Supplemental Information

Total Synthesis of Crotophorbolone

Tianzi Yu, Ying Sun, Canhui Tu, Ting Chen, Shaomin Fu and Bo Liu*

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I. General Information：

All reactions were performed under an argon atmosphere with dry solvents under anhydrous conditions, unless otherwise stated. DCM, DIPA, HMDS, TEA and toluene were distilled from calcium hydride under argon; MeOH was distilled from dry magnesium turnings and iodine under argon; THF was distilled from sodium-benzophenone under argon. Unless otherwise noted, all the other chemicals were purchased commercially and used without further purification.

Flash chromatography was performed using silica gel (200-300 mesh).

Thin layer chromatography (TLC) was used for monitoring reactions and visualized by a UV lamp (254 nm and 365 nm), I_2 and developing the plates with p-anisaldehyde or phosphomolybdic acid.

^{1}H and ^{13}C NMR were recorded on Bruker DRX-400 MHz NMR spectrometer or Bruker 600 MHz NMR spectrometer with TMS as the internal standard and were calibrated using residual undeuterated solvent as an internal reference ($CDCl_3$: ^{1}H NMR = 7.26, ^{13}C NMR = 77.16). Abbreviations in ^{1}H NMR data are illustrated as follows: s = singlet, d = doublet, t = triplet, dd = doublet of doublet, ddd = doublet of doublet of doublet, dt = doublet of triplet, td = triplet of doublet, m = multiplet, br = broad. Coupling constants (*J*) are reported in Hertz (Hz).

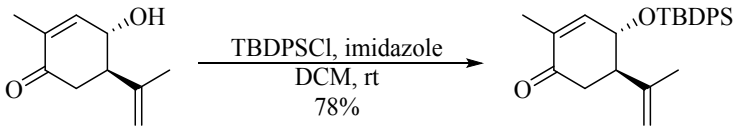
Optical rotations were measured at the sodium D line with a 100 mm path length cell, and are reported as follows: $[\alpha]_D^T$, S3 concentration (g/100 mL), and solvent.

High resolution mass spectra (HRMS) were recorded by using Bruker-FT-MS spectrometers.

Infrared (IR) spectra were recorded on a NEXUS 670 FT-IR device and are reported in wavenumbers (cm-1).

II. Experimental Procedures:

1. Synthesis of **SI-1**:



9 **SI-1**

To a stirred solution of compound **9** (4.5 g, 27.0 mmol) in dry DCM (120 mL) was added imidazole (2.8 g, 40.5 mmol) and TBDPSCl (11.4 g, 40.5 mmol) successively at room temperature under an argon atmosphere. The reaction was stirred for 3 hours before quenched with aqueous $NaHCO_3$ (50 mL) and extracted with DCM (50 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvent under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 40:1) to afford compound **SI-1** (8.6 g, 78%) as a light yellow oil.

$[\alpha]_D^{16}$: +170 (c 0.30, $CHCl_3$).

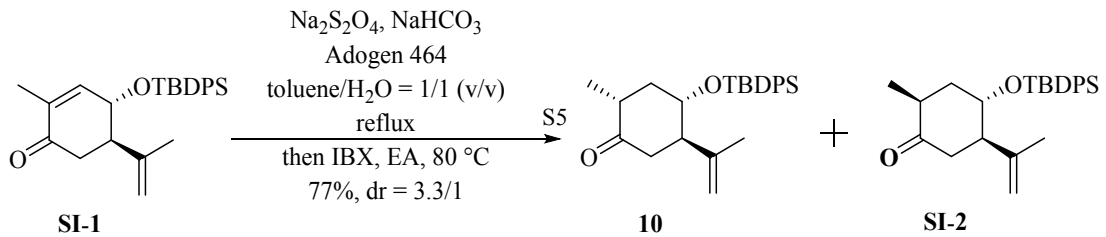
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 – 7.68 (m, 4H), 7.48 – 7.37 (m, 6H), 6.42 (dd, *J* = 2.5, 1.4 Hz, 1H), 4.84 – 4.82 (m, 1H), 4.81 (d, *J* = 0.5 Hz, 1H), 4.48 – 4.45 (m, 1H), 2.87 (ddd, *J* = 12.2, 8.3, 4.1 Hz, 1H), 2.51 (dd, *J* = 16.3, 4.1 Hz, 1H), 2.31 (dd, *J* = 16.3, 12.1 Hz, 1H), 1.63 (t, *J* = 1.5 Hz, 3H), 1.53 (s, 3H), 1.05 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 199.1, 147.3, 143.9, 136.2, 136.1, 134.8, 134.4, 133.1, 130.1, 130.0, 127.9, 127. 8, 114.1, 70.4, 52.3, 41.2, 27.0, 19.9, 19.6, 15.5.

HRMS (ESI$^+$) m/z Calculated for C26H33O2Si $[M+H]^+$: 405.2244, found 405.2242.

IR (neat) ν : 3072, 2933, 2858, 2362, 1682, 1428, 1363, 1267, 1107, 1078, 896, 853, 822, 749, 704, 614, 498 cm^{-1}.

2. Synthesis of compound **10**:



SI-1 **10** **SI-2**

To a stirred solution of compound **SI-1** (8.6 g, 21.2 mmol) in toluene (100 mL) and water (100 mL) was added Adogen® 464 (4.2 g, 10.5 mmol, 5.0 mL), $NaHCO_3$ (35.5 g, 420.0 mmol) and $Na_2S_2O_4$ (36.6 g, 210.0 mmol) successively at room temperature. Then the reaction was heated to reflux at 115 ºC for 1.5 hours, the reaction was diluted with water (100 mL) then extracted with EtOAc (200 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material which was used in the next step without further purification;

To a stirred solution of the above crude material in EtOAc (100 mL) was added IBX (6.3 g, 22 mmol) at room temperature in one portion, then it was heated to 80 ºC for 12 hours. Filtration through silica and the filter cake was washed with EtOAc (50 mL) five times, removal of the solvent under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 50:1) to afford compound **6** (5.1 g, 59%) as a light yellow solid along with compound **SI-2** (1.5 g, 18%) as a light yellow oil.

Compound **10**:

M.P.: 69 – 71 ºC.

$[\alpha]_D^{17}$: +34 (c 0.10, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 – 7.66 (m, 4H), 7.47 – 7.37 (m, 6H), 4.84 (s, 2H), 3.98 (td, *J* = 10.0, 4.0 Hz, 1H), 2.60 – 2.56 (m, 1H), 2.33 – 2.25 (m, 2H), 2.21 – 2.12 (m, 1H), 1.98 – 1.93 (m, 1H), 1.58 (s, 3H), 1.55 – 1.42 (m, 1H), 1.02 (s, 9H), 0.88 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 211.3, 144.8, 136.2, 136.0, 134.8, 133.6, 129.9, 129.8, 127.7, 127.6, 113.6, 72.0, 54.2, 44.0, 42.8, 42.1, 27.0, 19.5, 19.3, 14.6.

HRMS (ESI$^+$) m/z Calculated for C26H35O2Si $[M+H]^+$: 407.2401, found 407.2401.

IR (neat) ν : 2934, 2859, 2362, 1717, 1646, 1464, 1429, 1369, 1269, 1189, 1106, 1054, 896, 829, 752, 704, 612, 509 cm^{-1}.

Compound **SI-2**:

$[\alpha]_D^{20}$: +67 (c 0.44, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 1.3 Hz, 1H), 7.71 (d, *J* = 1.3 Hz, 2H), 7.69 (d, *J* = 1.5 Hz, 1H), 7.46 – 7.38 (m, 6H), 4.74 (s, 1H), 4.61 (s, 1H), 4.15 (s, 1H), 3.02

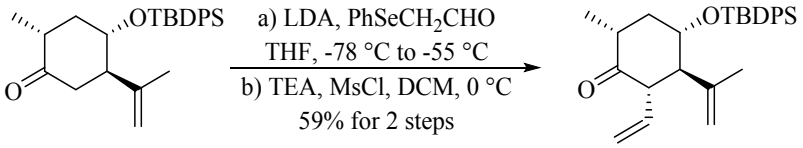
(dd, *J* = 14.6, 6.7 Hz, 1H), 2.99 – 2.89 (m, 1H), 2.62 (d, *J* = 3.2 Hz, 1H), 2.44 (d, *J* = 14.6 Hz, 1H), 1.88 – 1.81 (m, 1H), 1.56 – 1.49 (m, 1H), 1.32 (s, 3H), 1.13 (s, 9H), 0.99 (d, *J* = 6.7 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 213.5, 145.6, 136.0, 135.9, 134.0, 133.8, 130.1, 130.1, 127.9, 127.9, 113.5, 68.7, 51.1, 40.6, 39.3, 37.2, 27.2, 22.3, 19.5, 14.4.

HRMS (ESI$^+$) m/z Calculated for C26H35O2Si $[M+H]^+$: 407.2401, found 407.2402.

IR (neat) ν : 3730, 2932, 2362, 1712, 1270, 1109, 1072, 824, 755, 704 cm^{-1}.

3. Synthesis of compound **12**:



10 **12**

To a stirred solution of diisopropyl amine (1.9 g, 18.8 mmol, 2.6 mL) in dry THF (100 mL) was added a solution of ^{n}BuLi (18.8 mmol, 7.5 mL) dropwise at -78 ºC under an argon atmosphere. The resulting solution was stirred for 30 minutes at -78 ºC. A solution of ketone **10** (5.1 g, 12.5 mmol) in dry THF (10 mL) was then added dropwise by cannula. The resulting solution was stirred for 30 minutes at -78 ºC, followed by dropwise addition of a solution of phenylselenoacetaldehyde (3.8 g, 18.8 mmol) in dry THF (10 mL) by cannula. The resulting solution was slowly warmed to -55 ºC within 2 hours before quenched with aqueous NH_4Cl (50 mL) and extracted with EtOAc (50 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material which was used in the next step without further purification;

To a stirred solution of the above crude material in dry DCM (120 mL) was added TEA (5.1 g, 50.1 mmol, 7.0 mL) dropwise at 0 ºC under an argon atmesphere. Then a solution of methanesulfonyl chloride (4.3 g, 37.6 mmol, 3.0 mL) in dry DCM (10 mL) was added dropwise by cannula. Upon completion of the addition, the reaction was warmed to room temperature, and stirred for another 2 hours. The reaction was quenched with aqueous $NaHCO_3$ (50 mL) at 0 ºC, and extracted with DCM (50 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvent under reduced pressure gave a crude material, which

was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 50:1) to afford compound **12** (3.2 g, 59 % for 2 steps) as a light yellow oil.

$[\alpha]_D^{16}$: +133 (c 0.33, $CHCl_3$).

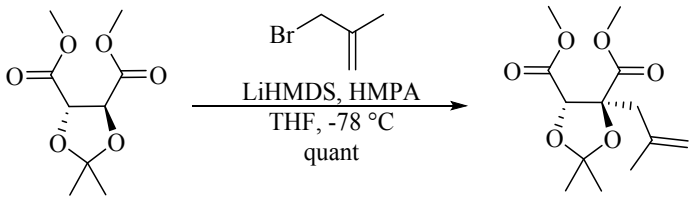
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.74 (d, *J* = 1.1 Hz, 1H), 7.72 (d, *J* = 1.3 Hz, 1H), 7.67 (d, *J* = 1.2 Hz, 1H), 7.66 (d, *J* = 1.3 Hz, 1H), 7.47 – 7.37 (m, 6H), 5.68 – 5.61 (m, 1H), 5.10 (dd, *J* = 10.3, 1.5 Hz, 1H), 4.88 – 4.87 (m, 1H), 4.85 (dd, *J* = 17.6, 1.7 Hz, 1H), 4.83 (s, 1H), 4.02 (td, *J* = 10.5, 4.2 Hz, 1H), 2.82 (dd, *J* = 12.4, 9.4 Hz, 1H), 2.50 (dd, *J* = 12.5, 9.9 Hz, 1H), 2.23 – 2.16 (m, 1H), 1.99 – 1.95 (m, 1H), 1.53 – 1.46 (m, 1H), 1.51 (s, 3H), 1.01 (s, 9H), 0.85 (d, *J* = 6.5 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 210.9, 142.6, 136.2, 136.1, 134.8, 134.2, 133.5, 130.0, 129.7, 127.3, 127.6, 117.5, 115.5, 71.2, 60.3, 55.7, 43.6, 42.0, 27.0, 19.5, 18.6, 14.3.

HRMS (ESI$^+$) m/z Calculated for C28H37O2Si $[M+H]^+$: 433.2557, found 433.2558.

IR (neat) ν : 3731, 2362, 1716, 1515, 1269, 1107, 755 cm^{-1}.

4. Synthesis of compound **13**:



(+)-8 **13**

To a stirred solution of compound (+)-**8** (5.0 g, 22.9 mmol), 3-Bromo-2-methylpropene (12.4 g, 91.7 mmol) and HMPA (16.4 g, 91.7 mmol, 16.0 ml) in dry THF (100 mL) was added LiHMDS (20.0 mL, 25.2 mmol) dropwise within 4 hours at -78 °C under an argon atmosphere. The mixture was stirred for 10 minutes at the same temperature before quenched with aqueous NH_4Cl (50 mL) and extracted with EtOAc (100 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 8:1) to afford **13** (6.3 g, quant) as a light yellow oil.

$[\alpha]_D^{20}$: +40 (c 1.10, $CHCl_3$).

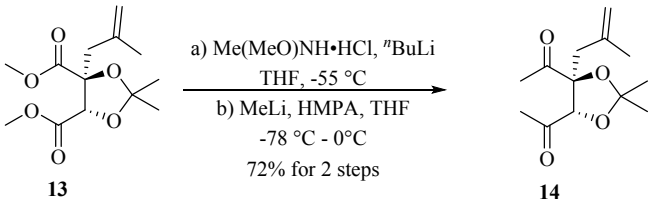
^{1}H NMR (400 MHz, $CDCl_3$) δ 4.87 (s, 1H), 4.84 – 4.82 (m, 1H), 4.70 (d, *J* = 0.9 Hz, 1H), 3.80 (s, 3H), 3.77 (s, 3H), 2.59 (dd, A of AB, *J* = 13.5, 0.5 Hz, 1H), 2.26 (d, B of AB, *J* = 13.4 Hz, 1H), 1.76 (s, 3H), 1.63 (s, 3H), 1.42 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 172.3, 169.0, 140.5, 115.3, 113.3, 86.5, 80.5, 52.6, 52.5, 42.3, 27.9, 26.1, 23.8.

HRMS (ESI^{+}) m/z Calculated for C13H21O6 $[M+H]^{+}$: 273.1333, found 273.1335.

IR (neat) ν : 2990, 2953, 2362, 1759, 1647, 1438, 1377, 1256, 1205, 1106, 900, 754 cm^{-1}.

5. Synthesis of compound **14**:



13 **14**

To a stirred solution of *N,O*-dimethylhydroxylamine hydrochloride (150.0 g, 1530.0 mmol) in dry THF (350 mL) was added a solution of ^{n}BuLi (1224.0 mL, 3060.0 mmol) dropwise within one hour at -55 °C under an argon atmosphere. After 30 minutes at the same temperature was added a solution of compound **13** (19.0 g, 180.0 mmol) in dry THF (150 mL) within 1 hour. Upon completion of the reaction, the mixture was quenched with aqueous NH_4Cl (500 mL) and extracted with EtOAc (300 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was used in the next step without further purification.

To a solution of the above crude material and HMPA (170.0 g, 948.0 mmol, 175.0 mL) in dry THF (500 mL) was added a solution of MeLi (474.0 mL, 948.0 mmol) dropwise within 1 hour at -78 °C under an argon atmosphere. The reaction was stirred at -78 ºC for 30 minutes before it was warmed to 0 ºC. The reaction was stirred for 30 minutes before quenched with aqueous NH_4Cl (600 mL) and extracted with EtOAc (500 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material,

which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 8:1) to afford compound **14** (31.2 g, 72% for 2 steps) as a light yellow oil.

$[\alpha]_D^{20}$: -9 (c 1.12, $CHCl_3$).

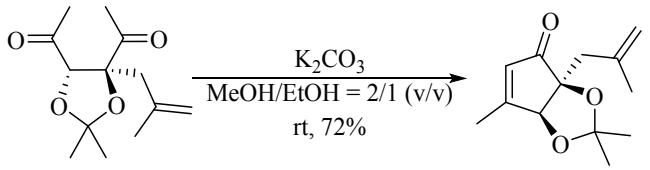
^{1}H NMR (400 MHz, $CDCl_3$) δ 4.83 (brs, 1H), 4.67 (s, 1H), 4.51 (s, 1H), 2.42 (d, A of AB, *J* = 13.6 Hz, 1H), 2.30 (s, 3H), 2.30 (s, 3H), 2.16 (d, B of AB, *J* = 13.6 Hz, 1H), 1.74 (s, 3H), 1.62 (s, 3H), 1.41 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 210.6, 203.9, 140.4, 115.9, 111.4, 90.3, 83.7, 41.6, 28.7, 28.0, 27.7, 26.0, 24.3.

HRMS (ESI$^+$) m/z Calculated for C13H21O4 $[M+H]^+$: 241.1434, found 241.1439.

IR (neat) ν : 3731, 2988, 2362, 1724, 1645, 1356, 1258, 1172, 1123, 1077, 901, 758, 670 cm^{-1}.

6. Synthesis of compound **16**:



14 **16**

To a stirred solution of compound **14** (31.2 g, 130.0 mmol) in MeOH (580 mL) and EtOH (290 mL) was added K_2CO_3 (18.0 g, 130.0 mmol) in one portion at room temperature. The resulting mixture was stirred for 13 hours at the same temperature before quenched with aqueous NH_4Cl (360 mL) and extracted with EtOAc (250 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 50:1 to 20:1) to afford compound **16** (20.8 g, 72%) as a light yellow oil.

$[\alpha]_D^{20}$: -3 (c 0.78, $CHCl_3$).

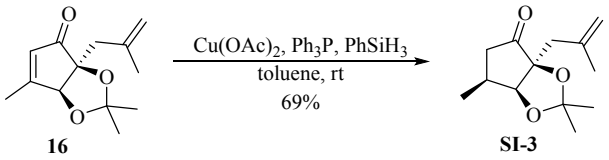
^{1}H NMR (400 MHz, $CDCl_3$) δ 5.97 (d, *J* = 1.2 Hz, 1H), 4.89 – 4.86 (m, 1H), 4.84 (s, 1H), 4.74 (d, *J* = 0.7 Hz, 1H), 2.56 (d, A of AB, *J* = 14.0 Hz, 1H), 2.49 (d, B of AB, *J* = 14.0 Hz, 1H), 2.19 (s, 3H), 1.74 (s, 3H), 1.43 (s, 3H), 1.27 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 204.7, 174.1, 140. 7, 130.4, 115.6, 114.6, 86.2, 84.5, 40.3, 28.8, 28.5, 24.3, 17.1.

HRMS (ESI$^+$) m/z Calculated for C13H19O3 $[M+H]^+$: 223.1329, found 223.1335.

IR (neat) ν : 3731, 2989, 2362, 2336, 1723, 1626, 1515, 1376, 1258, 1209, 1159, 1063, 900, 755, 671 cm^{-1}.

7. Synthesis of compound **SI-3**:



To a stirred solution of Ph_3P (118.0 g, 450 mmol) and $Cu(OAc)_2$ (40.9 g, 225.1 mmol) in dry toluene (800 mL) was added $PhSiH_3$ (33.3 mL, 270.0 mmol) by cannula dropwise at room temperature under an argon atmosphere. The resulting mixture was stirred for 1 hour at the same temperature, then a solution of compound **16** (10.0 g, 45.0 mmol) in dry toluene (300 mL) was added dropwise by constant pressure drop funnel. The mixture was stirred for another 5 hours before quenched with aqueous NH_4Cl (200 mL) very slowly. Filtration through diatomaceous earth and the filter cake was washed with EtOAc (50 mL) nine times, removal of the organic solvents under reduced pressure and aqueous phase extracted with EtOAc (100 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 100:1) to afford **SI-3** (7.0g, 69%) as a light yellow solid.

M.P.: 40 – 42 ºC.

$[\alpha]_D^{20}$: +48 (0.36, $CHCl_3$).

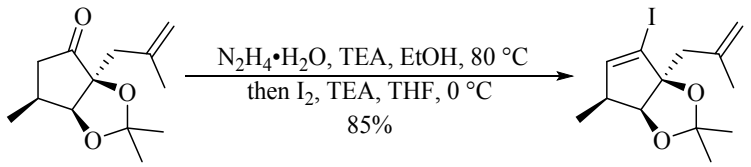
^{1}H NMR (400 MHz, $CDCl_3$) δ 4.93 – 4.92 (m, 1H), 4.75 (d, *J* = 0.8 Hz, 1H), 4.38 (d, *J* = 3.1 Hz, 1H), 2.41 (d, A of AB, *J* = 13.7 Hz, 1H), 2.35 (d, B of AB, *J* = 13.7 Hz, 1H), 2.34 – 2.23 (m, 2H), 2.24 – 2.12 (m, 1H), 1.78 (s, 3H), 1.35 (s, 3H), 1.34 (s, 3H), 1.21 (d, *J* = 6.5 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 217.3, 140.4, 116.0, 110.9, 88.6, 83.2, 41.1, 38.5, 29.4, 27.4, 26.2, 24.7, 15.1.

HRMS (ESI$^+$) m/z Calculated for C13H21O3 $[M+H]^+$: 225.1485, found 225.1488.

IR (neat) ν : 3731, 2984, 2932, 2362, 1754, 1646, 1457, 1377, 1259, 1160, 1074, 1014, 898, 755, 671 cm^{-1}.

8. Synthesis of compound **17**:



SI-3 **17**

A stirred solution of compound **SI-3** (11.0 g, 49.3 mmol), $N_2H_4 \cdot H_2O$ (10.0 mL, 197.2 mmol) and TEA (8.3 mL, 59.2 mmol) in EtOH (250 mL) was heated at 80 ºC for 20 hours. After the reaction was cooled to room temperature, the solvents were removed under reduced pressure to give a bright yellow oil, which was dried by oil pump for 4 hours before used in the next step without further purification;

To a stirred solution of the above crude material in dry THF (250 mL) was added TEA (68.5 mL, 493.0 mmol) dropwise at 0 ºC under an argon atmosphere, the resulting mixture was stirred for 30 minutes at the same temperature. Then a solution of I_2 (25.2 g, 98.6 mmol) in dry THF (250 mL) was added dropwise within 30 minutes under an argon atmosphere. Upon completion of addition, the reaction was quenched with aqueous $Na_2S_2O_3$ (100 mL), diluted with water (100 mL) and extracted with EtOAc (150 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 200:1) to afford compound **17** (14.1 g, 85%) as a light yellow oil.

$[\alpha]_D^{20}$: +32 (c 3.42, $CHCl_3$).

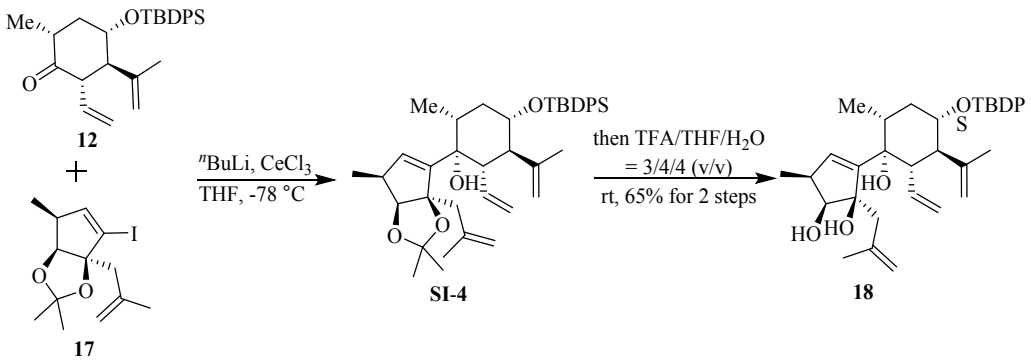
^{1}H NMR (400 MHz, $CDCl_3$) δ 5.91 (s, 1H), 4.88 (s, 1H), 4.78 (s, 1H), 4.42 (d, *J* = 4.5 Hz, 1H), 2.73 – 2.64 (m, 1H), 2.46 (d, A of AB, *J* = 13.7 Hz, 1H), 2.31 (d, B of AB, *J* = 13.7 Hz, 1H), 1.81 (s, 3H), 1.38 (s, 6H), 1.11 (d, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ143.7, 141.0, 115.6, 110.7, 106.0, 96.6, 81.1, 44.1, 42.6, 27.8, 27.7, 24.5, 13.2.

HRMS (ESI$^+$) m/z Calculated for C13H19IO2Na $[M+Na]^+$: 357.0322, found 357.0322.

IR (neat) ν : 3731, 2984, 2930, 2362, 1753, 1645, 1456, 1373, 1260, 1221, 1130, 1075, 1009, 896, 844, 755, 671, 498 cm^{-1}.

9. Synthesis of compound **18**:



To a stirred solution of anhydrous $CeCl_3$ (1.7 g, 7.1 mmol) in dry THF (65 mL) was added a solution of compound **12** (2.5 g, 6.5 mmol) in dry THF (10 mL) dropwise by cannula at room temperature under an argon atmosphere. The resulting solution was stirred for 2 hours before cooled to -78 ºC. To a stirred solution of compound **17** (6.5 g, 19.4 mmol) in dry THF (65 mL) was added a solution of ^{n}BuLi (17.8 mmol, 7.1 mL) at -78 ºC under an argon atmosphere dropwise by cannula. The resulting solution was stirred for 30 minutes at -78 ºC and then transferred dropwise via cannula to the ketone·$CeCl_3$ complex in THF at -78 °C under an argon atmosphere. Upon completion of the addition, the reaction was stirred for another 1 hour, quenched with aqueous NH_4Cl (30 mL) and extracted with EtOAc (60 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude **SI-4** which was used in the next step without further purification;

To a stirred solution of the above crude **SI-4** in THF (35.0 mL) and H_2O (35.0 mL) was added TFA (26.3 mL) dropwise at room temperature by cannula, the resulting solution was stirred at room temperature for 3 hours. Then transferred dropwise via cannula to a solution of aqueous $NaHCO_3$ (300 mL) at 0 ºC. Extracted with EtOAc (150 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 20:1) to afford compound **18** (2.6 g, 65% for 2 steps) as a light yellow oil.

$[\alpha]_D^{20}$: +36 (c 0.46, $CHCl_3$).

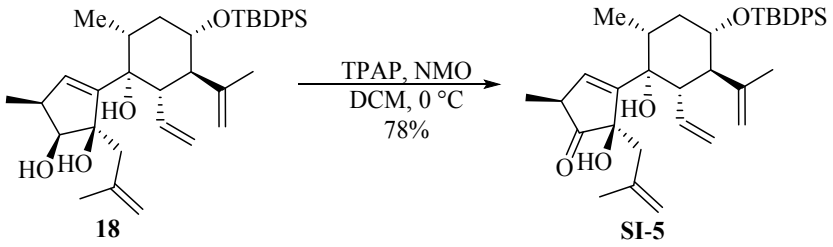
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 – 7.65 (m, 4H), 7.48 – 7.32 (m, 6H), 5.69 (dt, *J* = 17.2, 10.2 Hz, 1H), 4.99 (dd, *J* = 10.1, 2.4 Hz, 1H), 4.96 (s, 1H), 4.87 (s, 1H), 4.81 (s, 1H), 4.78 (s, 1H), 4.72 (dd, *J* = 17.2, 2.4 Hz, 1H), 4.67 (s, 1H), 3.93 (d, *J* = 4.2 Hz, 1H), 3.59 (td, *J* = 10.6, 4.4 Hz, 1H), 2.77 (d, A of AB, *J* = 14.2 Hz, 1H), 2.74 – 2.68 (m, 1H), 2.64 (t, *J* = 10.5 Hz, 1H), 1.91 (d, B of AB, *J* = 14.3 Hz, 1H), 1.82 (s, 3H), 1.80 – 1.68 (m, 2H), 1.41 (s, 3H), 1.48 – 1.36 (m, 1H), 1.38 – 1.29 (m, 1H), 1.01 (d, *J* = 8.5 Hz, 3H), 1.00 (s, 9H), 0.72 (d, *J* = 6.7 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 150.7, 143.4, 140.1, 136.3, 136.2, 135.5, 134.1, 129.6, 129.4, 127.5, 127.3, 126.0, 116.4, 114.8, 87.0, 78.3, 77.1, 43.8, 40.6, 39.6, 39.0, 27.0, 24.8, 19.5, 17.0, 13.8.

HRMS (ESI$^+$) m/z Calculated for C38H52O4SiNa $[M+Na]^+$: 627.3527, found 627.3534.

IR (neat) ν : 3465, 2932, 2362, 1644, 1462, 1270, 1111, 984, 819, 754, 705 cm^{-1}.

10. Synthesis of compound **SI-5**:



To a stirred solution of compound **18** (2531.0 mg, 4.2 mmol) in dry DCM (50 mL) was added a solution of TPAP (309.6 mg, 0.8 mmol) in dry DCM (5 mL) by cannula at 0 ºC under an argon atmosphere, then a solution of NMO (1038.8 mg, 8.5 mmol) in dry DCM (5 mL) was added dropwise by cannula successively. The reaction was stirred for 3 hours before quenched with aqueous $Na_2S_2O_3$ (60 mL). Filtration through silica and the filter cake was washed with EtOAc (50 mL) nine times, removal of the organic solvents under reduced pressure and aqueous phase extracted with DCM (50 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvent under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 30:1) to afford compound **SI-5** (1840.0 mg, 72%) as a light yellow oil.

$[\alpha]_D^{20}$: +18 (c 0.89, $CHCl_3$).

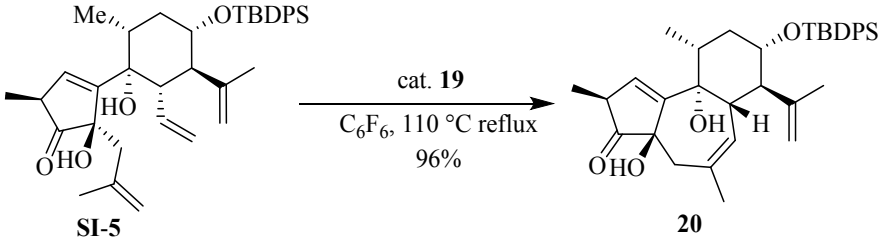
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 – 7.68 (m, 4H), 7.45 – 7.35 (m, 6H), 5.56 – 5.46 (m, 2H), 4.90 – 4.87 (m, 2H), 4.82 (s, 1H), 4.78 (s, 1H), 4.72 (s, 2H), 4.66 (s, 1H), 4.54 (d, *J* = 17.1 Hz, 1H), 3.61 (td, *J* = 10.4, 3.9 Hz, 1H), 3.16 (q, *J* = 7.0 Hz, 1H), 2.86 (d, A of AB, *J* = 14.0 Hz, 1H), 2.63 (t, *J* = 10.7 Hz, 1H), 2.19 (d, B of AB, *J* = 14.1 Hz, 1H), 1.82 – 1.68 (m, 2H), 1.71 (s, 3H), 1.51 – 1.42 (m, 2H), 1.40 (s, 3H), 1.07 (d, *J* = 7.1 Hz, 3H), 1.00 (s, 9H), 0.81 (d, *J* = 6.4 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 214.8, 150.7, 140.9, 138.0, 136.3, 136.2, 135.4, 134.1, 129.6, 129.4, 127.5, 127.4, 126.3, 117.4, 115.8, 83.1, 78.8, 52.8, 46.3, 42.7, 39.6, 38.8, 27.0, 24.1, 19.5, 17.0, 13.3.

HRMS (ESI$^+$) m/z Calculated for C38H51O4Si $[M+H]^+$: 599.3551, found 599.3553.

IR (neat) ν : 2969, 1262, 1757, 1644, 1462, 1269, 1110, 894, 823, 754, 705, 495 cm^{-1}.

11. Synthesis of compound **20**:



SI-5 **20**

To a stirred solution of catalyst **19** (56.3 mg, 0.06 mmol) in C_6F_6 (8 mL) was added a solution of compound **SI-5** (340.0 mg, 0.6 mmol) in C_6F_6 (2 mL) dropwise by cannula at room temperature under an argon atmosphere. Then the reaction was heated to reflux at 110 ºC for 2 hours. Upon completion of the reaction, removal of the solvent under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : DCM = 2 :1 to Petroleum ether : EtOAc = 6 :1) to afford compound **20** (286.3 mg, 88%) as a light yellow foam.

$[\alpha]_D^{20}$: +113 (c 0.74, CHCl3).

