12 points. 0.5 µL of each concentration, in duplicate, was pipetted into a dry 96 well assay plate using a TTP Mosquito. Control and blank wells received 0.5 µL of 100% DMSO instead of compound. This was followed by addition of 14.5 µL of assay mixture, containing appropriately diluted enzyme and 20 mM HEPES pH 7.4, 0.03% Triton X-100, 0.05 mg/mL phosphatidylserine, and 50 µM of the substrate peptide ERMRPRKRQGSVRRRV. The assay was started with the addition of 10 µL ATP containing γ-33P-ATP (specific activity approx. 500 cpm/pmol) to a final assay concentration of 15 µM. The reaction was allowed to proceed at room temperature for 40 min before the addition of 5 µL 3% ortho-phosphoric acid. Blank wells were acid blanks, and had 5 µL 3% ortho-phosphoric acid added before the addition of ATP. 10 µL of the stopped reaction products was transferred to a P30 filtermat which was then washed 4 times in 75 mM ortho-phosphoric acid, and once in methanol before drying. The filter was read by liquid scintillation counting using a Wallac Trilux.

Human PKC beta II (PKCβ II) activation

The potency and efficacy of test compounds in stimulating human recombinant protein kinase C (PKC) beta II isoform was determined by measuring phosphorylation of the PKC substrate histone H1 using 33P-ATP. Data points for the EC50 determinations were performed in duplicate. The assay was perfomed at Millipore (Dundee, UK).

Human PKC beta II (PKCβ II, Millipore cat# 14-496) was incubated with 20 mM HEPES pH 7.4, 0.03% Triton X-100, 0.1 mM $CaCl_2$, 0.1 mg/mL phosphatidylserine, 0.1 mg/mL histone H1, 10 mM $Mg(OAc)_2$. Amount of enzyme in each assay was 1.8 ng (final assay volume is 25 µL). The compounds were then diluted to 500 µM, and then serially diluted in 100% DMSO in semi-logarithmic decrements for 12 points. 0.5 µL of each concentration, in duplicate, was pipetted into a dry 96 well assay plate using a TTP Mosquito. Control and blank wells received 0.5 µL of 100% DMSO instead of

compound. 14.5 µl kinase in assay buffer was added to each well. The assay was started with the addition of 10 µL ATP containing γ-33P-ATP] (specific activity approx. 500 cpm/pmol), to a final assay concentration of 70 µM. The reaction was allowed to proceed at room temperature for 40 min before the addition of 5 µL 3% ortho-phosphoric acid. Blank wells were acid blanks, and had 5 µL 3% ortho-phosphoric acid added before the addition of ATP. 10 µL of the stopped reaction products was transferred to a P30 filtermat which was then washed 4 times in 75 mM ortho-phosphoric acid, and once in methanol before drying. The filter was read by liquid scintillation counting using a Wallac Trilux.

PKC isoform expression in primary human keratinocytes and polymorphonuclear cells

RNA was extracted from freshly isolated PMN (two different donors) or mono-layers of primary human epidermal keratinocytes (three different donors). Following RNA reverse-transcription, relative gene expression levels of classical (α, β, γ) and novel (δ, η, ε, θ) PKC isoforms was determined by real-time quantitative PCR (qPCR) using validated gene expression assays (Applied Biosystems; Hs99999905_m1 / GAPDH, Hs_00925195_m1 / PRKCalpha, Hs_00176998_m1 / PRKCbeta, Hs_00177010_m1 / PRKCgamma, Hs_00178914_m1 / PRKCdelta, Hs_00178933_m1 / PRKCeta, Hs_00178455_m1 / PRKCepsilon, Hs_00989970_m1 / PRKCtheta) and ABI PRISM® 7900HT sequence detection system. Data was normalized to GAPDH and relative quantitation of PKC isoform gene expression was done using the Comparative ($\Delta\Delta C_T$) Method (cf. Applied Biosystems, User Bulletin #2).

X-ray Crystallographic Data

Figure S1. X ray structure for **SI-4**

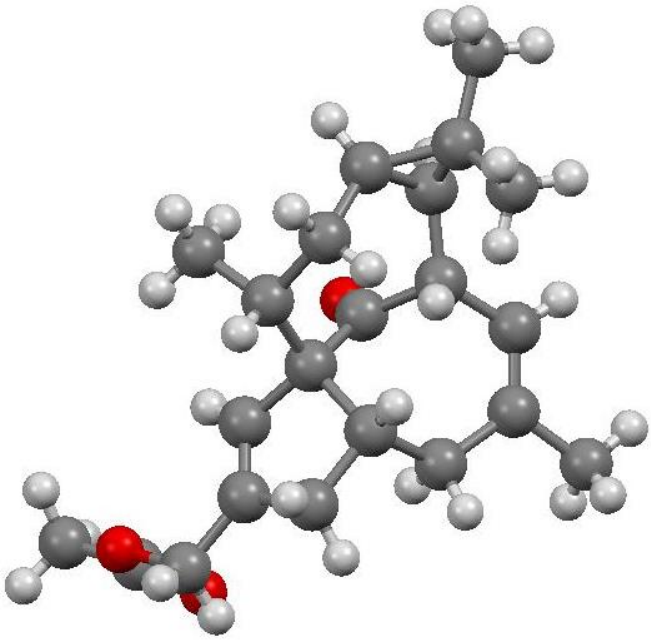


Table S3. Crystal data and structure refinement for **SI-4**.

Identification code	CCDC #1415412	
Empirical formula	C22 H30 O3	
Formula weight	342.46	
Temperature	273(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	P 21	
Unit cell dimensions	a = 6.6579(4) Å	□= 90°.
	b = 8.2473(5) Å	□= 90.413(3)°.
	c = 17.4458(10) Å	□ = 90°.
Volume	957.92(10) $Å^3$	
Z	2	
Density (calculated)	1.187 Mg/m^3	
Absorption coefficient	0.077 mm^{-1}	
F(000)	372	

Crystal size	0.330 x 0.300 x 0.250 mm^3
Theta range for data collection	2.335 to 26.374°.
Index ranges	-8<=h<=8, -10<=k<=10, -21<=l<=21
Reflections collected	16246
Independent reflections	3911 [R(int) = 0.0515]
Completeness to theta = 25.000°	99.9 %
Absorption correction	Multi-scan
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	3911 / 1 / 231
Goodness-of-fit on F^2	1.052
Final R indices [I>2sigma(I)]	R1 = 0.0324, wR2 = 0.0810
R indices (all data)	R1 = 0.0335, wR2 = 0.0821
Absolute structure parameter	-0.2(4)
Extinction coefficient	n/a
Largest diff. peak and hole	0.238 and -0.153 e.$Å^{-3}$

Figure S2. X ray structure for **26**

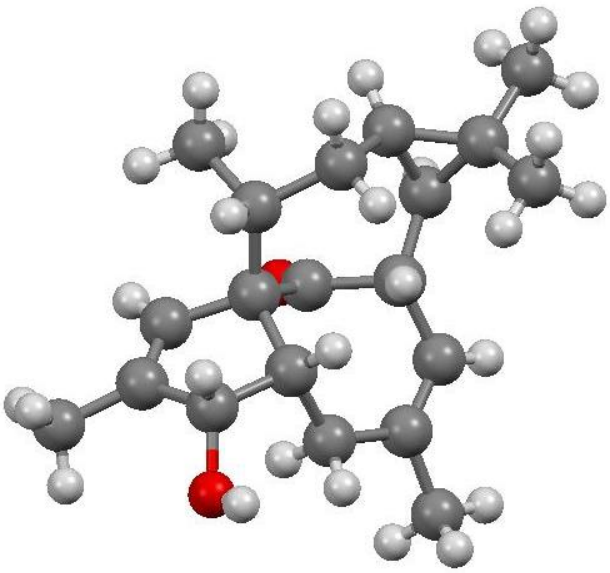


Table S4. Crystal data and structure refinement for **26**.

Identification code	CCDC #1415413	
Empirical formula	C20 H28 O2	
Formula weight	300.42	
Temperature	100(2) K	
Wavelength	1.54178 Å	
Crystal system	Orthorhombic	
Space group	P 21 21 21	
Unit cell dimensions	a = 10.1761(2) Å	□= 90°.
	b = 12.9916(3) Å	□= 90°.
	c = 12.9959(3) Å	□ = 90°.
Volume	1718.11(7) $Å^3$	
Z	4	
Density (calculated)	1.161 Mg/m^3	
Absorption coefficient	0.564 mm^{-1}	
F(000)	656	
Crystal size	0.400 x 0.350 x 0.320 mm^3	
Theta range for data collection	5.521 to 68.411°.	
Index ranges	-12<=h<=12, -12<=k<=15, -15<=l<=15	
Reflections collected	10817	
Independent reflections	3077 [R(int) = 0.0250]	
Completeness to theta = 66.000°	98.8 %	

Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.954 and 0.900
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	3077 / 0 / 208
Goodness-of-fit on F^2	0.996
Final R indices [I>2sigma(I)]	R1 = 0.0265, wR2 = 0.0660
R indices (all data)	R1 = 0.0266, wR2 = 0.0661
Absolute structure parameter	0.05(4) [abs stereochem confirmed]
Extinction coefficient	0.0040(13)
Largest diff. peak and hole	0.179 and -0.117 e.$Å^{-3}$

Figure S3. X ray structure for **23**

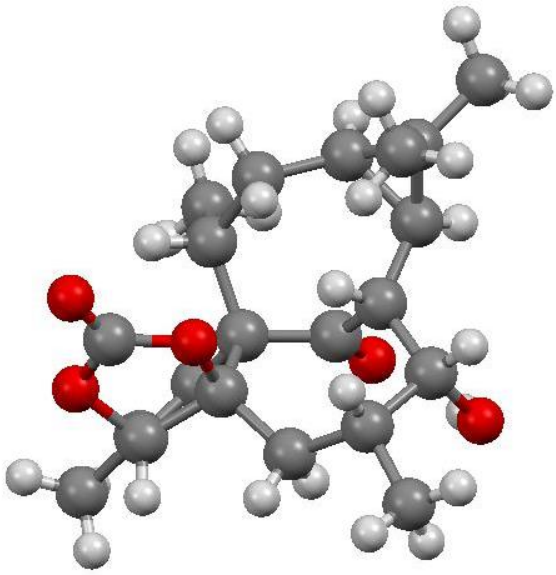


Table S5. Crystal data and structure refinement for **23**.

Identification code	CCDC #1415411	
Empirical formula	C21 H28 O5	
Formula weight	360.43	
Temperature	100(2) K	
Wavelength	1.54178 Å	
Crystal system	Monoclinic	
Space group	P 21	
Unit cell dimensions	a = 6.9165(3) Å	□= 90°.
	b = 8.7203(3) Å	□= 94.5150(10)°.
	c = 15.8818(6) Å	□ = 90°.
Volume	954.92(6) Å^3	
Z	2	
Density (calculated)	1.254 Mg/m^3	
Absorption coefficient	0.718 mm^{-1}	
F(000)	388	
Crystal size	0.330 x 0.300 x 0.230 mm^3	
Theta range for data collection	2.791 to 68.331°.	
Index ranges	-8<=h<=8, -10<=k<=10, -18<=l<=19	

Reflections collected	12279
Independent reflections	3434 [R(int) = 0.0238]
Completeness to theta = 66.500°	99.7 %
Absorption correction	Multi-scan
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	3434 / 1 / 243
Goodness-of-fit on F^2	1.067
Final R indices [I>2sigma(I)]	R1 = 0.0296, wR2 = 0.0803
R indices (all data)	R1 = 0.0297, wR2 = 0.0804
Absolute structure parameter	0.06(4)
Extinction coefficient	n/a
Largest diff. peak and hole	0.188 and -0.163 e.$Å^{-3}$

Figure S4. X ray structure for **21**

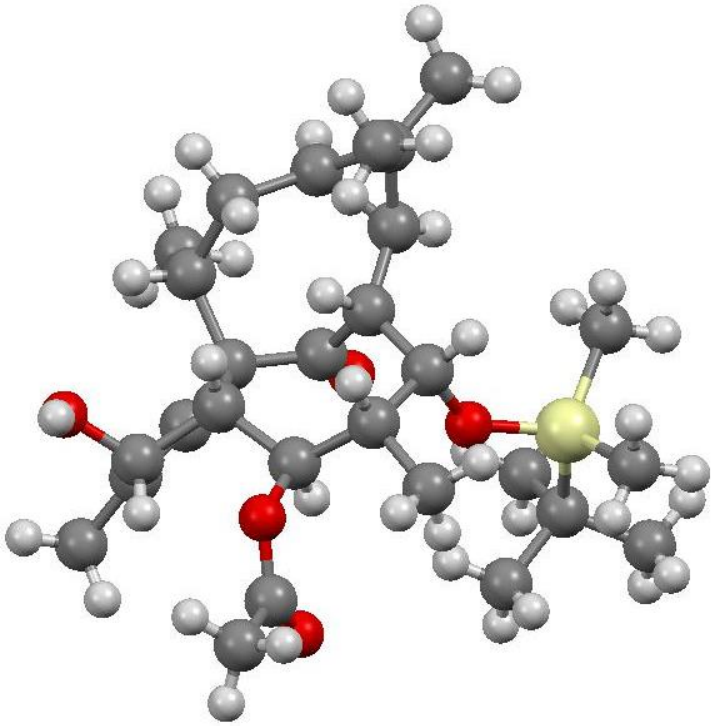


Table S6. Crystal data and structure refinement for **21**.

Report date	2015-03-04	
Identification code	CCDC #1415410	
Empirical formula	C28 H46 O5 Si	
Molecular formula	C28 H46 O5 Si	
Formula weight	490.74	
Temperature	100.0 K	
Wavelength	1.54178 Å	
Crystal system	Orthorhombic	
Space group	$P2_12_12_1$	
Unit cell dimensions	a = 10.0766(2) Å	□= 90°.
	b = 15.6158(4) Å	□= 90°.
	c = 18.4872(4) Å	□ = 90°.
Volume	2909.04(11) $Å^3$	
Z	4	
Density (calculated)	1.120 Mg/m^3	
Absorption coefficient	0.968 mm^{-1}	
F(000)	1072	

Crystal size	0.357 x 0.217 x 0.209 mm^3
Crystal color, habit	Colorless Block
Theta range for data collection	3.705 to 68.262°.
Index ranges	-11<=h<=12, -18<=k<=15, -22<=l<=22
Reflections collected	21090
Independent reflections	5254 [R(int) = 0.0397]
Completeness to theta = 68.000°	99.1 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.3200 and 0.2156
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	5254 / 0 / 319
Goodness-of-fit on F^2	1.026
Final R indices [I>2sigma(I)]	R1 = 0.0301, wR2 = 0.0784
R indices (all data)	R1 = 0.0307, wR2 = 0.0788
Absolute structure parameter	0.020(8)
Extinction coefficient	n/a
Largest diff. peak and hole	0.205 and -0.168 e.$Å^{-3}$

Figure S5. X ray structure for **4'**.

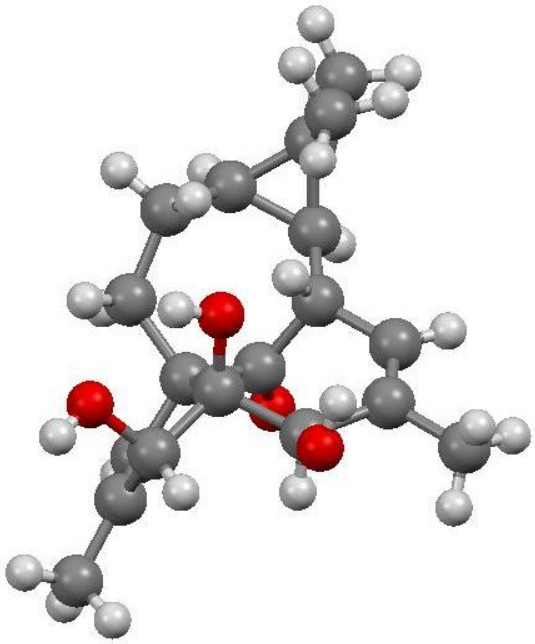


Table S7. Crystal data and structure refinement for **4'**.

Report date	2015-04-14	
Identification code	CCDC #1415409	
Empirical formula	C19 H26 O4	
Molecular formula	C19 H26 O4	
Formula weight	318.40	
Temperature	100.0 K	
Wavelength	1.54178 Å	
Crystal system	Monoclinic	
Space group	P 1 21 1	
Unit cell dimensions	a = 6.5753(4) Å	□= 90°.
	b = 8.2073(5) Å	□= 94.490(2)°.
	c = 15.4143(9) Å	□ = 90°.
Volume	829.29(9) $Å^3$	
Z	2	
Density (calculated)	1.275 Mg/m^3	
Absorption coefficient	0.709 mm^{-1}	
F(000)	344	

Crystal size	0.253 x 0.131 x 0.127 mm^3
Crystal color, habit	Colorless Block
Theta range for data collection	6.754 to 68.023°.
Index ranges	-7<=h<=7, -9<=k<=9, -18<=l<=18
Reflections collected	20860
Independent reflections	2889 [R(int) = 0.0391]
Completeness to theta = 68.000°	97.4 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.3197 and 0.2253
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	2889 / 1 / 215
Goodness-of-fit on F^2	1.065
Final R indices [I>2sigma(I)]	R1 = 0.0277, wR2 = 0.0705
R indices (all data)	R1 = 0.0278, wR2 = 0.0705
Absolute structure parameter	0.04(5)
Extinction coefficient	n/a
Largest diff. peak and hole	0.174 and -0.140 e.$Å^{-3}$

References

1. Jørgensen, L.; McKerrall, S. J.; Kuttruff, C. A.; Ungeheuer, F.; Felding J.; Baran, P. S. *Science* **2013**, *341*, 878–882.

