

Supporting Information

# **Total Synthesis of (+)-*ent*-Vetiverianine A via Lewis Acid-Mediated Cyclization**

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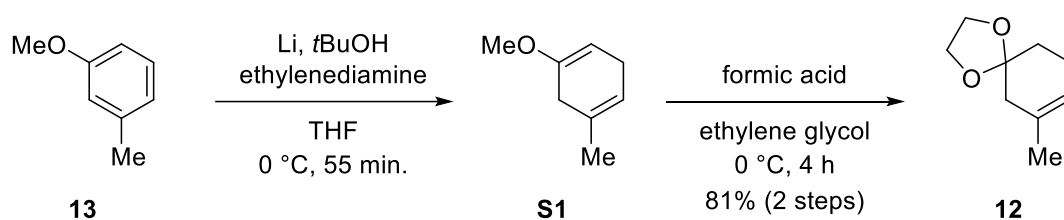
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## 1. General

All reactions were carried out in a round-bottom flask or a test tube fitted with a 3-way glass stopcock under an Ar atmosphere unless otherwise stated. Reagents were purchased from commercial suppliers and used as received unless otherwise noted. All work-up and purification procedures were carried out with reagent-grade solvents under ambient atmosphere. Analytical thin layer chromatography (TLC) was performed on Merck precoated TLC plates (silica gel 60 F<sub>254</sub>, 0.25 mm). Flash chromatography was performed using silica gel CHROMATOREX PSQ60B (neutral, 60 μm; Fuji Silysia Chemical LTD.). Melting point (Mp) data were determined using a Yanaco MP apparatus and were uncorrected. Optical rotation was measured on JASCO P-2200. IR spectra were recorded on a JASCO FT/IR 4100 spectrometer. <sup>1</sup>H and <sup>13</sup>C NMR spectra were recorded on JEOL ECA-600 spectrometers, using CDCl<sub>3</sub> as solvent. Chemical shift values are reported in δ (ppm) relative to residual solvent signals (CDCl<sub>3</sub>: 7.26 ppm for <sup>1</sup>H and 77.00 ppm for <sup>13</sup>C). NMR data are reported as follows: chemical shifts, multiplicity (s: singlet, d: doublet, t: triplet, q: quartet, quin: quintet, m: multiplet, br: broad signal), coupling constant, and integration. High-resolution mass spectra (ESI-TOF) were measured on JEOL JMS-T100LP. Analytical chiral HPLC was performed by LC-NetII/ADC system (JASCO, pump: PU-4180; UV detector: MD4017) with CHIRAL ART Cellulose-SB (YMC, 4.6 mm × 250 mm).

## 2. Experimental Procedures

### 7-methyl-1,4-dioxaspiro[4.5]dec-7-ene (**12**)

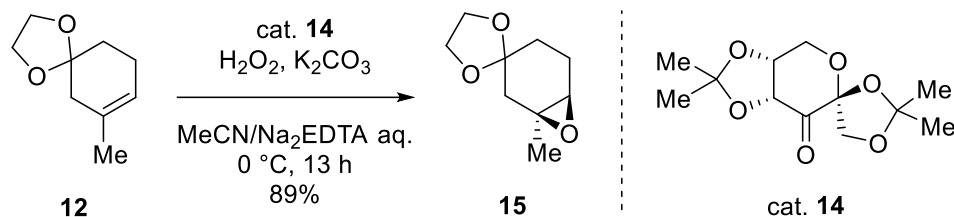


To a solution of **13** (1.00 g, 8.19 mmol), ethylenediamine (3.3 mL, 49 mmol), and *t*BuOH (2.0 mL, 21 mmol) in THF (28 mL) was added lithium wire (diam. 3.2 mm, 171 mg, 24.6 mmol) at 0 °C. The mixture was stirred for 55 min. at 0 °C. The reaction mixture was quenched by the carefully addition of sat. NH<sub>4</sub>Cl aq. and diluted with CH<sub>2</sub>Cl<sub>2</sub>. After the layers were separated, the aqueous layer was extracted with CH<sub>2</sub>Cl<sub>2</sub>. The combined organic solution was washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated to give crude **S1**, which was used next reaction without further purification.

To a solution of crude **S1** in ethylene glycol (8.5 mL) was added formic acid (ca. 90%, 1.0 mL, 24 mmol) at 0 °C. The mixture was stirred for 4 h at 0 °C. The reaction mixture was quenched by the addition of sat. NaHCO<sub>3</sub> aq. and diluted with CH<sub>2</sub>Cl<sub>2</sub>. After the layers were separated, the aqueous layer was extracted with CH<sub>2</sub>Cl<sub>2</sub>. The combined organic solution was washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (pentane/Et<sub>2</sub>O = 29/1 to 9/1) to give **12** (1.02 g, 6.61 mmol, 81%) as a colorless oil.

IR (neat)  $\nu_{\max}$  = 2952, 2926, 2881, 2855, 1366, 1173, 1104, 1065, 1016, 861 cm<sup>-1</sup>; <sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 5.43-5.41 (m, 1H), 4.01-3.96 (m, 4H), 2.22-2.19 (m, 2H), 2.18 (brs, 2H), 1.70 (t, *J* = 6.0 Hz, 2H), 1.68 (d, *J* = 1.2 Hz, 3H); <sup>13</sup>C NMR (150 MHz, CDCl<sub>3</sub>) δ 131.7, 120.2, 108.5, 64.4 (2C), 40.3, 30.6, 24.1, 23.4; HRMS (ESI) *m/z* calcd. for C<sub>9</sub>H<sub>15</sub>O<sub>2</sub> ([M+H]<sup>+</sup>) 155.1067, found 155.066.

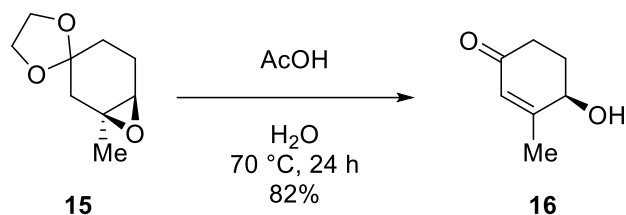
**(1*S*,6*R*)-1-methyl-7-oxaspiro(bicyclo[4.1.0]heptane-3,2'-[1,3]dioxolane) (15)**



To a solution of **12** (7.00 g, 45.4 mmol), Shi catalyst (**14**, 2.35 g, 9.10 mmol), and  $\text{K}_2\text{CO}_3$  (22.0 g, 159 mmol) in  $\text{MeCN}$  (75 mL) and  $4 \times 10^{-4}$  M  $\text{Na}_2\text{EDTA aq.}$  (80 mL) was added  $\text{H}_2\text{O}_2$  (18.7 mL, 182 mmol) at  $0\text{ }^\circ\text{C}$ . The mixture was stirred for 13 h at  $0\text{ }^\circ\text{C}$ . The reaction mixture was diluted with  $\text{H}_2\text{O}$  and quenched by the addition of sat.  $\text{Na}_2\text{S}_2\text{O}_3$  aq. The aqueous layer was extracted with  $\text{EtOAc}$ . The combined organic solution was washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (hexane/ $\text{EtOAc}$  = 9/1 to 3/1) to give **15** (6.90 g, 40.5 mmol, 89%) as a colorless oil.

$[\alpha]_{\text{D}}^{22.5} -11.4$  ( $c = 0.66$ ,  $\text{CHCl}_3$ ); IR (neat)  $\nu_{\text{max}} = 2962, 2925, 2882, 1434, 1369, 1257, 1163, 1111, 1062, 1039, 1010, 950, 842\text{ cm}^{-1}$ ;  $^1\text{H NMR}$  (600 MHz,  $\text{CDCl}_3$ )  $\delta$  3.93-3.82 (m, 4H), 2.98 (s, 1H), 2.08 (d,  $J = 15.0$  Hz, 2H), 2.03-1.97 (m, 1H), 1.84 (dd,  $J = 15.0, 1.8$  Hz, 1H), 1.57 (td,  $J = 12.0, 5.4$  Hz, 1H), 1.40-1.36 (m, 1H), 1.30 (s, 3H);  $^{13}\text{C NMR}$  (150 MHz,  $\text{CDCl}_3$ )  $\delta$  107.2, 64.35, 64.0, 59.1, 57.2, 39.6, 26.6, 24.2, 22.6; HRMS (ESI)  $m/z$  calcd. for  $\text{C}_9\text{H}_{14}\text{O}_3\text{Na}$  ( $[\text{M}+\text{Na}]^+$ ) 193.0835, found 193.0823.

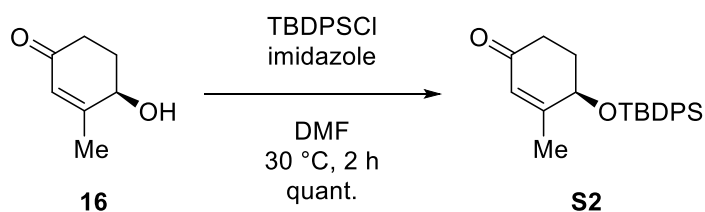
**(*R*)-4-hydroxy-3-methylcyclohex-2-en-1-one (16)**



A solution of **15** (6.10 g, 35.8 mmol) in  $\text{AcOH}$  (180 mL) and  $\text{H}_2\text{O}$  (360 mL) was stirred for 24 h at  $70\text{ }^\circ\text{C}$ . The reaction mixture was concentrated to give a residue. The residue was purified by flash column chromatography (hexane/ $\text{EtOAc}$  = 1/1 to 1/4) to give **16** (3.70 g, 29.3 mmol, 82%) as pale yellow oil.

$[\alpha]_{\text{D}}^{22.7} +20.1$  ( $c = 0.89$ ,  $\text{CHCl}_3$ ), lit. for ( $-$ )-**16**:  $[\alpha]_{\text{D}}^{25} -32.2$  ( $c 1.00$ ,  $\text{CHCl}_3$ )<sup>S1</sup>; IR (neat)  $\nu_{\text{max}} = 3390, 2953, 2928, 2872, 1661, 1441, 1377, 1325, 1258, 1201, 1080, 1060, 968, 950, 885\text{ cm}^{-1}$ ;  $^1\text{H NMR}$  (600 MHz,  $\text{CDCl}_3$ )  $\delta$  5.86 (s, 1H), 4.39 (q,  $J = 6.0$  Hz, 1H), 2.58 (dt,  $J = 16.2, 5.4$  Hz, 1H), 2.39-2.34 (m, 1H), 2.32-2.28 (m, 1H), 2.06 (s, 3H), 2.05-2.1.99 (m, 1H), 1.86 (brd,  $J = 6.0$  Hz, 1H);  $^{13}\text{C NMR}$  (150 MHz,  $\text{CDCl}_3$ )  $\delta$  199.2, 163.9, 126.7, 68.5, 34.8, 31.9, 20.6; HRMS (ESI)  $m/z$  calcd. for  $\text{C}_7\text{H}_{10}\text{O}_2\text{Na}$  ( $[\text{M}+\text{Na}]^+$ ) 149.0573, found 149.0577.

**(*R*)-4-((*tert*-butyldiphenylsilyl)oxy)-3-methylcyclohex-2-en-1-one (S2)**

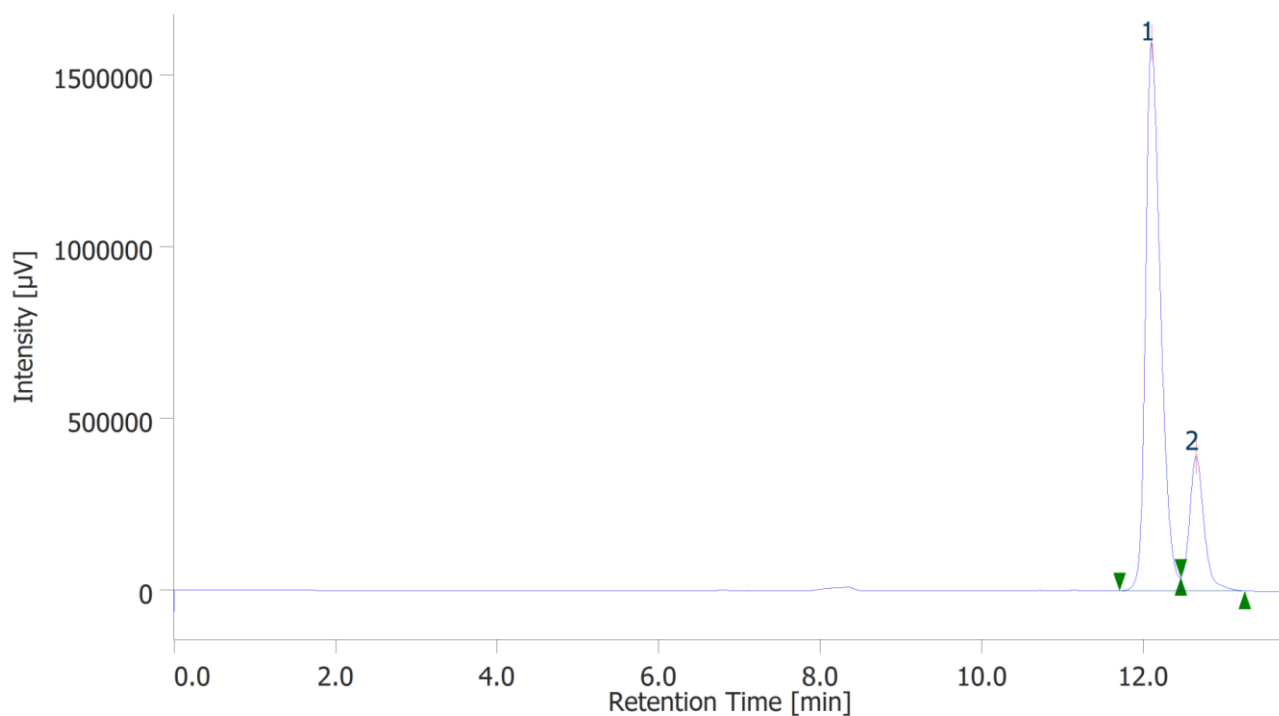


To a solution of **16** (20.0 mg, 159  $\mu\text{mol}$ ) and imidazole (64.8 mg, 952  $\mu\text{mol}$ ) in  $\text{DMF}$  (320  $\mu\text{L}$ ) was added

TBDPSCI (123.0 mg, 448  $\mu\text{mol}$ ) at rt. The mixture was stirred for 2 h at 30  $^{\circ}\text{C}$ . The reaction mixture was quenched by the addition of sat.  $\text{NH}_4\text{Cl}$  aq. and diluted with EtOAc. The aqueous layer was extracted with EtOAc. The combined organic solution was washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (hexane/EtOAc = 19/1 to 5/1) to give **S2** (57.5 mg, 158  $\mu\text{mol}$ , quant.) as a colorless oil.

$[\alpha]_{\text{D}}^{22.7} -2.8$  ( $c = 0.34$ ,  $\text{CHCl}_3$ ), lit. for (+)-**S2**:  $[\alpha]_{\text{D}}^{25} +8.7$  ( $c = 2.05$ ,  $\text{CHCl}_3$ )<sup>S2</sup>; IR (neat)  $\nu_{\text{max}} = 2956, 2931, 2858, 1675, 1428, 1112, 704 \text{ cm}^{-1}$ ;  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.72 (dd,  $J = 7.8, 1.2 \text{ Hz}$ , 2H), 7.69 (dd,  $J = 7.8, 1.2 \text{ Hz}$ , 2H), 7.48-7.45 (m, 2H), 7.43-7.38 (m, 4H), 5.80 (s, 1H), 4.35-4.33 (m, 1H), 2.50 (ddd,  $J = 17.4, 6.6, 4.8 \text{ Hz}$ , 1H), 2.12 (ddd,  $J = 17.4, 10.2, 4.8 \text{ Hz}$ , 1H), 2.03-1.91 (m, 2H), 1.94 (s, 3H), 1.08 (s, 9H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  198.8, 163.7, 135.9 (4C), 133.6, 132.9, 130.0, 129.9, 127.8 (2C), 127.6 (2C), 126.7, 70.5, 34.7, 32.2, 26.9 (3C), 21.5, 19.4; HRMS (ESI)  $m/z$  calcd. for  $\text{C}_{23}\text{H}_{29}\text{SiO}_2$  ( $[\text{M}+\text{H}]^+$ ) 365.1931, found 365.1918.

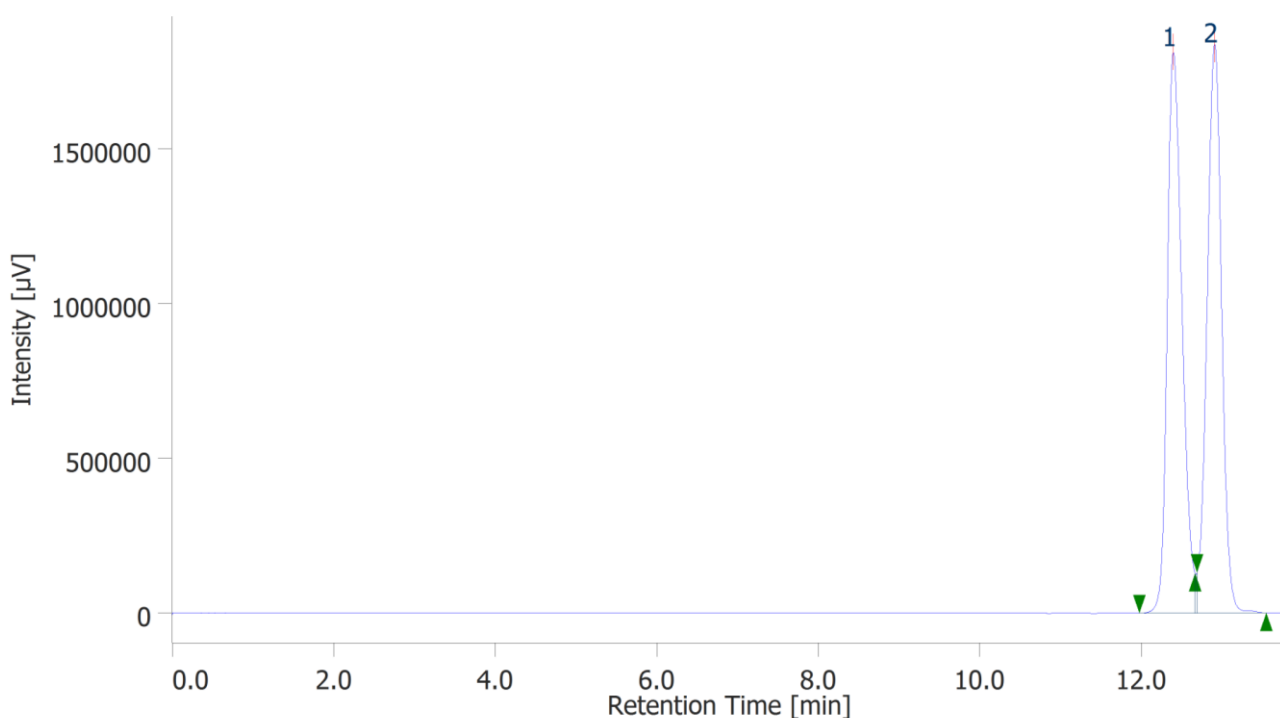
The enantiomeric excess of (–)-**S2** was determined by chiral HPLC analysis [CHIRAL ART Cellulose-SB (4.6  $\times$  250 mm), hexane/2-propanol = 97.5/2.5 v/v, 0.5 mL/min, UV 254 nm, RT,  $t_{\text{R}1} = 12.1 \text{ min}$  (80.6%),  $t_{\text{R}2} = 12.6 \text{ min}$  (19.4%)] to be 61% ee.



#### Peak Information

| # | tR [min] | Area [ $\mu\text{V}\cdot\text{sec}$ ] | Area%  | Height% | Symmetry Factor |
|---|----------|---------------------------------------|--------|---------|-----------------|
| 1 | 12.093   | 20578458                              | 80.555 | 80.234  | 1.370           |
| 2 | 12.643   | 4967372                               | 19.445 | 19.766  | N/A             |

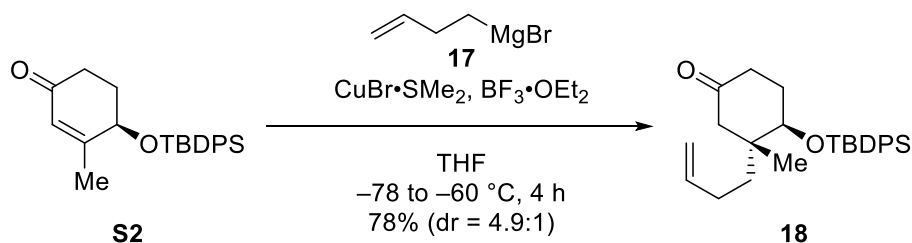
Racemic **S2** was prepared from compound **13** via epoxidation using *m*CPBA, hydrolysis of acetal and subsequent epoxide opening, and TBDPS protection of the resulting secondary alcohol.



#### Peak Information

| # | tR [min] | Area [µV·sec] | Area%  | Height% | Symmetry Factor |
|---|----------|---------------|--------|---------|-----------------|
| 1 | 12.390   | 23056099      | 49.944 | 49.671  | N/A             |
| 2 | 12.900   | 23107743      | 50.056 | 50.329  | N/A             |

#### (3*R*,4*R*)-3-(but-3-en-1-yl)-4-((*tert*-butyldiphenylsilyl)oxy)-3-methylcyclohexan-1-one (**18**)

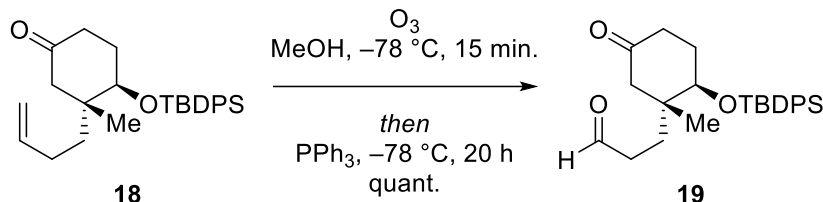


To a suspension of  $\text{CuBr}\cdot\text{SMe}_2$  (25.4 mg, 124  $\mu\text{mol}$ ) in THF (600  $\mu\text{L}$ ) was added 3-buten-1-ylmagnesium bromide (**17**, 0.7 M in THF, prepared from 4-bromo-1-butene and Mg powder in THF, 350  $\mu\text{L}$ , 245  $\mu\text{mol}$ ) at  $-78^\circ\text{C}$  and the mixture was stirred for 30 min at the same temperature. To the solution was added  $\text{BF}_3\cdot\text{OEt}_2$  (34  $\mu\text{L}$ , 291  $\mu\text{mol}$ ) at  $-78^\circ\text{C}$ . After 10 min., to the mixture was added a solution of **S2** (30.0 mg, 82.3  $\mu\text{mol}$ ) in THF (200  $\mu\text{L}$ ) at the same temperature. After 30 min, the solution was allowed to warm to  $-60^\circ\text{C}$  and stirred for further 3.5 h. the reaction mixture was quenched by the addition of 1 M HCl aq. and diluted with EtOAc. The aqueous layer was extracted with EtOAc. The combined organic solution was washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (hexane/EtOAc = 4/1) to give **18** (27.0 mg, 64.2  $\mu\text{mol}$ , 78%, dr = 4.9:1) as a colorless oil.