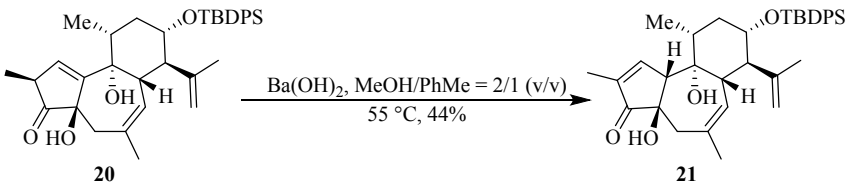
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 – 7.66 (m, 4H), 7.44 – 7.32 (m, 6H), 6.05 (d, *J* = 1.7 Hz, 1H), 5.22 (s, 1H), 4.93 (s, 1H), 4.88 (s, 1H), 3.73 – 3.62 (m, 1H), 3.02 – 2.93 (m, 1H), 2.70 – 2.57 (m, 2H), 2.49 (d, A of AB, *J* = 17.0 Hz, 1H), 2.26 (d, B of AB, *J* = 16.9 Hz, 1H), 1.68 – 1.54 (m, 2H), 1.59 (s, 3H), 1.55 – 1.46 (m, 1H), 1.42 (s, 3H), 1.14 (d, *J* = 7.2 Hz, 3H), 1.01 (s, 9H), 0.67 (d, *J* = 6.1 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 219.1, 149.4, 144.1, 136.2, 136.2, 135.5, 134.5, 134.1, 131.6, 129.6, 129.4, 127.5, 127.4, 126.3, 115.4, 78.9, 77.3, 72.4, 52.7, 43.6, 43.5, 42.3, 39.2, 36.2, 27.1, 25.5, 19.6, 18.9, 15.6, 14.9.

HRMS (ESI$^+$) m/z Calculated for C36H46O4SiNa $[M+Na]^+$: 593.3058, found 598.3062.

IR (neat) ν : 2934, 2362, 1749, 1463, 1269, 1112, 828, 754, 705 cm^{-1}.

12. synthesis of compound **21**:



20 **21**

To a stirred solution of compound **20** (340.0 mg, 0.6 mmol) in dry MeOH (10 mL) and dry PhMe (5 mL) was added a solution of $Ba(OH)_2$ (214.2 mg, 1.2 mmol) in dry MeOH (2.2 mL) at 55 ºC dropwise by cannula under an argon atmosphere. The resulting solution was stirred for 15 minutes before cooled to room temperature and

poured into a solution of aqueous NH_4Cl (20 mL) at 0 ºC. Extracted with EtOAc (20 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 3:1) to afford compound **21** (150.0 mg, 44%) as a light yellow foam.

$[\alpha]_D^{15}$: -29 (c 0.72, $CHCl_3$).

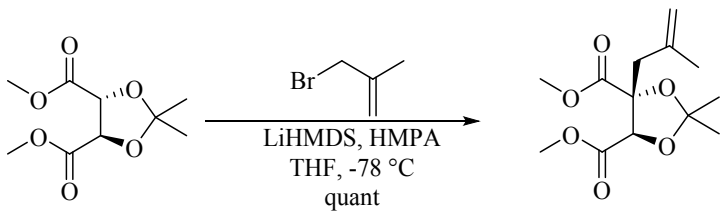
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 – 7.68 (m, 4H), 7.46 – 7.33 (m, 6H), 7.03 (brs, 1H), 4.98 (dd, *J* = 2.5, 1.0 Hz, 1H), 4.92 (brs, 1H), 4.85 (brs, 1H), 3.53 (td, *J* = 10.6, 4.3 Hz, 1H), 3.12 – 3.10 (m, 1H), 2.92 (d, A of AB, *J* = 14.1 Hz, 1H), 2.61 (s, 1H), 2.38 (dd, *J* = 11.4, 10.3 Hz, 1H), 2.26 (d, B of AB, *J* = 14.2 Hz, 1H), 2.24 (s, 1H), 1.80 – 1.72 (m, 1H), 1.76 (dd, *J* = 2.4, 1.3 Hz, 3H), 1.72 – 1.63 (m, 1H),1.69 (s, 3H), 1.55 – 1.45 (m, 1H), 1.51 (s, 3H), 1.44 – 1.37 (m, 1H), 1.00 (s, 9H), 0.83 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 210.1, 155.7, 144.2, 139.8, 136.2, 136.1, 135.3, 134.0, 131.3, 129.7, 129.5, 127.6, 127.4, 125.5, 115.3, 79.7, 74.0, 72.8, 56.9, 55.4, 45.2, 39.4, 38.9, 36.8, 28.2, 27.0, 20.2, 19.5, 15.4, 10.6.

HRMS (ESI$^+$) m/z Calculated for C36H47O4Si $[M+H]^+$: 571.3238, found 571.3241.

IR (neat) ν : 3428, 2931, 2362, 1709, 1644, 1431, 1270, 1108, 1056, 830, 754, 705, 499 cm^{-1}.

13. Synthesis of compound *ent*-**13**:



(-)-8 *ent*-**13**

To a stirred solution of compound (-)-**8** (47.9 g, 176.0 mmol), 3-Bromo-2-methylpropene (95.0 g, 703.7 mmol) and HMPA (126.1 g, 703.7 mmol, 122.4 ml) in dry THF (500 mL) was added a solution of LiHMDS (200.0 mL, 193.5 mmol) dropwise by constant pressure drop funnel within 4 hours at -78 ℃ under an argon

atmosphere. After 10 minutes at the same temperature, the mixture was quenched with aqueous NH_4Cl (200 mL) and extracted with EtOAc (300 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 8:1) to afford *ent*-**13** (58.7 g, quant) as a light yellow oil.

$[\alpha]_D^{20}$: -34 (c 5.65, $CHCl_3$).

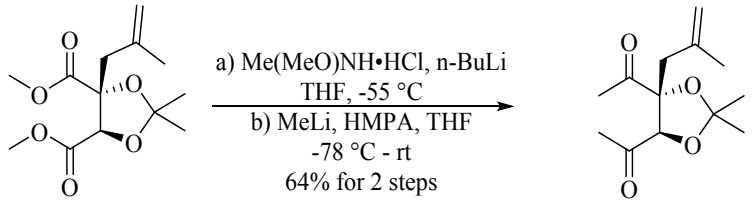
^{1}H NMR (400 MHz, $CDCl_3$) δ 4.82 (s, 1H), 4.77 (s, 1H), 4.65 (s, 1H), 3.75 (s, 3H), 3.71 (s, 3H), 2.54 (d, A of AB, *J* = 13.5 Hz, 1H), 2.20 (d, B of AB, *J* = 13.5 Hz, 1H), 1.70 (s, 3H), 1.57 (s, 3H), 1.36 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 172.2, 168.8, 140.4, 115.1, 113.2, 86.3, 80.4, 52.5, 52.3, 42.2, 27.7, 26.0, 23.6.

HRMS (ESI$^+$) m/z Calculated for C13H21O6 $[M+H]^+$: 273.1333, found 273.1329.

IR (neat) ν : 2954, 1758, 1737, 1437, 1373, 1334, 1254, 1207, 1133, 1106, 1080, 1014, 899, 850, 689, 588 cm^{-1}.

14. Synthesis of compound *ent*-**14**:



ent-**13** *ent*-**14**

To a stirred solution of *N, O*-dimethylhydroxylamine hydrochloride (35.7 g, 365.5 mmol) in dry THF (500 mL) was added a solution of ^{n}BuLi (292.5 mL, 731.0 mmol) dropwise by constant pressure drop funnel within 1 hour at -55 °C under an argon atmosphere. After 30 minutes at the same temperature was added a solution of compound *ent*-**13** (11.7 g, 43.0 mmol) in dry THF (150 mL) by constant pressure drop funnel within 2 hours, upon completion of addition, the mixture was quenched with aqueous NH_4Cl (400 mL) and extracted with EtOAc (200 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the

solvents under reduced pressure gave a crude material, which was used in the next reaction without further purification.

To a stirred soluiton of the above crude material and HMPA (46.2 g, 258.0 mmol, 45.0 mL) in dry THF (500 mL) was added a solution of MeLi (161.3 mL, 258.0 mmol) dropwise by constant pressure drop funnel within 1 hour at -78 °C under an argon atmosphere. The reaction was stirred at -78 ºC for 40 minutes before warmed to 0 ºC. After another 20minutes, the reaction was quenched with aqueous NH_4Cl (200 mL) and extracted with EtOAc (200 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 10:1) to afford compound *ent*-**14** (6.6 g, 64% for 2 steps) as a light yellow oil.

$[\alpha]_D^{20}$: +9 (c 1.84, $CHCl_3$).

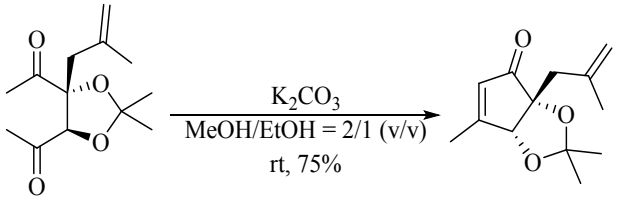
^{1}H NMR (400 MHz, $CDCl_3$) δ 4.80 (d, *J* = 1.4 Hz, 1H), 4.64 (s, 1H), 4.48 (d, *J* = 1.2 Hz, 1H), 2.39 (d, A of AB, *J* = 13.5 Hz, 1H), 2.27 (s, 6H), 2.13 (d, B of AB, *J* = 13.6 Hz, 1H), 1.71 (s, 3H), 1.59 (s, 3H), 1.38 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 210.5, 203.8, 140.3, 115.8, 111.3, 90.2, 83.6, 41.5, 28.6, 27.9, 27.6, 25.9, 24.3.

HRMS (ESI$^+$) m/z Calculated for C13H21O4 $[M+H]^+$: 241.1434, found 241.1437.

IR (neat) ν : 2988, 2360, 2341, 1728, 1419, 1377, 1356, 1246, 1218, 1171, 1122, 1074, 902 cm^{-1}.

15. Synthesis of compound *ent*-**16**:



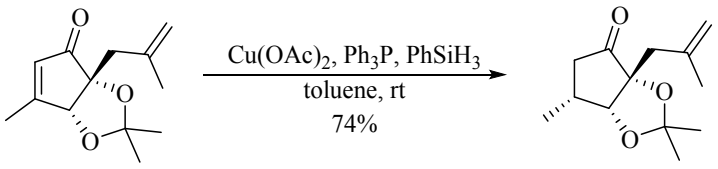
ent-**14** *ent*-**16**

To a stirred solution of compound *ent*-**14** (10.0 g, 41.8 mmol) in MeOH (200 mL) and EtOH (100 mL) was added K_2CO_3 (5.8 g, 41.8 mmol) in one portion at room

temperature. After stirred over night at the same temperature, the mixture was quenched with aqueous NH_4Cl (120 mL) and extracted with EtOAc (100 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 50:1) to afford compound *ent*-**16** (6.9 g, 75%) as a light yellow oil.

$[\alpha]_D^{20}$: +4 (c 2.69, $CHCl_3$).
^{1}H NMR (400 MHz, $CDCl_3$) δ 5.96 (d, *J* = 1.2 Hz, 1H), 4.88 – 4.85 (m, 1H), 4.83 (s, 1H), 4.73 (d, *J* = 0.9 Hz, 1H), 2.55 (d, A of AB, *J* = 14.1 Hz, 1H), 2.48 (d, B of AB, *J* = 14.1 Hz, 1H), 2.20 – 2.16 (m, 3H), 1.73 (s, 3H), 1.42 (s, 3H), 1.26 (s, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 204.6, 174.1, 140.6, 130.4, 115.6, 114.6, 86.2, 84.4, 40.3, 28.8, 28.4, 24.3, 17.1.
HRMS (ESI$^+$) m/z Calculated for C13H19O3 $[M+H]^+$: 223.1329, found 223.1332.
IR (neat) ν : 3731, 2989, 2362, 2336, 1722, 1626, 1515, 1376, 1242, 1064, 902, 760, 671, 424 cm^{-1}.

16. Synthesis of compound *ent*-**SI-3**:



ent-**16** *ent*-**SI-3**

To a stirred solution of Ph_3P (84.3 g, 320 mmol) and $Cu(OAc)_2$ (29.3 g, 160 mmol) in dry toluene (550 mL) was added $PhSiH_3$ (25.0 mL, 192.0 mmol) dropwise by cannula at room temperature under an argon atmosphere. After 1 hour at the same temperature was added a solution of compound *ent*-**16** (7.1 g, 32 mmol) in dry toluene (200 mL) dropwise by constant pressure drop funnel. The mixture was stirred for another 8 hours before quenched with aqueous NH_4Cl (200 mL) very slowly. Filtration through diatomaceous earth and the filter cake was washed with EtOAc (50 mL) nine times, removal of the organic solvents under reduced pressure and aqueous phase extracted with EtOAc (100 mL) three times. The combined organic layer was

dried over Na_2SO_4. After filtration, removal of the solvent under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 100:1) to afford compound *ent*-**SI-3** (5.3 g, 74%) as a light yellow solid.

M.P.: 45 – 47 ºC.

$[\alpha]_D^{20}$: -100 (c 1.33, $CHCl_3$).

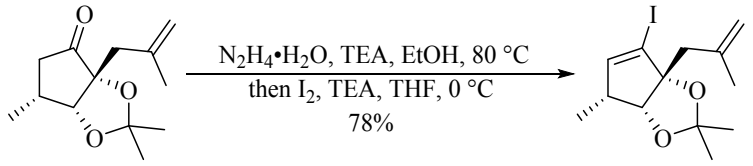
^{1}H NMR (400 MHz, $CDCl_3$) δ 4.90 – 4.86 (m, 1H), 4.71 (d, *J* = 0.8 Hz, 1H), 4.34 (d, *J* = 3.0 Hz, 1H), 2.37 (d, A of AB, *J* = 13.8 Hz, 1H), 2.31 (d, B of AB, *J* = 13.7 Hz, 1H), 2.30 – 2.18 (m, 2H), 2.20 – 2.10 (m, 1H), 1.75 (s, 3H), 1.31 (s, 3H), 1.30 (s, 3H), 1.18 (d, *J* = 6.5 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 217.2, 140.3, 115.9, 110.8, 88.5, 83.1, 41.0, 38.4, 29.3, 27.3, 26.1, 24.6, 15.0.

HRMS (ESI$^+$) m/z Calculated for C13H21O3 $[M+H]^+$: 225.1485, found 225.1489.

IR (neat) ν : 3731, 2362, 2336, 1645, 1515, 1273, 756, 671, 423 cm^{-1}.

17. Synthesis of compound *ent*-**17**:



ent-**SI-3** *ent*-**17**

A stirred solution of compound *ent*-**SI-3** (4.2 g, 20 mmol), $N_2H_4 \cdot H_2O$ (4.0 mL, 80 mmol) and TEA (3.4 mL, 24.0 mmol) in EtOH (200 mL) was heated at 80 ºC for 16 hours. After the reaction was cooled to room temperature, the solvents were removed under reduced pressure to give a bright yellow oil, which was dried by oil pump for 4 hours before used in the next step without further purification;

To a stirred solution of the above crude material in dry THF (150 mL) was added TEA (26.0 mL, 186.4 mmol) dropwise by cannula at 0 ºC under an argon atmosphere, after 20 minutes at the same temperature, a solution of I_2 (9.5 g, 37.3 mmol) in dry THF (100 mL) was added dropwise within 30 minutes. Upon completion of addition,

the reaction was quenched with aqueous $Na_2S_2O_3$ (200 mL) and extracted with EtOAc (200 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 100:1) to afford compound *ent*-**17** (5.2 g, 78%) as a light yellow oil.

$[\alpha]_D^{20}$: -31 (c 1.20, $CHCl_3$).

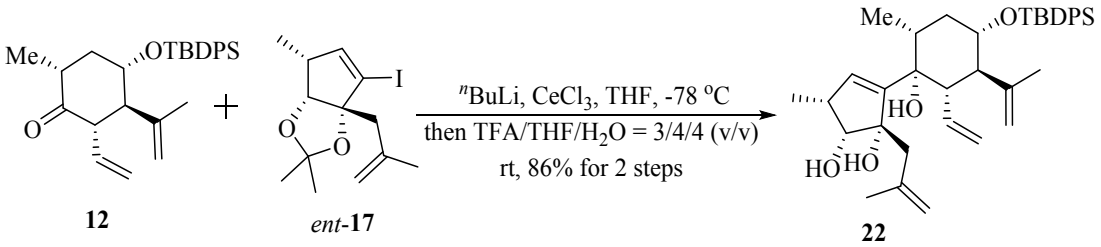
^{1}H NMR (400 MHz, $CDCl_3$) δ 5.92 (s, 1H), 4.89 (s, 1H), 4.78 (s, 1H), 4.43 (dd, *J* = 4.8, 1.0 Hz, 1H), 2.74 – 2.65 (m, 1H), 2.46 (d, A of AB, *J* = 13.7 Hz, 1H), 2.32 (d, B of AB, *J* = 13.7 Hz, 1H), 1.82 (s, 3H), 1.38 (s, 6H), 1.11 (d, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 141.0, 115.7, 110.7, 106.0, 96.6, 81.2, 44.1, 42.6, 27.8, 27.7, 24.5, 13.2.

HRMS (ESI$^+$) m/z Calculated for C13H19IO2Na $[M+Na]^+$: 357.0322, found 357.0321.

IR (neat) ν : 3731, 2984, 2930, 2362, 2336, 1455, 1373, 1258, 1220, 1129, 1076, 1009, 896, 842, 756, 495 cm^{-1}.

18. Synthesis of compound **22**:



12 *ent*-**17** **22**

To a stirred solution of anhydrous $CeCl_3$ (1.2 g, 4.9 mmol) in dry THF (40 mL) was added a solution of compound **12** (1.9 g, 4.3 mmol) in dry THF (10 mL) at room temperature under an argon atmosphere. The resulting solution was stirred for 2 hours before cooled to -78 ºC. To a solution of compound *ent*-**17** (4.7 g, 12.9 mmol) in dry THF (50 mL) was added a solution of ^{n}BuLi (12.9 mmol, 5.2 mL) at -78 ºC under an argon atmosphere dropwise by cannula. The resulting solution was stirred for 30 minutes at -78 ºC and transferred quickly via cannula to the ketone·$CeCl_3$ complex in THF at -78 °C. Upon completion of the addition, the reaction was stirred for another 1

hour. quenched with aqueous NH_4Cl (30 mL) and extracted with EtOAc (50 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material which was used in the next step without further purification;

To a stirred solution of the above crude material in THF (25.0 mL) and H_2O (25.0 mL) was added TFA (18.0 mL) dropwise at room temperature dropwise by cannula, the resulting solution was stirred at room temperature for 4 hours. Then transferred dropwise via cannula to a solution of aqueous $NaHCO_3$ (250 mL) at 0 ºC. Extracted with EtOAc (150 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 10:1) to afford compound **22** (2.2 g, 86% for 2 steps) as a light yellow foam.

$[\alpha]_D^{20}$: +10 (c 0.75, $CHCl_3$).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 – 7.67 (m, 4H), 7.45 – 7.32 (m, 6H), 5.68 (dt, *J* = 17.3, 10.1 Hz, 1H), 4.97 (s, 1H), 4.90 (s, 1H), 4.89 (dd, *J* = 10.1, 2.1 Hz, 1H), 4.83 (s, 1H), 4.79 (s, 1H), 4.69 (s, 1H), 4.62 (dd, *J* = 17.2, 2.1 Hz, 1H), 4.30 (d, *J* = 0.8 Hz, 1H), 4.03 (t, *J* = 3.5 Hz, 1H), 3.66 – 3.58 (m, 2H), 2.73 (d, A of AB, *J* = 14.6 Hz, 1H), 2.69 – 2.64 (m, 1H), 2.60 (t, *J* = 11.0 Hz, 1H), 2.07 – 2.02 (m, 1H), 1.90 (d, B of AB, *J* = 14.8 Hz, 1H), 1.83 (s, 3H), 1.69 (dd, *J* = 23.8, 12.5 Hz, 1H), 1.44 (s, 3H), 1.40 – 1.33 (m, 1H), 1.32 – 1.22 (m, 1H), 1.02 (d, *J* = 7.4 Hz, 3H), 1.00 (s, 9H), 0.70 (d, *J* = 6.7 Hz, 3H).

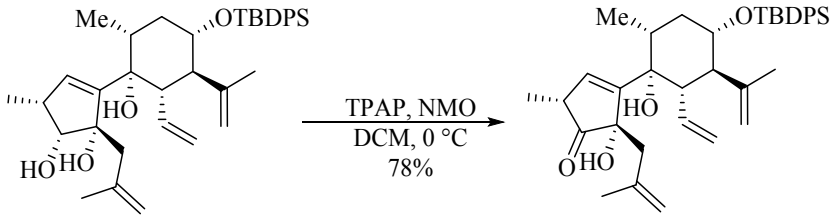
^{13}C NMR (100 MHz, $CDCl_3$) δ 149.3, 143.9, 138.8, 136.2, 136.2, 135.5, 134.2, 129.6, 129.4, 127.5, 127.3, 127.1, 116.2, 114.9, 86.6, 78.6, 77.3, 53.0, 44.5, 43.9, 39.7, 39.2, 27.0, 25.0, 19.5, 16.3, 13.5.

HRMS (ESI$^+$) m/z Calculated for C38H52O4SiNa $[M+Na]^+$: 627.3527, found 627.3530.

IR (neat) ν : 3731, 3625, 2972, 2362, 2336, 1707, 1515, 1272, 1112, 818, 755, 706, 700 cm^{-1}.

19. Synthesis of compound **SI-6**:

To a stirred solution of compound **22** (1525.2 mg, 2.5 mmol) in dry DCM (35



22 **SI-6**

mL) was added a solution of TPAP (251.1 mg, 0.7 mmol) in dry DCM (5 mL) by cannula under an argon atmosphere, then a solution of NMO (835.2 mg, 7.0 mmol) in dry DCM (5 mL) was added dropwise successively. The reaction was stirred for 2.5 hours at the same temperature before quenched with aqueous $Na_2S_2O_3$ (40 mL). Filtration through silica and the filter cake was washed with EtOAc (50 mL) nine times, removal of the organic solvents under reduced pressure and the aqueous phase extracted with DCM (50 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvent under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 30:1) to afford compound **SI-6** (1185.7 mg, 78%) as a light yellow foam.

$[\alpha]_D^{20}$: +37 (c 0.51, $CHCl_3$).

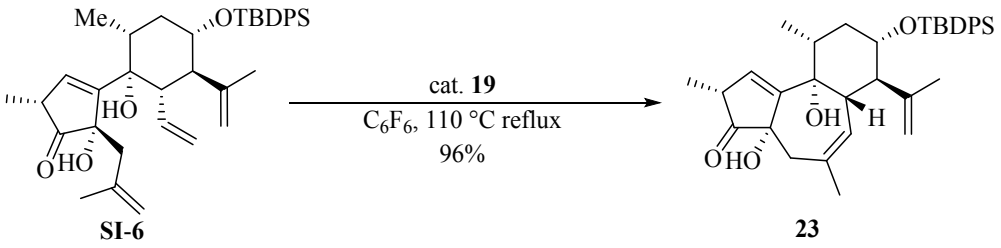
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 – 7.65 (m, 4H), 7.45 – 7.31 (m, 6H), 5.73 (dt, *J* = 17.3, 10.1 Hz, 1H), 5.55 (d, *J* = 1.2 Hz, 1H), 4.96 (dd, *J* = 10.3, 1.7 Hz, 1H), 4.95 (s, 1H), 4.85 (s, 1H), 4.82 (s, 1H), 4.73 (s, 1H), 4.71 (dd, *J* = 16.8, 2.3 Hz, 1H), 3.73 (s, 1H), 3.64 (td, *J* = 10.6, 4.3 Hz, 1H), 3.25 (s, 1H), 3.16 (qd, *J* = 7.0, 1.4 Hz, 1H), 2.82 (d, A of AB, *J* = 14.3 Hz, 1H), 2.65 (t, *J* = 10.2 Hz, 1H), 2.14 (d, B of AB, *J* = 14.2 Hz, 1H), 1.93 (t, *J* = 10.7 Hz, 1H), 1.75 – 1.63 (m, 1H), 1.67 (s, 3H), 1.47 (s, 3H), 1.42 – 1.34 (m, 1H), 1.32 – 1.20 (m, 1H), 1.07 (d, *J* = 7.1 Hz, 3H), 1.00 (s, 9H), 0.60 (d, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 215.7, 150.0, 140.7, 138.7, 136.2, 136.2, 135.5, 134.2, 129.6, 129.4, 127.5, 127.4, 127.0, 116.9, 116.4, 81.9, 79.2, 46.4, 43.2, 42.8, 38.9, 27.0, 24.2, 19.5, 16.2, 13.3.

HRMS (ESI$^+$) m/z Calculated for C38H51O4Si $[M+H]^+$: 599.3551, found 599.3552.

IR (neat) ν : 3731, 2970, 2362, 2336, 1755, 1645, 1515, 1269, 1112, 1070, 823, 755, 706, 670 cm^{-1}.

20. Synthesis of compound **23**:



SI-6 **23**

To a stirred solution of catalyst **19** (134.4 mg, 0.13 mmol) in C_6F_6 (10 mL) was added a solution of compound **SI-6** (1140.4 mg, 1.9 mmol) in C_6F_6 (15 mL) at room temperature under an argon atmosphere. Then the reaction was heated to reflux at 110 ºC for 3 hours. Upon completion of the reaction, removal of the solvent under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : DCM = 2 :1 to Petroleum ether : EtOAc = 6 :1) to afford compound **23** (1144.4 mg, 96%) as a light yellow foam.

$[\alpha]_D^{20}$: -19 (c 0.26, $CHCl_3$).

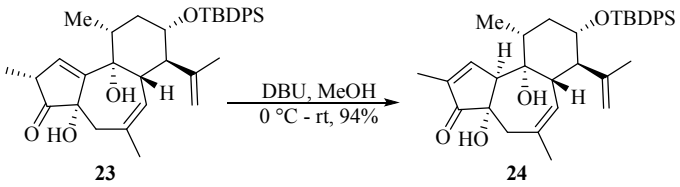
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 – 7.67 (m, 4H), 7.45 – 7.34 (m, 6H), 5.70 (d, *J* = 1.9 Hz, 1H), 5.30 (brs, 1H), 4.96 (s, 2H), 3.53 (td, *J* = 10.4, 3.8 Hz, 1H), 3.08 (d, *J* = 0.5 Hz, 1H), 3.03 (qd, *J* = 7.2, 1.7 Hz, 1H), 2.93 (s, 1H), 2.45 (dd, *J* = 11.7, 10.4 Hz, 1H), 2.28 (d, A of AB, *J* = 14.0 Hz, 1H), 2.11 (d, B of AB, *J* = 13.7 Hz, 1H), 2.01 (dd, *J* = 11.2, 2.2 Hz, 1H), 1.86 (s, 3H), 1.74 – 1.66 (m, 1H), 1.68 – 1.57 (m, 1H), 1.49 (s, 3H), 1.44 (dt, *J* = 7.0, 3.2 Hz, 1H), 1.16 (d, *J* = 7.2 Hz, 3H), 1.01 (s, 9H), 0.80 (d, *J* = 6.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 218.2, 148.1, 144.0, 136.2, 136.2, 135.4, 134.7, 134.1, 129.7, 129.5, 127.9, 127.6, 127.4, 127.2, 115.9, 82.1, 75.4, 72.3, 56.9, 48.7, 42.8, 42.3, 38.6, 34.8, 29.9, 28.6, 27.0, 19.5, 16.6, 14.1.

HRMS (ESI$^+$) m/z Calculated for C36H46O4SiNa $[M+Na]^+$: 593.3058, found 598.3057.

IR (neat) ν : 3731, 3626, 2936, 2362, 2336, 1754, 1515, 1269, 1108, 1065, 755, 705, 671 cm^{-1}.

21. Synthesis of compound **24**:



23 **24**

To a stirred solution of compound **23** (714.5 mg, 1.3 mmol) in dry MeOH (20 mL) was added DBU (952.8 mg, 6.3 mmol) dropwise at 0 ºC by cannula under an argon atmosphere. After 1.5 hours slowly warmed to room temperature, the resulting solution was poured into aqueous NH_4Cl (20 mL) at 0 ºC. Extracted with EtOAc (30 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 3:1) to afford compound **24** (668.7 mg, 94%) as a light yellow foam.

$[\alpha]_D^{20}$: -64 (c 0.50, $CHCl_3$).

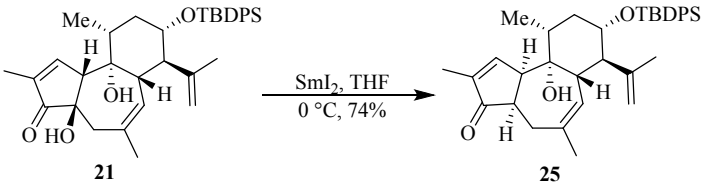
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 1.3 Hz, 1H), 7.70 (s, 1H), 7.70 (s, 1H), 7.68 (d, *J* = 1.5 Hz, 1H), 7.46 – 7.33 (m, 6H), 7.03 (brs, 1H), 4.98 (dd, *J* = 2.5, 1.0 Hz, 1H), 4.92 (s, 1H), 4.85 (s, 1H), 3.53 (td, *J* = 10.6, 4.3 Hz, 1H), 3.13 – 3.08 (m, 1H), 2.93 (d, A of AB, *J* = 14.1 Hz, 1H), 2.64 (s, 1H), 2.39 (t, *J* = 10.9 Hz, 1H), 2.27 (s, 1H), 2.26 (d, B of AB, *J* = 14.1 Hz, 1H), 1.81 – 1.72 (m, 1H), 1.76 (dd, *J* = 2.3, 1.3 Hz, 3H), 1.72 – 1.64 (m, 1H),1.69 (s, 3H), 1.56 – 1.45 (m, 1H), 1.51 (s, 3H), 1.44 – 1.37 (m, 1H), 1.00 (s, 9H), 0.83 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 210.1, 155.7, 144.2, 139.8, 136.2, 136.2, 135.3, 134.0, 131.3, 129.7, 129.5, 127.6, 127.4, 125.5, 115.3, 79.7, 74.0, 72.7, 56.9, 55.4, 45.2, 39.4, 38.9, 36.8, 28.2, 27.0, 20.2, 19.5, 15.4, 10.6.

HRMS (ESI$^+$) m/z Calculated for C36H46O4SiNa $[M+Na]^+$: 593.3058, found 598.3054.

IR (neat) ν : 3731, 3440, 21933, 2362, 2336, 1709, 1644, 1515, 1464, 1431, 1270, 1108, 1059, 755, 705, 670, 499 cm^{-1}.

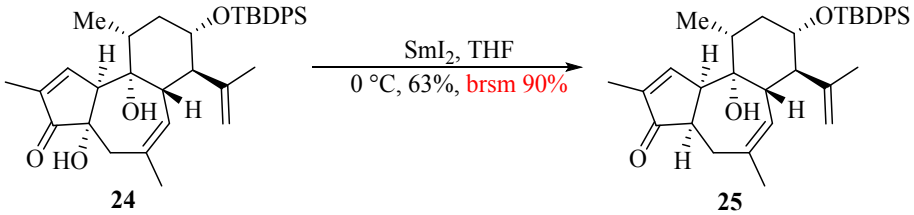
22. Synthesis of compound **25** from **21**:



21 **25**

To a stirred solution of compound **21** (86.0 mg, 0.15 mmol) in deoxygenated dry THF (10 mL) was added a solution of SmI_2 (5.0 mL, 1.5 mmol) at 0 ºC dropwise by cannula under an argon atmosphere. After 15 minutes with the disappearance of dark blue color, the resulting solution was quenched with aqueous $NaHCO_3$ (10 mL) at 0 ºC, diluted with water (25 mL). Extracted with EtOAc (30 mL) five times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 6:1) to afford compound **25** (62.5 mg, 74%) as a light yellow crystal.

23. Synthesis of compound **25** from **24**:



24 **25**

To a stirred solution of compound **24** (668.7 mg, 1.2 mmol) in deoxygenated dry THF (15 mL) was added a solution of SmI_2 (10.0 mL, 8.0 mmol) at 0 ºC dropwise via cannula under an argon atmosphere. After 20 minutes with the disappearance of dark blue color, the resulting solution was quenched with aqueous $NaHCO_3$ (20 mL) at 0

ºC, diluted with water (50 mL). Extracted with EtOAc (50 mL) five times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 6:1 to 2 : 1) to afford compound **25** (409.1 mg, 63%, 90% brsm) as a light yellow crystal along with compound **24** (200.1 mg).

