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I) General Methods

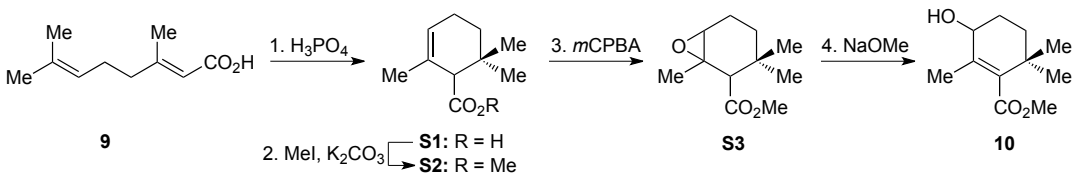
All reactions were carried out under an argon atmosphere unless otherwise noted. Methylene chloride, tetrahydrofuran, toluene, methanol, dimethylformamide, acetonitrile, diisopropylamine, and triethylamine were dried prior to use by passage through an activated alumina column unless otherwise noted.[1] Anhydrous acetone, ethyl acetate, and 1,2-dichloroethane were purchased from commercial suppliers and stored under argon. Yields refer to chromatographically and spectroscopically (^{1}H NMR) homogenous material, unless otherwise stated.

Reactions were monitored by thin-layer chromatography (TLC) carried out on 0.25 mm E. Merck silica gel plates (60F-254) and were visualized using UV light and an ethanolic solution of phosphomolybdic acid and cerium sulfate or an aqueous solution of potassium permanganate. Flash column chromatography using E. Merck silica gel (60, particle size 0.040–0.063 mm) was performed as described by Still.[2] NMR spectra were recorded on a Bruker DRX-600 equipped with a 5 mm DCH cryoprobe, Bruker DRX-500, Bruker AV-400, or Varian INOVA-400 instrument and calibrated using residual undeuterated solvent for ^{1}H NMR [δ_H = 7.26 ($CHCl_3$), 7.16 (C_6D_5H), 2.05 (D_5H-acetone), and 5.32 ($CDHCl_2$) ppm] and ^{13}C deuterated

solvent for ^{13}C NMR [δ_C = 77.16 ($CDCl_3$), 128.06 (C_6D_6), 206.68 (d_6-acetone), and 53.84 (CD_2Cl_2) ppm] as an internal reference at 298 K.[3] The following abbreviations were used to designate the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, b = broad, ap = apparent.

ATR-Infrared (IR) spectra were recorded on a Perkin-Elmer 1600 series FT-IR spectrometer. High-resolution mass spectra (HRMS) were recorded on an Agilent LC/MSD/TOF mass spectrometer using ESI (electrospray ionization). Melting points were recorded on a Fisher-Johns 12-144 melting point apparatus. X-Ray crystallographic structures were collected using a Bruker Smart-APEX instrument (CCD detector) and a Molybdenum sealed X-ray tube.

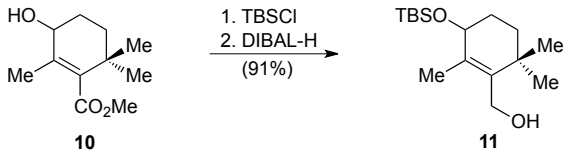
II) Experimental Procedures for Preparation and Physical Data of Compounds



9 **S3** **10**

Allylic alcohol 10: Allylic alcohol **10** was prepared using the following modification of the published four-step procedure.[4] Geranic acid (30.98 g, 184.2 mmol) was dissolved in toluene (450 mL, not dried prior to use) to which was added H_3PO_4 (~2 mL). The mixture was heated to reflux and vigorously stirred at that temperature for 1.5 hours. After cooling to room temperature, water (100 mL) was added, the layers were separated, and the toluene layer was concentrated to give crude cyclogeranic acid (**S1**) as a solid. The crude residue was then dissolved in acetone (600 mL, technical grade) and treated with K_2CO_3 (50.0 g, 362 mmol, 2 equiv) and MeI (45 mL, 100 g, 0.72 mol, 3.9 equiv). The suspension was vigorously stirred at room temperature for 15 hours. The solids were filtered through a short pad of silica gel, rinsed with Et_2O, and concentrated to give cyclogeranic acid methyl ester (**S2**). The crude methyl ester was dissolved in CH_2Cl_2 (500 mL) and cooled to 0 °C using an ice bath. Separately, a solution of *m*CPBA (70–75%, 51.0 g, ~220 mmol, ~1.2 equiv) in CH_2Cl_2 (900 mL) was added to the substrate solution via addition funnel over ca. 1 hour. The ice bath was then removed, and the resulting solution was allowed to stir at room temperature for 2 hours. The reaction was then quenched with a saturated solution of aq. $Na_2S_2O_3$ (1 L) and stirred for 30 minutes. The layers were separated, and the organic layer was then washed with saturated aq. $NaHCO_3$ solution (2 × 1 L). The phases were separated, and the organic phase was dried over Na_2SO_4, filtered, and concentrated to give crude epoxide **S3**. The crude epoxide was dissolved in anhydrous methanol (600 mL) to which was added NaOMe (15 g, 0.28 mol, 1.5 equiv). The solution was refluxed for

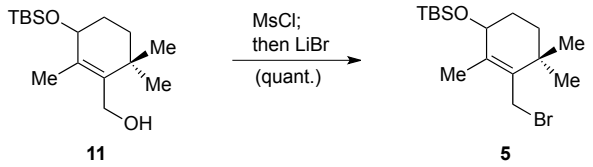
17 hours and then cooled to room temperature, acidified to pH = 1 using 1 N aq. HCl, and diluted with water (1 L) and extracted with EtOAc (1 L). The phases were separated, and the organic phase was dried over Na_2SO_4, filtered, and concentrated. The crude residue was purified by flash column chromatography (10→20→30→50% EtOAc:hexanes) to give allylic alcohol **10** (25.7 g, 130 mmol, 70% yield for 4 steps). The physical and spectroscopic data matched those reported in the literature.[4]