$[\alpha]_{\text{D}}^{22.9} -3.1$  ( $c = 1.35$ ,  $\text{CHCl}_3$ ); IR (neat)  $\nu_{\text{max}} = 2960, 2932, 2857, 1719, 1427, 1111, 1086, 998, 822, 741, 704$   $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.73-7.67 (m, 4H), 7.48-7.37 (m, 6H), 5.75-5.67 (m, 1H), 4.95-4.89 (m, 2H), 3.84 (q,  $J = 3.6$  Hz, 0.83H), 3.77-3.76 (m, 0.17H), 2.65-2.36 (m, 2H), 2.10-1.64 (m, 6H), 1.44-1.23 (m, 2H), 1.11 (s, 1.6H), 1.10 (s, 7.4H), 0.99 (s, 2.5H), 0.81 (s, 0.5H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  211.7, 211.3, 138.8, 138.5,

136.1 (2C), 136.0 (2C), 135.9 (4C), 134.4, 134.3, 133.3, 133.2, 129.9 (2C), 129.8, 129.7, 127.7 (4C), 127.6 (2C), 127.5 (2C), 114.5, 114.2, 74.4, 74.0, 49.2, 49.1, 43.0, 38.5, 37.2, 36.7, 36.1, 29.7, 29.2, 29.0, 27.3 (3C), 27.2, 27.1 (3C), 23.0, 20.9 (2C), 19.59, 19.56; HRMS (ESI)  $m/z$  calcd. for  $C_{27}H_{36}SiO_2Na$  ( $[M+Na]^+$ ) 443.2377, found 443.2396.

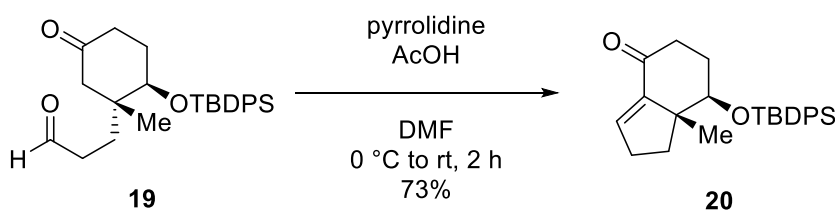
### 3-((1*R*,2*R*)-2-((*tert*-butyldiphenylsilyl)oxy)-1-methyl-5-oxocyclohexyl)propanal (**19**)



A solution of **18** (1.76 g, 4.18 mmol, dr = 4.9:1) in MeOH (209 mL) was added cooled to  $-78$  °C, and ozone was passed through the solution for 15 min. After the mixture was purged with Ar,  $PPh_3$  (7.68 g, 29.3 mmol) was added. The solution was allowed to warm to rt and stirred for further 20 h, and then concentrated to give a residue. The residue was purified by flash column chromatography (hexane/EtOAc = 7/3) to give **19** (1.78 g, 4.21 mmol, quant., dr = 4.9:1) as a colorless oil.

$[\alpha]_D^{22.8} -4.7$  ( $c = 0.34$ ,  $CHCl_3$ ); IR (neat)  $\nu_{max} = 2959, 2933, 2892, 2858, 1723, 1713, 1427, 1111, 1086, 822, 741, 704$   $cm^{-1}$ ;  $^1H$  NMR (600 MHz,  $CDCl_3$ )  $\delta$  9.65 (s, 0.81H), 9.57 (s, 0.18H), 7.73 (d,  $J = 6.6$  Hz, 2H), 7.68 (d,  $J = 6.6$  Hz, 2H), 7.47-7.37 (m, 6H), 3.80 (dd,  $J = 7.2, 4.2$  Hz, 0.83H), 3.76 (dd,  $J = 5.4, 3.0$  Hz, 0.17H), 2.65-2.33 (m, 2H), 2.24-1.75 (m, 6H), 1.62-1.57 (m, 1H), 1.11 (s, 1.6H), 1.10 (s, 7.4H), 0.98 (s, 2.6H), 0.77 (s, 0.4H);  $^{13}C$  NMR (150 MHz,  $CDCl_3$ )  $\delta$  210.55, 210.45, 201.8, 201.5, 136.1 (2C), 136.0 (4C), 135.9 (2C), 134.22, 134.15, 133.1, 133.0, 130.0, 129.9, 129.8, 129.8, 127.8 (4C), 127.6 (2C), 127.6 (2C), 74.14, 74.09, 49.1, 48.8, 42.6, 42.5, 38.0, 37.4, 37.3, 36.6, 30.9, 29.4, 29.3, 29.0, 27.2 (3C), 27.1 (3C), 22.8, 20.32, 20.26, 19.5; HRMS (ESI)  $m/z$  calcd. for  $C_{26}H_{35}SiO_3$  ( $[M+H]^+$ ) 423.2350, found 423.2364.

### (7*R*,7*aR*)-7-((*tert*-butyldiphenylsilyl)oxy)-7*a*-methyl-1,2,5,6,7,7*a*-hexahydro-4*H*-inden-4-one (**20**)

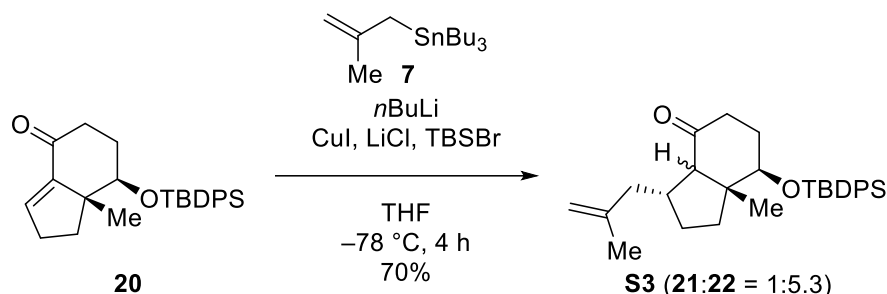


To a solution of **19** (2.70 g, 6.39 mmol, dr = 4.9:1) in DMF (32 mL) was added pyrrolidine (1.3 mL, 15.7 mmol) and AcOH (457  $\mu$ L, 7.99 mmol) at  $0$  °C. The mixture was stirred for 2 h at rt. The reaction mixture was quenched by the addition of sat.  $NH_4Cl$  aq. and diluted with EtOAc. The aqueous layer was extracted with EtOAc. The combined organic solution was washed with brine, dried over  $Na_2SO_4$ , filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (hexane/EtOAc = 1/1) to give **20** (1.90 g, 4.70 mmol, 73%) as a colorless oil.

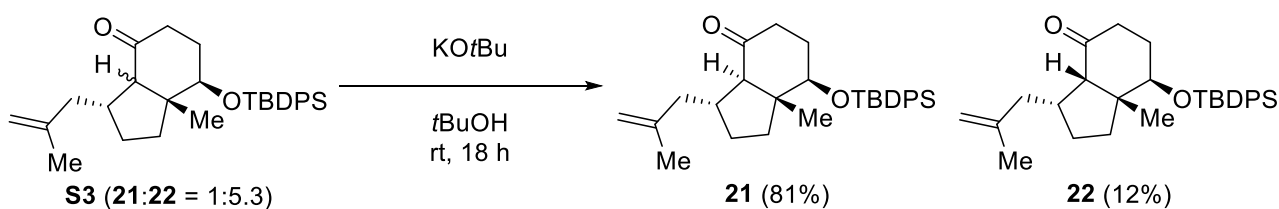
$[\alpha]_D^{22.7} +11.0$  ( $c = 0.15$ ,  $CHCl_3$ ), lit.  $[\alpha]_D^{25} -22.2$  ( $c = 0.92$ ,  $CHCl_3$ )<sup>S2</sup>; IR (neat)  $\nu_{max} = 2957, 2931, 2892, 2857, 1686, 1427, 1262, 1111, 1092, 1069, 822, 704$   $cm^{-1}$ ;  $^1H$  NMR (600 MHz,  $CDCl_3$ )  $\delta$  7.71 (d,  $J = 7.2$  Hz, 2H), 7.68 (d,  $J = 7.8$  Hz, 2H), 7.46-7.38 (m, 6H), 6.43-6.42 (m, 1H), 3.77 (dd,  $J = 10.8, 4.2$  Hz, 1H), 2.48-2.42 (m, 1H), 2.34-2.27 (m, 2H), 2.09-1.97 (m, 3H), 1.75-1.68 (m, 2H), 1.19 (s, 3H), 1.08 (s, 9H);  $^{13}C$  NMR (150 MHz,  $CDCl_3$ )  $\delta$

198.7, 147.7, 138.3, 135.9 (2C), 135.8(2C), 134.5, 133.4, 129.8, 129.6, 127.7 (2C), 127.5 (2C), 78.2, 52.4, 40.6, 38.1, 30.0, 29.2, 27.0 (3C), 19.4, 17.6; HRMS (ESI)  $m/z$  calcd. for  $C_{26}H_{33}SiO_2$  ( $[M+H]^+$ ) 405.2244, found 405.2259.

**(3R,3aR,7R,7aR)-7-((tert-butylidiphenylsilyl)oxy)-7a-methyl-3-(2-methylallyl)octahydro-4H-inden-4-one (21)**  
**and (3R,3aS,7R,7aR)-7-((tert-butylidiphenylsilyl)oxy)-7a-methyl-3-(2-methylallyl)octahydro-4H-inden-4-one (22)**



To a solution of **7** (1.41 g, 4.08 mmol) in THF (5 mL) was added  $n\text{BuLi}$  (2.6 M in hexane, 1.4 mL, 3.64 mmol) at  $-78\text{ }^\circ\text{C}$ . The mixture was stirred for 25 min at the same temperature. Then, this mixture was added to a stirred solution of  $\text{LiCl}$  (172.9 mg, 4.08 mmol) and recrystallized  $\text{CuI}$  (776.6 mg, 4.08 mmol) in THF (10 mL) at  $-78\text{ }^\circ\text{C}$ . The solution was stirred for 30 min at  $-60\text{ }^\circ\text{C}$ . After the solution was cooled to  $-78\text{ }^\circ\text{C}$ , to the solution was added  $\text{TMSBr}$  (962  $\mu\text{L}$ , 7.41 mmol) and a solution of **20** (300 mg, 741  $\mu\text{mol}$ ) in THF (4.0 mL). The mixture was stirred for 4 h at  $-78\text{ }^\circ\text{C}$ . The reaction mixture was quenched by the addition of  $\text{NH}_4\text{Cl}/\text{NH}_3\text{OH}$  aq. (pH  $\sim 8$ ) and diluted with  $\text{EtOAc}$ . The aqueous layer was extracted with  $\text{EtOAc}$ . The combined organic solution was washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated to give a mixture of crude **S3** and TMS-enol ether. The mixture was dissolved in a mixture of 1M  $\text{HCl}$  aq. (10 mL) and THF (10 mL) and the solution was stirred for 2 h at rt. The solution was diluted with  $\text{EtOAc}$ . The aqueous layer was extracted with  $\text{EtOAc}$ . The combined organic solution was washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (hexane/ $\text{EtOAc}$  = 4/1) to give **S3** (239 mg, 519  $\mu\text{mol}$ , 70%, **21:22** = 1:5.3) as a yellow oil.



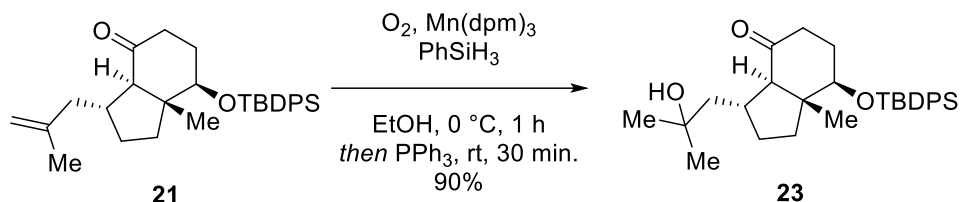
To a solution of **S3** (280 mg, 610  $\mu\text{mol}$ , **21:22** = 1:5.3) in  $t\text{BuOH}$  (11.7 mL) was added  $\text{KOtBu}$  (85.3 mg, 760  $\mu\text{mol}$ ) at rt. The mixture was stirred for 18 h at rt. The reaction mixture was quenched by the addition of sat.  $\text{NH}_4\text{Cl}$  aq. and diluted with  $\text{EtOAc}$ . The aqueous layer was extracted with  $\text{EtOAc}$ . The combined organic solution was washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (hexane/ $\text{Et}_2\text{O}$  = 4/1) to give **21** (228 mg, 495  $\mu\text{mol}$ , 81%) and **22** (33 mg, 72  $\mu\text{mol}$ , 12%) as a colorless oil.

**21**:  $[\alpha]_D^{24.0} +32.9$  ( $c = 0.06$ ,  $\text{CHCl}_3$ ), lit. for (–)-**21**:  $[\alpha]_D^{25} -37.1$  ( $c = 1.27$ ,  $\text{CHCl}_3$ )<sup>S2</sup>; IR (neat)  $\nu_{\text{max}} = 2953, 2892, 2858, 1720, 1112, 886, 703\text{ cm}^{-1}$ ;  $^1\text{H NMR}$  (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.71 (dd,  $J = 7.2, 1.2\text{ Hz}$ , 2H), 7.67 (dd,  $J = 7.8, 1.2\text{ Hz}$ , 2H), 7.47-7.37 (m, 6H), 4.64 (s, 1H), 4.59 (s, 1H), 3.88 (dd,  $J = 10.8, 5.4\text{ Hz}$ , 1H), 2.50-2.43 (m, 1H), 2.16 (dd,  $J = 13.8, 4.8\text{ Hz}$ , 1H), 2.11-2.02 (m, 2H), 1.93-1.78 (m, 4H), 1.75-1.71 (m, 1H), 1.71 (s, 3H), 1.67 (dd,  $J = 13.8,$

10.8 Hz, 1H), 1.32-1.25 (m, 1H), 1.23-1.16 (m, 1H), 1.06 (s, 9H), 0.89 (s, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  209.7, 145.3, 136.0 (2C), 135.9 (2C), 134.5, 133.6, 129.8, 129.6, 127.6 (2C), 127.5 (2C), 110.6, 78.8, 63.0, 52.4, 44.5, 39.5, 38.4, 32.7, 32.0, 27.1, 27.0 (3C), 22.3, 19.4, 13.3; HRMS (ESI)  $m/z$  calcd. for  $\text{C}_{30}\text{H}_{41}\text{SiO}_2$  ( $[\text{M}+\text{H}]^+$ ) 461.2870, found 461.2862.

**22**:  $[\alpha]_{\text{D}}^{24.0} +43.8$  ( $c = 0.12$ ,  $\text{CHCl}_3$ ) {lit. for (-)-**22**:  $[\alpha]_{\text{D}}^{25} -73.0$  ( $c = 1.79$ ,  $\text{CHCl}_3$ )<sup>S2</sup>; IR (neat)  $\nu_{\text{max}} = 2952, 2895, 2858, 1702, 1427, 1111, 1092, 887, 822, 741, 703$   $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.72 (dd,  $J = 8.4, 1.8$  Hz, 2H), 7.66 (dd,  $J = 8.4, 1.8$  Hz, 2H), 7.46-7.37 (m, 6H), 4.64 (s, 1H), 4.47 (s, 1H), 3.75 (dd,  $J = 9.6, 3.6$  Hz, 1H), 2.50 (dd,  $J = 9.6, 2.4$  Hz, 1H), 2.48-2.42 (m, 1H), 2.35-2.31 (m, 1H), 1.92-1.80 (m, 5H), 1.69-1.63 (m, 1H), 1.59 (s, 3H, overlap with  $\text{H}_2\text{O}$ ), 1.43 (t,  $J = 13.2$  Hz, 1H), 1.36-1.31 (m, 1H), 1.18 (s, 3H), 1.34-1.08 (m, 1H), 1.07 (s, 9H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  213.5, 144.0, 136.04 (2C), 135.95 (2C), 134.4, 133.3, 129.8, 129.7, 127.7 (2C), 127.5 (2C), 111.5, 74.1, 62.8, 49.5, 40.7, 40.4, 39.3, 37.9, 30.2, 27.9, 27.0 (3C), 23.5, 21.9, 19.5; HRMS (ESI)  $m/z$  calcd. for  $\text{C}_{30}\text{H}_{41}\text{SiO}_2$  ( $[\text{M}+\text{H}]^+$ ) 461.2870, found 461.2880.

**(3*R*,3*aR*,7*R*,7*aR*)-7-((*tert*-butyldiphenylsilyl)oxy)-3-(2-hydroxy-2-methylpropyl)-7*a*-methyloctahydro-4*H*-inden-4-one (23)**

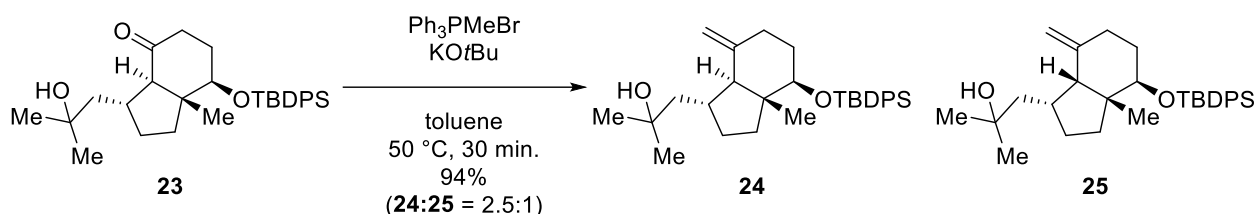


To a solution of **21** (200 mg, 434  $\mu\text{mol}$ ) in EtOH (8.6 mL) was added  $\text{Mn}(\text{dpm})_3$  (52.5 mg, 86.8  $\mu\text{mol}$ ) at 0  $^\circ\text{C}$ . After the mixture was stirred for 20 min at 0  $^\circ\text{C}$ , phenylsilane (80  $\mu\text{L}$ , 651  $\mu\text{mol}$ ) was added and the solution was stirred for further 40 min. To the reaction mixture was added  $\text{PPh}_3$  (570 mg, 2.17 mmol) and the mixture was stirred for further 30 min at rt. The reaction mixture was concentrated to give a residue. The residue was purified by flash column chromatography (hexane/EtOAc = 5/1 to 1/1) to give **23** (186.2 mg, 389  $\mu\text{mol}$ , 90%) as a colorless oil.

$[\alpha]_{\text{D}}^{22.9} +19.2$  ( $c = 0.14$ ,  $\text{CHCl}_3$ ); IR (neat)  $\nu_{\text{max}} = 3425, 2963, 2932, 2892, 2859, 1712, 1428, 1112, 1046, 822, 741, 703$   $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.72 (dd,  $J = 7.8, 1.2$  Hz, 2H), 7.67 (dd,  $J = 7.2, 1.2$  Hz, 2H), 7.47-7.37 (m, 6H), 3.88 (dd,  $J = 10.2, 4.8$  Hz, 1H), 2.45-2.39 (m, 1H), 2.24 (brs, 1H), 2.12 (ddd,  $J = 15.6, 7.2, 1.2$  Hz, 1H), 2.09-2.02 (m, 2H), 1.98 (d,  $J = 11.4$  Hz, 1H), 1.95-1.87 (m, 1H), 1.85-1.80 (m, 1H), 1.76-1.72 (m, 1H), 1.57 (dd,  $J = 14.4, 4.2$  Hz, 1H), 1.37-1.24 (m, 3H), 1.21 (s, 3H), 1.17 (s, 3H), 1.07 (s, 9H), 0.90 (s, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  211.5, 136.0 (2C), 135.9 (2C), 134.4, 133.5, 129.8, 129.6, 127.6 (2C), 127.5 (2C), 78.7, 70.7, 63.6, 52.1, 50.0, 39.6, 38.6, 31.9, 30.6, 30.4, 30.0, 29.2, 27.0 (3C), 19.4, 13.3; HRMS (ESI)  $m/z$  calcd. for  $\text{C}_{30}\text{H}_{42}\text{SiO}_3\text{Na}$  ( $[\text{M}+\text{Na}]^+$ ) 501.2795, found 501.2796.

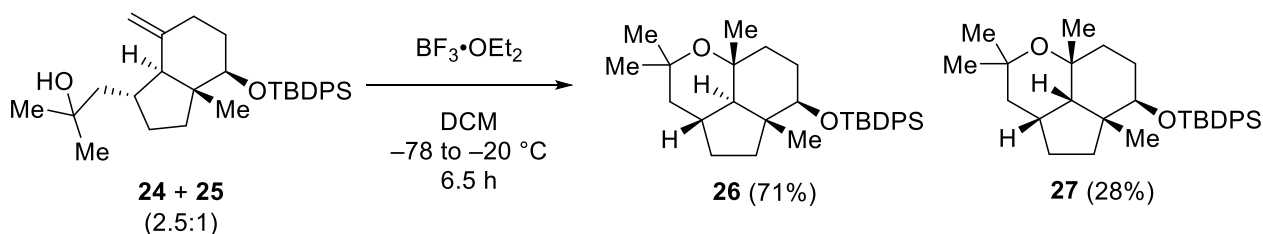
*tert*-butyldiphenyl(((3*aR*,3*a*<sup>1</sup>*R*,5*aR*,6*R*,8*aR*)-2,2,5*a*,8*a*-tetramethyldecahydro-2*H*-cyclopenta[*de*]chromen-6-yl)oxy)silane (**26**) and *tert*-butyldiphenyl(((3*aR*,3*a*<sup>1</sup>*S*,5*aR*,6*R*,8*aR*)-2,2,5*a*,8*a*-tetramethyldecahydro-2*H*-cyclopenta[*de*]chromen-6-yl)oxy)silane (**27**)





To a solution of methyltriphenylphosphonium bromide ( $\text{Ph}_3\text{PMeBr}$ , 112 mg, 313  $\mu\text{mol}$ ) in toluene (1.0 mL) was added  $\text{KOtBu}$  (28.1 mg, 250  $\mu\text{mol}$ ) at  $50\text{ }^\circ\text{C}$ . The mixture was slowly warmed to reflux over 1 h, stirred for further 1 h, and then cooled to  $50\text{ }^\circ\text{C}$ . To the mixture was added a solution of **23** (15.0 mg, 31.3  $\mu\text{mol}$ ) in toluene (500  $\mu\text{mol}$ ) and stirred for further 30 min at  $50\text{ }^\circ\text{C}$ . The reaction mixture was quenched by the addition of sat.  $\text{NH}_4\text{Cl}$  aq. and diluted with EtOAc. The aqueous layer was extracted with EtOAc. The combined organic solution was washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (hexane/EtOAc = 19/1 to 4/1) to give **24** (14.0 mg, 29.4  $\mu\text{mol}$ , 94%, inseparable mixture with C5 epimer **25**, 24:25 = 2.5:1) as a colorless oil.

$^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ , 24:25 = 2.5:1)  $\delta$  7.73-7.65 (m, 10H for **24**, 4H for **25**), 7.44-7.35 (m, 15H for **24**, 6H for **25**), 4.76 (br m, 2.5H for **24**, 1H for **25**), 4.58 (br t,  $J = 1.8$  Hz, 1H for **25**), 4.52 (br d,  $J = 1.2$  Hz, 2.5H for **24**), 3.49 (dd,  $J = 10.8, 4.8$  Hz, 2.5H for **24**), 3.41 (dd,  $J = 11.4, 4.8$  Hz, 1H for **25**), 2.42 (d,  $J = 11.4$  Hz, 1H for **25**), 2.19-1.96 (m, 7.5H for **24**, 3H for **25**), 1.76-1.67 (m, 5H for **24**, 5H for **25**), 1.57-1.49 (m, overlap with  $\text{H}_2\text{O}$ , 5H for **24**, 3H for **25**), 1.42 (d,  $J = 11.4$  Hz, 1H for **25**), 1.37-1.14 (m, 15H for **24**), 1.22 (s, 7.5H for **24**), 1.21 (s, 7.5H for **24**), 1.063 (s, 3H for **25**), 1.057 (s, 9H for **25**), 1.05 (s, 6H for **25**), 1.04 (s, 22.5H for **24**), 0.78 (s, 7.5H for **24**);  $^{13}\text{C}$  NMR for **25** (150 MHz,  $\text{CDCl}_3$ )  $\delta$  146.8, 136.2 (2C), 136.02 (2C), 135.0, 133.8, 129.6, 127.6 (2C), 127.2 (2C), 115.3, 113.3, 72.9, 71.4, 58.4, 48.29, 47.85, 37.8, 33.9, 32.64, 32.59, 30.38, 29.68, 29.66, 27.1 (3C), 19.44, 19.40.