M.P.: decomposition while heating.

$[\alpha]_D^{20}$: -40 (c 0.48, $CHCl_3$).

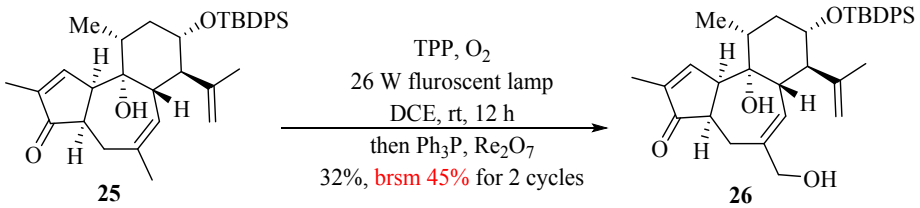
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 – 7.66 (m, 4H), 7.47 – 7.33 (m, 6H), 7.00 (s, 1H), 4.93 (s, 1H), 4.93 (s, 1H), 4.83 (s, 1H), 3.49 (td, *J* = 10.7, 4.3 Hz, 1H), 3.40 – 3.35 (m, 1H), 2.86 (dd, *J* = 16.5, 2.4 Hz, 1H), 2.61 – 2.56 (m, 1H), 2.51 (dd, *J* = 16.5, 4.4 Hz, 1H), 2.14 (dd, *J* = 11.9, 10.1 Hz, 1H), 2.03 (s, 1H), 1.82 (dd, *J* = 12.3, 2.1 Hz, 1H), 1.74 (s, 3H), 1.74 (s, 3H), 1.68 – 1.58 (m, 1H), 1.48 (s, 3H), 1.48 – 1.40 (m, 1H), 1.37 – 1.30 (m, 1H), 0.98 (s, 9H), 0.89 (d, *J* = 6.7 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 210.8, 156.3, 144.3, 142.4, 136.1, 136.0, 135.6, 135.2, 133.9, 129.5, 129.4, 127.4, 127.3, 122.7, 115.6, 76.6, 72.6, 56.2, 48.9, 48.9, 44.7, 38.6, 37.0, 30.6, 28.9, 26.9, 19.4, 15.6, 10.4.

HRMS (ESI$^+$) m/z Calculated for C36H47O3Si $[M+H]^+$: 555.3289, found 555.3288.

IR (neat) ν : 3731, 3625, 2362, 2336, 1703, 1645, 1515, 1270, 1108, 822, 755, 708, 670 cm^{-1}.

24. Synthesis of compound **26**:



To a stirred solution of compound **25** (392.5 mg, 0.71 mmol) in DCE (15 mL) was added a solution of TPP (9.1 mg, 0.014 mmol) in DCE (5 mL) dropwise by cannula at room temperature with oxygen bubbling in. The resulting purple solution was irradiated by two fluorescent lamps from a distance of 3 cm^{-1} for 12 hours.

Removal of the light and oxygen was added Ph_3P (189.3 mg, 0.71 mmol) at 0 °C. After 20 minutes, the resulting solution was transferred dropwise by cannula to a solution of Re_2O_7 (344.1 mg, 0.71 mmol) in DCM (15 mL) at 0 °C. Upon completion of the addition, the reaction was stirred for another 15 minutes, quenched with aqueous $NaHCO_3$ (10 mL) and $Na_2S_2O_3$ (10 mL) successively, extracted with DCM (50 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 4:1 to 1:1) to afford compound **26** (128.8 mg, 32%, brsm 45%) as a light yellow oil along with compound **25** (112.0 mg, 29%) after 2 cycles.

$[\alpha]_D^{20}$: +90 (c 0.29, $CHCl_3$).

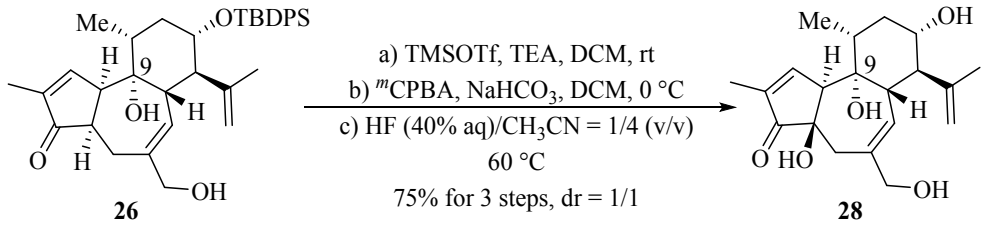
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 – 7.64 (m, 4H), 7.48 – 7.33 (m, 6H), 7.01 (s, 1H), 5.20 (s, 1H), 4.93 (s, 1H), 4.82 (s, 1H), 3.95 (d, A of AB, *J* = 12.1 Hz, 1H), 3.86 (d, B of AB, *J* = 12.1 Hz, 1H), 3.51 (td, *J* = 10.5, 4.4 Hz, 1H), 3.46 – 3.41 (m, 1H), 3.06 – 2.98 (m, 1H), 2.71 – 2.67 (m, 1H), 2.61 (dd, *J* = 16.2, 4.6 Hz, 1H), 2.31 (brd, *J* = 3.2 Hz, 1H), 2.19 (dd, *J* = 11.9, 10.0 Hz, 1H), 2.03 (s, 1H), 1.82 (d, *J* = 12.1 Hz, 1H), 1.73 (s, 3H), 1.63 (dd, *J* = 23.6, 12.3 Hz, 1H), 1.49 (s, 3H), 1.49 – 1.43 (m, 1H), 1.42 – 1.34 (m, 1H), 0.98 (s, 9H), 0.90 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 212.4, 156.7, 144.2, 143.0, 137.8, 136.2, 136.1, 135.3, 133.9, 129.7, 129.5, 127.6, 127.4, 125.3, 115.8, 72.6, 70.1, 55.7, 51.3, 49.5, 48.8, 45.3, 38.7, 37.3, 27.0, 25.7, 22.9, 19.5, 15.6, 10.5.

HRMS (ESI$^+$) m/z Calculated for C36H46O4SiNa $[M+Na]^+$: 593.3058, found 593.3060.

IR (neat) ν : 3731, 2362, 2336, 1706, 1645, 1515, 1270, 756, 670 cm^{-1}.

25. Synthesis of compound **28**:



To a stirred solution of compound **26** (29.6 mg, 0.052 mmol) in dry DCM (6 mL) was added TEA (209.4 mg, 2.1 mmol, 0.3 mL), TMSOTf (230.0 mg, 1.0 mmol, 0.2 mL) successively by cannula at room temperature under an argon atmosphere. Upon completion of the addition, the reaction was stirred for 1 hour, quenched with aqueous $NaHCO_3$ (5 mL), diluted with water (10 mL) then extracted with DCM (10 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvent under reduced pressure gave a crude material which was used in the next step without further purification;

To a stirred solution of the above crude material in DCM (3 mL) was added $NaHCO_3$ (9.6 mg, 0.11 mmol) at 0 ºC, then *m*CPBA (11.5 mg, 0.057 mmol) in DCM (0.5 mL) was added in one portion by cannula at the same temperature. Upon completion of the addition, the reaction was stirred for 8 minutes, quenched with aqueous $Na_2S_2O_3$ (5 mL), diluted with water (10 mL), then extracted with DCM (10 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvent under reduced pressure gave a crude material which was used in the next step without further purification;

To a stirred solution of the above crude material in CH_3CN (2 mL) was added HF (40% aq, 0.5 mL) at room temperature dropwise by cannula. The reaction was transferred to a preheated oil bath at 60 ºC. After 2 hours, the cooled to room temperature resulting solution was poured into aqueous $NaHCO_3$ (20 mL) at 0 ºC. Extracted with EtOAc (15 mL) fifteen times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (DCM : MeOH = 15:1) to afford compound **28** (6.8 mg, 38%) as a colorless oil along with C-4 diastereomer compound **28'** (6.6 mg, 37%).

Compound **28**:

$[\alpha]_D^{20}$: +40 (c 0.07, MeOH).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (s, 1H), 5.50 (d, *J* = 6.2 Hz, 1H), 5.03 (s, 1H), 4.99 (s, 1H), 4.01 (d, A of AB, *J* = 12.7 Hz, 1H), 3.94 (d, B of AB, *J* = 12.7 Hz, 1H), 3.55 (td, *J* = 10.7, 5.0 Hz, 1H), 3.18 (dd, *J* = 12.2, 6.2 Hz, 1H), 3.09 – 3.04 (m, 1H), 2.51 (s, 2H), 2.43 (dd, *J* = 12.3, 10.0 Hz, 1H), 2.40 (s, 1H), 2.36 – 2.25 (m, 1H), 1.84

– 1.75 (m, 1H), 1.80 (dd, *J* = 2.7, 1.2 Hz, 3H), 1.61 (s, 3H), 1.60 – 1.51 (m, 1H), 0.98 (d, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 208.9, 159.4, 143.9, 141.2, 133.8, 125.9, 117.2, 77 (C9, deduced from HMBC), 73.8, 68.9, 68.1, 57.8, 53.5, 42.8, 38.9, 38.4, 36.2, 18.0, 17.8, 10.4.

HRMS (ESI$^+$) m/z Calculated for C20H28O5Na $[M+Na]^+$: 371.1829, found 371.1830.

IR (neat) ν : 3731, 3401, 2978, 2362, 2336, 1705, 1643, 1515, 1460, 1260, 1035, 879, 756, 671 cm^{-1}.

Compound **28'**:

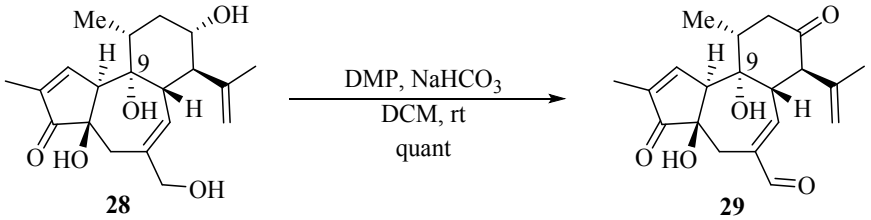
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 (s, 1H), 5.22 (d, *J* = 3.7 Hz, 1H), 5.06 (s, 1H), 4.96 (s, 1H), 3.92 (s, 2H), 3.48 (td, *J* = 10.8, 4.3 Hz, 1H), 3.28 – 3.24 (m, 1H), 2.97 (d, A of AB, *J* = 14.7 Hz, 1H), 2.45 (d, B of AB, *J* = 14.4 Hz, 1H), 2.30 – 2.23 (m, 1H), 2.08 – 2.02 (m, 1H), 1.97 – 1.88 (m, 1H), 1.89 – 1.83 (m, 1H), 1.82 (dd, *J* = 2.4, 1.4 Hz, 3H), 1.72 – 1.64 (m, 1H), 1.64 (s, 3H), 1.09 (d, *J* = 6.7 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 210.4, 155.6, 143.2, 140.1, 134.4, 128.0, 117.7, 79.5, 74.2, 69.1 (C9 and C20, deduced from HMBC), 57.2, 56.0, 44.0, 36.9, 36.9, 35.5, 18.3, 15.4, 10.8.

HRMS (ESI$^+$) m/z Calculated for C20H28O5Na $[M+Na]^+$: 371.1829, found 371.1830.

IR (neat) ν : 3731, 3385, 2975, 2362, 2336, 1705, 1643, 1460, 1260, 1033, 880, 755, 671 cm^{-1}.

26. Synthesis of compound **29**:



28 **29**

To a stirred solution of compound **28** (6.8 mg, 0.02 mmol) in DCM (2 mL) was added $NaHCO_3$ (20.2 mg, 0.24 mmol), Dess-Martin periodinane (34.3 mg, 0.08 mmol)

successively in one portion at room temperature. After 3 hours at room temperature, the reaction was quenched with aqueous $Na_2S_2O_3$ (5 mL), diluted with water (10 mL), then extracted with DCM (10 mL) three times. The combined organic layer was dried over Na_2SO_4. After filtration, removal of the solvent under reduced pressure gave a crude material, which was purified by flash silica gel column chromatography (Petroleum ether : EtOAc = 1:1) to afford compound **29** (6.9 mg, quant) as a colorless oil.

$[\alpha]_D^{20}$: +76 (c 0.06, MeOH).

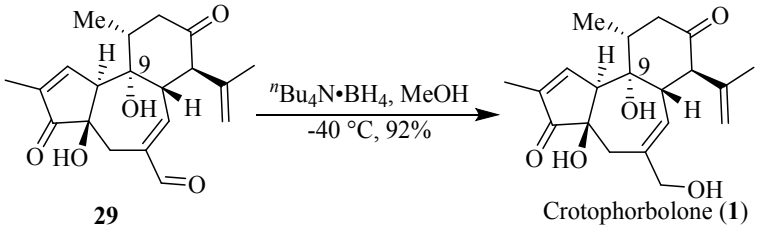
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.41 (s, 1H), 7.49 (s, 1H), 6.55 (dd, *J* = 5.7, 1.9 Hz, 1H), 5.13 (s, 1H), 4.91 (s, 1H), 4.09 (dd, *J* = 13.1, 5.9 Hz, 1H), 3.58 (d, *J* = 13.1 Hz, 1H), 2.94 (s, 1H), 2.89 (d, A of AB, *J* = 20.0 Hz, 1H), 2.84 – 2.74 (m, 1H), 2.54 (s, 1H), 2.52 (d, B of AB, *J* = 19.2 Hz, 1H), 2.48 – 2.36 (m, 2H), 1.84 (dd, *J* = 2.6, 1.2 Hz, 3H), 1.67 (s, 3H), 1.03 (d, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 208.4, 207.4, 193.8, 156.7, 152.5, 143.6, 140.7, 135.9, 117.5, 77 (C9, deduced from HMBC), 72.7, 58.1, 57.5, 46.2, 45.7, 38.0, 34.6, 20.3, 17.9, 10.4.

HRMS (ESI$^+$) m/z Calculated for C20H26O5 $[M+H]^+$: 345.1697, found 345.1706.

IR (neat) ν : 3731, 2985, 2362, 2336, 1703, 1515, 1270, 755, 670 cm^{-1}.

27. Synthesis of crotophorbolone (**1**):



29 Crotophorbolone (**1**)

To a stirred solution of compound **29** (1.4 mg, 0.004 mmol) in MeOH (2 mL) was added ^{n}Bu$_4$N·BH$_4$ (1.2 mg, 0.004 mmol) in one portion at -40 ºC. After 10 minutes, the resulting solution was filtered through a short silica cake, washed with EtOAc (5 mL) nine times. After filtration, removal of the solvents under reduced pressure gave a crude material, which was purified by flash silica gel column

chromatography (EtOAc) to afford crotophorbolone (**1**) (1.3 mg, 92%) as a colorless oil.

$[\alpha]_D^{20}$: 116 (c 0.03, MeOH).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (s, 1H), 5.51 (d, *J* = 5.5 Hz, 1H), 5.05 (s, 1H), 4.83 (s, 1H), 4.05 (d, A of AB, *J* = 12.9 Hz, 1H), 3.99 (d, B of AB, *J* = 13.0 Hz, 1H), 3.71 (dd, *J* = 13.2, 5.7 Hz, 1H), 3.40 (d, *J* = 13.2 Hz, 1H), 3.10 (s, 1H), 2.75 – 2.63 (m, 1H), 2.54 (d, *J* = 19.0 Hz, 1H), 2.49 (d, *J* = 19.5 Hz, 1H), 2.47 (m, 1H), 2.31 (dd, *J* = 14.8, 5.4 Hz, 1H), 2.23 (s, 1H, -OH), 1.83 (dd, *J* = 2.8, 1.3 Hz, 3H), 1.64 (s, 3H), 1.02 (d, *J* = 6.7 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 209.5, 208.3, 158.0, 141.7, 141.4, 134.9, 125.3, 116.7, 77 (C9, deduced from HMBC), 73.6, 68.0, 58.5, 58.1, 46.5, 44.3, 38.5, 37.9, 20.1, 18.0, 10.4.

HRMS (ESI$^+$) m/z Calculated for C20H26O5Na $[M+Na]^+$: 369.1672, found 369.1671.

IR (neat) ν : 3732, 2362, 2336, 1705, 1645, 1515, 1269, 755, 671 cm^{-1}.

Table 1. Comparison of ^{1}H NMR data of natural and synthetic Crotophorbolone (**1**) in $CDCl_3$.

No.	^{1}H [δ, multi. *J* (Hz)] natural	^{1}H [δ, multi. *J* (Hz)] Synthetic 1	^{1}H [δ, multi. *J* (Hz)] Synthetic 2 (our work)
1	7.55 (m)	7.55 (m)	7.55 (brs)
2			
3			
4			
5a	2.50 (d, 19.2)	2.49 (d, 18.9)	2.49 (d, 19.6)
5b	2.55 (d, 19.2)	2.54 (d, 18.9)	2.54 (d, 18.8)
6			

7	5.51 (d, 6.0)	5.50 (d, 5.5)	5.51 (d, 5.6)
8	3.71 (dd, 13.3, 6.0)	3.70 (m)	3.71 (dd, 13.2, 5.6)
9			
10	3.11 (m)	3.11 (m)	3.10 (brs)
11	2.69 (m)	2.68 (m)	2.69 (m)
12a	2.31 (dd, 14.6, 5.5)	2.31 (dd, 15.1, 5.5)	2.31 (dd, 14.8, 5.2)
12b	2.47 (m)	2.49 (m)	2.47 (m)
13			
14	3.40 (d, 13.3)	3.38 (d, 12.6)	3.40 (d, 13.2)
15			
16a	4.83 (brs)	4.83 (brs)	4.83 (brs)
16b	5.04 (m)	5.04 (m)	5.05 (m)
17	1.64 (s)	1.64 (s)	1.64 (s)
18	1.02 (d, 6.9)	1.02 (d, 6.9)	1.02 (d, 6.8)
19	1.83 (m)	1.83 (m)	1.83 (dd, 2.8, 1.3)
20a	3.98 (d, 12.8)	3.98 (d, 12.6)	3.99 (d, 13.2)
20b	4.04 (d, 12.8)	4.04 (d, 12.6)	4.05 (d, 12.8)

Synthetic 1 according to Masayuki Inoue's previous work.
The frequency is 400 MHz for ^{1}H NMR.

Table 2. Comparison of ^{13}C NMR data of natural and synthetic Crotophorbolone (**1**) in $CDCl_3$.

No.	^{13}C (δ) natural	^{13}C (δ) Synthetic 1	^{13}C (δ) Synthetic 2 (our work)
1	157.9	157.9	158.0
2	134.8	134.8	134.9
3	209.3	209.3	209.5
4	73.4	73.4	73.6
5a	38.3	38.4	38.5
5b			
6	141.5	141.5	141.7

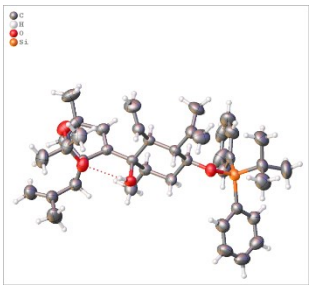
7	125.2	125.1	125.3
8	44.2	44.2	44.3
9	77[a]	77[a]	77[a]
10	58.4	58.4	58.5
11	37.7	37.7	37.9
12a	46.3	46.3	46.5
12b			
13	208.2	208.1	208.3
14	57.9	57.9	58.1
15	141.2	141.2	141.4
16a	116.5	116.6	116.7
16b			
17	19.9	19.9	20.1
18	17.8	17.8	18.0
19	10.3	10.2	10.4
20a	67.8	67.8	68.0
20b	-	-	-

Synthetic 1 according to Masayuki Inoue's previous work.

The frequency is 100 MHz for ^{13}C NMR.

[a]The chemical shift was deduced from the HMBC spectrum.

III. X-ray Crystallographic Data:

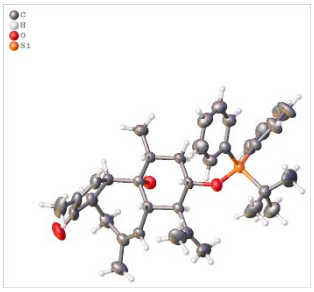


1.X-ray crystallographic data for **SI-4** (CCDC 1989322):

Table 3 Crystal data and structure refinement for **SI-4.**

Identification code	**SI-4**
Empirical formula	$C_{41}H_{56}O_4Si$
Formula weight	640.94
Temperature/K	293.15
Crystal system	orthorhombic
Space group	$P2_12_12_1$
a/Å	11.4985(3)
b/Å	13.7129(5)
c/Å	24.4365(7)
α/°	90
β/°	90
γ/°	90
Volume/Å^3	3853.1(2)
Z	4
ρ_{calc}g/cm^3	1.105
μ/mm^{-1}	0.098
F(000)	1392.0
Crystal size/mm^3	0.35 × 0.3 × 0.25
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	5.942 to 52.742
Index ranges	-11 ≤ h ≤ 14, -17 ≤ k ≤ 10, -29 ≤ l ≤ 30
Reflections collected	11916
Independent reflections	7151 [R_{int} = 0.0236, R_{sigma} = 0.0641]
Data/restraints/parameters	7151/0/441
Goodness-of-fit on F^2	0.961

Final R indexes [I>=2σ (I)]	R_1 = 0.0484, wR_2 = 0.0855
Final R indexes [all data]	R_1 = 0.0839, wR_2 = 0.0967
Largest diff. peak/hole / e Å^{-3}	0.17/-0.20



2. X-ray crystallographic data for compound **25** (CCDC 1989323):

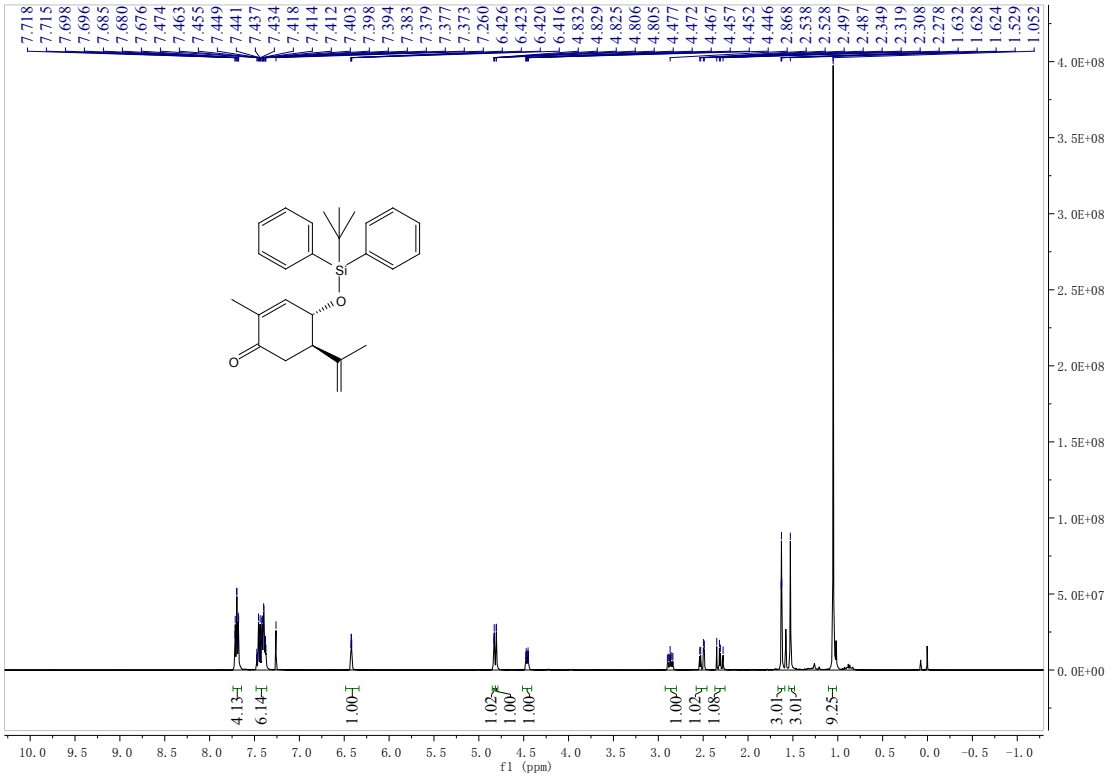
Table 4 Crystal data and structure refinement for **25**.

Identification code	**25**
Empirical formula	$C_{36}H_{47}O_3Si$
Formula weight	555.82
Temperature/K	293.15
Crystal system	orthorhombic
Space group	$P2_12_12_1$
a/Å	10.7809(7)
b/Å	12.9537(10)
c/Å	23.2649(18)
α/°	90
β/°	90
γ/°	90
Volume/Å^3	3249.0(4)
Z	4
ρ_{calc}g/cm^3	1.136
μ/mm^{-1}	0.105
F(000)	1204.0
Crystal size/mm^3	0.35 × 0.3 × 0.25
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	6.036 to 52.744
Index ranges	-10 ≤ h ≤ 13, -16 ≤ k ≤ 9, -29 ≤ l ≤ 27
Reflections collected	10558
Independent reflections	6350 [R_{int} = 0.0599, R_{sigma} = 0.0920]
Data/restraints/parameters	6350/0/370

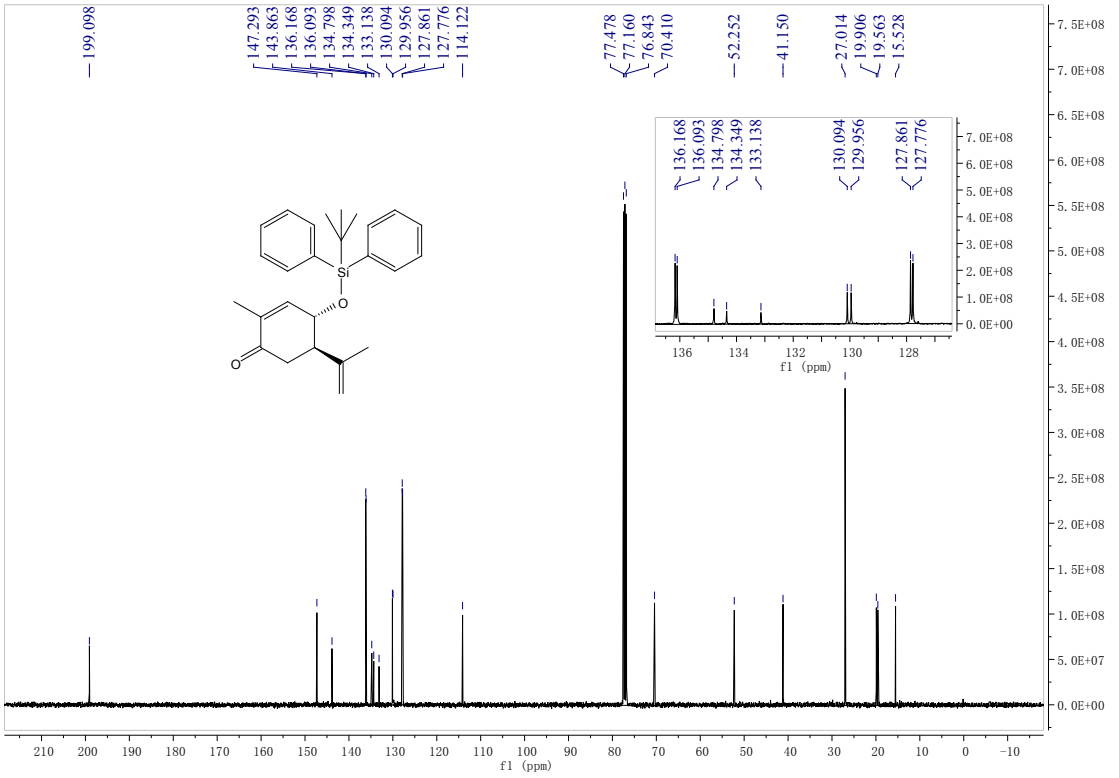
Goodness-of-fit on F^2	1.016
Final R indexes [I>=2σ (I)]	R_1 = 0.0681, wR_2 = 0.1419
Final R indexes [all data]	R_1 = 0.0929, wR_2 = 0.1623
Largest diff. peak/hole / e Å^{-3}	0.43/-0.24

IV. NMR Spectra：

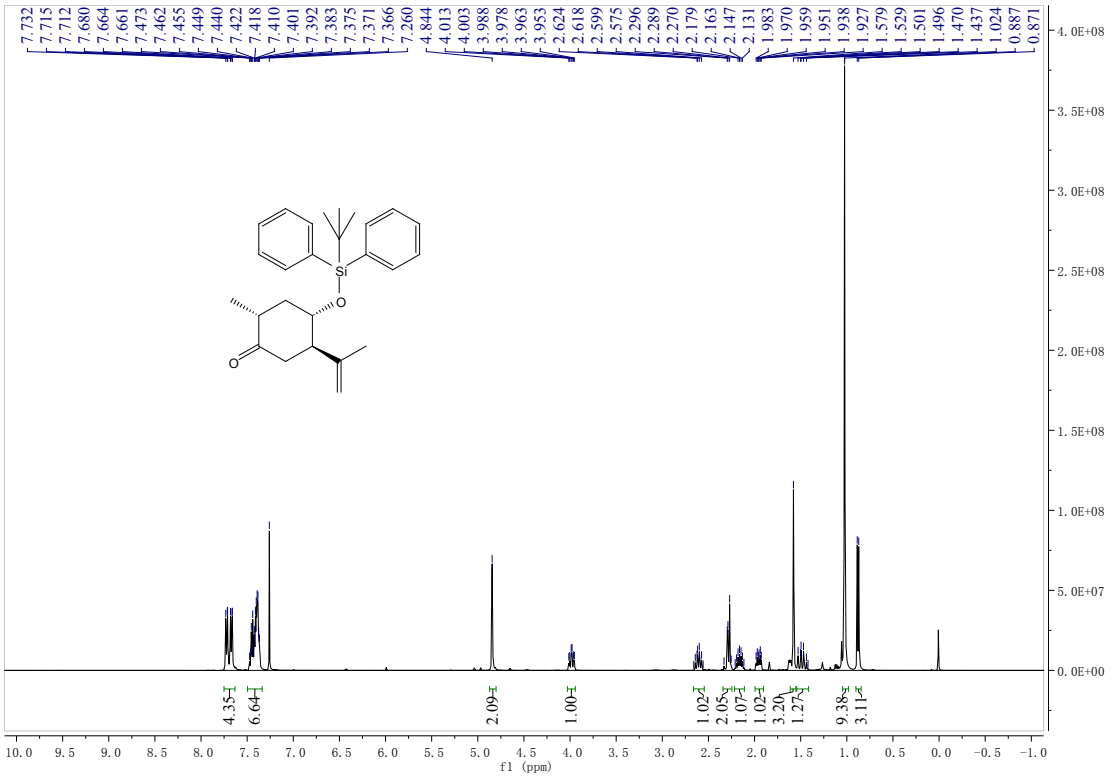
^{1}H NMR spectrum of **SI-1** (400 MHz, $CDCl_3$):



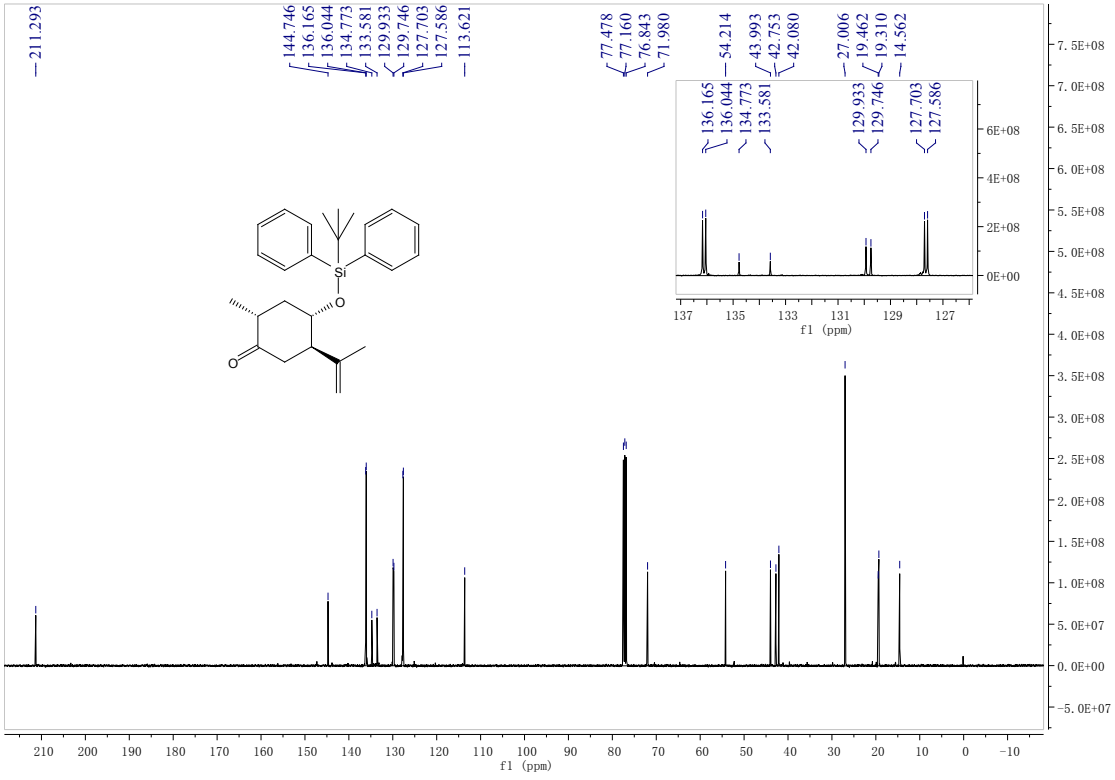
^{13}C NMR spectrum of **SI-1** (100 MHz, $CDCl_3$):