10 **11**

TBS ether 11: Allylic alcohol **10** (15.6 g, 78.8 mmol) was dissolved in CH_2Cl_2 (800 mL) at room temperature. Imidazole (10.6 g, 156 mmol, 2.0 equiv) and TBSCl (18.9 g, 126 mmol, 1.6 equiv) were added sequentially, and the suspension was stirred at room temperature for 12 hours. The reaction was quenched with saturated $NaHCO_3$ solution (500 mL), and the phases were separated. The organic phase was dried over Na_2SO_4, filtered, and concentrated. Residual volatiles were then azeotropically removed with toluene (twice). The crude TBS ether was dissolved in CH_2Cl_2 (700 mL) and cooled to –78 °C. DIBAL-H (210 mL, 1.0 M solution in hexanes, 210 mmol, 2.7 equiv) was added to the reaction mixture over 20 minutes, and the cooling bath was then warmed to 0 °C. The reaction mixture was stirred at this temperature for 70 minutes. The reaction was cautiously quenched with methanol (100 mL). The mixture was allowed to warm to room temperature, and saturated aq. Rochelle's salt (800 mL) was added. The resulting thick emulsion was vigorously stirred at room temperature for 5 hours. The phases were separated, and the organic phase was dried over Na_2SO_4, filtered, and concentrated to give the crude allylic alcohol. The residue was purified by flash column chromatography

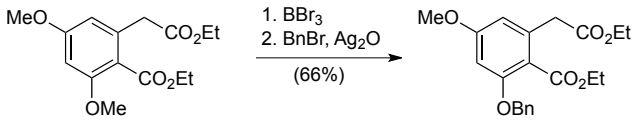
(5→10→15% EtOAc:hexanes) to give allylic alcohol **11** (20.5 g, 72.2 mmol, 91% for 2 steps) as a colorless oil that slowly solidified. **11**: R_f = 0.2 (silica gel, EtOAc:hexanes 1:9); FT-IR (neat) ν_{max} = 3337, 2951, 2930, 2857, 1472, 1361, 1251, 1084, 1049, 1004, 935, 888, 834, 772, 671 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 4.14 (d, *J* = 11.4 Hz, 1 H), 4.09 (d, *J* = 11.4 Hz, 1 H), 4.00 (dd, *J* = 6.0, 6.0 Hz, 1 H), 1.80 (m, 1 H), 1.79 (s, 3 H), 1.65 – 1.57 (m, 2 H), 1.37 (ddd, *J* = 13.2, 10.5, 2.8 Hz, 1 H), 1.06 (s, 3 H), 1.02 (s, 3 H), 0.90 (s, 9 H), 0.10 (s, 3 H), 0.08 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 140.1, 136.1, 71.3, 59.4, 35.5, 34.6, 29.5, 28.2, 28.0, 26.1, 18.3, 16.3, –4.1, –4.5 ppm; HRMS (ESI) calcd for $C_{16}H_{32}O_2SiH^+$ [*M*+H^+] 285.2244, found 285.2245.



11 **5**

Allylic bromide 5: To a solution of allylic alcohol **11** (23.9 g, 84.2 mmol) in CH_2Cl_2 (450 mL) was added triethylamine (23.3 mL, 168 mmol, 2.0 equiv). The solution was cooled to –50 °C, and methanesulfonyl chloride (11.0 mL, 143 mmol, 1.7 equiv) was added dropwise. The solution was stirred at this temperature for 1 hour, during which a thick white suspension formed. A solution of lithium bromide (25.6 g, 294 mmol, 3.5 equiv) in THF (98 mL) was then transferred to the reaction flask via cannula over 10 minutes. The mixture was allowed to warm to –20 °C and was stirred at this temperature for 1 hour. The reaction was quenched by pouring the slurry into water (1 L). The mixture was extracted with hexanes (1 L), dried over Na_2SO_4, filtered, and concentrated to give the allylic bromide **5** (29.1 g, 84.1 mmol, quant.) as a pale yellow oil which was used crude for further reactions. The material was analytically pure and could be stored neat at –38 °C for several months with no signs of decomposition. **5**: R_f = 0.8 (silica gel,

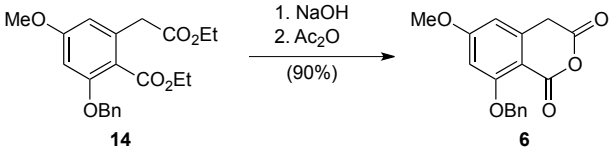
EtOAc:hexanes 1:10); FT-IR (neat) ν_{max} = 2955, 2929, 2856, 1471, 1362, 1251, 1204, 1083, 1051, 1027, 1005, 936, 887, 834, 772, 678 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 4.05 (d, *J* = 10.2 Hz, 1 H), 4.02 (ap t, *J* = 6.6 Hz, 1 H), 3.95 (d, *J* = 10.2 Hz, 1 H), 1.83 – 1.76 (m, 4 H), 1.65 – 1.54 (m, 2 H), 1.42 (m, 1 H), 1.12 (s, 3 H), 1.09 (s, 3 H), 0.90 (s, 9 H), 0.10 (s, 3 H), 0.08 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 139.7, 136.3, 71.5, 35.9, 35.3, 30.3, 29.3, 28.6, 28.1, 26.0, 18.3, 16.6, –4.0, –4.6 ppm; HRMS (ESI) calcd for $C_{16}H_{31}BrOSiNa^+$ [*M*+Na^+] 369.1220, found 369.1231.