To a solution of **24/25** (17.0 mg, 35.7  $\mu\text{mol}$ , 24:25 = 2.5:1) in DCM (700  $\mu\text{L}$ ) was added  $\text{BF}_3 \cdot \text{OEt}_2$  (8.9  $\mu\text{L}$ , 71  $\mu\text{mol}$ ) at  $-78\text{ }^\circ\text{C}$ . After the mixture was stirred for 30 min at  $-40\text{ }^\circ\text{C}$ , solution was warmed to  $-20\text{ }^\circ\text{C}$  and stirred for further 6 h. The reaction mixture was quenched by the addition of sat.  $\text{NaHCO}_3$  aq. and diluted with EtOAc. The aqueous layer was extracted with EtOAc. The combined organic solution was washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (hexane/Et<sub>2</sub>O = 39/1 to 19/1) to give **26** (12.1 mg, 25.4  $\mu\text{mol}$ , 71%) and **27** (4.7 mg, 9.9  $\mu\text{mol}$ , 28%) as a colorless oil.

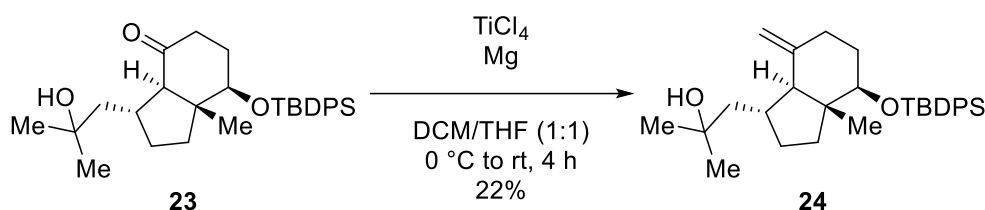
**26**:  $[\alpha]_{\text{D}}^{22.9} + 8.1$  ( $c = 0.65$ ,  $\text{CHCl}_3$ ); IR (neat)  $\nu_{\text{max}} = 2931, 2858, 1113, 1082, 974, 703\text{ cm}^{-1}$ ;  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.68-7.65 (m, 4H), 7.44-7.40 (m, 2H), 7.38-7.35 (m, 4H), 3.40 (dd,  $J = 11.4, 4.8$  Hz, 1H), 2.00-1.84 (m, 3H), 1.62-1.49 (m, 5H, overlap with  $\text{H}_2\text{O}$ ), 1.222 (s, 3H), 1.218 (s, 3H), 1.17-1.06 (m, 3H), 1.12 (s, 3H), 1.05 (s, 9H), 0.95 (s, 3H), 0.68 (d,  $J = 12.6$  Hz, 1H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  136.0 (2C), 135.9 (2C), 135.0, 134.0, 129.6, 129.4, 127.5 (2C), 127.3 (2C), 81.8, 73.9, 73.6, 58.7, 47.0, 45.8, 41.1, 40.8, 33.6, 31.1, 28.8, 28.6, 28.0, 27.0 (3C), 22.7, 19.4, 14.9; HRMS (ESI)  $m/z$  calcd. for  $\text{C}_{31}\text{H}_{45}\text{SiO}_2$  ( $[\text{M}+\text{H}]^+$ ) 477.3183, found 477.3193.

**27**:  $[\alpha]_{\text{D}}^{23.0} + 7.5$  ( $c = 0.65$ ,  $\text{CHCl}_3$ ); IR (neat)  $\nu_{\text{max}} = 2959, 2931, 2857, 1261, 1111, 1080, 821, 703\text{ cm}^{-1}$ ;  $^1\text{H}$  NMR

(600 MHz, CDCl<sub>3</sub>)  $\delta$  7.71 (dd,  $J$  = 7.8, 1.2 Hz, 2H), 7.67 (dd,  $J$  = 8.4, 1.2 Hz, 2H), 7.43-7.34 (m, 6H), 3.68 (dd,  $J$  = 10.2, 5.4 Hz, 1H), 2.29-2.22 (m, 1H), 1.83-1.79 (m, 1H), 1.66-1.52 (m, 5H), 1.47-1.43 (m, 1H), 1.33-1.27 (m, 2H), 1.23-1.19 (m, 1H), 1.21 (s, 3H), 1.20 (s, 3H), 1.08 (s, 3H), 1.06 (s, 9H), 1.03-0.97 (m, 1H), 0.90 (s, 3H); <sup>13</sup>C NMR (150 MHz, CDCl<sub>3</sub>)  $\delta$  136.03 (2C), 136.00 (2C), 135.0, 134.2, 129.5, 129.3, 127.5 (2C), 127.3 (2C), 75.1, 72.7, 70.6, 53.3, 46.5, 38.23, 38.16, 37.4, 33.1, 32.8, 32.0, 30.1, 28.8, 28.1, 27.1 (3C), 23.3, 19.5; HRMS (ESI)  $m/z$  calcd. for C<sub>31</sub>H<sub>45</sub>SiO<sub>2</sub> ([M+H]<sup>+</sup>) 477.3183, found 477.3201.

#### Attempted synthesis of pure **24**.

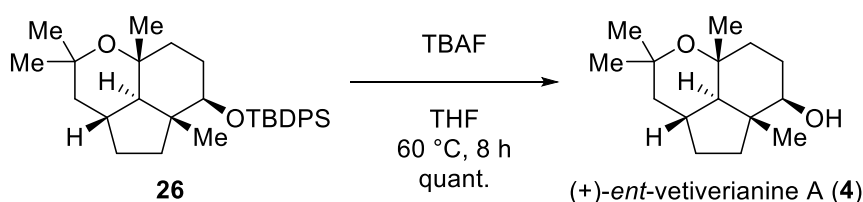
#### 1-((1*R*,3*aR*,4*R*,7*aS*)-4-((*tert*-butyldiphenylsilyl)oxy)-3*a*-methyl-7-methyleneoctahydro-1*H*-inden-1-yl)-2-methylpropan-2-ol (**24**)



To a solution of Mg powder (30.9 mg, 1.27 mmol) in DCM (1.6 mL) and THF (1.9 mL) was added TiCl<sub>4</sub> (79  $\mu$ L, 318  $\mu$ mol) at 0 °C. The mixture was stirred for 30 min at the same temperature. To the mixture was added **23** (38 mg, 79  $\mu$ mol) in DCM (300  $\mu$ L) at 0 °C. The solution was stirred for 4 h at rt. The reaction mixture was quenched by the addition of H<sub>2</sub>O and diluted with DCM. The aqueous layer was extracted with DCM. The combined organic solution was washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (hexane/EtOAc = 4/1) to give **24** (8.3 mg, 17  $\mu$ mol, 22%) as a colorless oil.

$[\alpha]_D^{22.9} +25.7$  ( $c$  = 0.40, CHCl<sub>3</sub>); IR (neat)  $\nu_{\max}$  = 2953, 2932, 2858, 1112, 1090, 703 cm<sup>-1</sup>; <sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>)  $\delta$  7.70 (dd,  $J$  = 7.8, 1.2 Hz, 2H), 7.66 (dd,  $J$  = 7.2, 1.2 Hz, 2H), 7.44-7.35 (m, 6H), 4.76 (d,  $J$  = 1.8 Hz, 1H), 4.52 (d,  $J$  = 1.2 Hz, 1H), 3.50 (dd,  $J$  = 10.8, 4.8 Hz, 1H), 2.17-2.01 (m, 3H), 1.77-1.68 (m, 2H), 1.58-1.50 (m, 2H), 1.37-1.14 (m, 6H), 1.220 (s, 3H), 1.215 (s, 3H), 1.04 (s, 9H), 0.78 (s, 3H); <sup>13</sup>C NMR (150 MHz, CDCl<sub>3</sub>)  $\delta$  146.4, 136.0 (2C), 135.9 (2C), 135.1, 134.1, 129.5, 129.3, 127.5 (2C), 127.3 (2C), 106.0, 80.6, 71.6, 57.6, 49.5, 48.3, 38.3, 34.6, 32.6, 32.5, 30.4, 30.1, 29.8, 27.0 (3C), 19.5, 12.6; HRMS (ESI)  $m/z$  calcd. for C<sub>31</sub>H<sub>45</sub>SiO<sub>2</sub> ([M+H]<sup>+</sup>) 477.3183, found 477.3195.

#### (+)-*ent*-vetiverianine A (**4**)

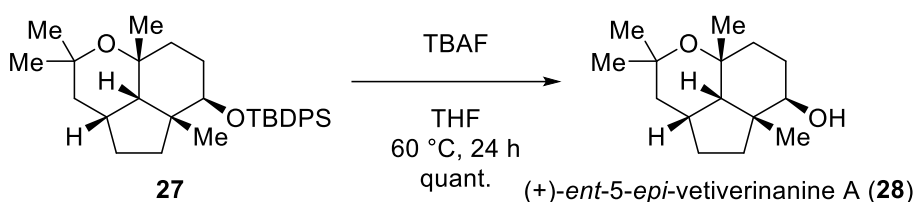


To a solution of **26** (24.0 mg, 50.3  $\mu$ mol) in THF (1.0 mL) was added TBAF (1.0 M in THF, 500  $\mu$ L, 500  $\mu$ mol) at rt. The solution was stirred for 8 h at 60 °C. The reaction mixture was quenched by the addition of sat. NH<sub>4</sub>Cl aq. and diluted with EtOAc. The aqueous layer was extracted with EtOAc. The combined organic solution was washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated to give a residue. The residue was purified by flash column

chromatography (hexane/EtOAc = 2/1) to give (+)-*ent*-vetiverianine A (**4**, 12.0 mg, 50.3  $\mu\text{mol}$ , quant.) as a colorless solid.

$[\alpha]_{\text{D}}^{26.2} +6.6$  ( $c = 0.40$ ,  $\text{CHCl}_3$ ), lit.  $[\alpha]_{\text{D}}^{25} -17$  ( $c = 0.3$ ,  $\text{CHCl}_3$ )<sup>S3</sup>; Mp = 65.5 – 69.0 °C ; IR (neat)  $\nu_{\text{max}} = 3400$ , 2970, 2939, 2867, 1462, 1377, 1115, 1065, 966  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  3.47 (dd,  $J = 11.4, 4.2$  Hz, 1H), 2.03-1.96 (m, 2H), 1.93 (dd,  $J = 12.6, 3.6$  Hz, 1H), 1.80-1.73 (m, 2H), 1.65 (ddd, 12.0, 8.4, 3.6 Hz, 1H), 1.58-1.50 (m, 1H), 1.45-1.36 (m, 2H), 1.26 (s, 3H), 1.24 (s, 3H), 1.24-1.23 (m, 1H), 1.19 (s, 3H), 1.14 (dd,  $J = 12.6, 10.8$  Hz, 1H), 0.88 (d,  $J = 12.6$  Hz, 1H), 0.82 (s, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  80.6, 73.9, 73.7, 59.0, 47.1, 45.0, 41.3, 40.2, 33.7, 30.7, 28.8, 28.5, 28.2, 22.7, 14.2; HRMS (ESI)  $m/z$  calcd. for  $\text{C}_{15}\text{H}_{27}\text{O}_2$  ( $[\text{M}+\text{H}]^+$ ) 239.2006, found 239.2018.

**(+)-*ent*-5-*epi*-vetiverianine A (**28**)**

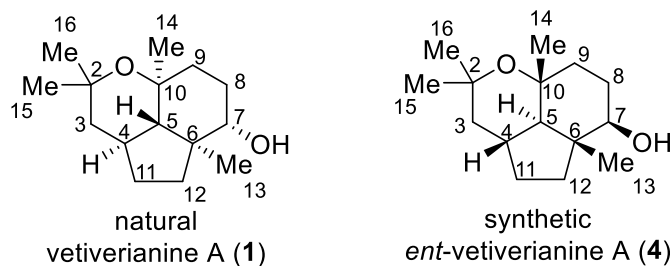


To a solution of **27** (21.0 mg, 44.0  $\mu\text{mol}$ ) in THF (800  $\mu\text{L}$ ) was added TBAF (1.0 M in THF, 450  $\mu\text{L}$ , 450  $\mu\text{mol}$ ) at rt. The solution was stirred for 24 h at 60 °C. The reaction mixture was quenched by the addition of sat.  $\text{NH}_4\text{Cl}$  aq. and diluted with EtOAc. The aqueous layer was extracted with EtOAc. The combined organic solution was washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated to give a residue. The residue was purified by flash column chromatography (hexane/EtOAc = 2/1) to give (+)-*ent*-5-*epi*-vetiverianine A (**28**, 10.5 mg, 44.0  $\mu\text{mol}$ , quant.) as a colorless oil.

$[\alpha]_{\text{D}}^{24.4} +3.5$  ( $c = 0.50$ ,  $\text{CHCl}_3$ ); IR (neat)  $\nu_{\text{max}} = 3410, 2969, 2937, 2872, 1468, 1378, 1364, 1090, 1011$   $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  3.74 (dd,  $J = 10.8, 5.4$  Hz, 1H), 2.43-2.36 (m, 1H), 1.91-1.81 (m, 4H), 1.64-1.57 (m, 3H), 1.50-1.35 (m, 5H), 1.28 (s, 3H), 1.20 (s, 3H), 1.17 (s, 3H), 1.06 (s, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  73.3, 73.1, 71.0, 53.3, 46.0, 38.8, 37.7, 37.4, 33.3, 33.0, 32.0, 30.4, 29.0, 27.9, 22.1; HRMS (ESI)  $m/z$  calcd. for  $\text{C}_{15}\text{H}_{27}\text{O}_2$  ( $[\text{M}+\text{H}]^+$ ) 239.2006, found 239.2012.

### 3. <sup>1</sup>H and <sup>13</sup>C NMR spectroscopic data

**Table S1. NMR spectroscopic data (CDCl<sub>3</sub>) for natural vetiverianine A (1)<sup>S3</sup> and synthetic (+)-*ent*-vetiverianine A (4).**



| No.         | Natural 1  |                                   | Synthetic 4 |                                   |
|-------------|------------|-----------------------------------|-------------|-----------------------------------|
|             | $\delta_C$ | $\delta_H$ (mult, <i>J</i> in Hz) | $\delta_C$  | $\delta_H$ (mult, <i>J</i> in Hz) |
| 2           | 73.7       |                                   | 73.7        |                                   |
| 3 $\alpha$  | 47.0       | 1.93 (dd, 13.5, 3.7)              | 47.1        | 1.93 (dd, 12.6, 3.6)              |
| 3 $\beta$   |            | 1.15 (dd, 13.5, 8.5)              |             | 1.14 (dd, 12.6, 10.8)             |
| 4           | 28.5       | 1.99 (brd, 10.7)                  | 28.5        | 1.99 (m)                          |
| 5           | 58.9       | 0.88 (d, 12.5)                    | 59.0        | 0.88 (d, 12.6)                    |
| 6           | 44.9       |                                   | 45.0        |                                   |
| 7           | 80.6       | 3.47 (dd, 11.5, 4.3)              | 80.6        | 3.47 (dd, 11.4, 4.2)              |
| 8 $\alpha$  | 30.6       | 1.54 (dd, 11.5, 4.0)              | 30.7        | 1.54 (m)                          |
| 8 $\beta$   |            | 1.78 (dd, 11.5, 7.6)              |             | 1.78 (m)                          |
| 9 $\alpha$  | 41.3       | 1.75 (dd, 8.2, 6.7)               | 41.3        | 1.75 (m)                          |
| 9 $\beta$   |            | 1.38<br>(ddd, 14.7, 8.2, 4.0)     |             | 1.38 (m)<br>(overlapping)         |
| 10          | 73.8       |                                   | 73.9        |                                   |
| 11 $\alpha$ | 28.2       | 1.99 (m)                          | 28.2        | 1.99 (m)                          |
| 11 $\beta$  |            | 1.24 (overlapping)                |             | 1.24 (overlapping)                |
| 12 $\alpha$ | 40.2       | 1.65<br>(ddd, 12.0, 8.9, 3.0)     | 40.2        | 1.65<br>(ddd, 12.0, 8.4, 3.6)     |
| 12 $\beta$  |            | 1.45 (overlapping)                |             | 1.45 (overlapping)                |
| 13          | 14.1       | 0.82 (s)                          | 14.2        | 0.82 (s)                          |
| 14          | 22.7       | 1.24 (s)                          | 22.7        | 1.24 (s)                          |
| 15          | 33.7       | 1.19 (s)                          | 33.7        | 1.19 (s)                          |
| 16          | 28.8       | 1.26 (s)                          | 28.8        | 1.26 (s)                          |

Figure S1. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound 12.

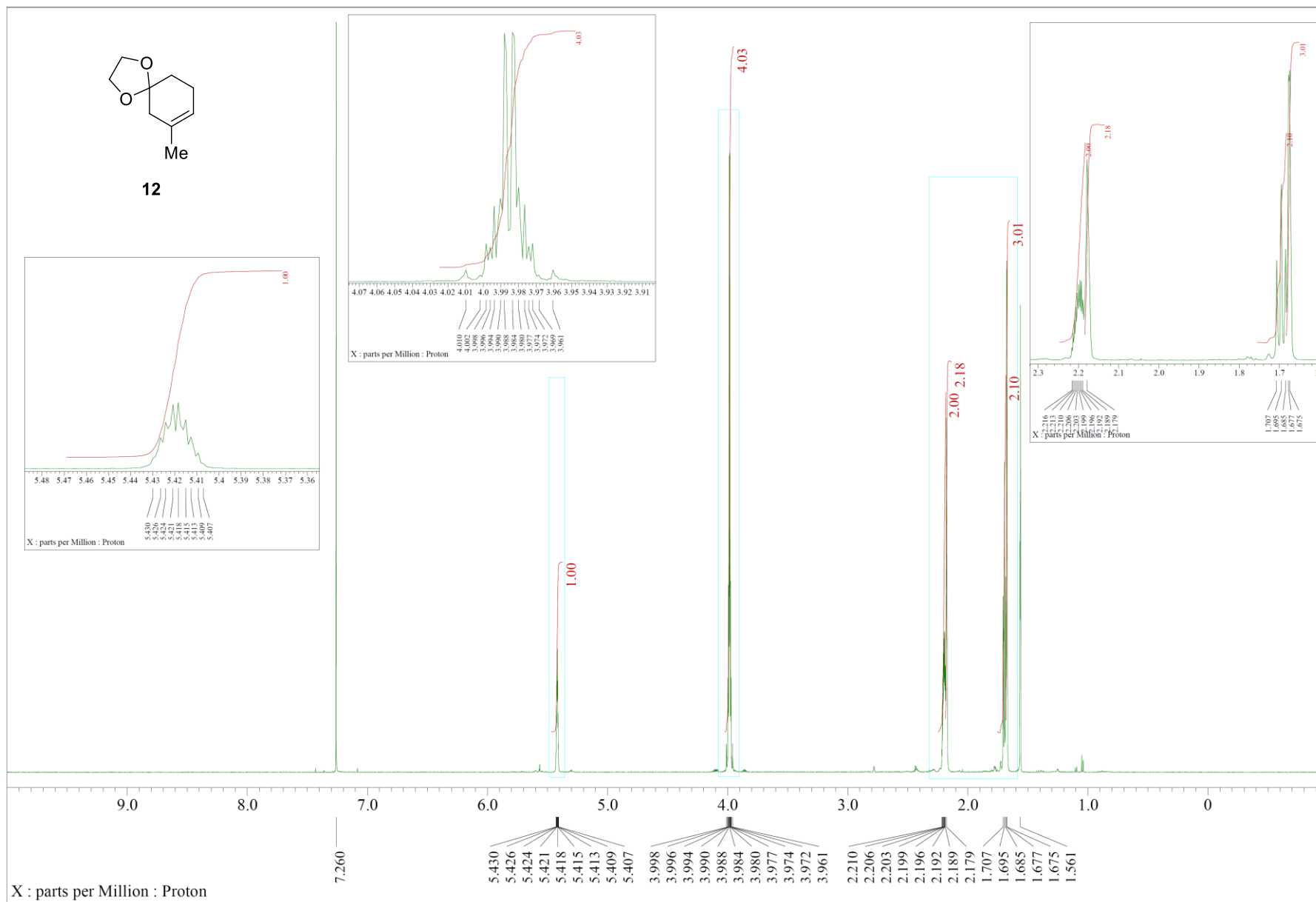


Figure S2.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound 12.

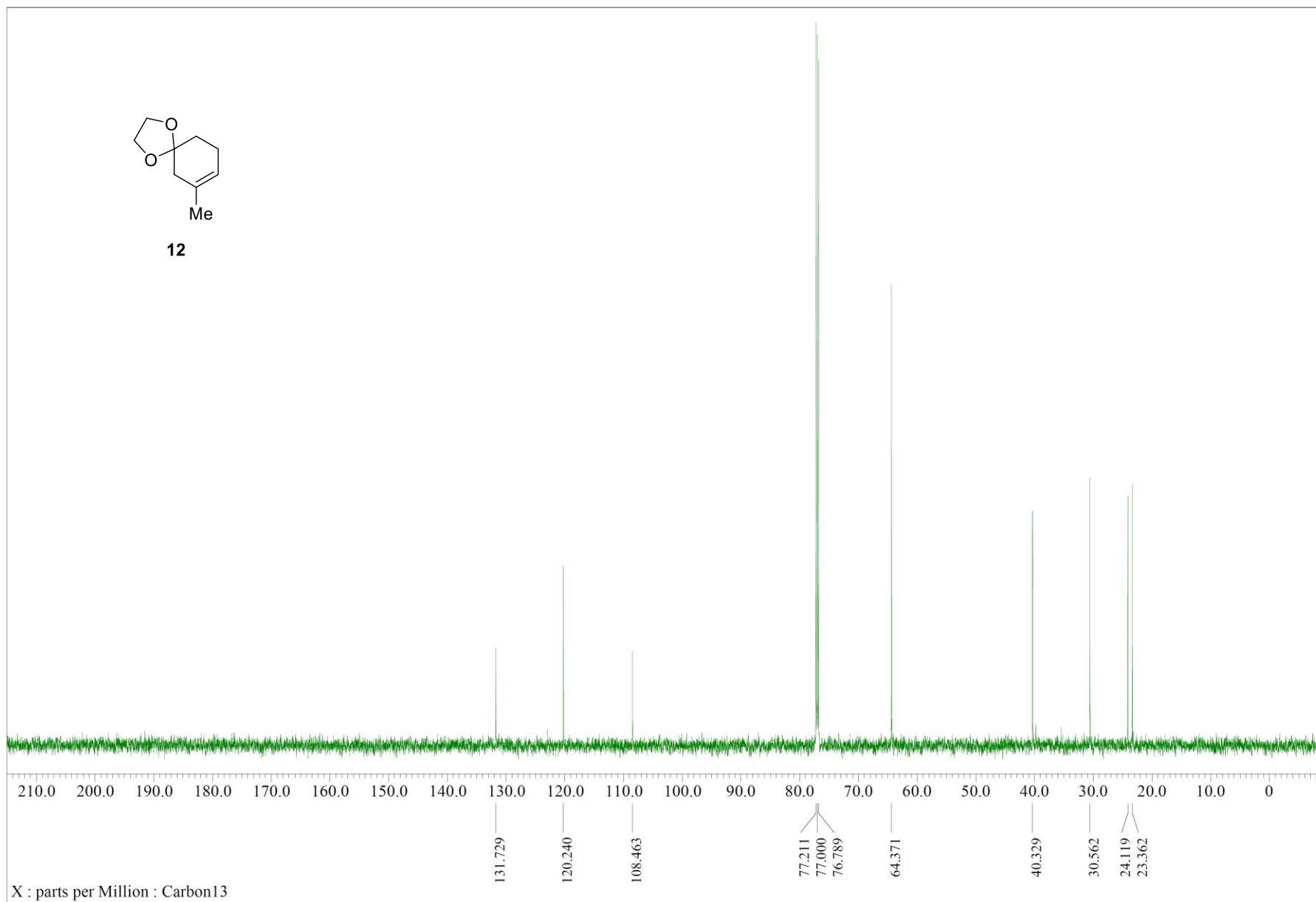


Figure S3. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound 15.