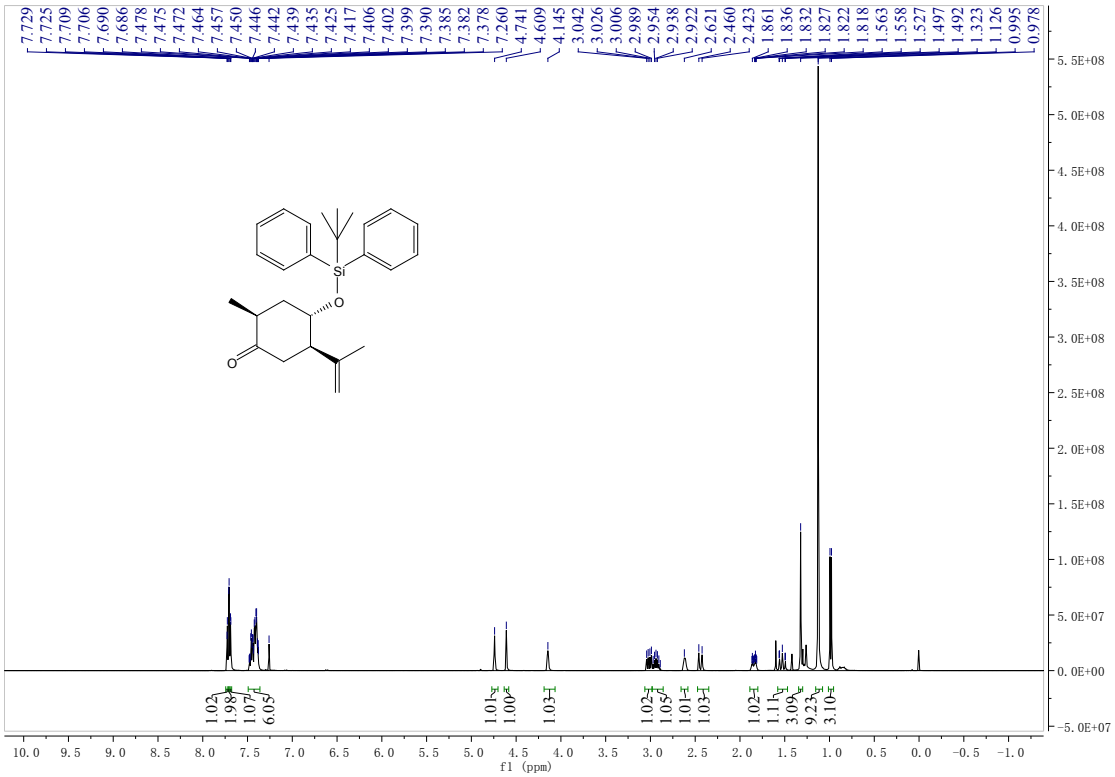
^{1}H NMR spectrum of **10** (400 MHz, $CDCl_3$):



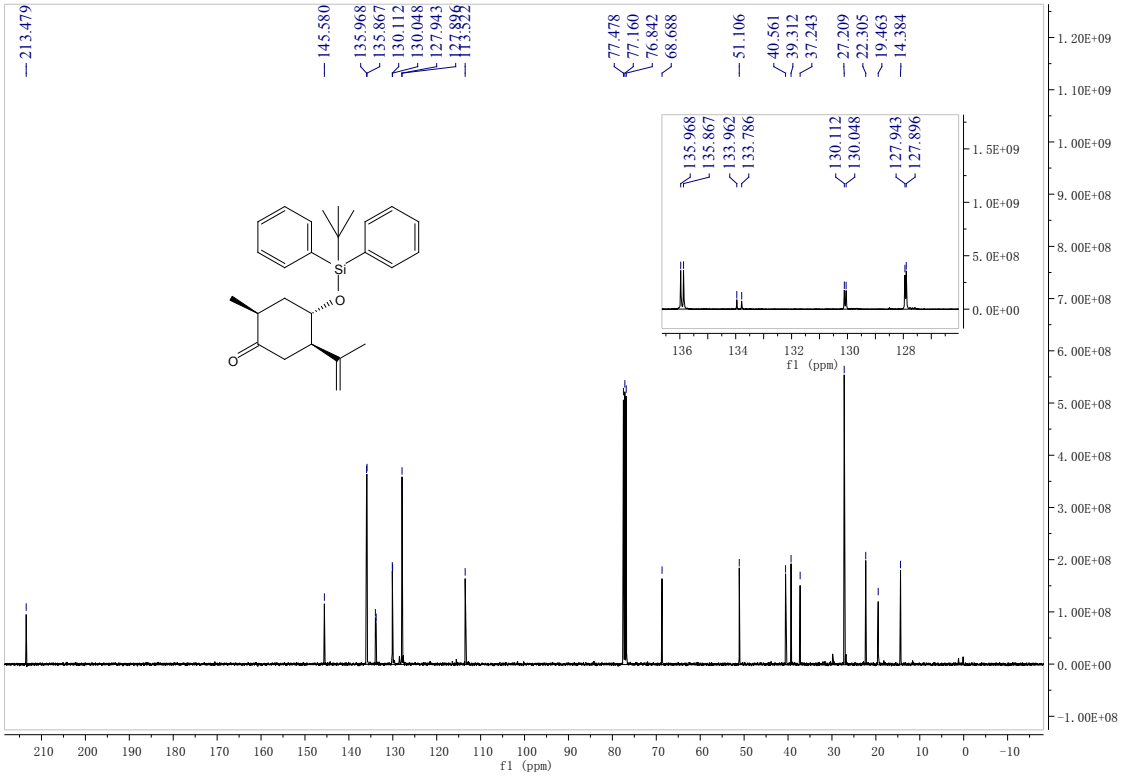
^{13}C NMR spectrum of **10** (100 MHz, $CDCl_3$):



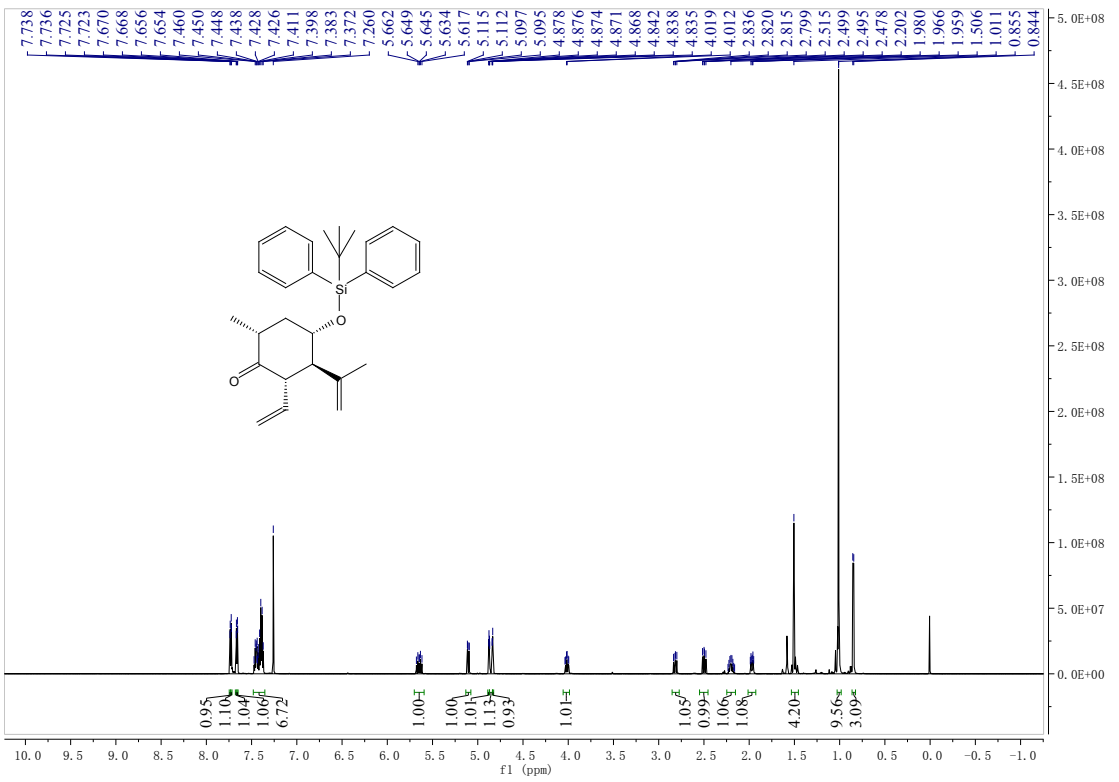
^{1}H NMR spectrum of **SI-2** (400 MHz, $CDCl_3$):



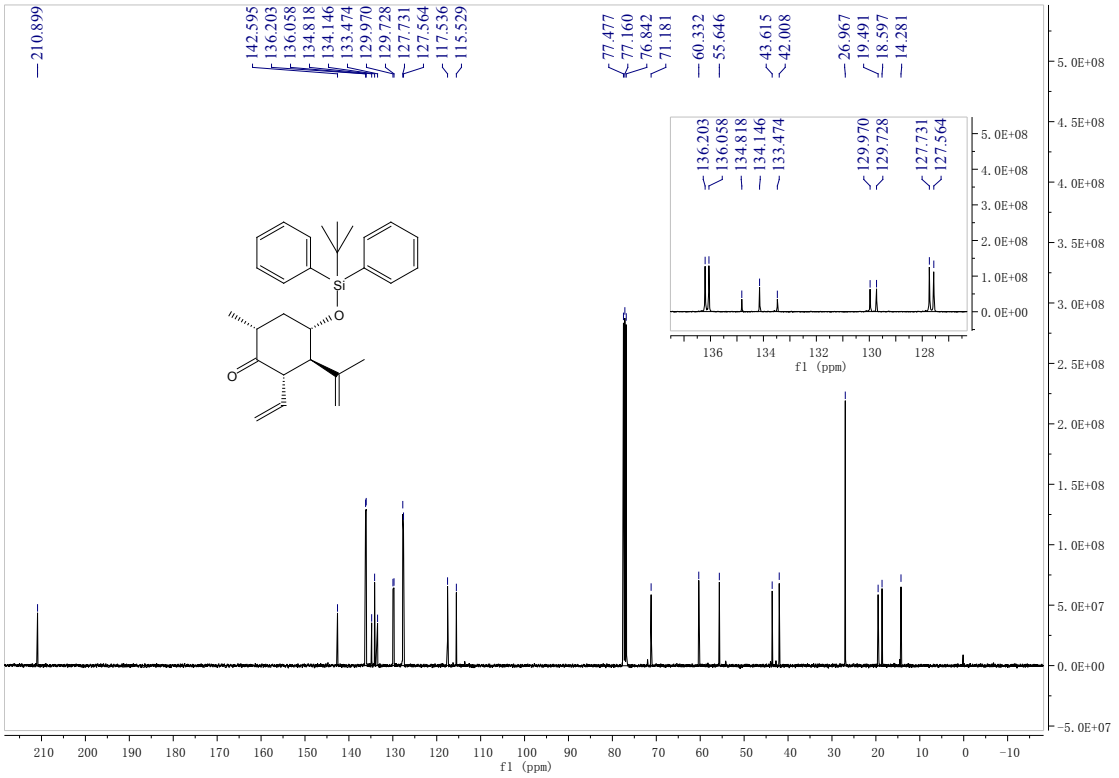
^{13}C NMR spectrum of **SI-2** (100 MHz, $CDCl_3$):



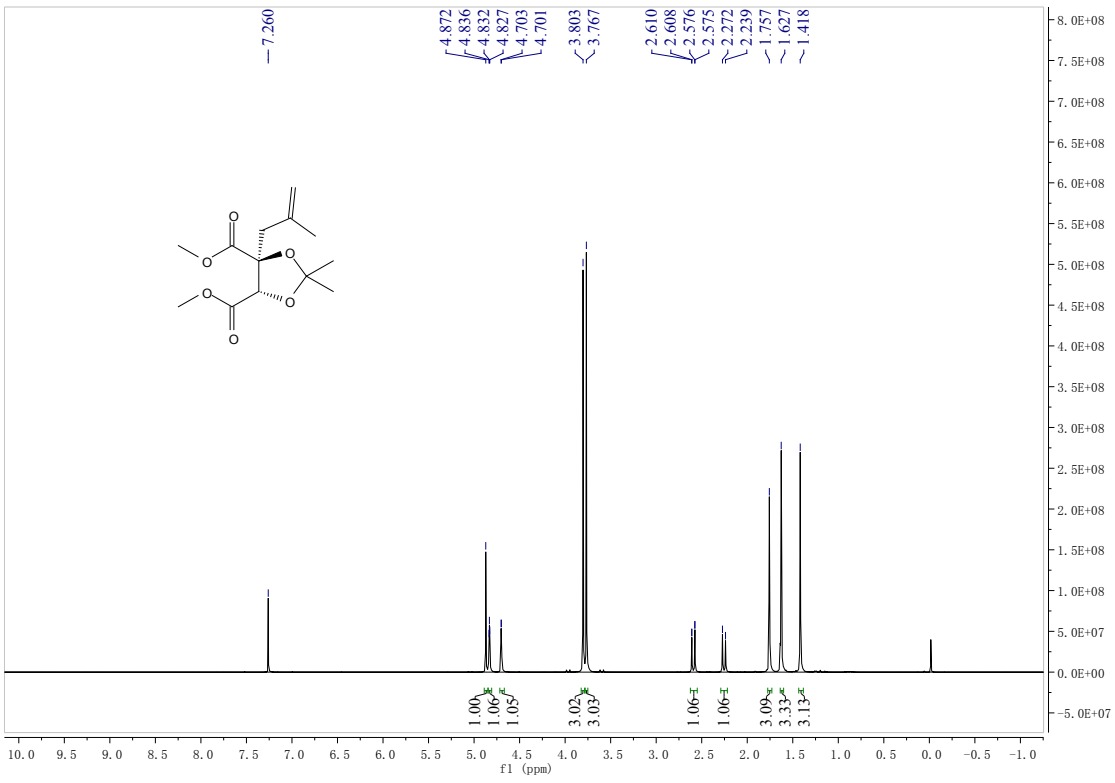
^{1}H NMR spectrum of **12** (400 MHz, $CDCl_3$):



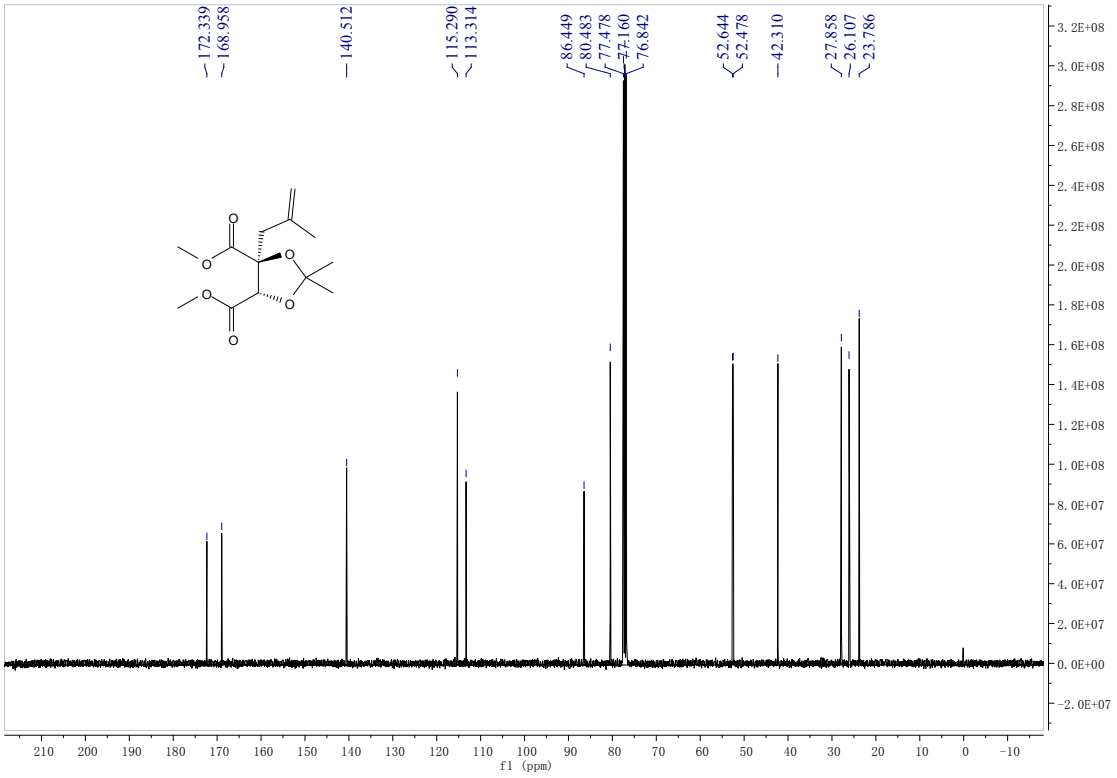
^{13}C NMR spectrum of **12** (100 MHz, $CDCl_3$):



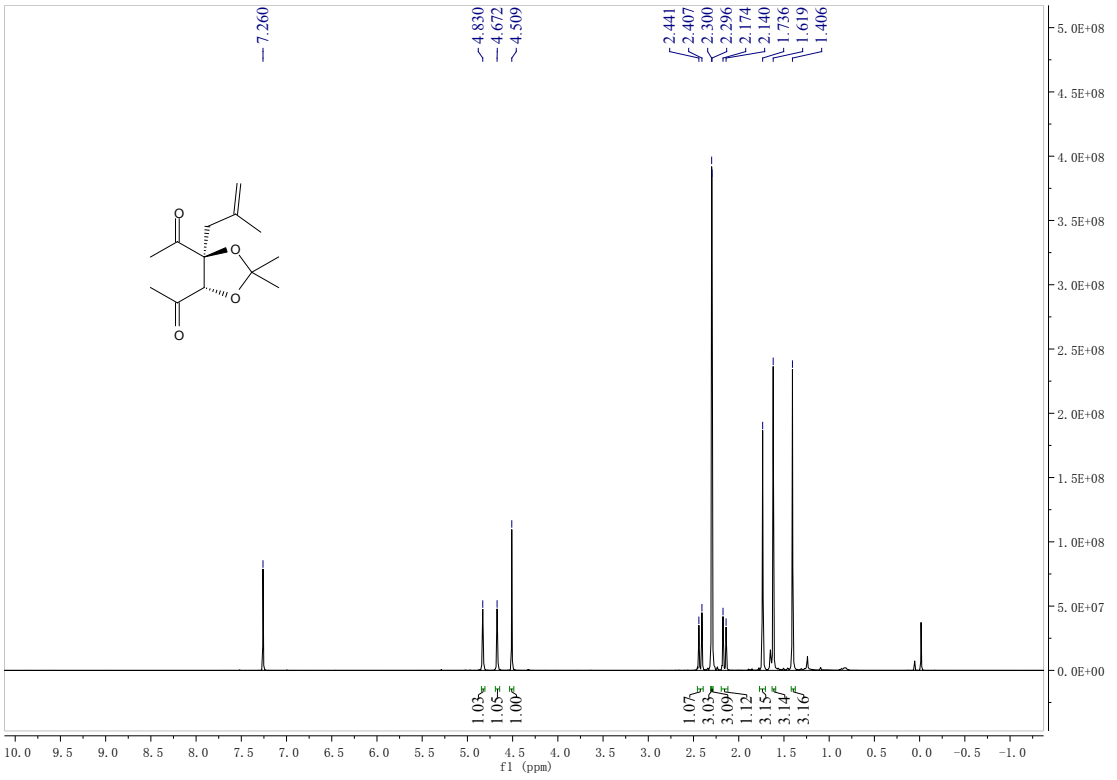
^{1}H NMR spectrum of **13** (400 MHz, $CDCl_3$):



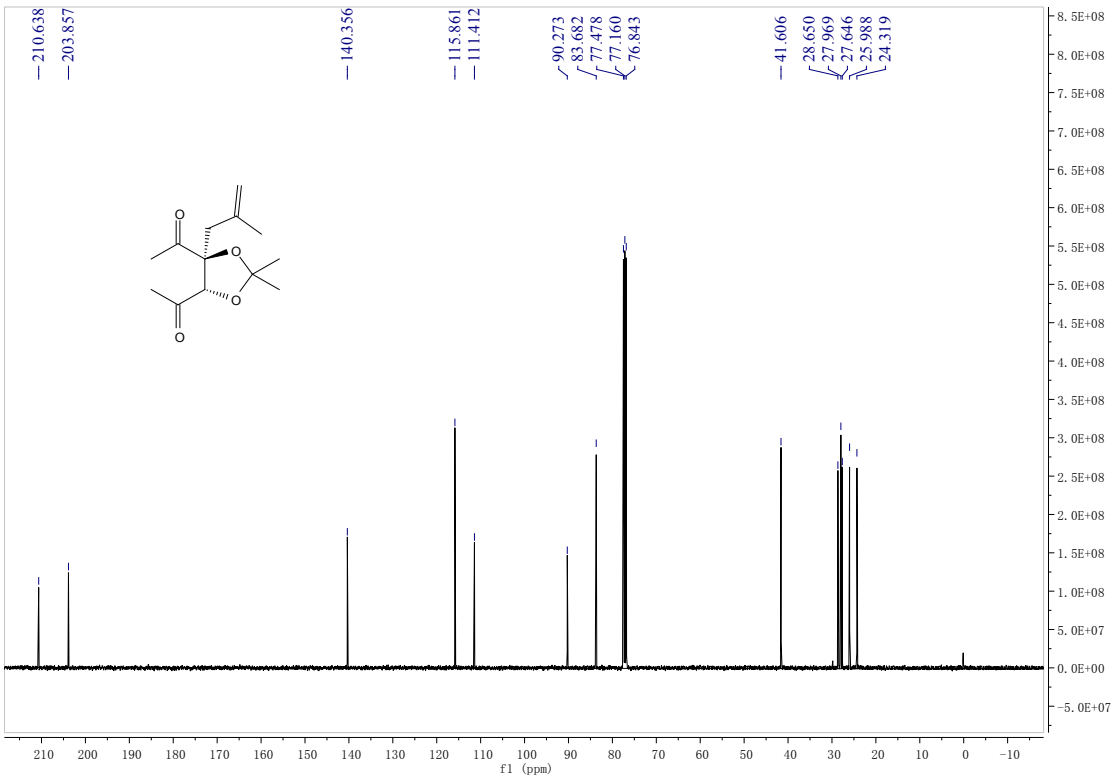
^{13}C NMR spectrum of **13** (100 MHz, $CDCl_3$):



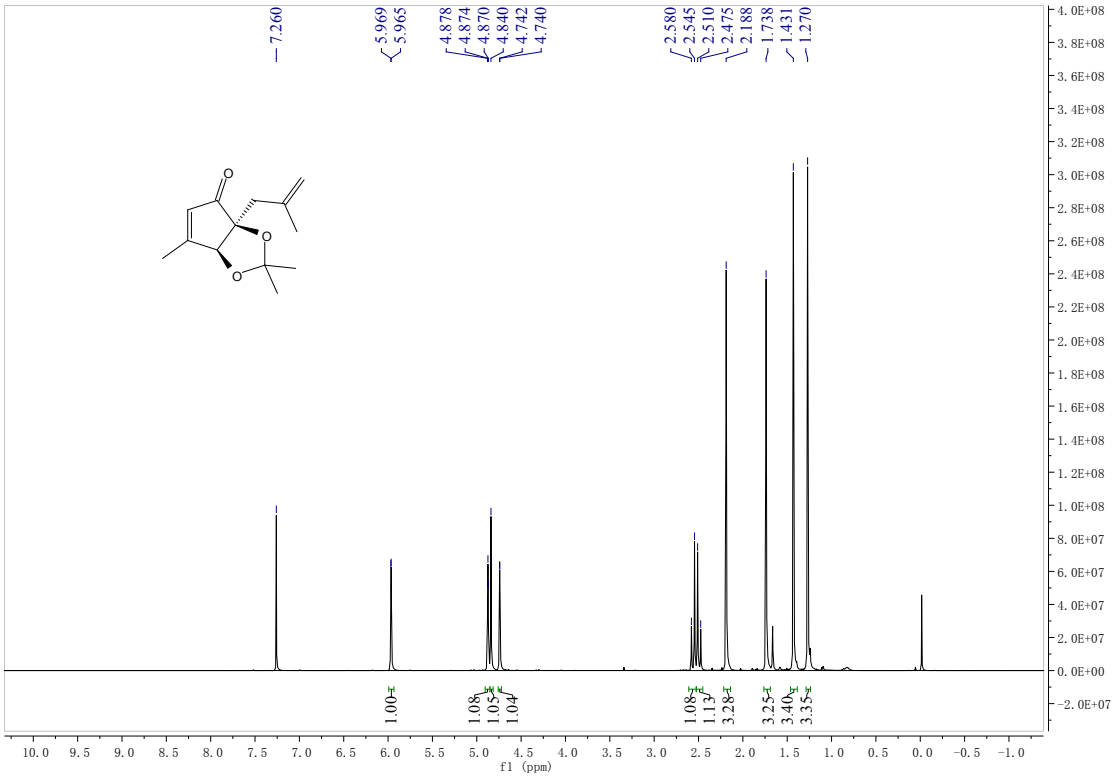
^{1}H NMR spectrum of **14** (400 MHz, $CDCl_3$):



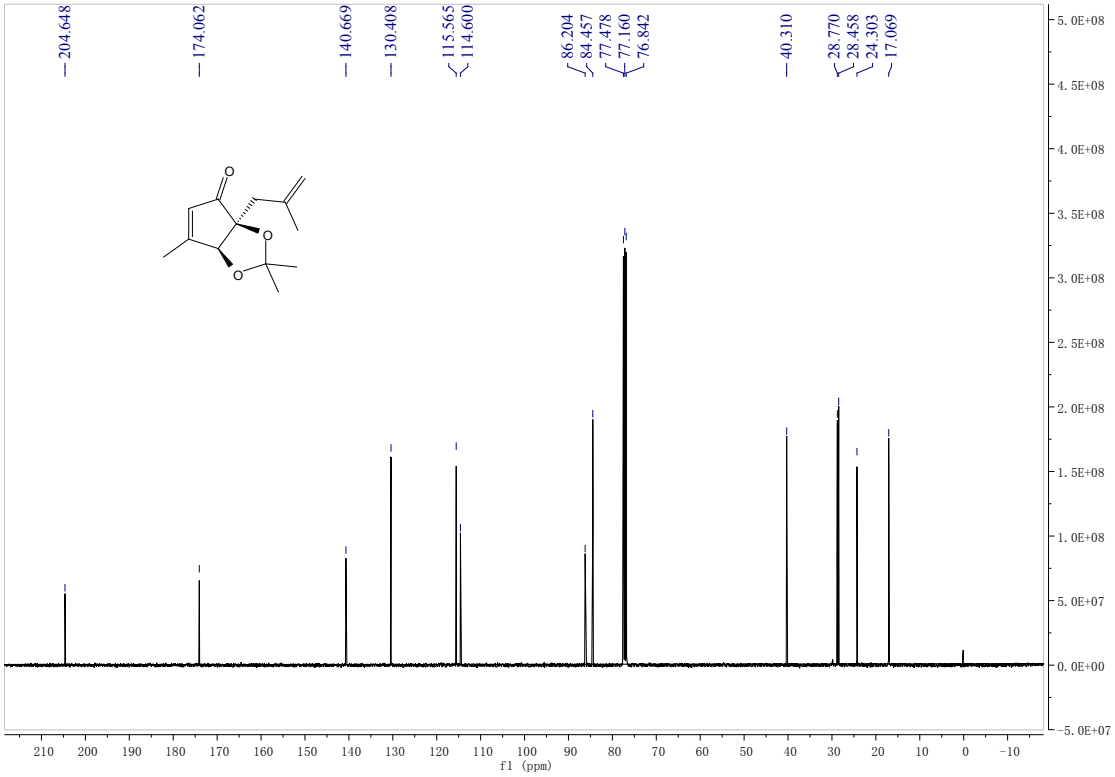
^{13}C NMR spectrum of **14** (100 MHz, $CDCl_3$):



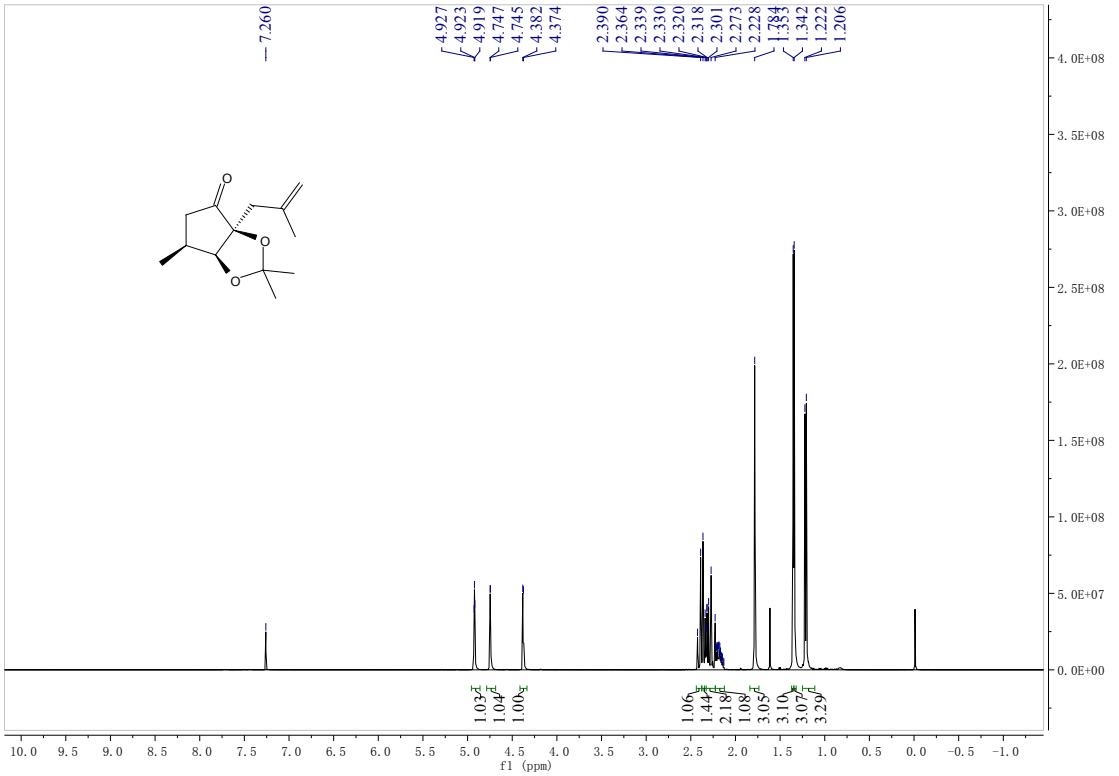
^{1}H NMR spectrum of **16** (400 MHz, $CDCl_3$):