13 **14**

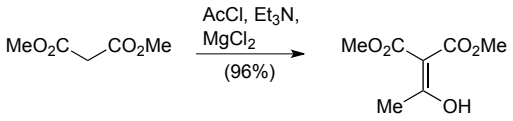
Diester 14: Compound **13** was prepared by the literature procedure.[5] To two separate batches of substrate **13** (19.0 g, 64.1 mmol each) in CH_2Cl_2 (570 mL) at –78 °C was added a freshly prepared solution of BBr_3 (1 M in CH_2Cl_2, 86.6 mL, 86.6 mmol, 1.35 equiv) dropwise over 15 minutes. The reaction mixture was stirred for an additional 15 minutes at –78 °C and was then allowed to warm to room temperature. The two batches were combined and poured into ice water, extracted with CH_2Cl_2 (2 × 500 mL), washed with brine (200 mL), dried over Na_2SO_4, and concentrated to afford an off-white solid (33.1 g). To a solution of the previous crude residue in DMF (840 mL) were added Ag_2O (57.4 g, 248 mmol, 1.9 equiv) and benzyl bromide (16.7 mL, 141 mmol, 1.1 equiv). The reaction mixture was shielded from light using aluminum foil and was stirred for 15 hours at room temperature. The solution was then filtered through a pad of silica gel, rinsed with EtOAc, and concentrated. The residue was then diluted with water (500 mL) and extracted with diethyl ether (1 L). The organic phase was dried over Na_2SO_4, filtered, and concentrated to give a crude oil which was purified by flash column

chromatography (2→5→10% EtOAc:hexanes) to give benzylated product **14** (31.4 g, 84.3 mmol, 66% for 2 steps) as a colorless oil. **14**: R_f = 0.4 (silica gel, EtOAc:hexanes 1:4); FT-IR (neat) ν_{max} = 2981, 1727, 1603, 1583, 1463, 1455, 1434, 1366, 1317, 1268, 1194, 1155, 1095, 1071, 1048, 1027, 961, 834, 738, 697 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 7.43 – 7.40 (m, 2 H), 7.38 – 7.34 (m, 2 H), 7.30 (m, 1 H), 6.45 (d, *J* = 2.1 Hz, 1 H), 6.42 (d, *J* = 2.1 Hz, 1 H), 5.07 (s, 2 H), 4.31 (q, *J* = 7.1 Hz, 2 H), 4.15 (q, *J* = 7.1 Hz, 2 H), 3.78 (s, 3 H), 3.69 (s, 2 H), 1.28 (t, *J* = 7.1 Hz, 3 H), 1.25 (t, *J* = 7.1 Hz, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 170.9, 167.5, 161.6, 158.1, 136.7, 135.3, 128.6, 128.0, 127.2, 117.0, 107.9, 99.3, 70.7, 61.1, 61.0, 55.5, 39.7, 14.3, 14.2 ppm; HRMS (ESI) calcd for $C_{21}H_{24}O_6H^+$ [*M*+H^+] 373.1646, found 373.1643.



Cyclic anhydride 6: A solution of NaOH (20 g, 0.50 mol, 27 equiv) in water (50 mL) was added to a solution of diester **14** (6.80 g, 18.2 mmol) in EtOH (70 mL) at room temperature. The resulting mixture was stirred for 15 hours at reflux. The EtOH was then removed under reduced pressure, and the remaining aqueous phase was acidified to pH 1 with 12 N aq. HCl. The aqueous phase was extracted with EtOAc (200 mL), and the organic phase was dried over Na_2SO_4, filtered, and concentrated to obtain the crude diacid as a white solid (5.48 g). Acetic anhydride (1.74 mL, 18.4 mmol, 1.1 equiv) was added via syringe to a slurry of the diacid in toluene (42 mL), and the resulting mixture was heated at reflux for 1 hour. The flask was then cooled in an ice bath, the solid product was filtered, and the filter cake was washed with pentane. The solids were collected and dried to afford **6** as light yellow crystals (4.90 g, 16.4 mmol, 90%). **6**: R_f = 0.3 (silica gel, EtOAc:hexanes 1:4); FT-IR (neat) ν_{max} = 1785, 1746, 1605, 1584, 1345,

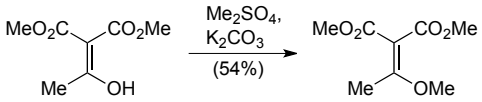
1274, 1226, 1196, 1175, 1154, 998, 738 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 7.55 – 7.53 (m, 2 H), 7.42 – 7.38 (m, 2 H), 7.32 (m, 1 H), 6.50 (d, *J* = 2.2 Hz, 1 H), 6.34 (m, 1 H), 5.25 (s, 2 H), 3.99 (s, 2 H), 3.85 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 165.8, 165.4, 162.8, 156.8, 138.8, 135.8, 128.9, 128.2, 126.8, 104.4, 104.1, 99.9, 70.8, 56.0, 35.6 ppm; HRMS (ESI) calcd for $C_{17}H_{14}O_5H^+$ [*M*+H^+] 299.0914, found 299.0918.



15 **S4**

Acyl malonate S4:[6] Dimethyl malonate (**15**) (30.2 mL, 34.8 g, 0.264 mol) was added to a suspension of magnesium chloride (25.3 g, 0.266 mol, 1.0 equiv) in acetonitrile (265 mL). The suspension was cooled to 0 °C and triethylamine (74 mL, 54 g, 0.53 mol, 2.0 equiv) was added. After stirring for 15 minutes, freshly distilled acetyl chloride (19 mL, 21 g, 0.27 mol, 1.0 equiv) was added, and the reaction mixture was stirred for one hour at 0 °C and then allowed to warm to room temperature. After stirring for 23 hours at room temperature, the reaction mixture was cooled to 0 °C, quenched with 5 N aq. HCl (200 mL) and extracted with Et_2O (4 × 200 mL). The combined organic layers were washed with brine, dried over $MgSO_4$, filtered, and concentrated to give crude **S4** as a light yellow-green liquid. The crude product was purified by distillation under reduced pressure to yield 44.3 g (0.254 mol, 96%, keto/enol = 1:3.4) of **S4** as a colorless liquid. **S4**: R_f = 0.5 (silica gel, EtOAc:hexanes 1:3); FT-IR (neat) ν_{max} = 2957, 1721, 1650, 1604, 1437, 1241, 1148, 1087 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz) δ = 13.53 (s, 1 H, enol tautomer), 4.46 (s, 1 H, keto tautomer), 3.81 – 3.76 (m, 6 H, keto tautomer + 6 H, enol tautomer), 2.32 (s, 3 H, keto tautomer), 2.19 (s, 3 H, enol tautomer) ppm; ^{13}C NMR ($CDCl_3$, 101 MHz) δ = 196.5,

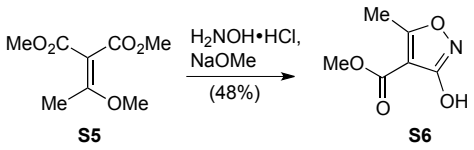
181.6, 171.7, 166.5, 165.0, 99.3, 65.6, 53.2, 52.4, 52.1, 29.2, 21.1 ppm; HRMS (ESI) calcd for $C_7H_{10}O_5Na^+$ [M+Na^+] 197.0420, found 197.0425.