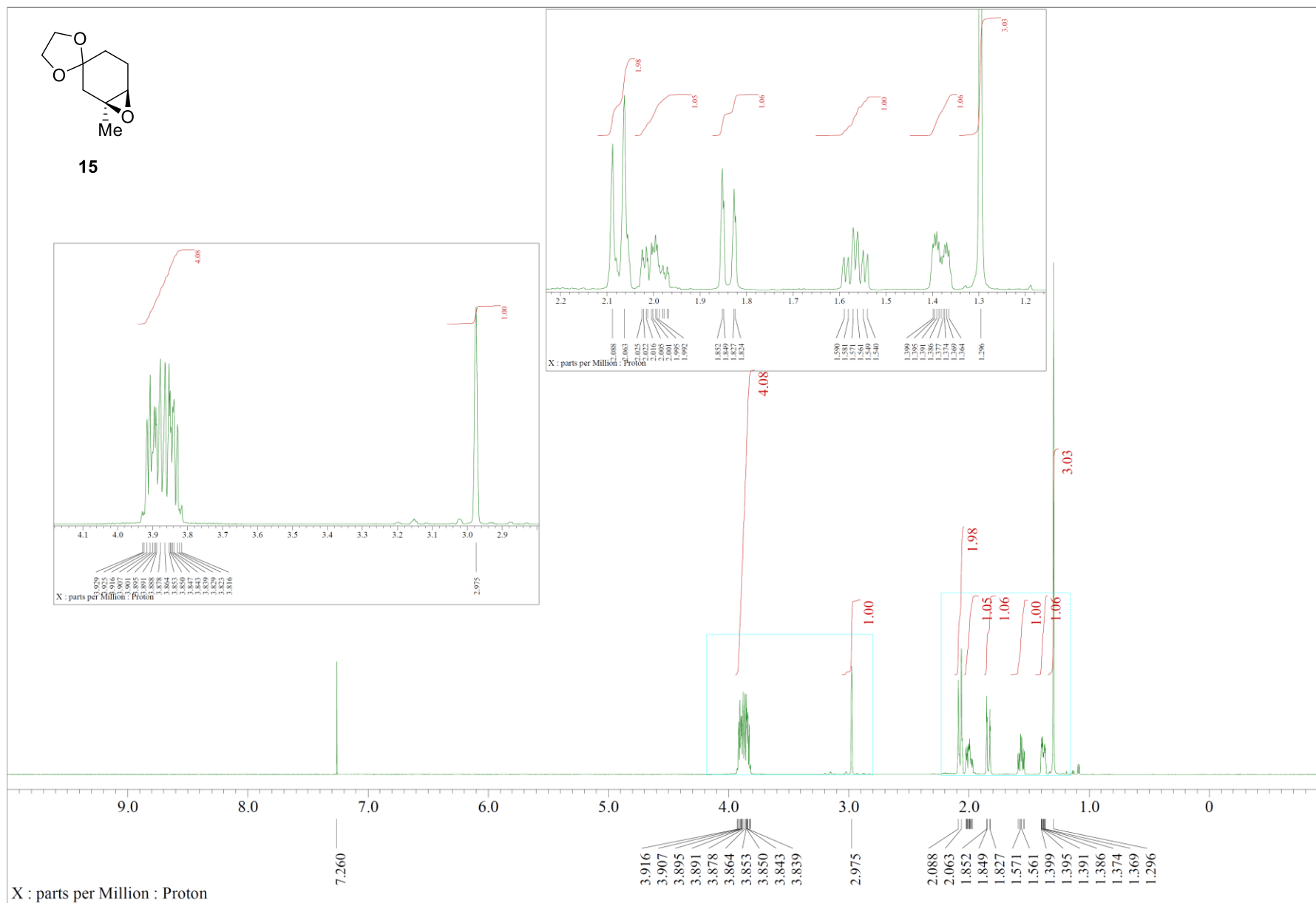


Figure S4.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound 15.

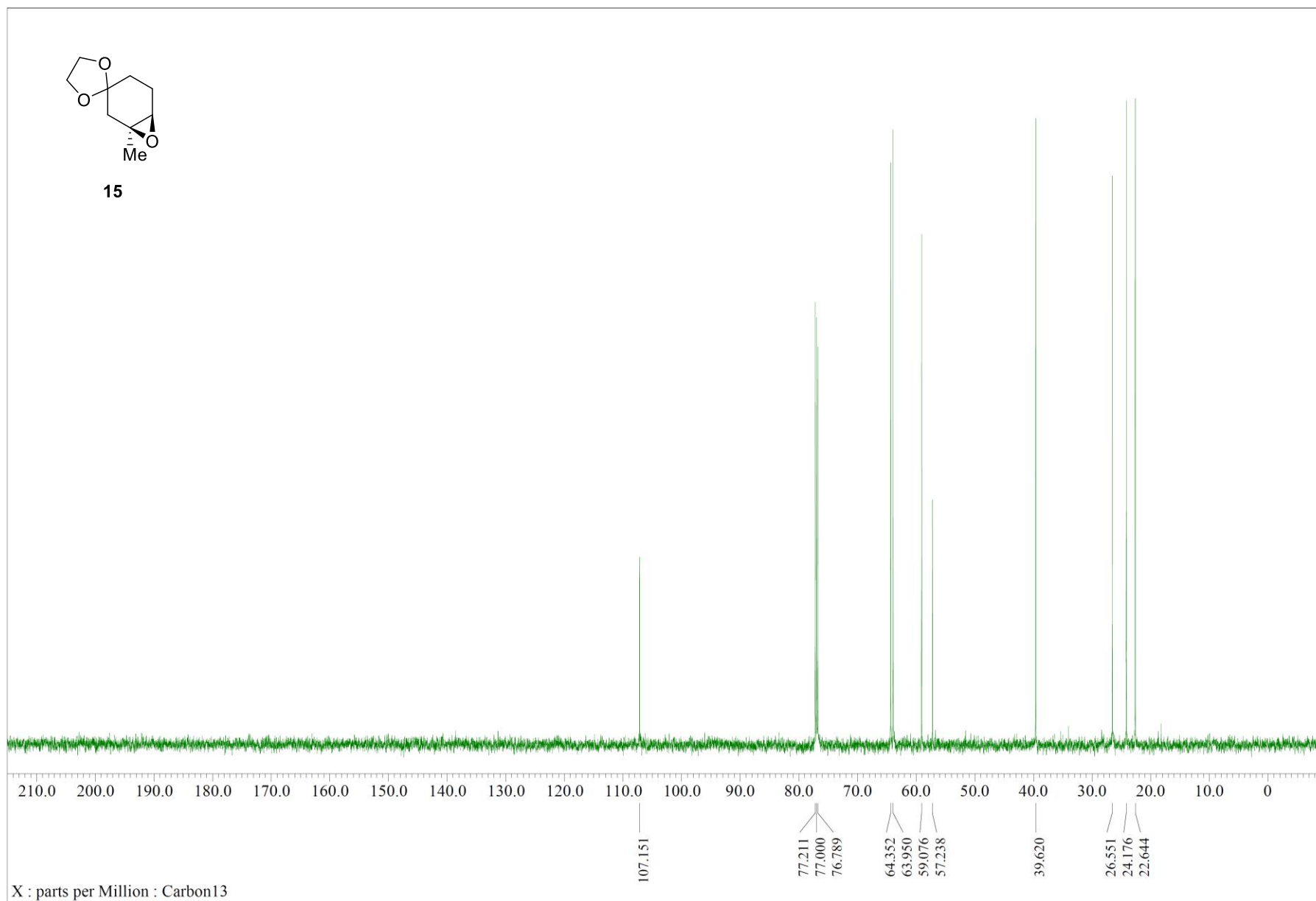




Figure S5. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound 16.

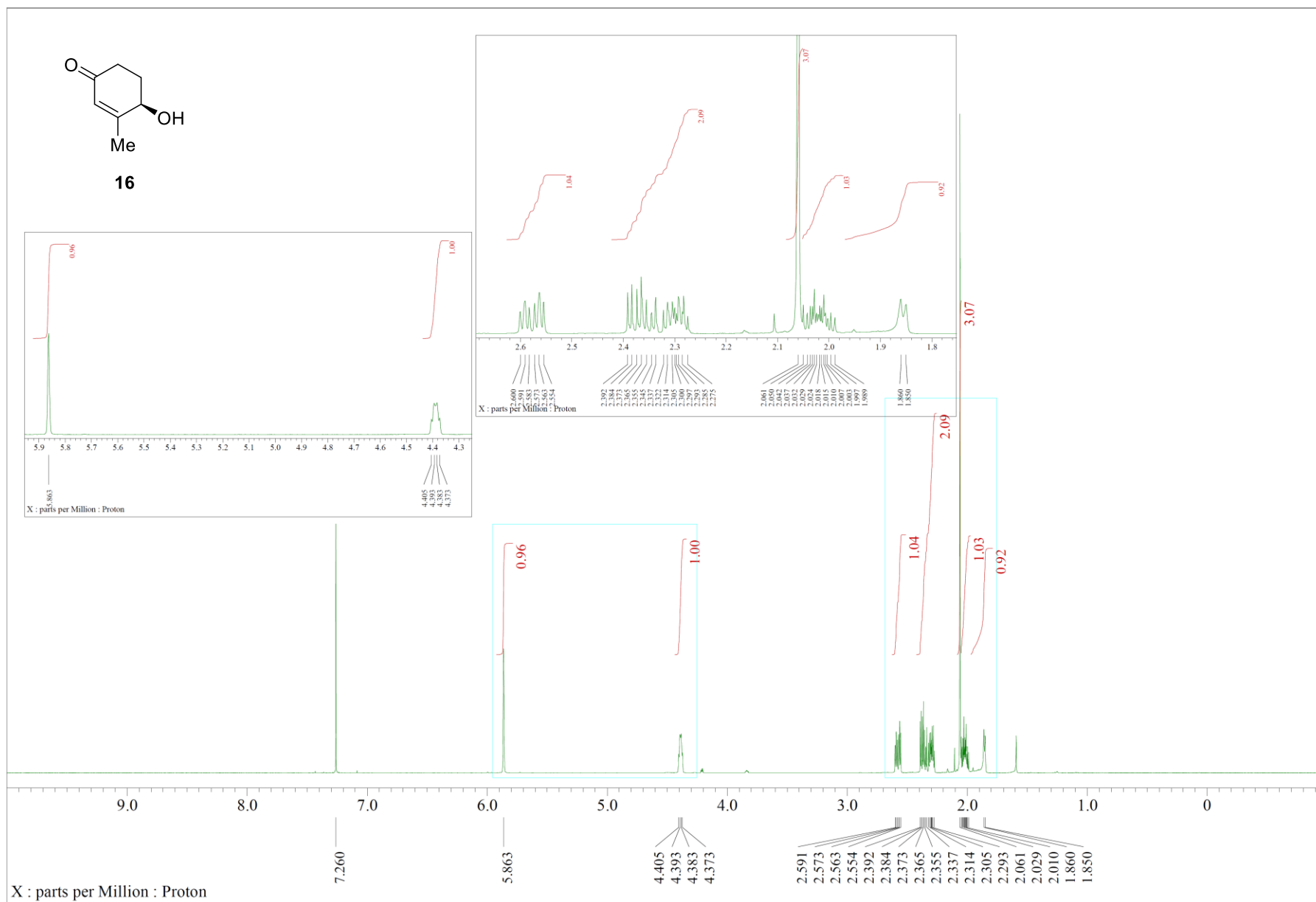


Figure S6.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound 16.

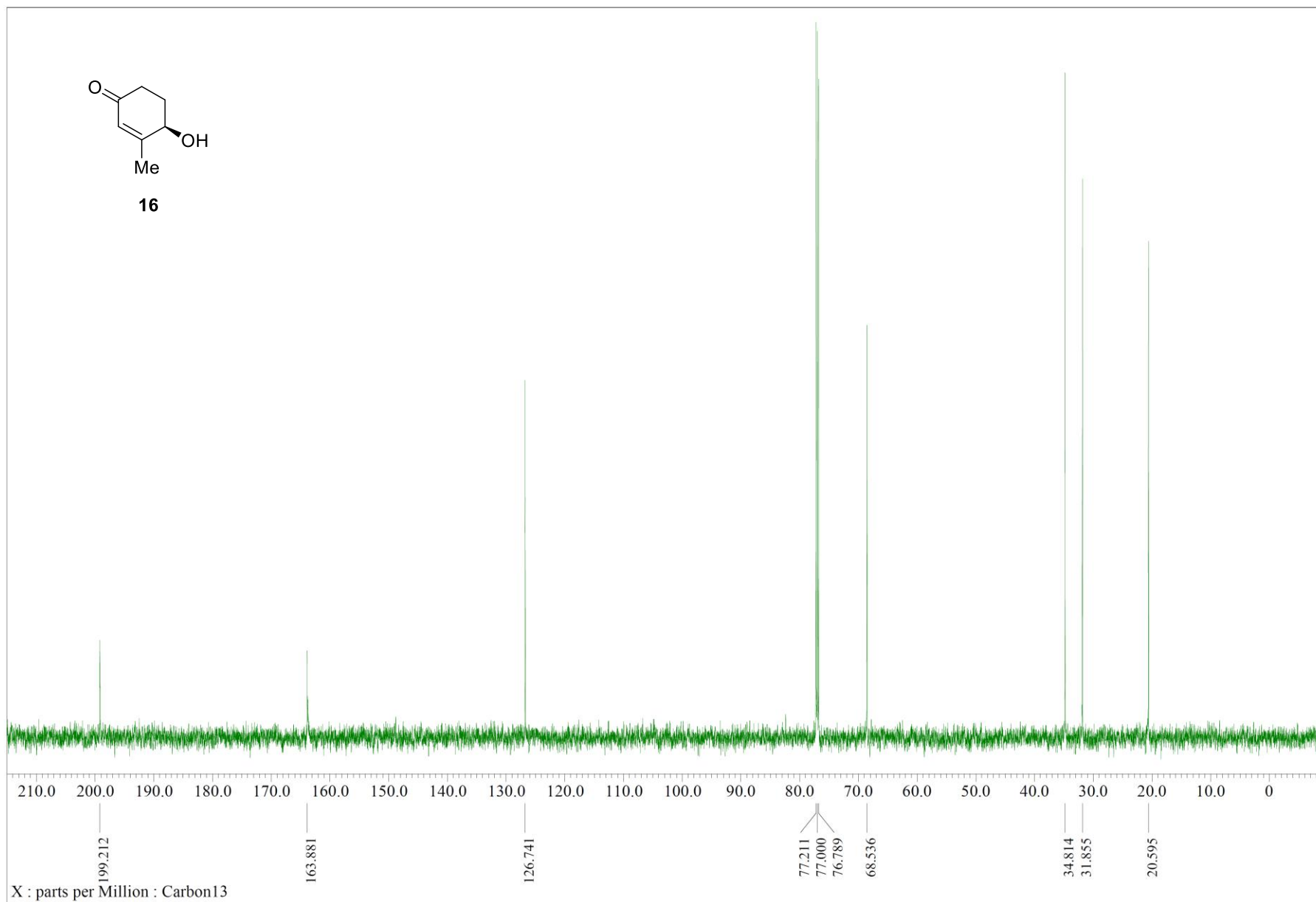


Figure S7. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound S2.

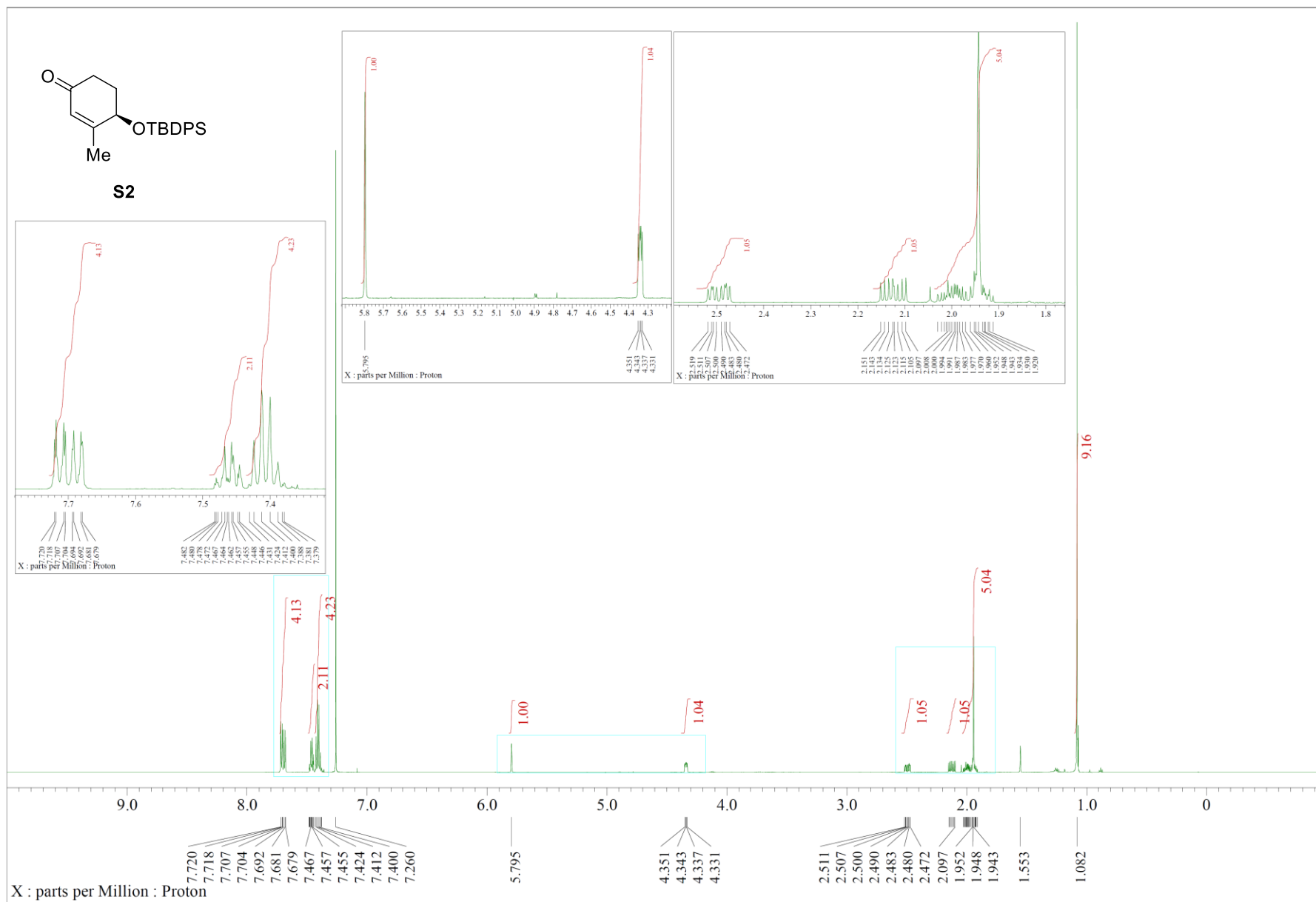


Figure S8.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound S2.

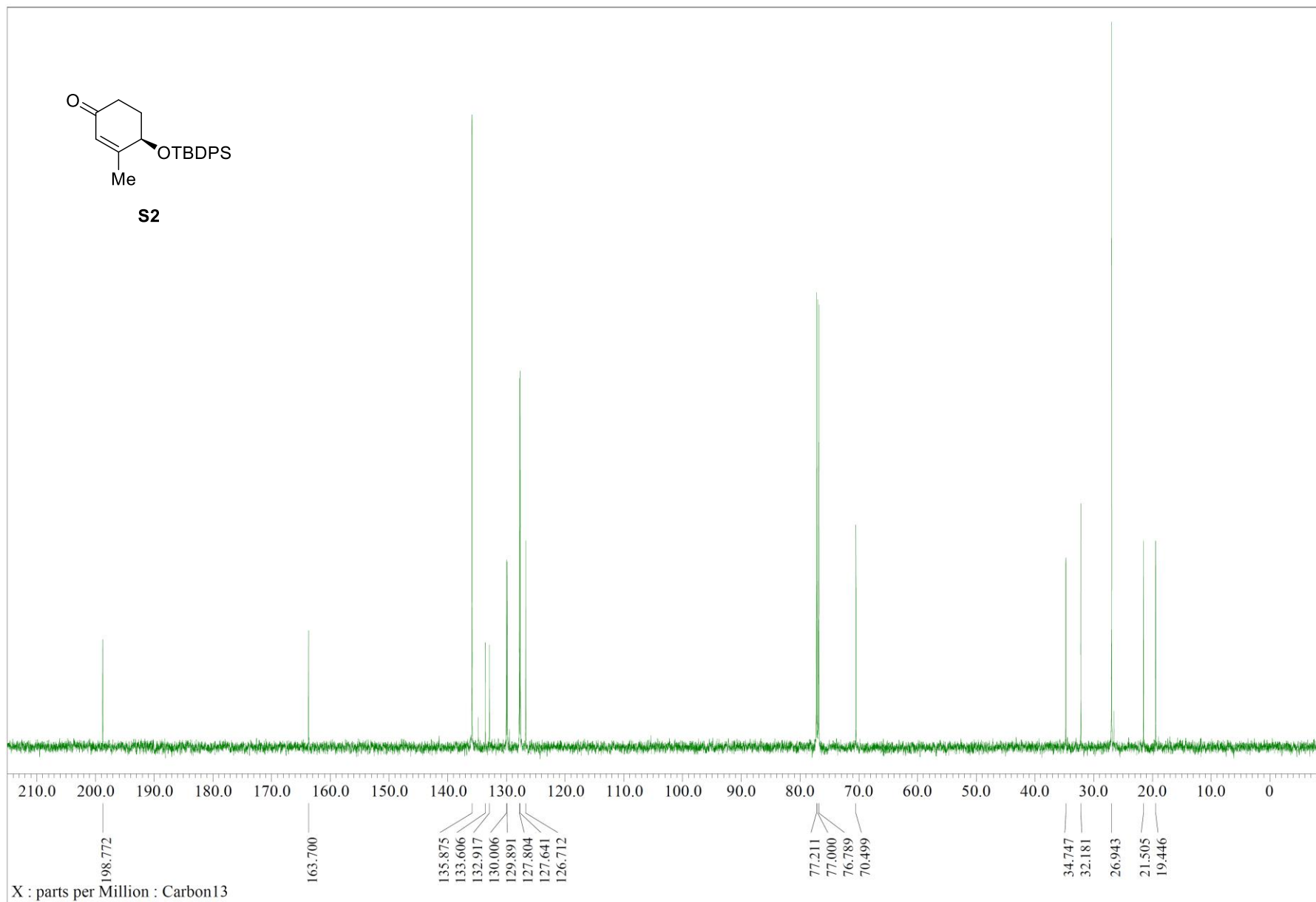


Figure S9. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>, 4.9:1 rotamer mixture) of compound 18.