2. Paquette, L. A.; Ross R. J.; Shi, Y. *J. Org. Chem.* **1990**, *55*, 1589–1598.

3. Liang, X.; Grue-Sørensen, G.; Petersen, A. K.; Högberg, T. *Synlett* **2012**, *23*, 2647–2652.

SUPPORTING INFORMATION

Part 2: NMR Spectrum

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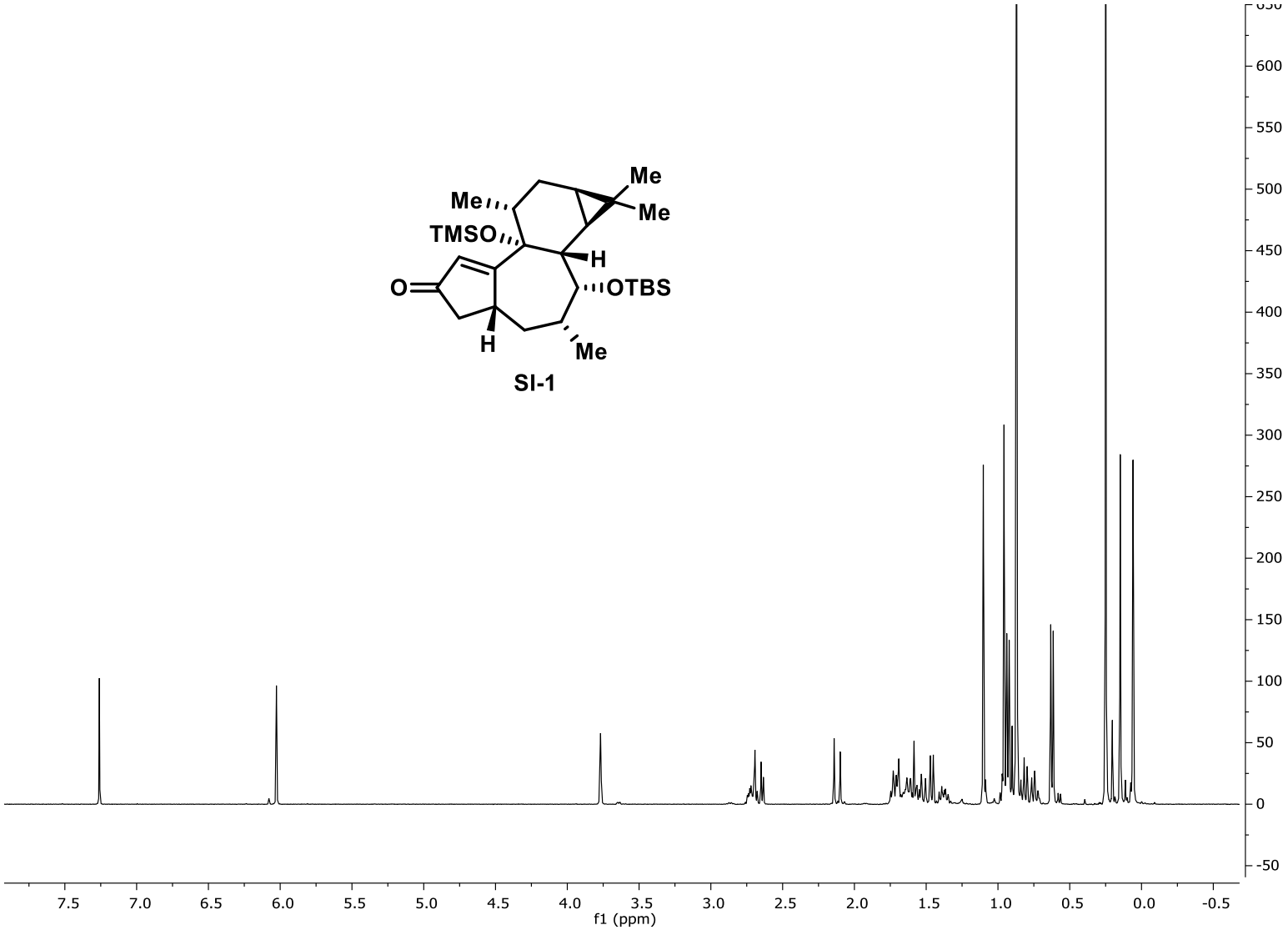
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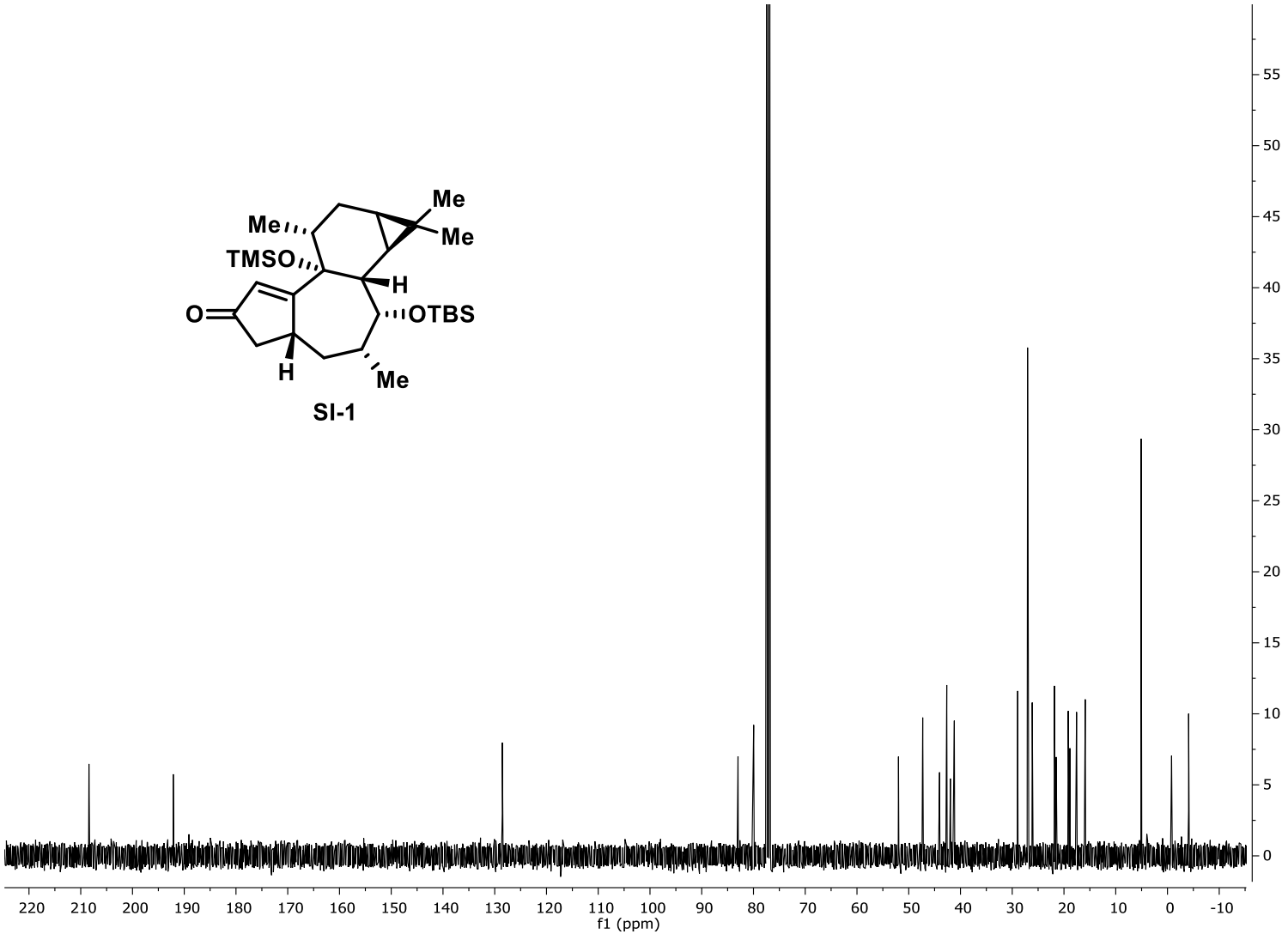
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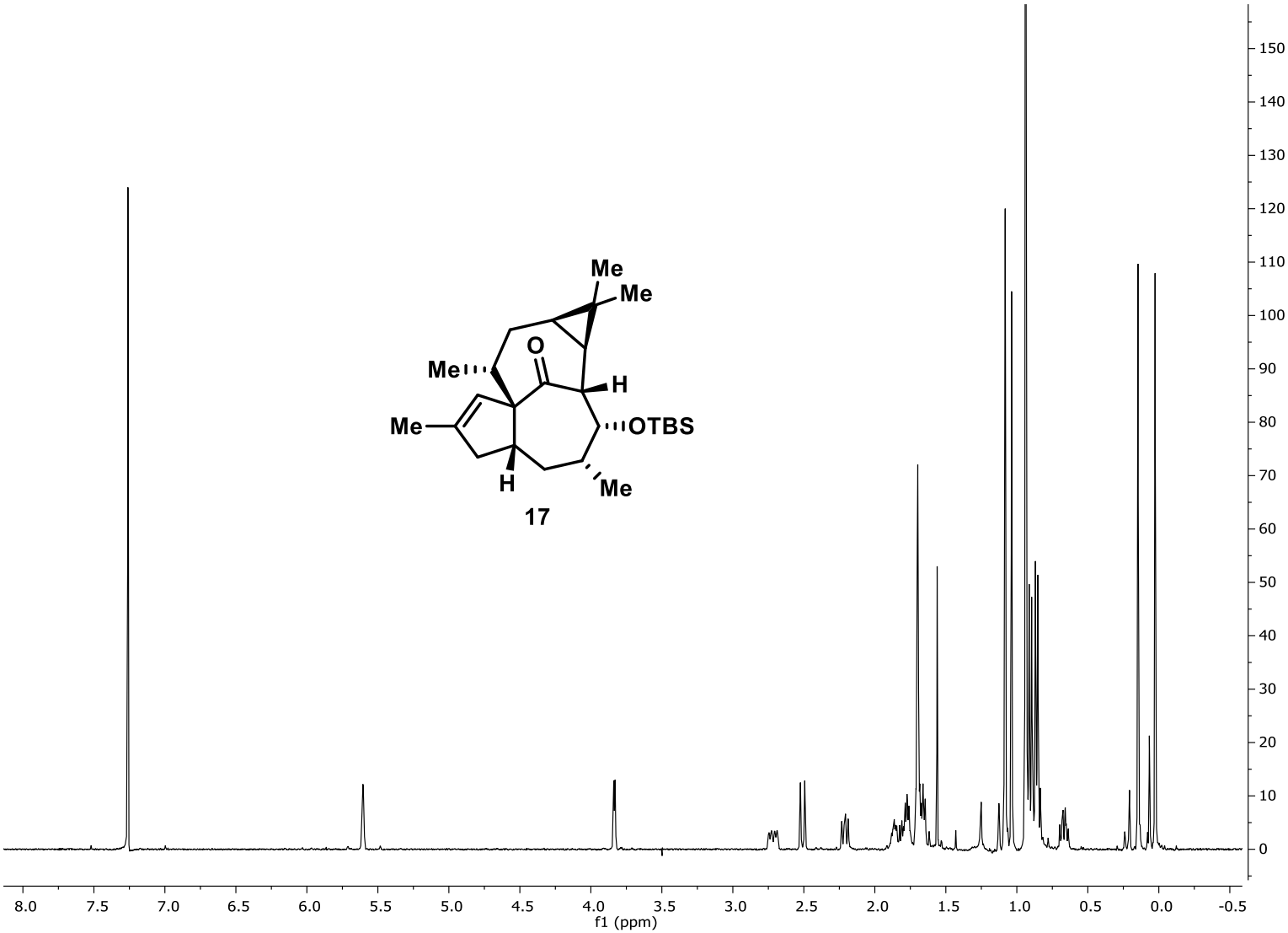
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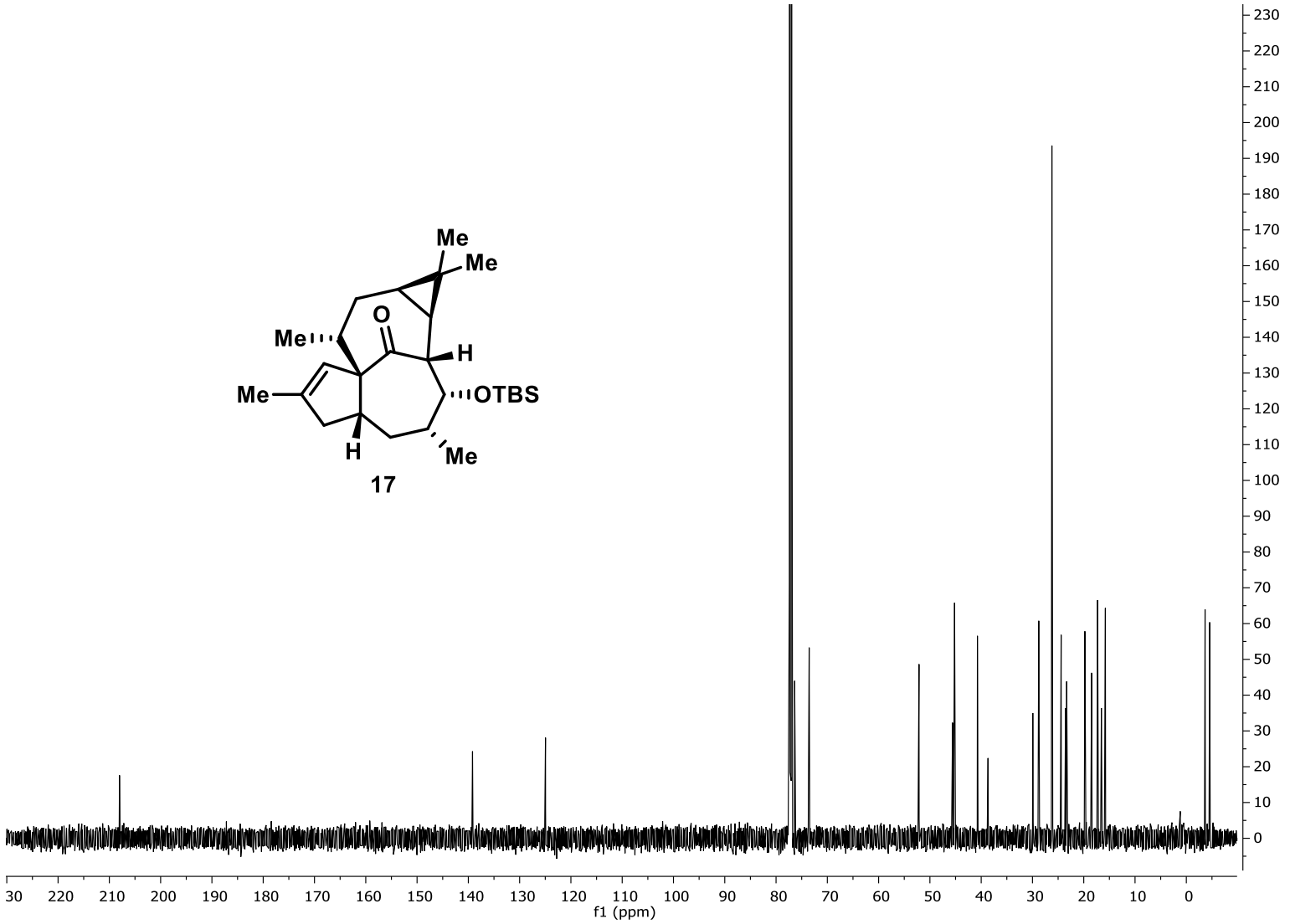
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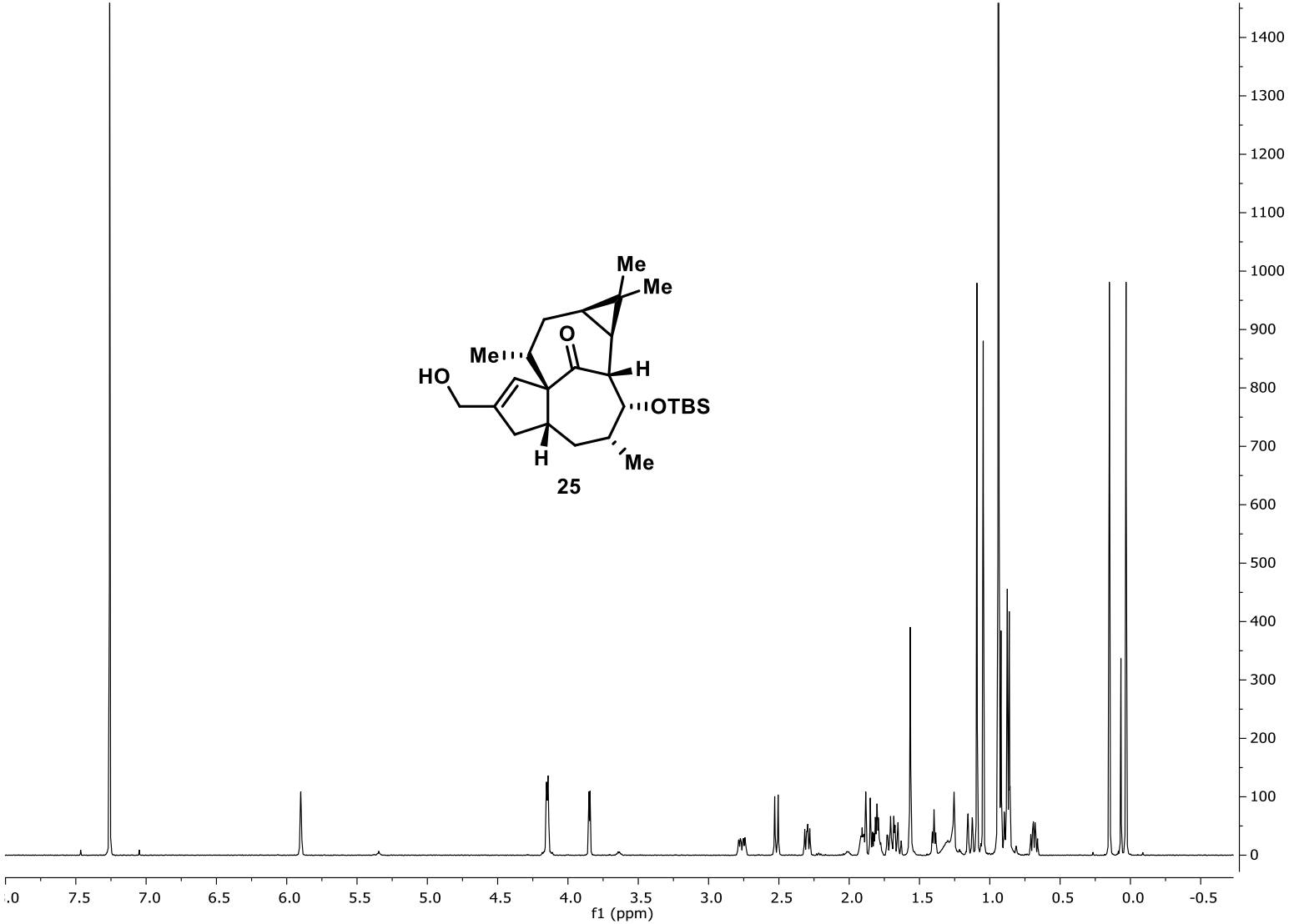
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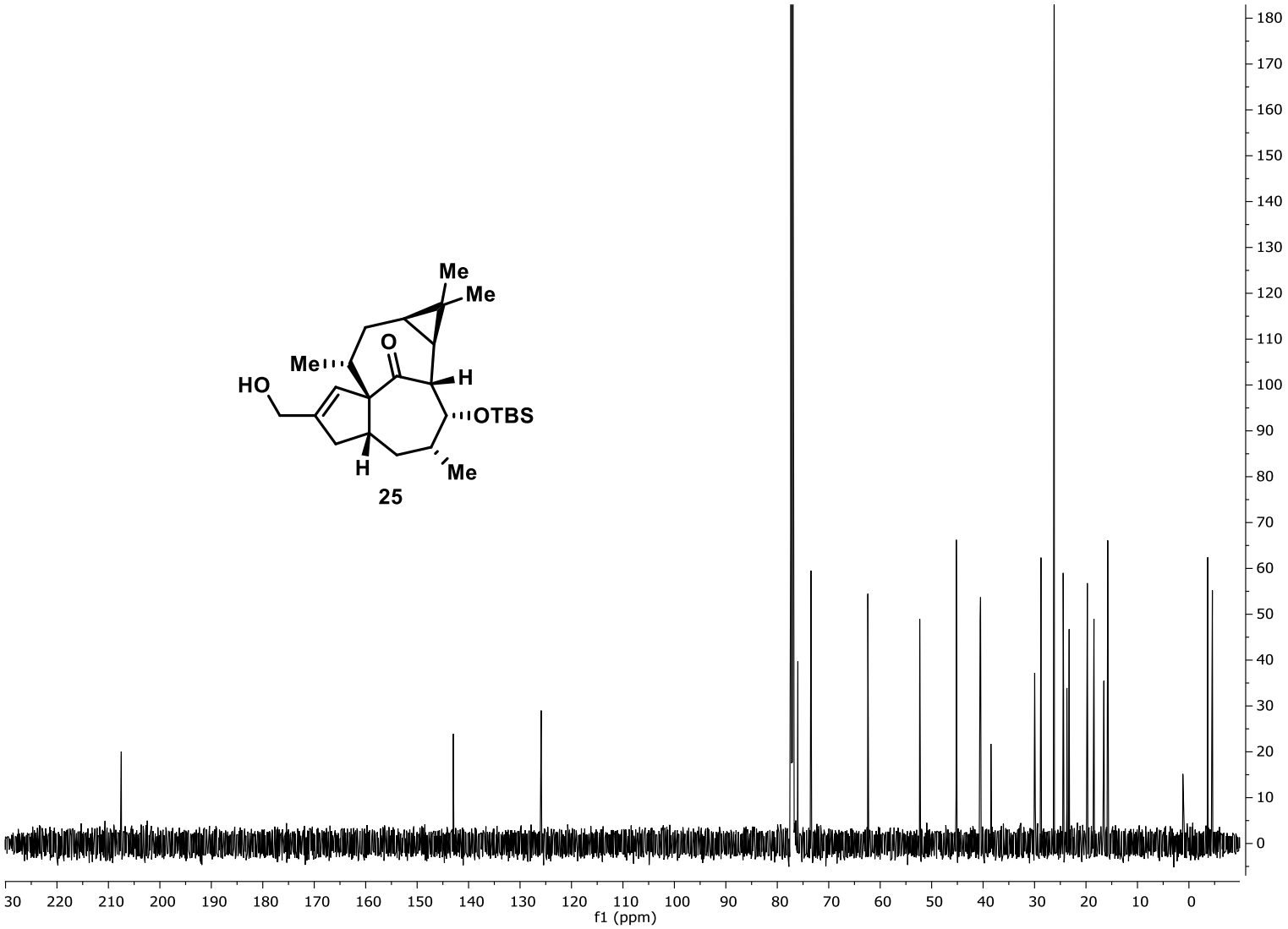
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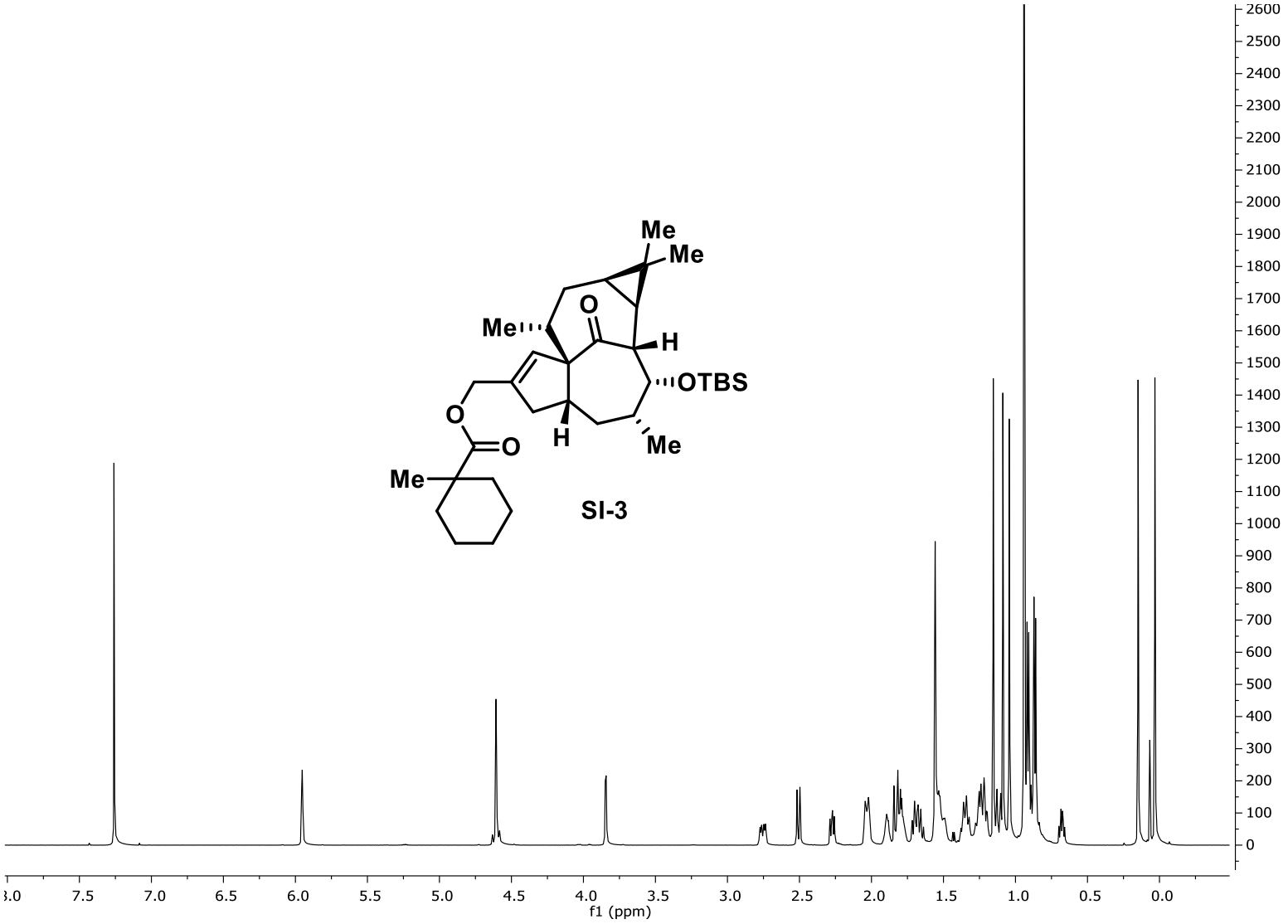
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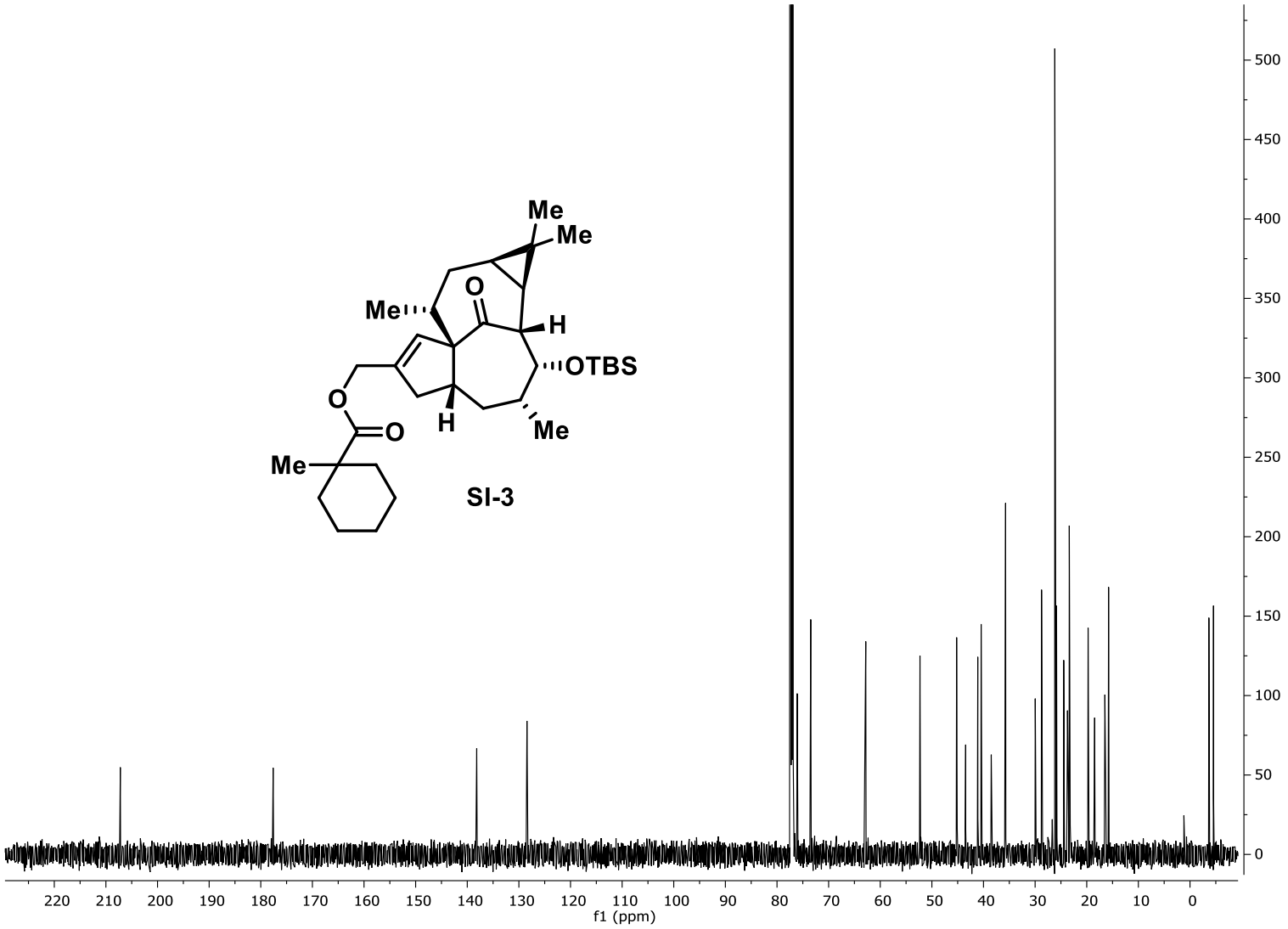
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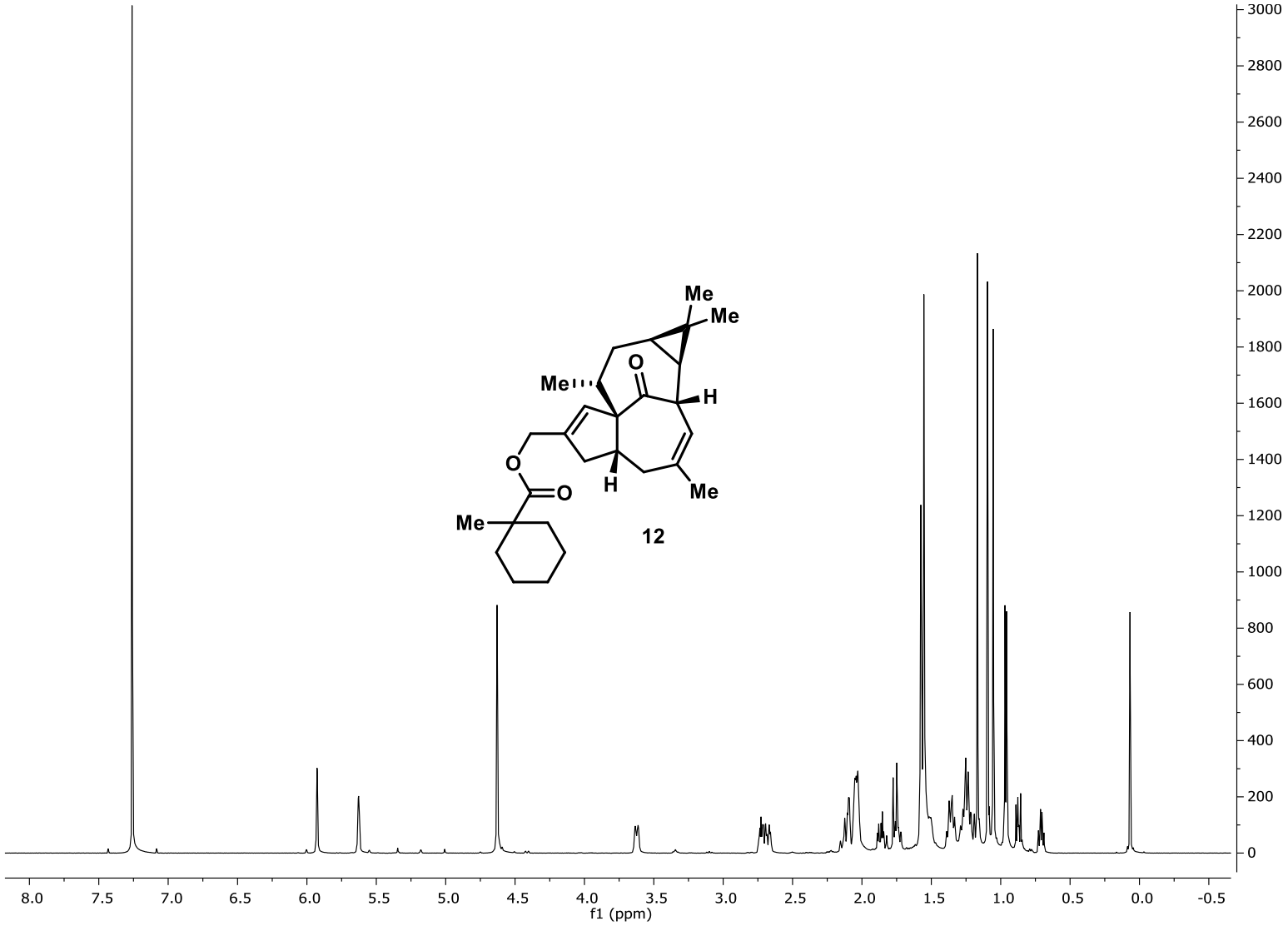
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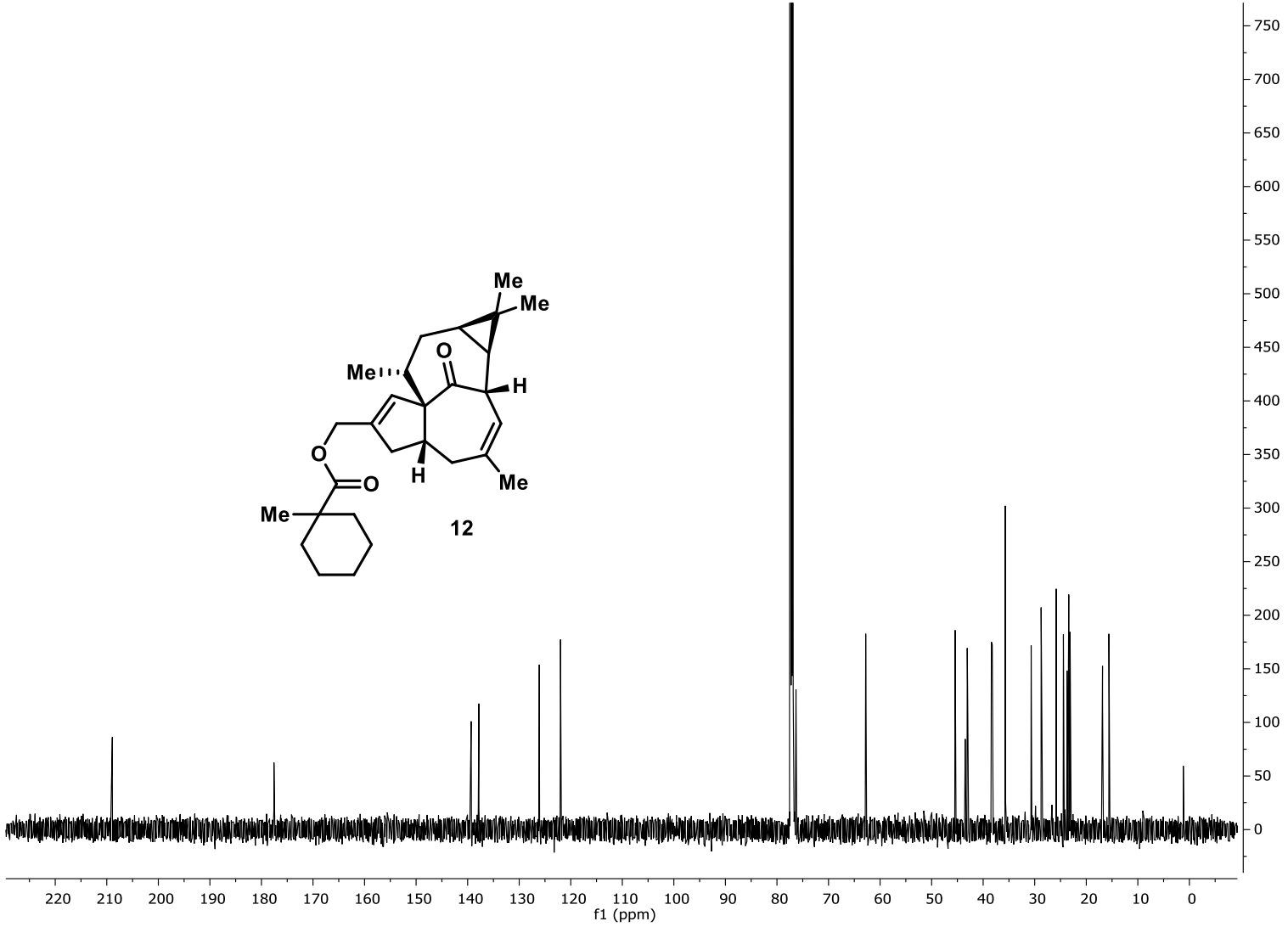
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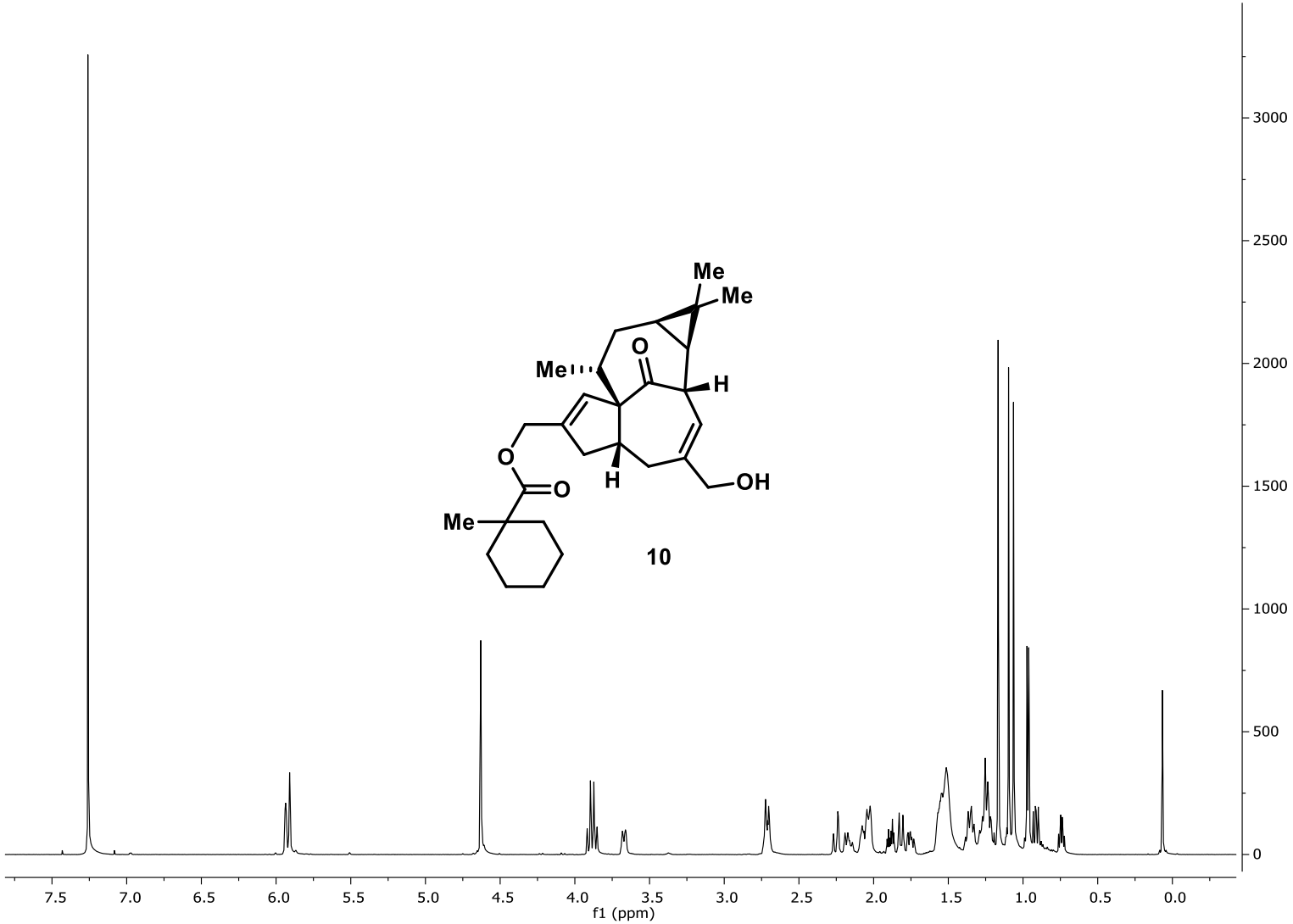
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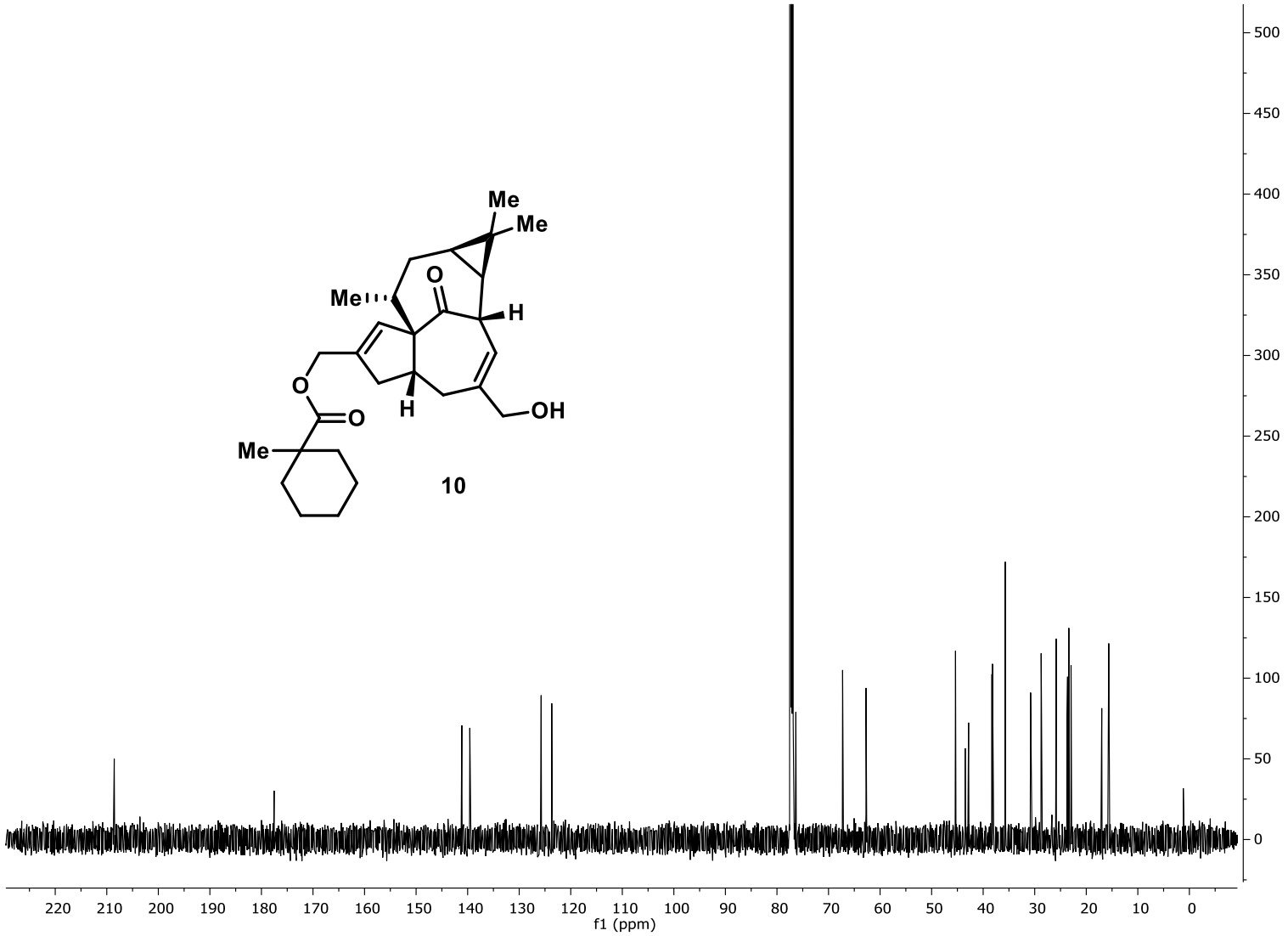
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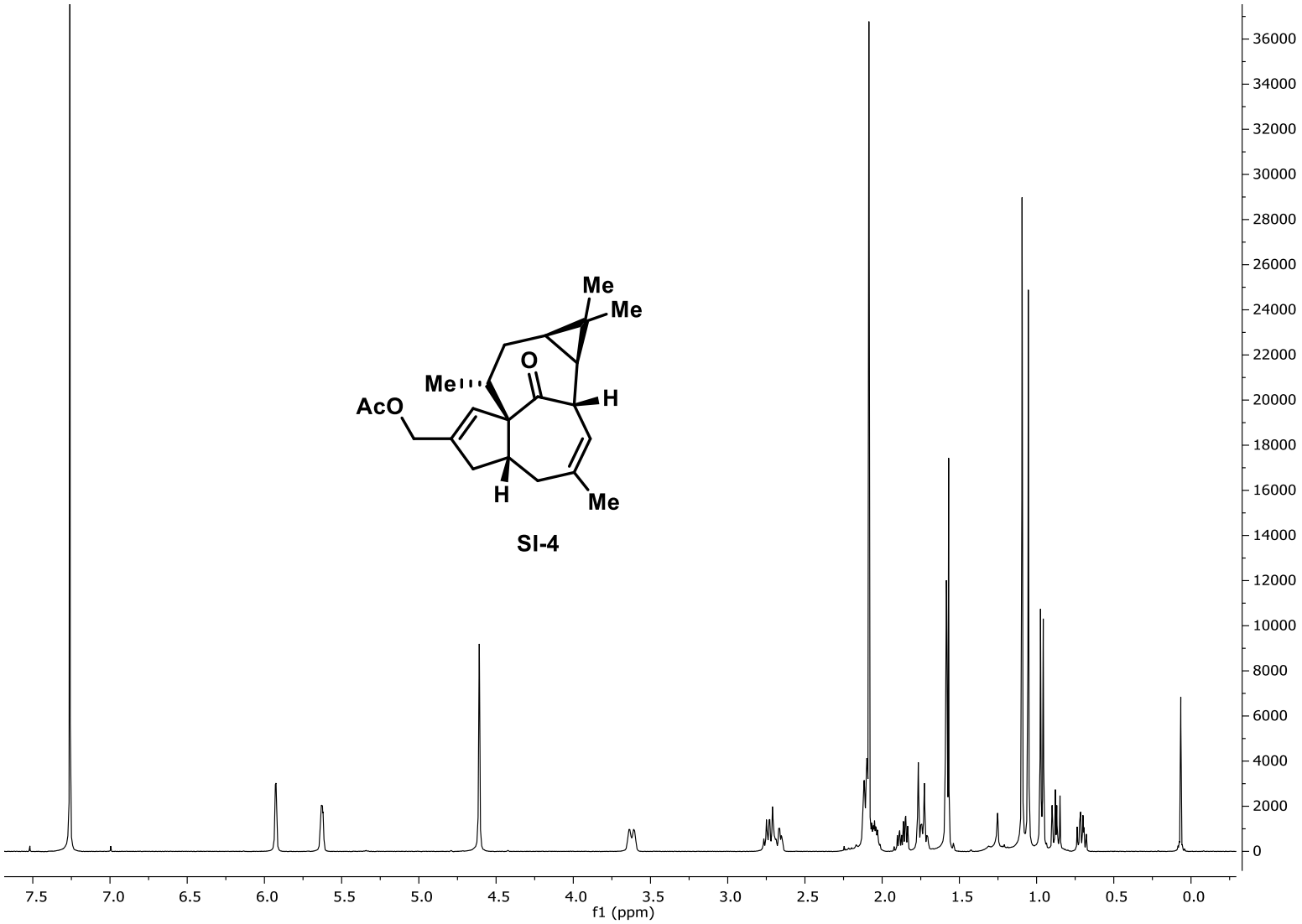
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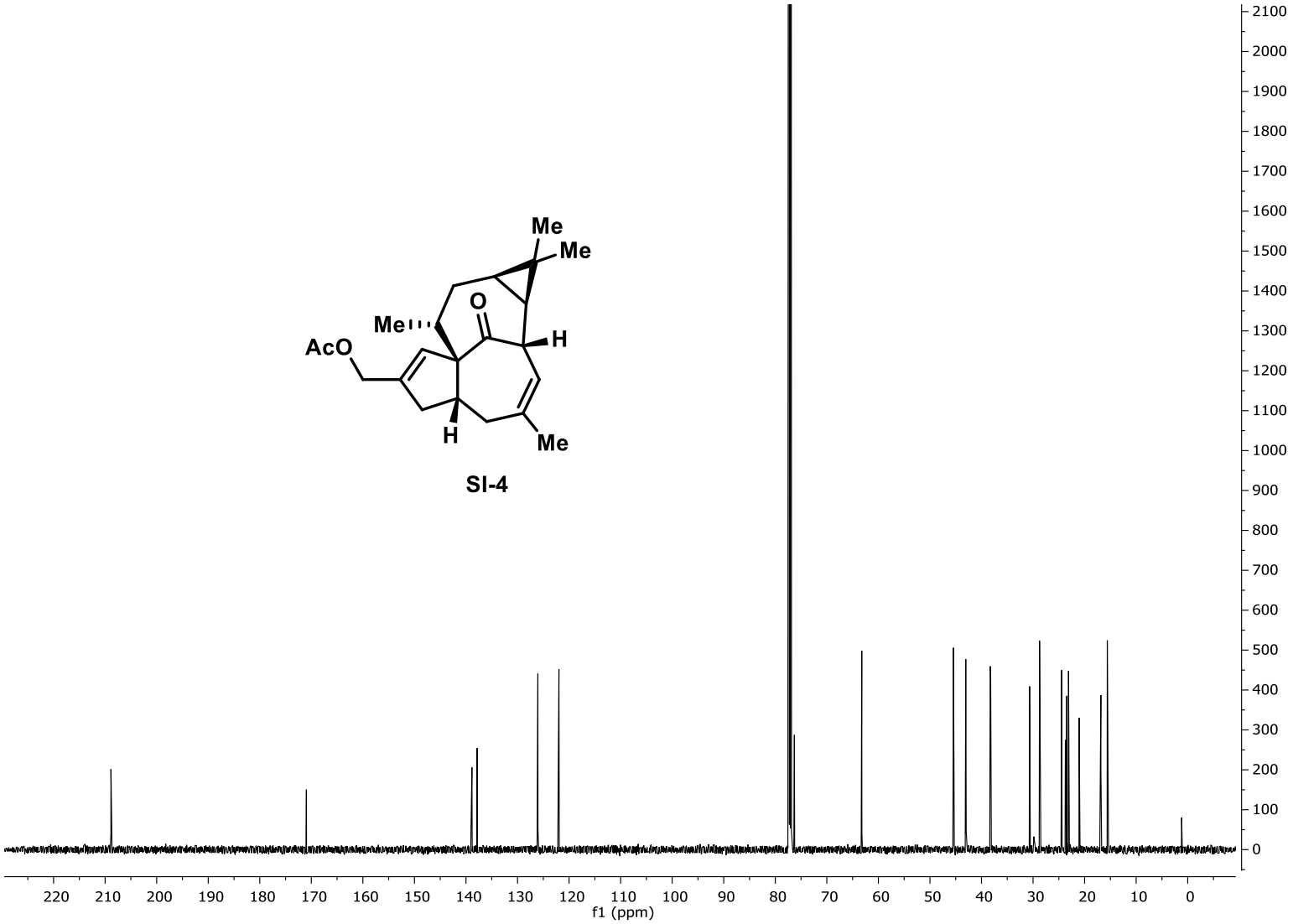
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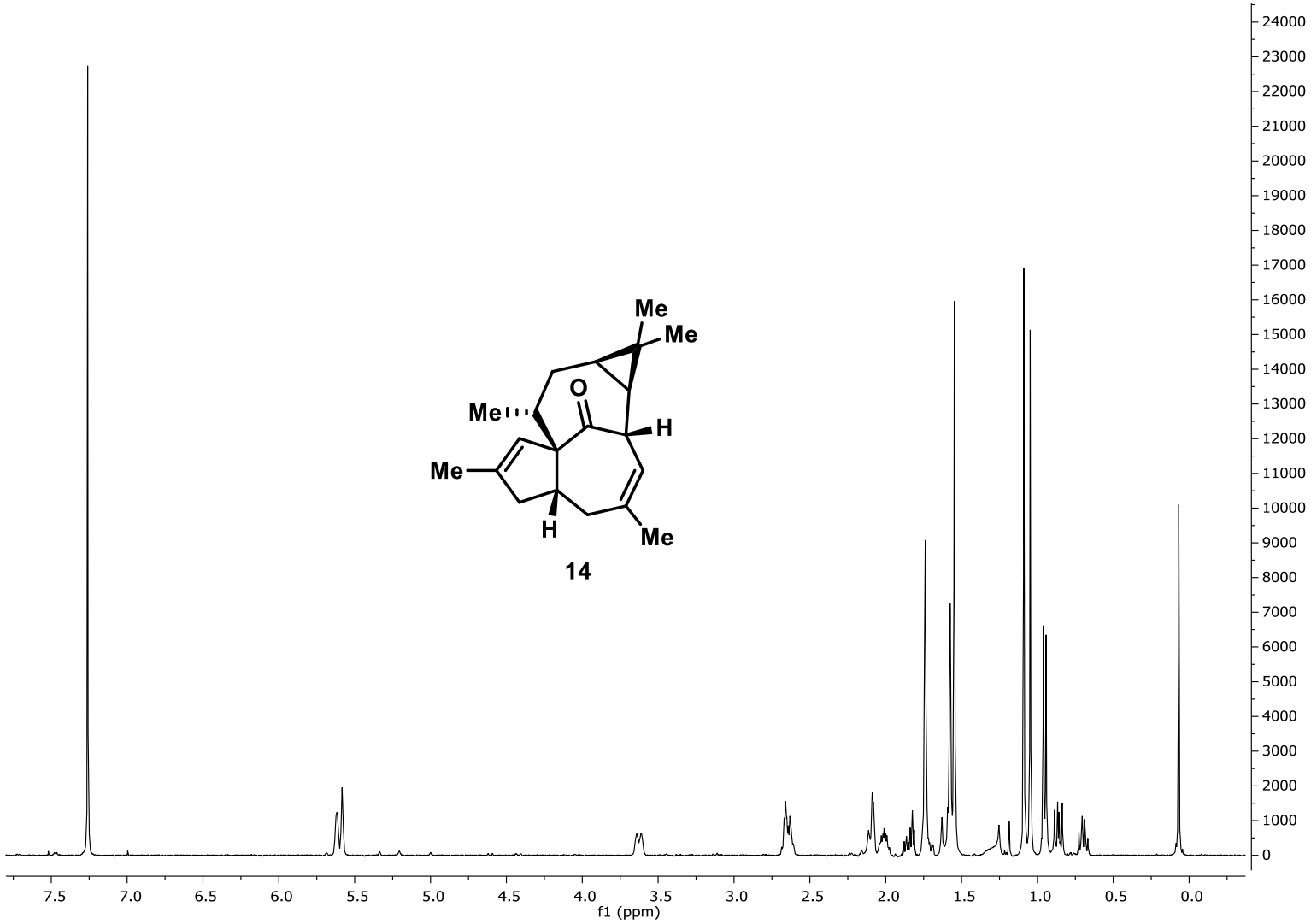
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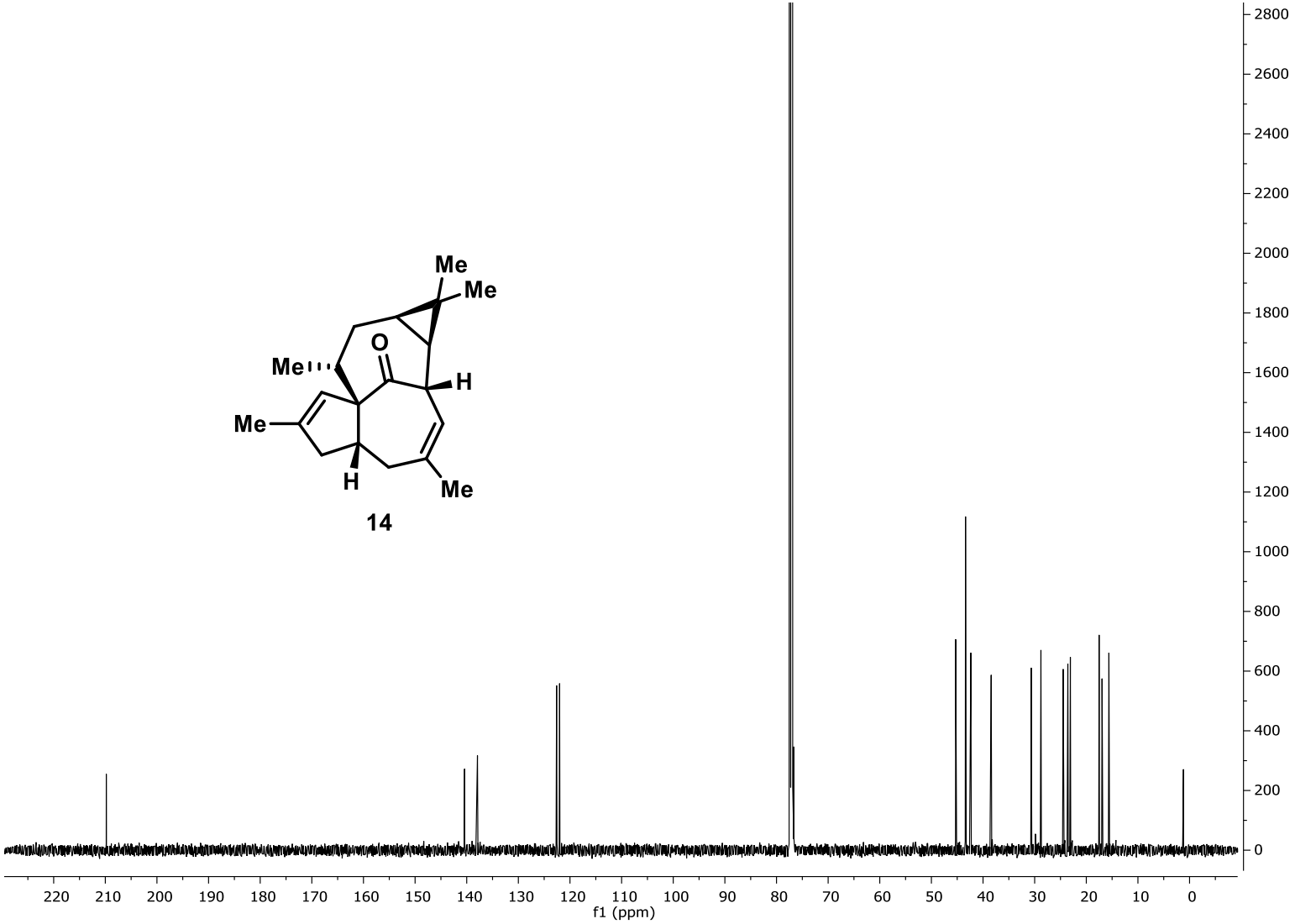
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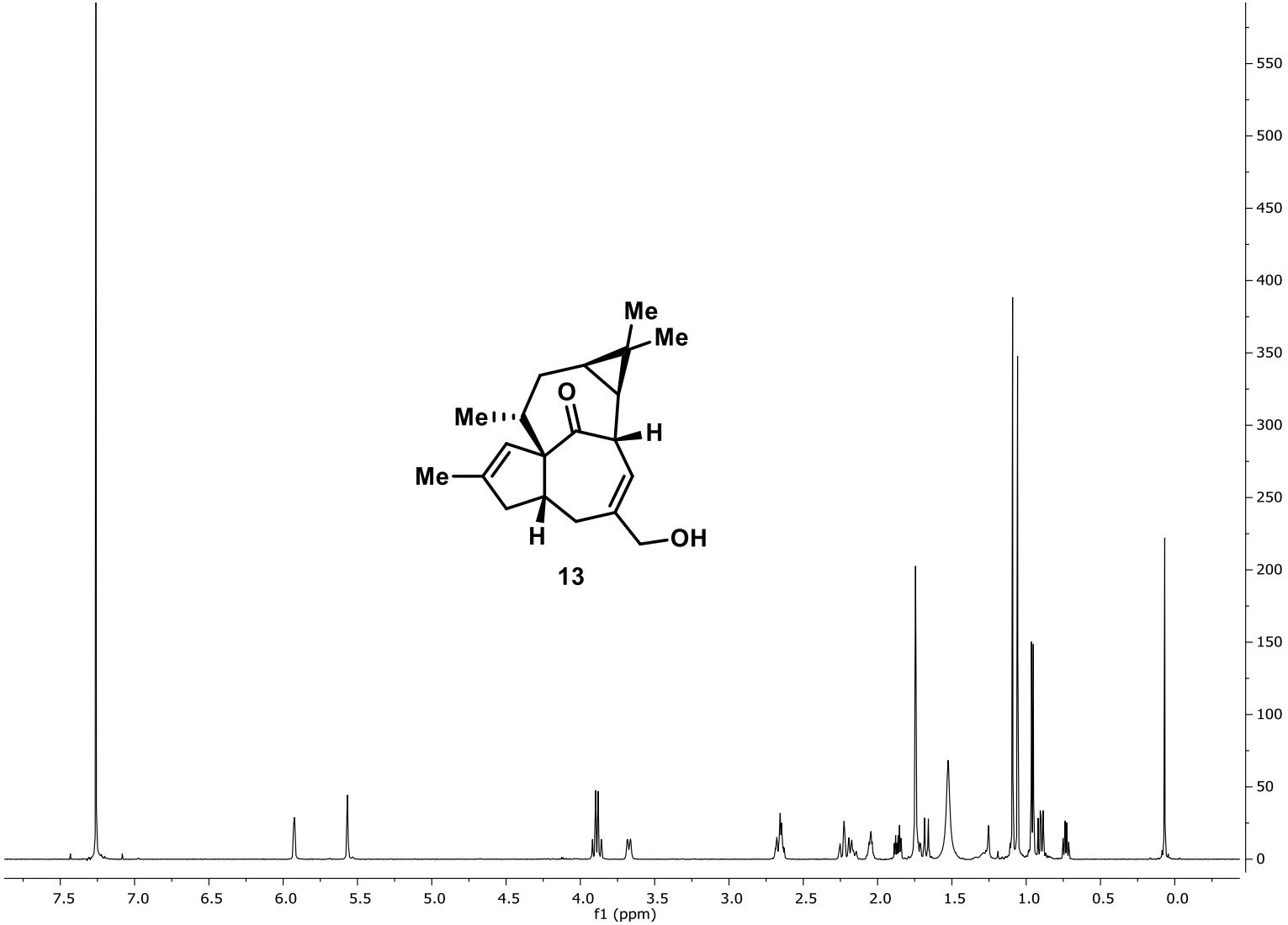
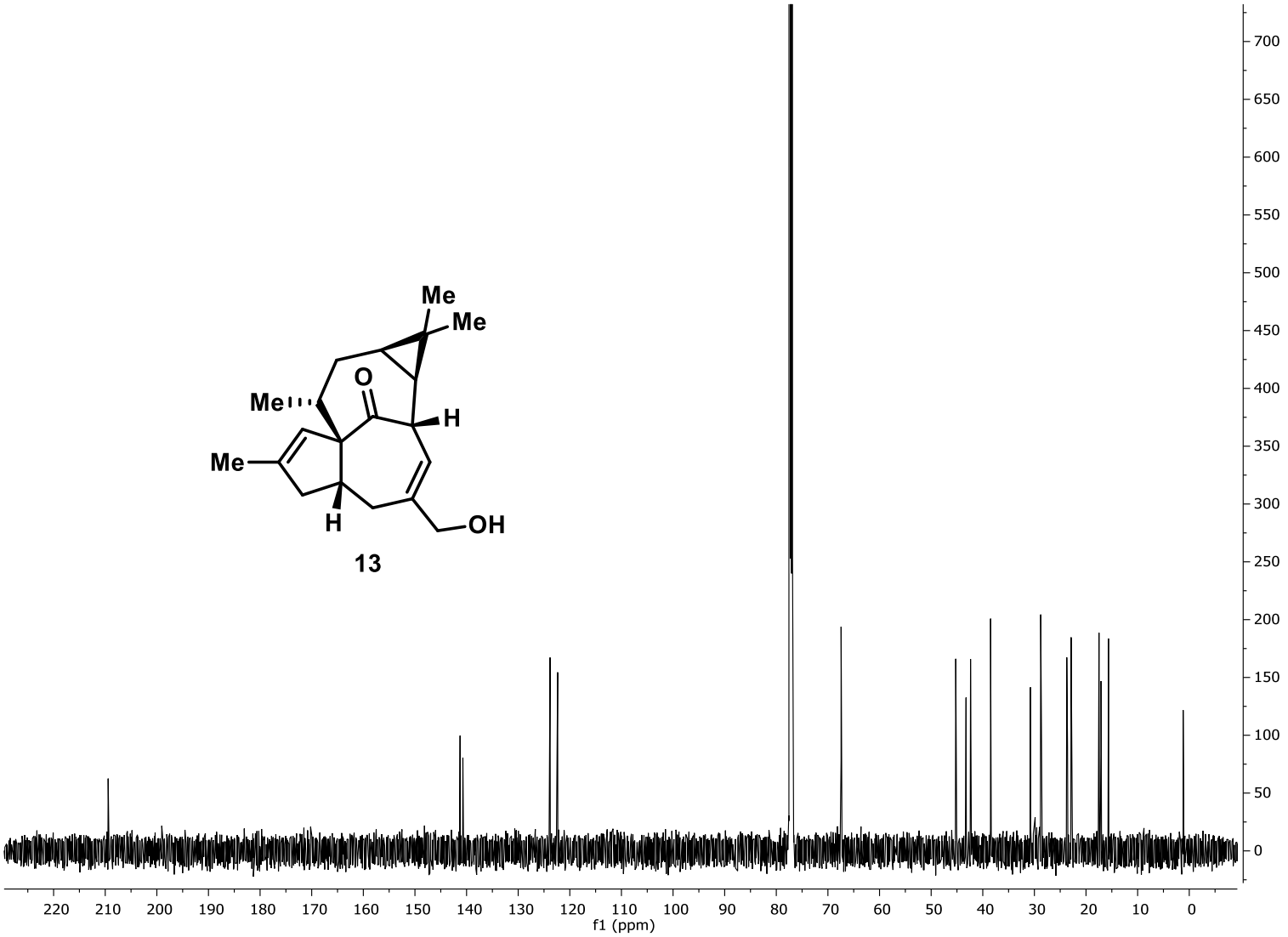
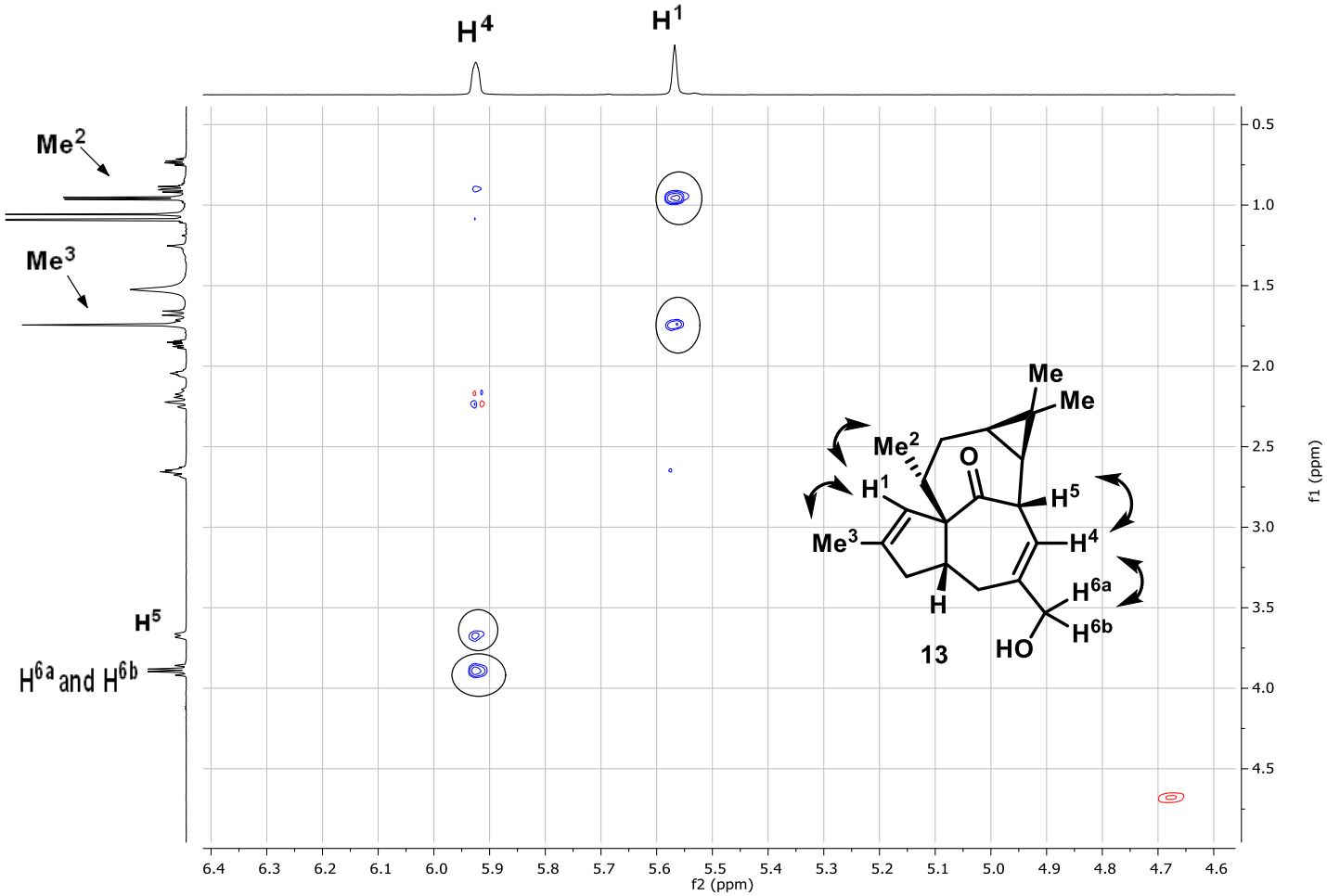
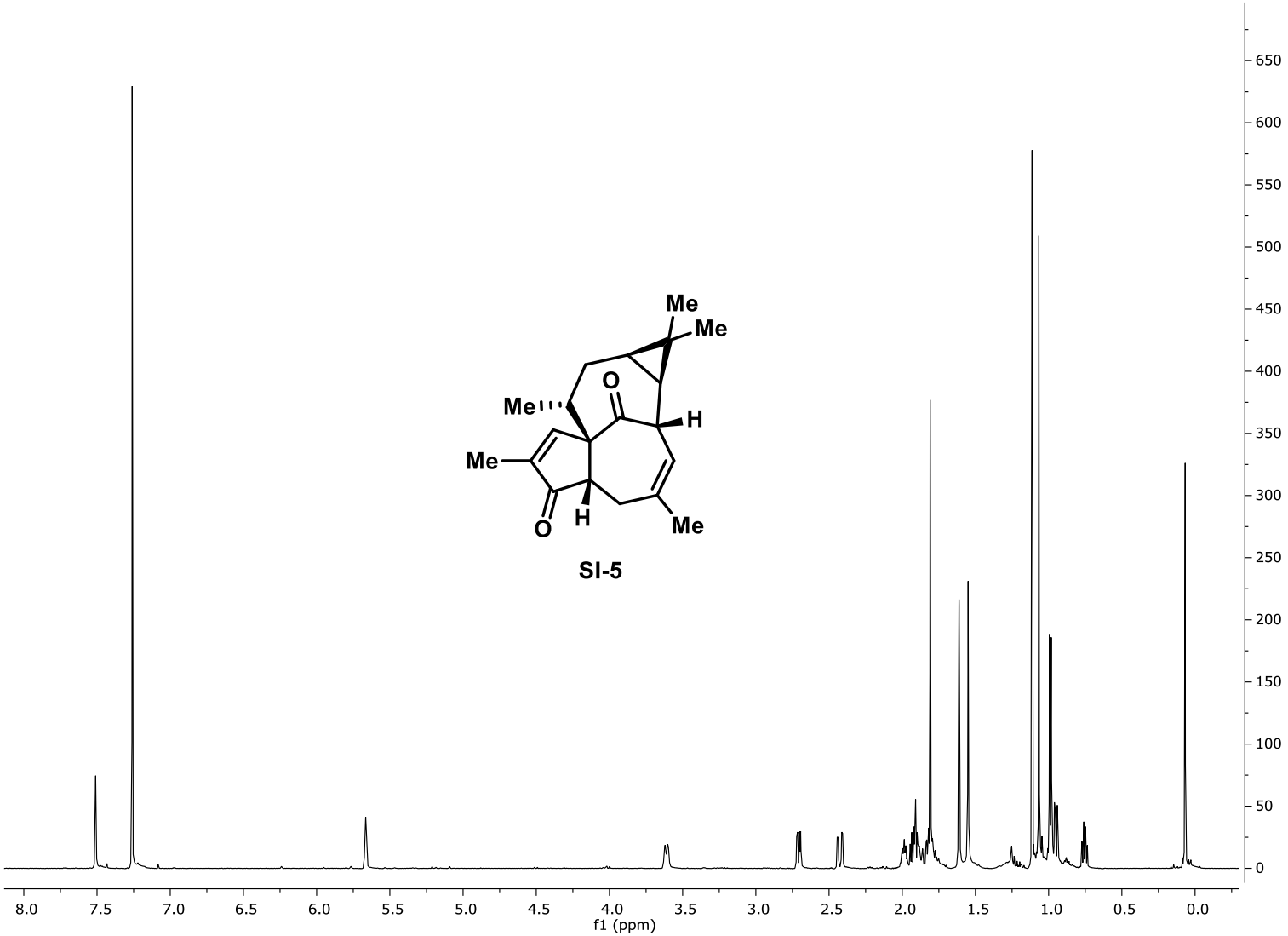
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

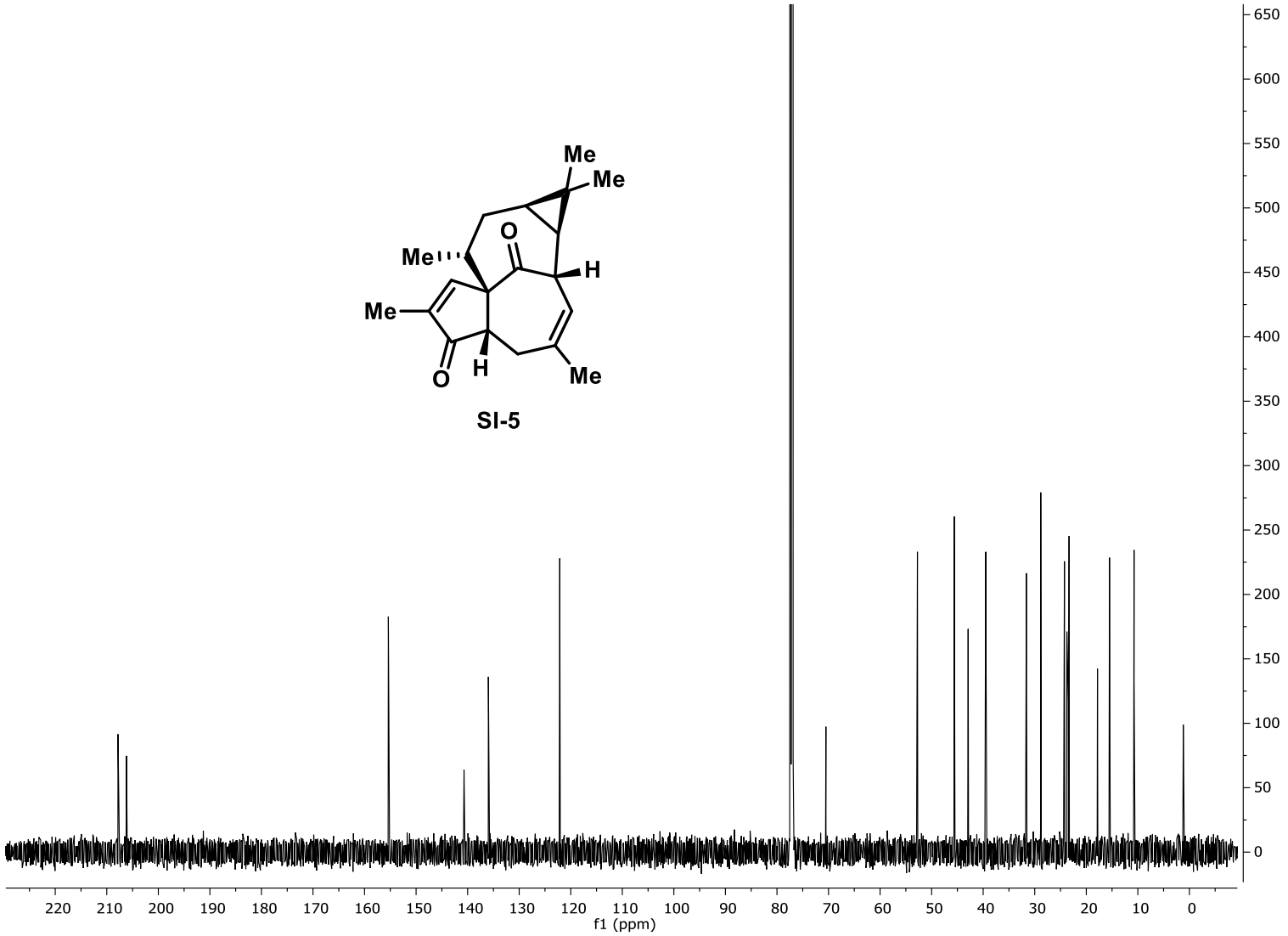

Me
Me
O
Me
H
Me
H
OH
13
550
500
450
400
350
300
250
200
150
100
50
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