S4 **S5**

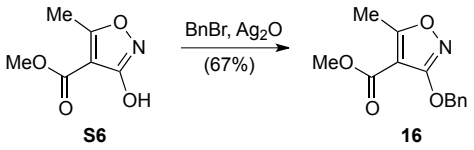
Diester S5: To a solution of **S4** (8.7 g, 50 mmol) in dry DMF (255 mL) at 0 °C was added K_2CO_3 (9.3 g, 67 mmol, 1.3 equiv). After stirring for 20 minutes, dimethyl sulfate (6.3 mL, 8.4 g, 67 mmol, 1.3 equiv) was added dropwise. After 17 hours, saturated NH_4Cl solution (90 mL) was carefully added, the phases were separated, and the aqueous layer was extracted with EtOAc (6 × 100 mL). The combined organic phases were washed with brine, dried over $MgSO_4$, filtered, and concentrated. The crude product was purified by column chromatography (silica gel, 1:3→1:1 EtOAc:hexanes) to yield **S5** (5.0 g, 27 mmol, 54%) of a colorless solid.* **S5**: R_f = 0.5 (silica gel, EtOAc:hexanes 1:1); FT-IR (neat) ν_{max} = 2954, 1709, 1615, 1434, 1379, 1309, 1220, 1095, 1064 cm^{-1}; ^1H NMR ($CDCl_3$, 500 MHz) δ = 3.76 (s, 3 H), 3.75 (s, 3 H), 3.67 (s, 3 H), 2.42 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 126 MHz) δ = 171.3, 167.0, 165.5, 106.9, 55.6, 52.4, 51.7, 14.1 ppm; HRMS (ESI) calcd for $C_8H_{12}O_5Na^+$ [M+Na^+] 211.0577, found 211.0579.

*On multidecagram scale, column chromatographic purification could be replaced by distillation under reduced pressure. The so-obtained product was less pure, but could be used in the next step without additional purification.



S5 S6

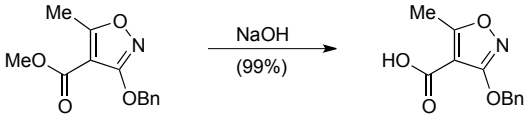
Isoxazole S6: A solution of sodium methoxide was prepared by treating sodium (2.80 g, 122 mmol, 3.1 equiv, cut into small pieces) with dry methanol (28 mL). A solution of hydroxylamine hydrochloride (3.70 g, 53.2 mmol, 1.4 equiv) in dry methanol (30 mL) and, subsequently, a solution of diester **S5** (7.30 g) in dry methanol (21 mL) were slowly added to the sodium methoxide solution at 0 °C. The reaction was allowed to warm to room temperature and stirred for 24 hours. The reaction was quenched with saturated aq. NH_4Cl solution (20 mL) and concentrated by rotary evaporation to remove most of the methanol. The residue was acidified to pH 4 with 5% aq. HCl, extracted with chloroform (6 × 100 mL), dried over $MgSO_4$, filtered, and concentrated to give isoxazole **S6** (2.94 g, 18.7 mmol, 48%) as a colorless solid. **S6**: R_f = 0.3 (silica gel, EtOAc:hexanes 1:1); FT-IR (neat) ν_{max} = 2959, 2826, 2611, 1704, 1630, 1535, 1430, 1312, 1187, 1121, 1082, 954, 812, 783 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz) δ = 8.41 (bs, 1 H), 3.94 (s, 3 H), 2.60 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 101 MHz) δ = 175.2, 169.6, 164.3, 98.9, 52.5, 14.1 ppm; HRMS (ESI) calcd for $C_6H_7NO_4H^+$ [M+H^+] 158.0448, found 158.0451.



S6 16

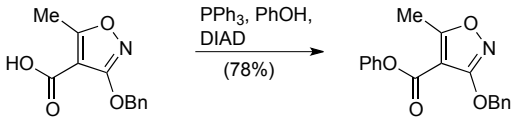
Benzyl isoxazole 16: To a stirred solution of isoxazole **S6** (8.16 g, 51.9 mmol) in dry DMF (500 mL) was added Ag_2O (18.2 g, 78.5 mmol, 1.5 equiv). After stirring for 5 minutes, benzyl bromide (7.6 mL, 11 g, 64 mmol, 1.2 equiv) was added and the reaction mixture was shielded from light with aluminum foil and stirred at room temperature for 18 hours. The reaction mixture

was then filtered through a silica gel pad and rinsed with EtOAc. The filtrate was concentrated to give the crude product as a thick dark orange-brown oil. Purification by column chromatography (EtOAc:hexanes 1:4) yielded **16** (8.58 g, 34.7 mmol, 67%) as a colorless solid. **16**: R_f = 0.3 (silica gel, EtOAc:hexanes 1:5); FT-IR (neat) ν_{max} = 3033, 2953, 1732, 1715, 1621, 1510, 1319, 1117, 784, 738, 697 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 7.49 – 7.46 (m, 2 H), 7.40 – 7.37 (m, 2 H), 7.34 (m, 1 H), 5.35 (s, 2 H), 3.84 (s, 3 H), 2.61 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 177.2, 169.2, 162.0, 135.8, 128.7, 128.4, 127.9, 100.7, 71.7, 51.8, 14.1 ppm; HRMS (ESI) calcd for $C_{13}H_{13}NO_4H^+$ [M+H^+] 248.0917, found 248.0906.