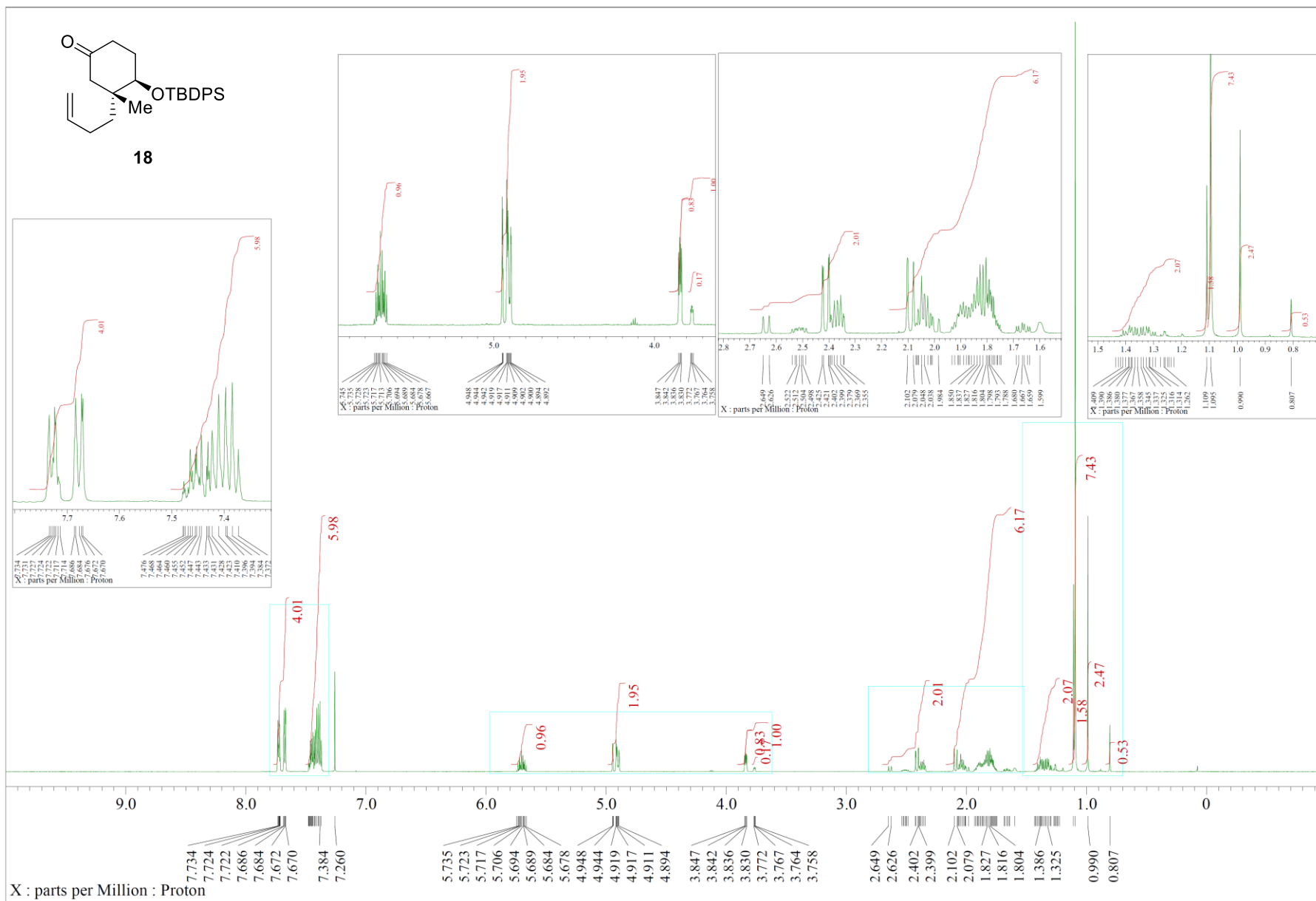


Figure S10.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ , 4.9:1 rotamer mixture) of compound 18.

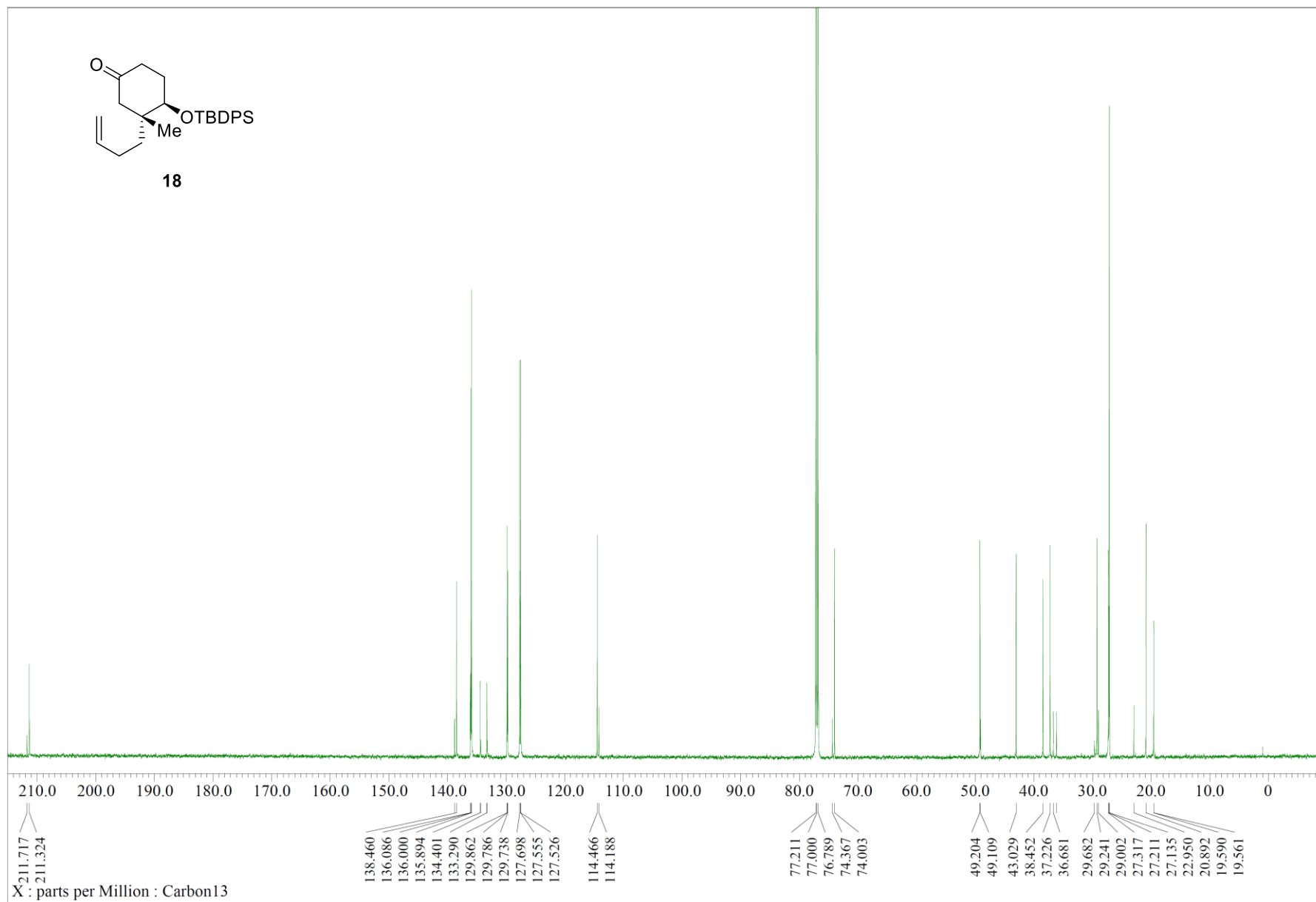


Figure S11. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>, 4.9:1 rotamer mixture) of compound 19.

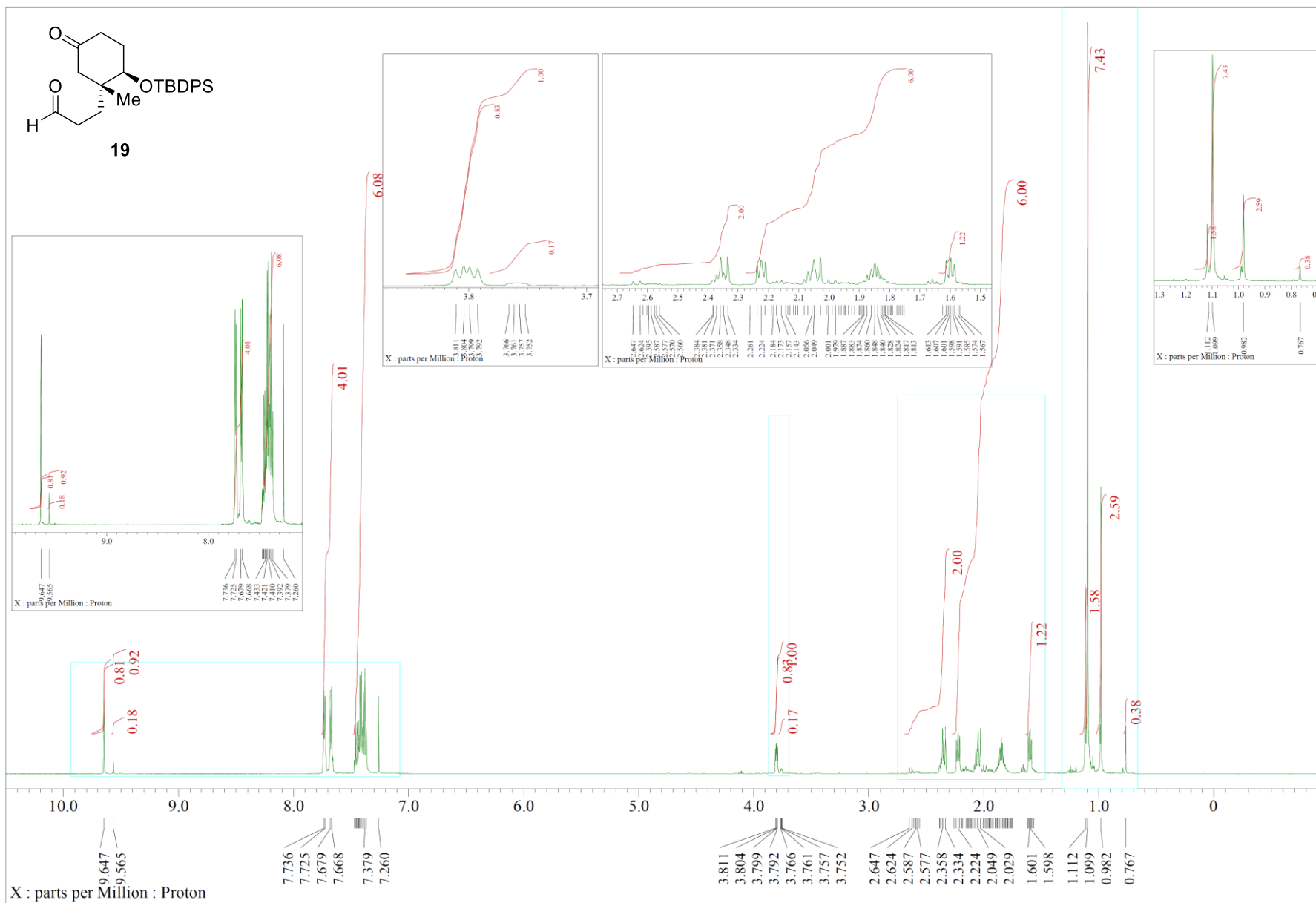


Figure S12.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ , 4.9:1 rotamer mixture) of compound 19.

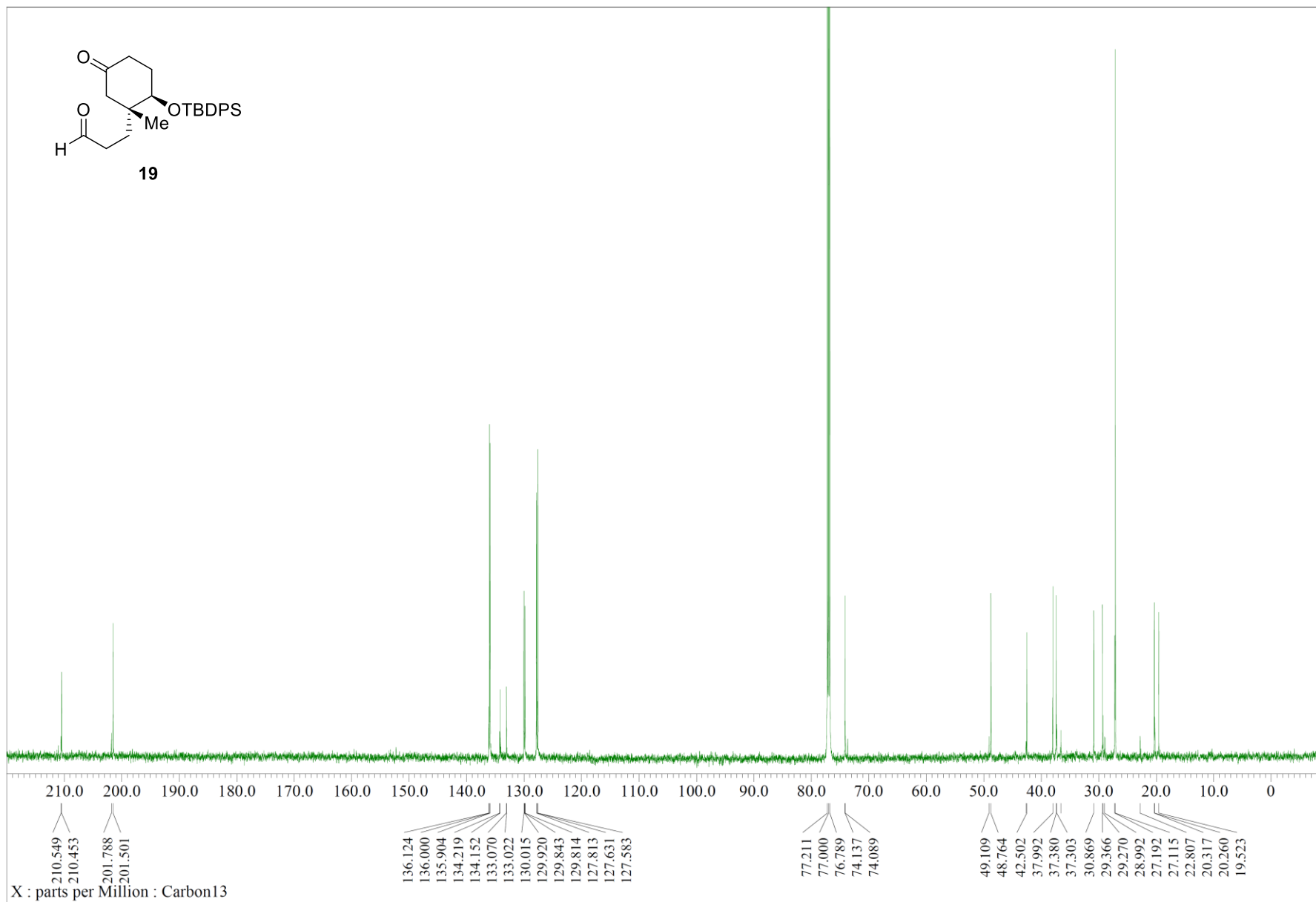




Figure S13. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound 20.

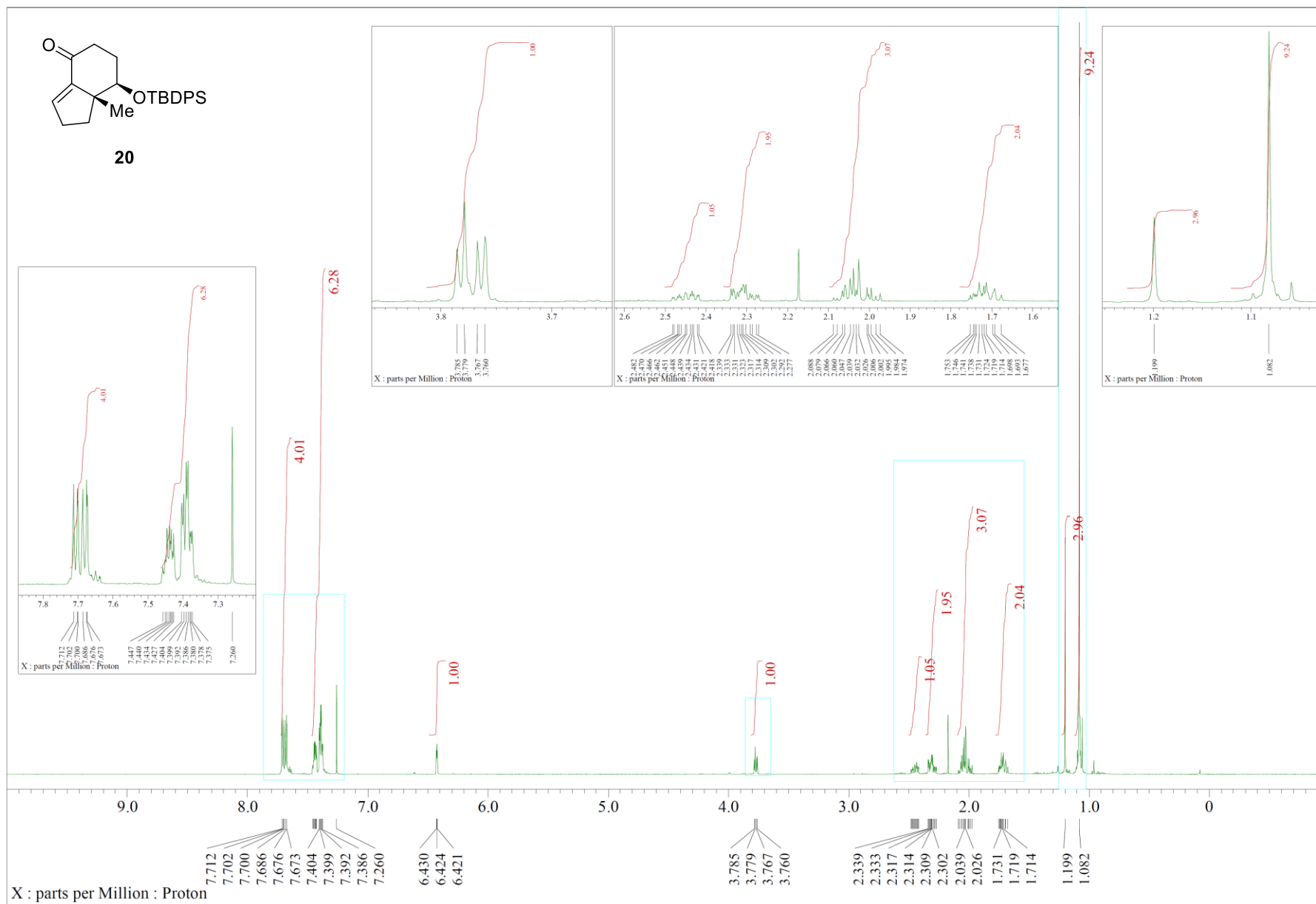


Figure S14.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound 20.

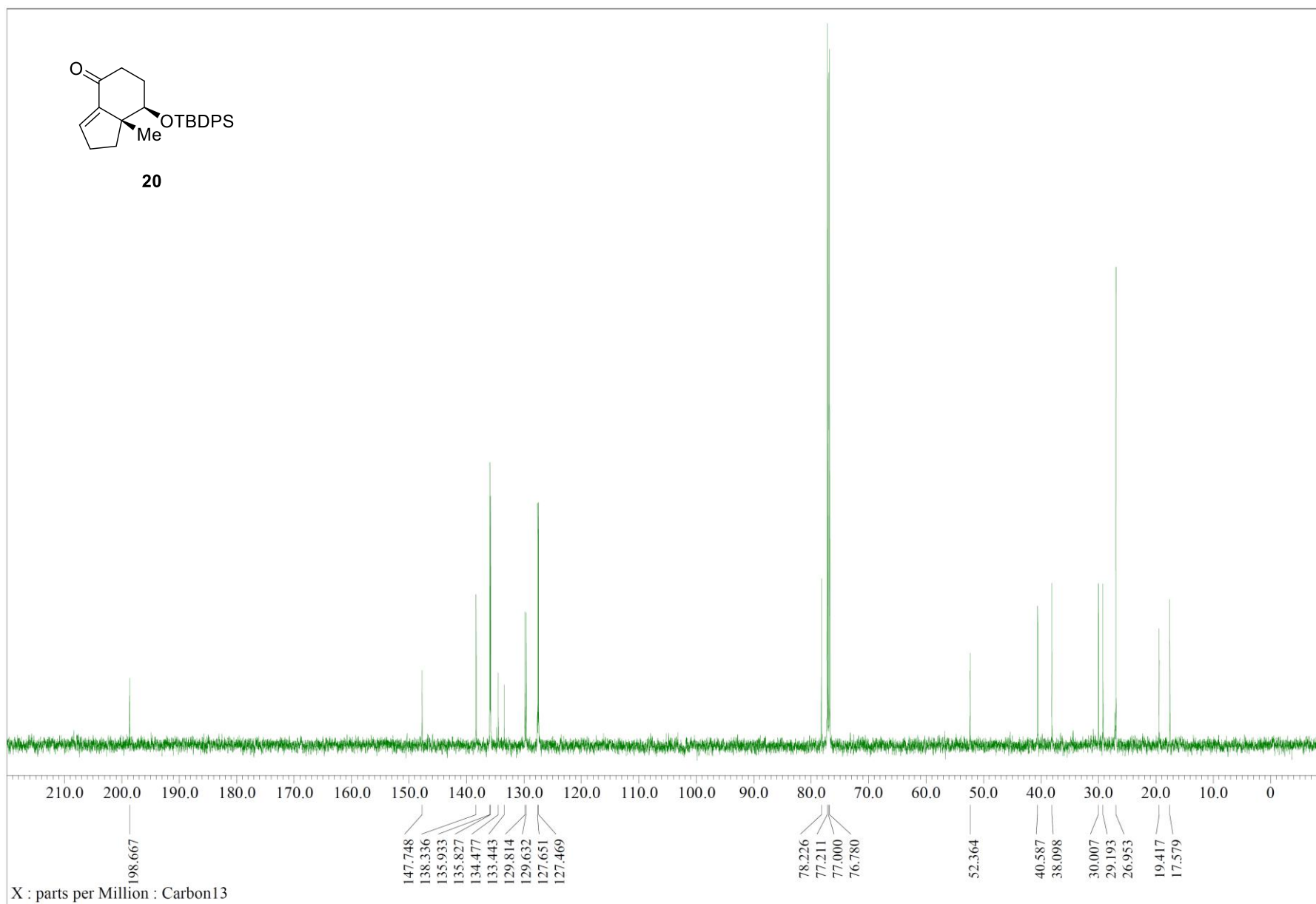


Figure S15. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound 21.