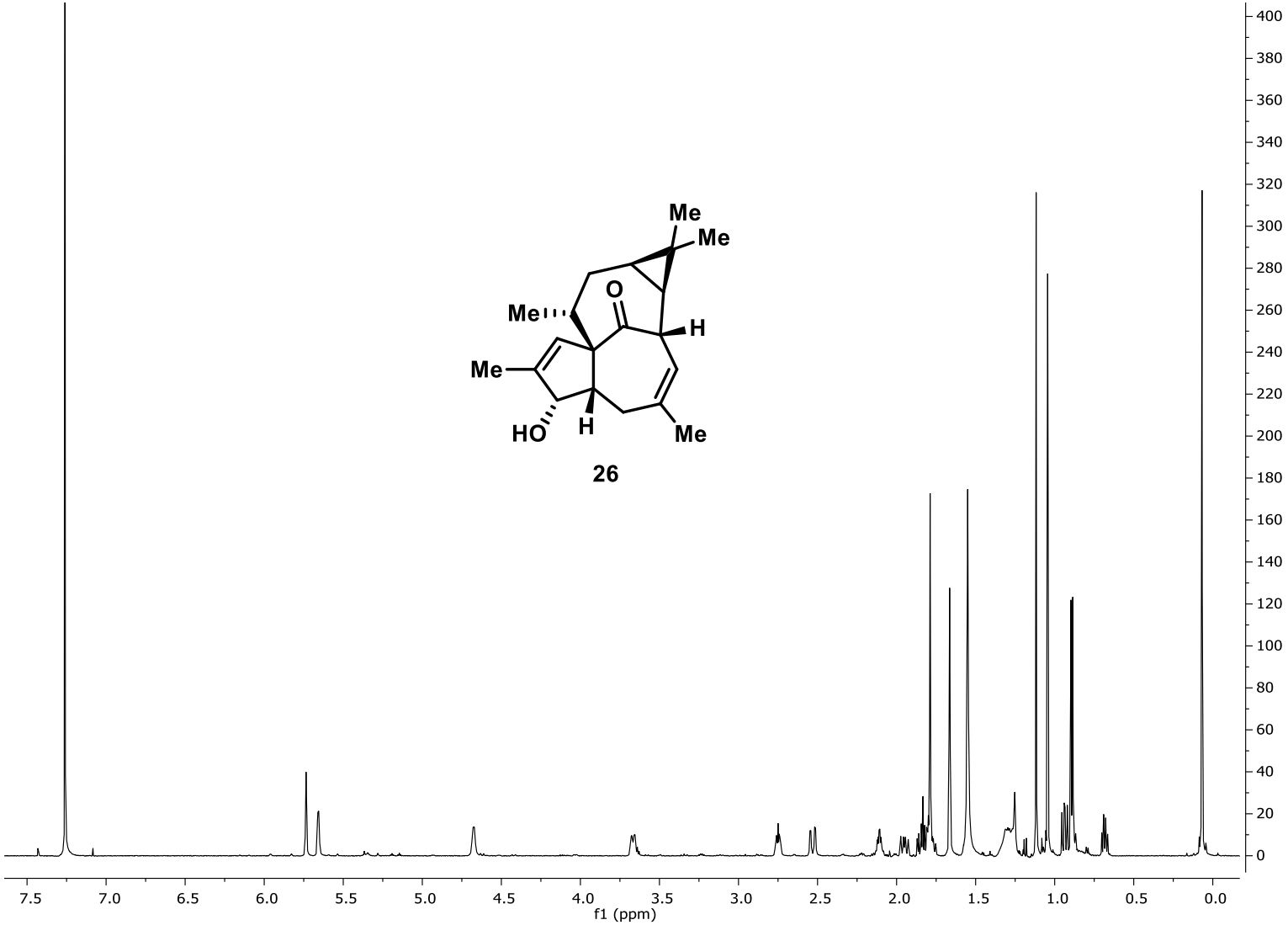

Me
Me
O
Me
H
Me
H
OH
13
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

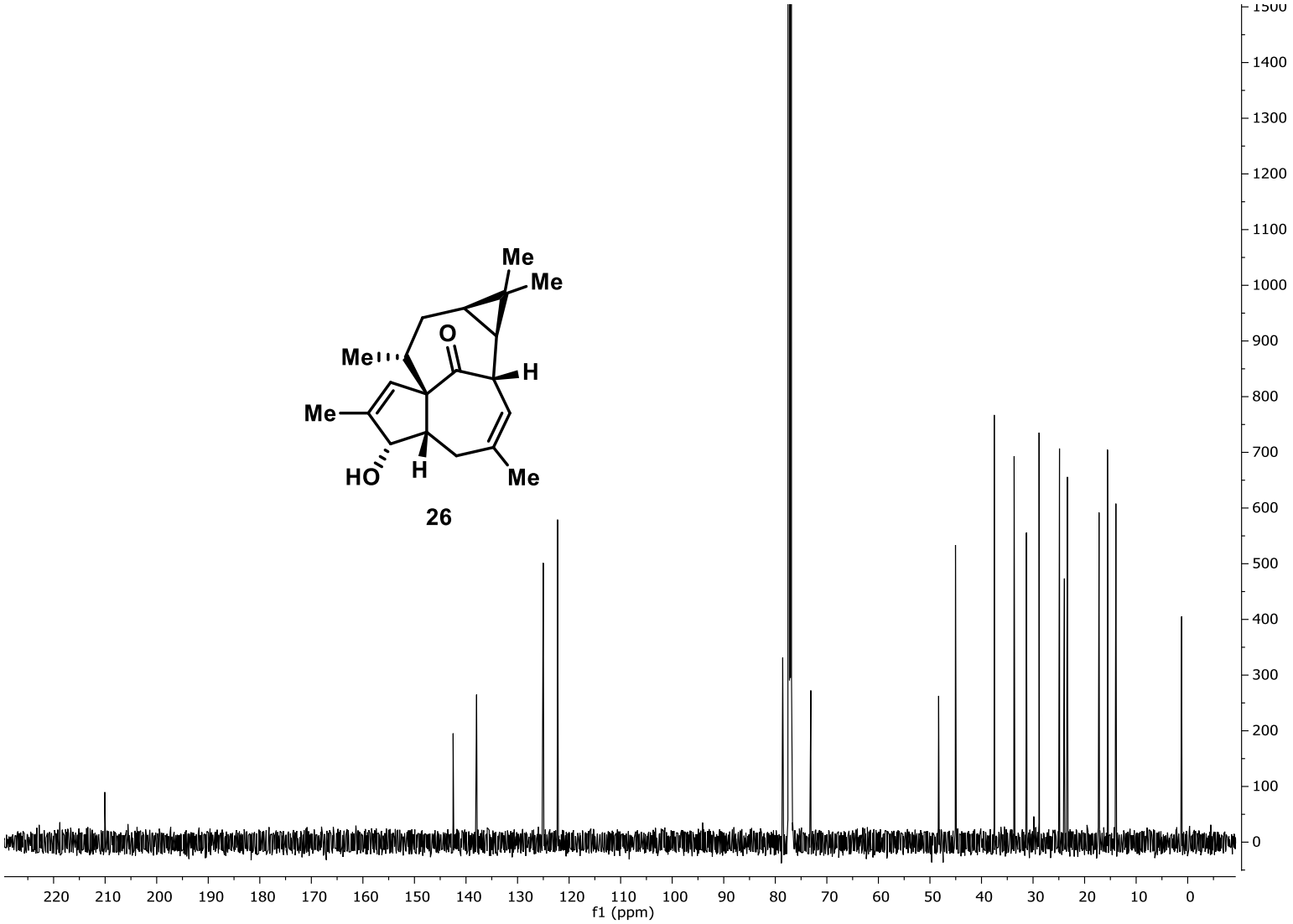
2D NOESY

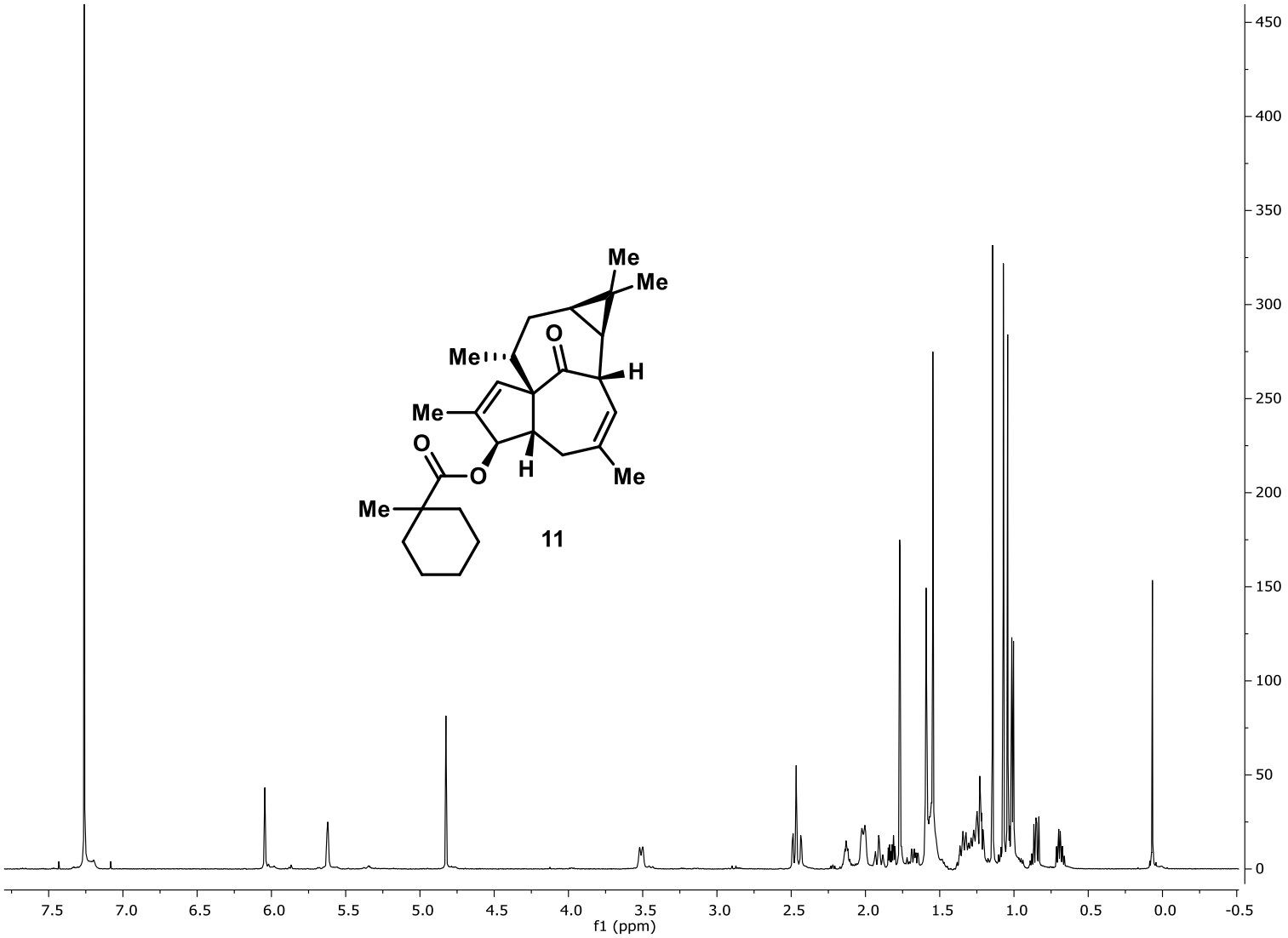

H4
H1
Me2
Me3
H5
H6a and H6b
Me
Me
Me2
O
H1
H5
Me3
H4
H6a
H
H6b
HO
13
f2 (ppm)
f1 (ppm)

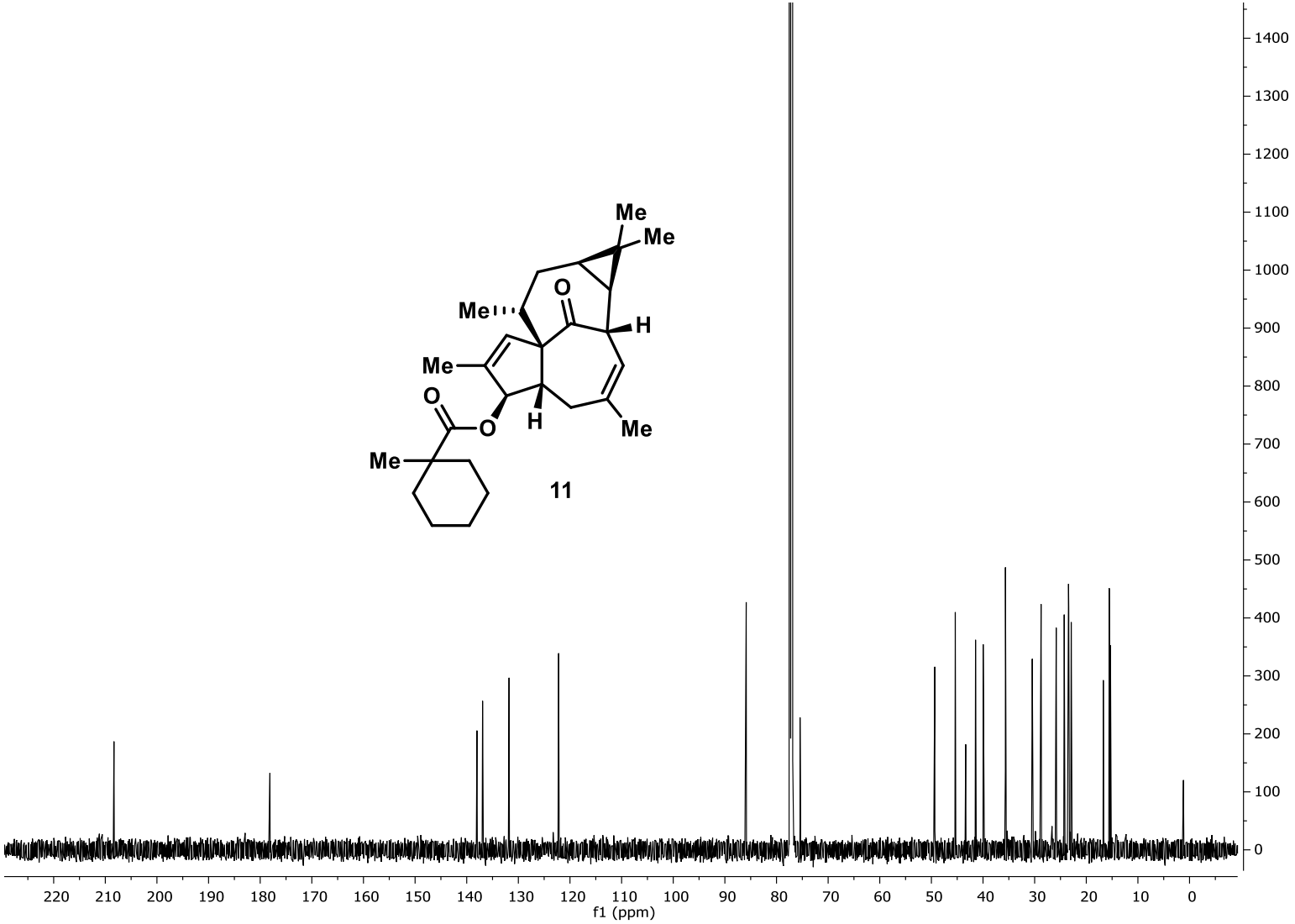

Me
Me
O
Me
H
Me
O
H
Me
SI-5
650
600
550
500
450
400
350
300
250
200
150
100
50
0
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

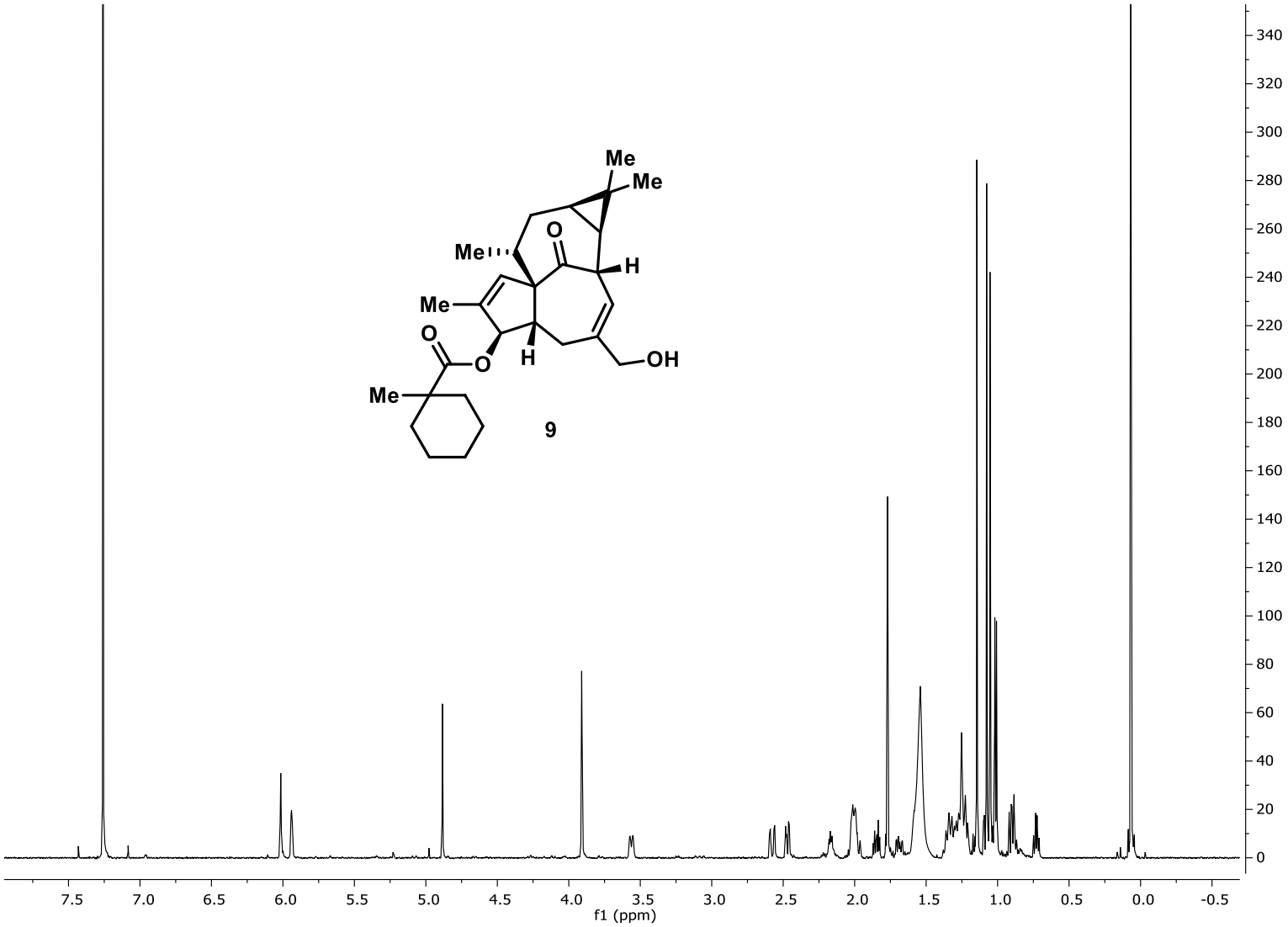

Me
Me
Me
O
H
Me
O
H
Me
SI-5
650
600
550
500
450
400
350
300
250
200
150
100
50
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

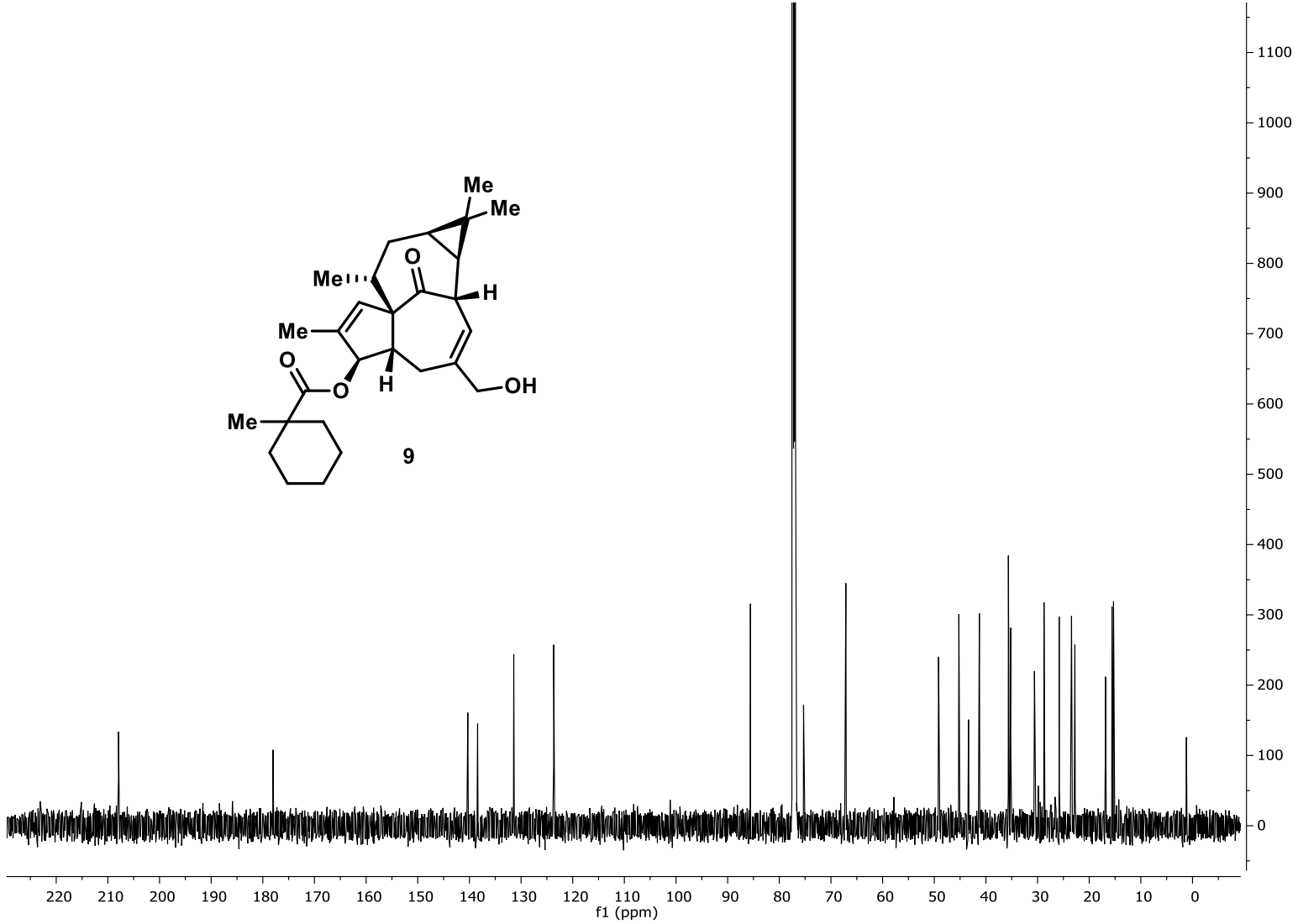

Me
Me
O
Me
H
Me
HO
H
Me
26
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


Me
Me
O
Me
H
Me
HO
H
Me
26
f1 (ppm)

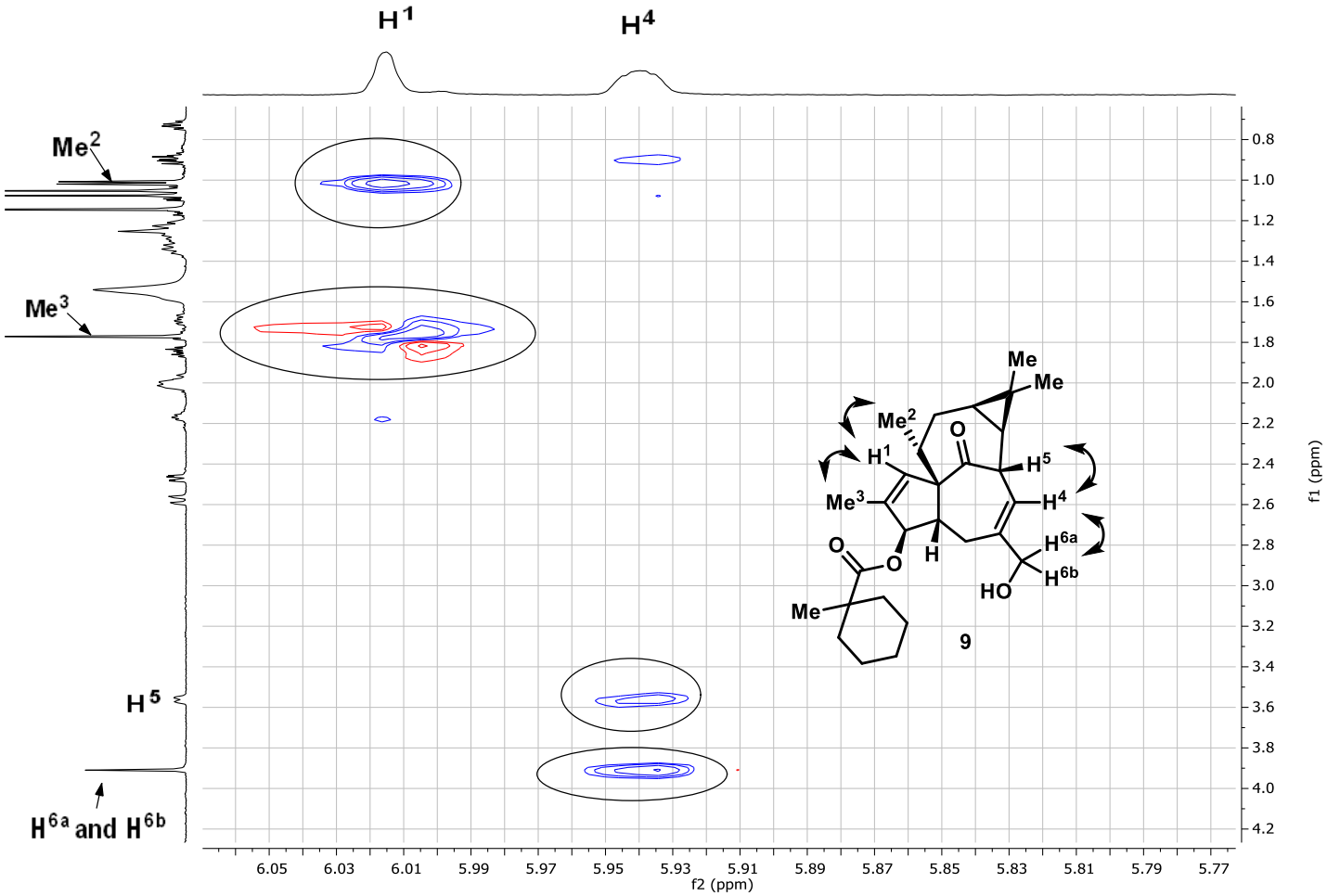

Me
Me
O
Me
H
Me
O
O
H
Me
Me
11
450
400
350
300
250
200
150
100
50
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

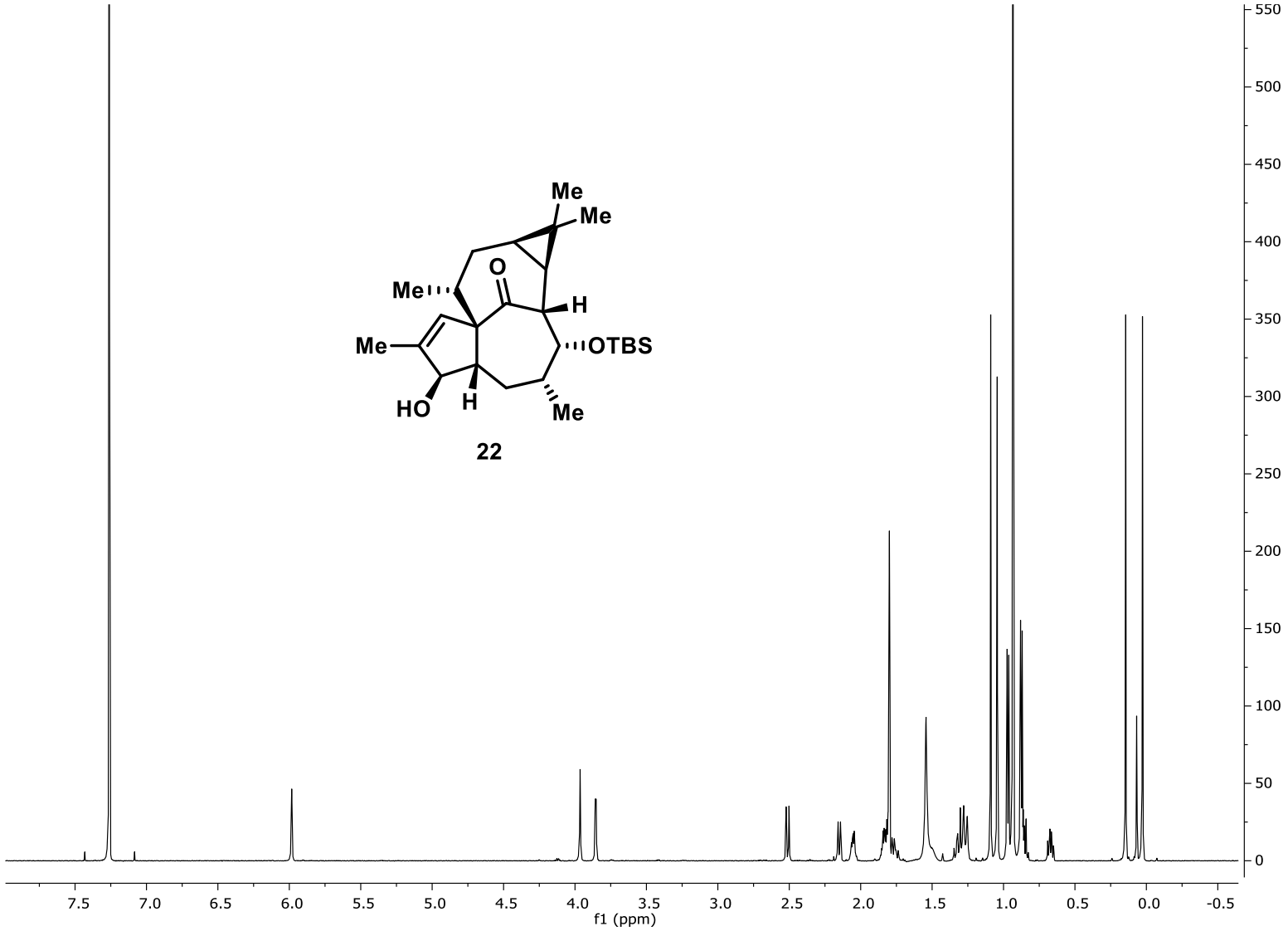

Me
Me
O
Me
H
Me
O
O
H
Me
Me
11
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

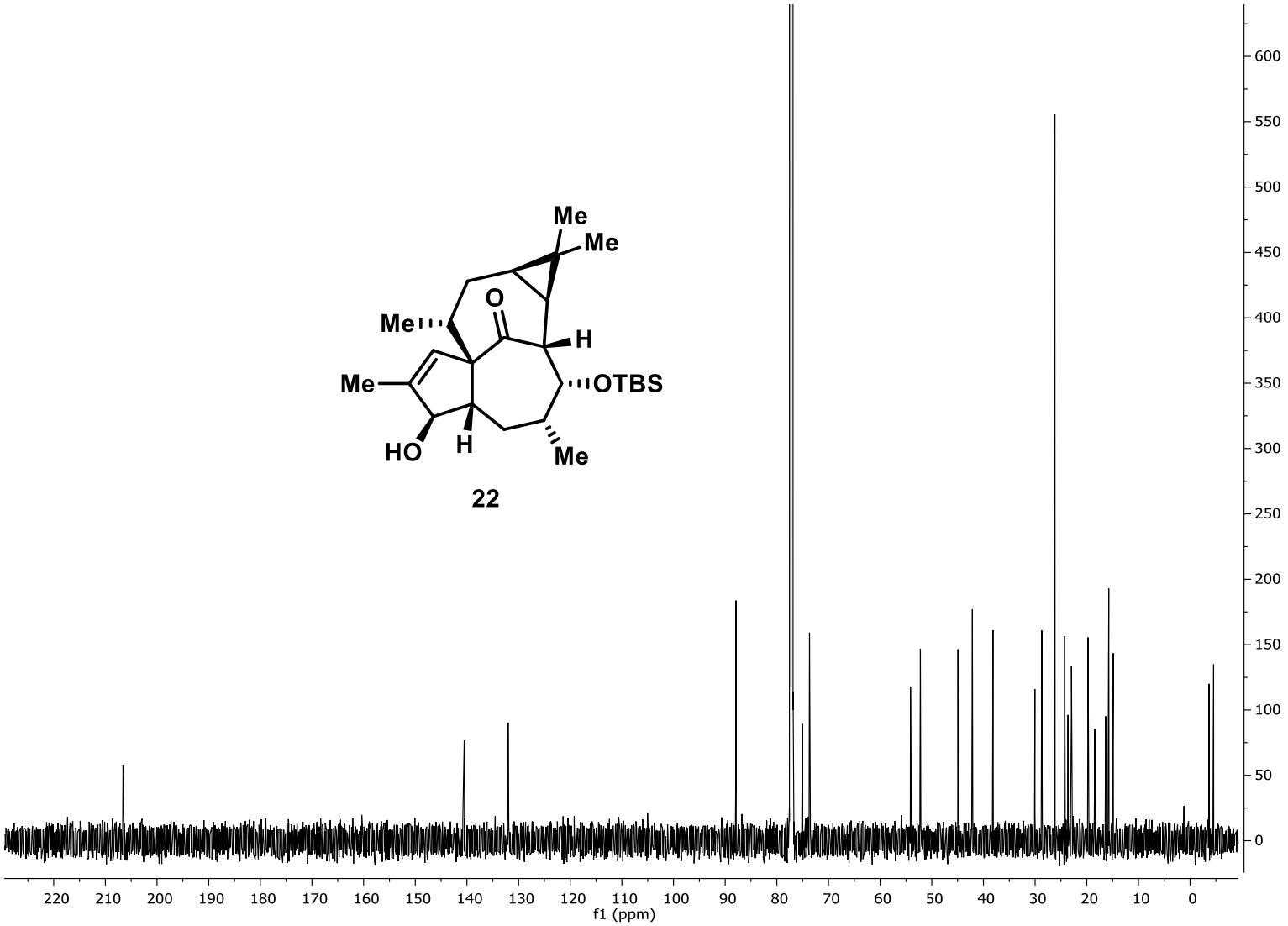

Me
Me
Me
O
H
Me
O
O
H
OH
Me
9
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

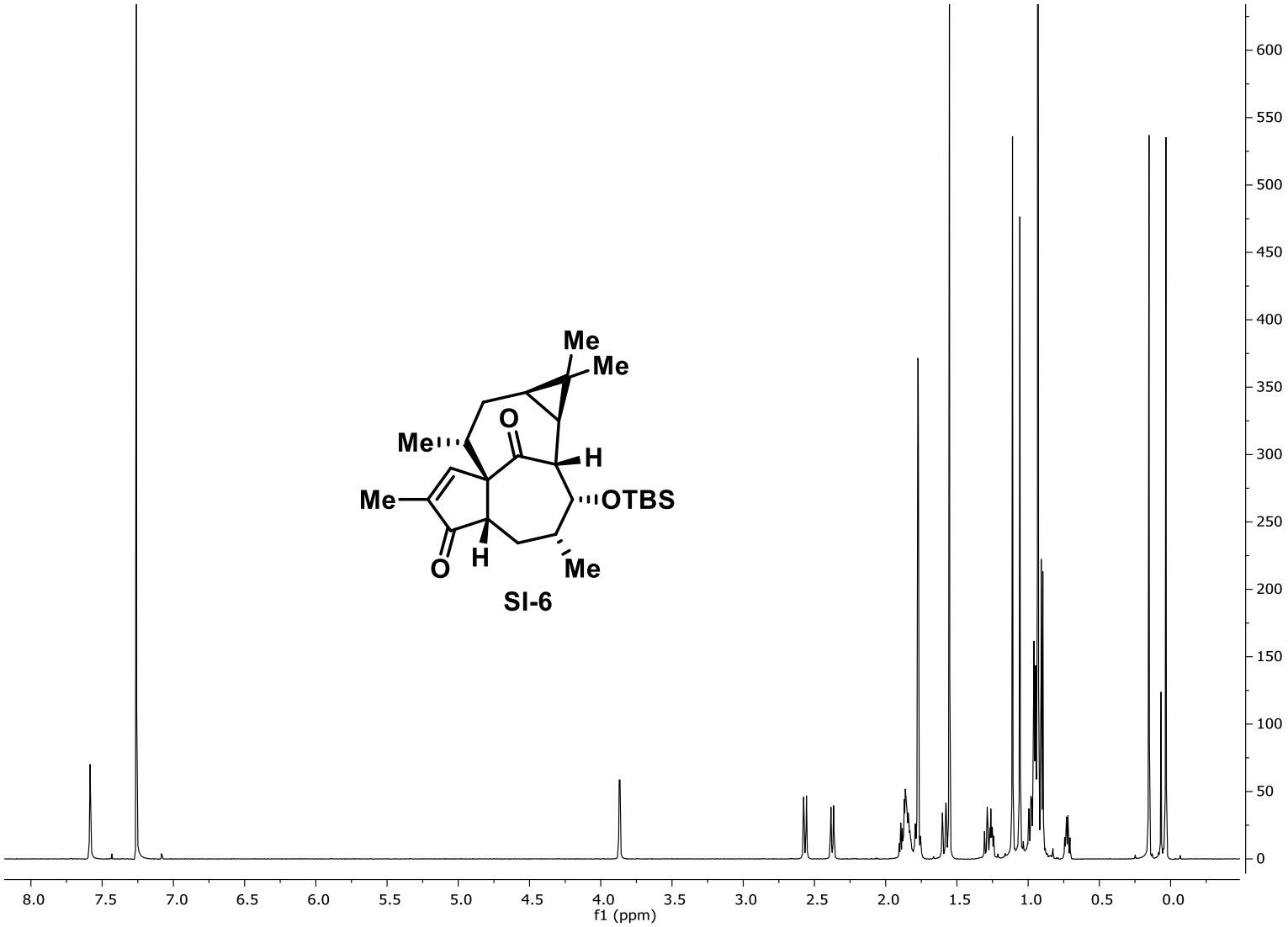

Me
Me
Me
O
H
Me
O
O
H
OH
Me
9
1100
1000
900
800
700
600
500
400
300
200
100
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

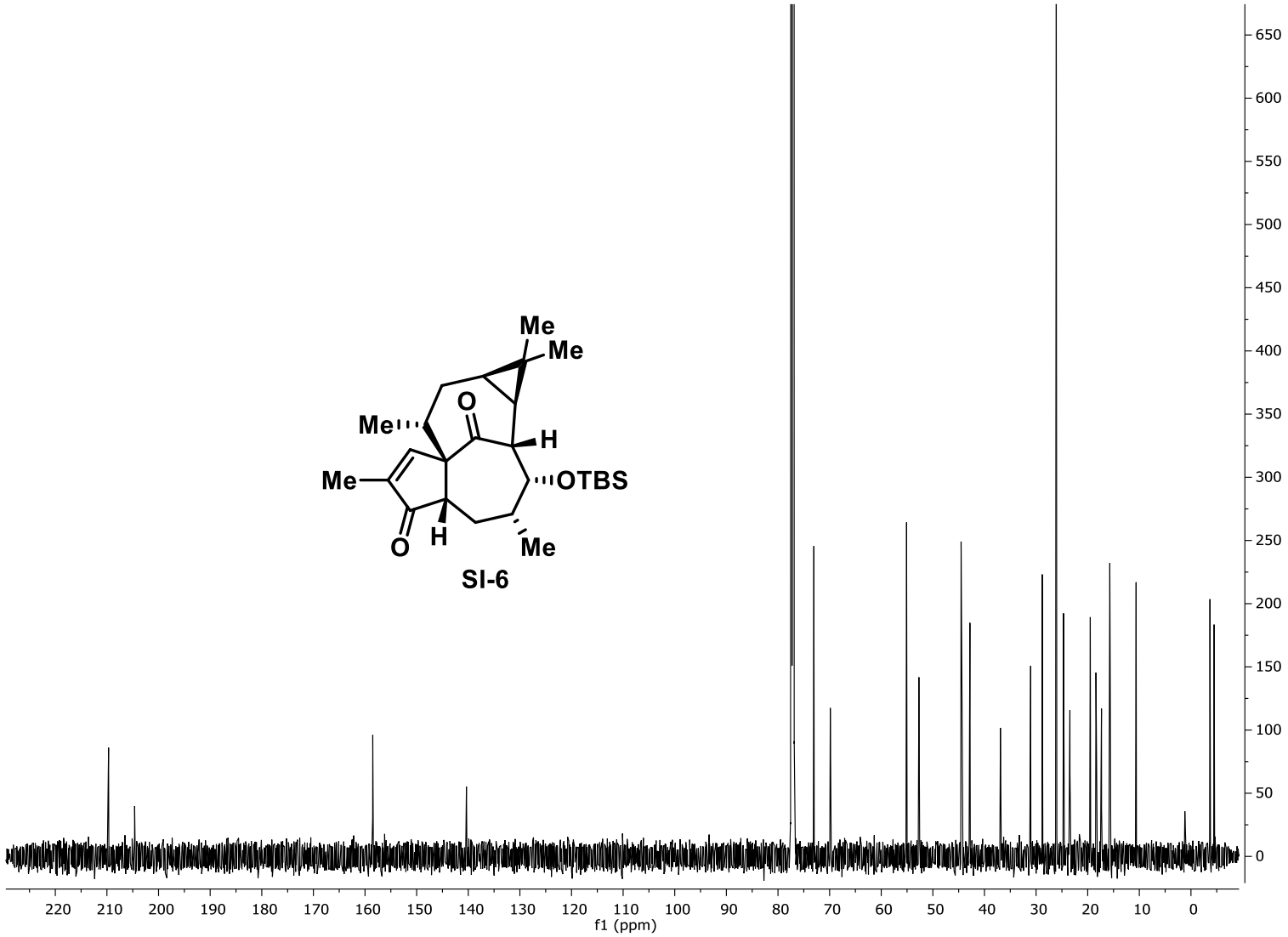
2D NOESY

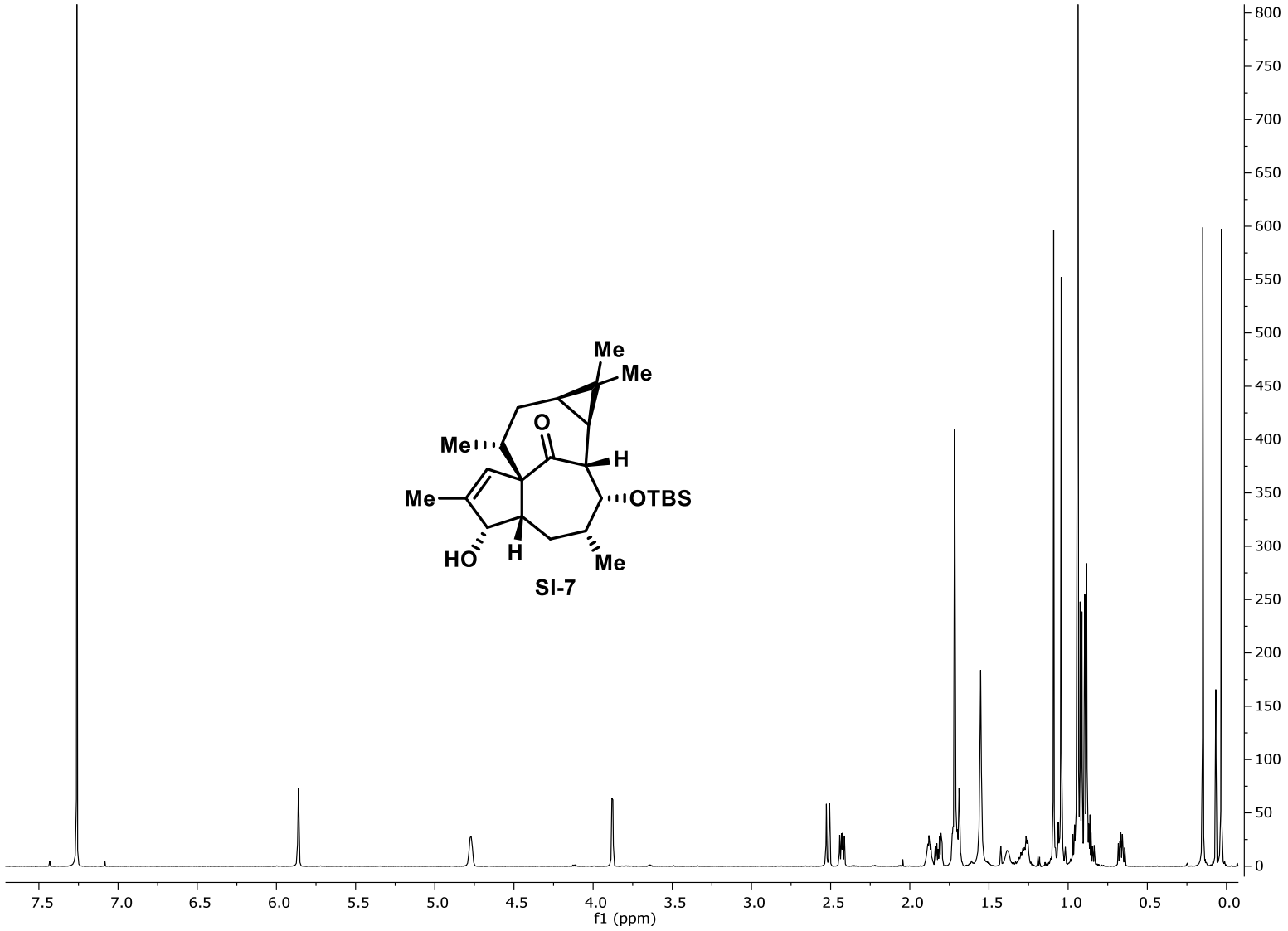

H1
H4
Me2
Me3
H5
H6a and H6b
f2 (ppm)
f1 (ppm)
Me
Me
Me2
O
H1
H5
Me3
H4
O
O
H
H6a
H6b
HO
Me
9