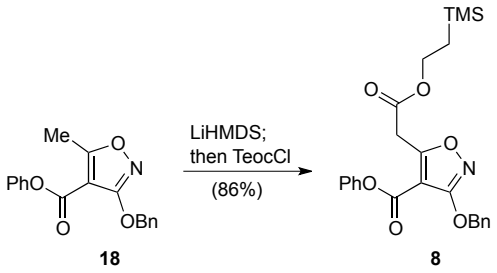
16 **17**

Isoxazole carboxylic acid 17: To a solution of methyl ester **16** (11.96 g, 48.38 mmol) in EtOH (100 mL) was added a solution of NaOH (3.7 g, 92 mmol, 1.9 equiv) in H_2O (30 mL), and the reaction mixture was stirred at room temperature for 3 hours. The reaction mixture was acidified to pH ~1 (5% aq. HCl), extracted with EtOAc (2 × 500 mL) and washed with brine (1 × 300 mL). The combined organic extracts were dried over Na_2SO_4 and concentrated to afford the acid **17** (11.14 g, 47.77 mmol, 99%) as a white solid. **17**: R_f = 0.7 (silica gel, MeOH:CH_2Cl_2 1:3); FT-IR (neat) ν_{max} = 3061, 3036, 2934, 1732, 1617, 1523, 1474, 1456, 1367, 1318, 1284, 1242, 1220, 1112, 1093, 1025, 986, 970, 953, 922, 909, 843, 782, 751, 738, 699 cm^{-1}; ^1H NMR (d_6-acetone, 600 MHz) δ = 7.54 – 7.51 (m, 2 H), 7.42 – 7.38 (m, 2 H), 7.35 (m, 1 H), 5.32 (s, 2 H), 2.61 (s, 3 H) ppm; ^{13}C NMR (d_6-acetone, 151 MHz) δ = 178.6, 170.6, 162.7, 137.6, 129.7, 129.5, 129.3, 101.7, 72.5, 14.3 ppm; HRMS (ESI) calcd for $C_{12}H_{10}NO_4H^+$ [M+H^+] 234.0761, found 234.0762.



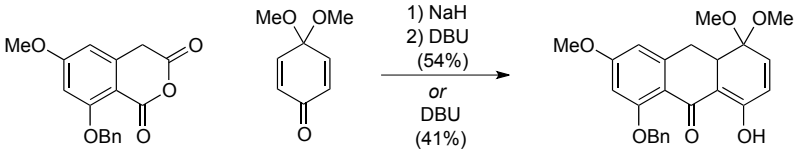
17 **18**

Phenyl ester isoxazole 18: To a solution of carboxylic acid **17** (11.0 g, 47.2 mmol) in THF (220 mL) were added PPh_3 (13.0 g, 49.6 mmol, 1.05 equiv) and phenol (4.67 g, 49.6 mmol, 1.05 equiv), and the resulting mixture was stirred at room temperature for 10 minutes. Then diisopropyl azodicarboxylate (DIAD, 9.8 mL, 49 mmol, 1.05 equiv) was added and the resulting mixture was heated at reflux for 3 hours. The reaction mixture was then cooled to room temperature and concentrated. The crude residue was purified by flash column chromatography (5% acetone:toluene) to give the phenyl ester **18** (11.4 g, 36.9 mmol, 78%) as a colorless oil that slowly solidified. The residue was recrystallized from CH_2Cl_2:pentane (1:8) in the fridge (4 °C) to give colorless needles (m.p. = 70–72 °C). **18**: R_f = 0.7 (silica gel, 5% acetone:toluene); FT-IR (neat) ν_{max} = 3067, 2931, 1952, 1801, 1720, 1682, 1620, 1587, 1515, 1494, 1468, 1453, 1445, 1368, 1308, 1295, 1270, 1192, 1163, 1111, 1066, 1033, 1024, 999, 978, 924, 910, 852, 833, 809, 776, 742, 729, 687 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz) δ = 7.51 – 7.48 (m, 2 H), 7.44 – 7.27 (m, 6 H), 7.20 – 7.18 (m, 2 H), 5.40 (s, 2 H), 2.70 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 101 MHz) δ = 178.1, 169.3, 159.8, 150.3, 135.7, 129.6, 128.6, 128.4, 127.7, 126.2, 121.8, 100.5, 71.7, 14.3 ppm; HRMS (ESI) calcd for $C_{18}H_{14}NO_4H^+$ [M+H^+] 310.1074, found 310.1067.