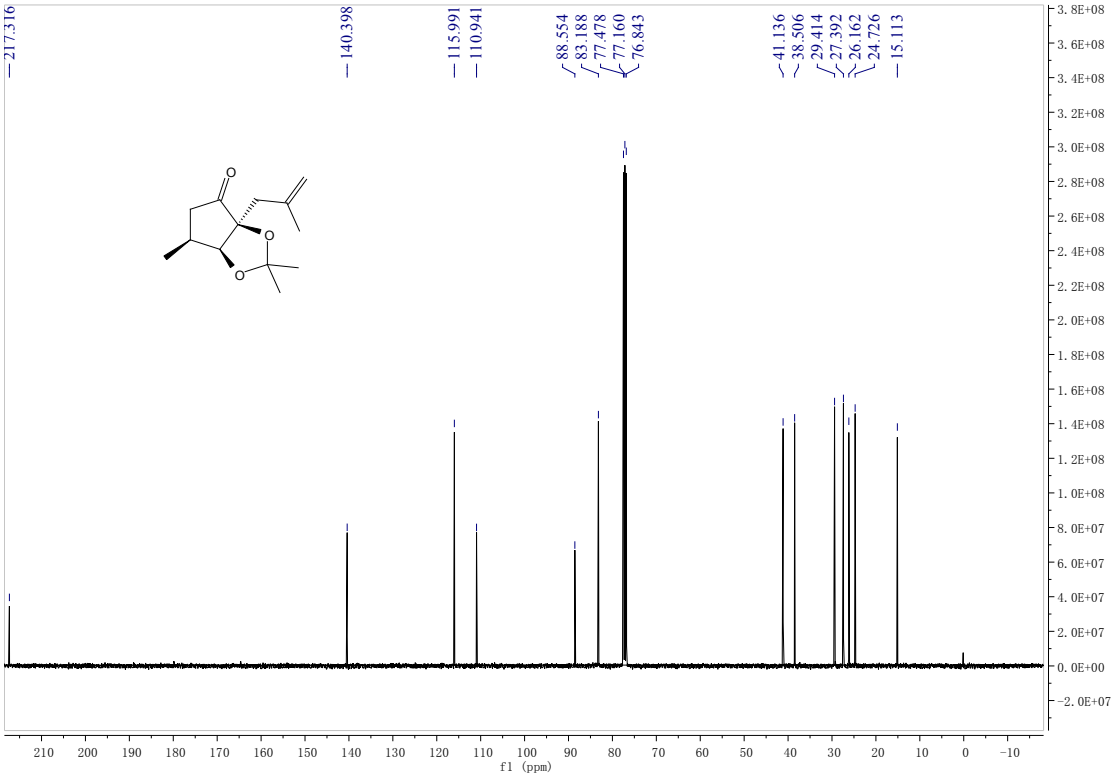
^{13}C NMR spectrum of **16** (100 MHz, $CDCl_3$):



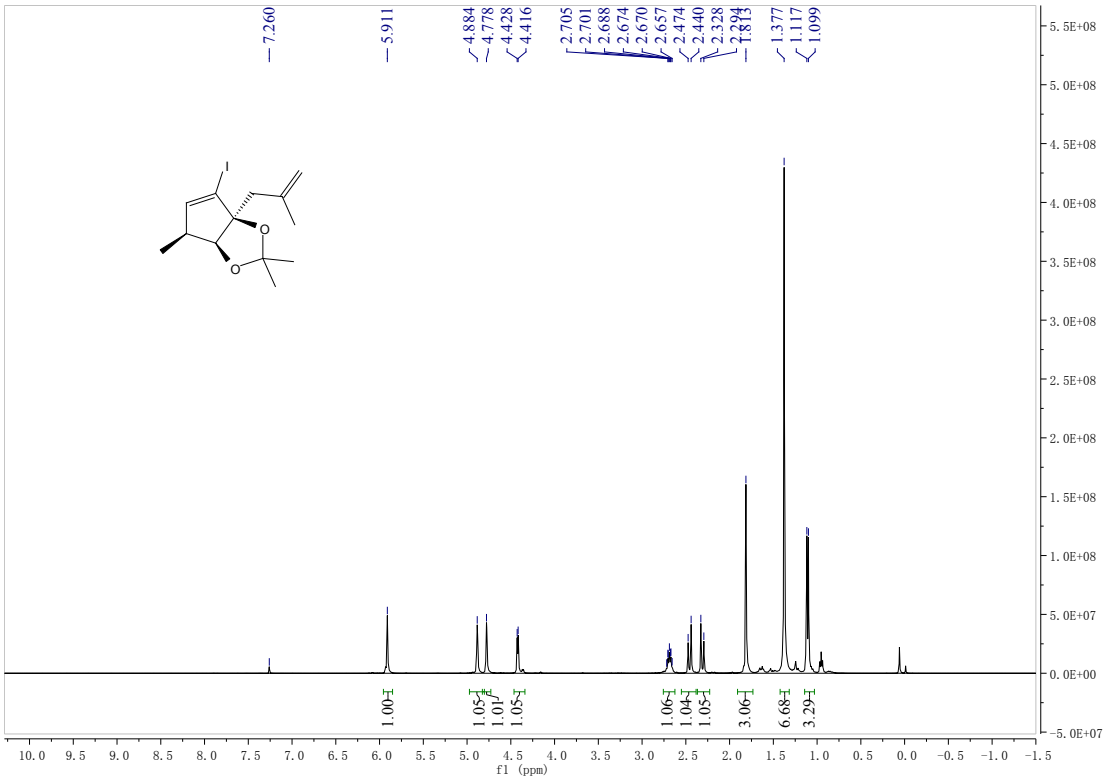
^{1}H NMR spectrum of **SI-3** (400 MHz, $CDCl_3$):



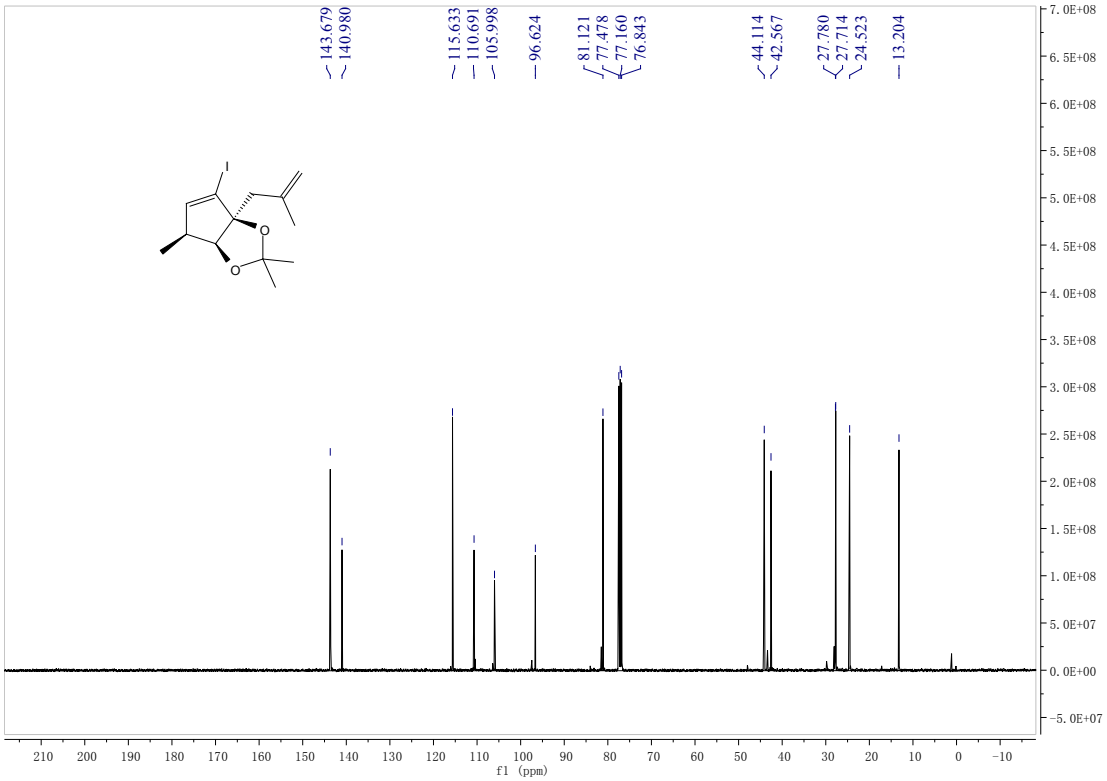
^{13}C NMR spectrum of **SI-3** (100 MHz, $CDCl_3$):



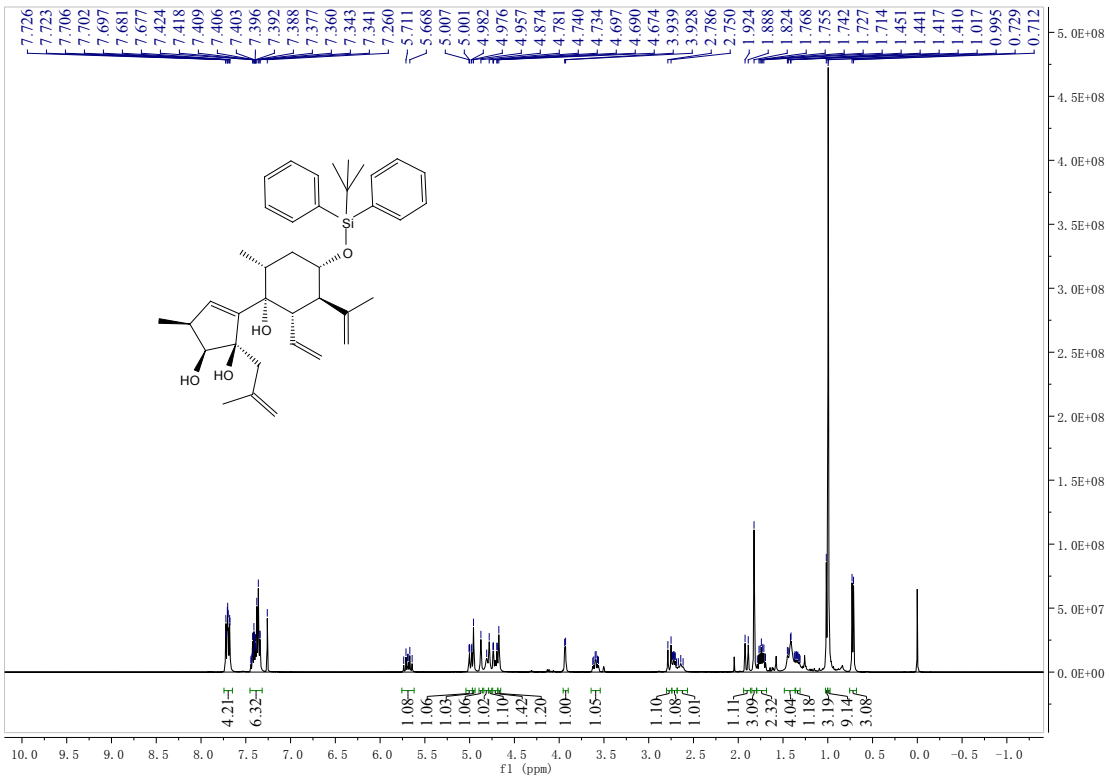
^{1}H NMR spectrum of **17** (400 MHz, $CDCl_3$):



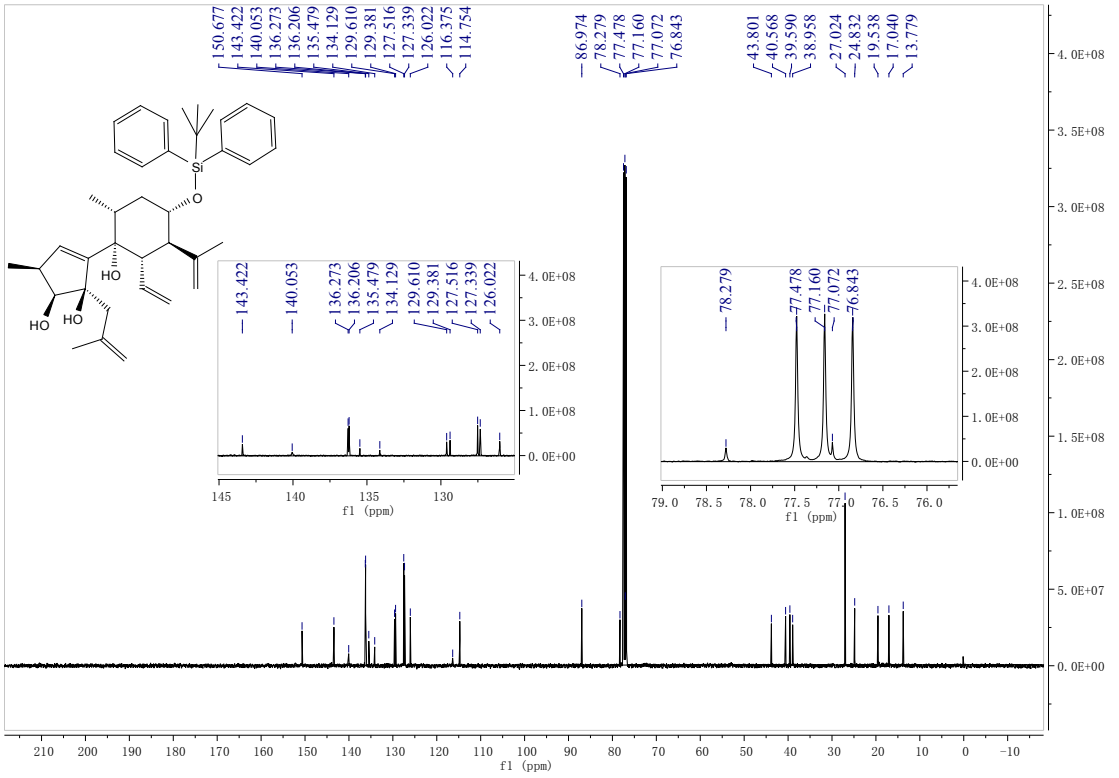
^{13}C NMR spectrum of **17** (100 MHz, $CDCl_3$):



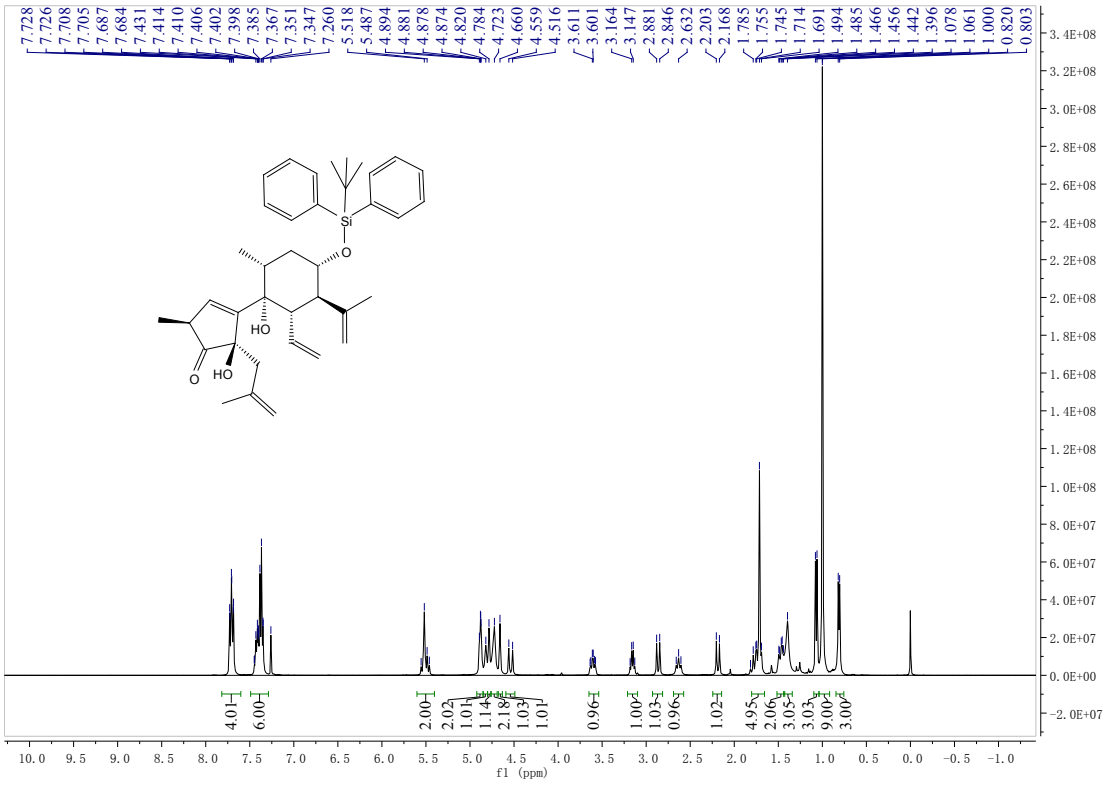
^{1}H NMR spectrum of **18** (400 MHz, $CDCl_3$):



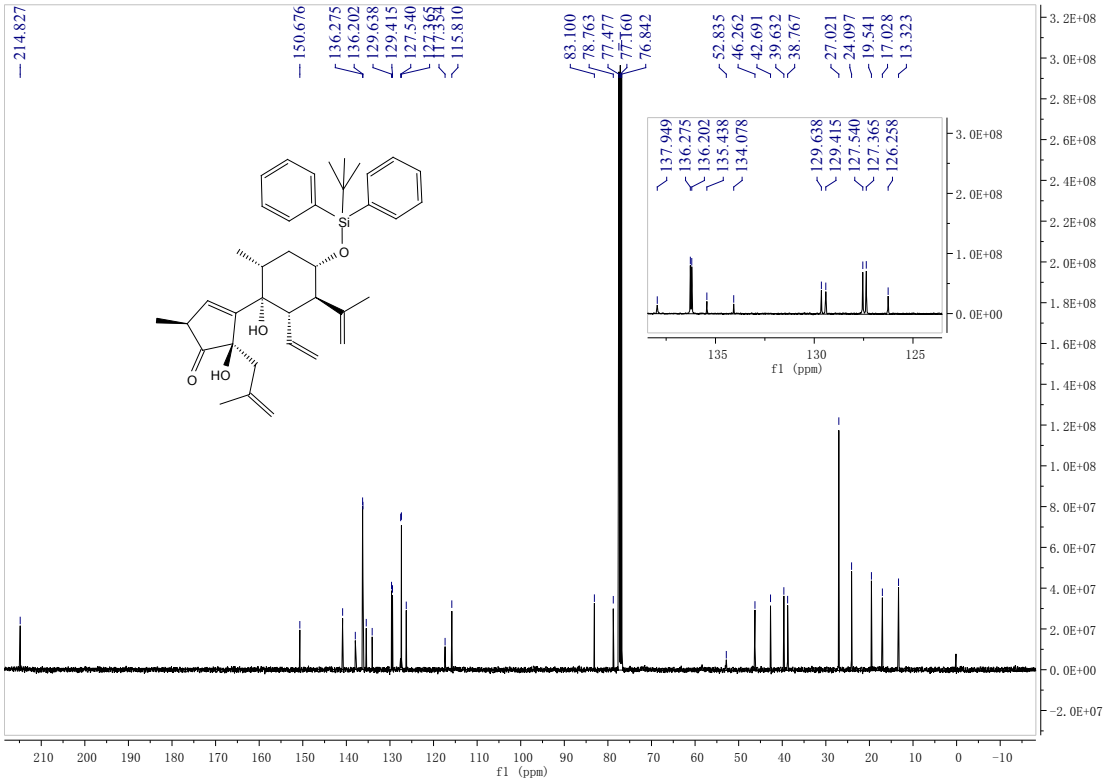
^{13}C NMR spectrum of **18** (100 MHz, $CDCl_3$):



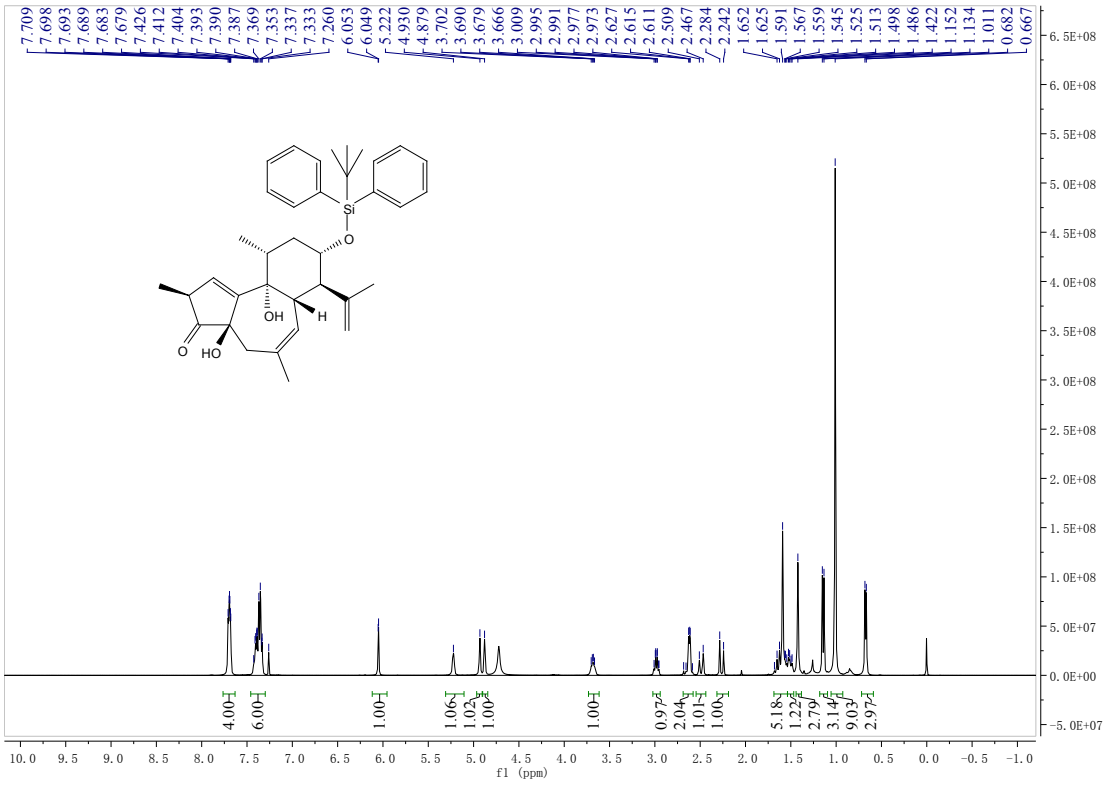
^{1}H NMR spectrum of **SI-5** (400 MHz, $CDCl_3$):



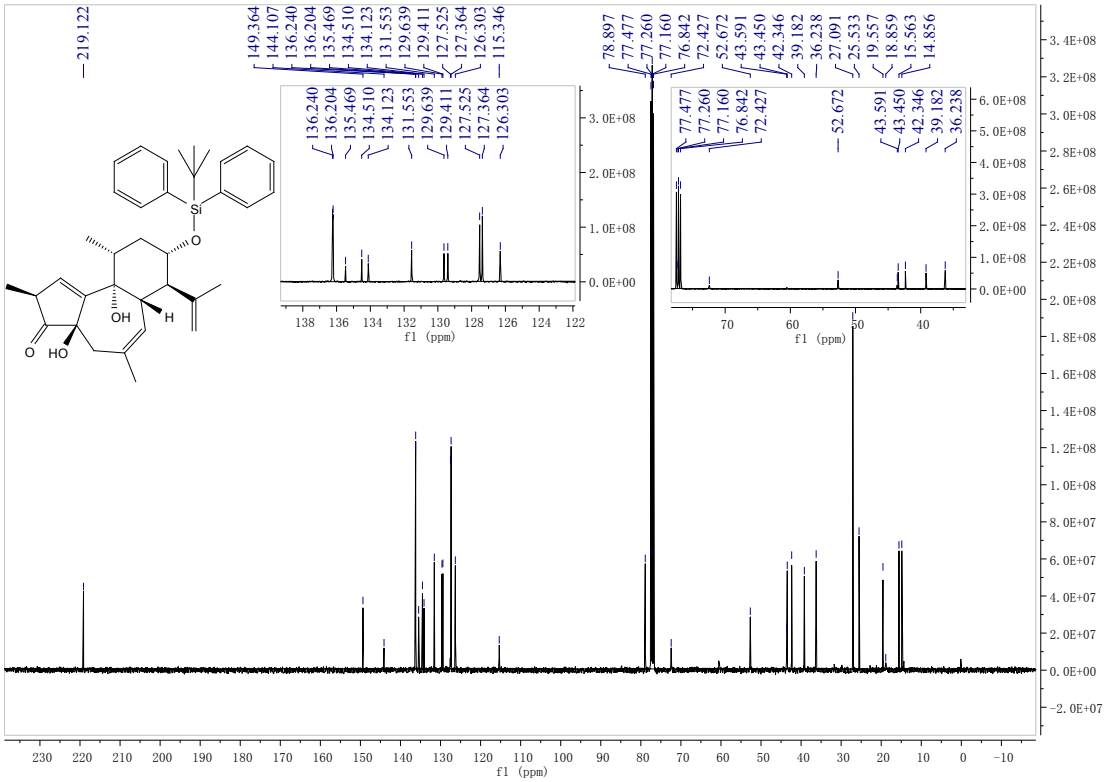
^{13}C NMR spectrum of **SI-5** (100 MHz, $CDCl_3$):



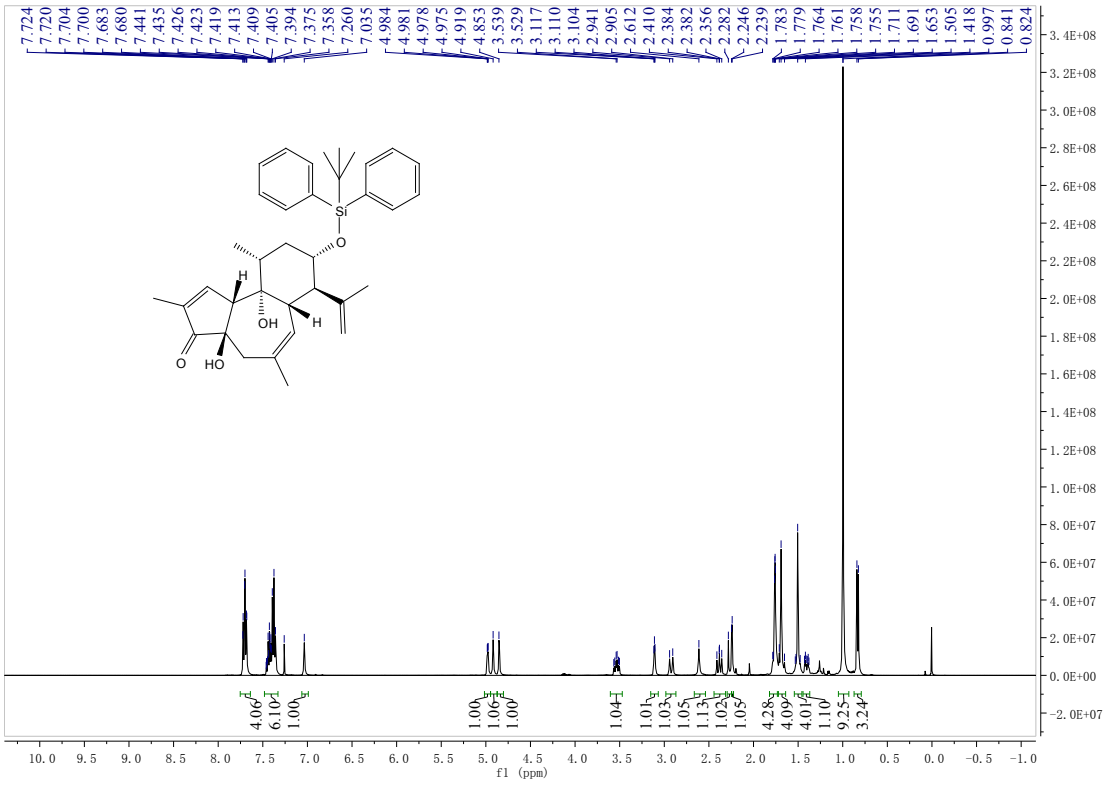
^{1}H NMR spectrum of **20** (400 MHz, $CDCl_3$):



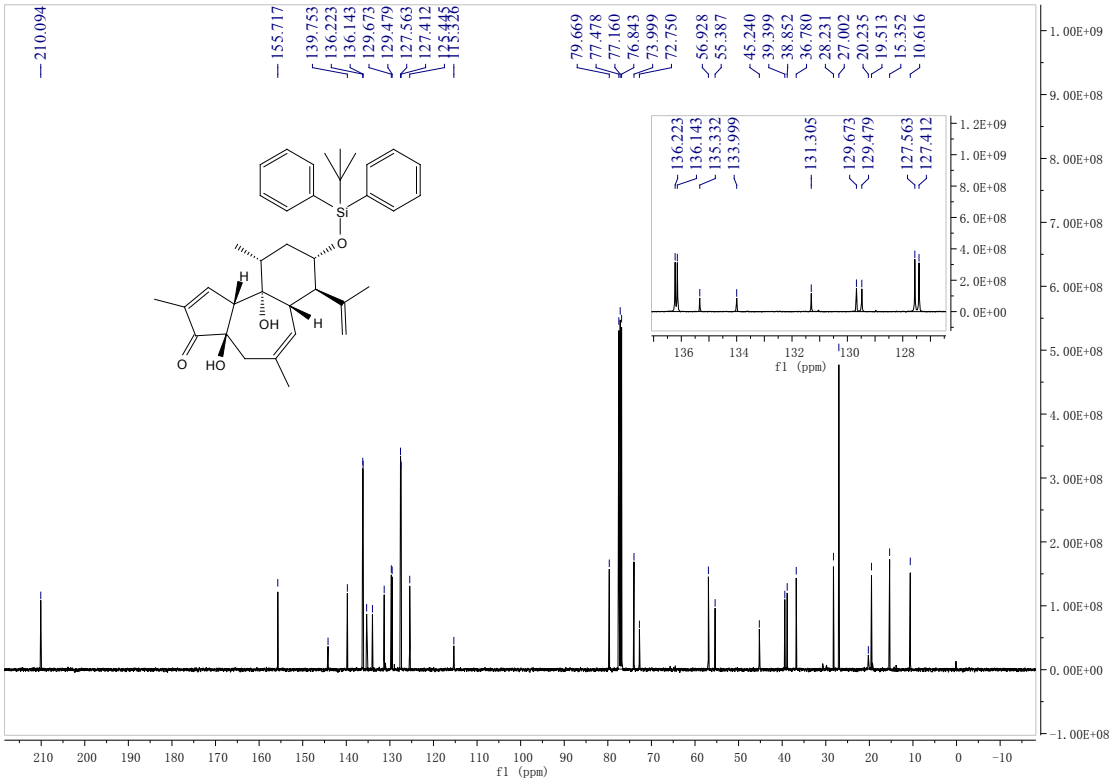
^{13}C NMR spectrum of **20** (100 MHz, $CDCl_3$):



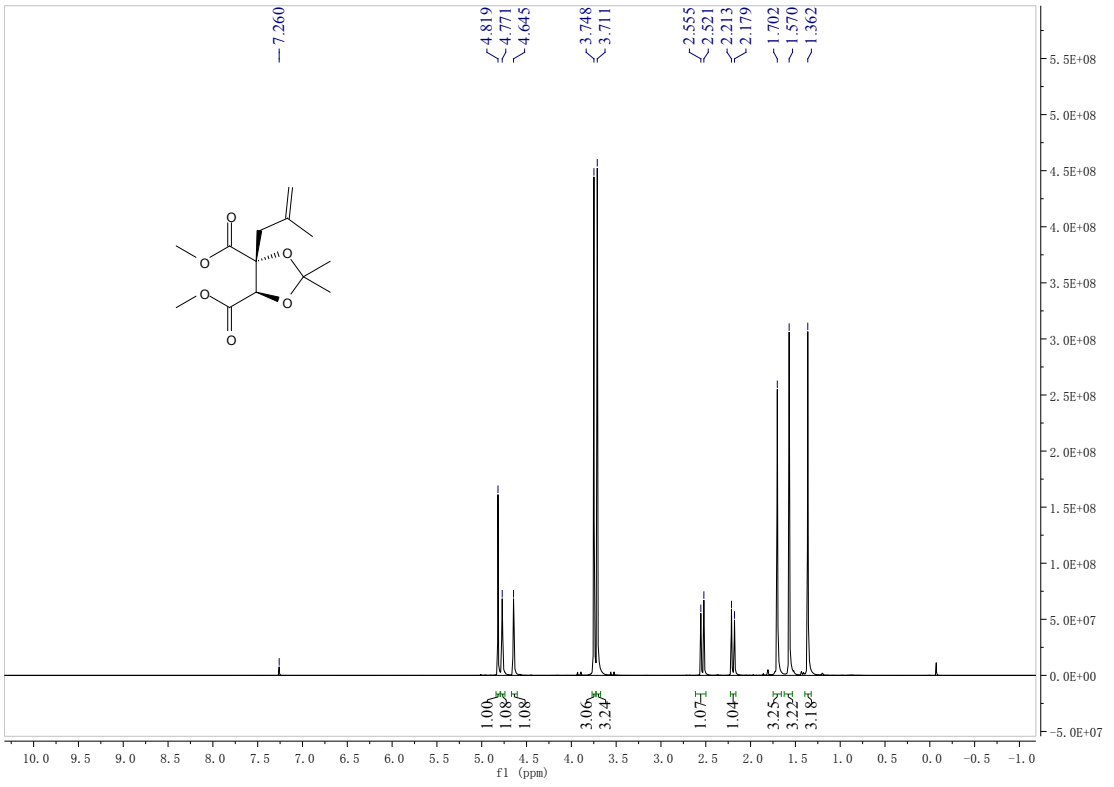
^{1}H NMR spectrum of **21** (400 MHz, $CDCl_3$):