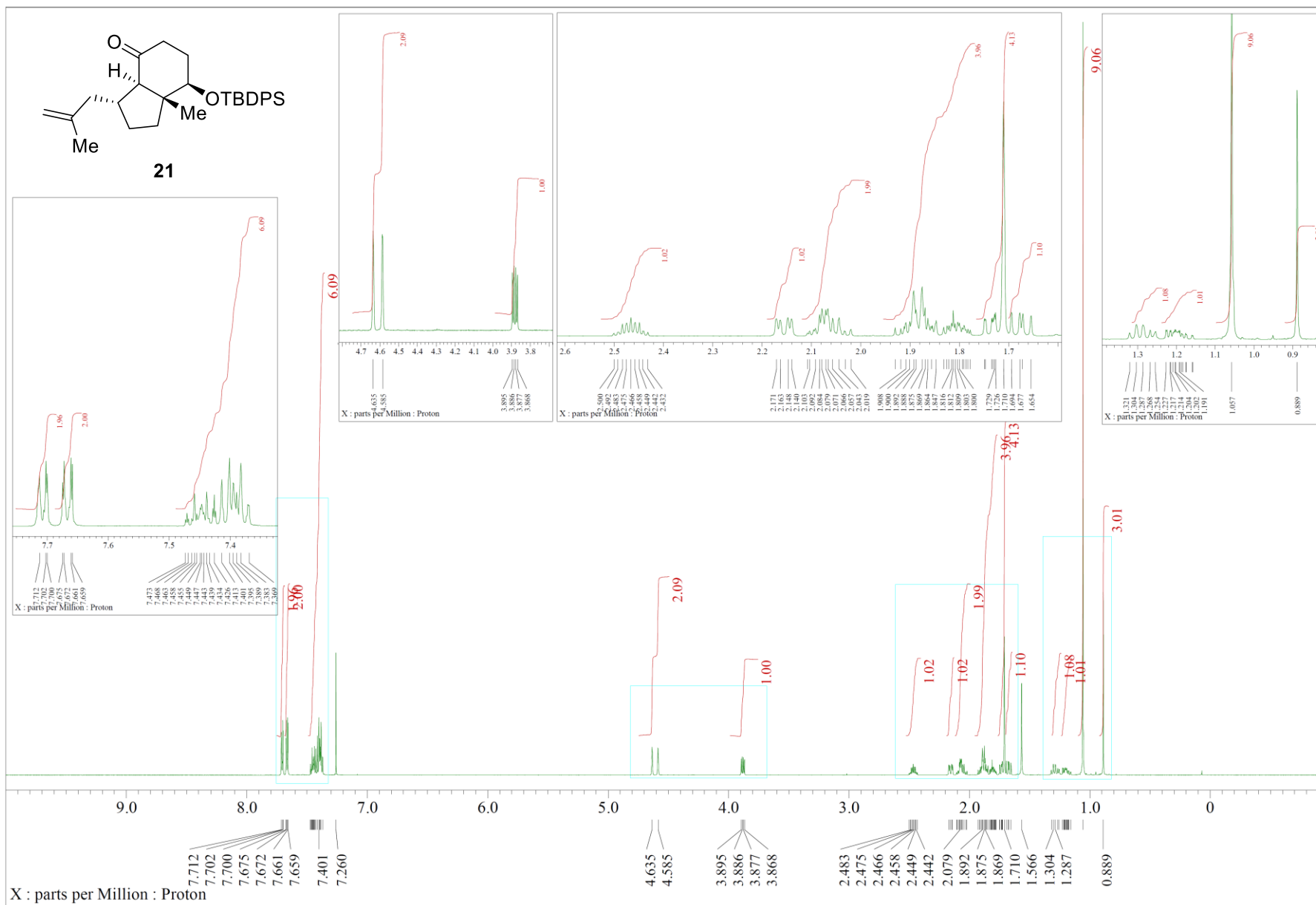


Figure S16.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound 21.

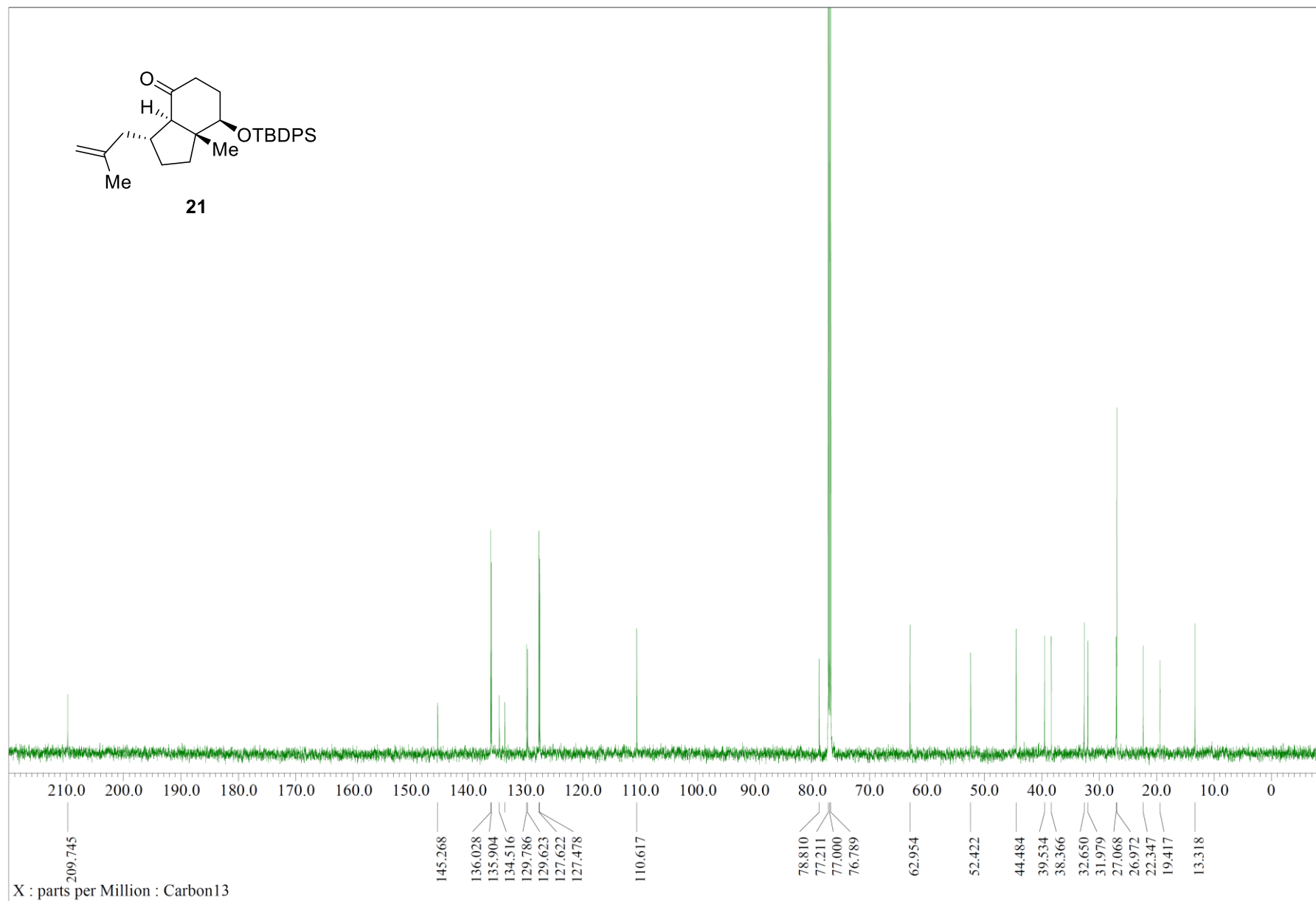


Figure S17. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound 22.

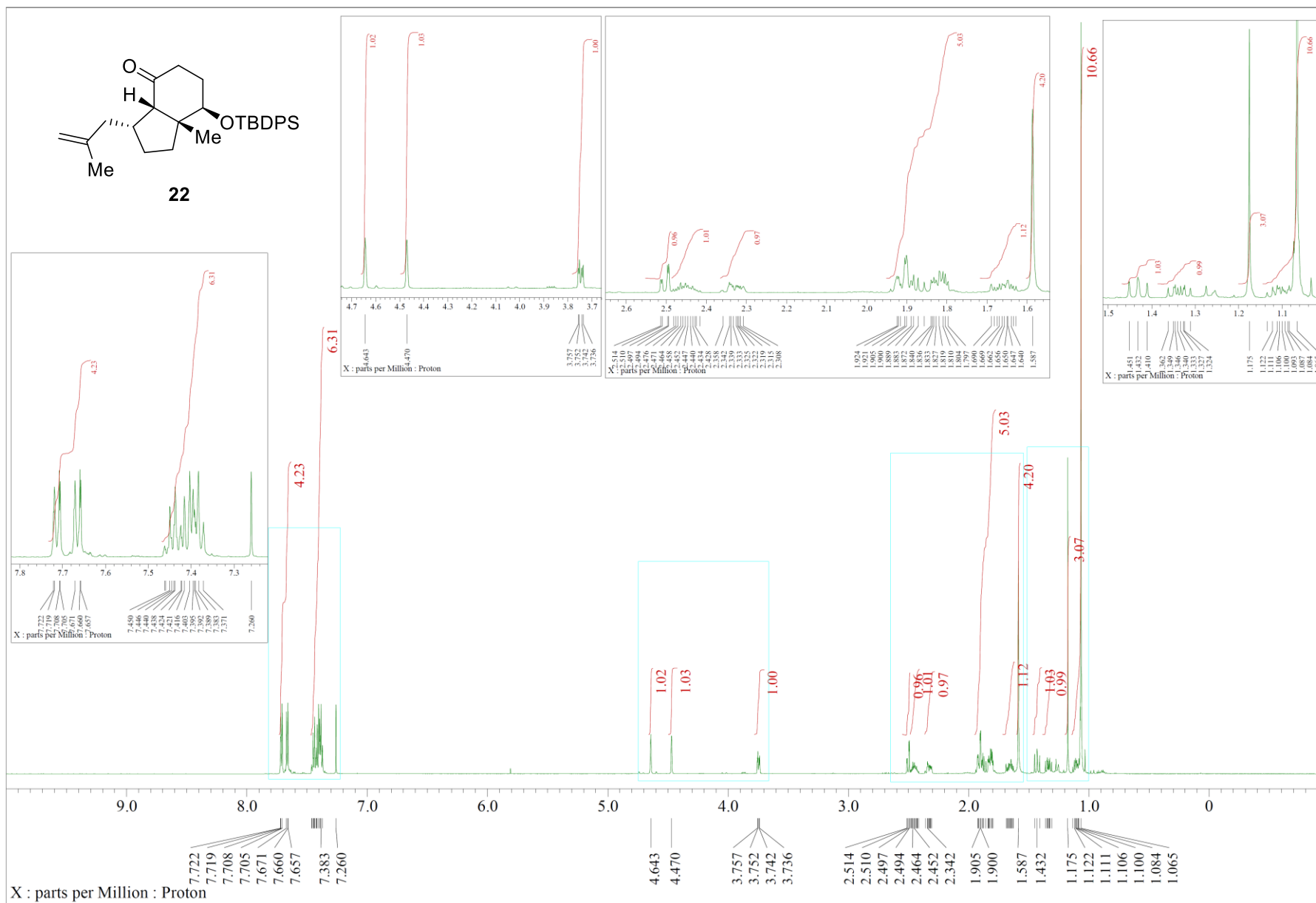


Figure S18.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound 22.

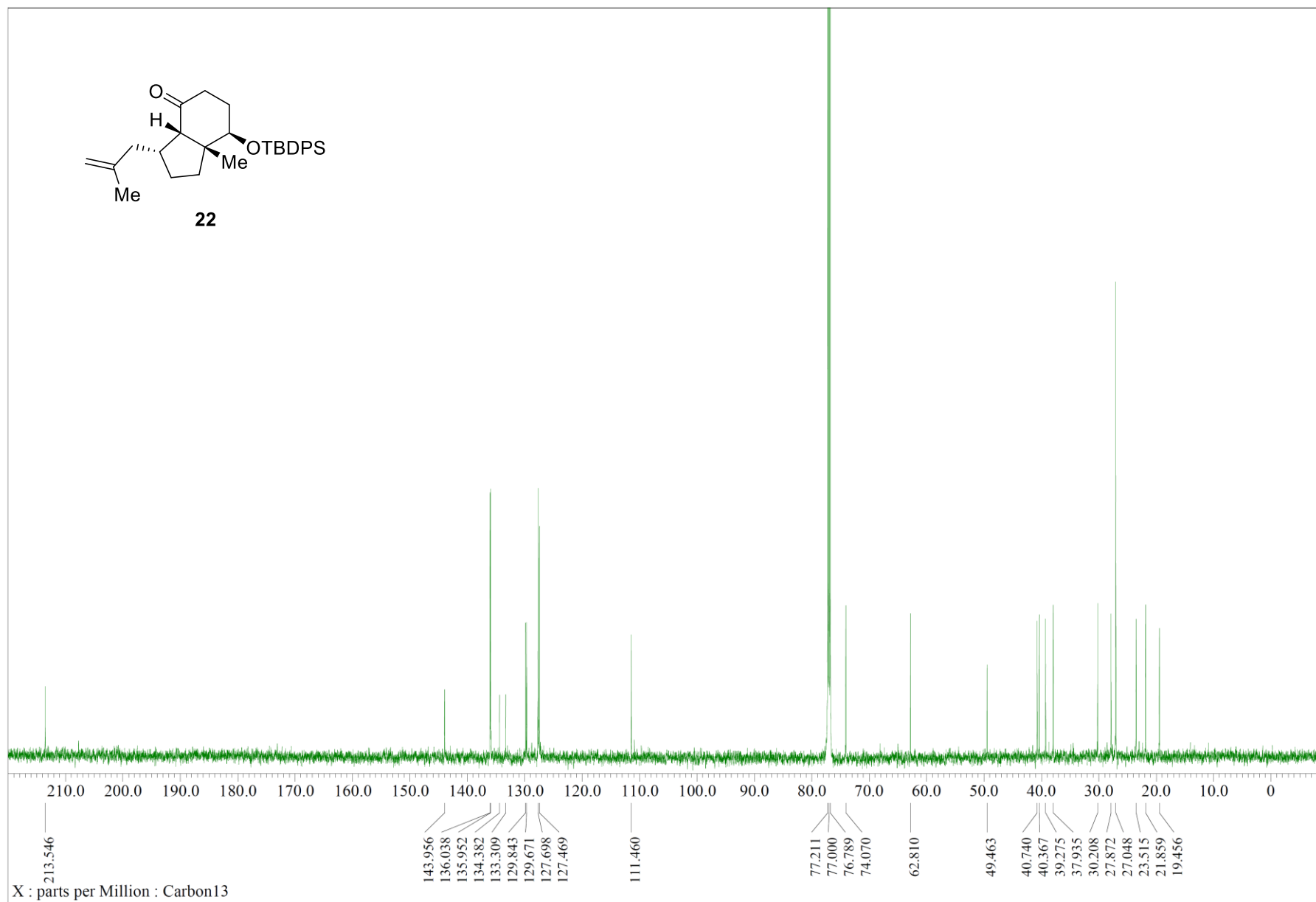


Figure S19. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound 23.

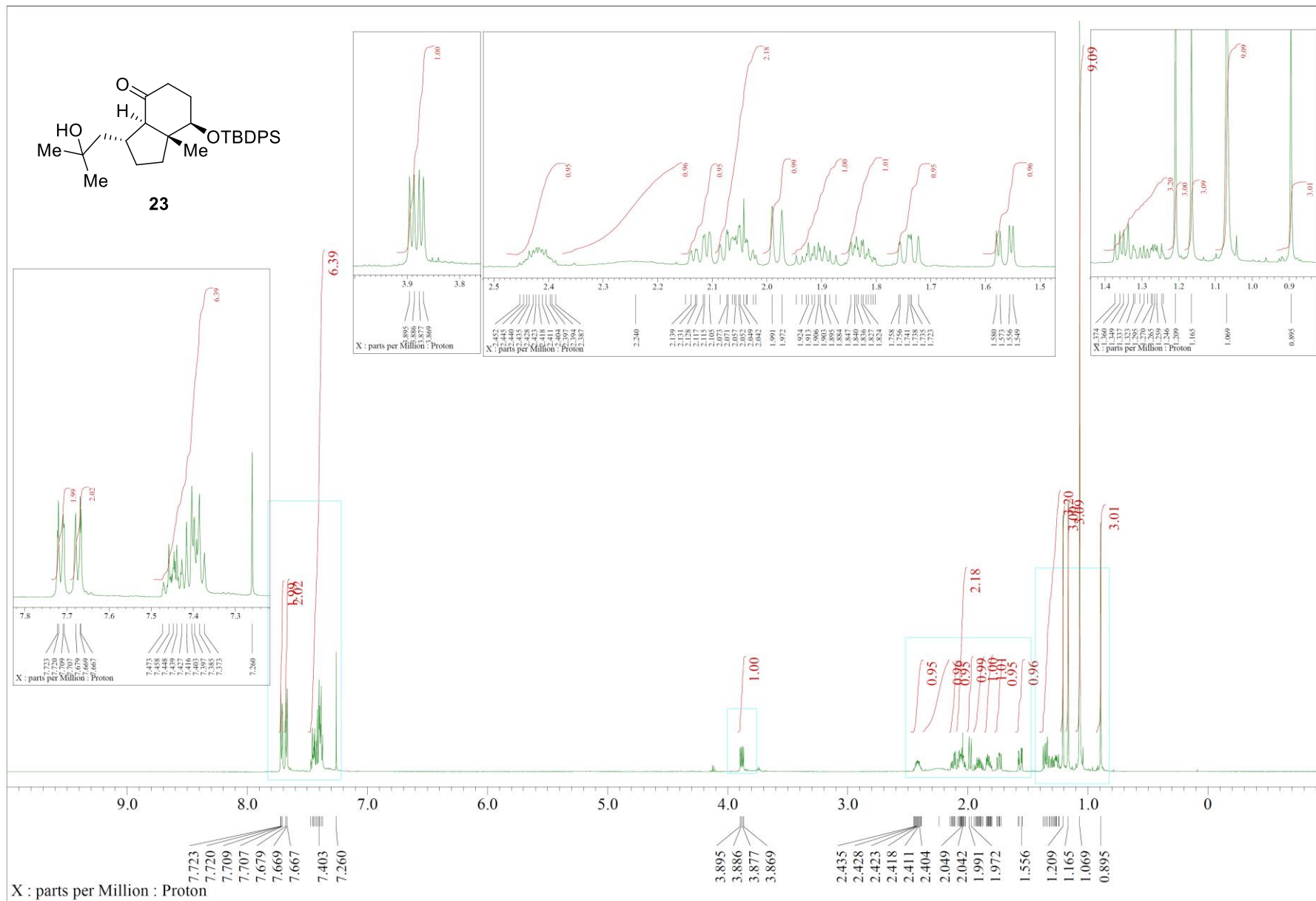


Figure S20.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound 23.

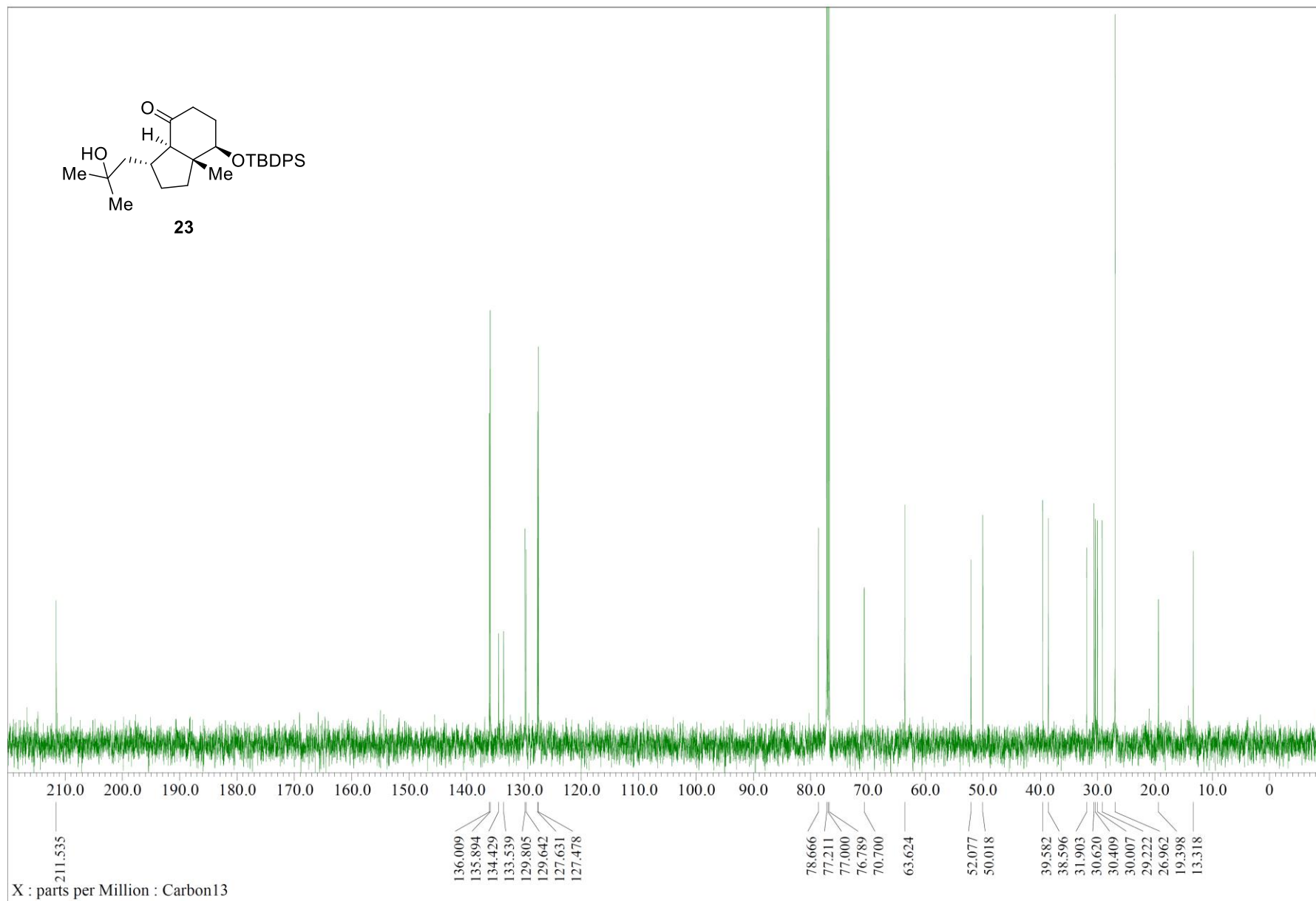




Figure S21. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of a 2.5:1 mixture of compounds 24 and 25.

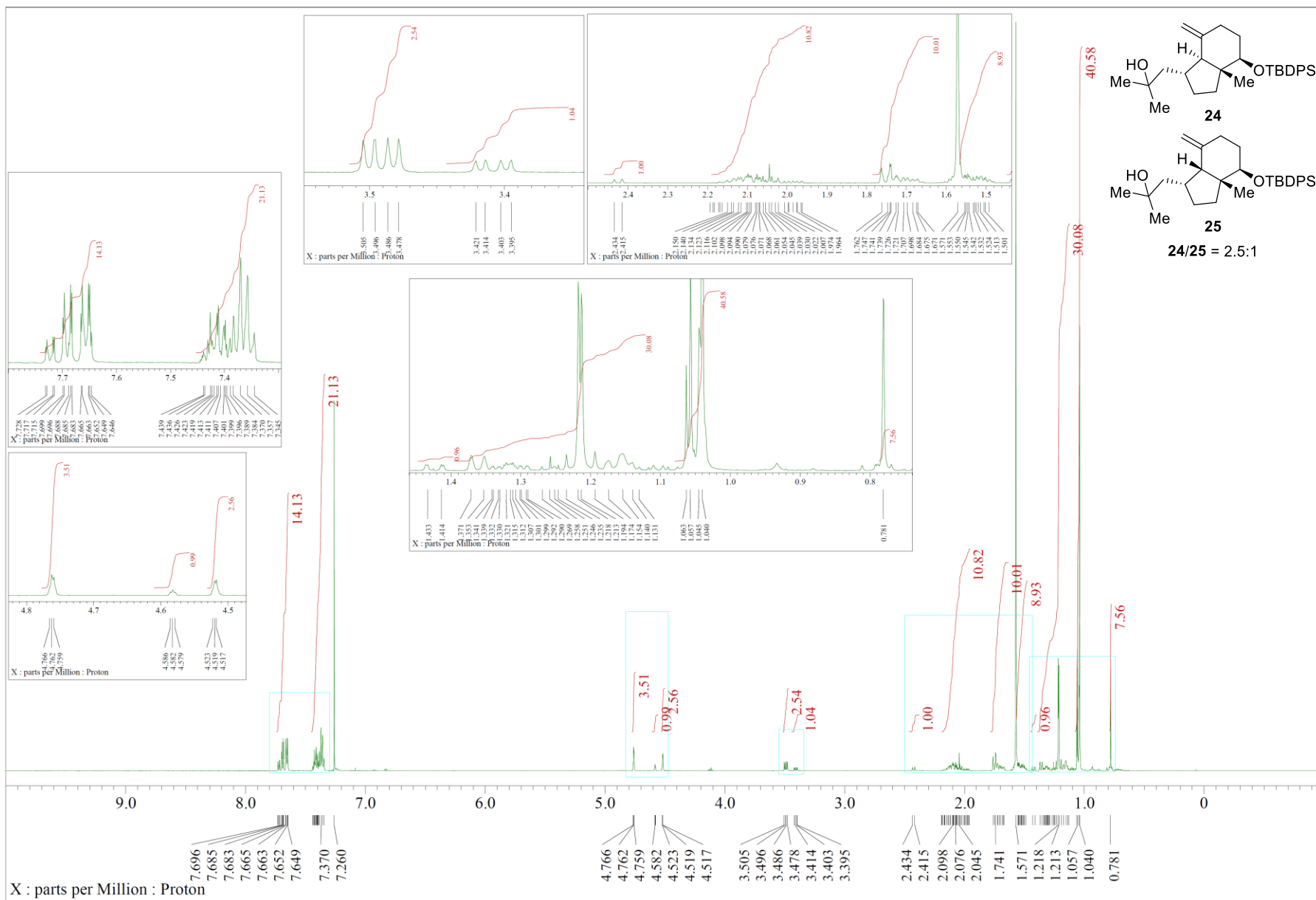


Figure S22.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of a 2.5:1 mixture of compounds 24 and 25.