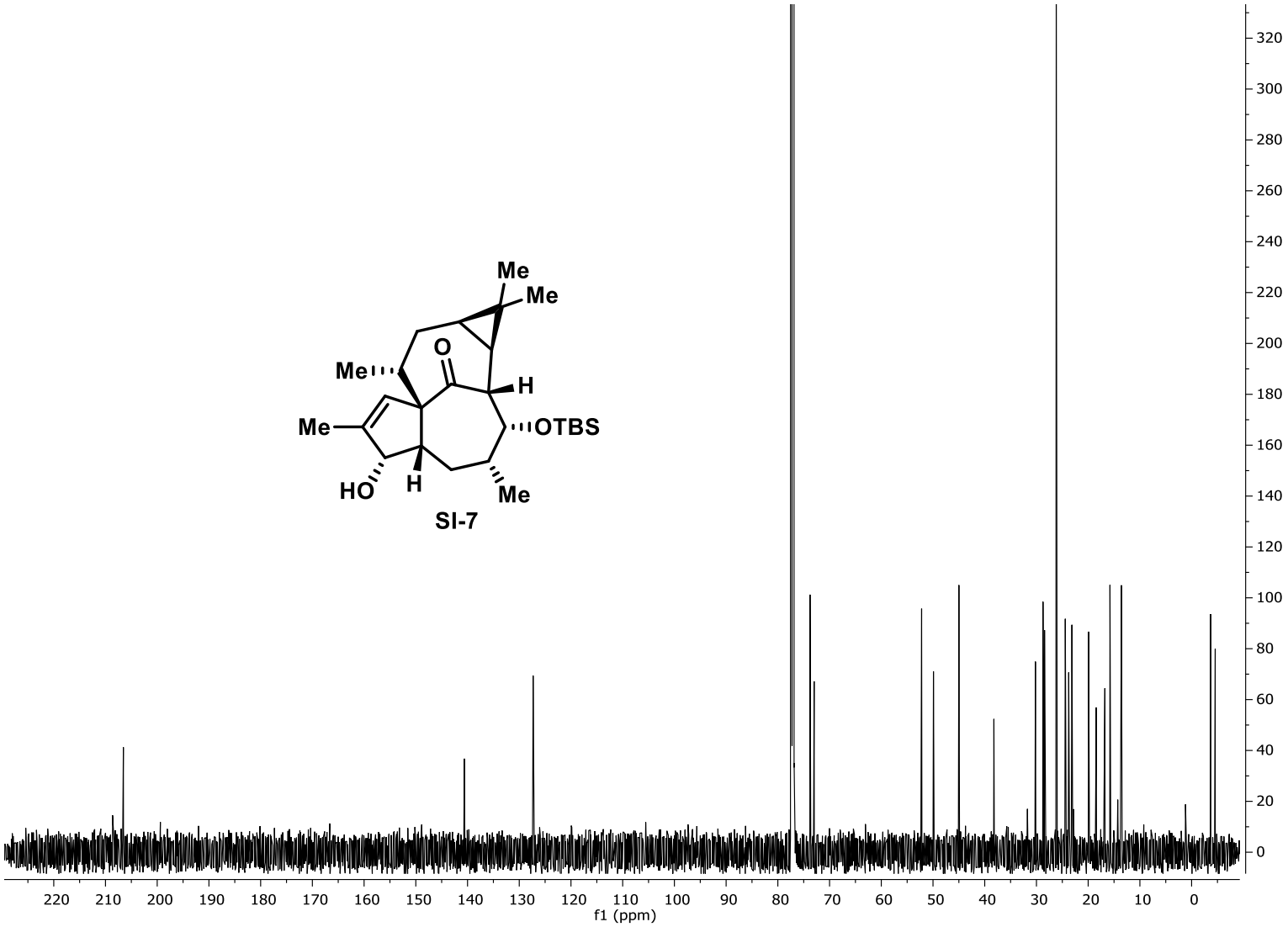

Me
Me
O
Me
H
Me
OTBS
HO
H
Me
22
550
500
450
400
350
300
250
200
150
100
50
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

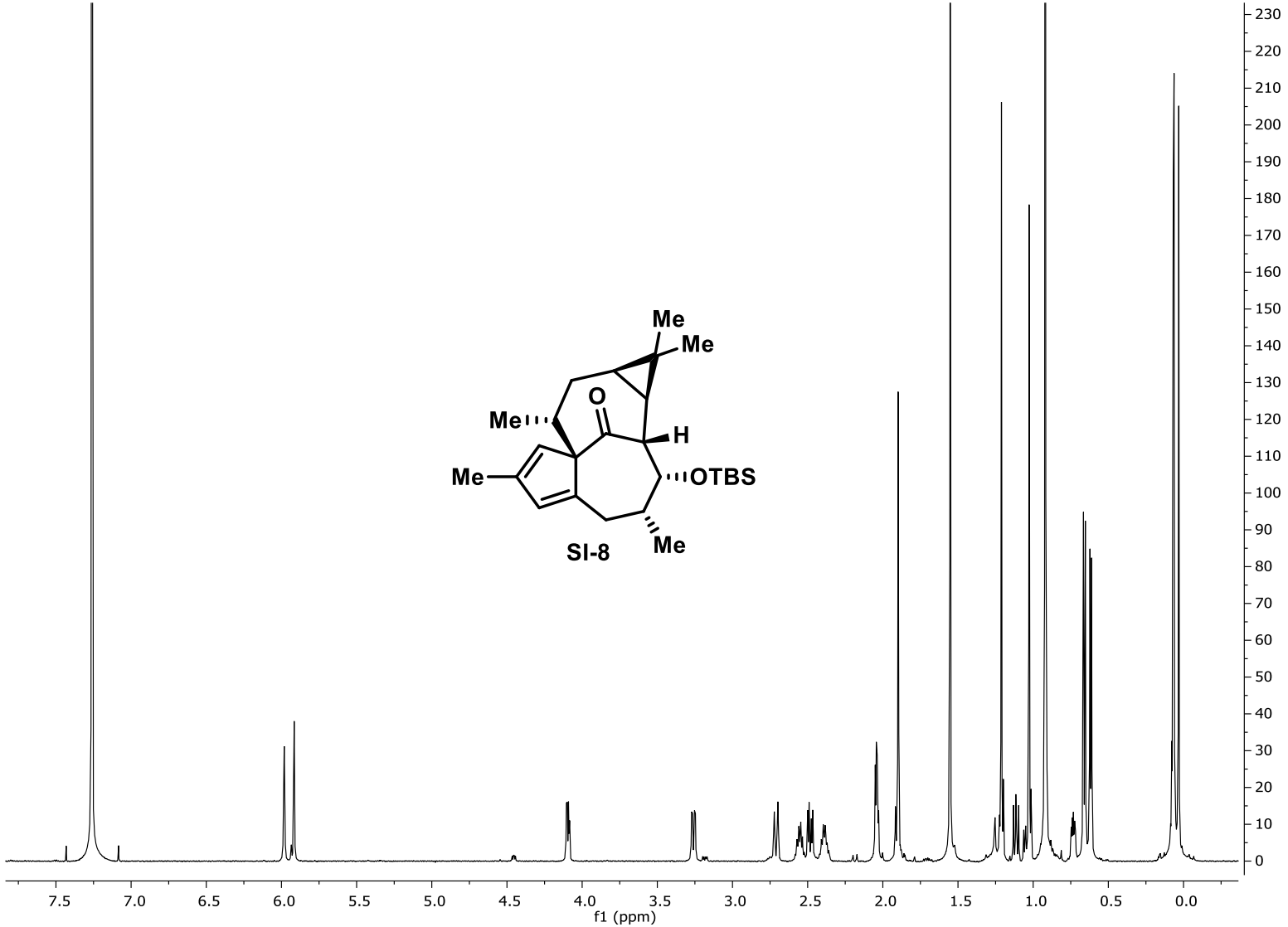

Me
Me
O
Me
H
Me
OTBS
HO
H
Me
22
600
550
500
450
400
350
300
250
200
150
100
50
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

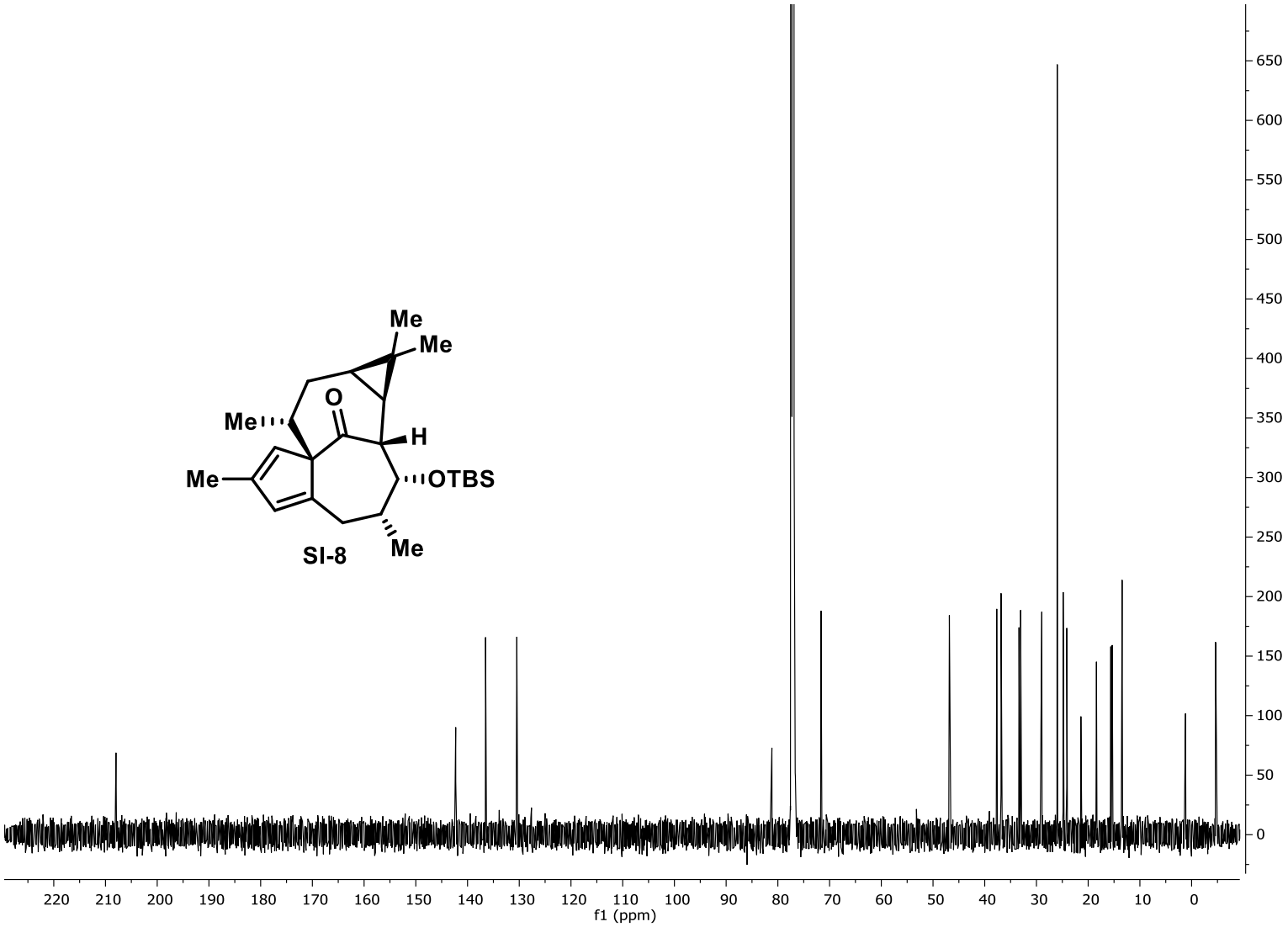

Me
Me
O
Me
H
Me
OTBS
O
H
Me
SI-6
600
550
500
450
400
350
300
250
200
150
100
50
0
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

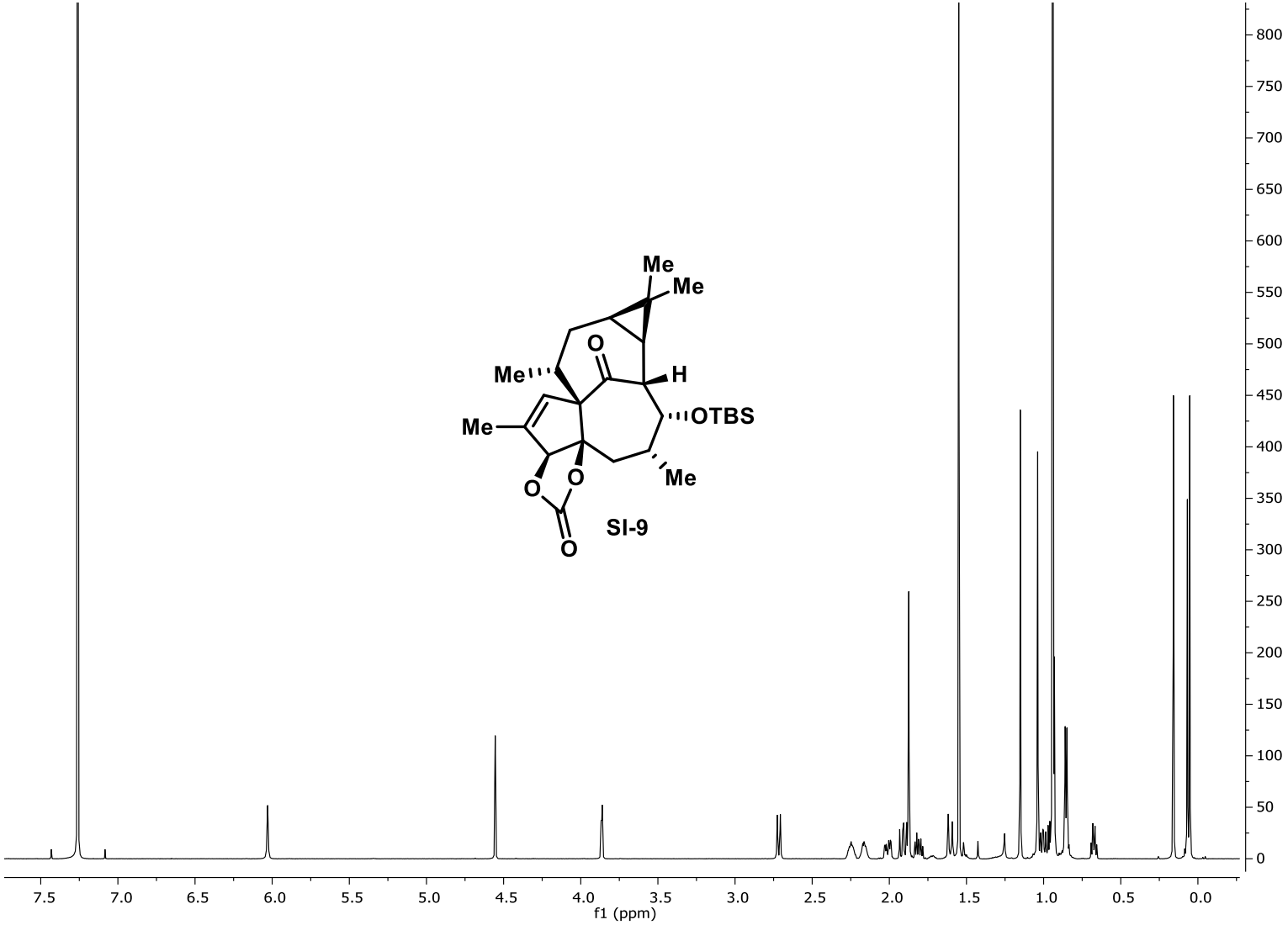

Me
Me
O
Me
H
Me
OTBS
O
H
Me
SI-6
650
600
550
500
450
400
350
300
250
200
150
100
50
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

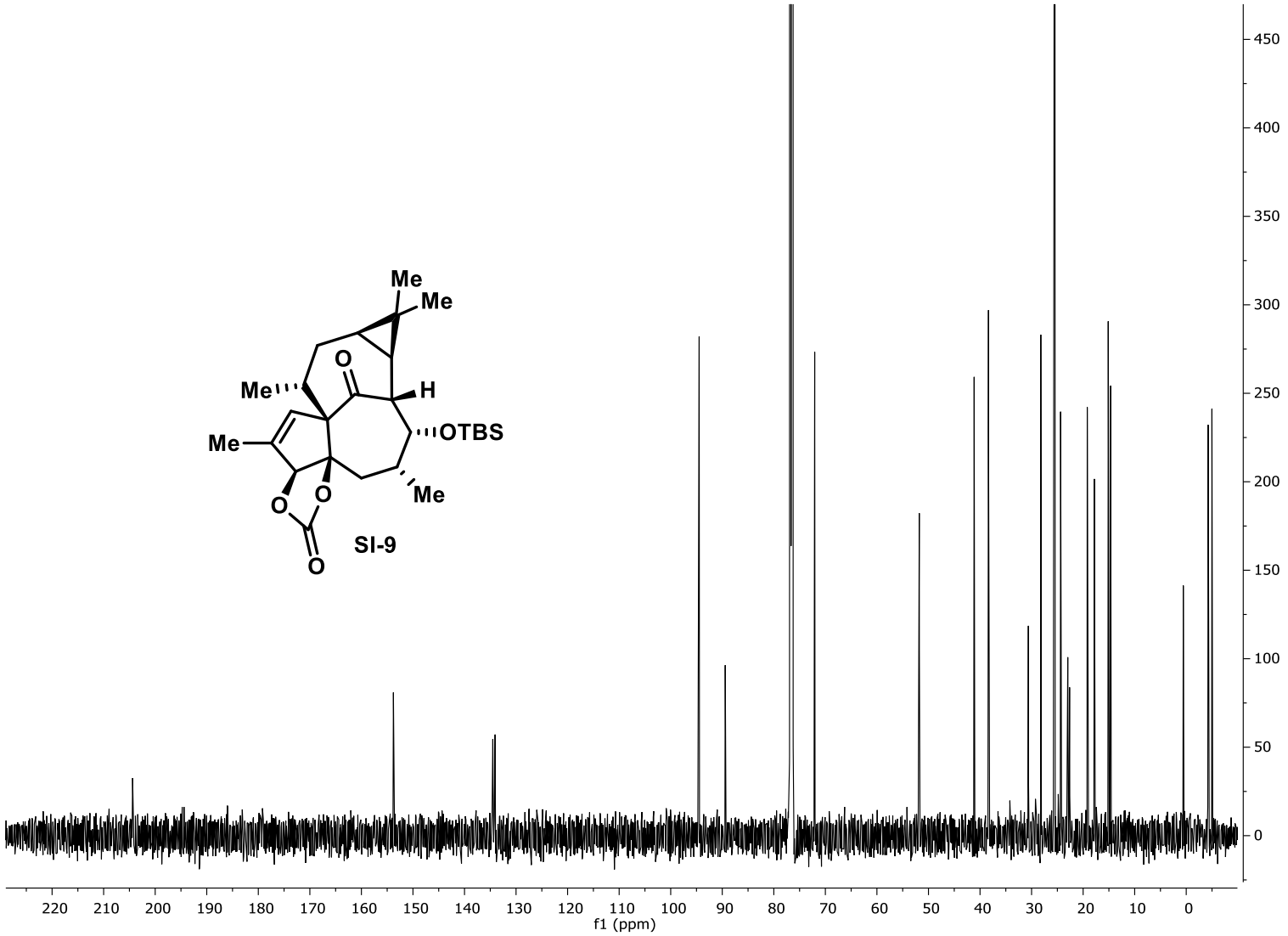

Me
Me
O
Me
H
Me
OTBS
HO
H
Me
SI-7
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

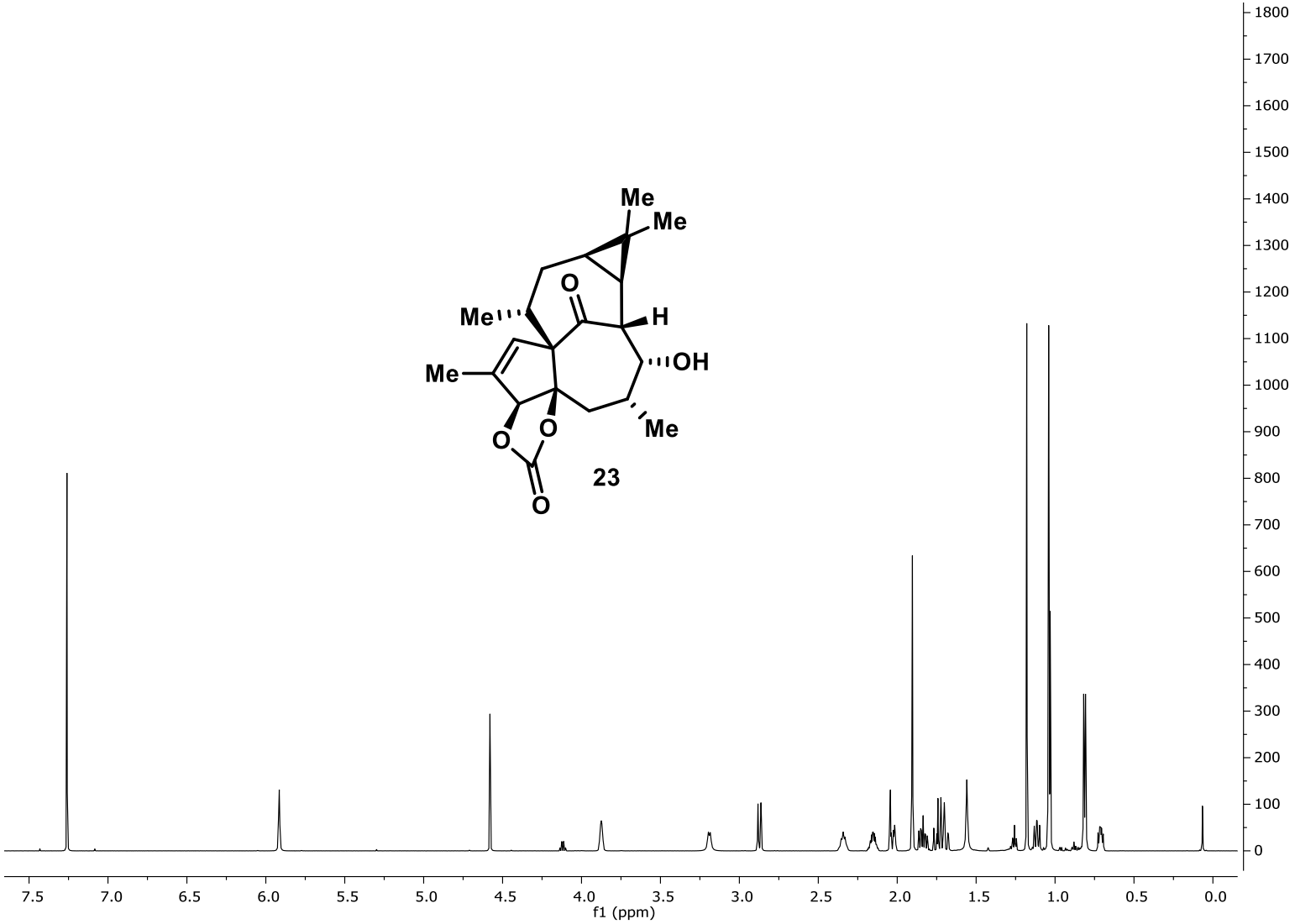

Me
Me
O
Me
H
Me
OTBS
HO
H
Me
SI-7
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

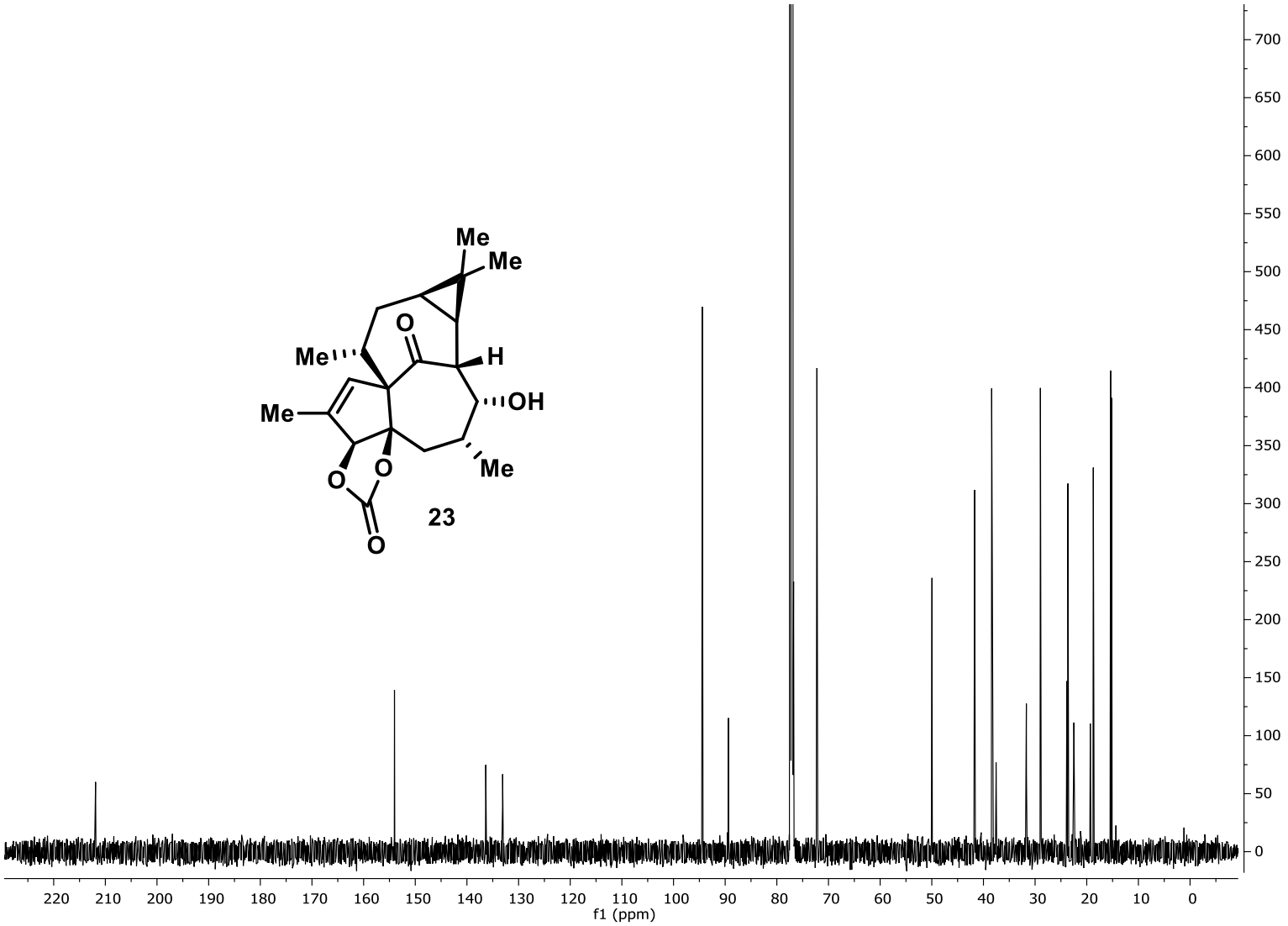

Me
Me
O
Me
H
Me
OTBS
Me
SI-8
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

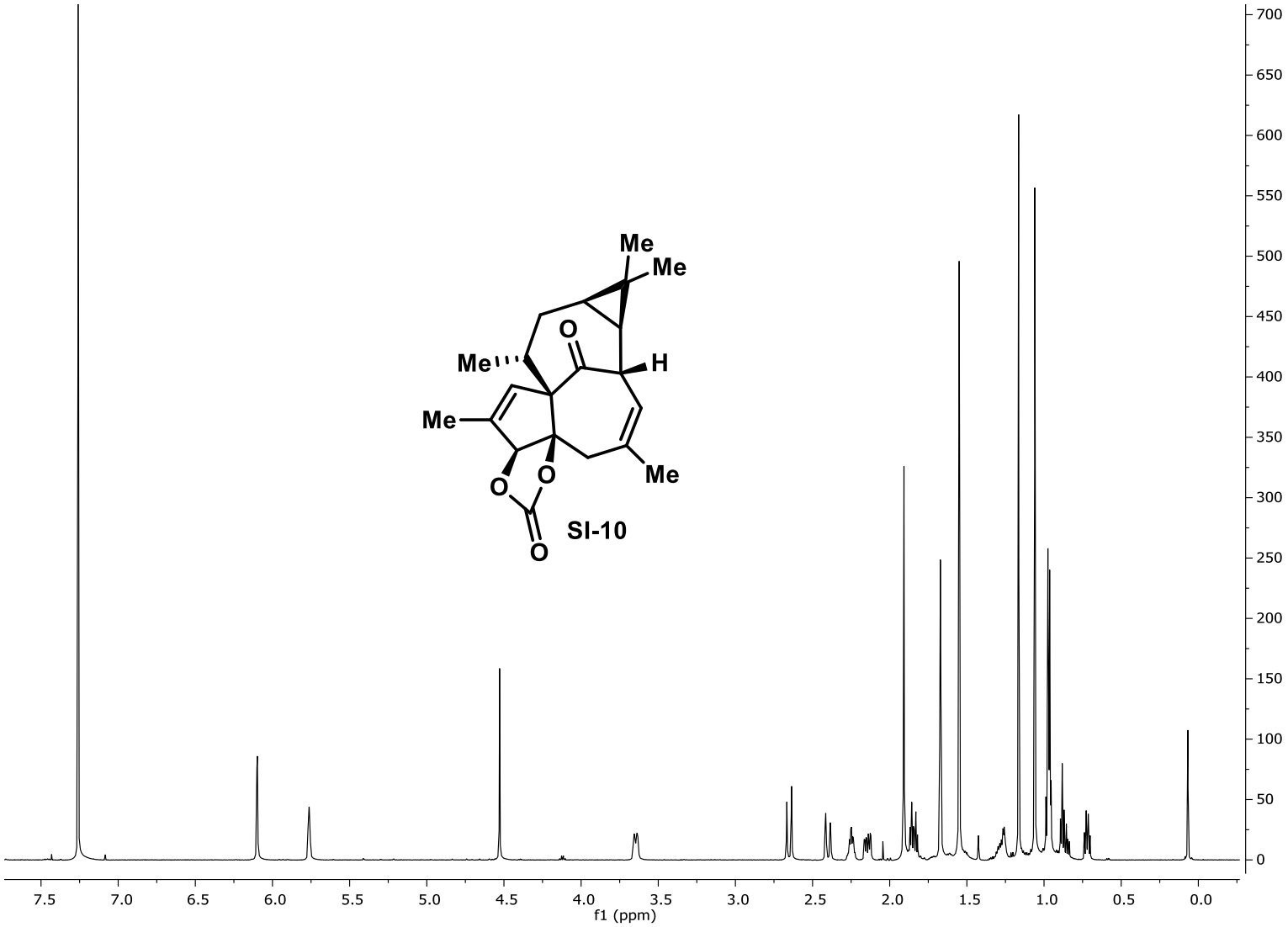

Me
Me
O
Me
H
Me
OTBS
Me
SI-8
650
600
550
500
450
400
350
300
250
200
150
100
50
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

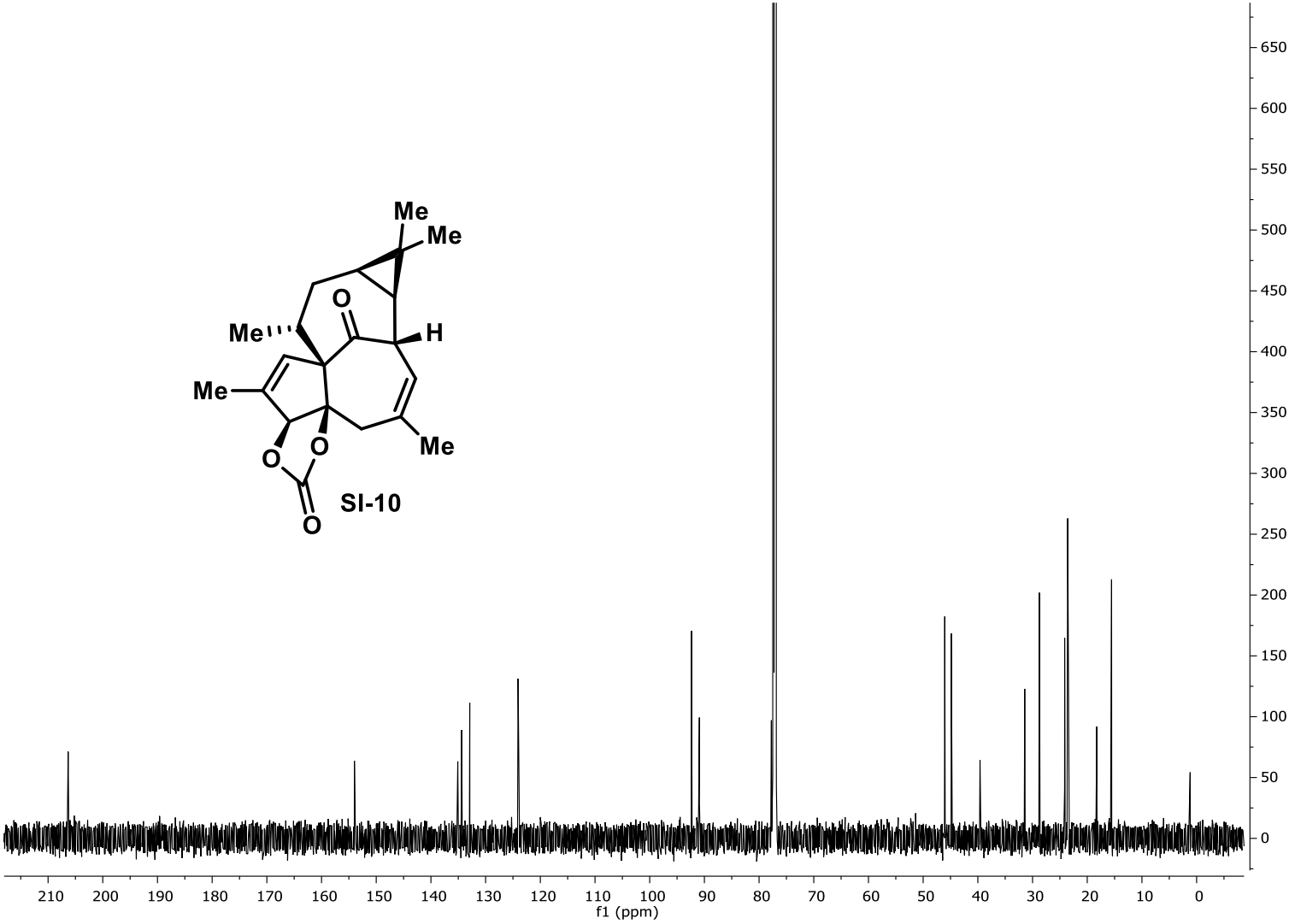

Me
Me
O
Me
H
OTBS
Me
Me
O
O
O
SI-9
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

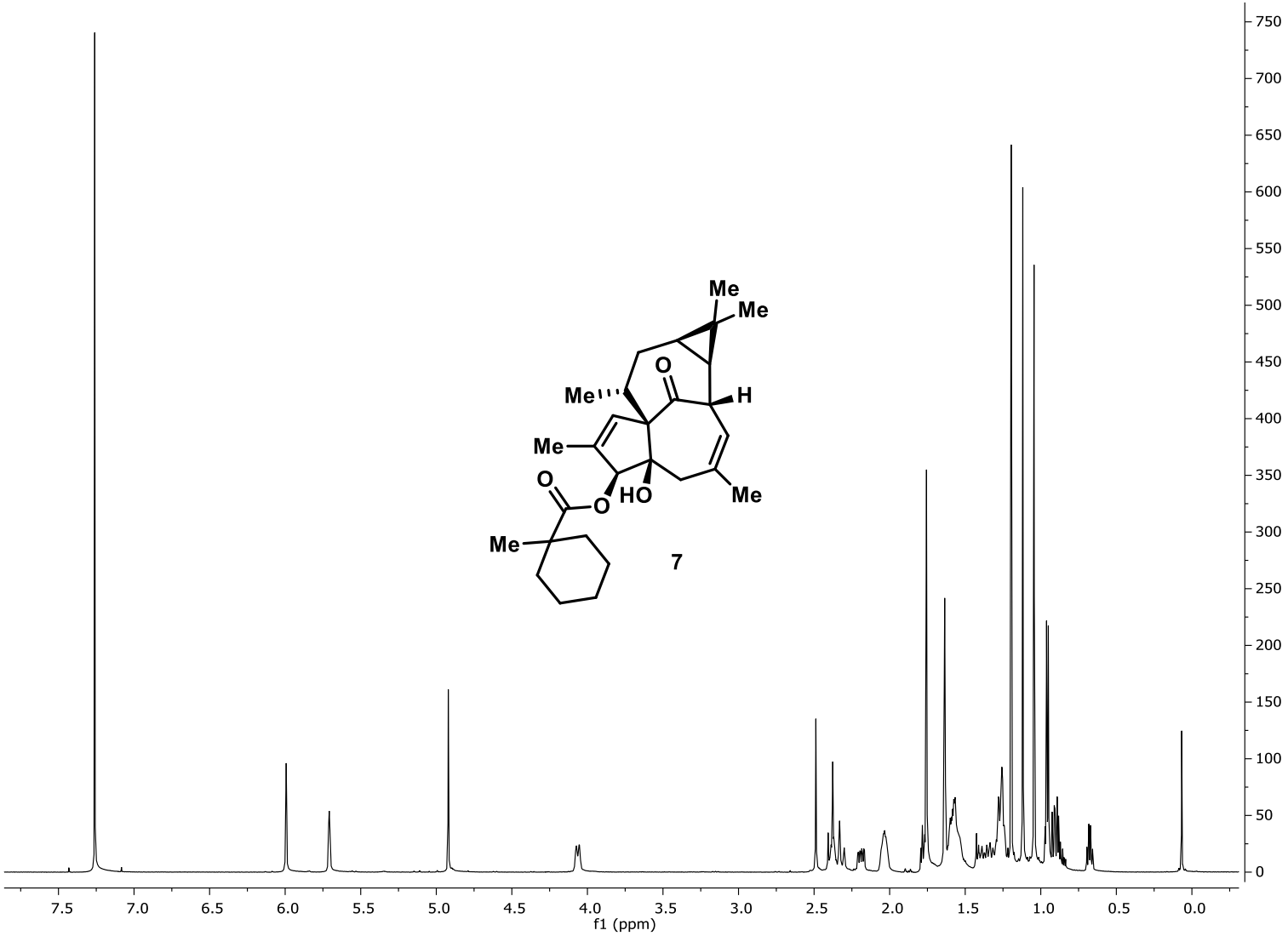

Me
Me
O
Me
H
OTBS
Me
Me
O
O
O
O
SI-9
450
400
350
300
250
200
150
100
50
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

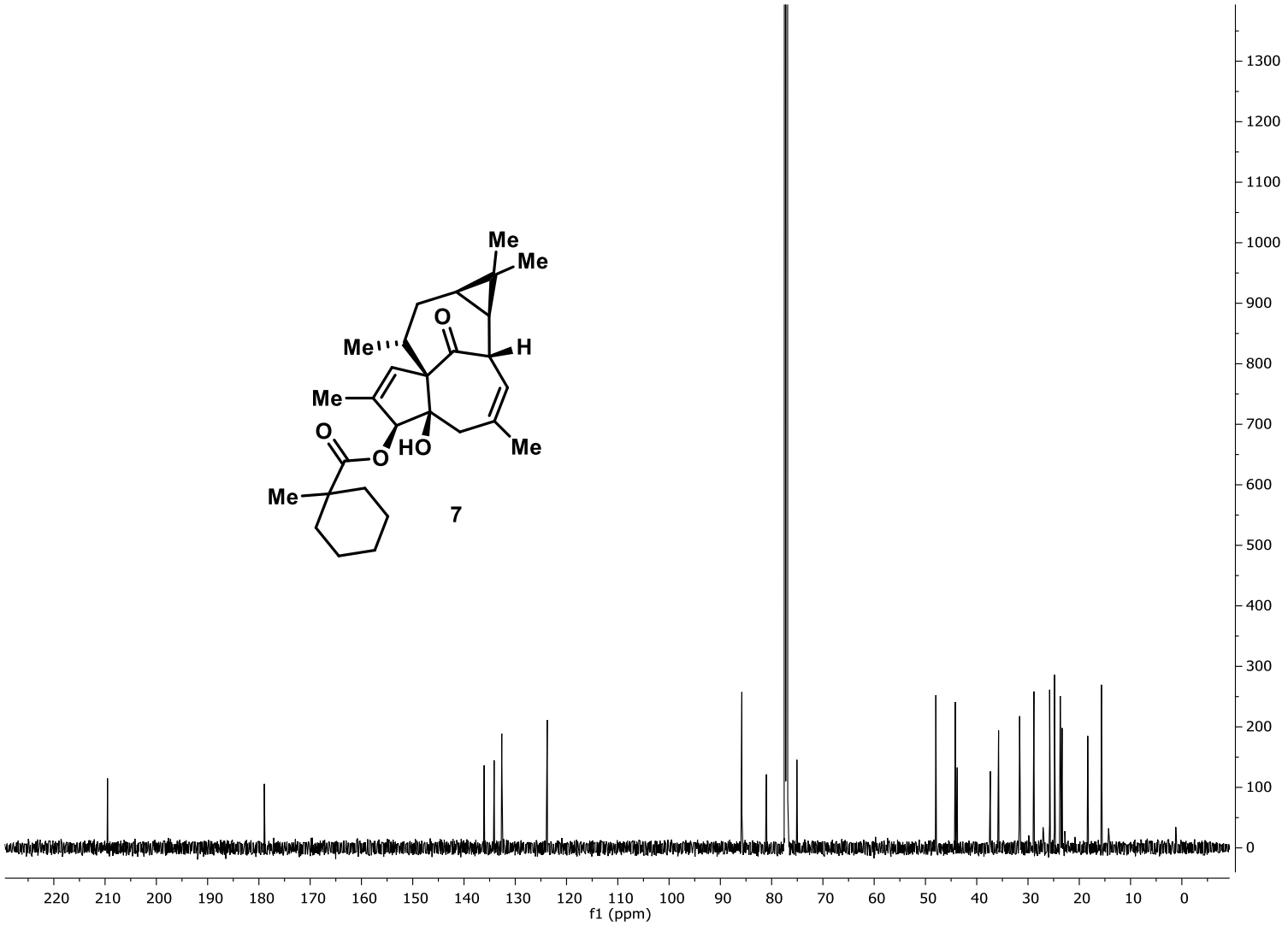

Me
Me
O
Me
H
OH
Me
Me
O
O
O
O
23
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

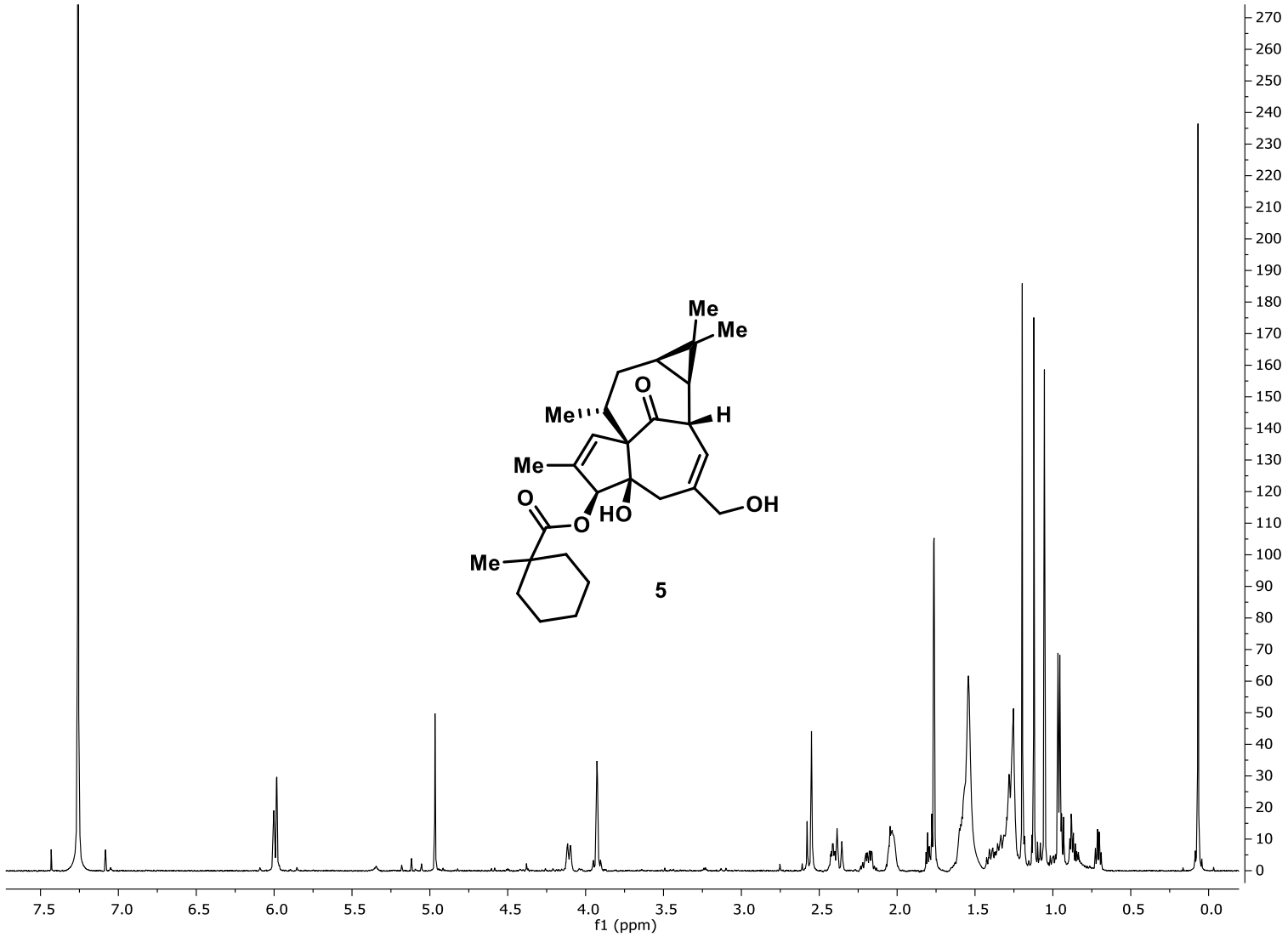

Me
Me
O
Me
H
OH
Me
O
O
Me
O
O
23
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