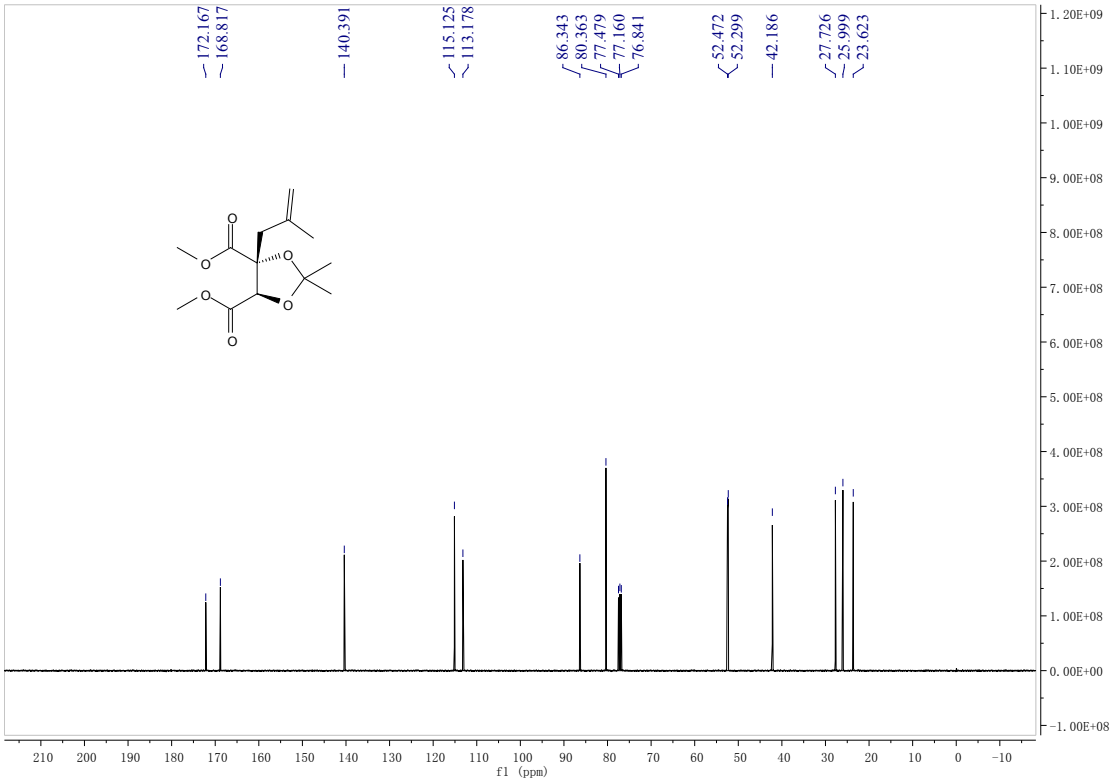
^{13}C NMR spectrum of **21** (100 MHz, $CDCl_3$):



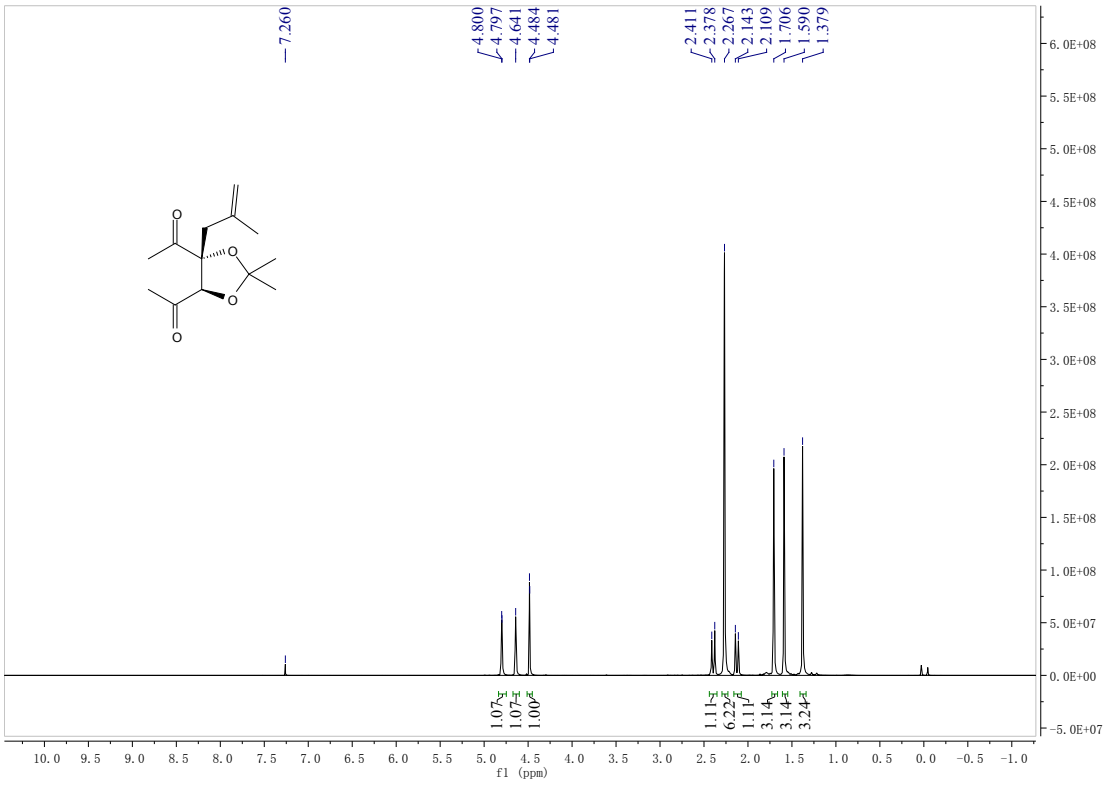
^{1}H NMR spectrum of *ent*-**13** (400 MHz, $CDCl_3$):



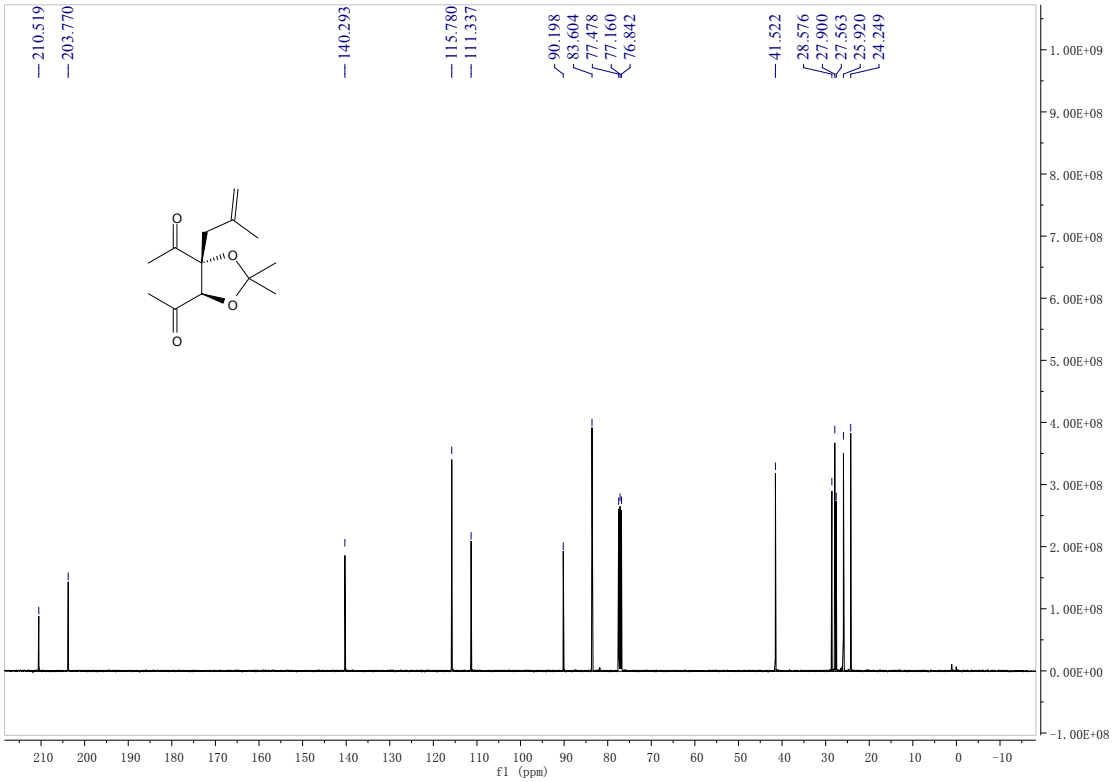
^{13}C NMR spectrum of *ent*-**13** (100 MHz, $CDCl_3$):



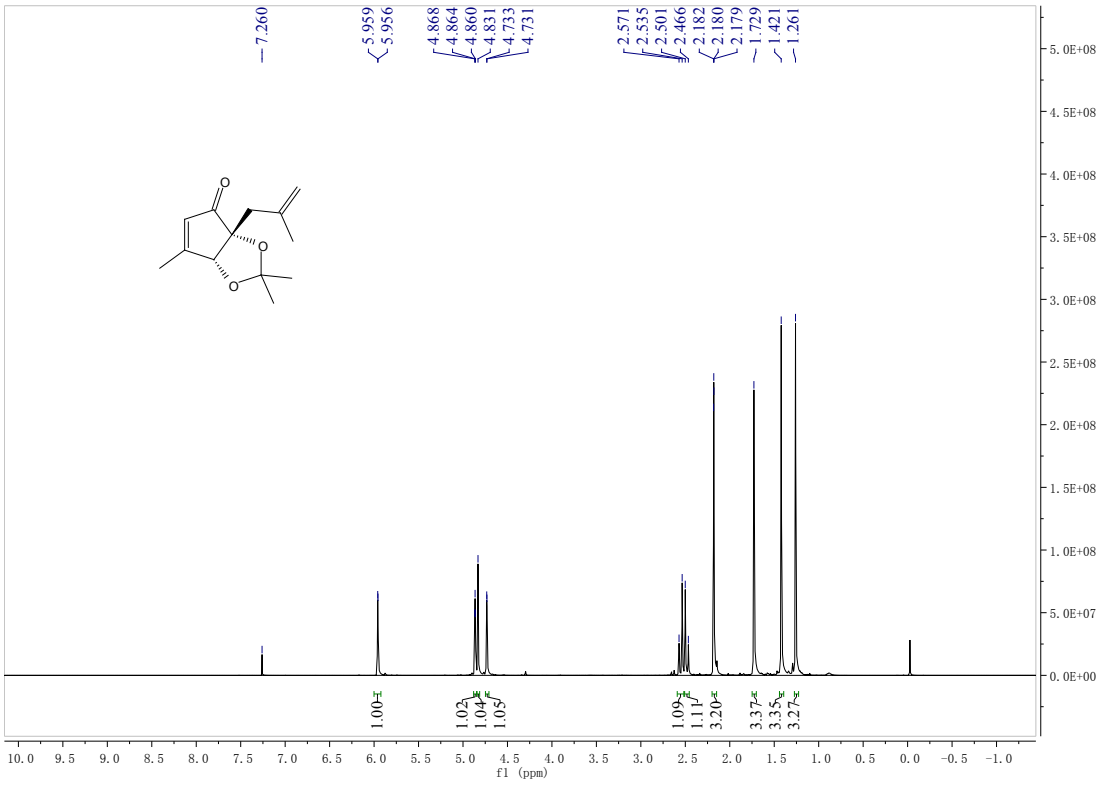
^{1}H NMR spectrum of *ent*-**14** (400 MHz, $CDCl_3$):



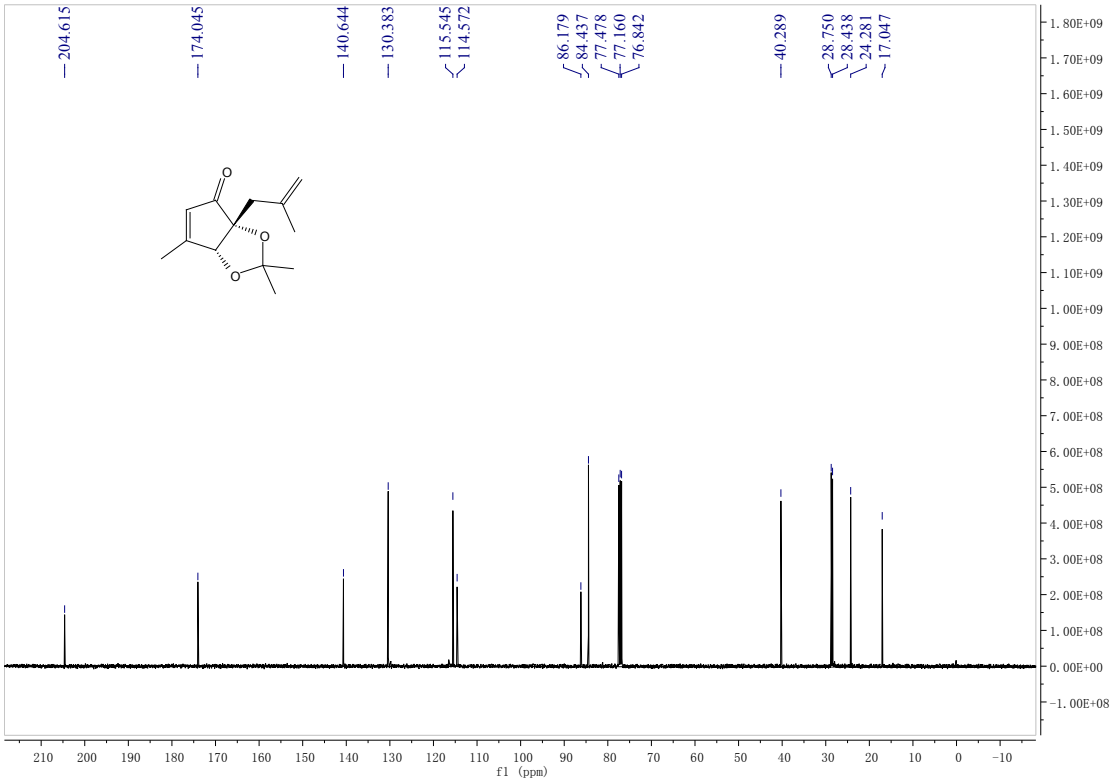
^{13}C NMR spectrum of *ent*-**14** (100 MHz, $CDCl_3$):



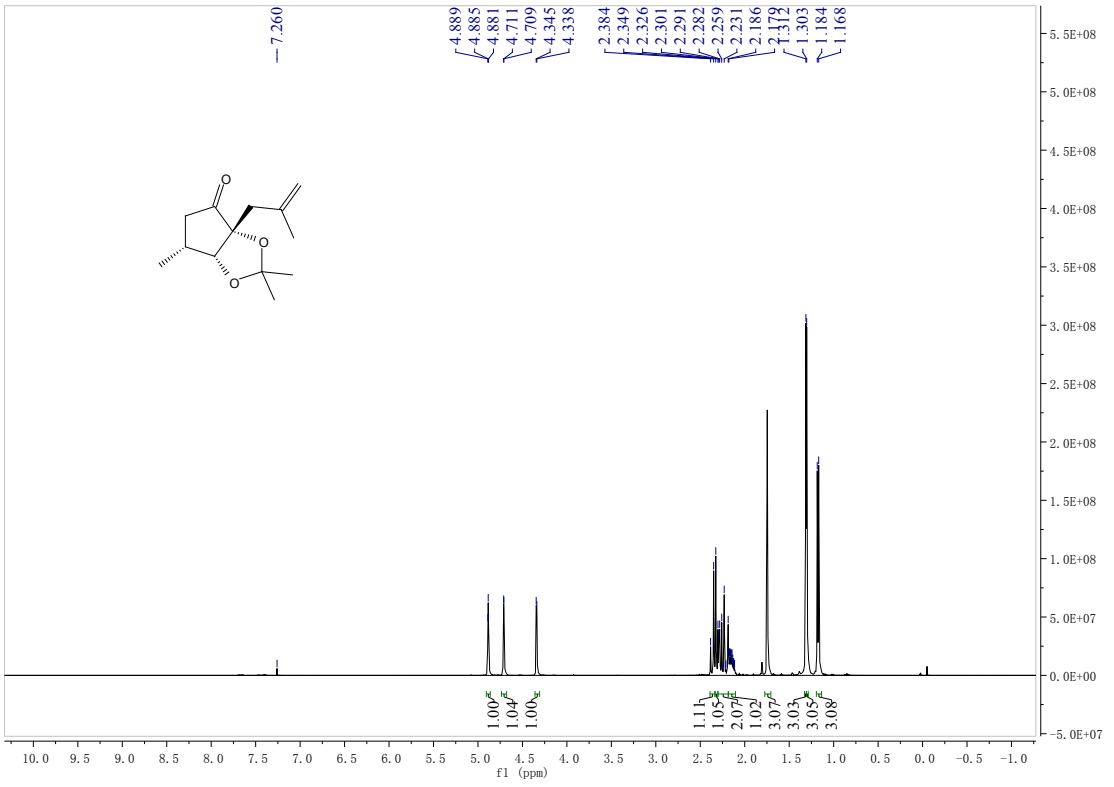
^{1}H NMR spectrum of *ent*-**16** (400 MHz, $CDCl_3$):



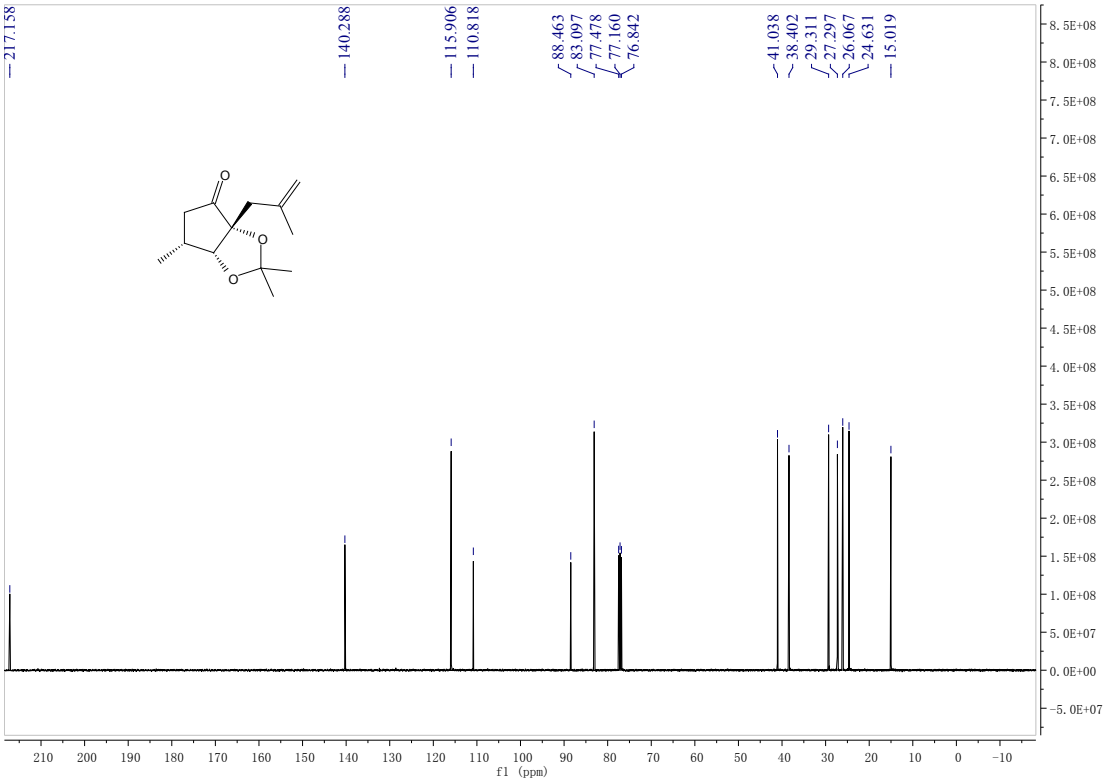
^{13}C NMR spectrum of *ent*-**16** (100 MHz, $CDCl_3$):



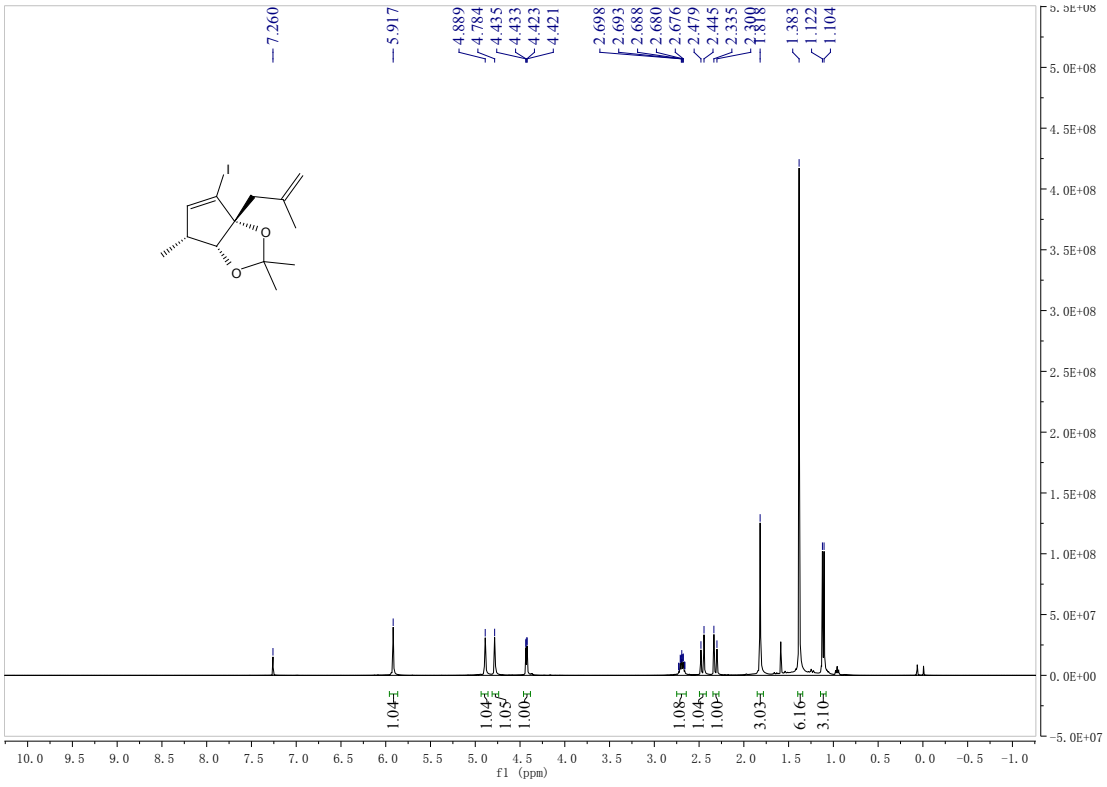
^{1}H NMR spectrum of *ent*-**SI-3** (400 MHz, $CDCl_3$):



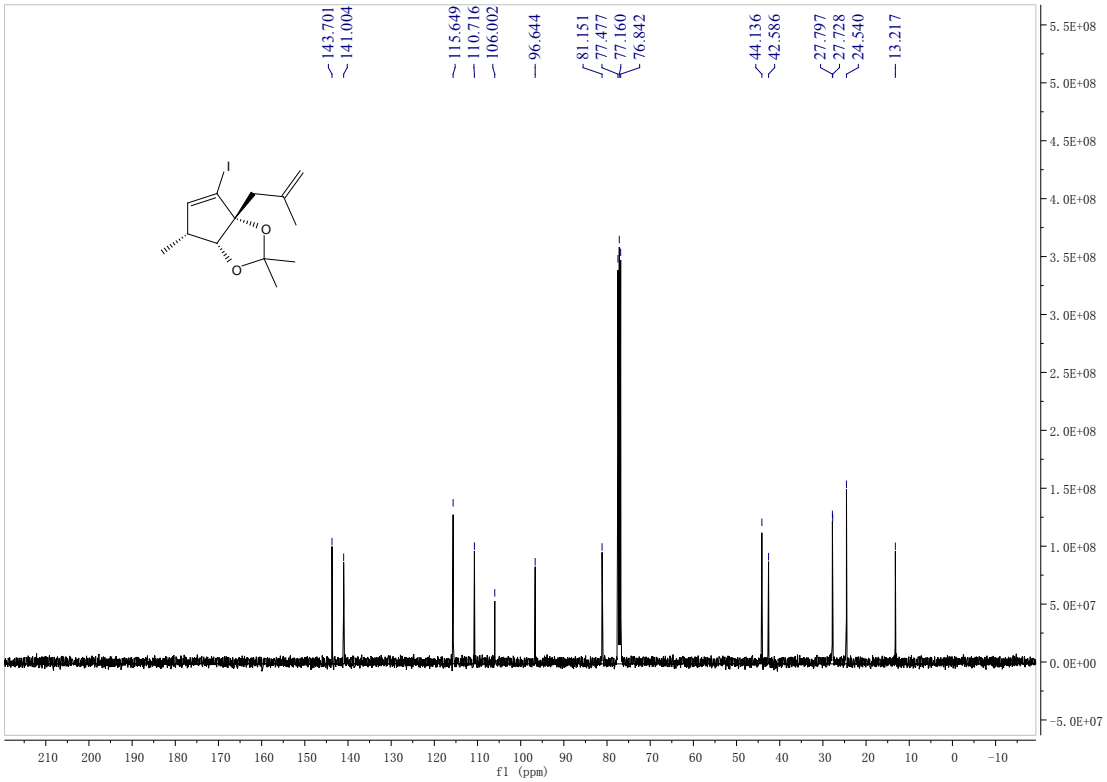
^{13}C NMR spectrum of *ent*-**SI-3** (100 MHz, $CDCl_3$):



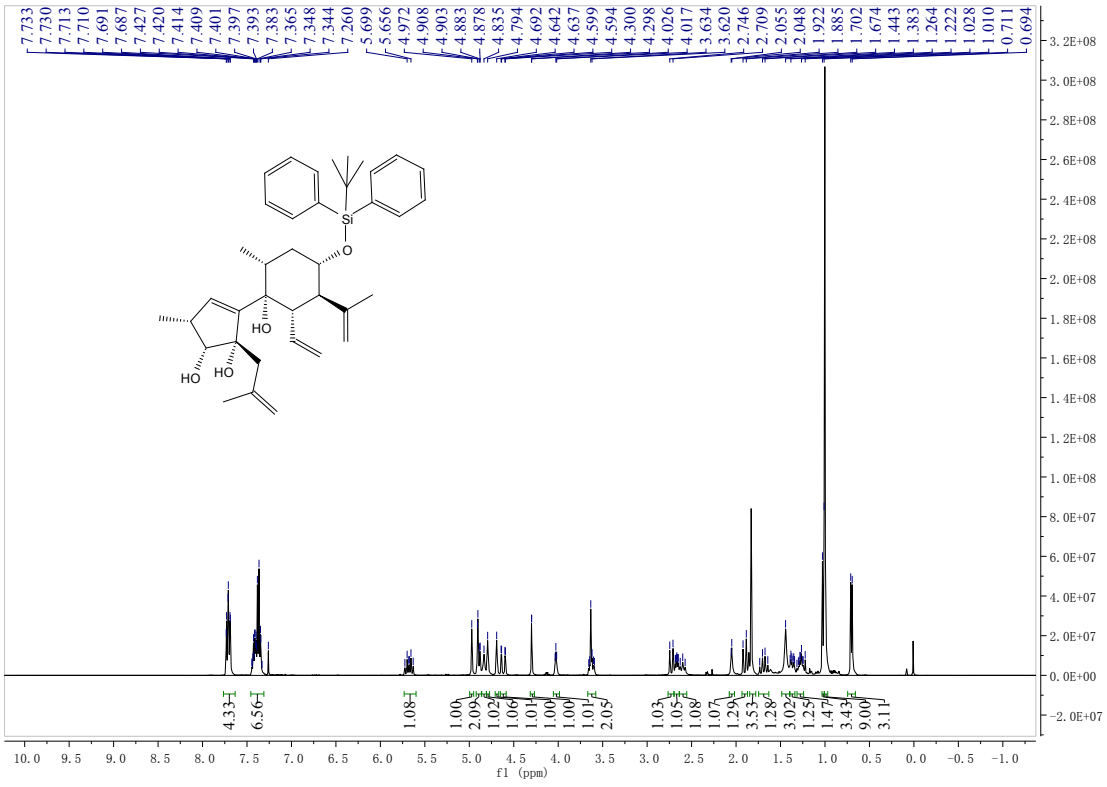
^{1}H NMR spectrum of *ent*-**17** (400 MHz, $CDCl_3$):



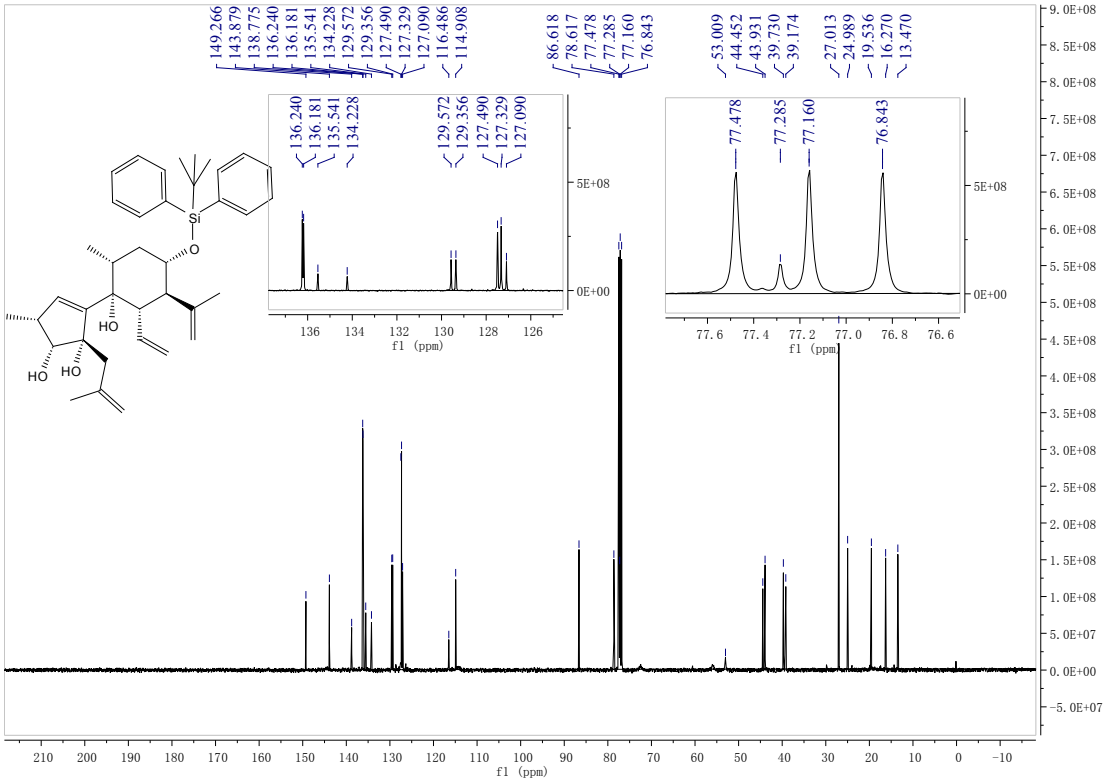
^{13}C NMR spectrum of *ent*-**17** (100 MHz, $CDCl_3$):