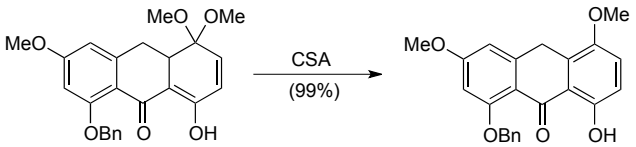
18 8

Teoc isoxazole 8: A solution of phenyl ester isoxazole **18** (5.0 g, 16 mmol) in THF (100 mL) was cooled to –78 °C and LiHMDS (1 M solution in THF:ethylbenzene, 35.6 mL, 35.6 mmol, 2.2 equiv) was added dropwise. The resulting red solution was stirred at –78 °C for 30 minutes. A separately prepared solution of TeocCl[7] (6.43 g, 35.6 mmol, 2.2 equiv) in THF (50 mL) was added dropwise and the mixture was stirred at –78 °C for 2 hours before being quenched with saturated aq. NH_4Cl solution. The mixture was diluted with water and extracted with Et_2O (3 × 200 mL). The organic phase was dried over Na_2SO_4, concentrated, and purified by flash column chromatography (Et_2O:hexanes 1:4) to give the product **8** (6.30 g, 13.9 mmol, 86%) as a pale yellow oil. **8**: R_f = 0.4 (silica gel, Et_2O:hexanes 1:4); FT-IR (neat) ν_{max} = 3293, 2984, 2940, 2840, 2163, 2051, 1981, 1738, 1663, 1628, 1592, 1515, 1476, 1442, 1389, 1368, 1330, 1290, 1266, 1241, 1223, 1192, 1165, 1135, 1104, 1056, 1027, 963, 897, 883, 866, 856, 798, 778, 750, 723, 690 cm^{-1}; ^1H NMR ($CDCl_3$, 400 MHz) δ = 7.51 – 7.48 (m, 2 H), 7.42 – 7.33 (m, 5 H), 7.28 – 7.24 (m, 1 H), 7.18 – 7.15 (m, 2 H), 5.41 (s, 2 H), 4.25 – 4.20 (m, 2 H), 4.12 (s, 2 H), 0.99 – 0.94 (m, 2 H), 0.02 (s, 9 H) ppm; ^{13}C NMR ($CDCl_3$, 101 MHz) δ = 173.3, 169.2, 166.6, 159.3, 150.1, 135.6, 129.6, 128.7, 128.5, 127.8, 126.3, 121.7, 102.1, 72.0, 64.5, 34.5, 17.4, –1.5 ppm; HRMS (ESI) calcd for $C_{24}H_{27}NO_6SiH^+$ [M+H^+] 454.1680, found 454.1685.



BCD Tricycle 19: To a solution of quinone **7** (3.10 g, 20.1 mmol, 3.0 equiv) in THF (45 mL) at 0 °C was added NaH (57–63% oil dispersion, 804 mg, 20.1 mmol, 3.0 equiv). Separately, a slurry of cyclic anhydride **6** (2.00 g, 6.71 mmol) in THF (45 mL) was prepared, and the cyclic anhydride solution was added to the quinone solution dropwise over 45 minutes, during which time a strong yellow color evolved. The cyclic anhydride flask was rinsed with additional THF (2 × 10 mL). The reaction flask was allowed to warm to room temperature and stirred for 1 hour. The reaction mixture was then re-cooled to 0 °C and quenched by cautious addition of saturated aq. NH_4Cl solution. The mixture was diluted with EtOAc (200 mL) and brine (100 mL) was added. The organic phase was separated, dried over Na_2SO_4, and concentrated. The crude residue was slurried in toluene (120 mL) and heated to 65 °C with vigorous stirring. DBU (3.0 mL, 20 mmol, 3.0 equiv) was injected into the reaction vessel while maintaining vigorous stirring. After 2 hours, an additional portion of DBU (2.0 mL, 13 mmol, 2 equiv) was added. After an additional 2.5 hours, the dark solution was cooled to room temperature and washed with brine (2 × 100 mL). The organic phase was concentrated, and the crude residue was purified by flash column chromatography (5→10→20→25→30% EtOAc:hexanes, 0.1% Et_3N) to give the tricyclic product **19** (1.48 g, 3.62 mmol, 54%) as a yellow foam. Alternatively, the reaction can be performed using the following "one-pot" protocol, which was run in two batches in parallel. Quinone **7** (3.90 g, 25.2 mmol, 3.0 equiv) was dissolved in MeCN (55 mL), and DBU (3.8 mL, 25 mmol, 3.0 equiv) was added. Separately, cyclic anhydride **6** (2.50 g, 8.39 mmol, 1.0 equiv) was slurried in MeCN (55 mL) and added to the quinone solution at room temperature over

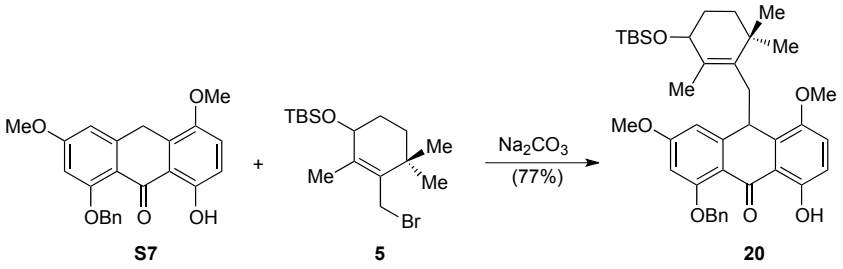
1 hour using a syringe pump with constant agitation. After the addition was complete, the mixture was heated to 65 °C for 3 hours. The dark mixture was then cooled to room temperature and concentrated. Purification by column chromatography (same gradient as above) gave the BCD tricycle **19** (2.80 g from two batches, 6.86 mmol, 41%). **19**: R_f = 0.3 (silica gel, EtOAc:hexanes 1:4); FT-IR (neat) ν_{max} = 2939, 2833, 1598, 1456, 1439, 1371, 1322, 1278, 1223, 1196, 1163, 1139, 1087, 1074 cm^{-1}; ^1H NMR (C_6D_6, 600 MHz) δ = 17.31 (s, 1 H), 7.59 – 7.56 (m, 2 H), 7.20 – 7.17 (m, 2 H), 7.07 (m, 1 H), 6.33 (d, *J* = 2.2 Hz, 1 H), 6.19 (d, *J* = 10.4 Hz, 1 H), 6.17 (m, 1 H), 5.93 (d, *J* = 10.4 Hz, 1 H), 4.87 (d, *J* = 12.5 Hz, 1 H, AB system), 4.79 (d, *J* = 12.5 Hz, 1 H, AB system), 3.31 (ap t, *J* = 15.0 Hz, 1 H), 3.19 (s, 3 H), 3.09 (dd, *J* = 14.4, 4.5 Hz, 1 H), 3.05 (s, 3 H), 3.01 (s, 3 H), 2.89 (dd, *J* = 15.3, 4.5 Hz, 1 H) ppm; ^{13}C NMR (C_6D_6, 151 MHz) δ = 183.8, 174.2, 164.2, 161.4, 146.3, 138.0, 137.4, 130.8, 128.7, 127.8, 127.1, 114.6, 105.8, 105.3, 99.8, 98.1, 70.6, 54.9, 50.5, 50.2, 38.2, 29.4 ppm; HRMS (ESI) calcd for $C_{24}H_{24}O_6H^+$ [*M*+H^+] 409.1646, found 409.1658.