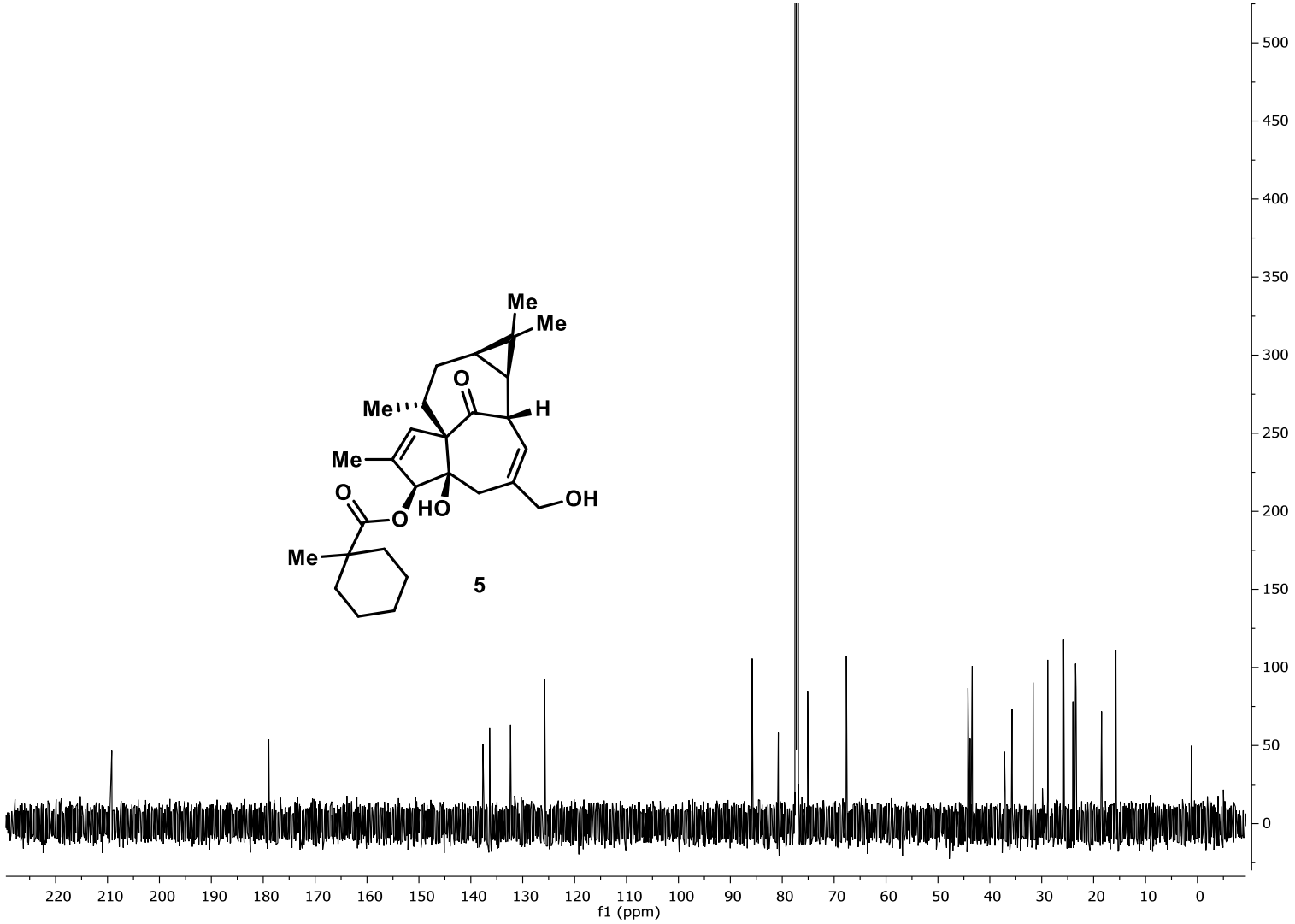

Me
Me
O
Me
H
Me
Me
O
O
O
SI-10
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


Me
Me
O
Me
H
Me
Me
O
O
O
SI-10
650
600
550
500
450
400
350
300
250
200
150
100
50
0
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

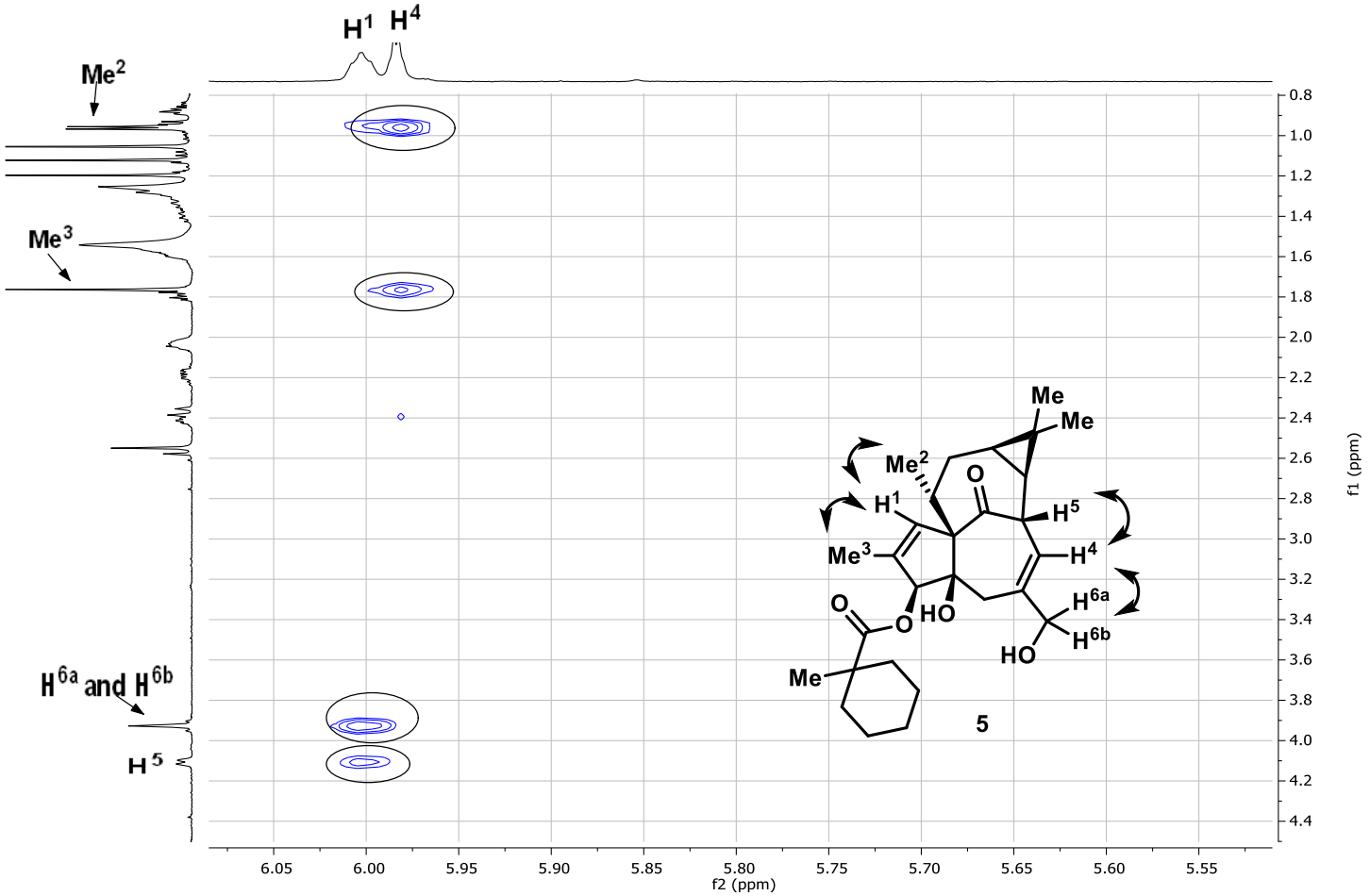

Me
Me
O
Me
H
Me
O
O
HO
Me
Me
7
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

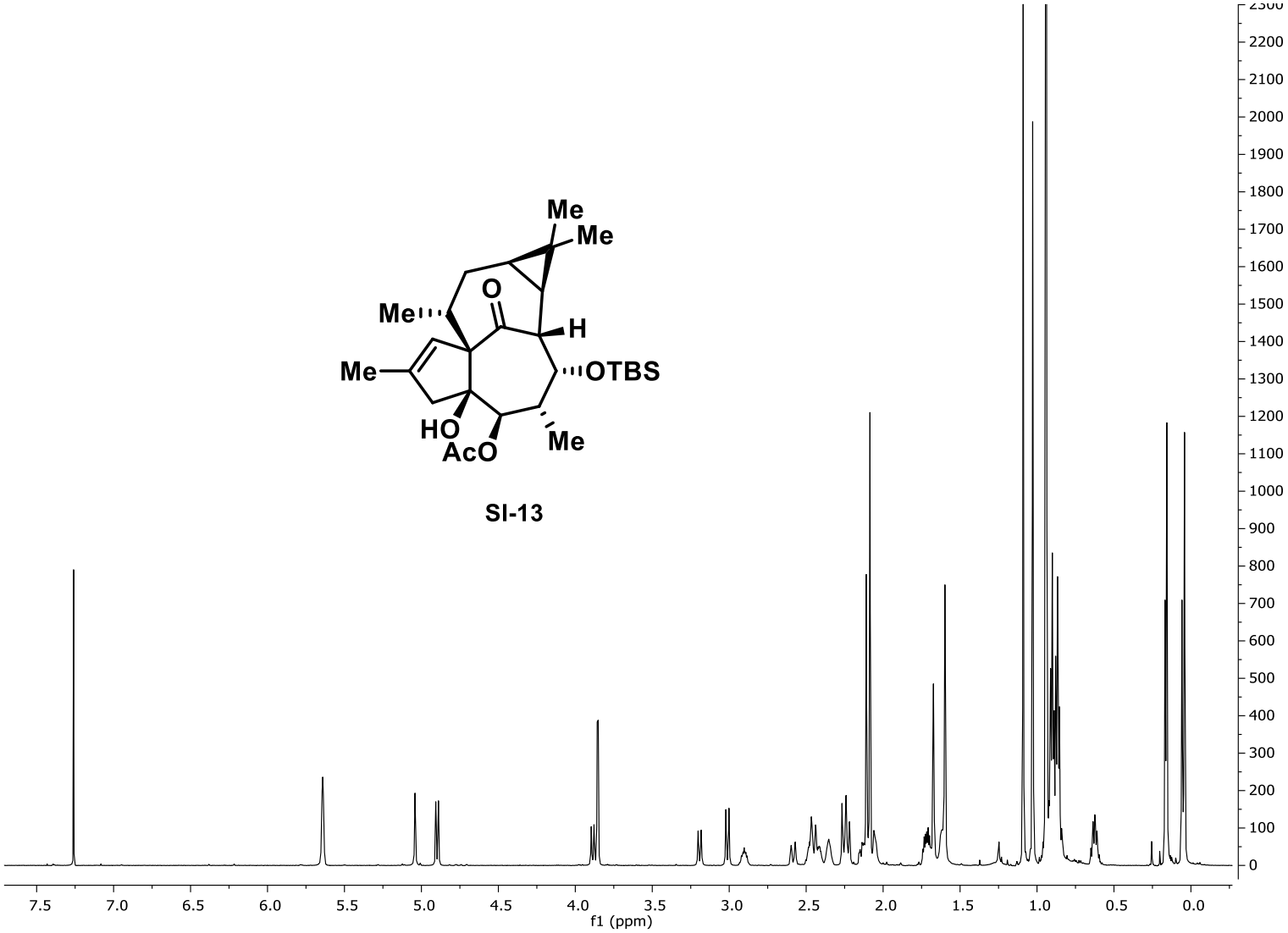

Me
Me
O
Me
H
Me
O
HO
Me
O
Me
7
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

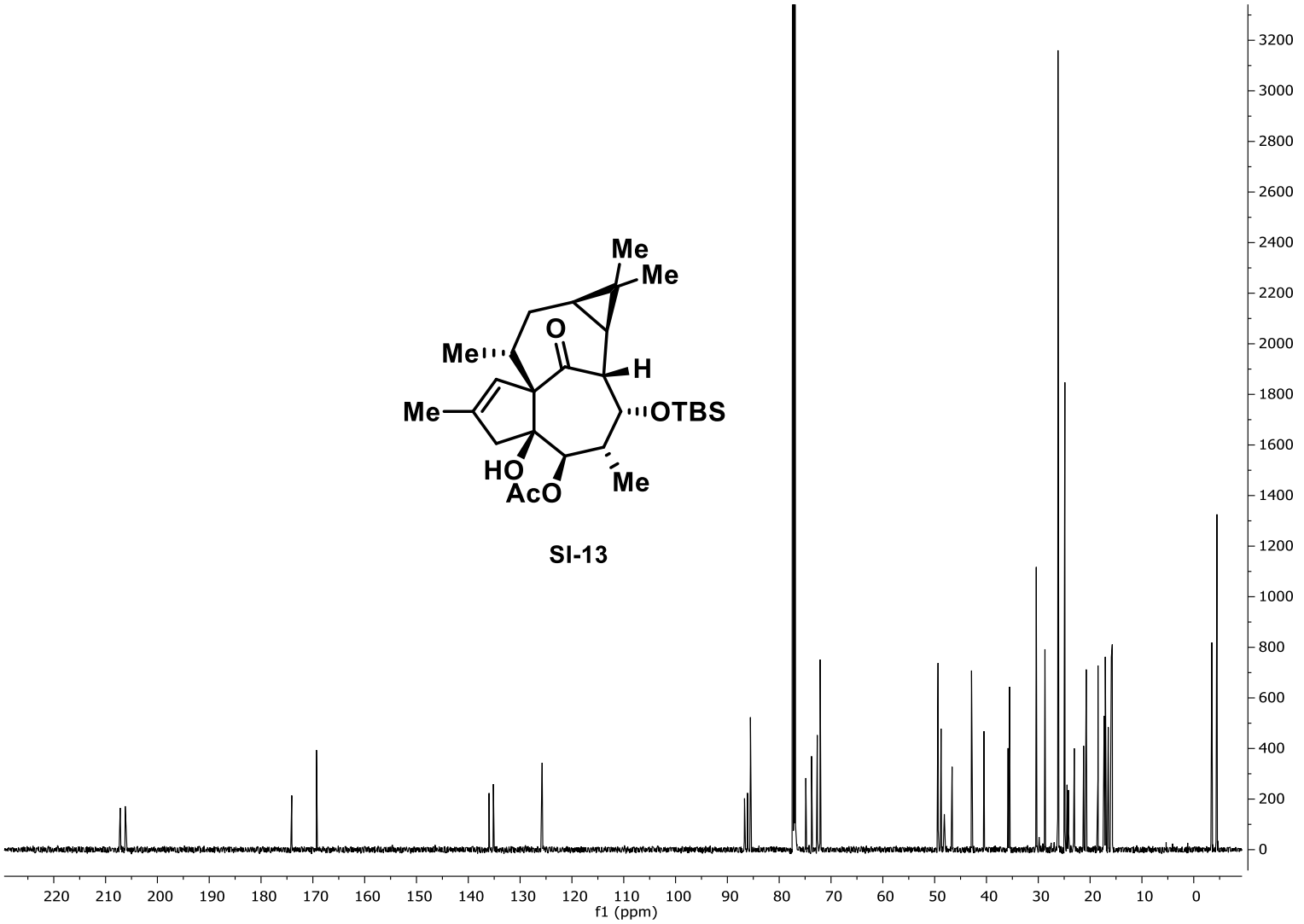

Me
Me
O
Me
H
Me
O
HO
OH
O
Me
5
f1 (ppm)


Me
Me
O
Me
H
Me
O
O
HO
OH
Me
5
500
450
400
350
300
250
200
150
100
50
0
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

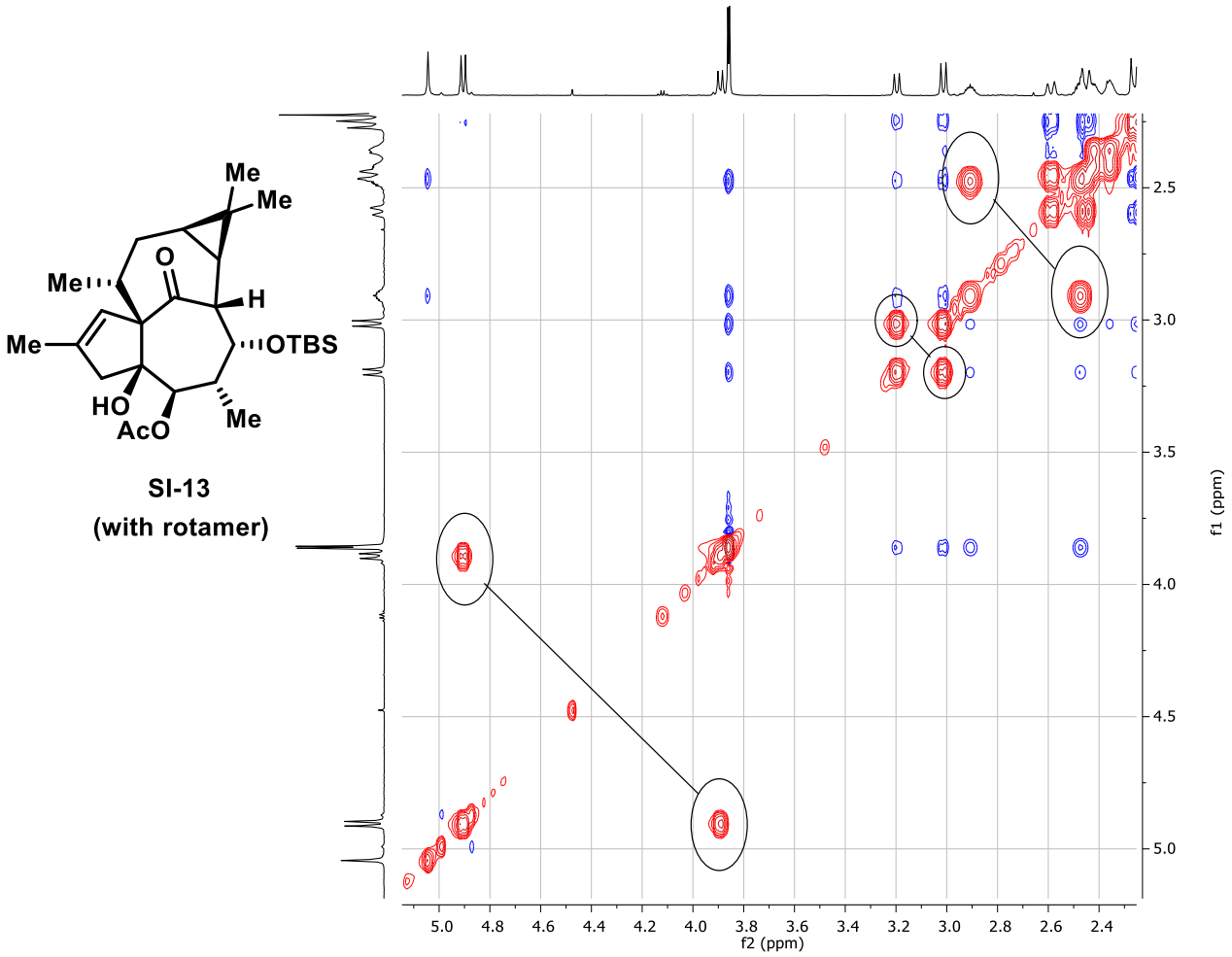
2D NOESY

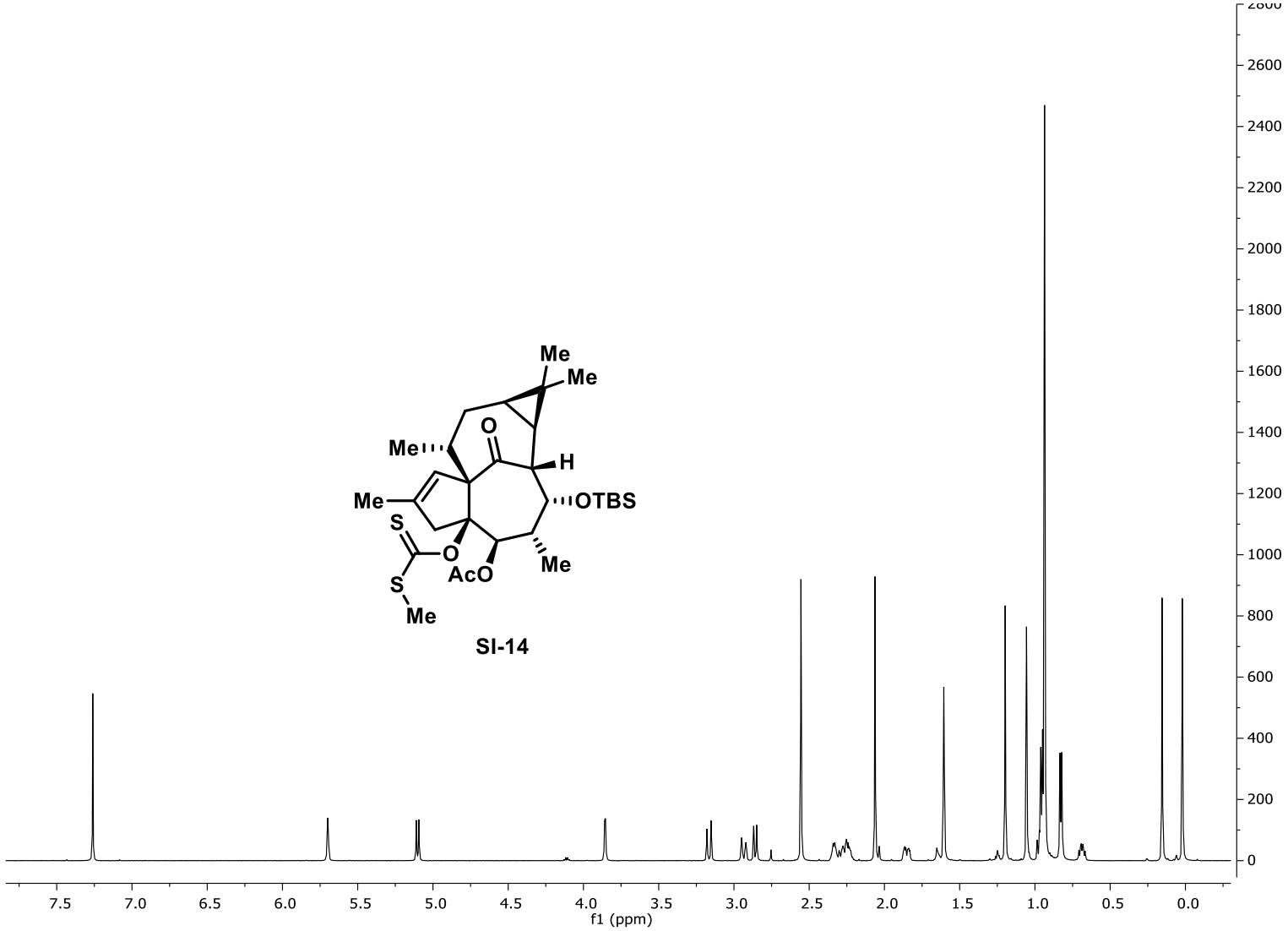

H1 H4
Me2
Me3
H6a and H6b
H5
f2 (ppm)
f1 (ppm)
Me
Me
Me2
O
H1
H5
Me3
H4
O
O
HO
H6a
H6b
HO
Me
5

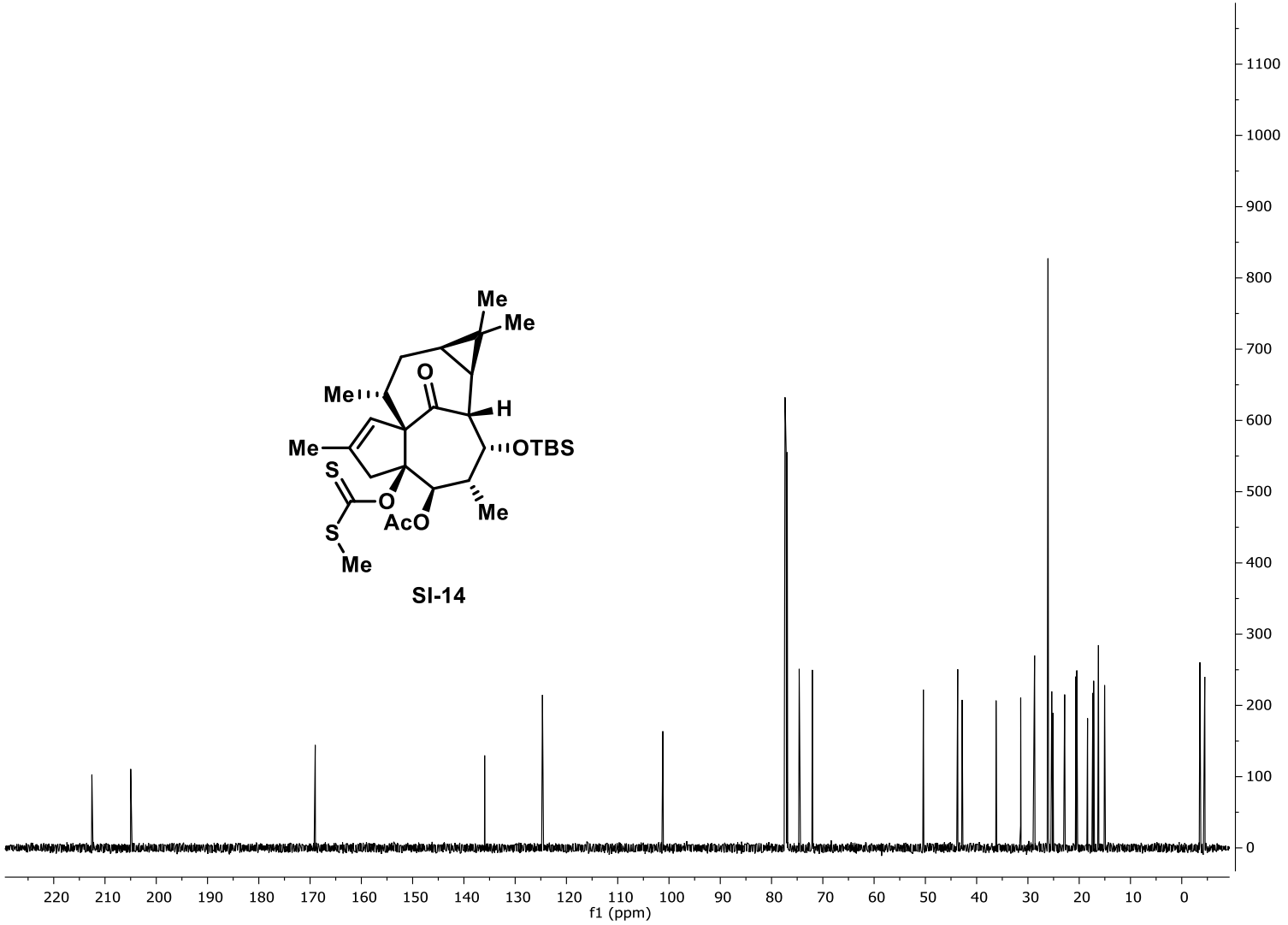

Me
Me
O
Me
H
Me
OTBS
HO
AcO
Me
SI-13
f1 (ppm)

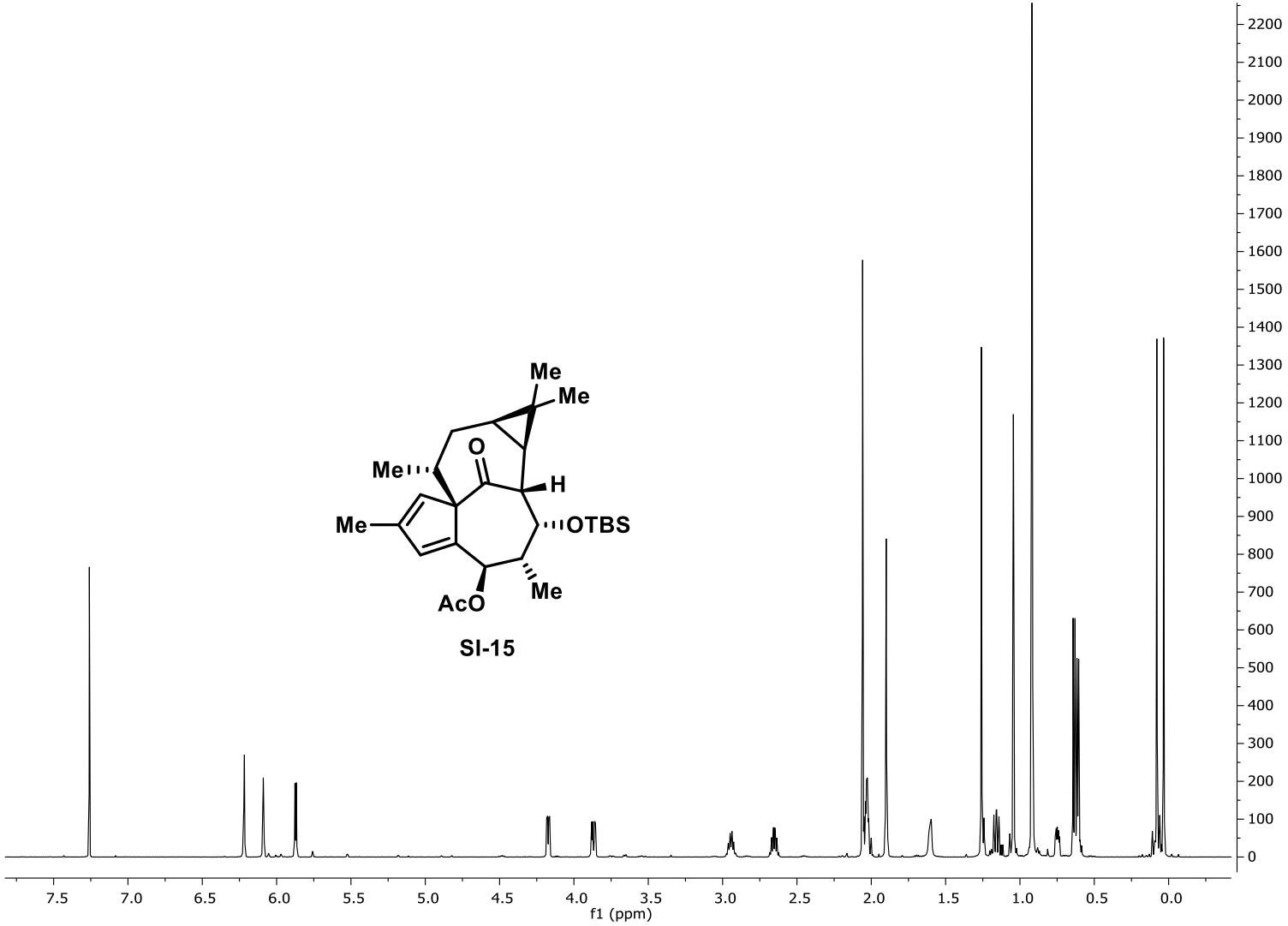

Me
Me
O
Me
H
Me
OTBS
HO
AcO
Me
SI-13
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

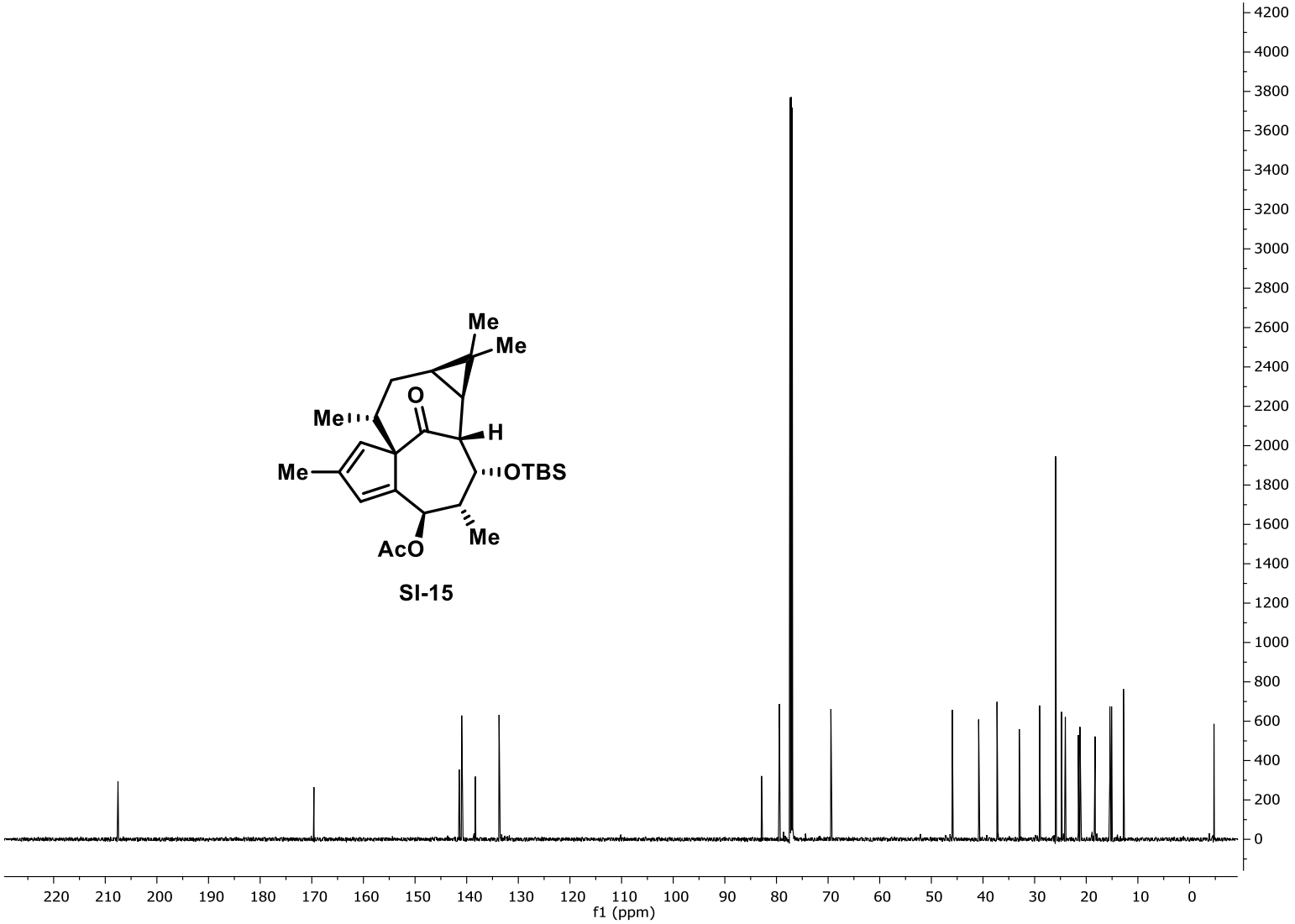
2D NOESY

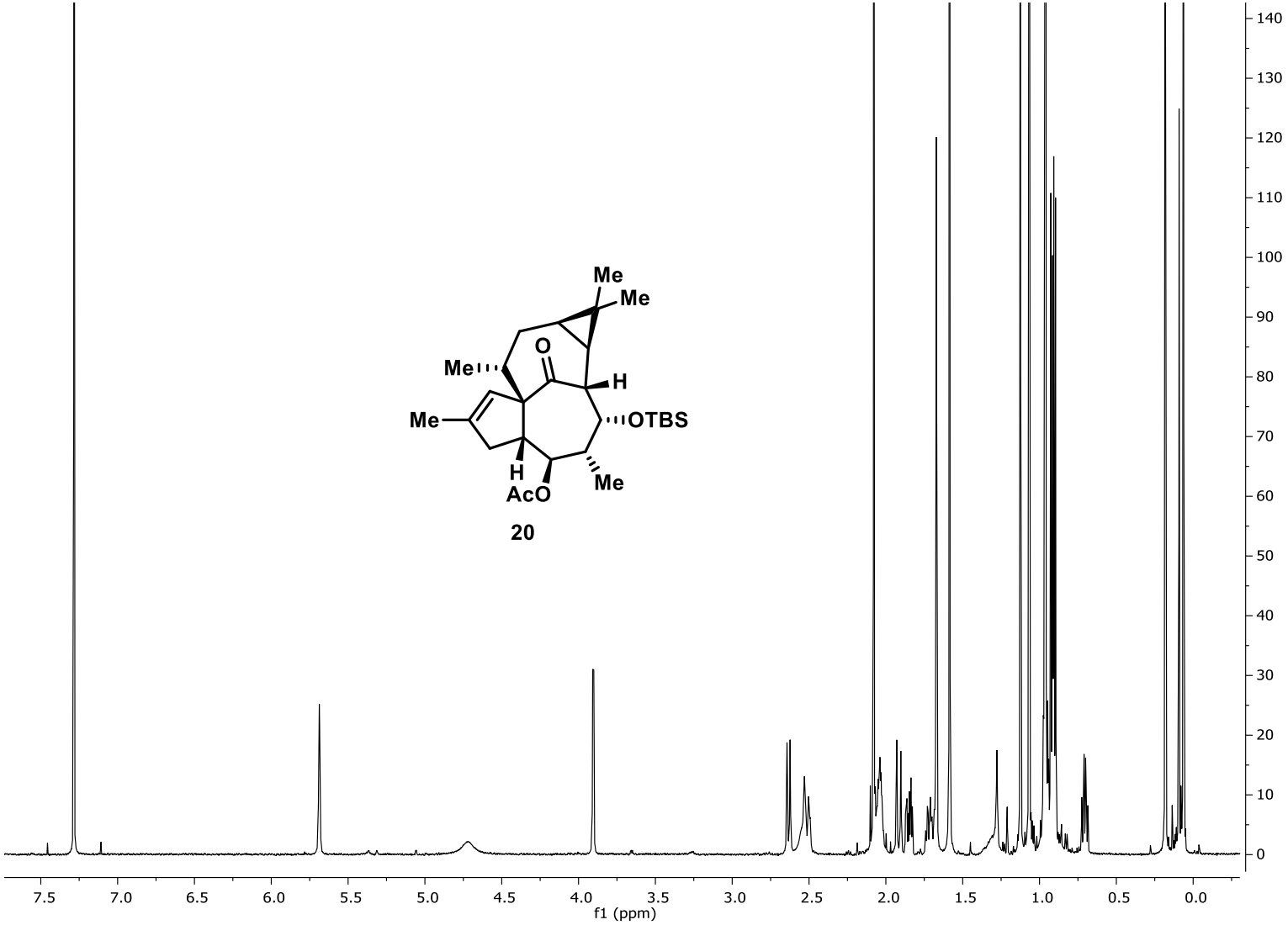

Me
Me
O
Me
H
Me
OTBS
HO
AcO
Me
SI-13
(with rotamer)
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
f2 (ppm)
2.5
3.0
3.5
4.0
4.5
5.0
f1 (ppm)

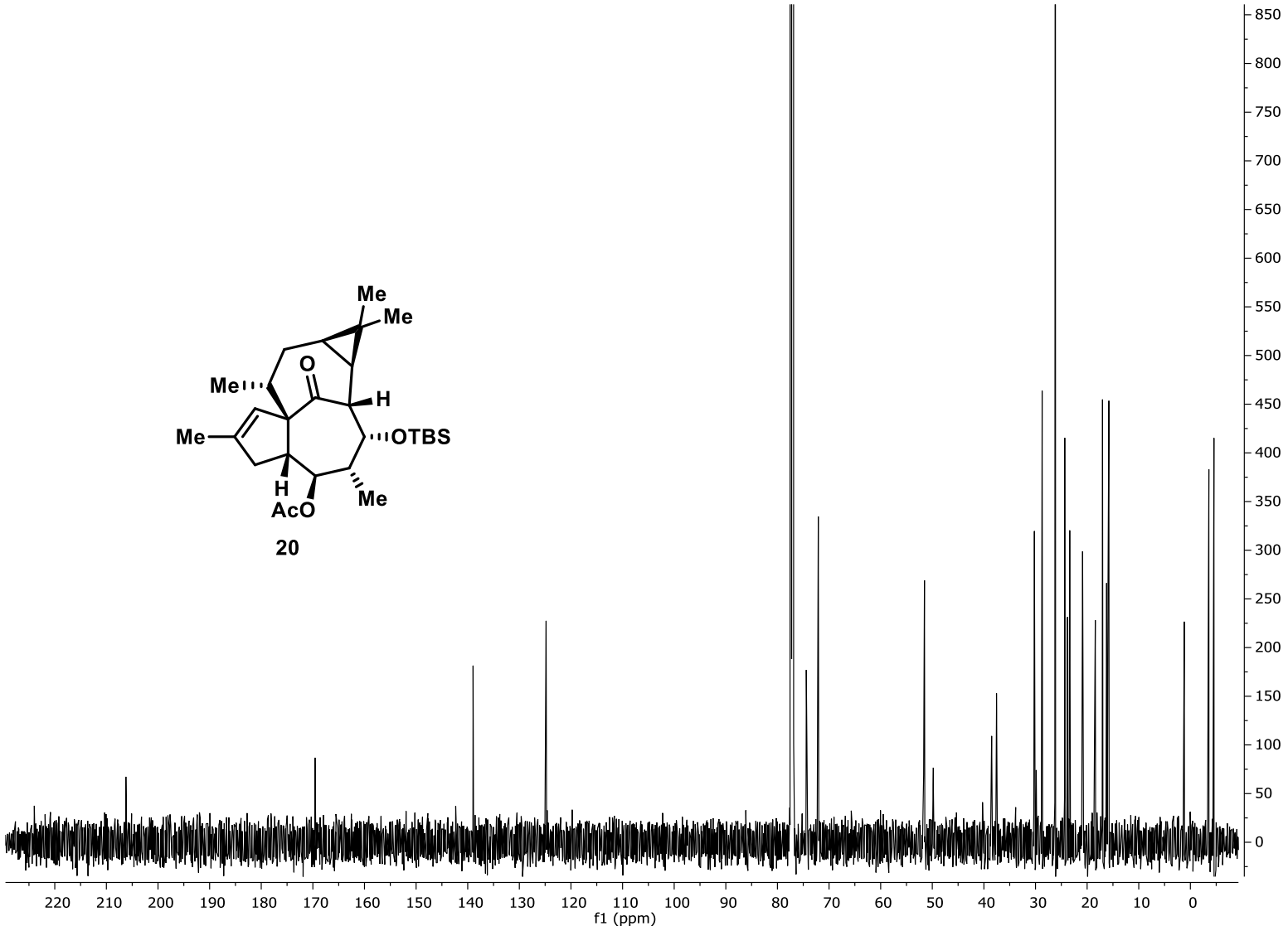

Me
Me
O
Me
H
Me
OTBS
S
O
AcO
Me
S
Me
SI-14
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

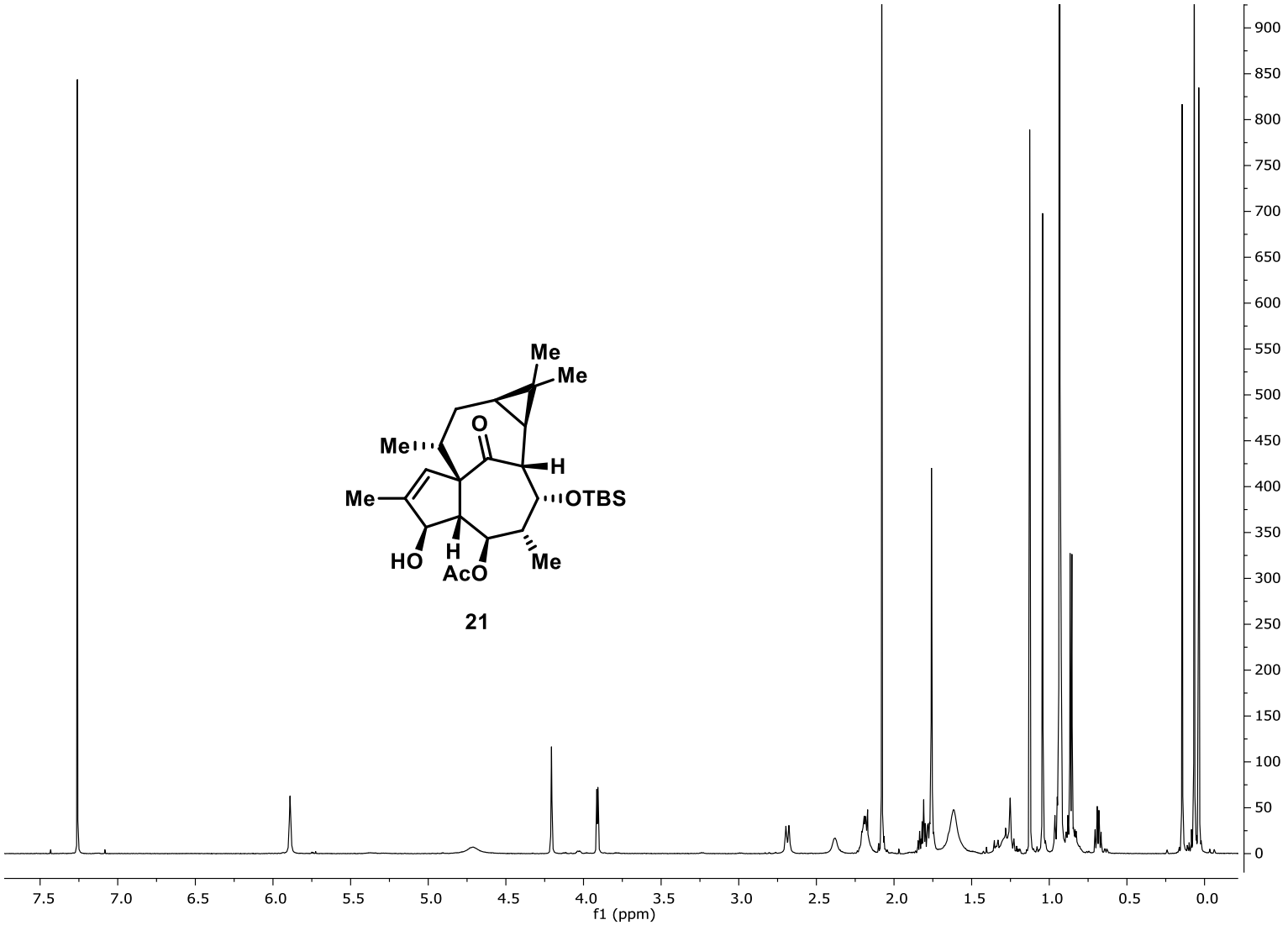

Me
Me
O
Me
H
Me
OTBS
S
O
AcO
Me
S
Me
SI-14
1100
1000
900
800
700
600
500
400
300
200
100
0
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

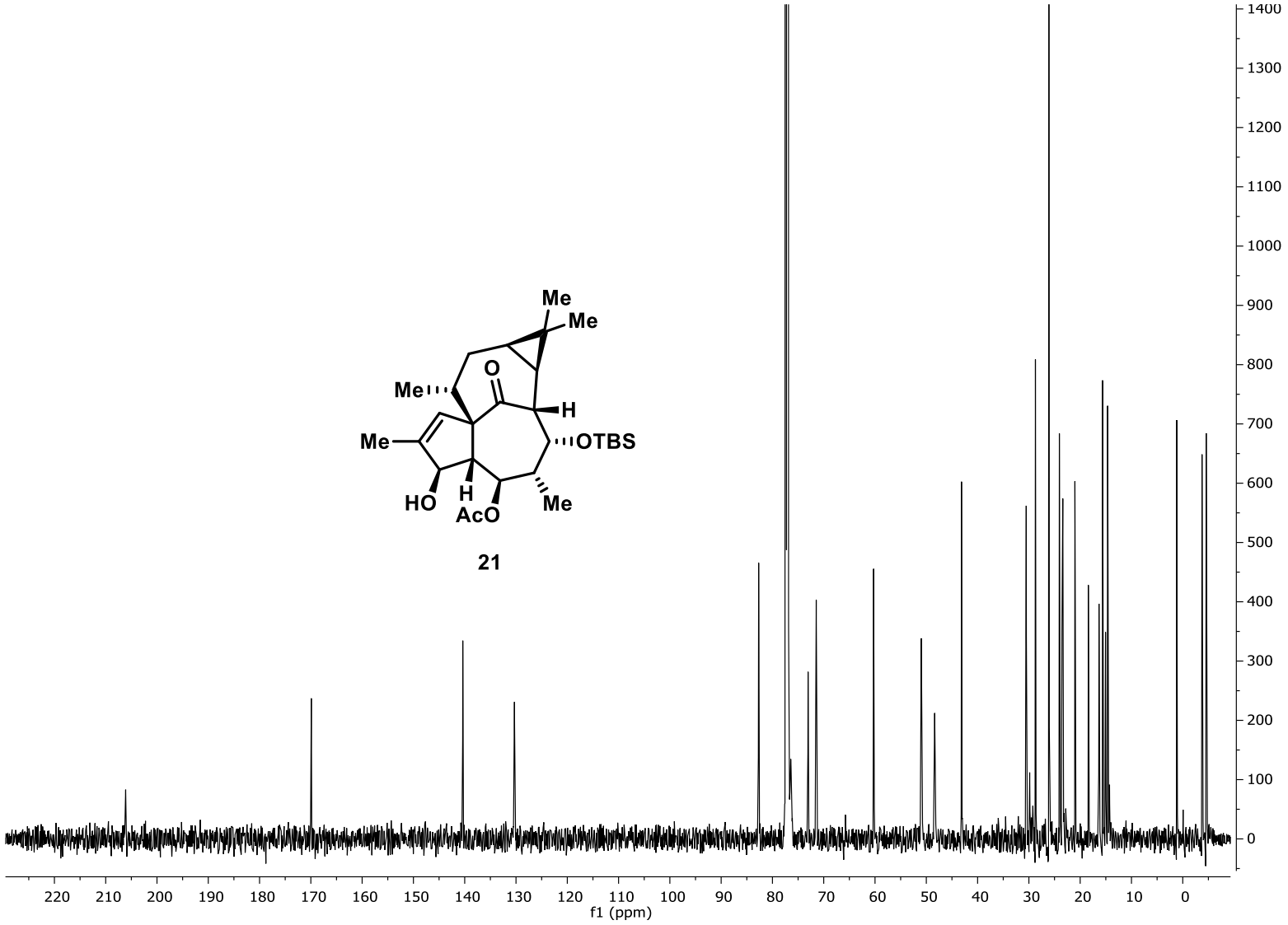

Me
Me
O
Me
H
Me
OTBS
AcO
Me
SI-15
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