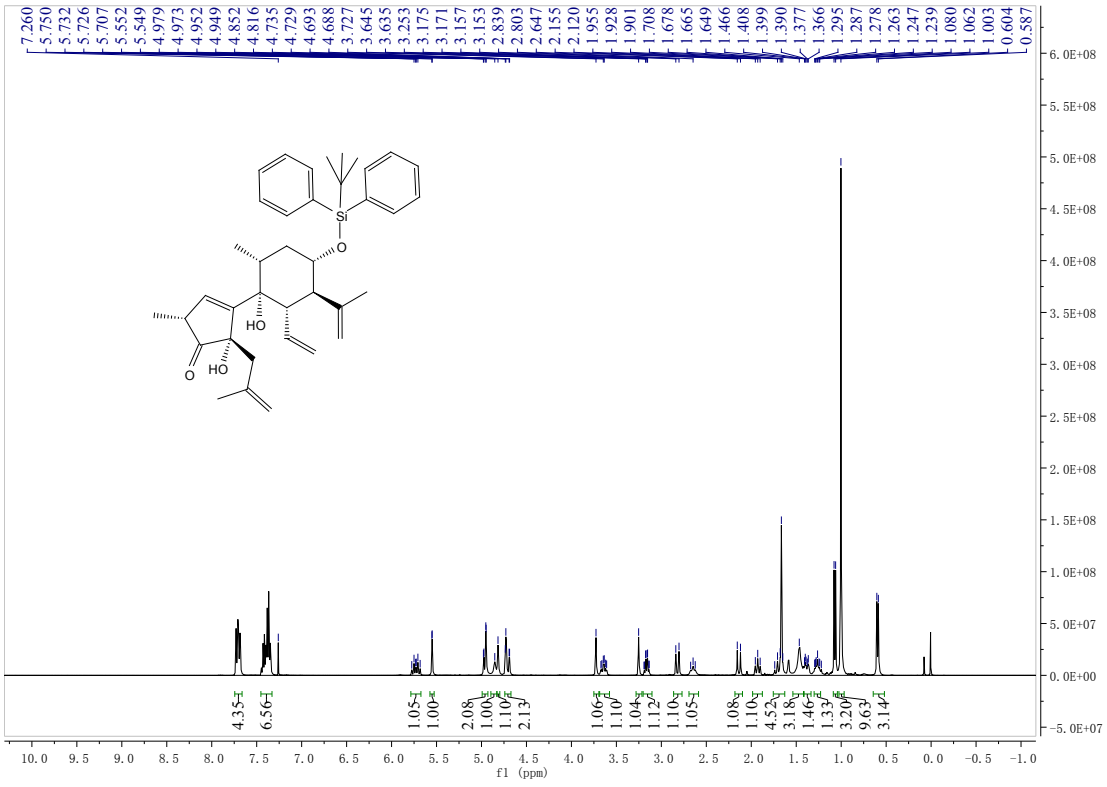
^{1}H NMR spectrum of **22** (400 MHz, $CDCl_3$):



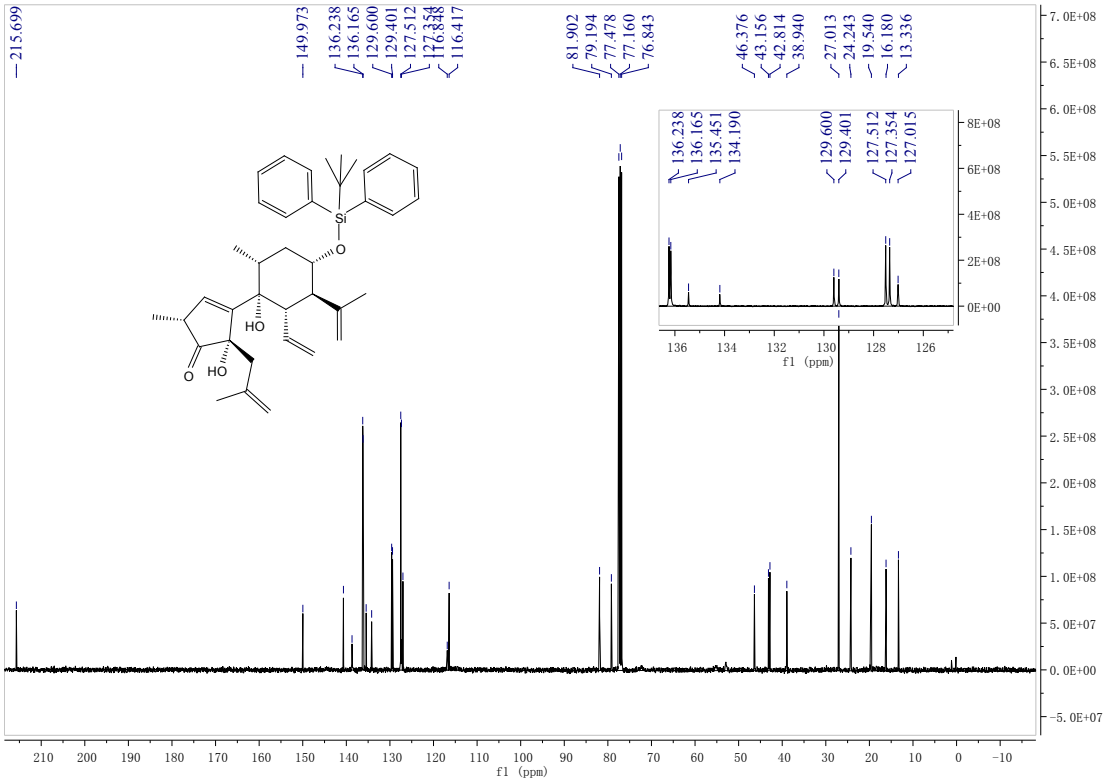
^{13}C NMR spectrum of **22** (100 MHz, $CDCl_3$):



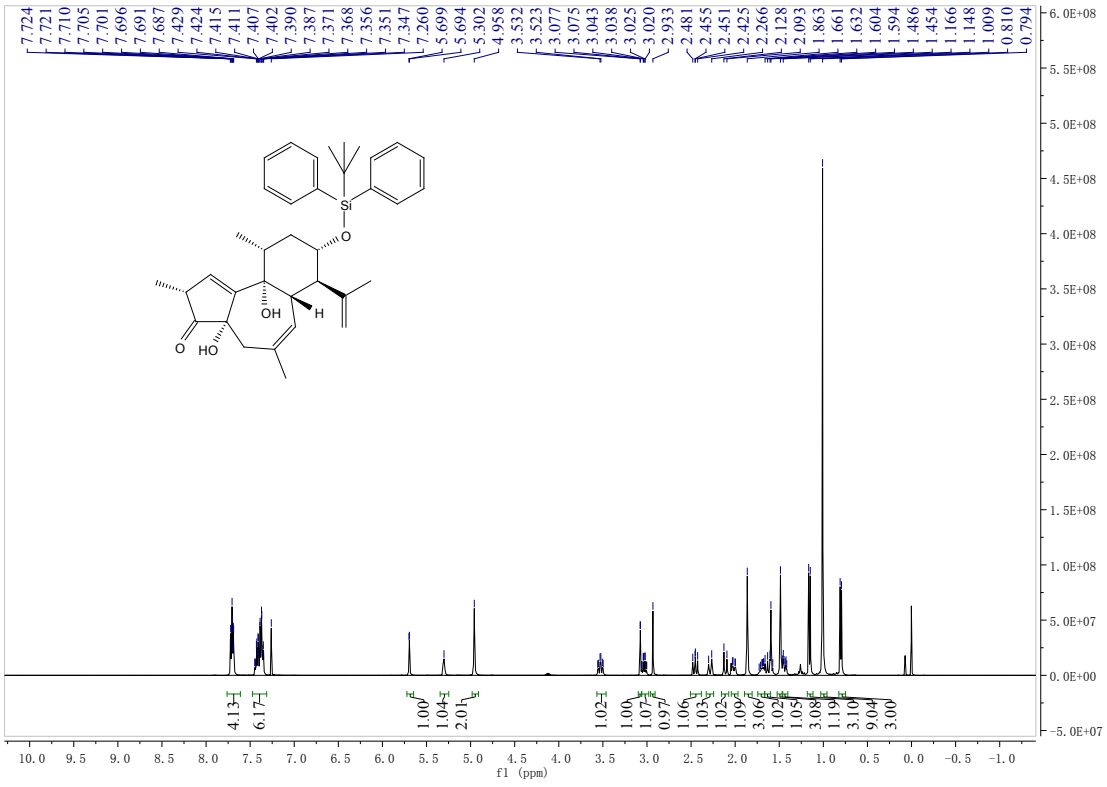
^{1}H NMR spectrum of **SI-6** (400 MHz, $CDCl_3$):



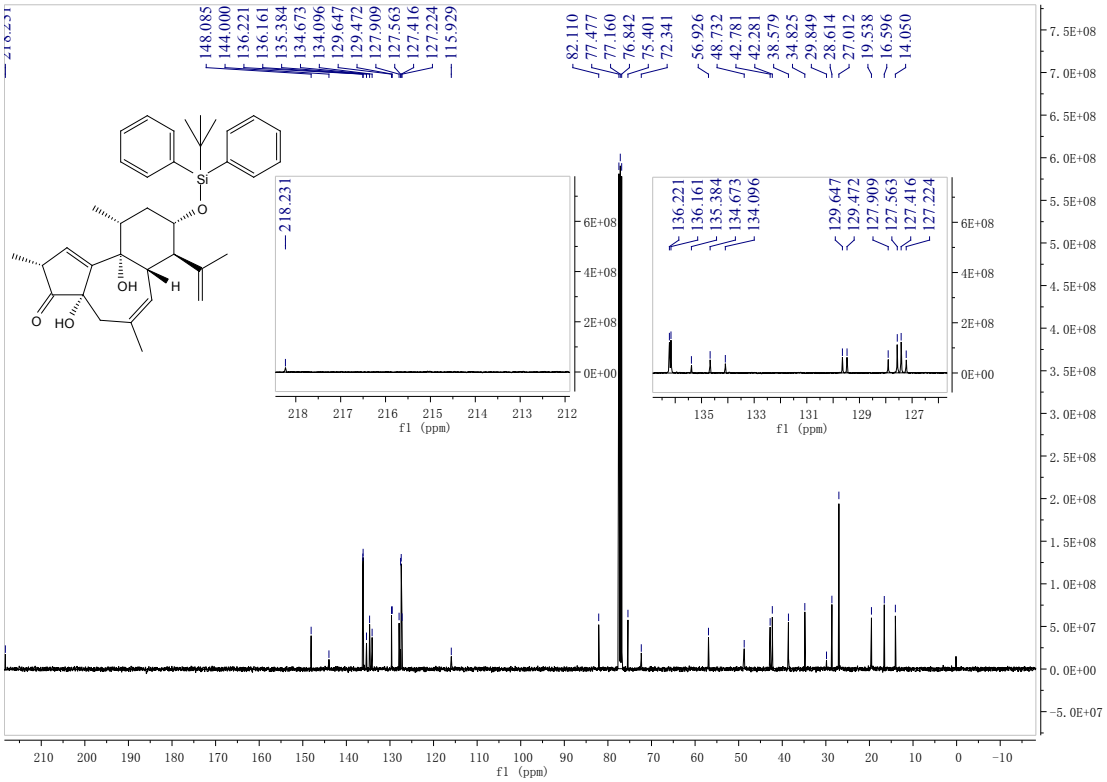
^{13}C NMR spectrum of **SI-6** (100 MHz, $CDCl_3$):



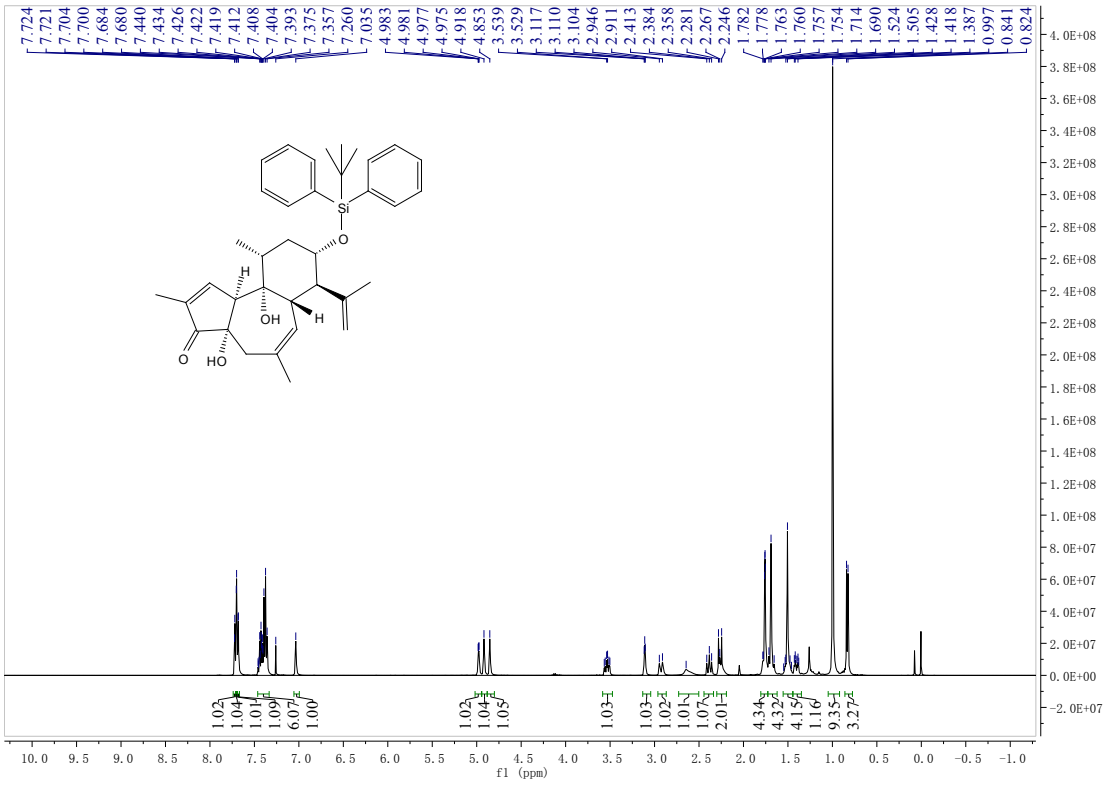
^{1}H NMR spectrum of **23** (400 MHz, $CDCl_3$):



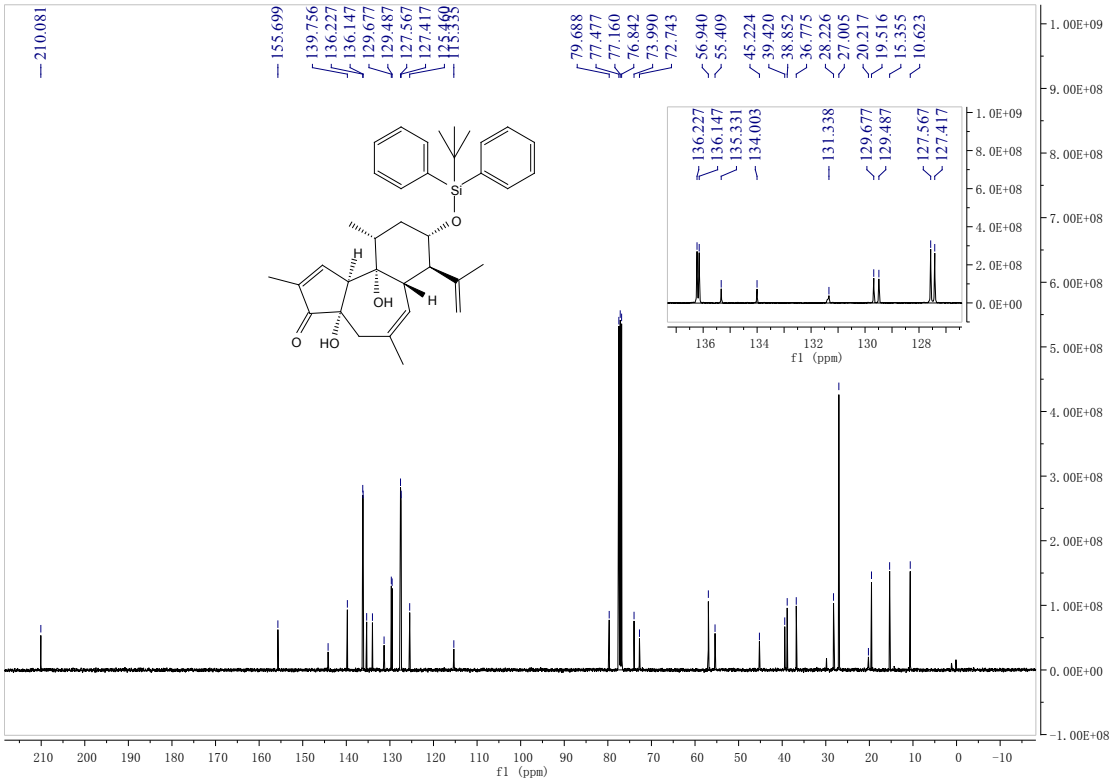
^{13}C NMR spectrum of **23** (100 MHz, $CDCl_3$):



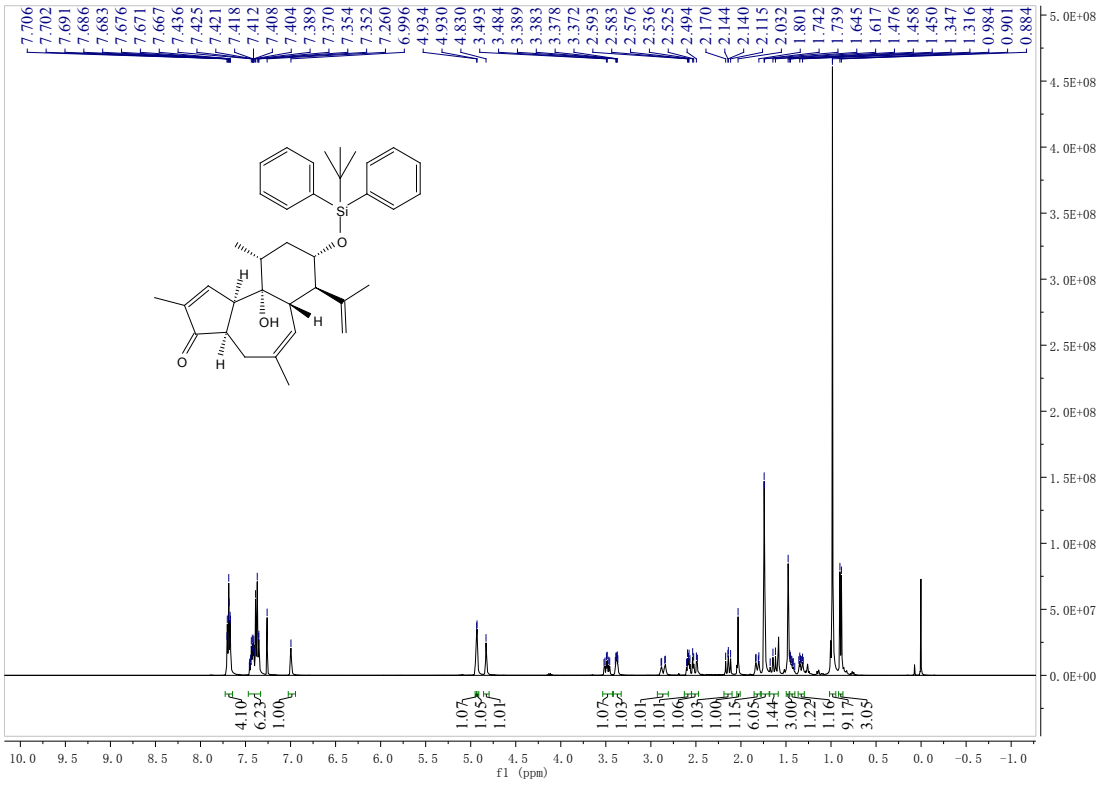
^{1}H NMR spectrum of **24** (400 MHz, $CDCl_3$):



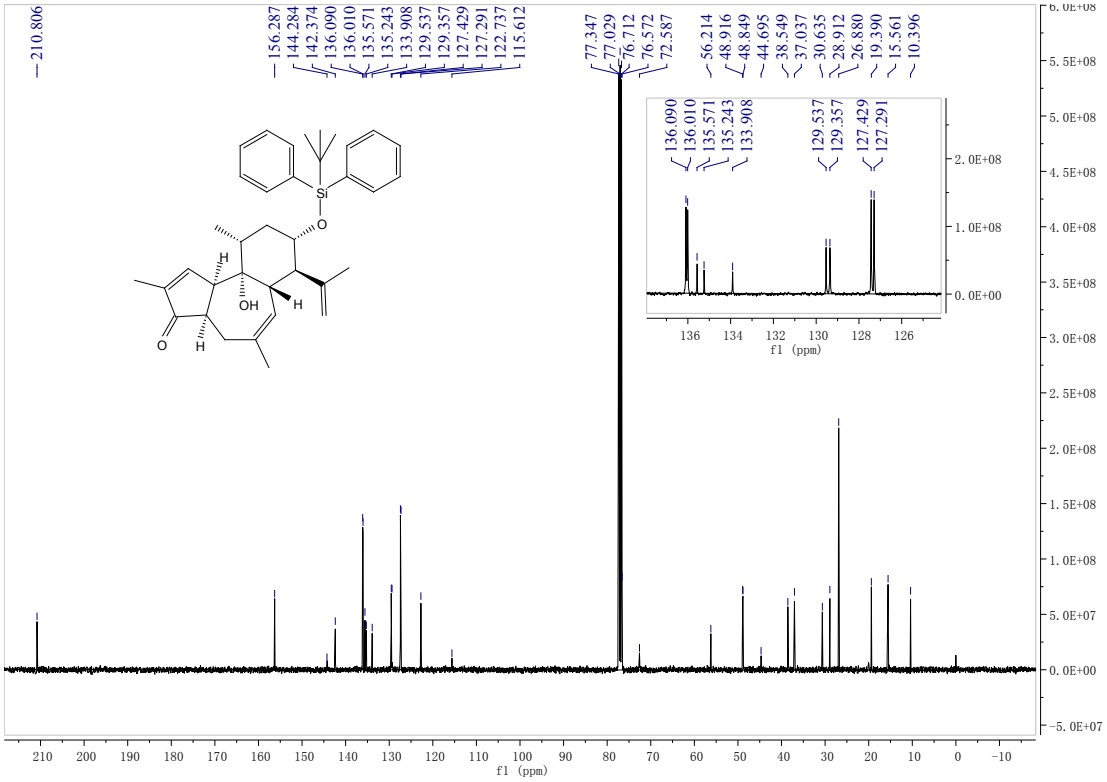
^{13}C NMR spectrum of **24** (100 MHz, $CDCl_3$):



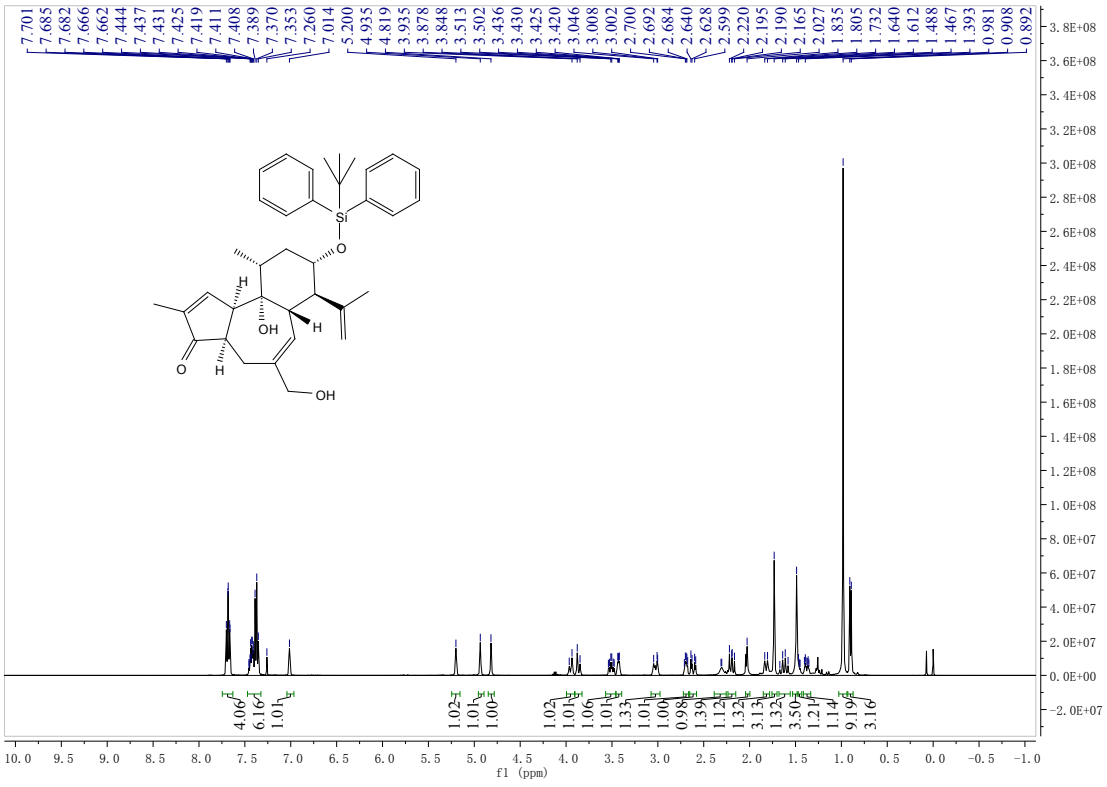
^{1}H NMR spectrum of **25** (400 MHz, $CDCl_3$):



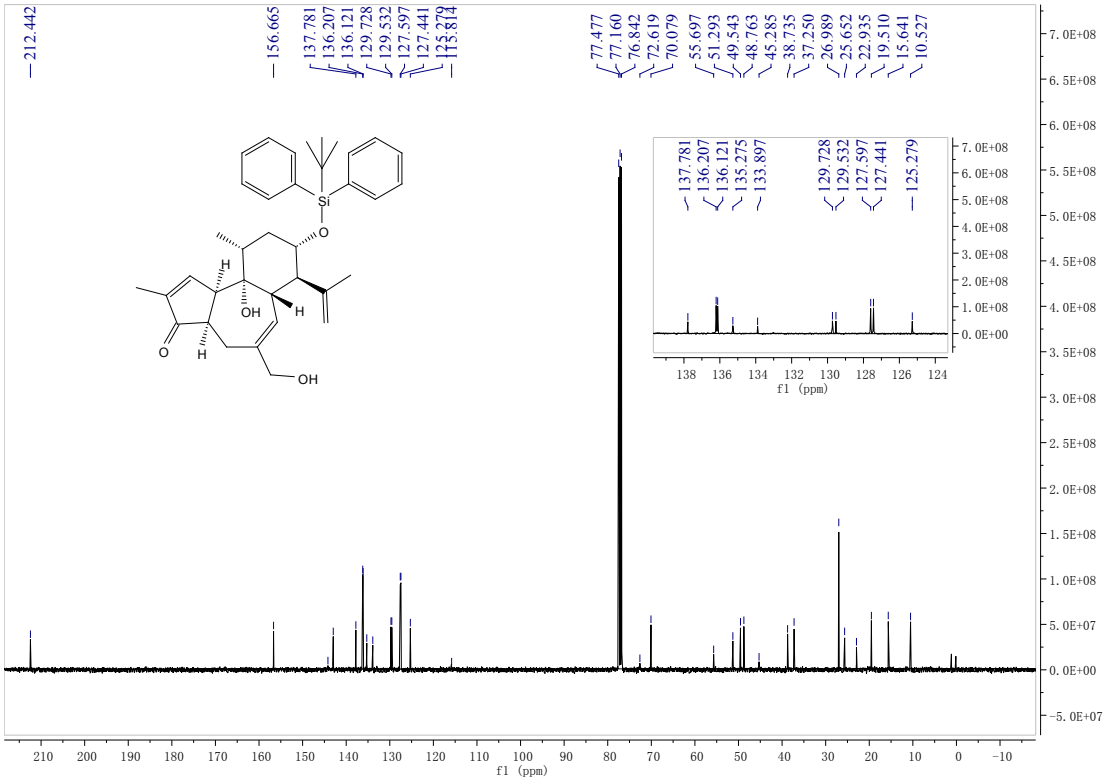
^{13}C NMR spectrum of **25** (100 MHz, $CDCl_3$):



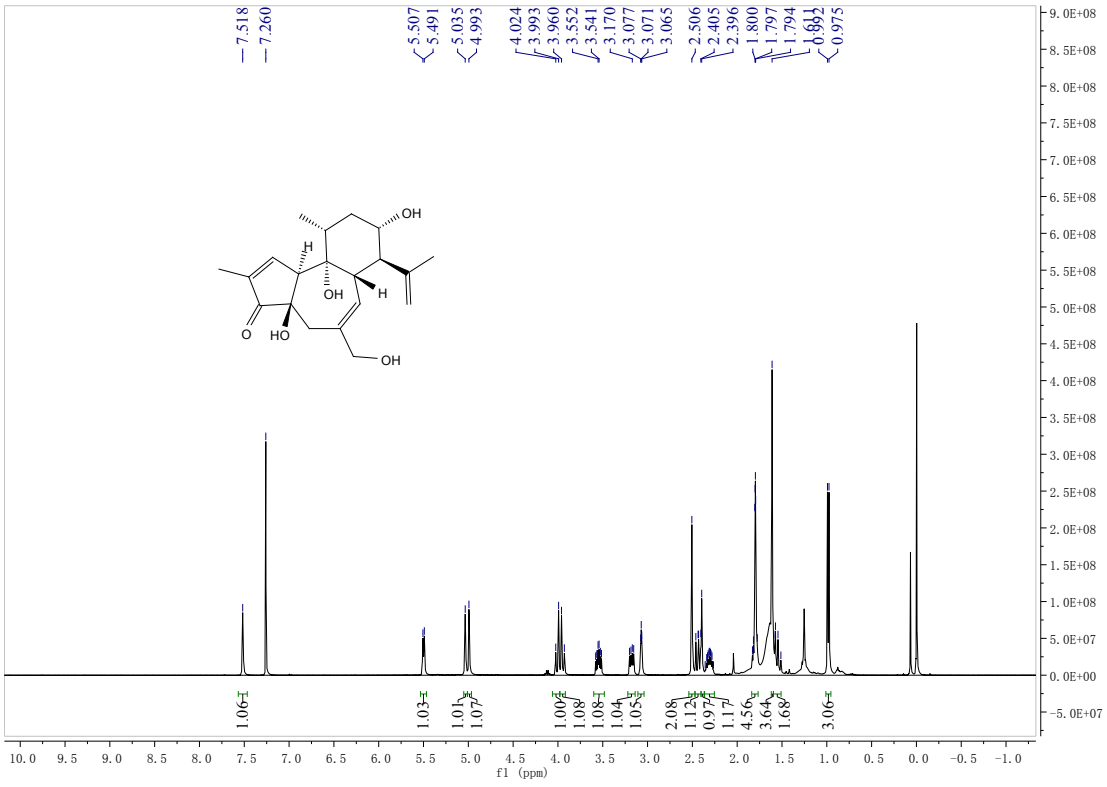
^{1}H NMR spectrum of **26** (400 MHz, $CDCl_3$):



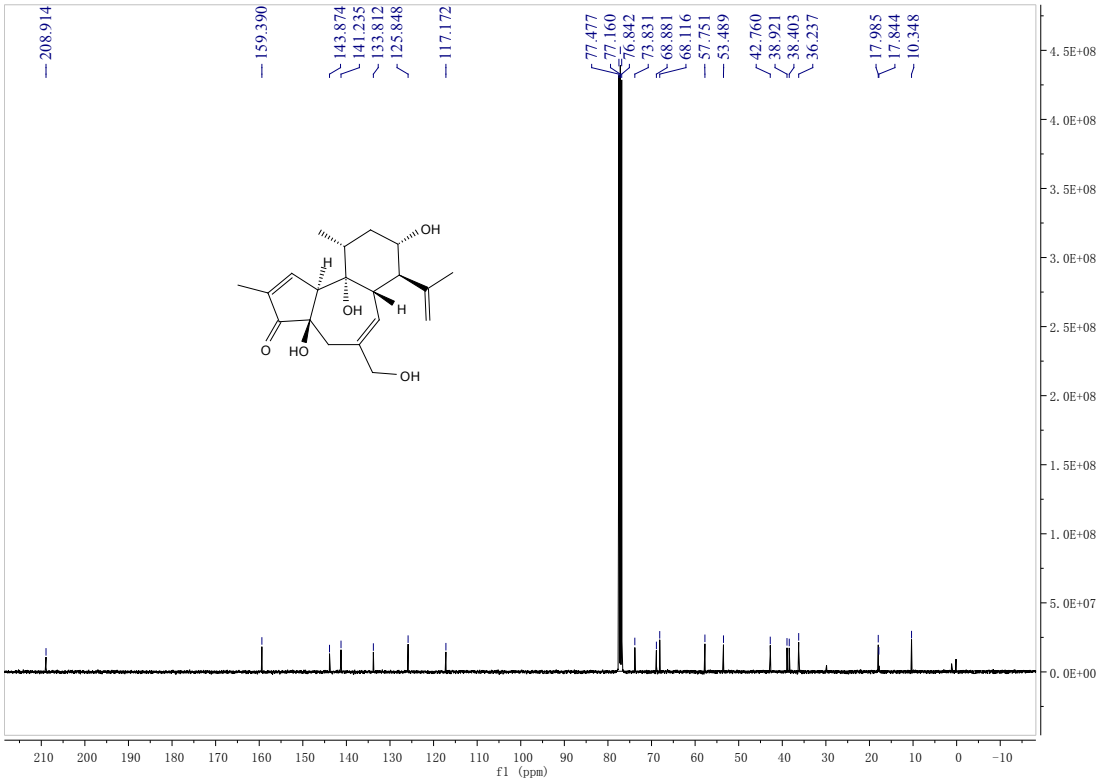
^{13}C NMR spectrum of **26** (100 MHz, $CDCl_3$):