19 **S7**

Anthrone S7: BCD tricycle **19** (3.6 g, 8.8 mmol) was dissolved in CH_2Cl_2 (88 mL) at room temperature and freshly crystallized CSA (41 mg, 0.18 mmol, 0.02 equiv) was added. The resulting solution was stirred for 30 minutes and was then quenched with saturated aq. $NaHCO_3$ solution (80 mL). The layers were separated, and the organic phase was dried over Na_2SO_4, filtered, and concentrated to give anthrone **S7** (3.28 g, 8.72 mmol, 99%) as an orange foam. **S7**: R_f = 0.3 (silica gel, EtOAc:hexanes 3:7); FT-IR (neat) ν_{max} = 2936, 2836, 1636, 1599, 1583,

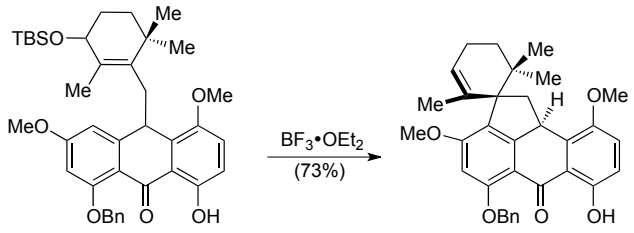
1475, 1432, 1384, 1330, 1267, 1228, 1195, 1170, 1096, 1059, 1027, 817, 733 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 13.03 (s, 1 H), 7.62 – 7.59 (m, 2 H), 7.43 – 7.39 (m, 2 H), 7.32 (m, 1 H), 7.02 (d, *J* = 8.9 Hz, 1 H), 6.85 (d, *J* = 8.9 Hz, 1 H), 6.51 (m, 1 H), 6.45 (m, 1 H), 5.24 (s, 2 H), 4.14 (s, 2 H), 3.85 (s, 3 H), 3.82 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 188.6, 164.2, 162.2, 156.4, 147.8, 146.3, 136.7, 128.8, 127.8, 127.4, 126.8, 117.7, 116.9, 115.2, 114.7, 105.0, 99.6, 70.7, 56.1, 55.6, 29.1 ppm; HRMS (ESI) calcd for $C_{23}H_{20}O_5H^+$ [*M*+H^+] 377.1389, found 377.1386.



Anthrone 20: A solution of anthrone **S7** (4.69 g, 12.5 mmol) and allylic bromide **5** (4.75 g, 13.7 mmol, 1.1 equiv) in DMF (250 mL) was degassed for 40 minutes by bubbling argon through the solution. During this time, the reaction flask was shielded from light using aluminum foil. After the degassing period, Na_2CO_3 (13.3 g, 125 mmol, 10 equiv) was added to the reaction flask, and the mixture was vigorously stirred for 1 hour in the dark. During this time, the reaction mixture typically turned very dark. The reaction was quenched by the addition of brine (1 L) and diluted with EtOAc (800 mL). The aqueous phase was extracted with EtOAc (500 mL), and the combined organics were washed with brine (1 L). The organic layer was dried over Na_2SO_4, filtered, and concentrated to give a crude oil which was purified by flash column chromatography (2→5→10% EtOAc:hexanes) to give pure alkylated anthrone **20** (6.19 g, 9.64 mmol, 77%) as a yellow foam (d.r. ca. 1:1 as judged by ^1H NMR analysis). **20**: R_f = 0.5 (silica gel, EtOAc:hexanes 1:4); FT-IR (neat) ν_{max} = 2932, 2856, 1636, 1599, 1583, 1568, 1472,

1432, 1328, 1265, 1227, 1196, 1164, 1148, 1101, 1034, 1002, 907, 832, 772, 728 cm^{-1}; This compound exhibited broad NMR signals (both in ^{1}H NMR and ^{13}C NMR) on the NMR timescale due to hindered bond rotation of the newly-formed C–C bond. ^{1}H NMR ($CDCl_3$, 600 MHz, 298 K) δ = 12.72 (bs, 1 H), 12.71 (s, 1 H), 7.58 – 7.56 (m, 4 H), 7.41 – 7.37 (m, 4 H), 7.32 – 7.28 (m, 2 H), 7.05 (d, *J* = 9.0 Hz, 1 H), 7.045 (d, *J* = 9.0 Hz, 1 H), 6.86 (d, *J* = 9.0 Hz, 1 H), 6.85 (d, *J* = 9.0 Hz, 1 H), 6.44 (d, *J* = 2.3 Hz, 1 H), 6.43 (d, *J* = 2.3 Hz, 1 H), 6.39 (bs, 1 H), 6.29 (m, 1 H), 5.28 (d, *J* = 12.9 Hz, 2 H, AB system), 5.25 – 5.20 (m, 2 H), 4.64 (bs, 1 H), 4.56 (bs, 1 H), 3.98 – 3.95 (m, 2 H), 3.91 – 3.88 (m, 6 H), 3.85 – 3.82 (m, 6 H), 2.75 – 2.65 (m, 2 H), 2.04 – 0.88 (m, 40 H), 0.83 – 0.59 (m, 3 H), 0.32 – 0.00 (m, 15 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz, 23 °C)* δ = 188.6, 188.5, 163.7, 163.6, 161.9, 161.8, 156.23, 156.20, 150.3 (b), 129.6 (b), 147.7, 147.6, 136.68, 136.65, 133.6, 133.4, 128.7, 127.74, 127.73, 126.70, 126.69, 117.70, 117.67, 117.65, 117.61, 115.05, 115.0, 114.99, 114.89, 106.6, 106.4, 100.1, 71.6, 70.7, 56.02, 55.99, 55.7, 55.5, 41.1, 40.6, 38.6, 37.1, 35.9, 34.4, 29.74, 29.66, 29.1, 28.9, 26.6, 26.1, 26.0, 25.8, 18.32, 18.31, 16.6, 16.4, 11.6, –4.0, –4.2, –4.66, –4.68 ppm; HRMS (ESI) calcd for $C_{39}H_{50}O_6SiH^+$ [M+H^+] 643.3449, found 643.3441.