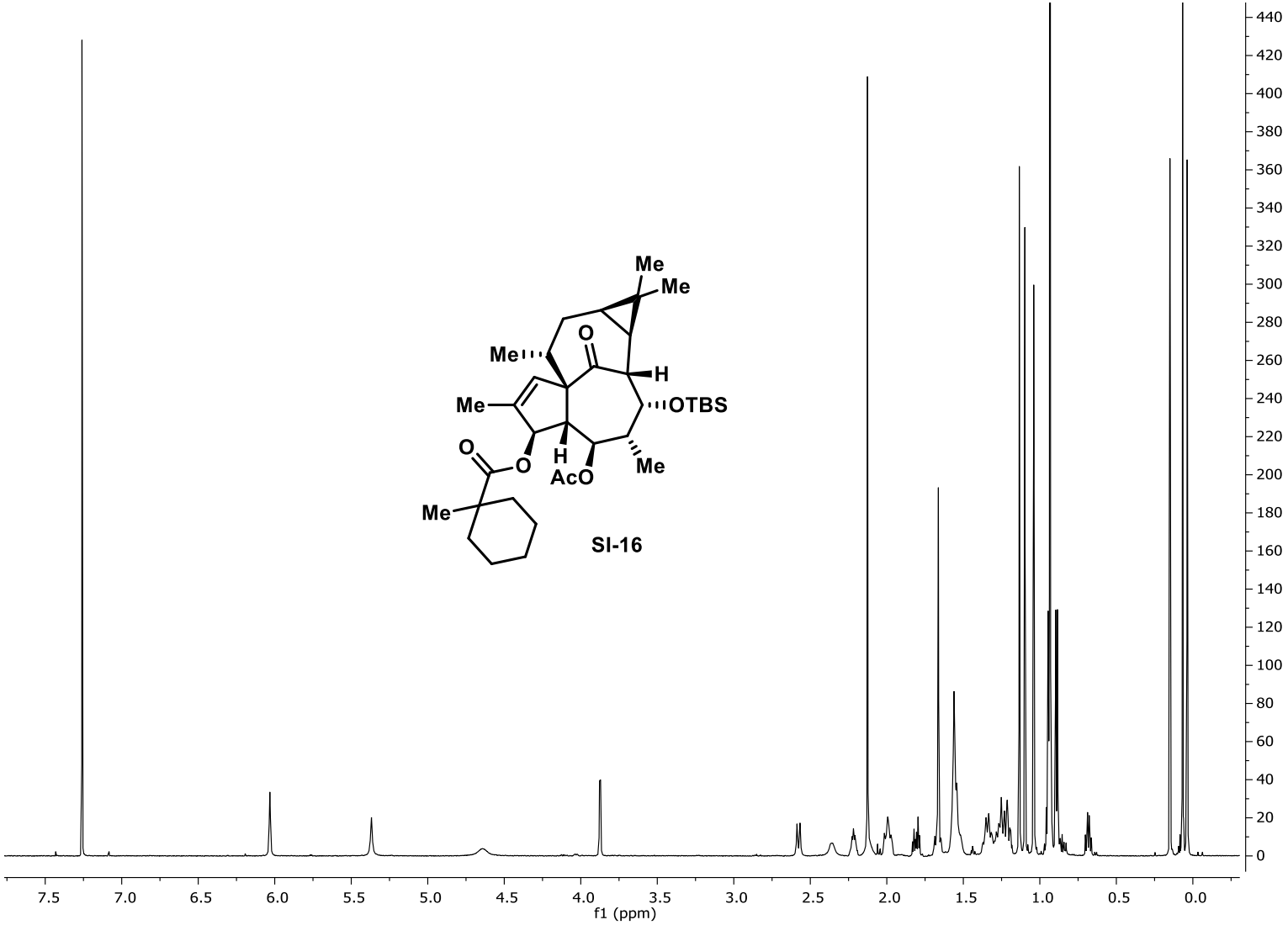

Me
Me
O
Me
H
Me
OTBS
Me
AcO
SI-15
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

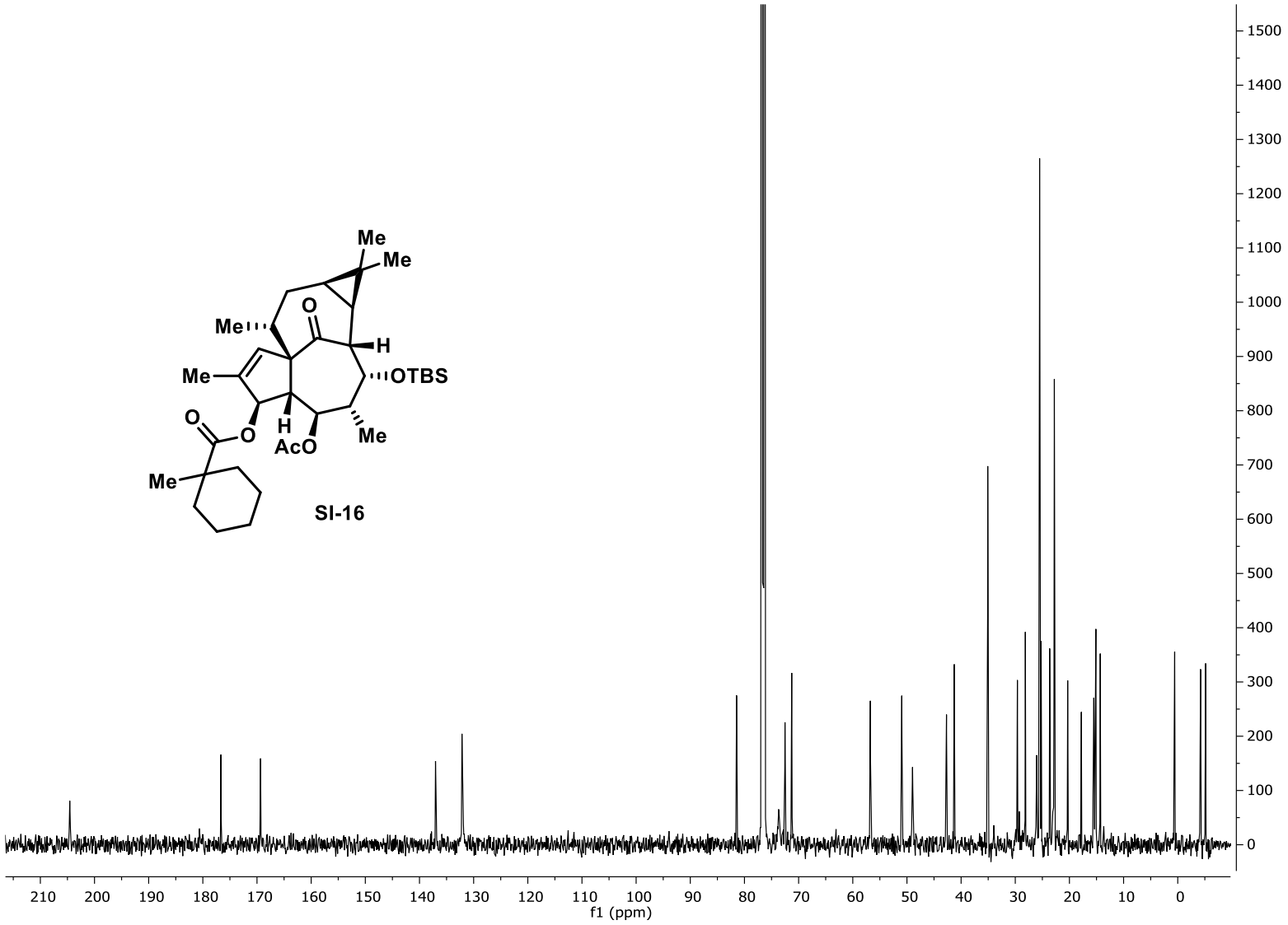

Me
Me
O
Me
H
Me
OTBS
H
AcO
Me
20
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

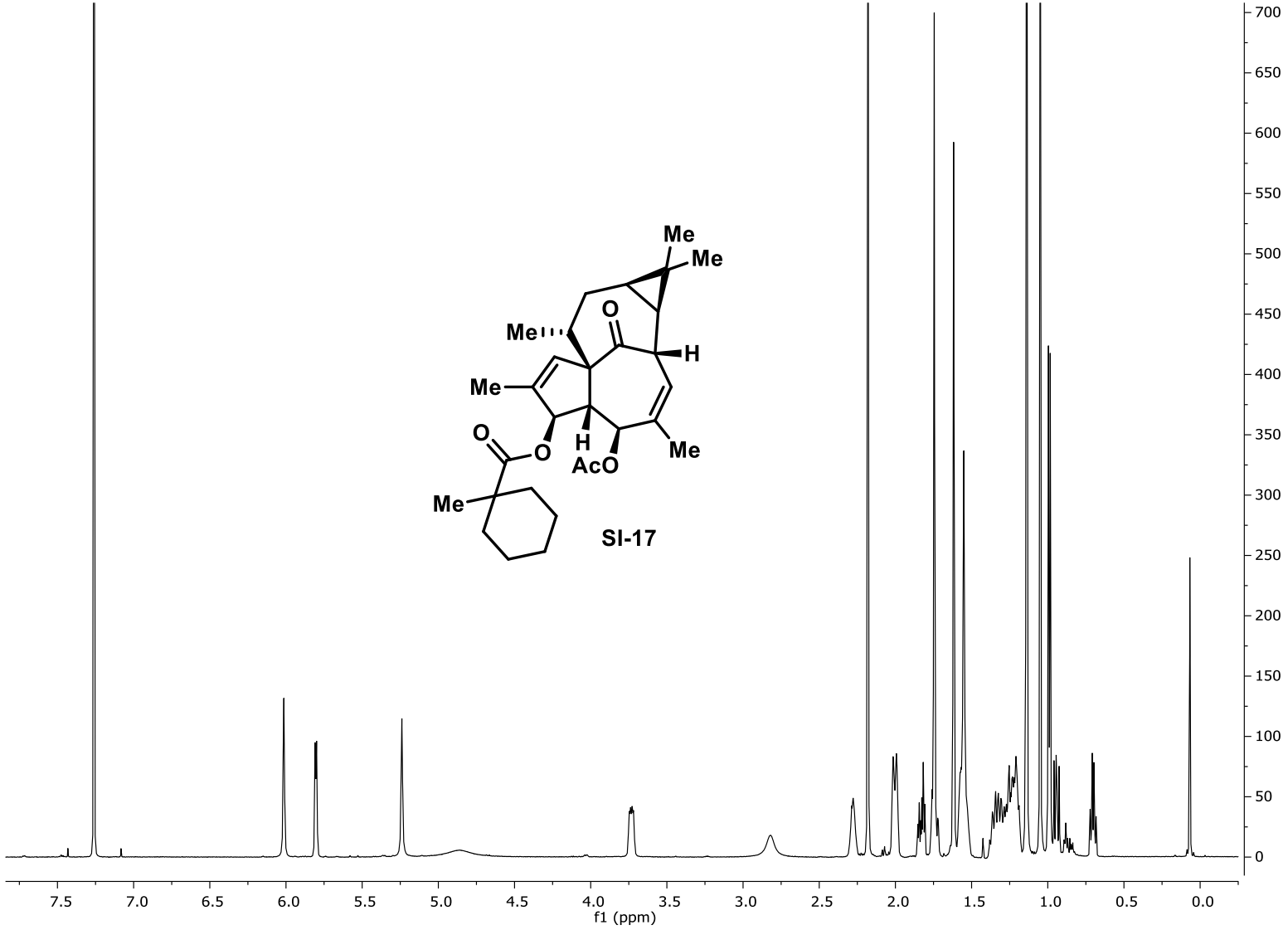

Me
Me
O
Me
H
Me
OTBS
H
AcO
Me
20
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

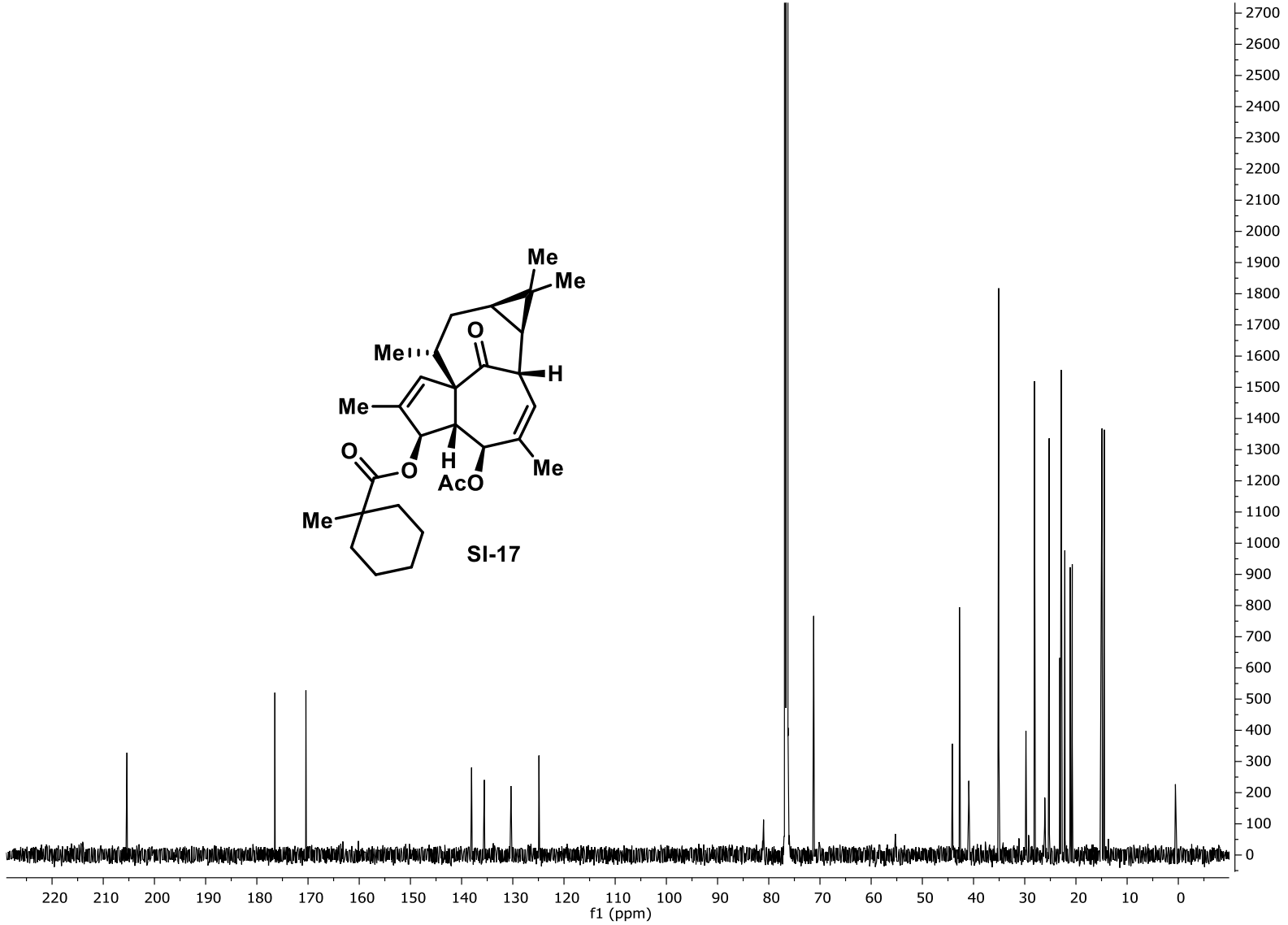

Me
Me
O
Me
H
Me
OTBS
HO
H
AcO
Me
21
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

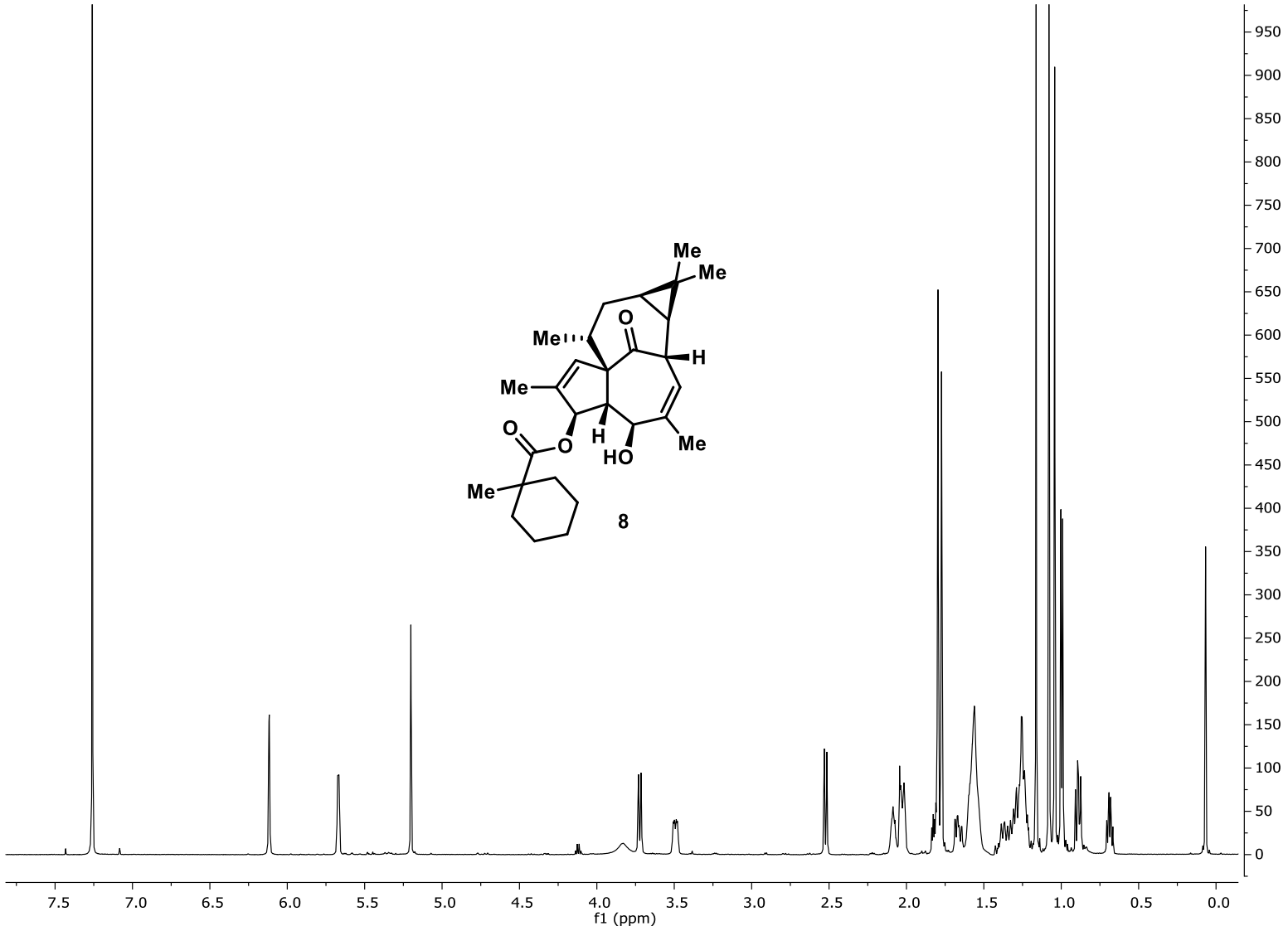

Me
Me
O
Me
H
Me
OTBS
HO
H
AcO
Me
21
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

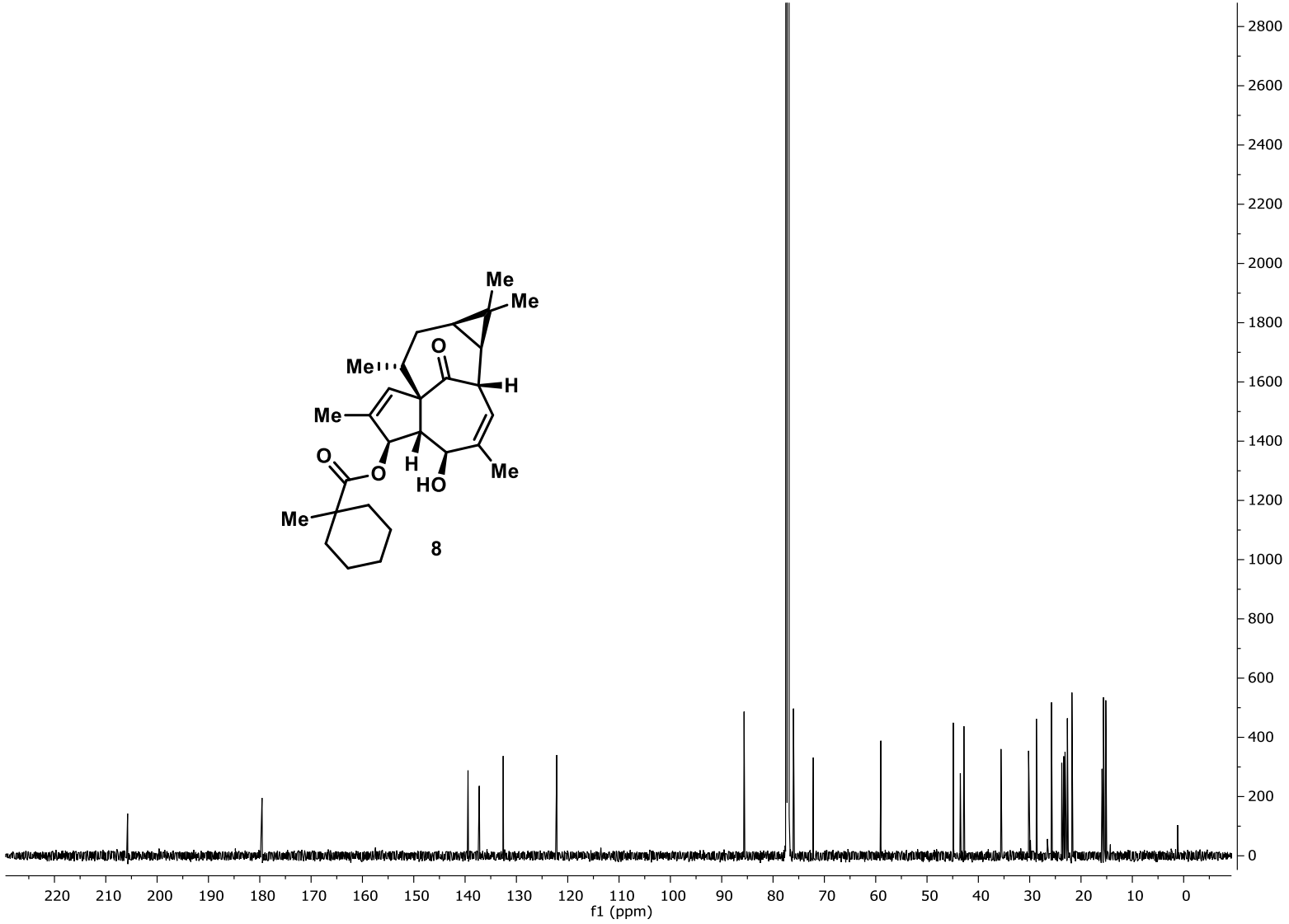

Me
Me
O
Me
H
Me
OTBS
O
O
H
AcO
Me
Me
SI-16
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

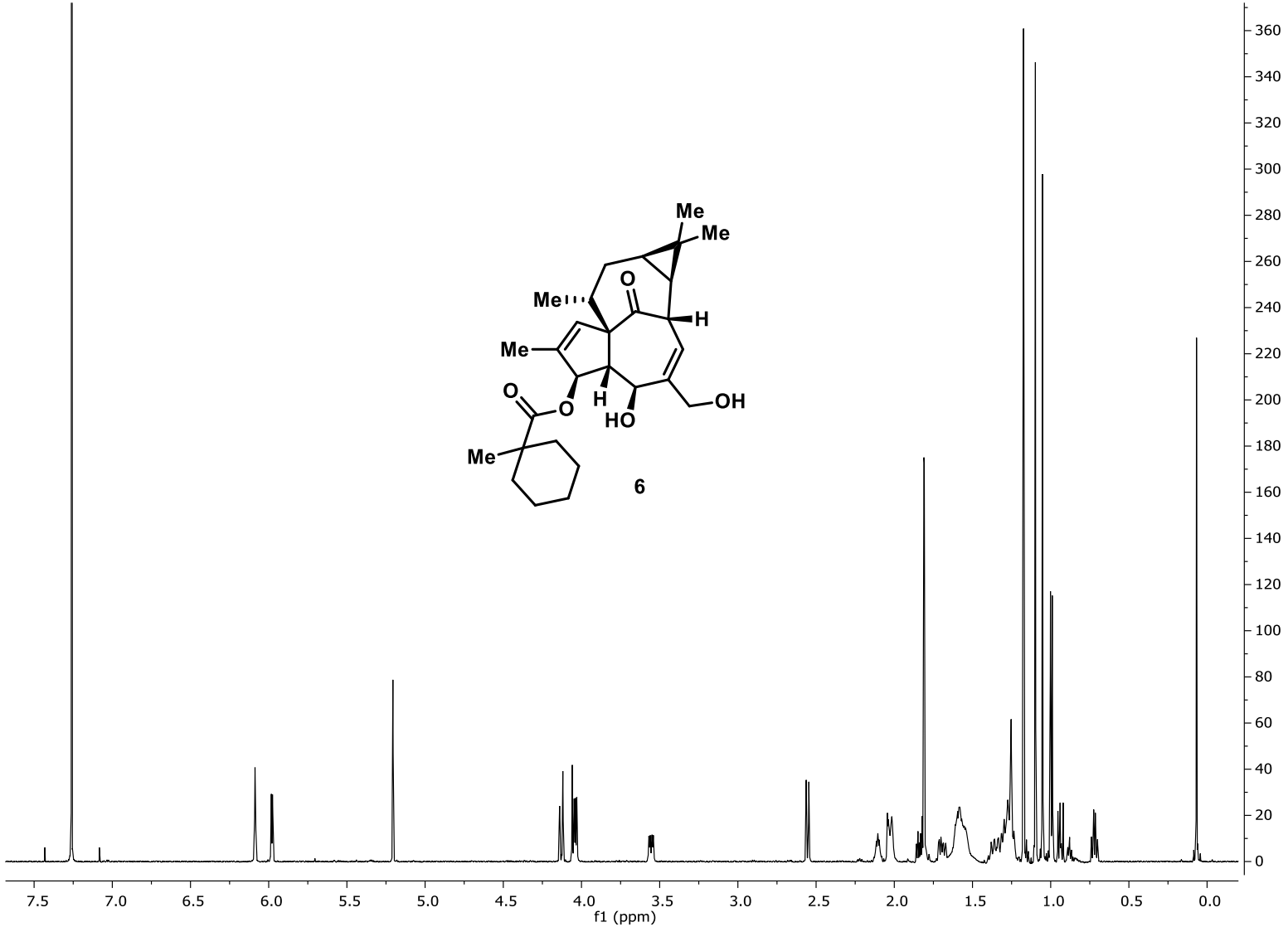

Me
Me
O
Me
H
Me
OTBS
O
O
H
AcO
Me
Me
SI-16
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

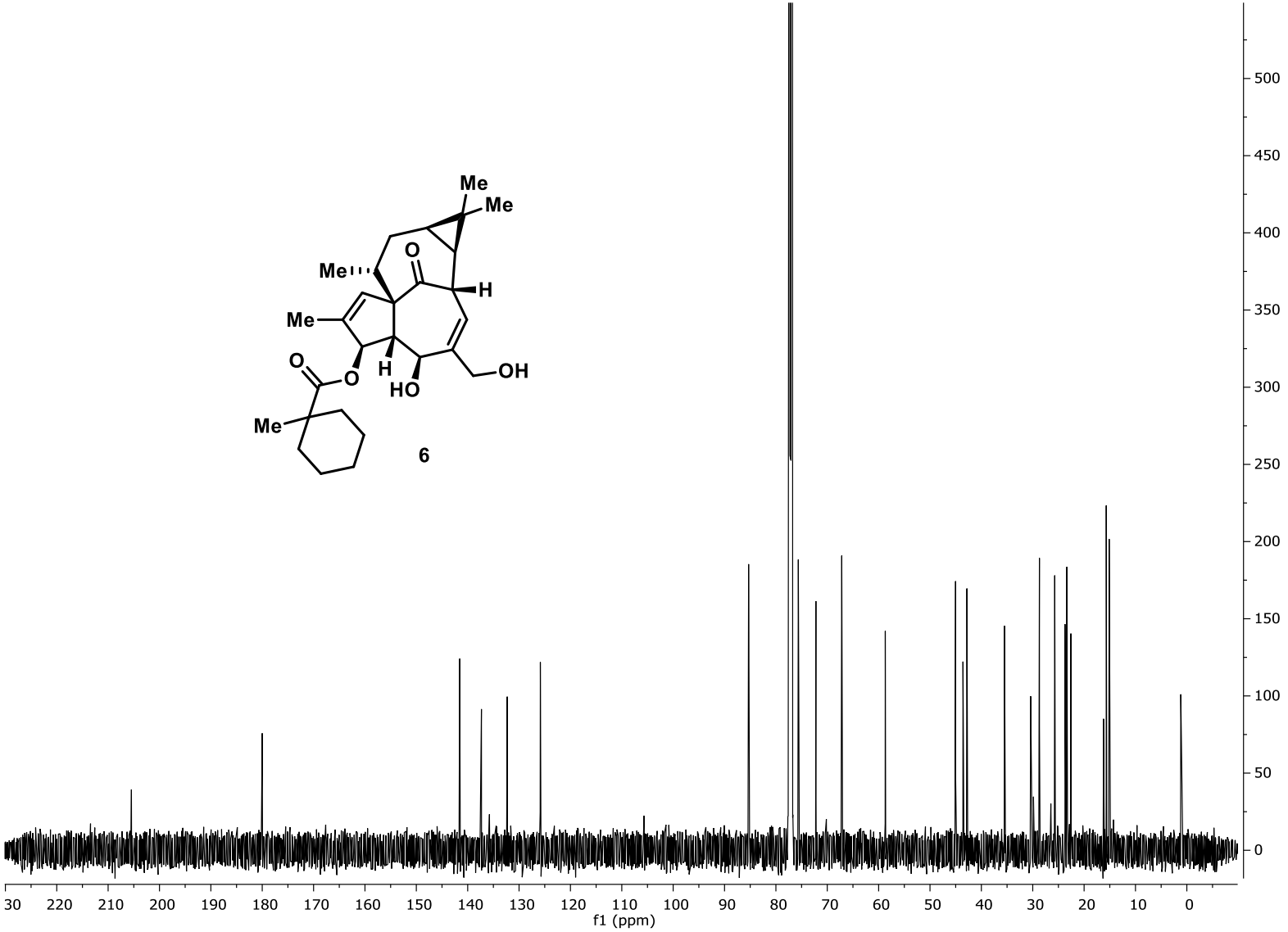

Me
Me
O
Me
H
Me
O
O
H
AcO
Me
Me
SI-17
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


Me
Me
Me
O
H
Me
O
O
H
AcO
Me
Me
SI-17
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

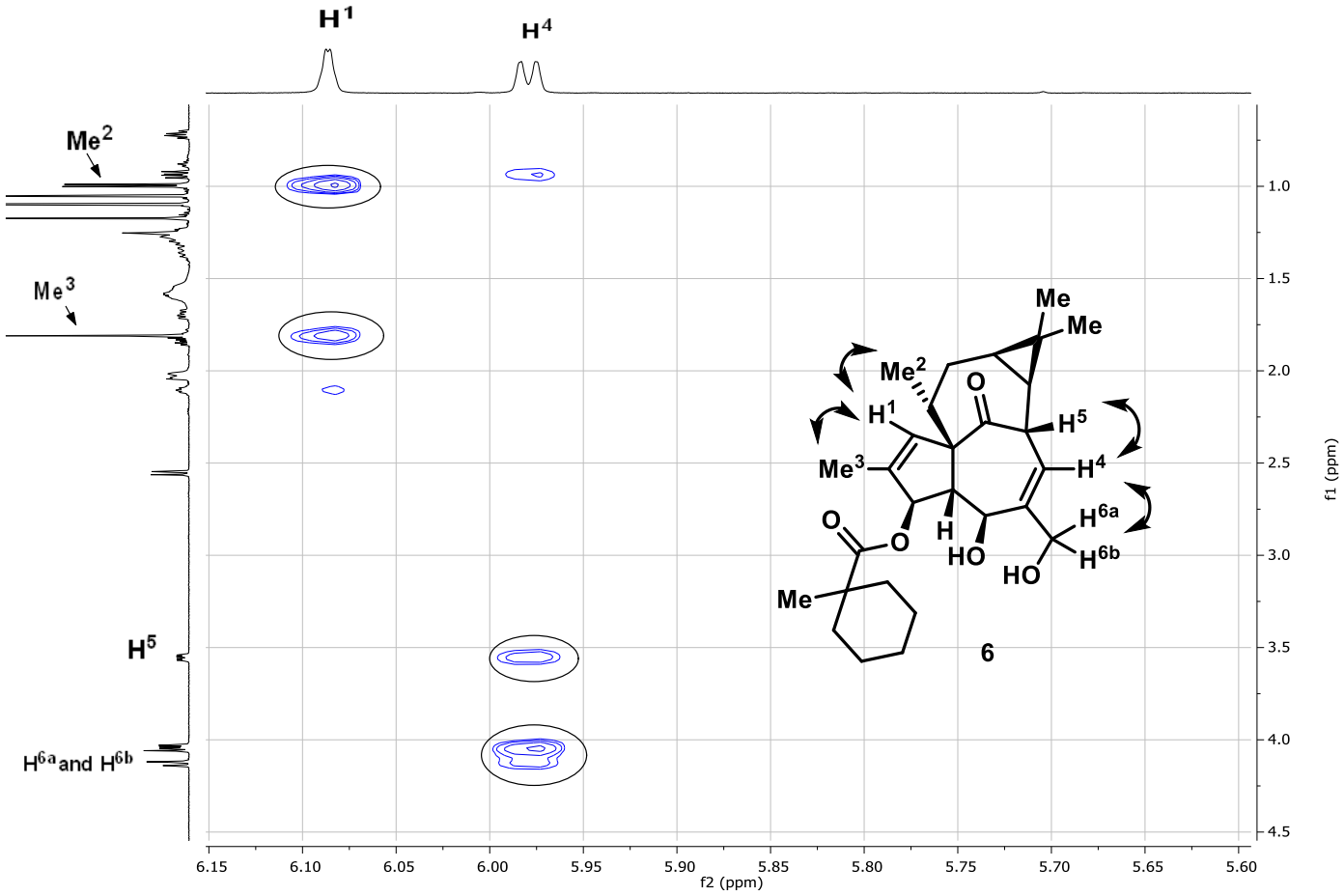

Me
Me
Me
O
H
Me
O
O
H
HO
Me
Me
8
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

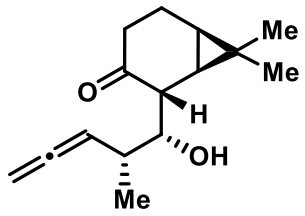

Me
Me
O
Me
H
Me
O
O
H
HO
Me
Me
8
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Me
Me
O
Me
H
Me
O
O
H
HO
OH
Me
6
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


Me
Me
O
Me
H
Me
O
O
H
HO
OH
Me
6
500
450
400
350
300
250
200
150
100
50
0
30 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

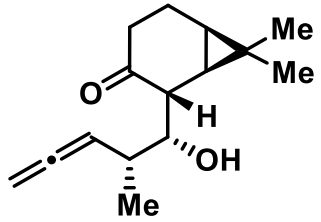
2D NOESY


H1
H4
Me2
Me3
H5
H6a and H6b
f2 (ppm)
f1 (ppm)
Me
Me
Me2
O
H1
H5
Me3
H4
O
O
H
HO
H6a
H6b
HO
Me
6

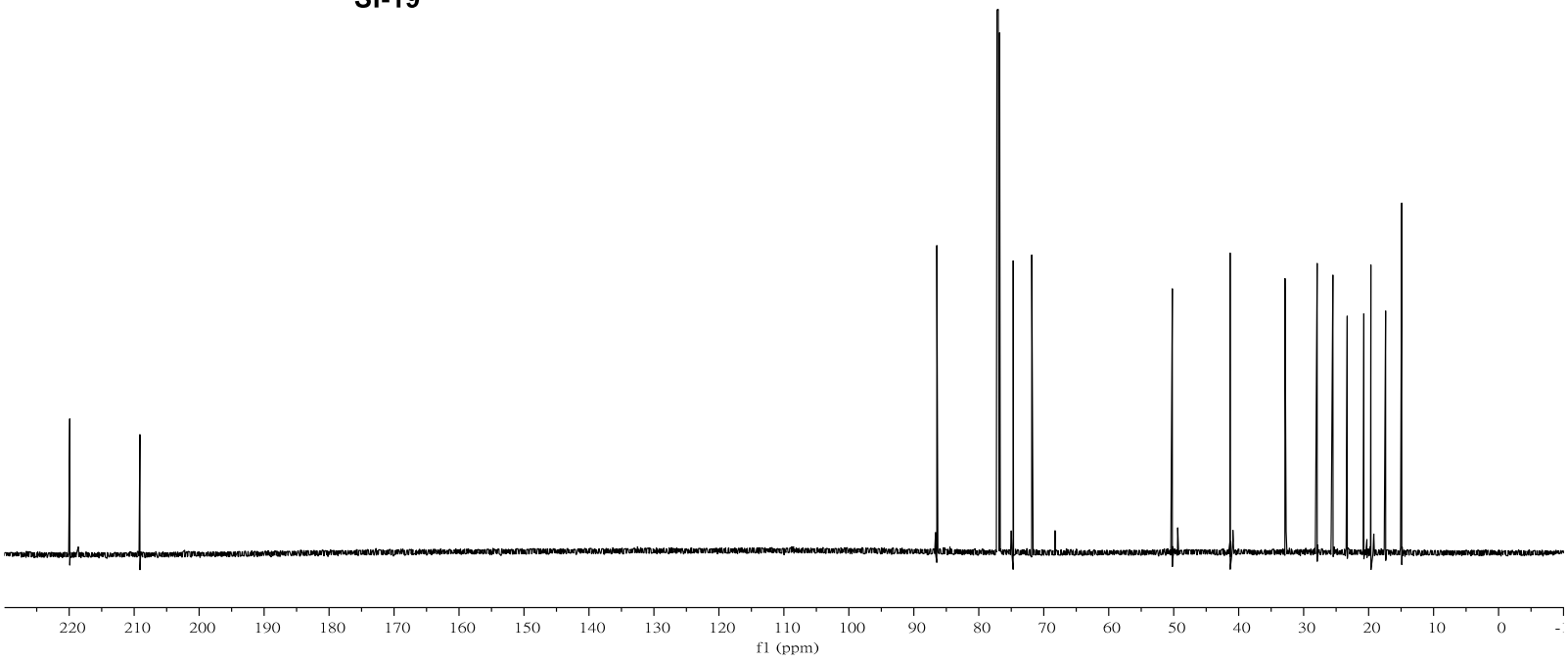

Me
Me
O
H
OH
Me

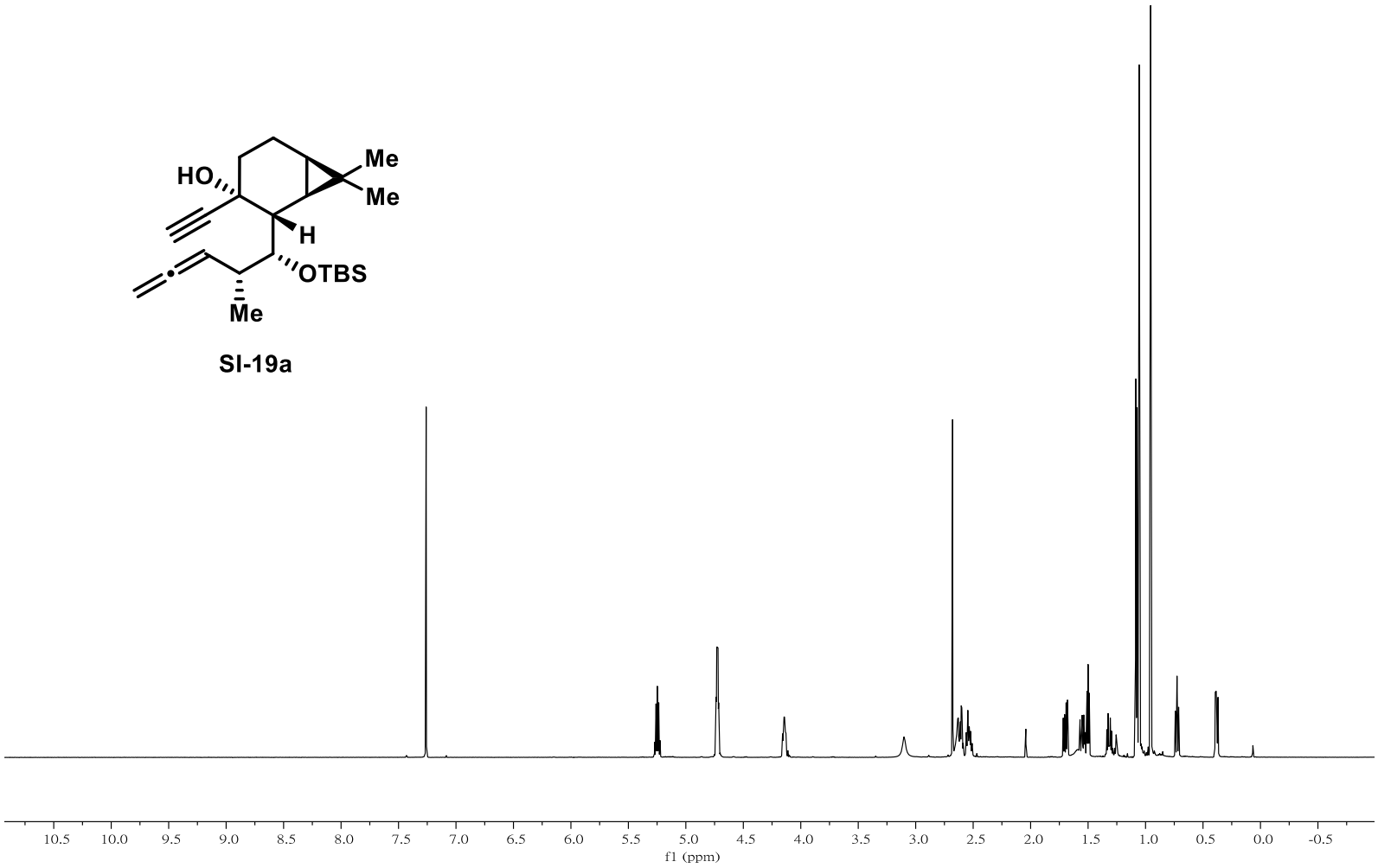
SI-19

10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)