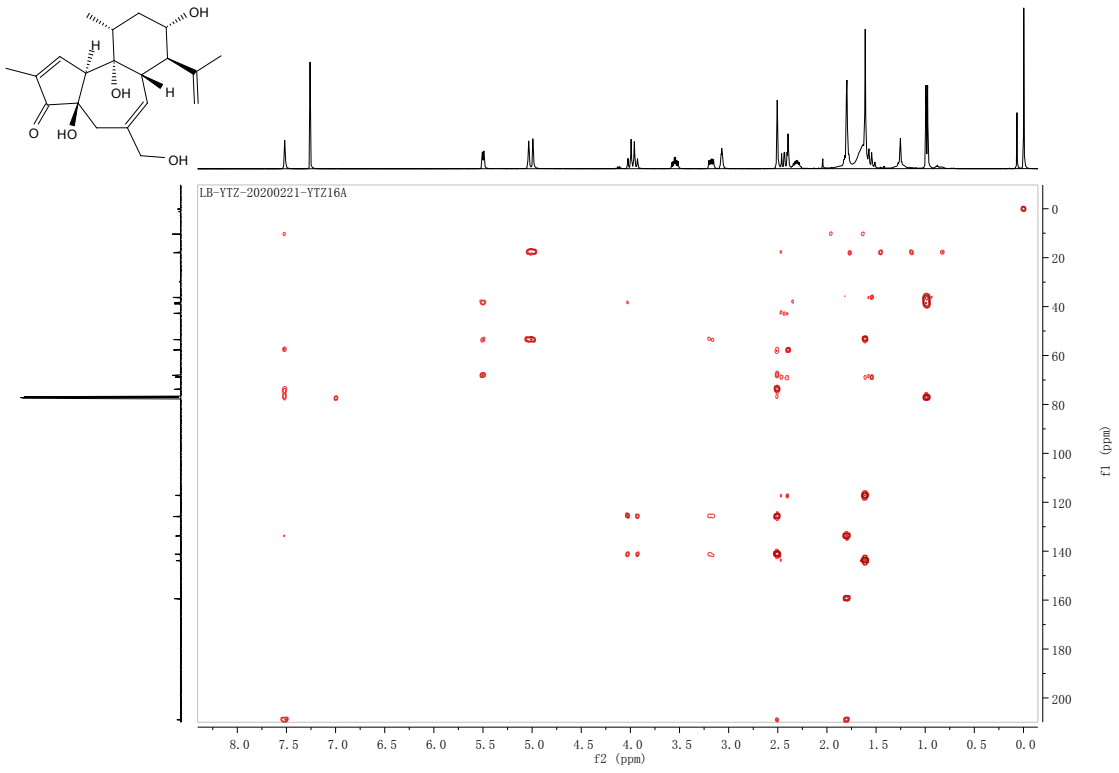
^{1}H NMR spectrum of **28** (400 MHz, $CDCl_3$):



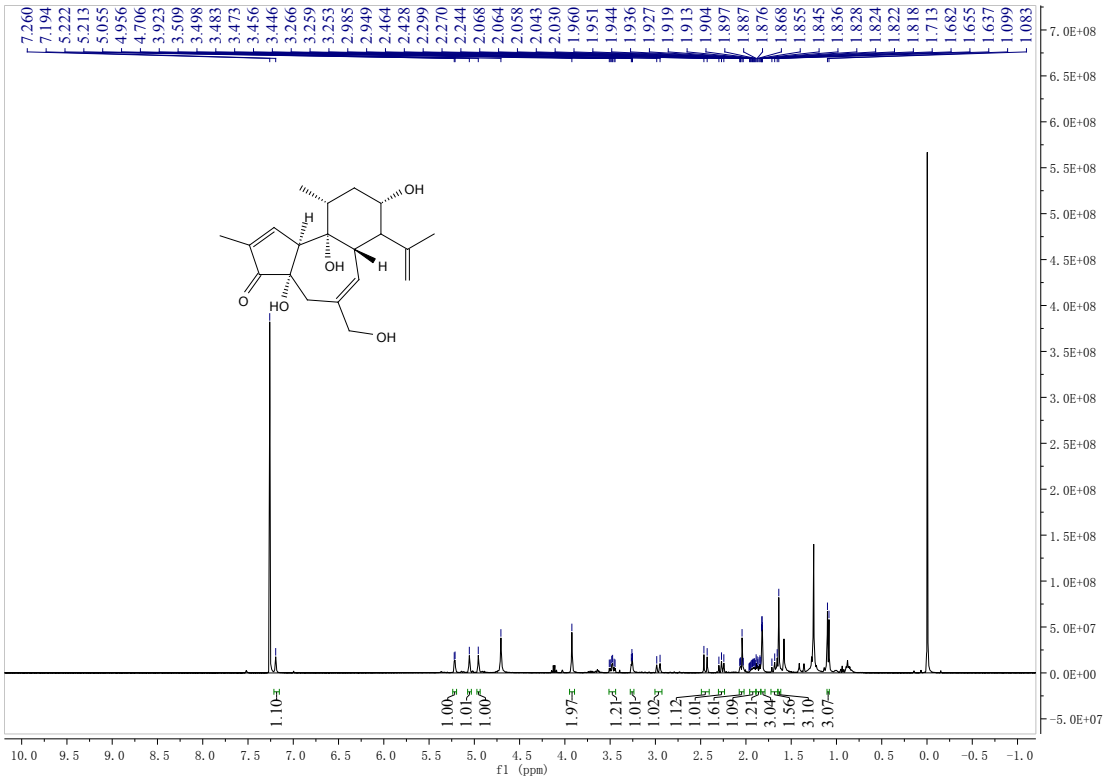
^{13}C NMR spectrum of **28** (100 MHz, $CDCl_3$):



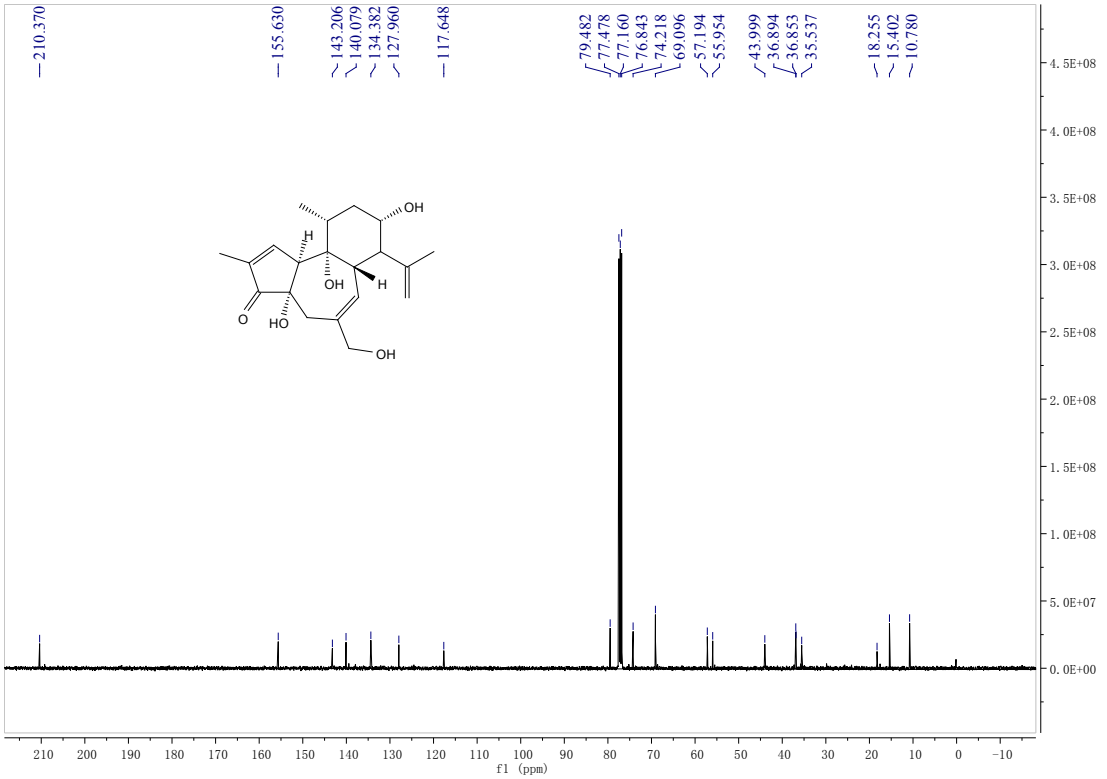
HMBC spectrum of **28** ($CDCl_3$):



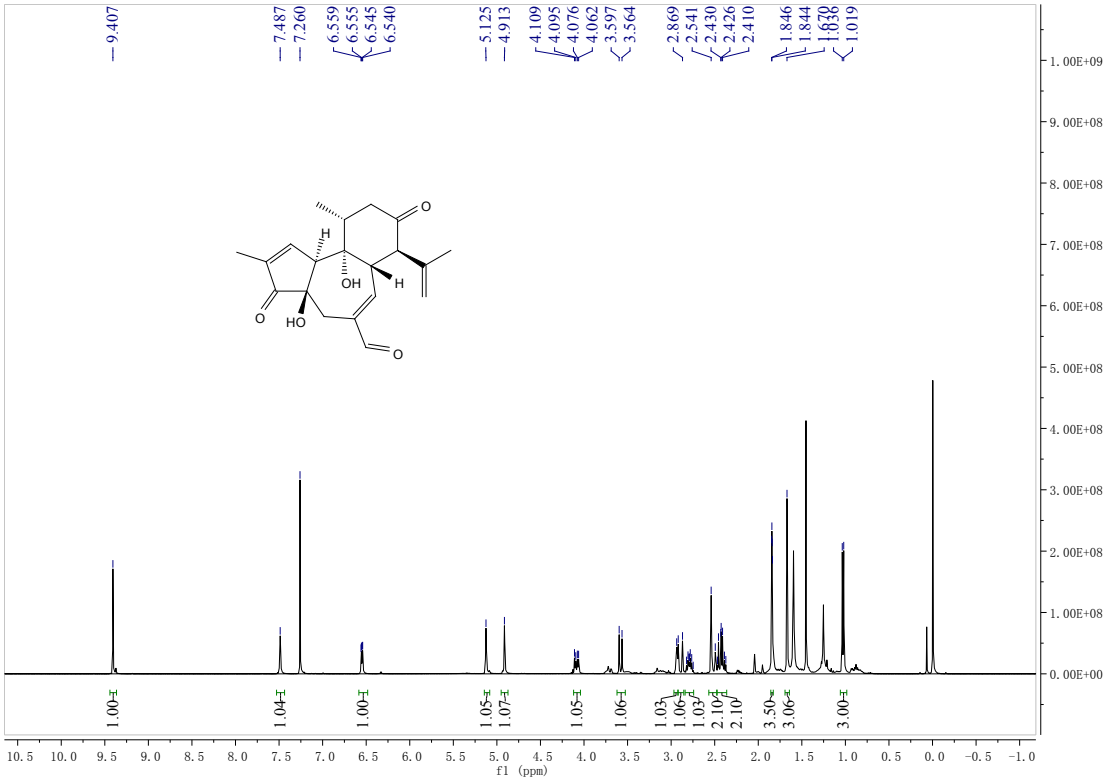
^{1}H NMR spectrum of **28'** (400 MHz, $CDCl_3$):



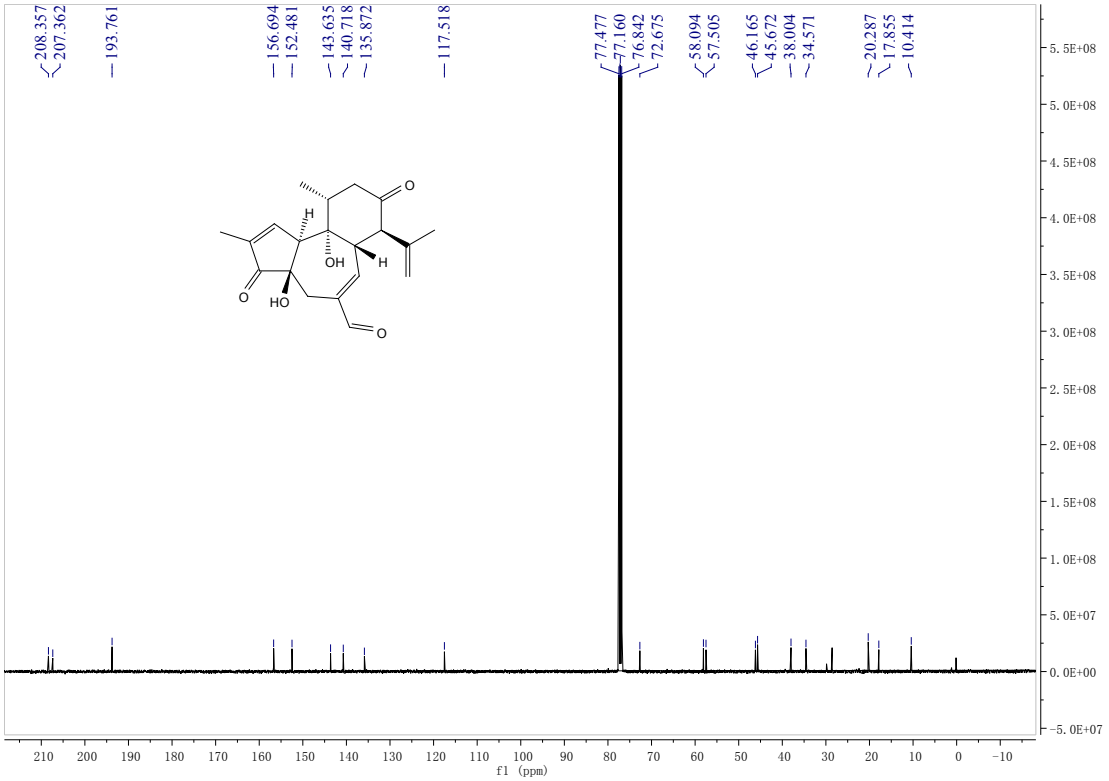
^{13}C NMR spectrum of **28'** (100 MHz, $CDCl_3$):



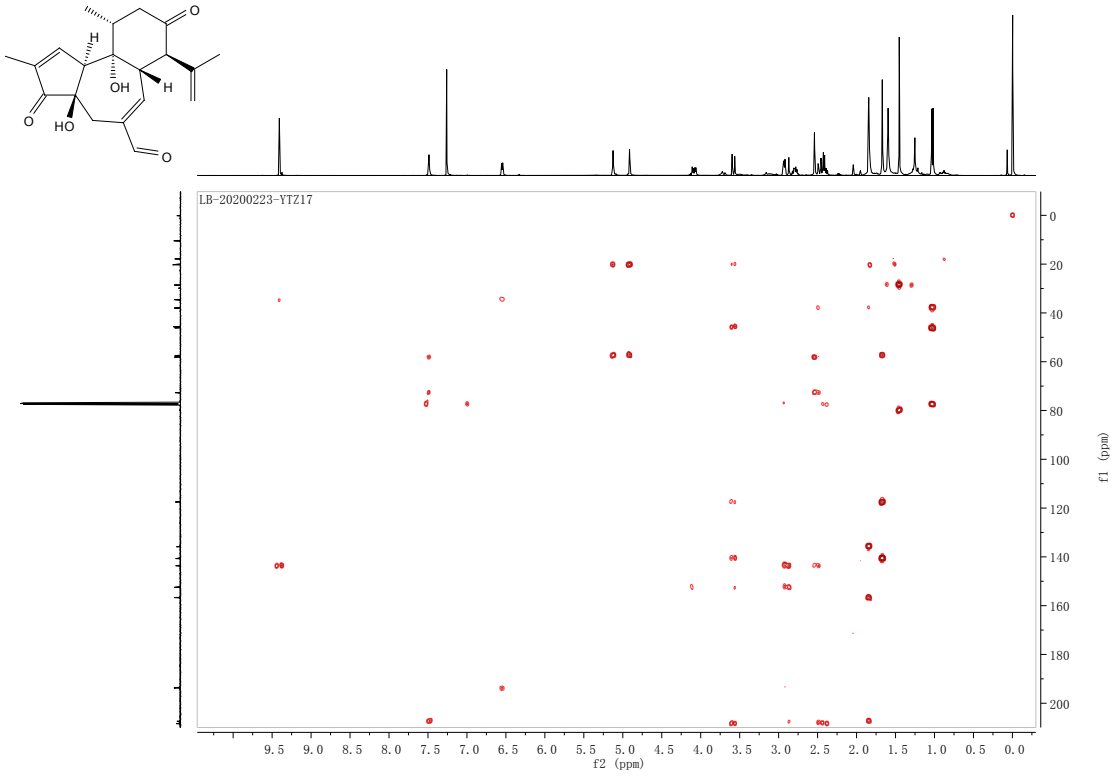
^{1}H NMR spectrum of **29** (400 MHz, $CDCl_3$):



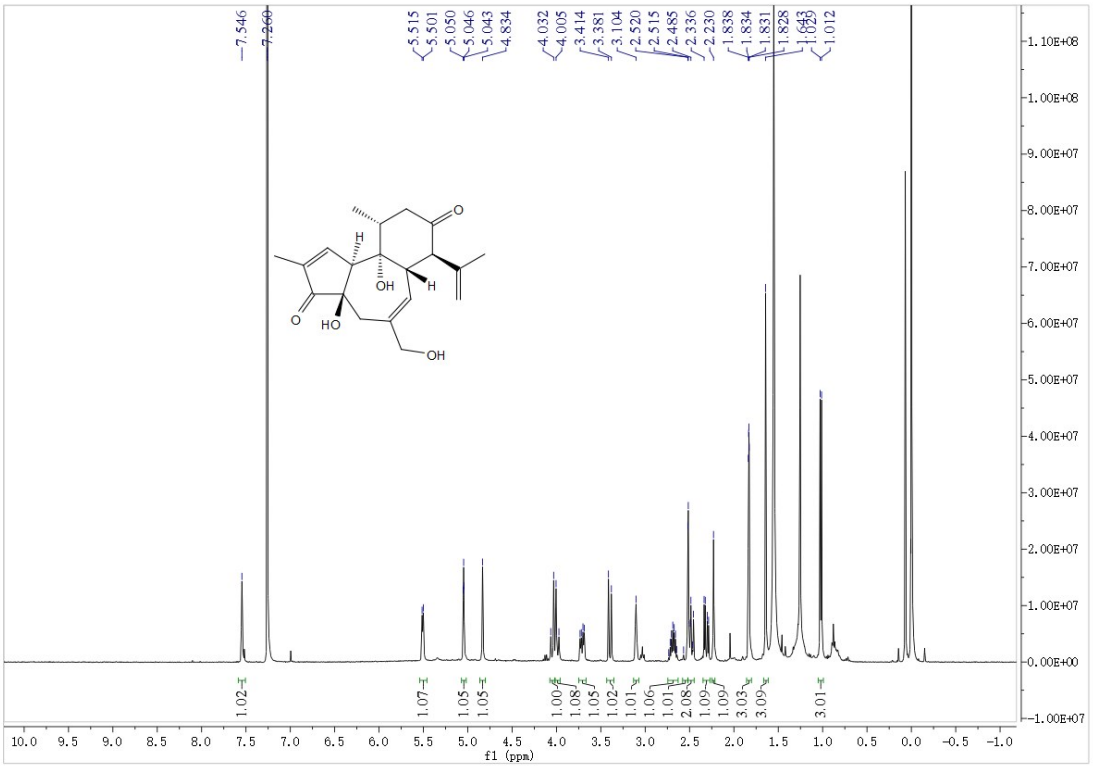
^{13}C NMR spectrum of **29** (100 MHz, $CDCl_3$):



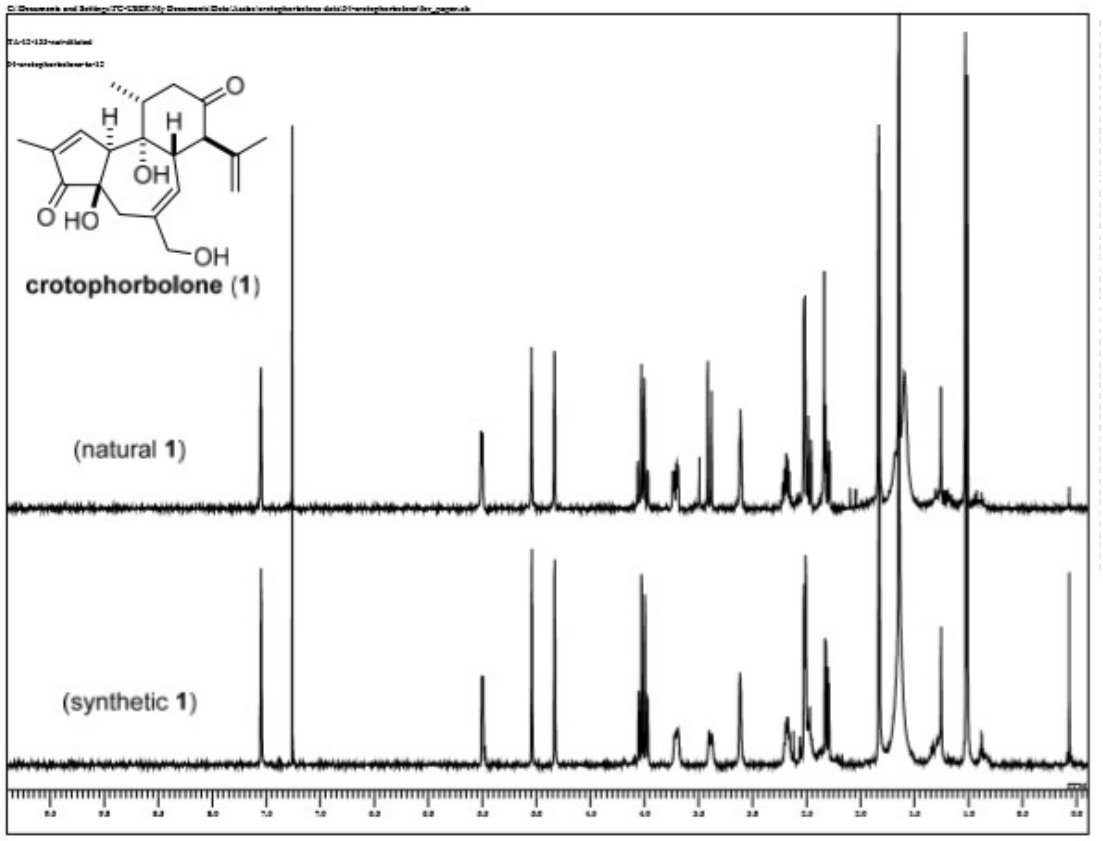
HMBC spectrum of **29** ($CDCl_3$):



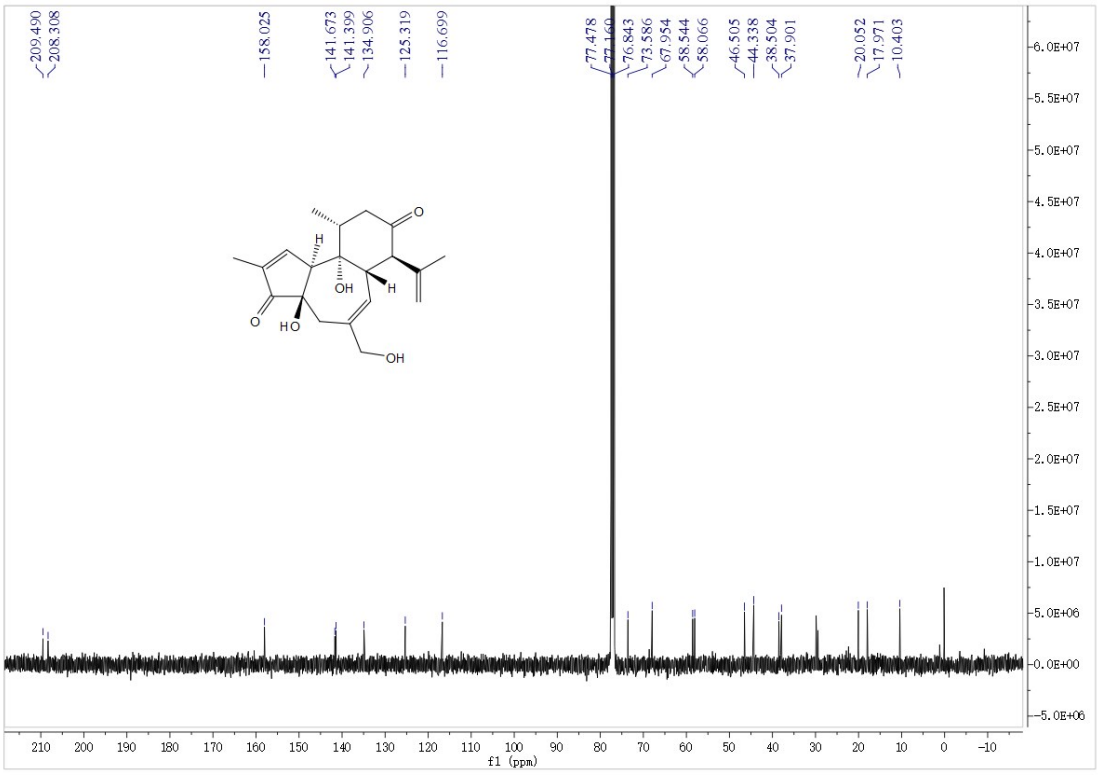
^{1}H NMR spectrum of Crotophorbolone (**1**) for this work (400 MHz, $CDCl_3$):



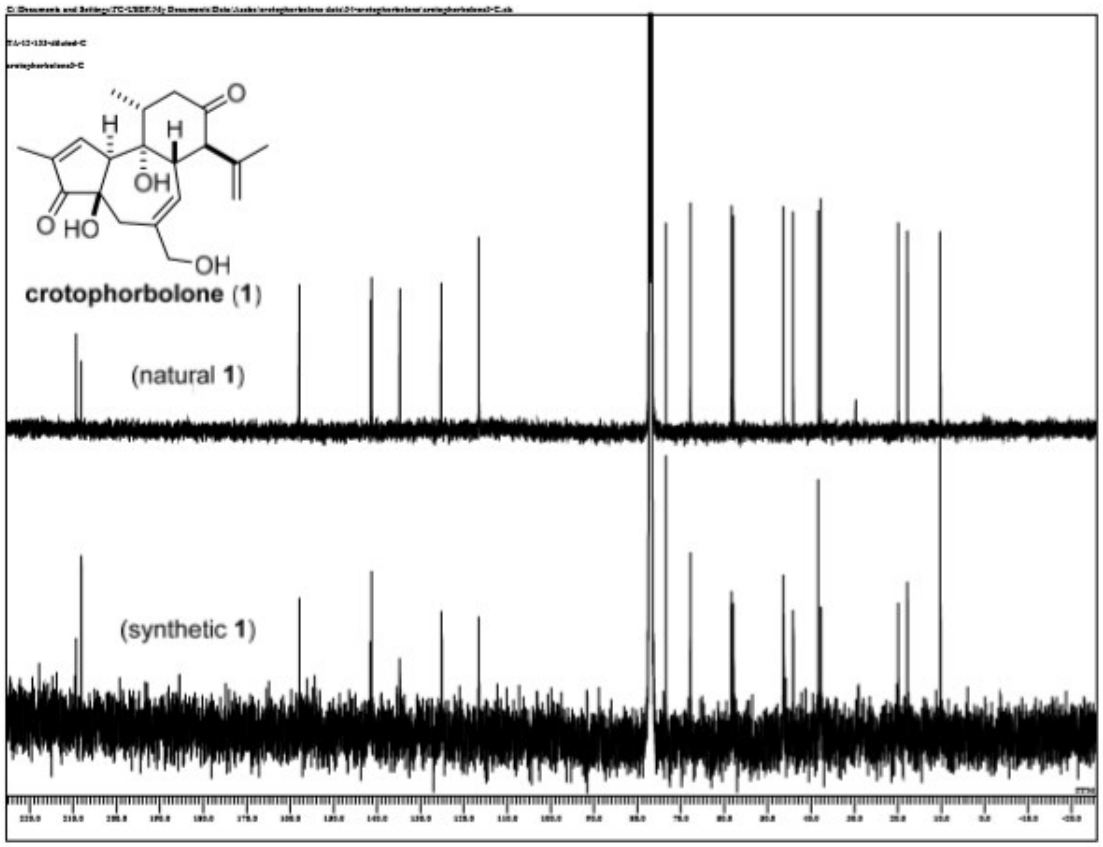
^{1}H NMR Comparison of Natural and Inoue's synthetic Crotophorbolone:



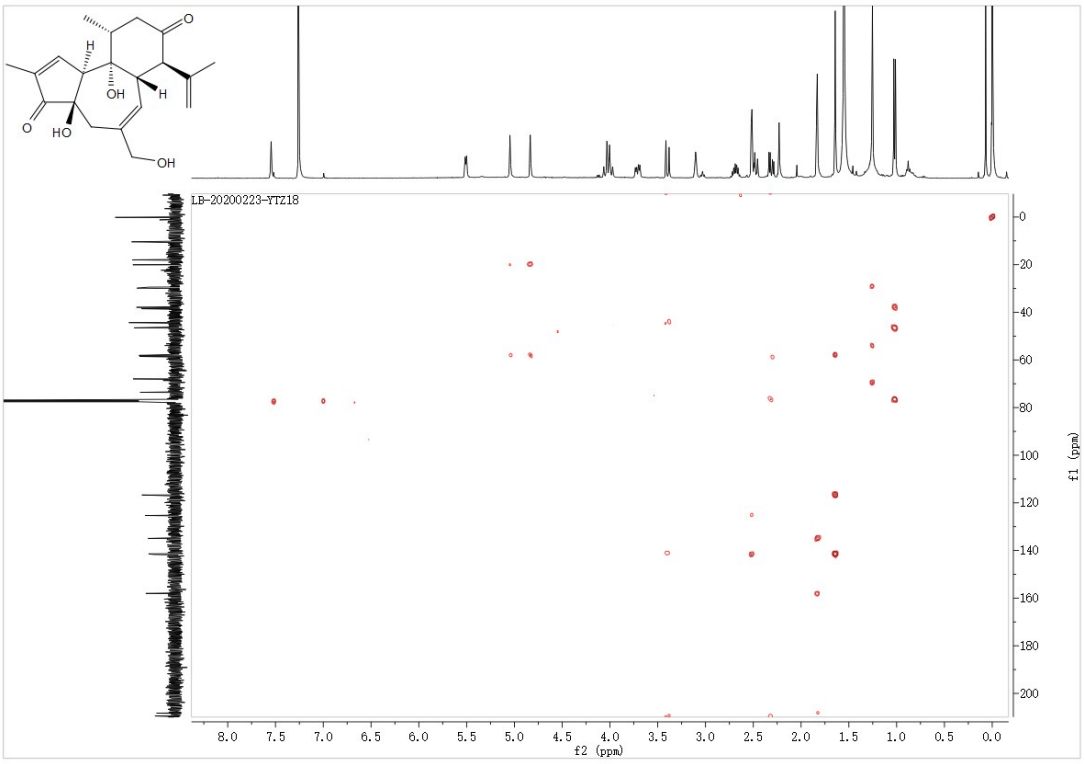
^{13}C NMR spectrum of Crotophorbolone (**1**) for this work (100 MHz, $CDCl_3$):



^{13}C NMR Comparison of Natural and Inoue's synthetic Crotophorbolone:



HMBC spectrum of Crotophorbolone (**1**) ($CDCl_3$):


LB-20200223-YTZ18
f2 (ppm)
f1 (ppm)