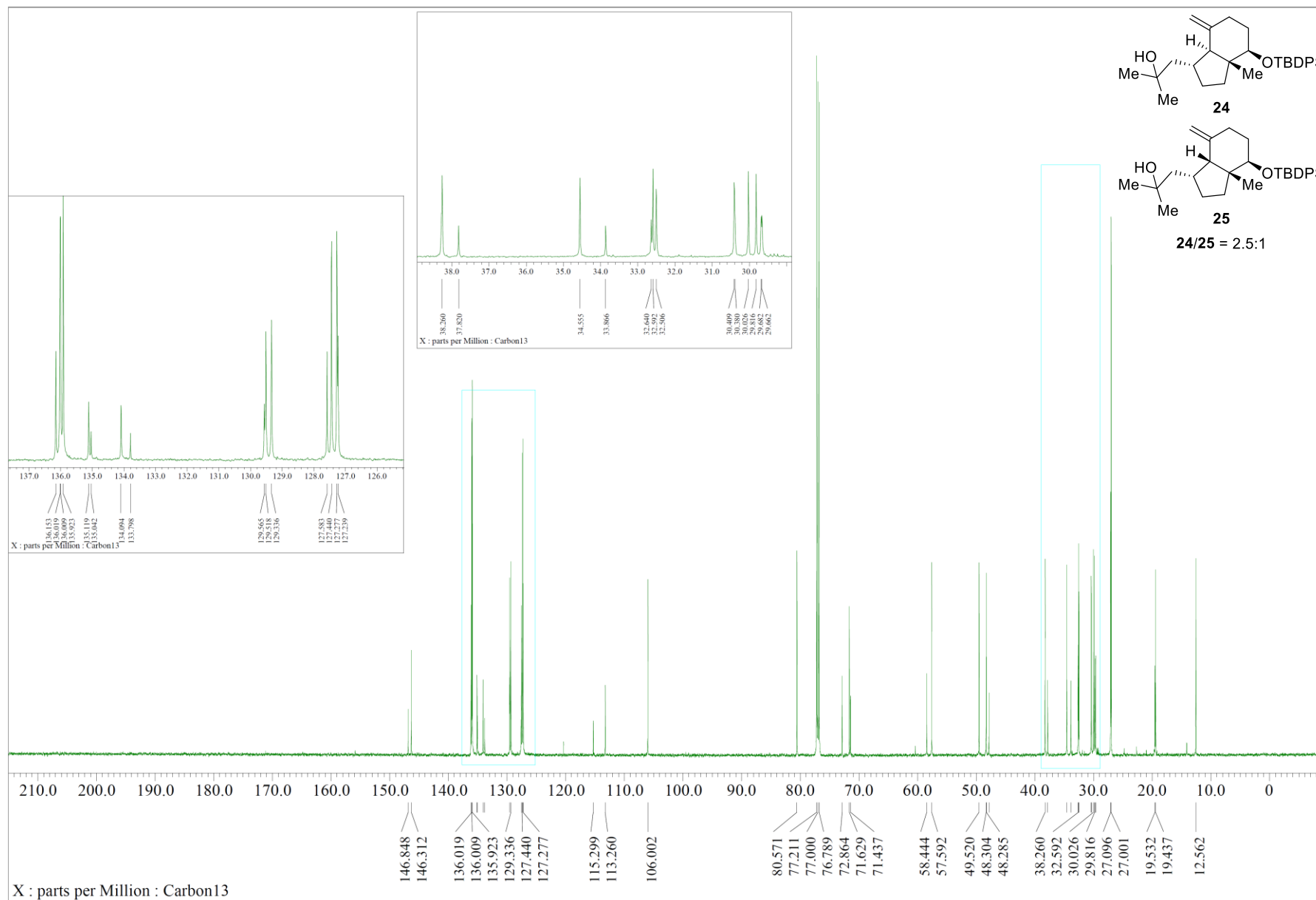


Figure S23. HSQC spectrum (600 MHz, CDCl<sub>3</sub>) of a 2.5:1 mixture of compounds 24 and 25.

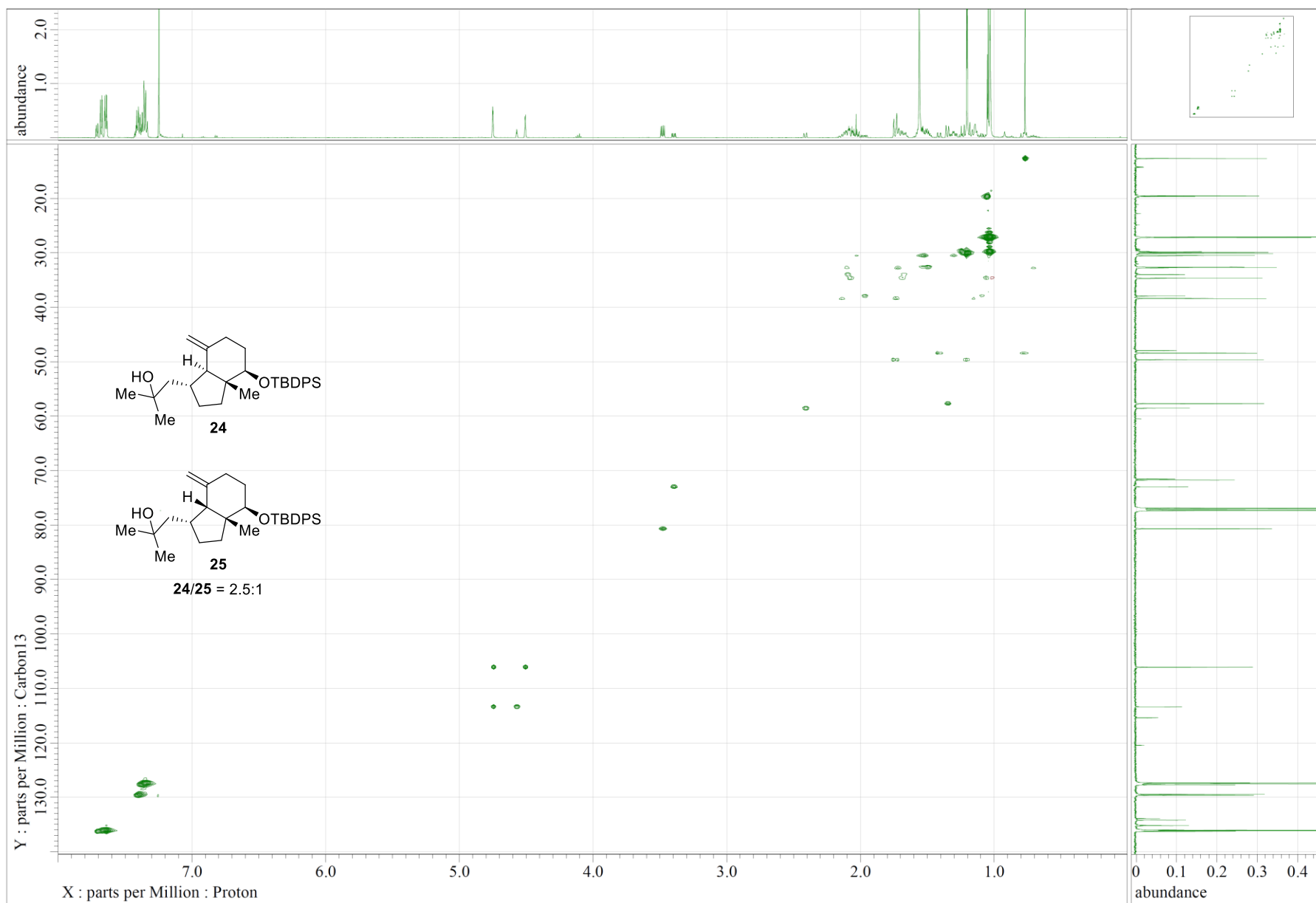


Figure S24. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound 24.

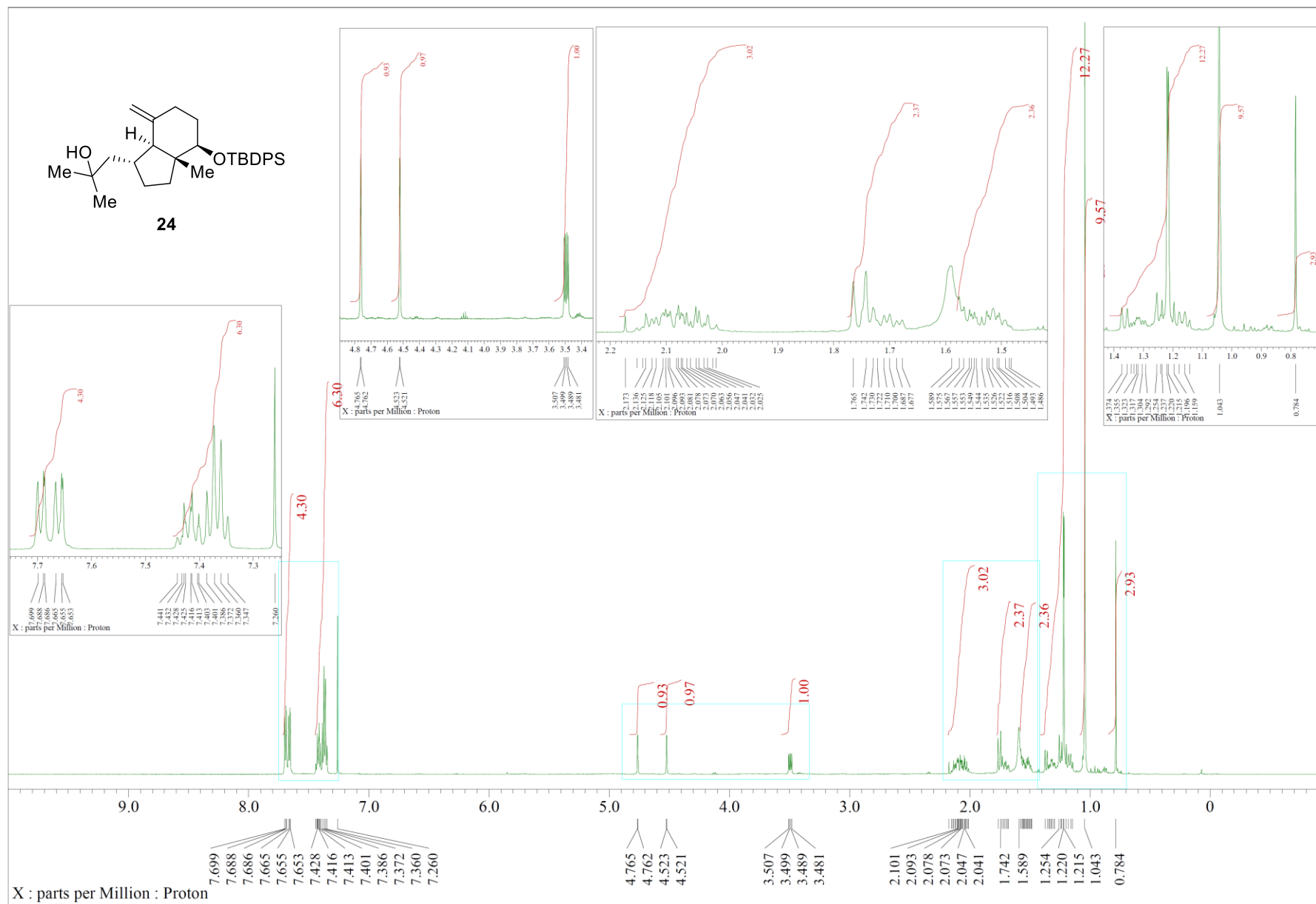


Figure S25.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound 24.

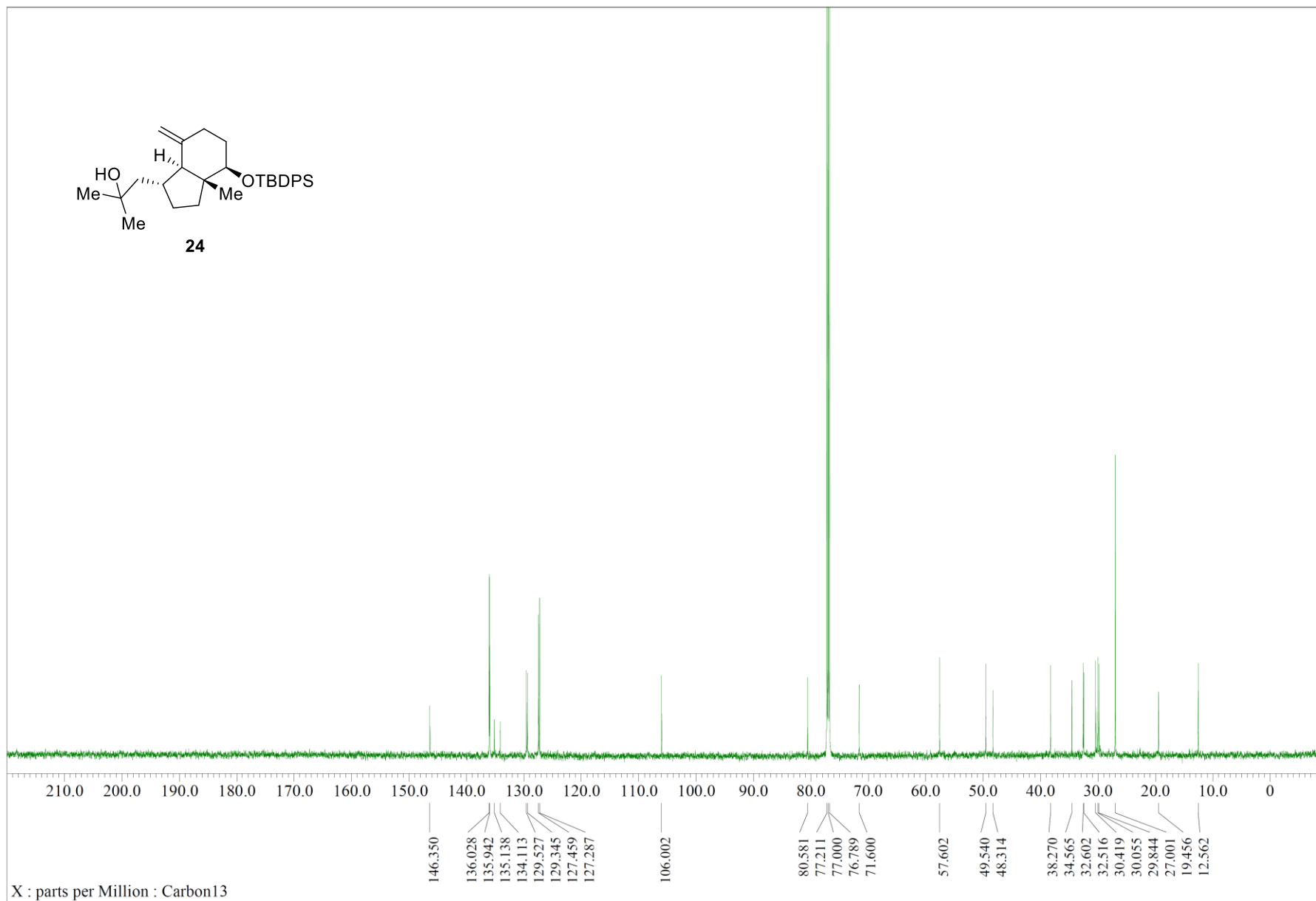


Figure S26. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound 26.

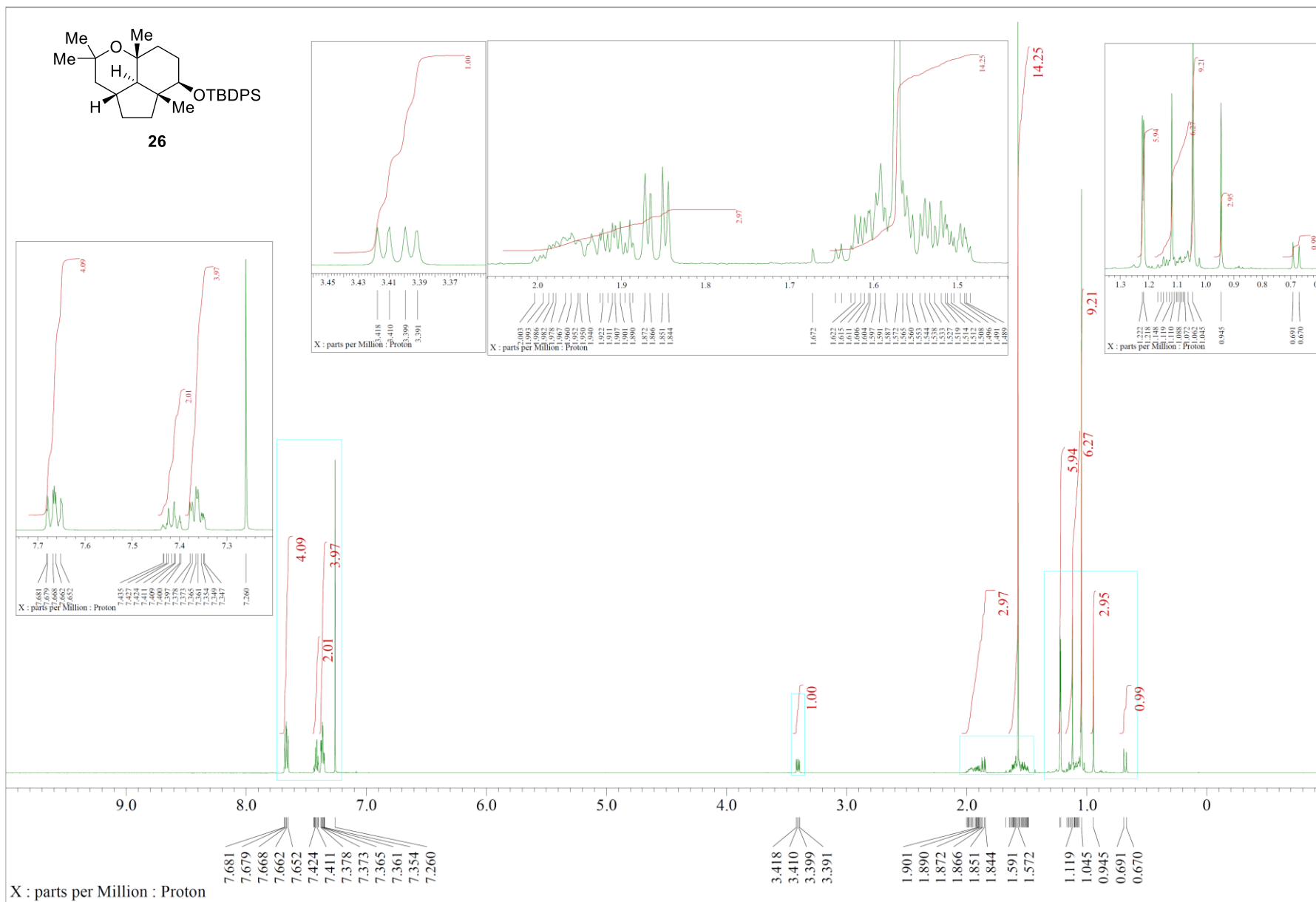


Figure S27.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound 26.

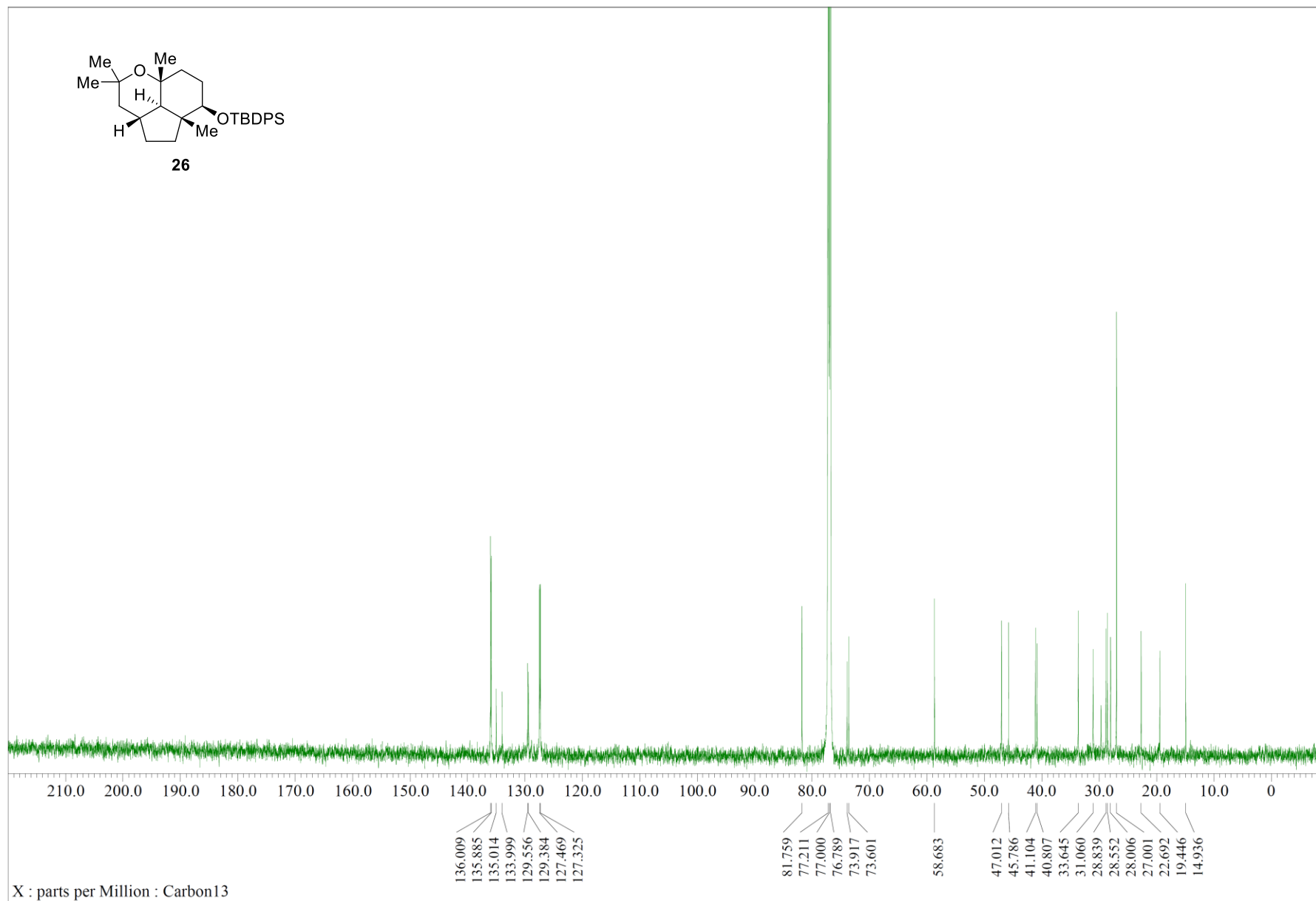


Figure S28. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of compound 27.