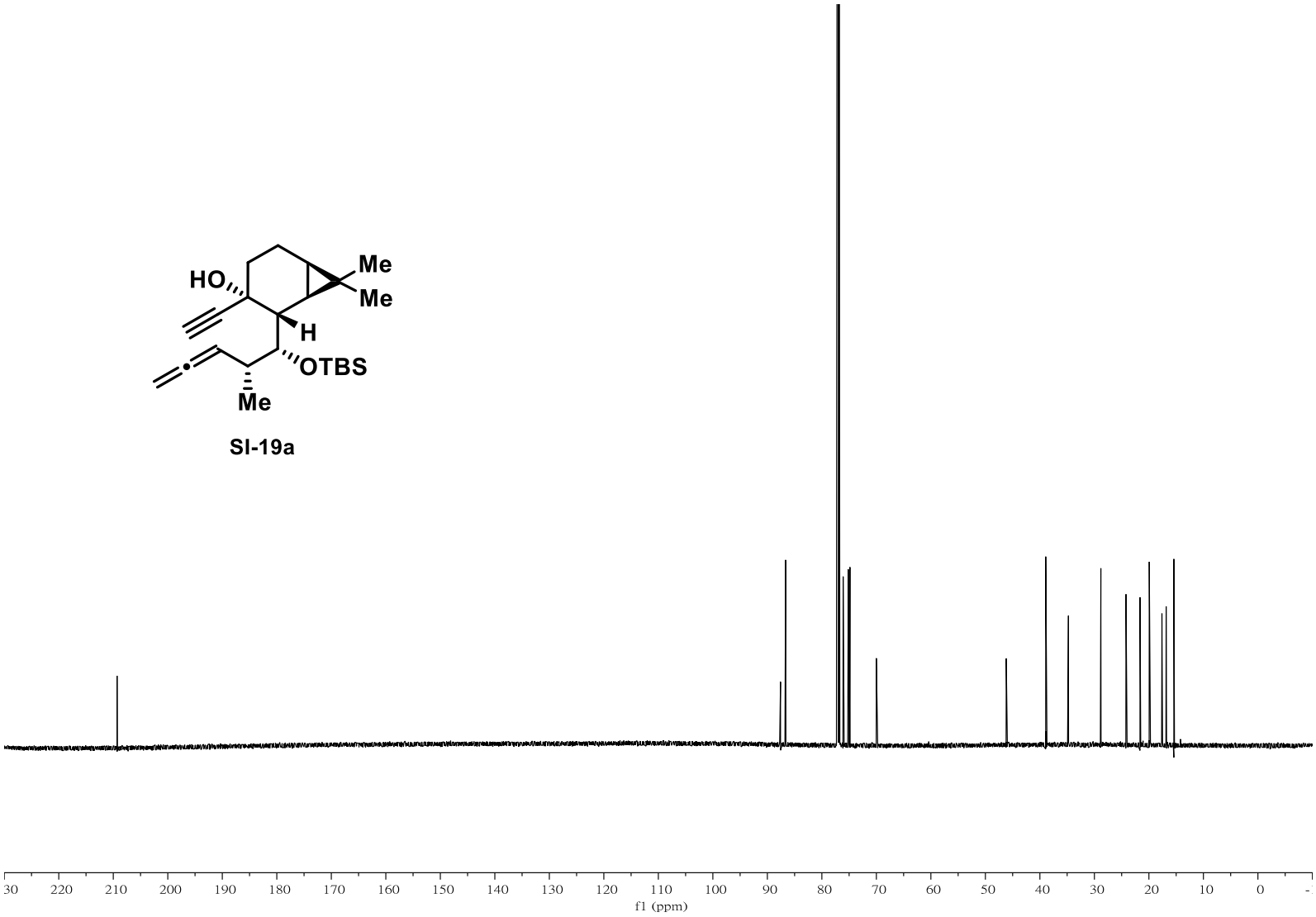

Me
Me
O
H
OH
Me

SI-19

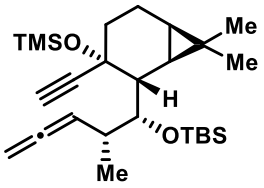

220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


HO
Me
Me
H
OTBS
Me
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

SI-19a

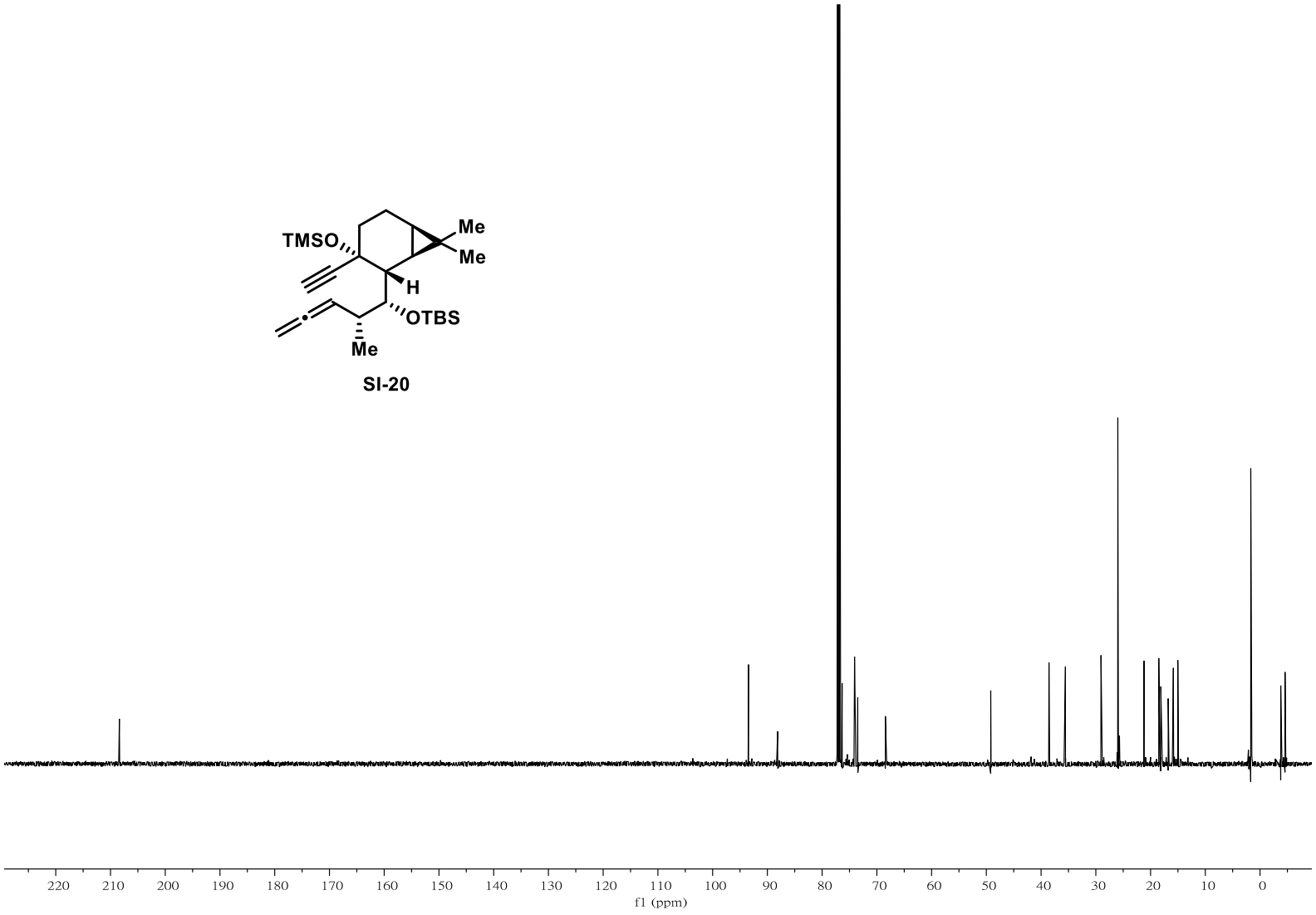

HO
Me
Me
H
OTBS
Me
30
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-
f1 (ppm)

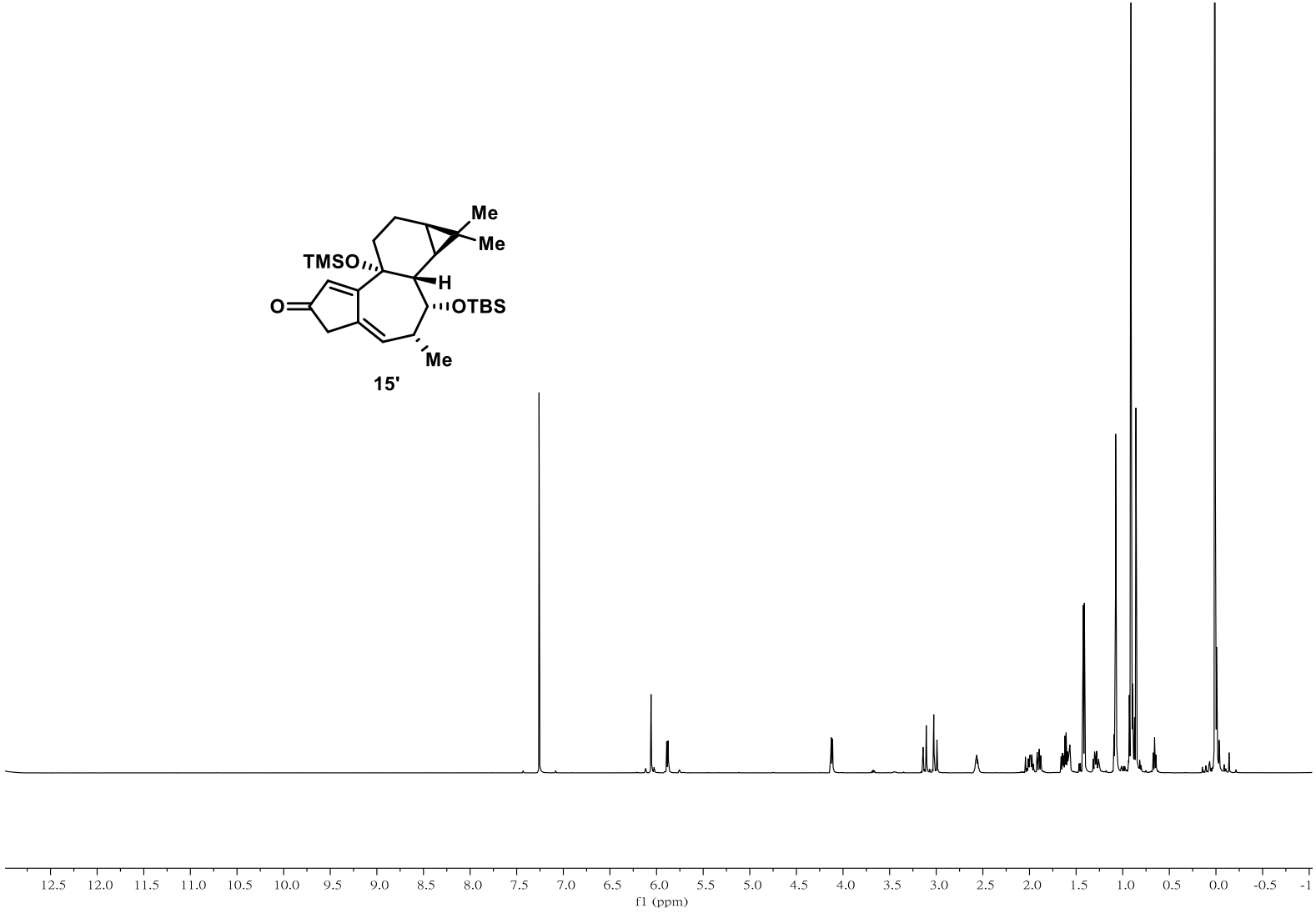
SI-19a

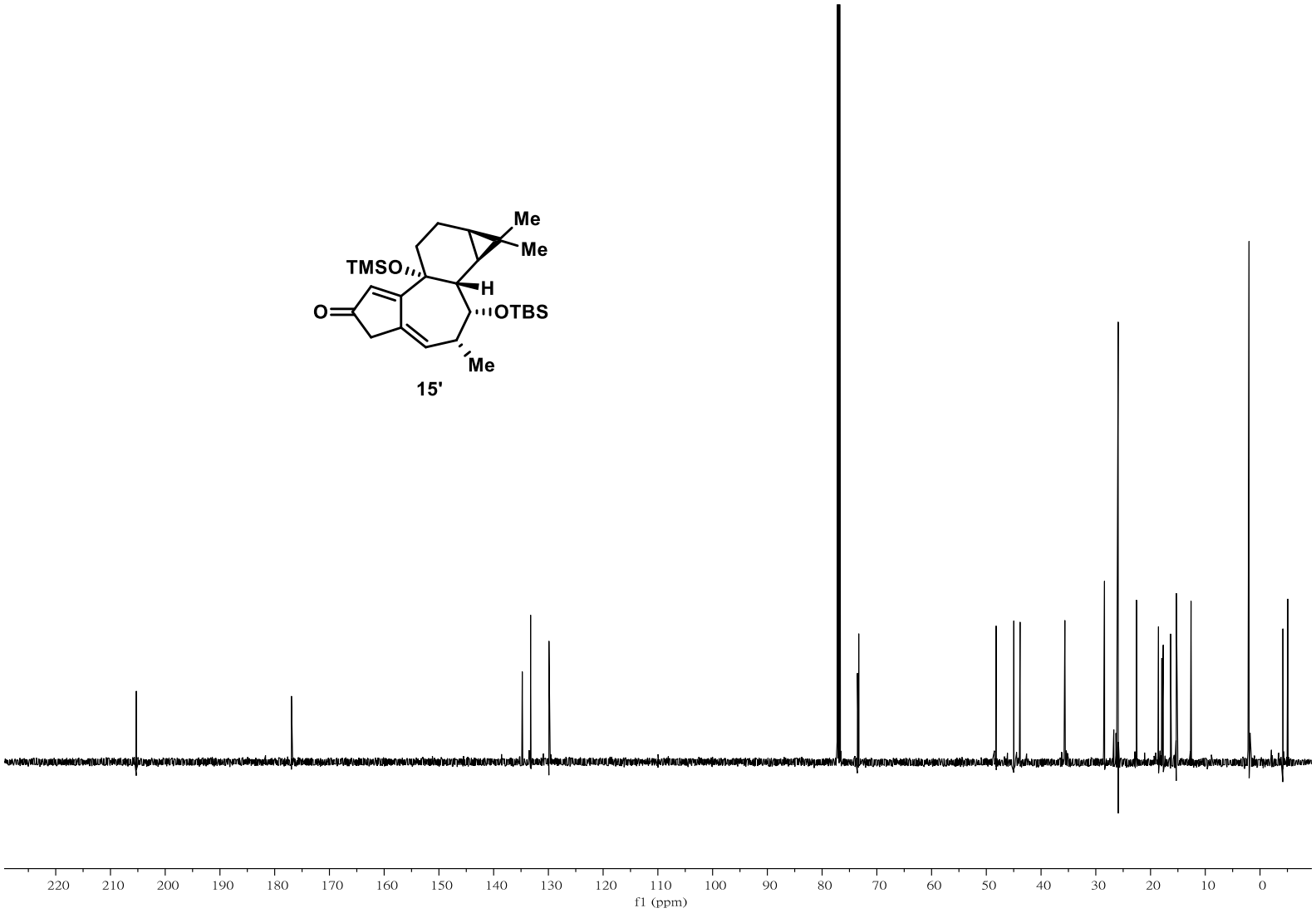

TMSO
Me
Me
H
OTBS
Me

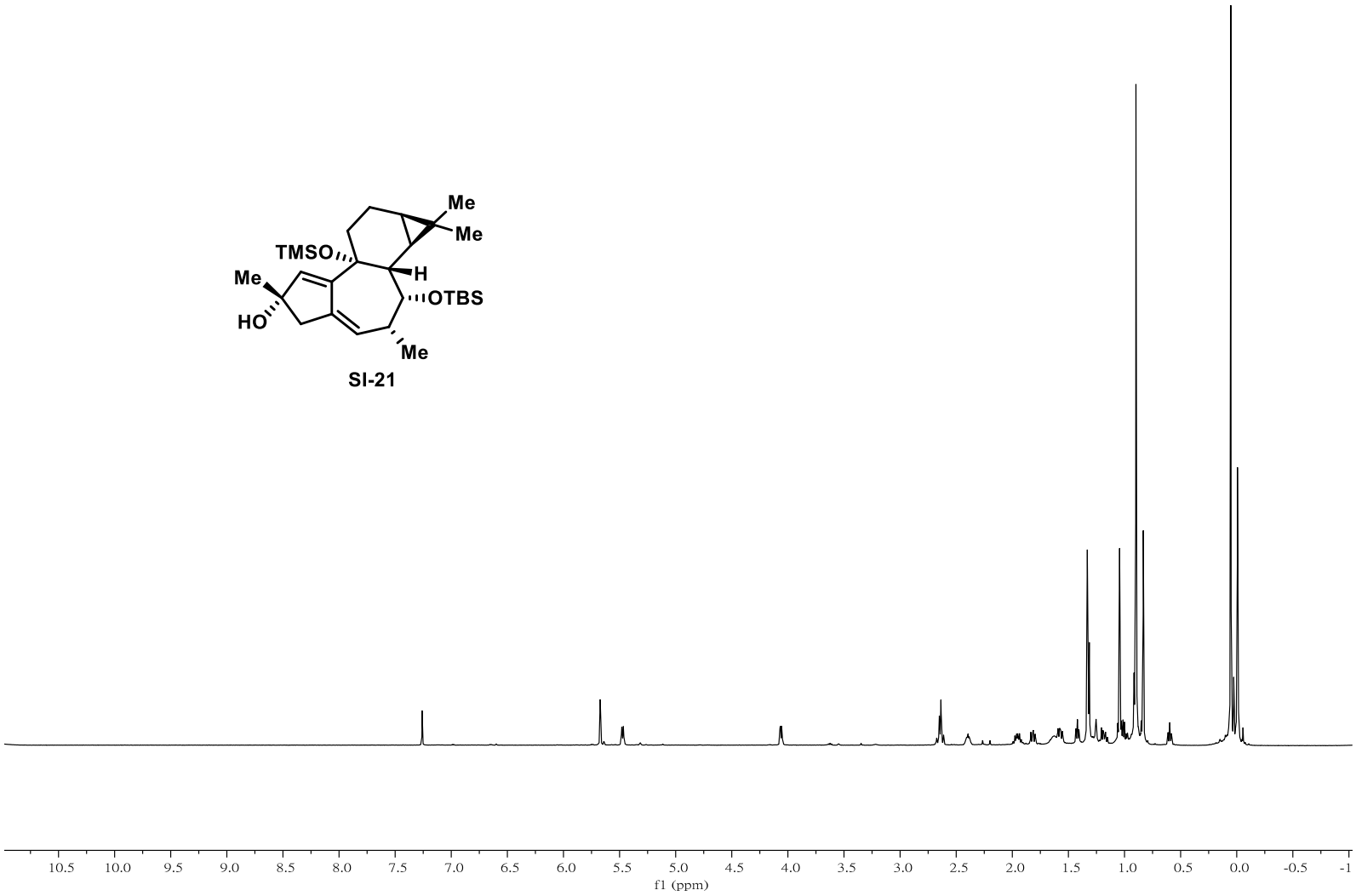
SI-20

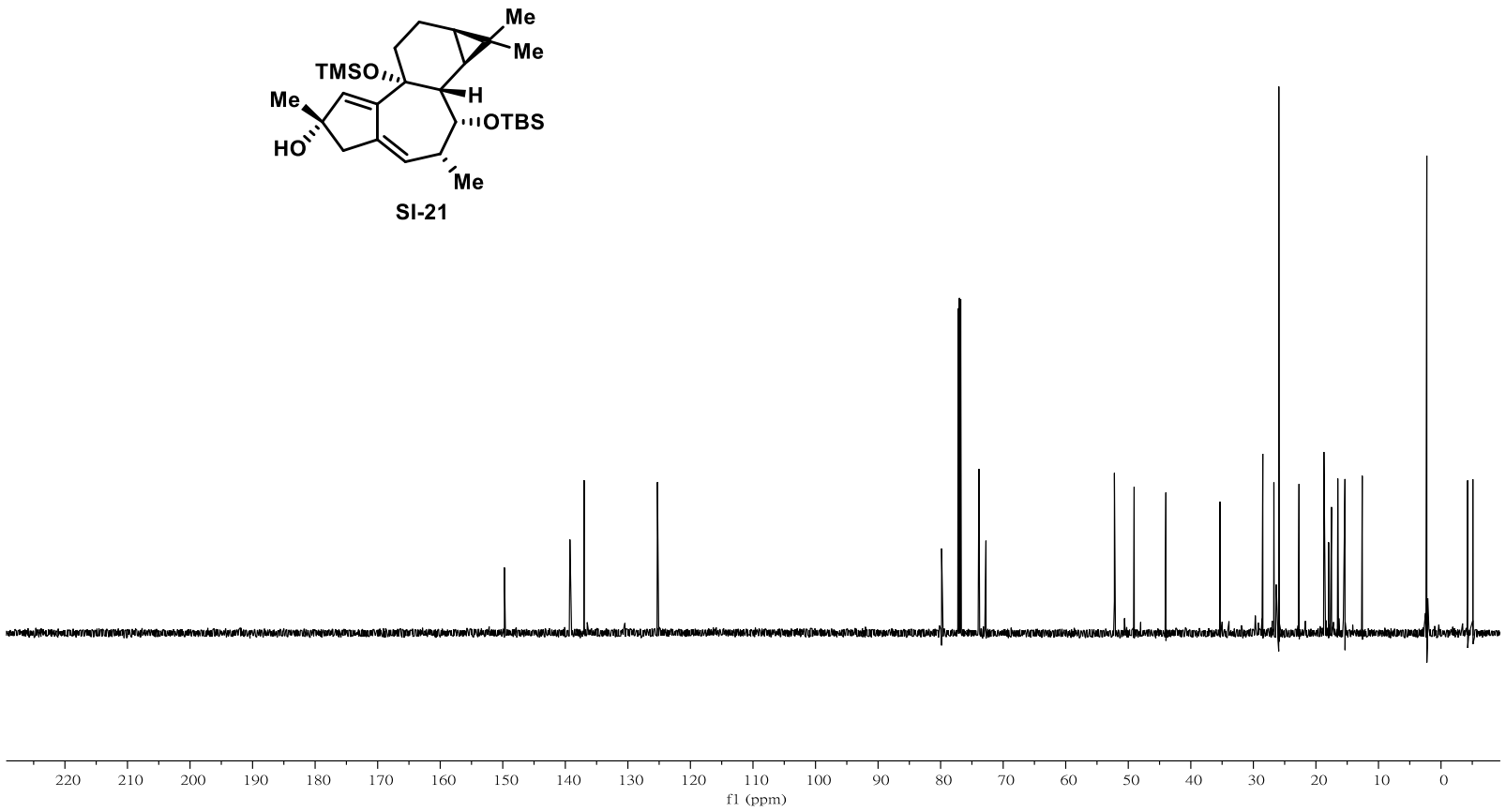
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

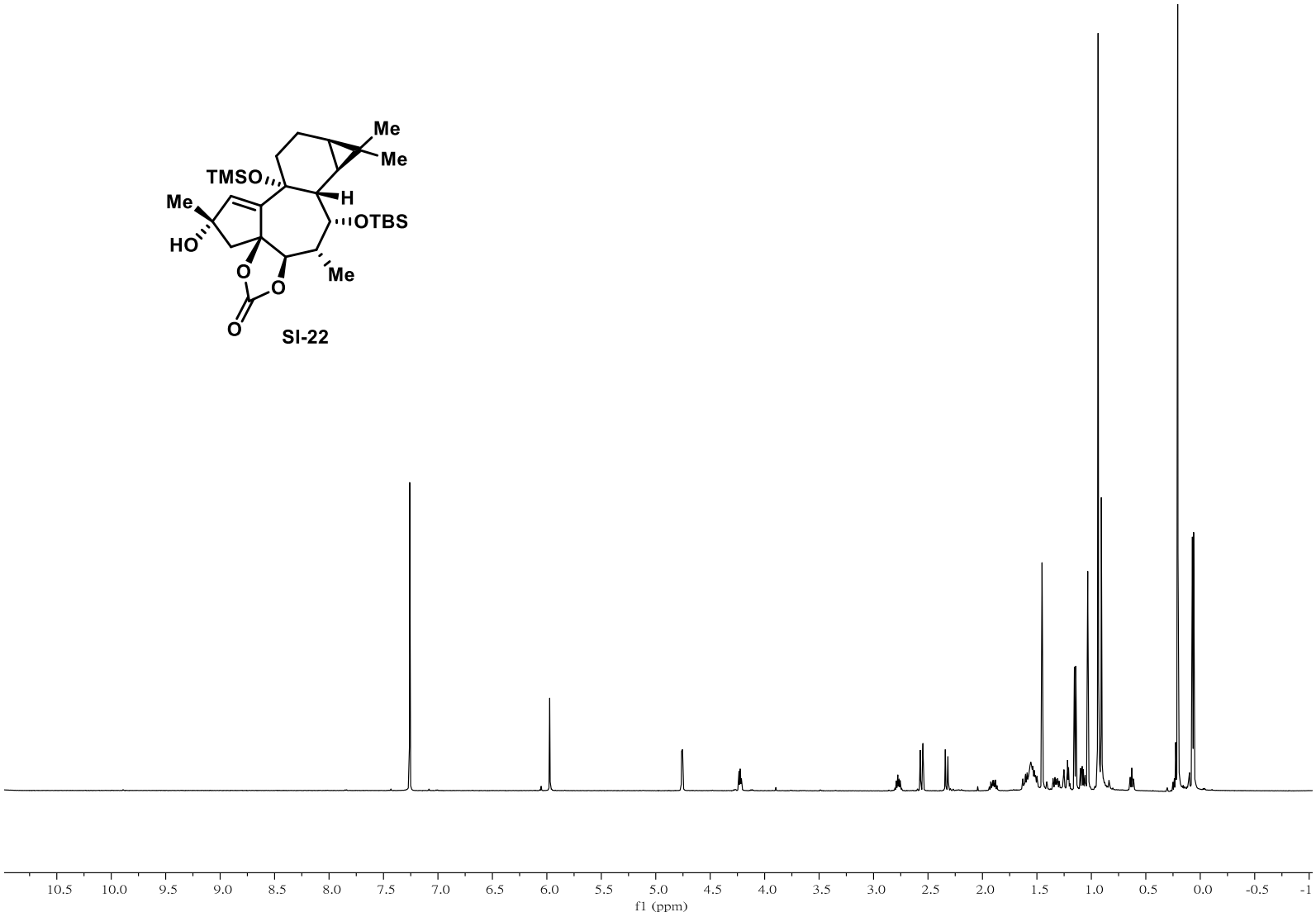

TMSO
Me
Me
H
OTBS
Me
SI-20
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

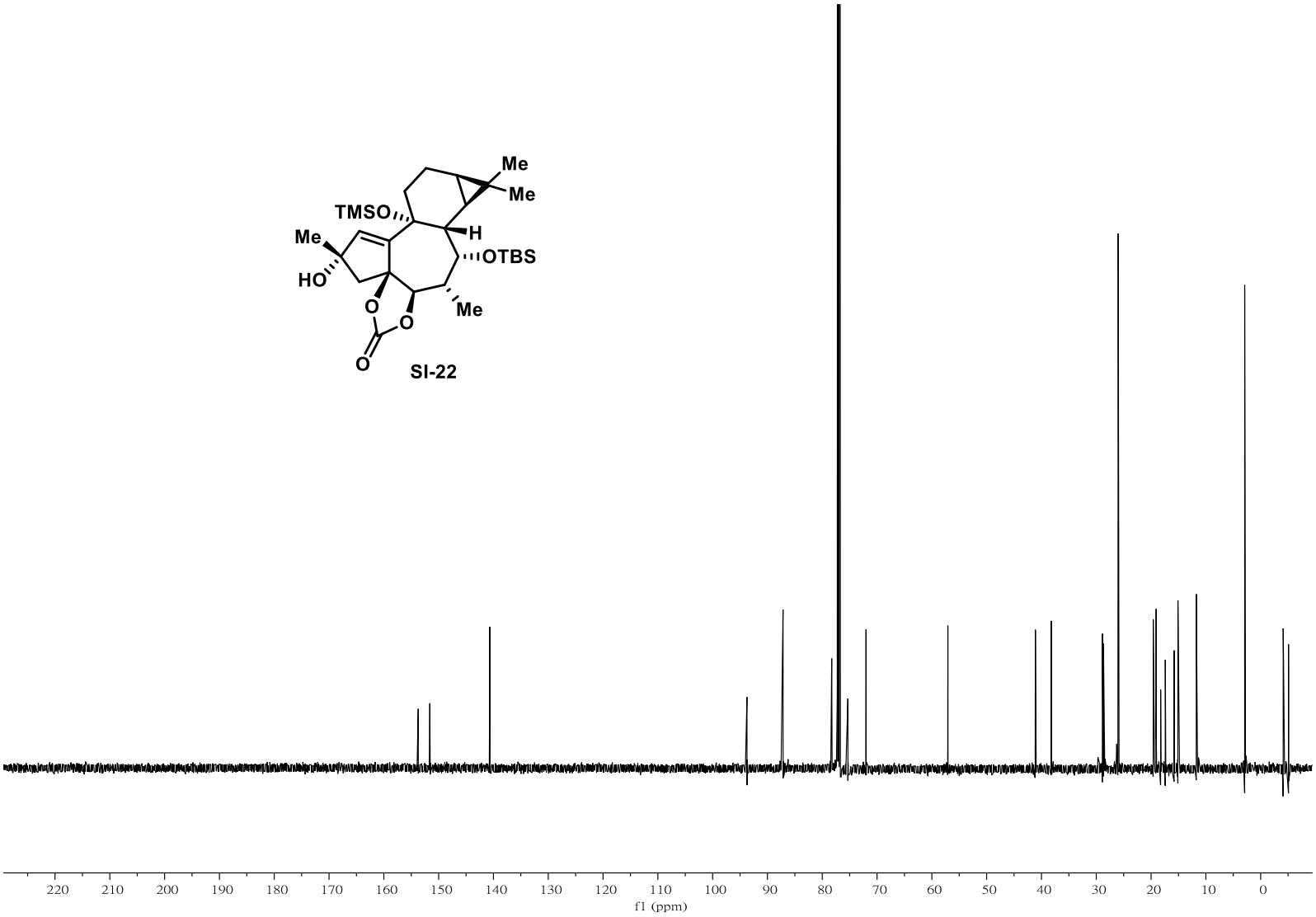

Me
Me
TMSO
H
O
OTBS
Me
15'
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)

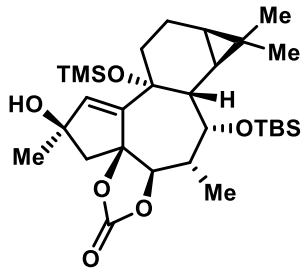

Me
Me
TMSO
H
O
OTBS
Me
15'
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


Me
Me
TMSO
H
Me
OTBS
HO
Me
SI-21
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)


Me
Me
TMSO
Me
H
OTBS
HO
Me
SI-21
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

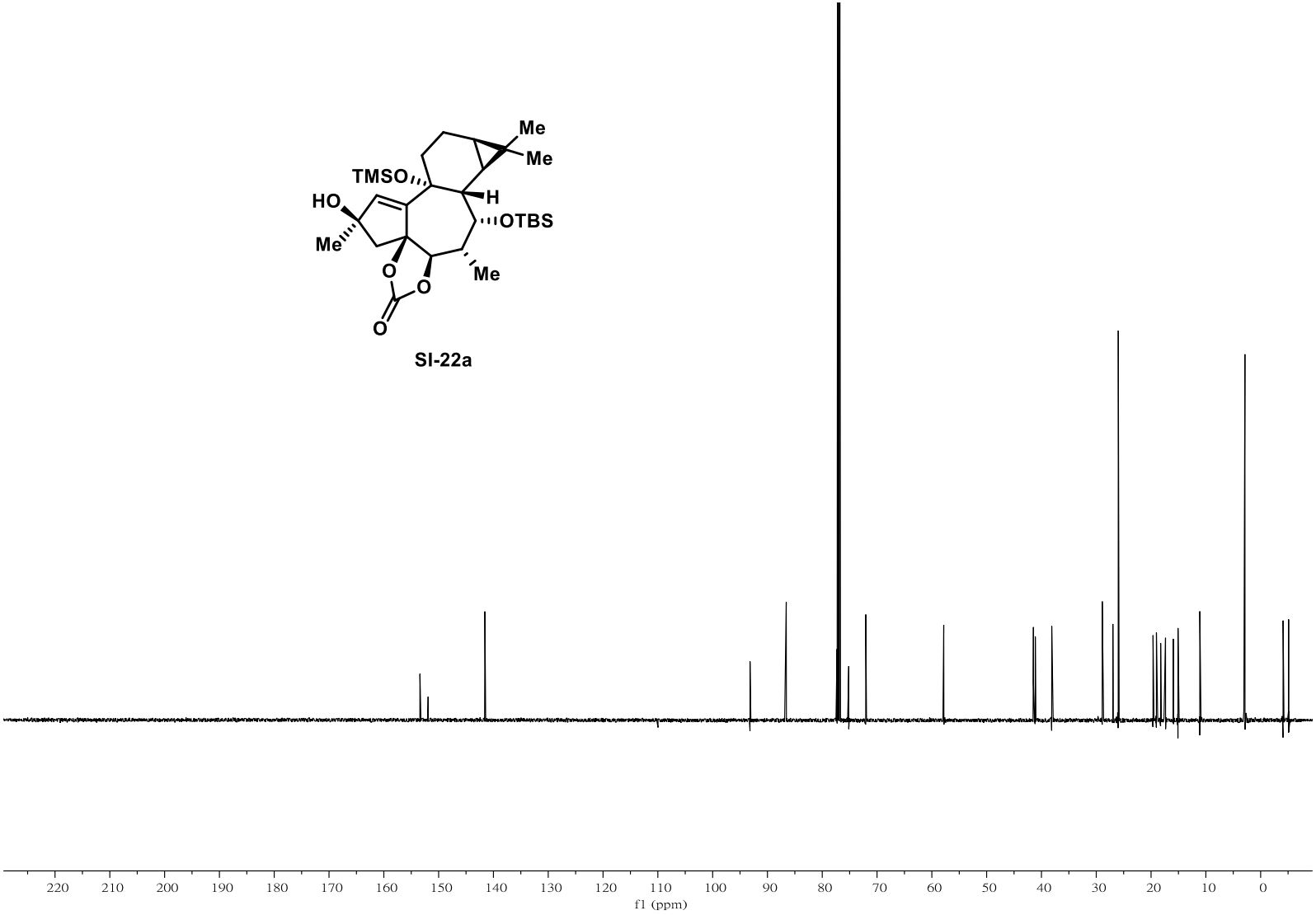

Me
Me
TMSO
H
Me
OTBS
HO
Me
O
O
O
SI-22
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)

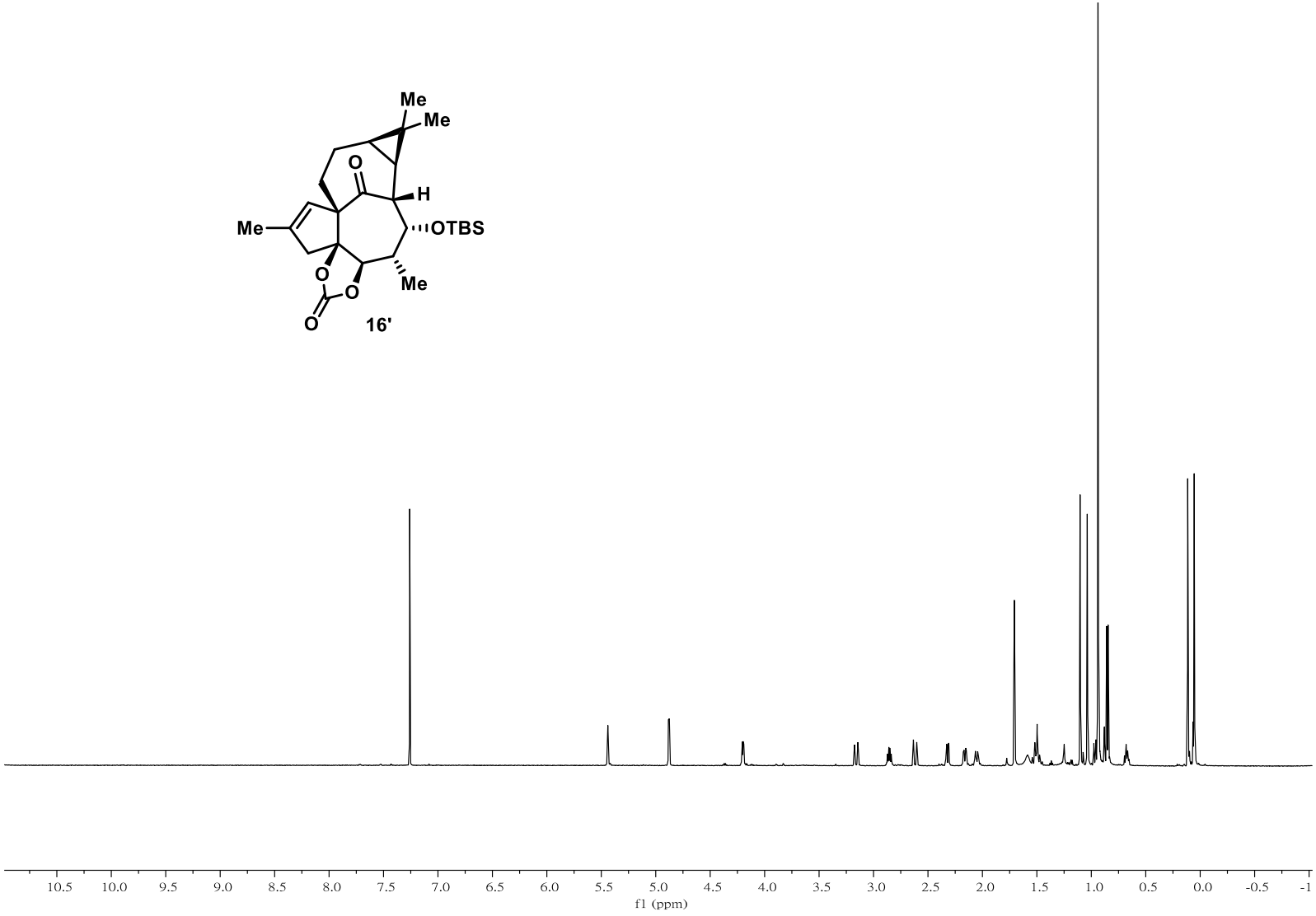

Me
Me
TMSO
H
Me
OTBS
HO
O
O
Me
O
SI-22
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

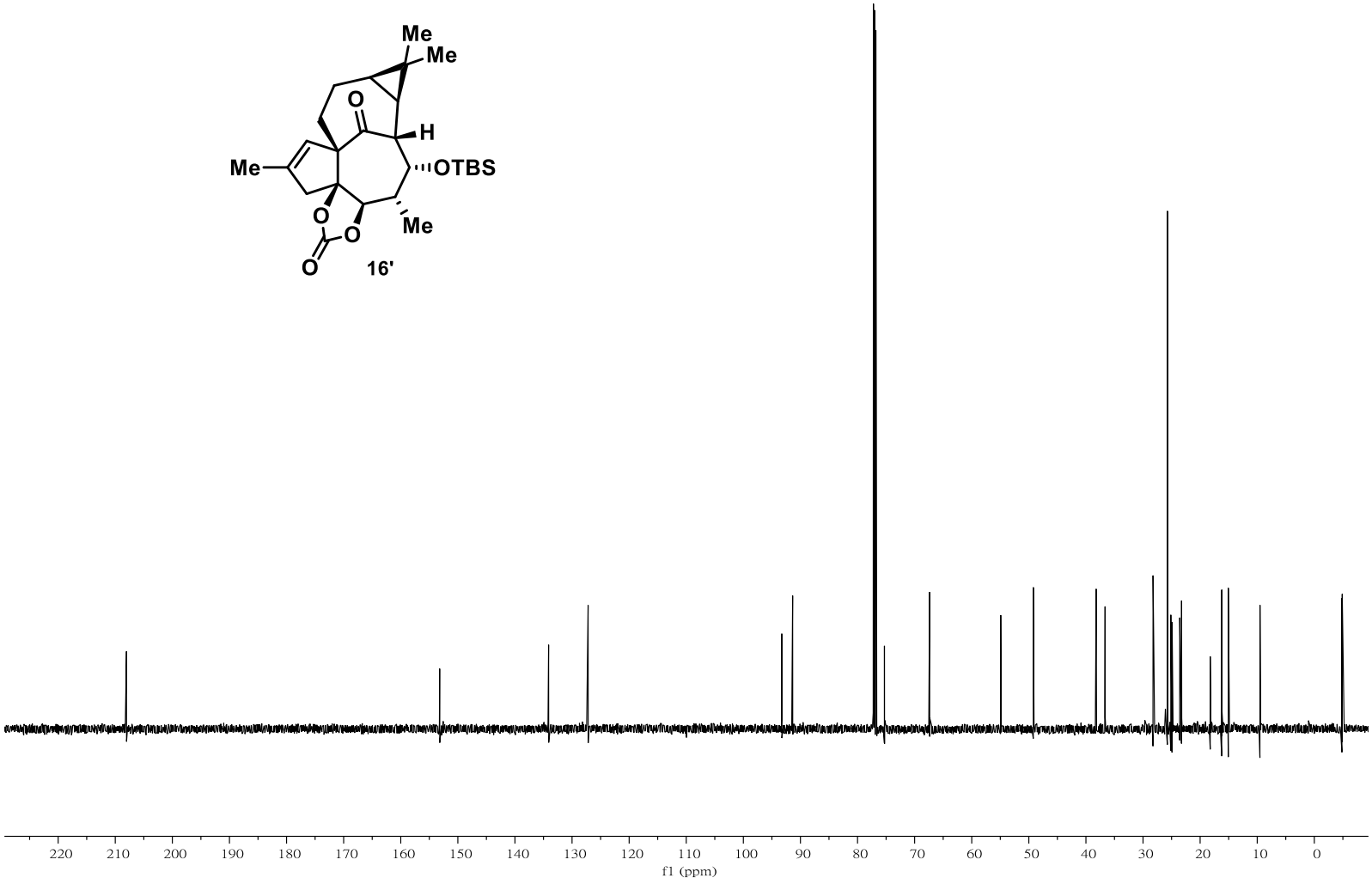

Me
Me
TMSO
H
HO
OTBS
Me
Me
O
O
O

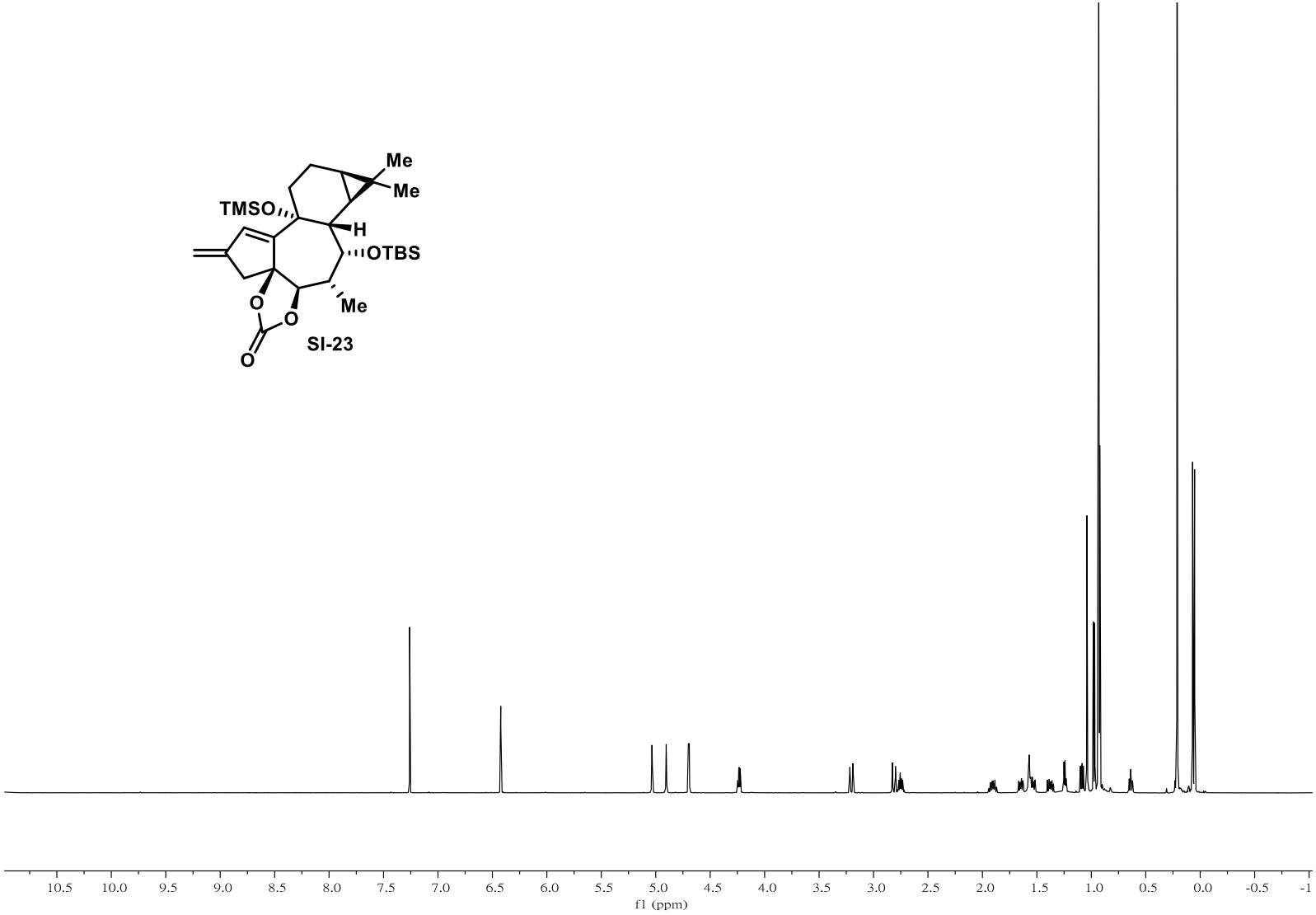
SI-22a

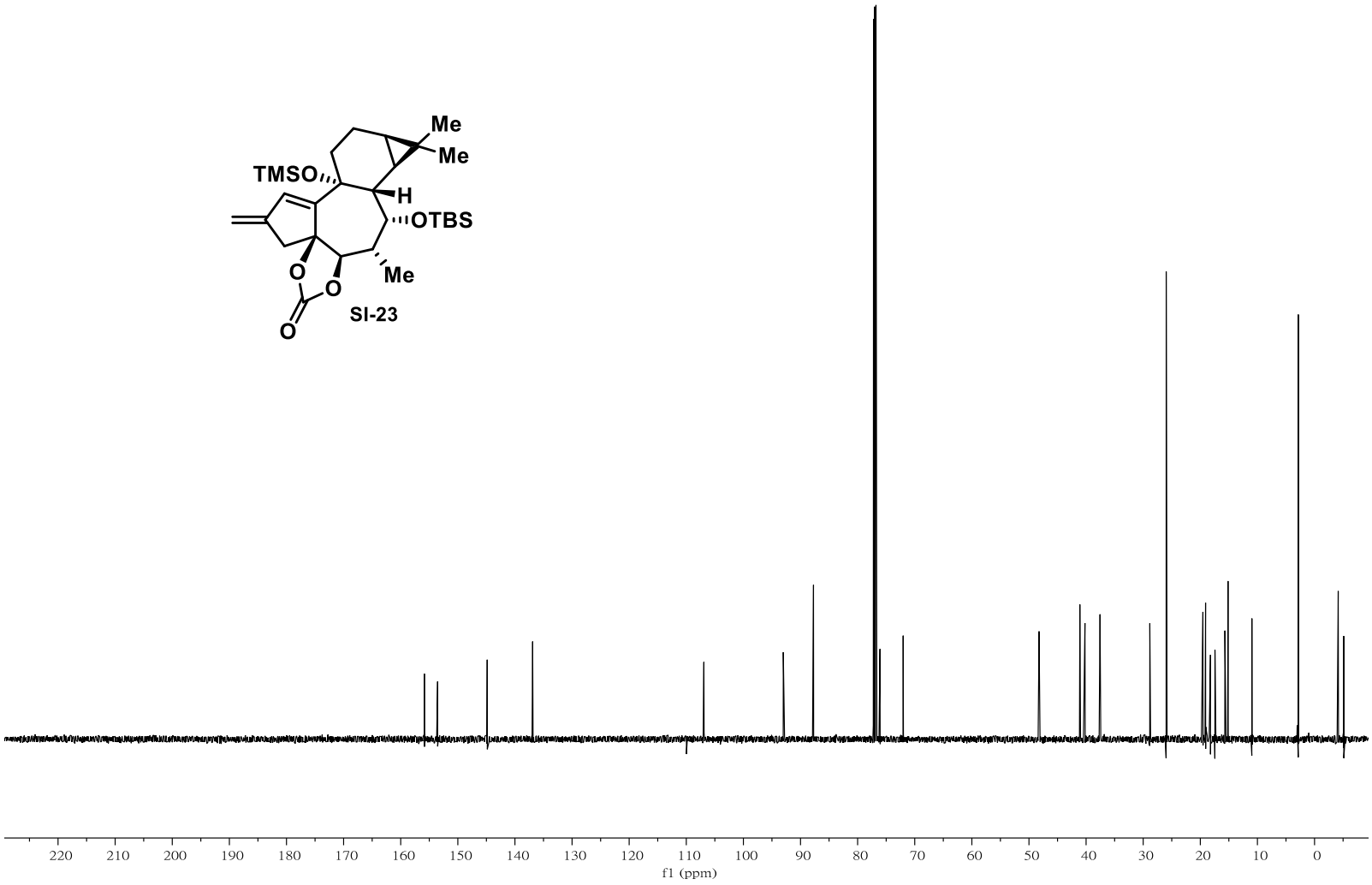
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)