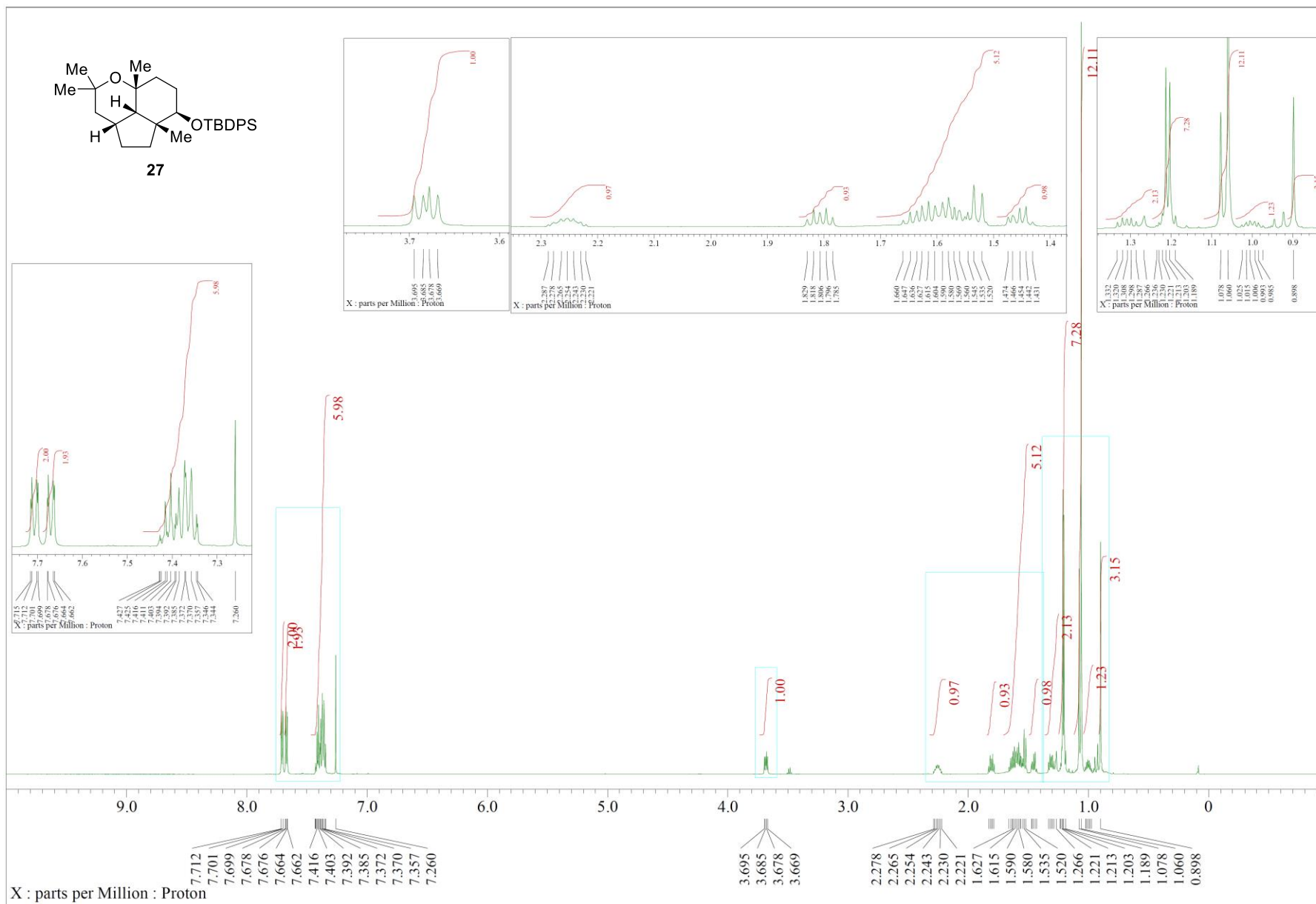




Figure S29.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of compound 27.

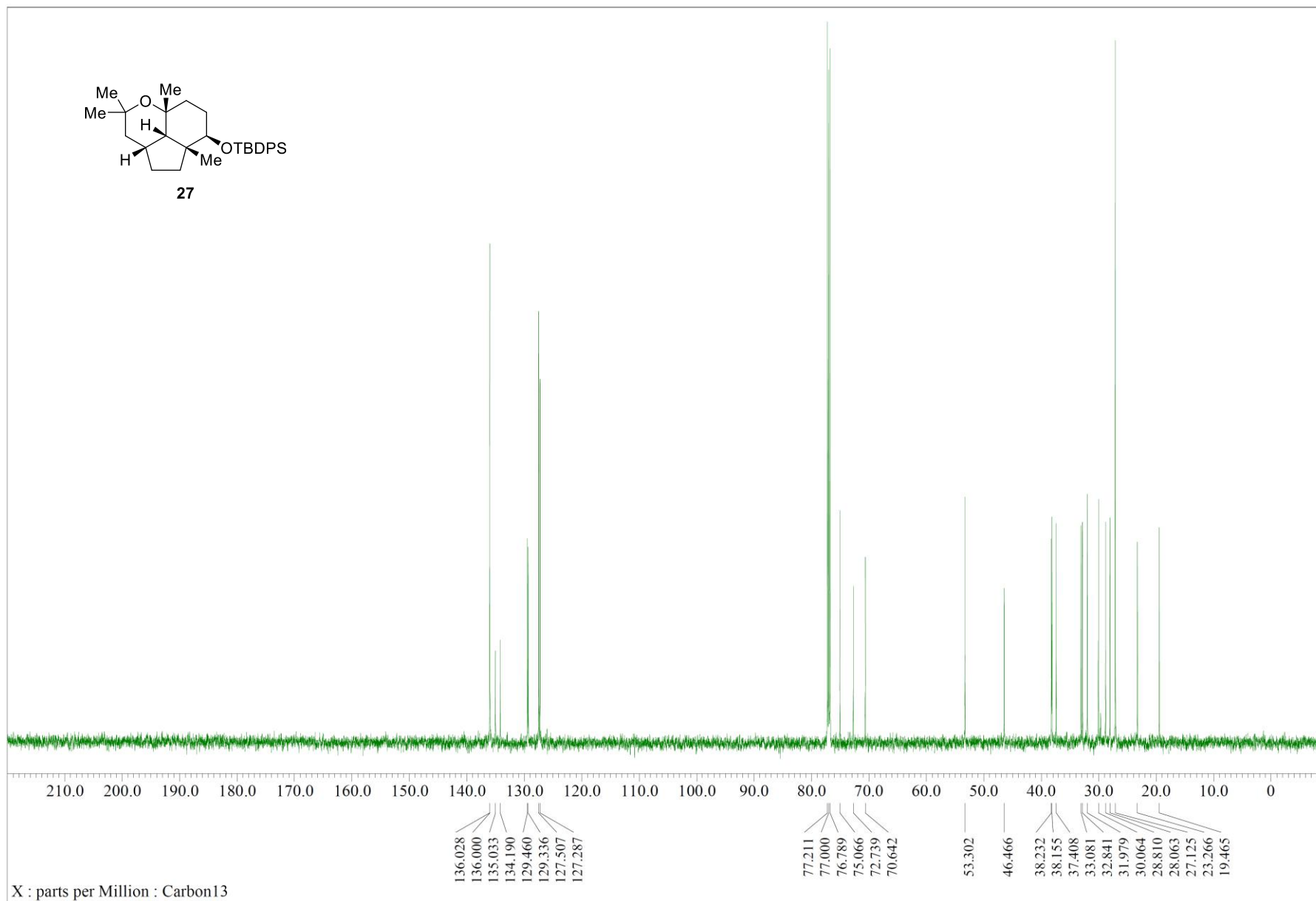


Figure S30. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of (+)-*ent*-vetiverianine A (4).

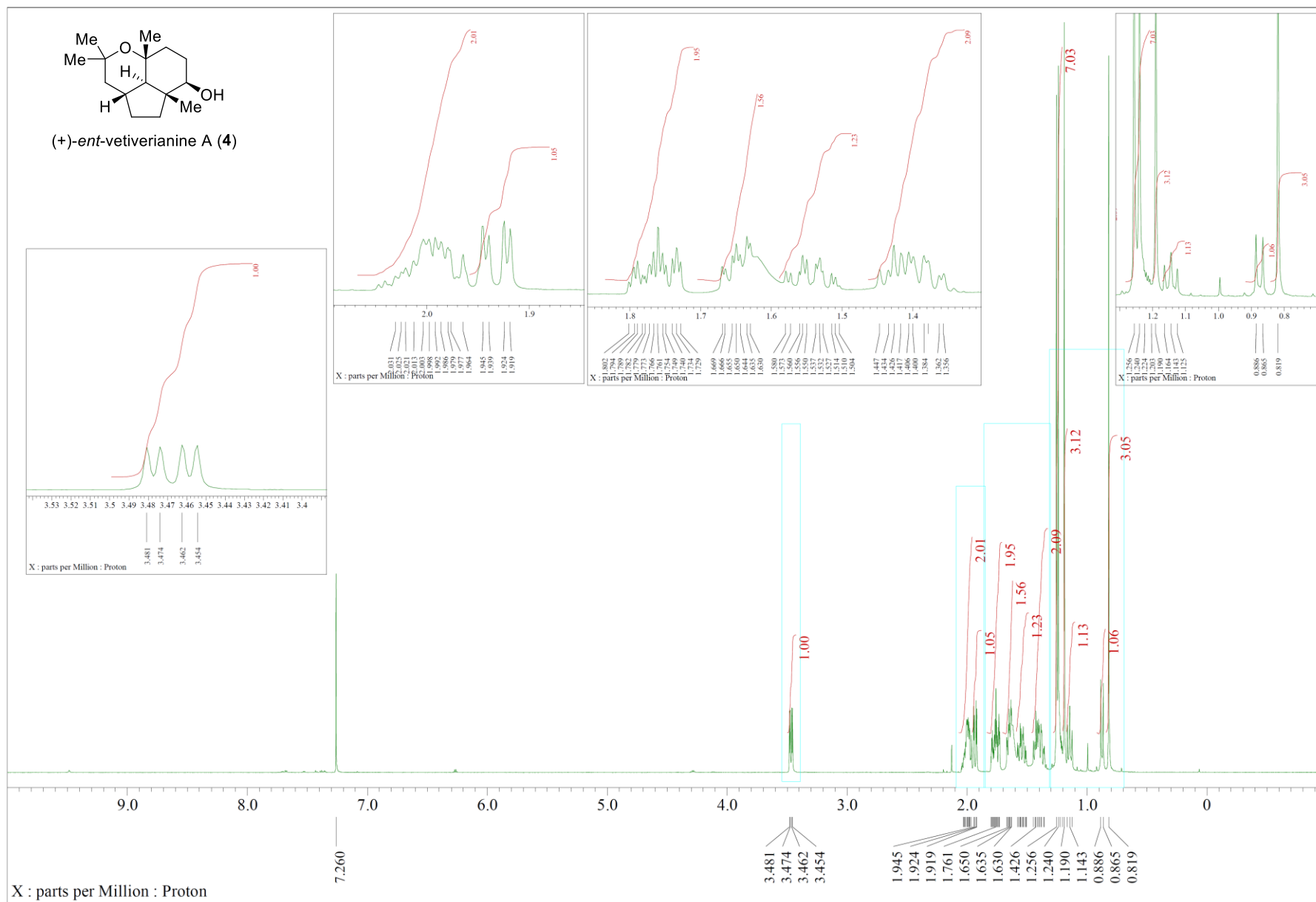


Figure S31.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of (+)-*ent*-vetiverianine A (4).

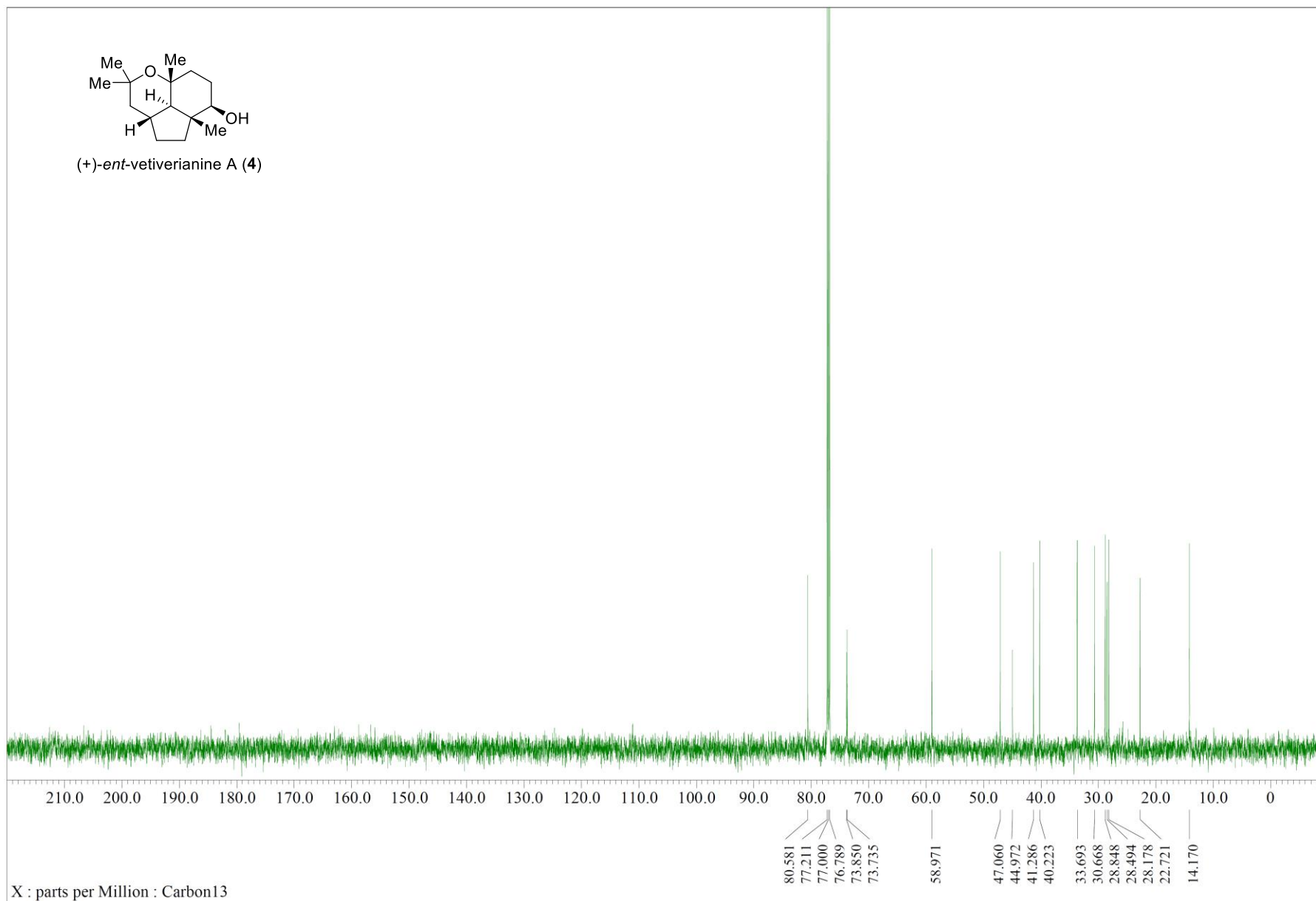


Figure S32. <sup>1</sup>H NMR spectrum (600 MHz, CDCl<sub>3</sub>) of (+)-*ent*-5-*epi*-vetiverianine A (28).

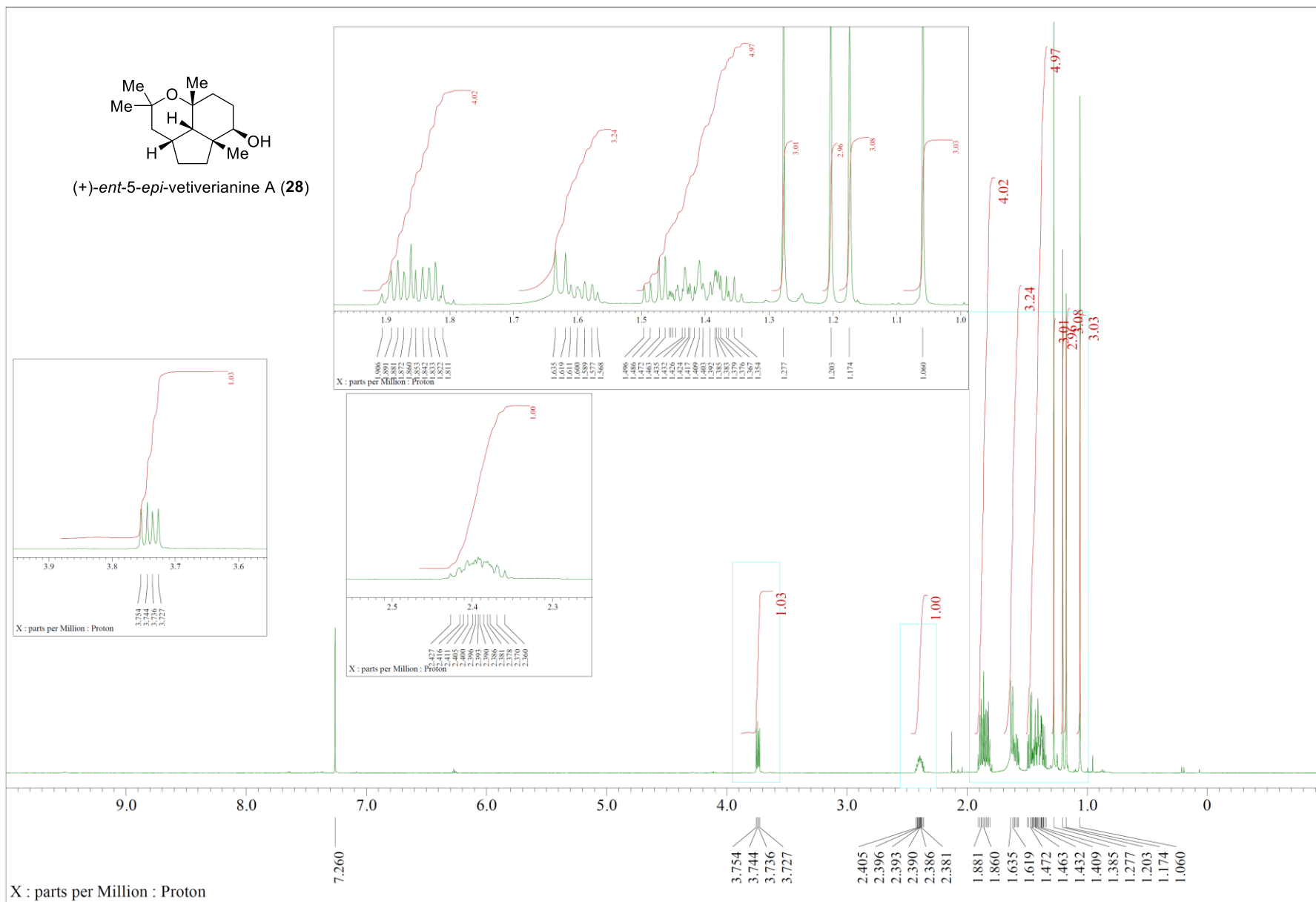
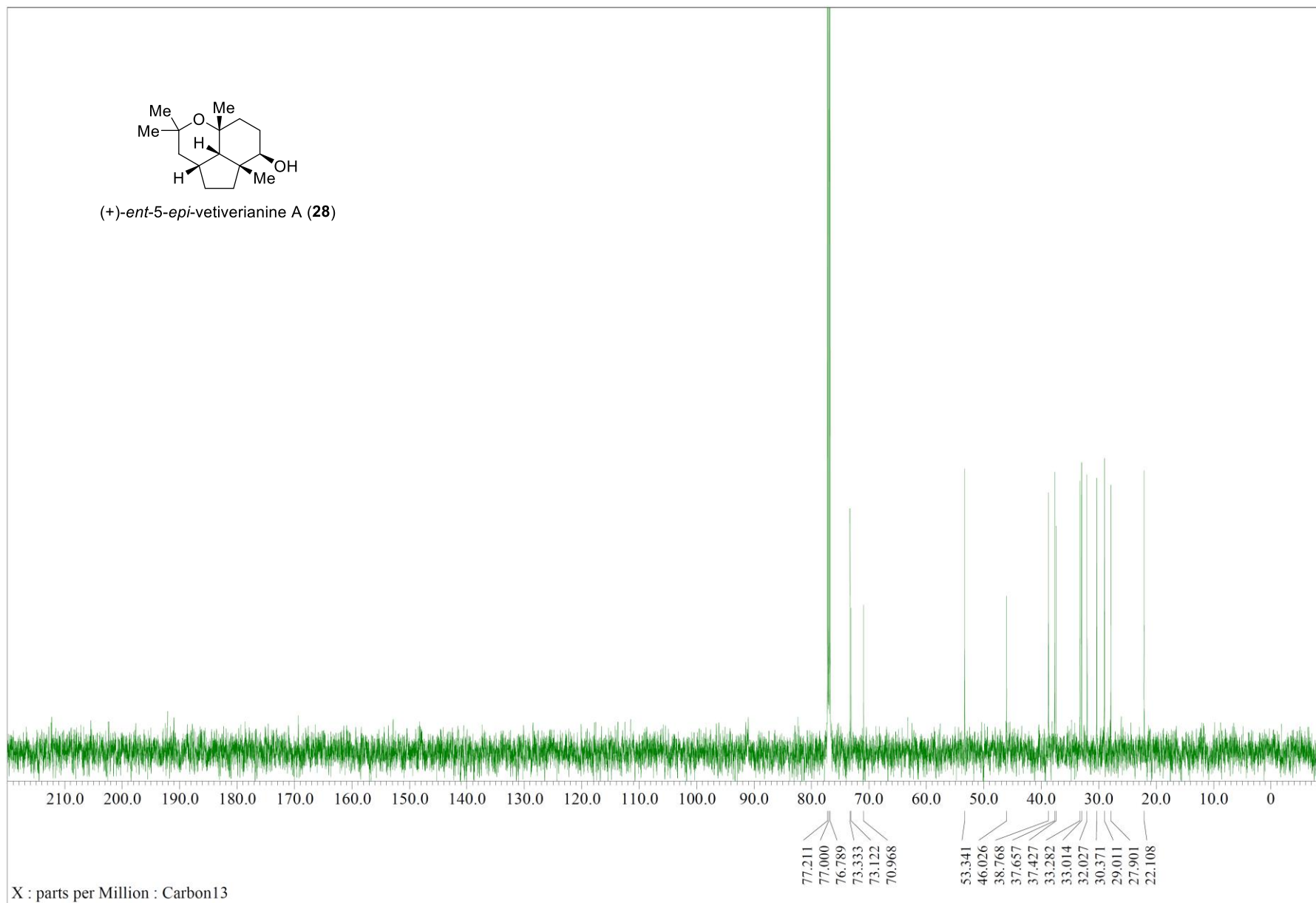


Figure S33.  $^{13}\text{C}$  NMR spectrum (150 MHz,  $\text{CDCl}_3$ ) of (+)-*ent*-5-*epi*-vetiverianine A (**28**).



#### 4. References

- S1) Li, J.; Zhang, W.; Zhang, F.; Chen, Y.; Li, A. *J. Am. Chem. Soc.* **2017**, *139*, 14893–14896.
- S2) Piers, E.; Oballa, R. M. *J. Org. Chem.* **1996**, *61*, 8439–8447.
- S3) Matsuo, Y.; Maeda, S.; Ohba, C.; Fukaya, H.; Mimaki, Y. *J. Nat. Prod.* **2016**, *79*, 2175–2180.