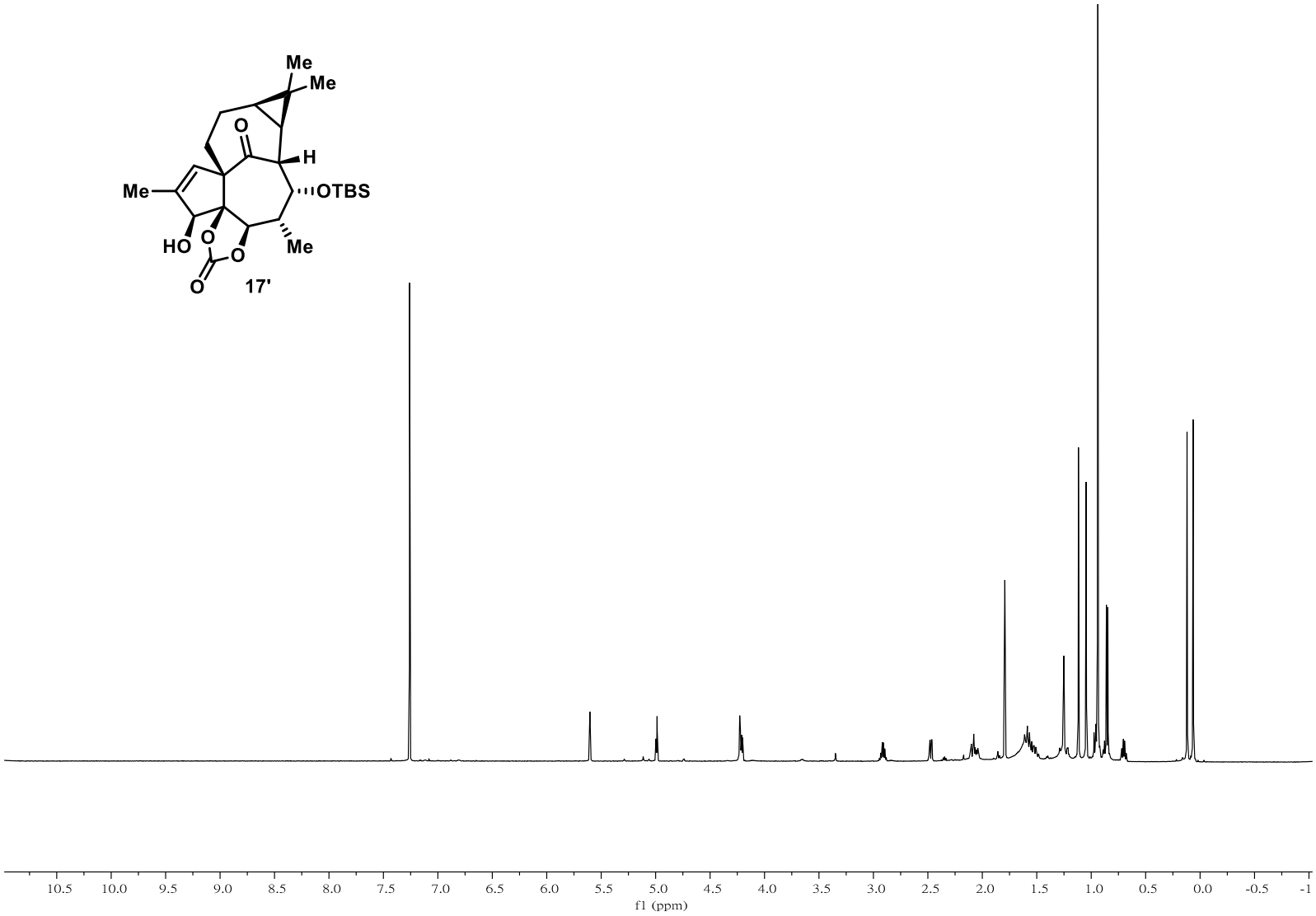

Me
Me
TMSO
HO
H
OTBS
Me
Me
O
O
O
SI-22a
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

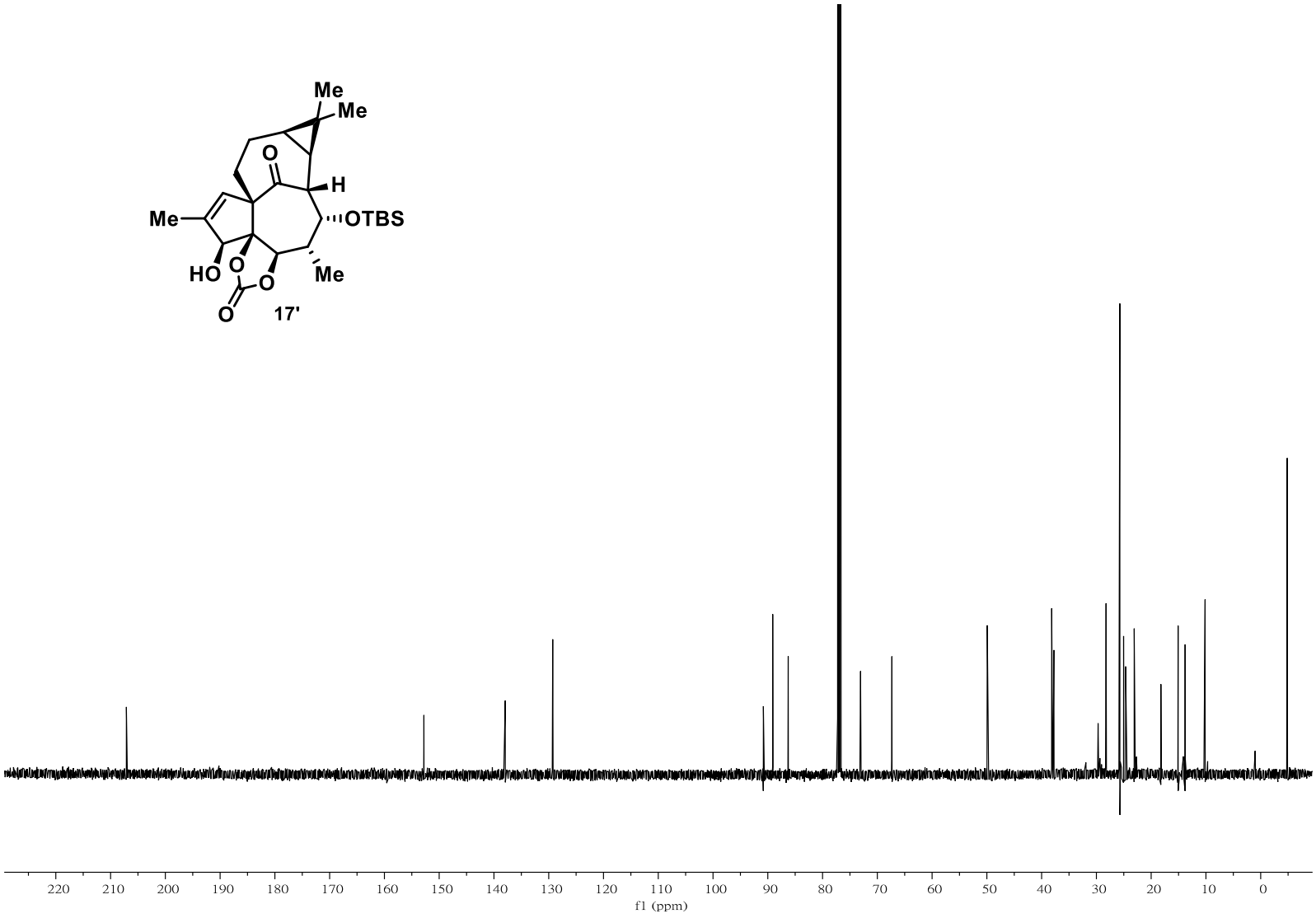

Me
Me
O
H
Me
OTBS
O
O
Me
O
16'
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)

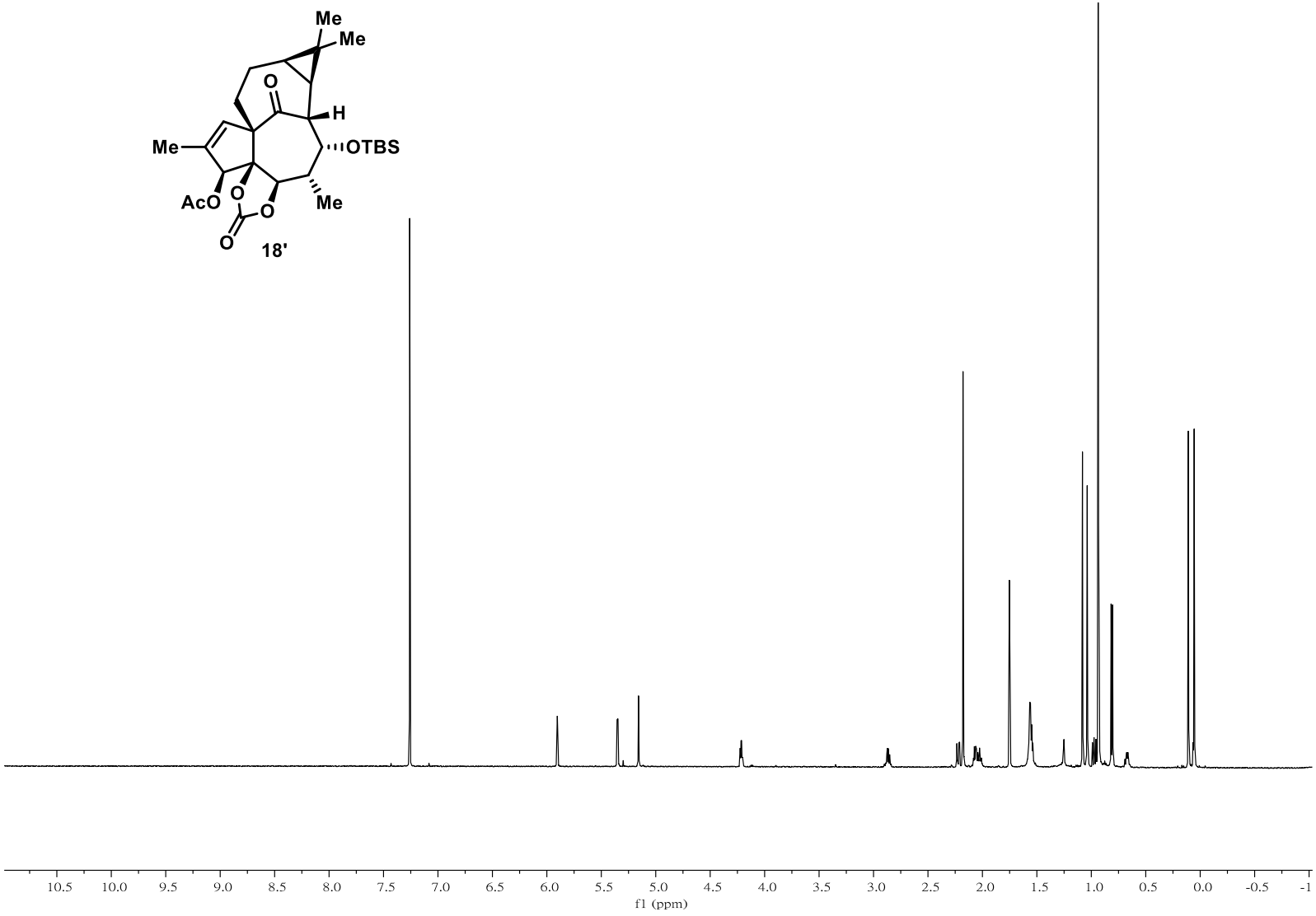

Me
Me
O
H
Me
OTBS
O
O
Me
O
16'
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

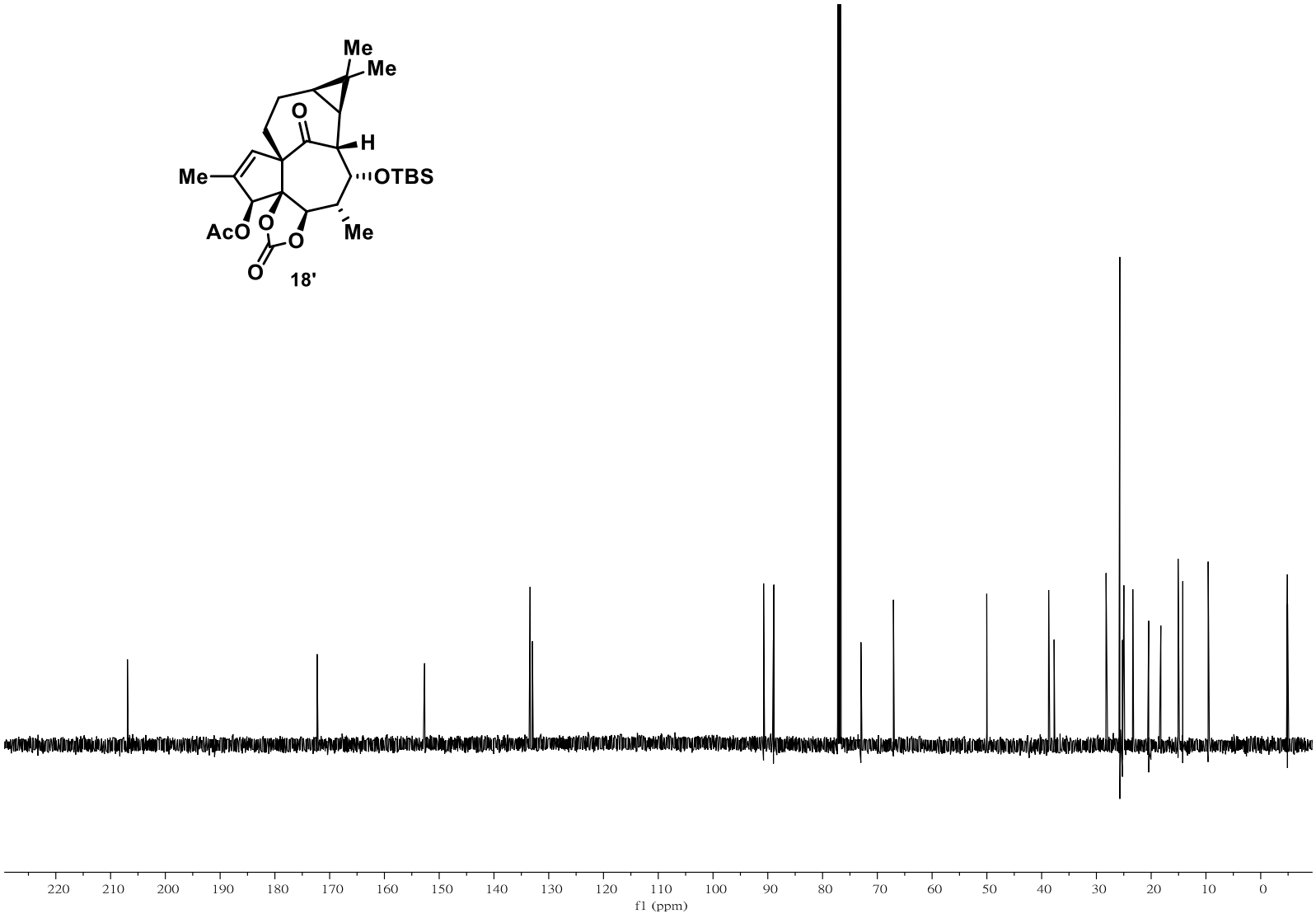

Me
Me
TMSO
H
OTBS
Me
O
O
O
SI-23
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)

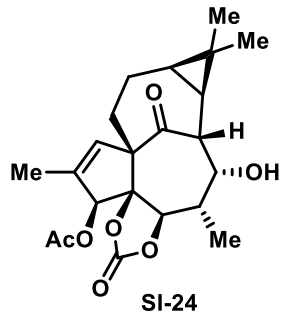

Me
Me
TMSO
H
OTBS
Me
O
O
O
SI-23
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Me
Me
O
H
Me
OTBS
HO
O
O
Me
O
17'
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)


Me
Me
O
H
Me
OTBS
HO
O
O
Me
O
17'
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

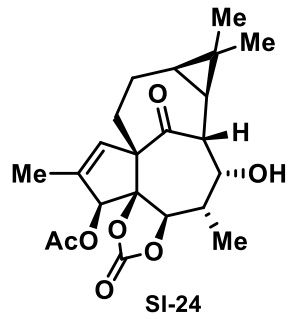

Me
Me
O
H
Me
OTBS
AcO
O
O
Me
O
18'
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)


Me
Me
O
H
Me
OTBS
AcO
O
O
Me
O
18'
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


Me
Me
O
H
Me
OH
AcO
O
O
Me
O
O

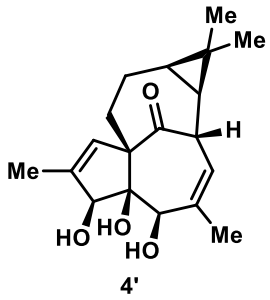
SI-24

10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)


Me
Me
O
H
Me
OH
AcO
O
O
Me
O

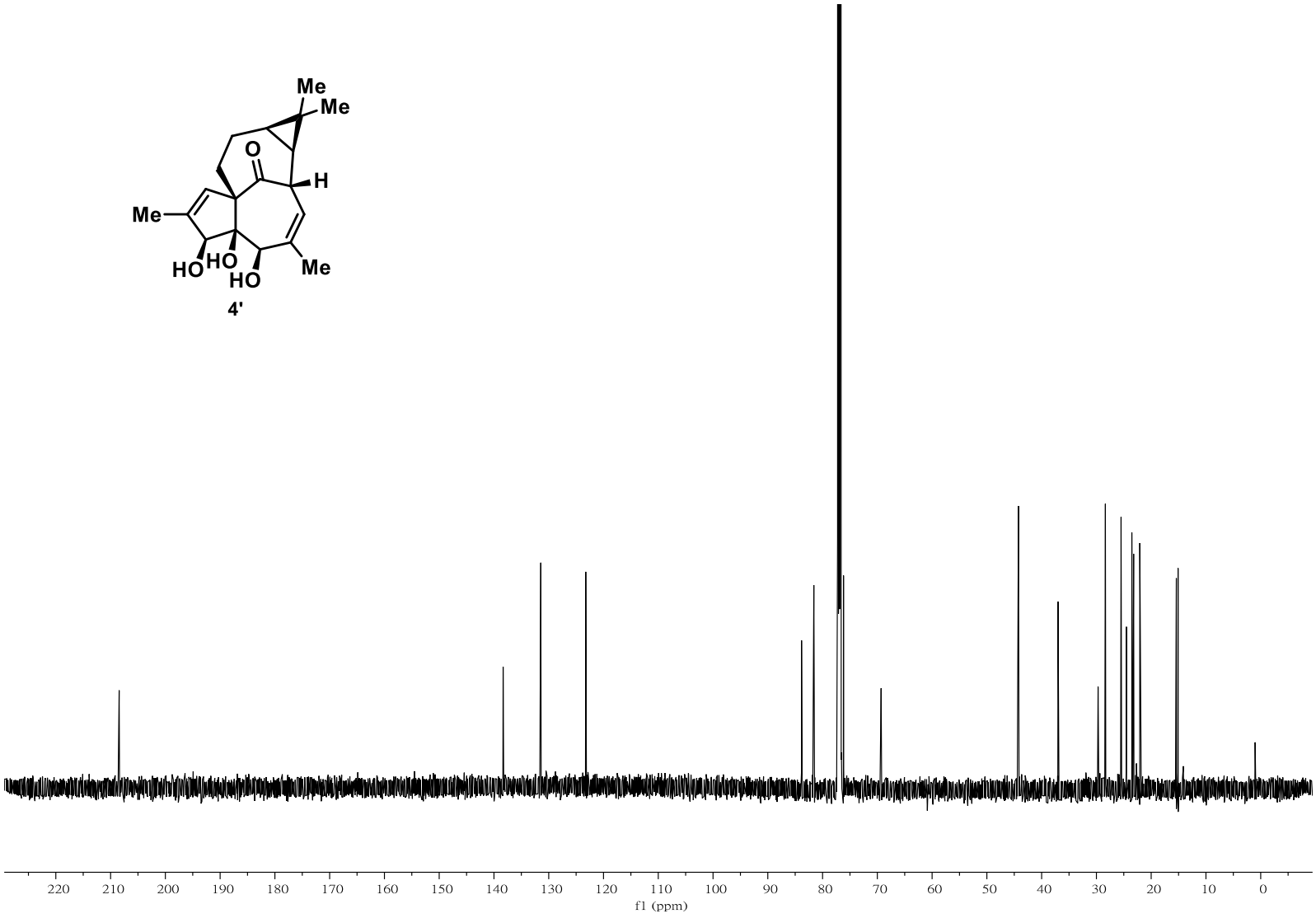
SI-24

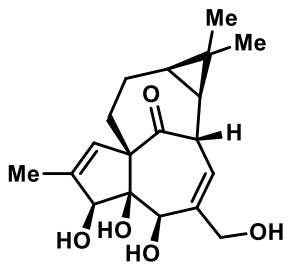
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


Me
Me
O
H
Me
HO
HO
HO
Me

4'

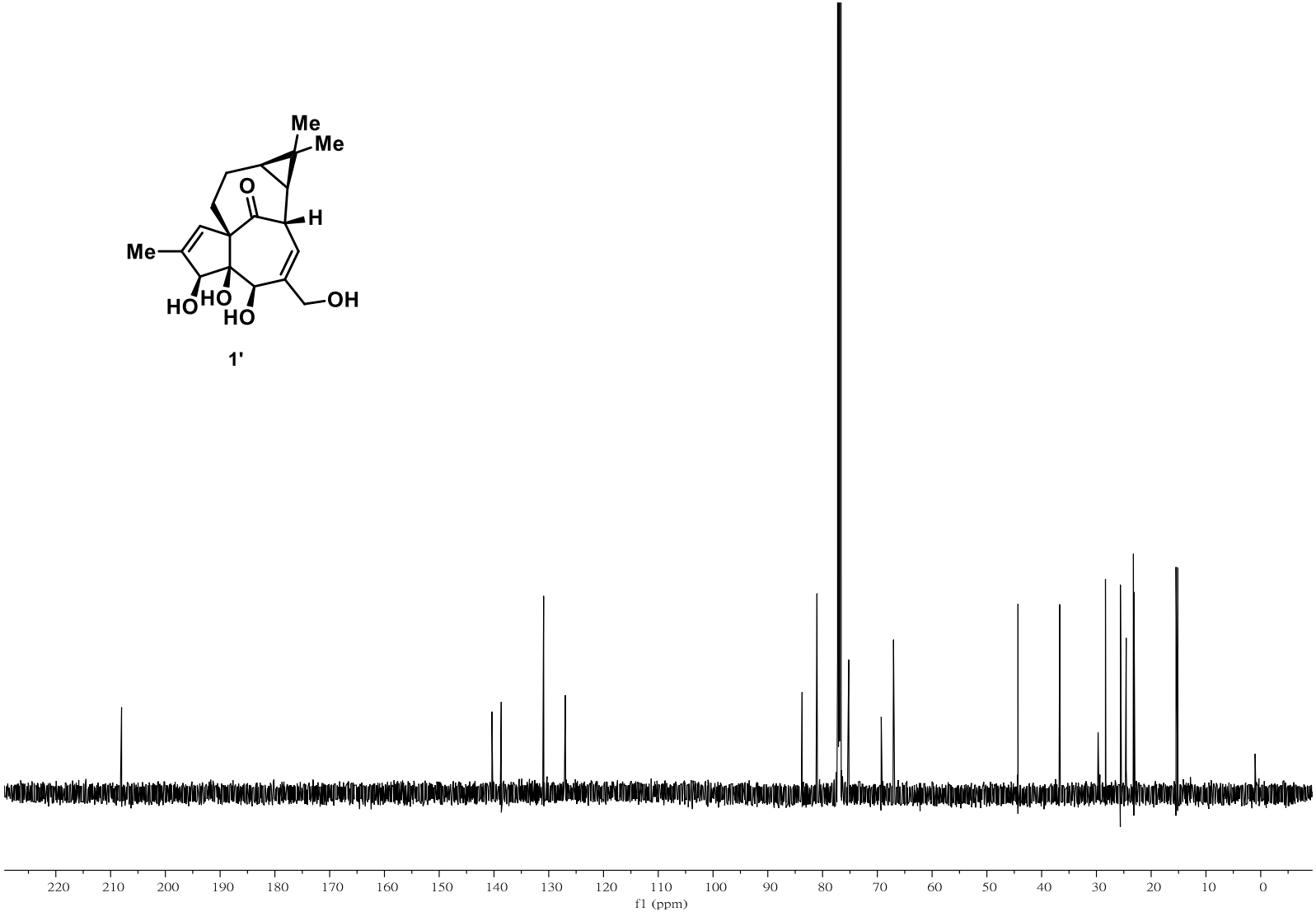
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)

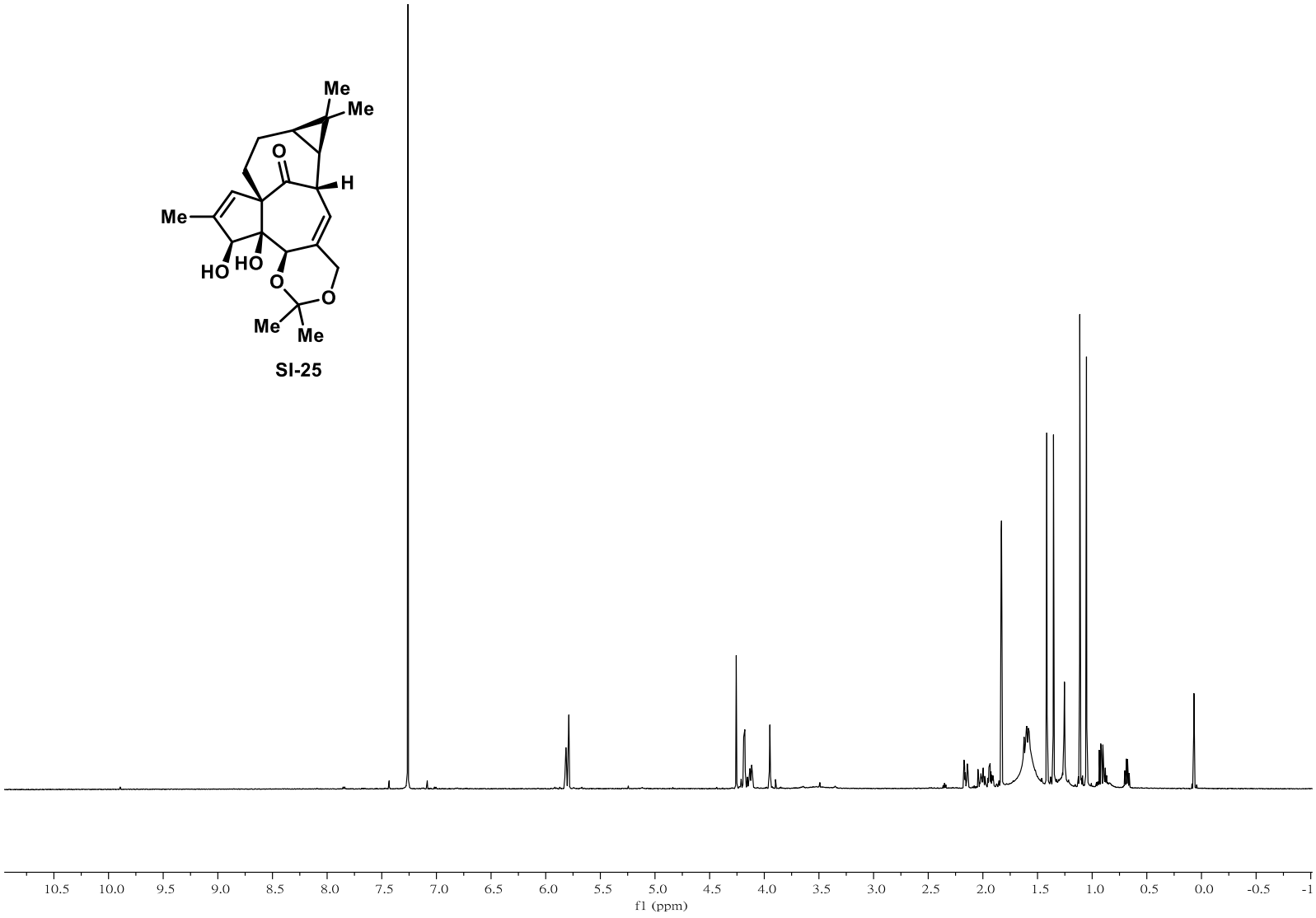

Me
Me
O
H
Me
HO
HO
HO
Me
4'
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

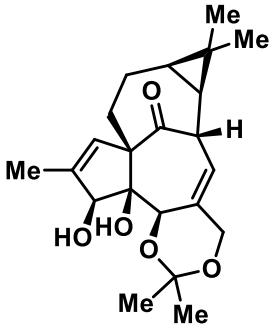

Me
Me
O
H
Me
HO
HO
HO
OH

1'

10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)

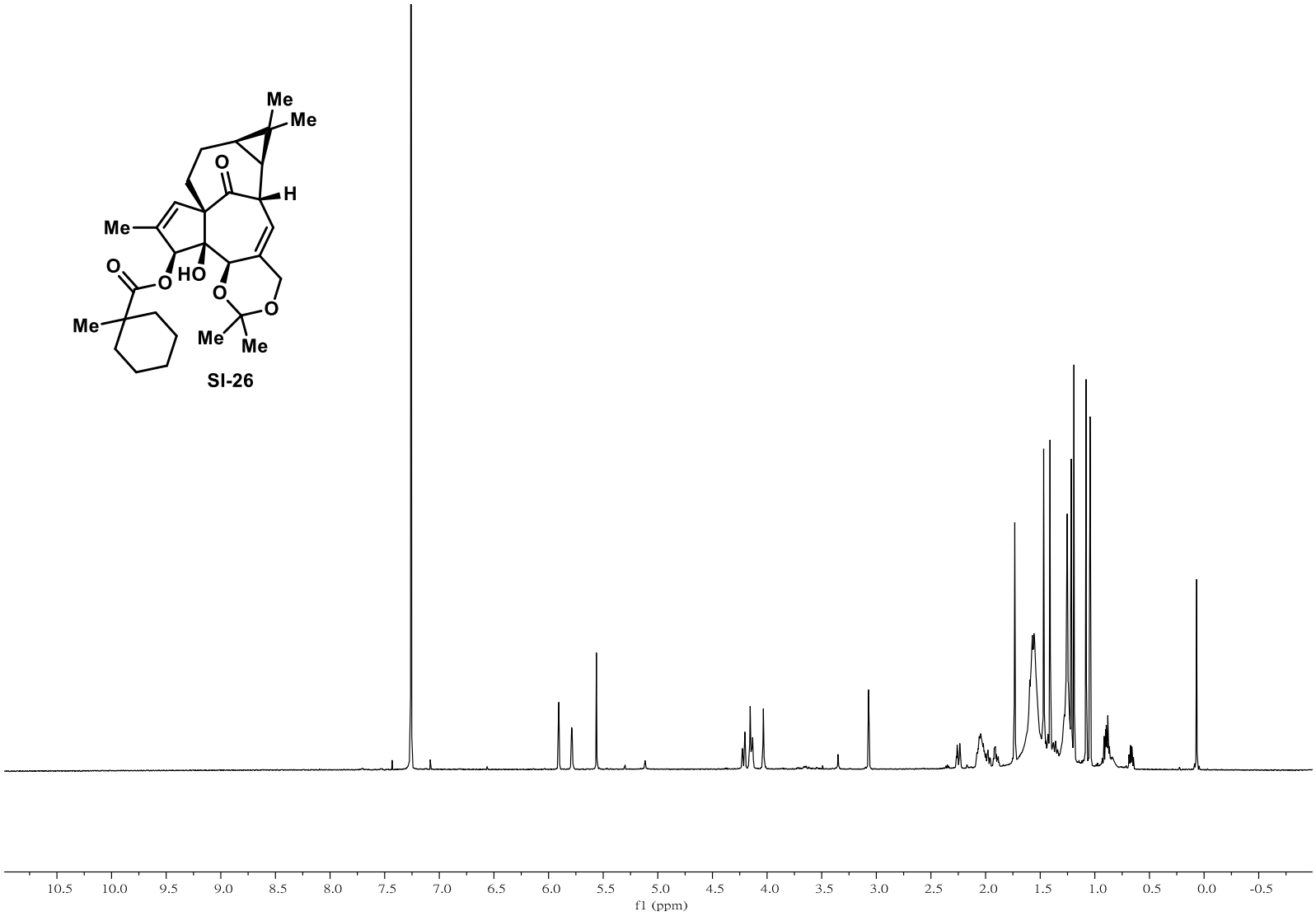

Me
Me
O
H
Me
HO
HO
HO
OH
1'
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

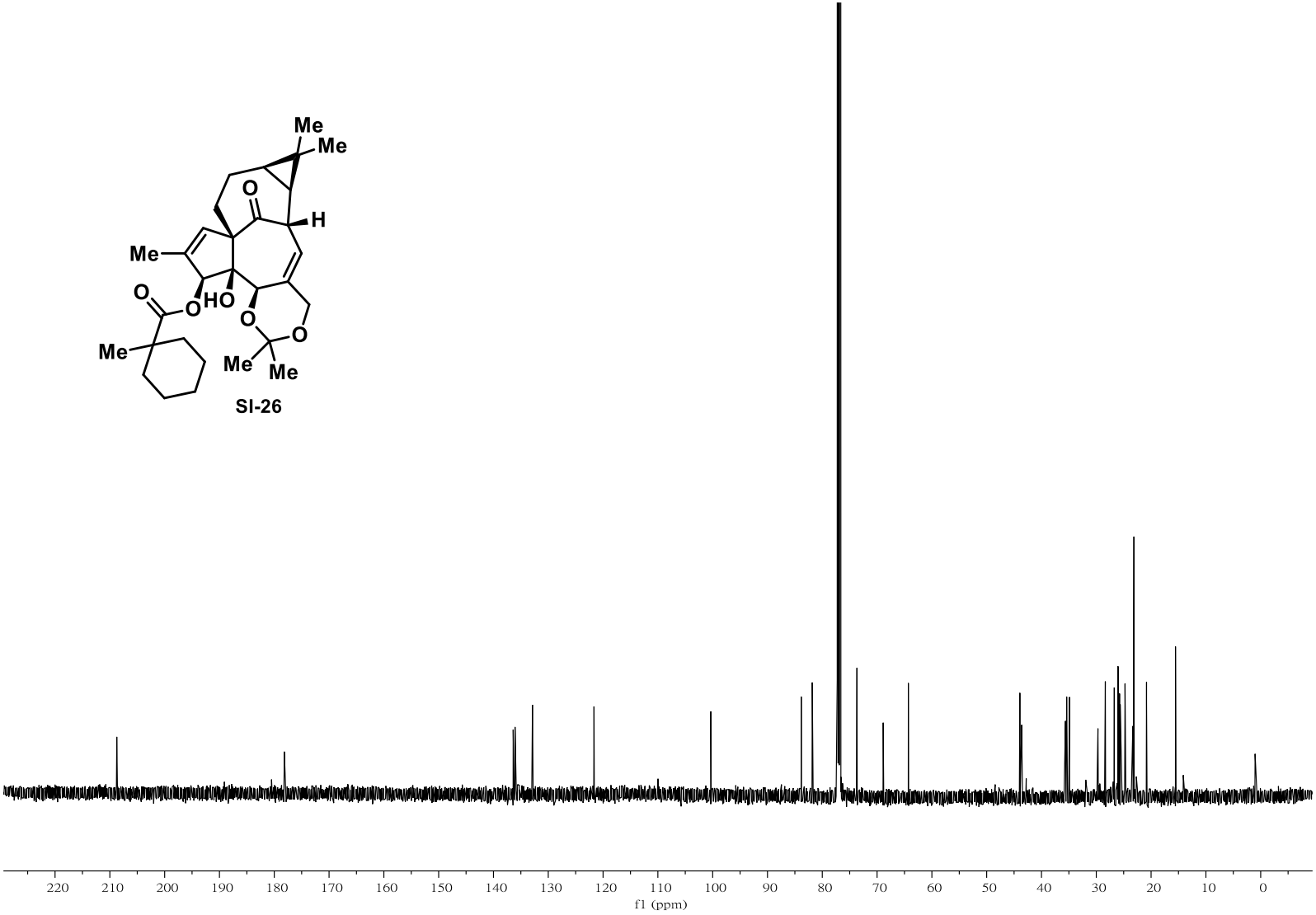

Me
Me
O
H
Me
HO
HO
O
O
Me
Me
SI-25
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)

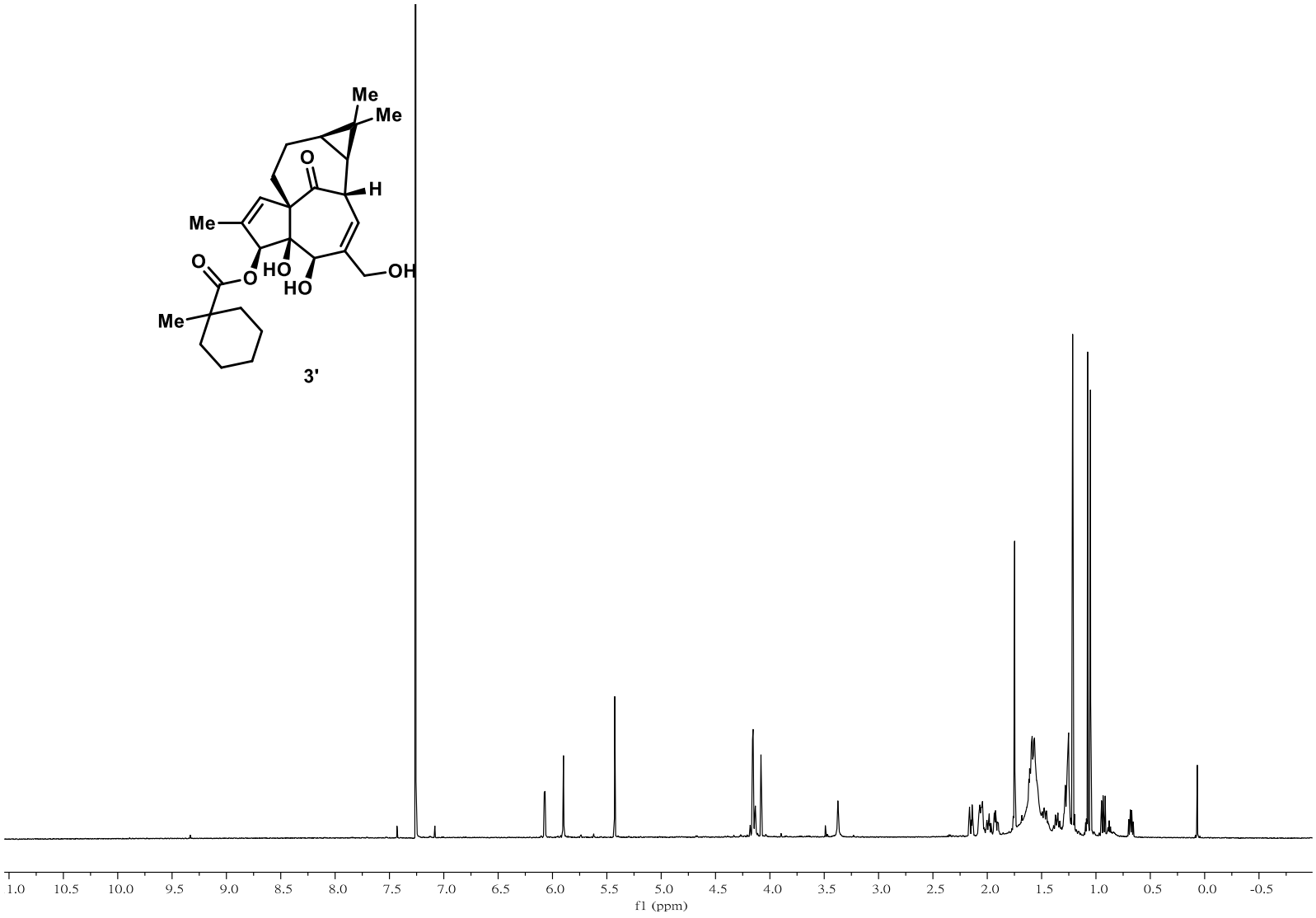

Me
Me
O
H
Me
HO
HO
O
O
Me
Me

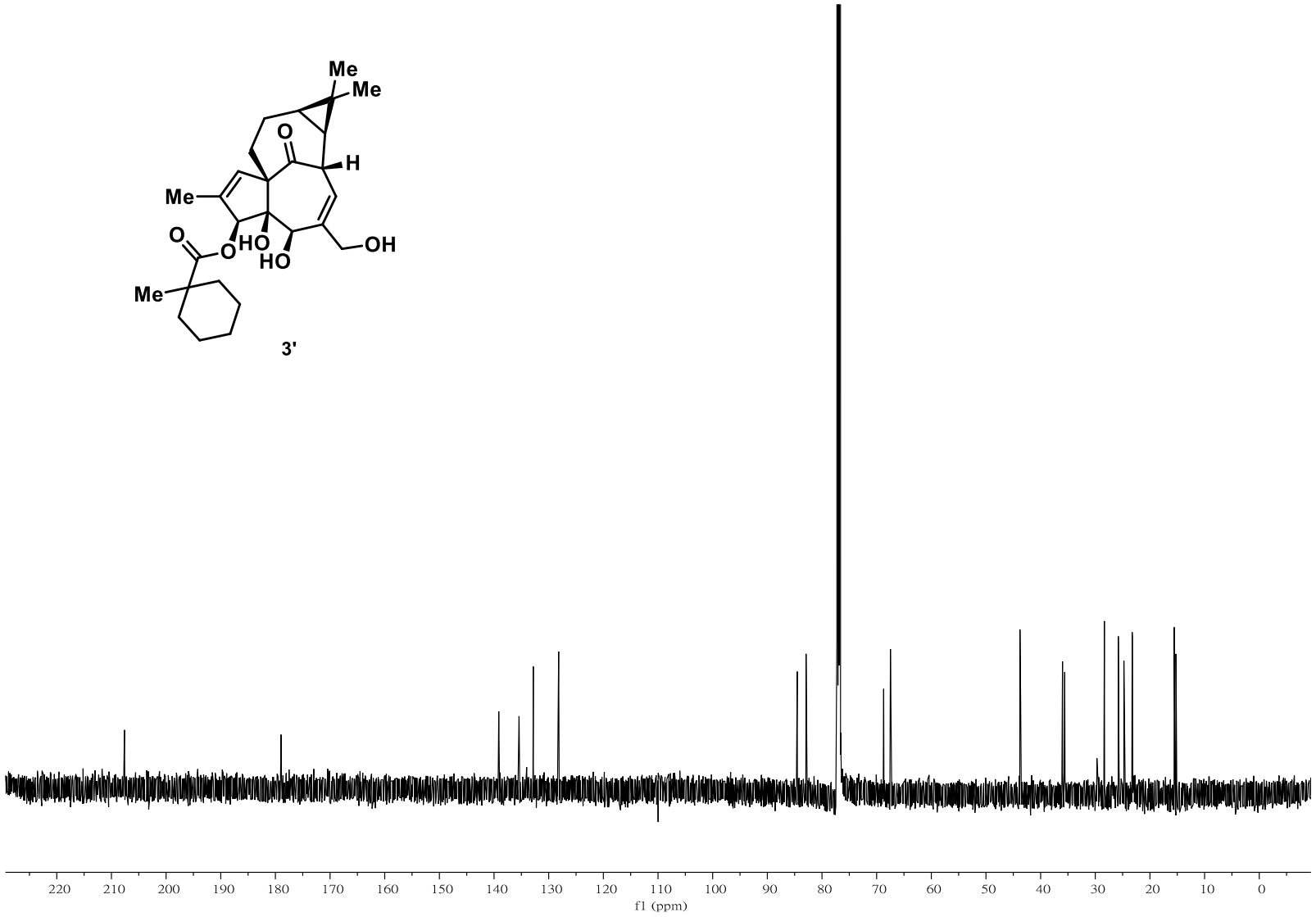
SI-25

220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

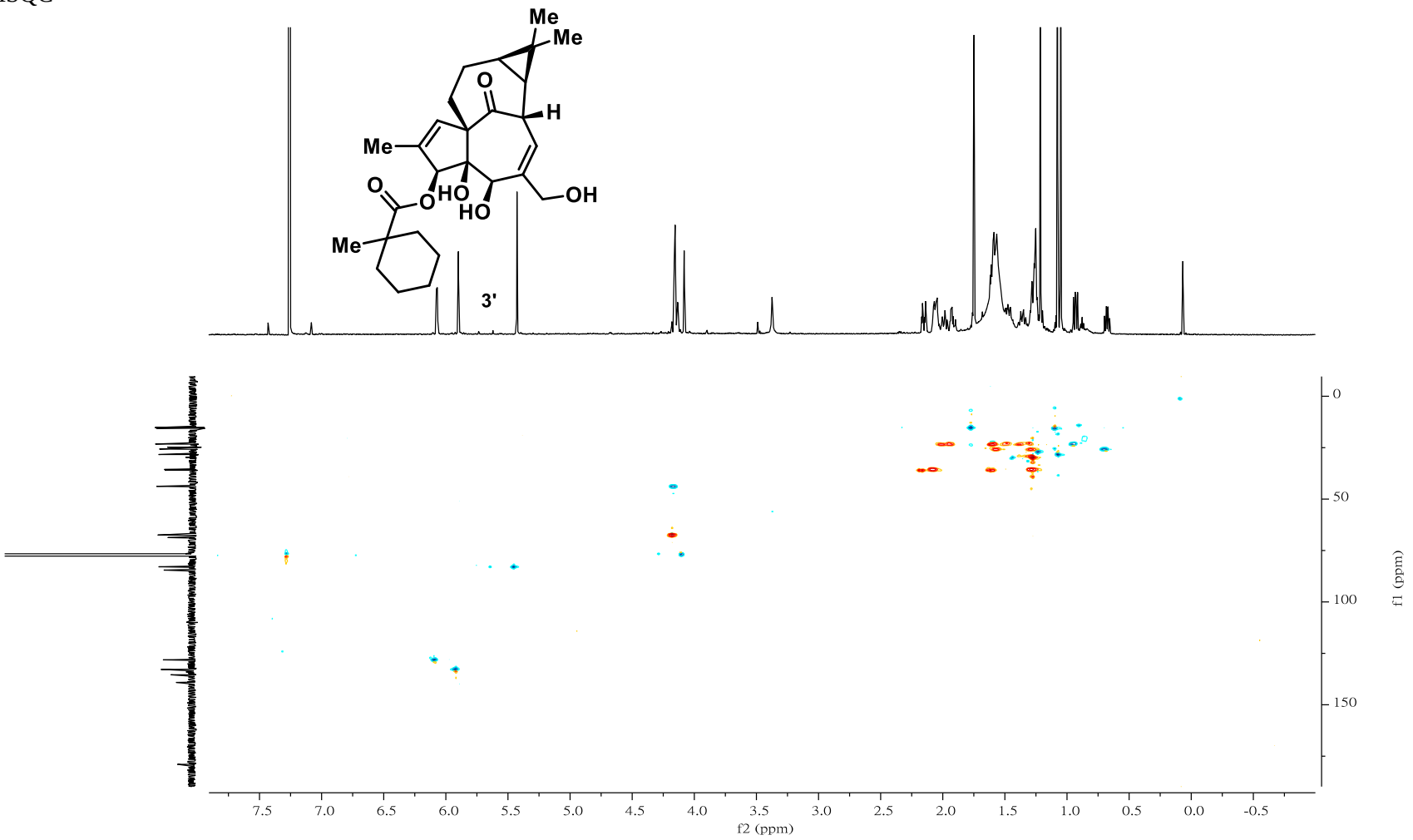

Me
Me
O
H
Me
O
O
HO
O
O
Me
Me
Me
SI-26
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


Me
Me
O
H
Me
O
HO
O
O
Me
O
Me
Me
SI-26
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


Me
Me
O
H
Me
O
O
HO
HO
OH
Me
3'
1.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


Me
Me
O
H
Me
O
O
HO
HO
OH
Me
3'
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

HSQC


Me
Me
O
H
Me
O
O
HO
HO
OH
Me
3'
0
50
100
150
f1 (ppm)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f2 (ppm)