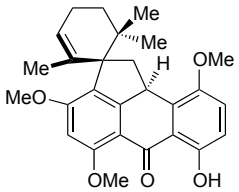
*Due to signal broadening, not all the ^{13}C signals could be identified.



20 **22**

BCDEF Spirocycle 22: Alkylated anthrone **20** (2.30 g, 3.58 mmol) was dissolved in CH_2Cl_2 (180 mL) and cooled to 0 °C. A freshly prepared solution of BF_3•OEt_2 (3.6 mL of a 0.1 M in

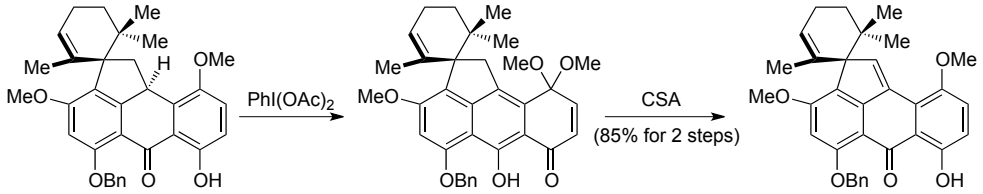
CH_2Cl_2, 0.36 mmol, 0.15 equiv) was added dropwise, and the reaction mixture was allowed to stir for 20 minutes. The reaction was quenched with saturated aq. $NaHCO_3$ solution (100 mL), and the phases were separated. The aqueous phase was extracted with CH_2Cl_2 (100 mL), and the combined organic layers were dried over Na_2SO_4, filtered, and concentrated. The residue was purified by flash column chromatography (5→10% EtOAc:hexanes) to give spirocycle **22** (1.34 g, 2.62 mmol, 73%) as a yellow foam. **22**: R_f = 0.5 (silica gel, EtOAc:hexanes 1:4); FT-IR (neat) ν_{max} = 2919, 2838, 1633, 1598, 1567, 1472, 1441, 1384, 1327, 1301, 1270, 1257, 1221, 1200, 1139, 1106, 1039, 1001, 909, 825, 732 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 13.15 (s, 1 H), 7.62 – 7.59 (m, 2 H), 7.43 – 7.40 (m, 2 H), 7.32 (m, 1 H), 7.06 (d, *J* = 9.0 Hz, 1 H), 6.86 (d, *J* = 9.0 Hz, 1 H), 6.40 (s, 1 H), 5.43 (bs, 1 H), 5.37 (d, *J* = 12.7 Hz, 1 H, AB system), 5.28 (d, *J* = 12.7 Hz, 1 H, AB system), 4.39 (dd, *J* = 11.8, 7.5 Hz, 1 H), 3.81 (s, 3 H), 3.75 (s, 3 H), 3.13 (dd, *J* = 13.7, 7.5 Hz, 1 H), 2.25 – 2.16 (m, 2 H), 2.04 (m, 1 H), 1.95 (ddd, *J* = 12.7, 12.7, 6.0 Hz, 1 H), 1.37 (dd, *J* = 12.7, 5.8 Hz, 1 H), 1.26 (s, 3 H), 1.00 (s, 3 H), 0.96 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 188.9, 162.1, 161.2, 157.4, 155.4, 149.2, 138.3, 136.9, 131.1, 128.8, 128.0, 127.0, 124.0, 121.3, 119.2, 118.1, 115.7, 112.7, 96.9, 71.5, 58.7, 56.6, 55.2, 44.9, 41.7, 38.8, 34.9, 27.8, 24.9, 23.1, 20.5 ppm; HRMS (ESI) calcd for $C_{33}H_{34}O_5H^+$ [*M*+H^+] 511.2479, found 511.2467.



23

Spirocycle 23: This compound was prepared using an analogous procedure as above starting from the corresponding bis-methylated cyclic anhydride. The material was crystallized from $CHCl_3$:EtOAc (1:1) to give crystals suitable for X-ray crystallographic analysis (m.p. = 114–115

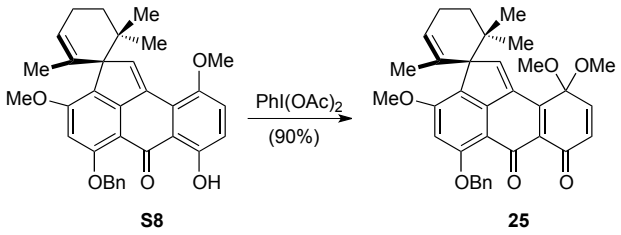
°C). **23**: R_f = 0.5 (silica gel, EtOAc:hexanes 3:7); FT-IR (neat) ν_{max} = 2940, 2916, 2835, 1632, 1600, 1567, 1471, 1438, 1329, 1302, 1257, 1217, 1137, 1107, 1039, 1002, 922, 825, 730 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 13.01 (s, 1 H), 7.05 (d, *J* = 9.0 Hz, 1 H), 6.85 (d, *J* = 9.0 Hz, 1 H), 6.38 (s, 1 H), 5.44 (bs, 1 H), 4.38 (dd, *J* = 11.8, 7.5 Hz, 1 H), 4.04 (s, 3 H), 3.86 (s, 3 H), 3.81 (s, 3 H), 3.13 (dd, *J* = 13.7, 7.5 Hz, 1 H), 2.25 – 2.17 (m, 2 H), 2.03 (m, 1 H), 1.95 (ddd, *J* = 12.5, 12.5, 6.1 Hz, 1 H), 1.38 (dd, *J* = 12.5, 6.0 Hz, 1 H), 1.29 (s, 3 H), 1.01 (s, 3 H), 0.96 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 189.1, 162.4, 162.3, 157.3, 155.6, 149.2, 138.3, 131.0, 123.5, 121.3, 119.3, 118.1, 115.8, 112.1, 94.3, 58.7, 56.6, 56.5, 55.2, 44.8, 41.7, 38.8, 34.9, 27.8, 24.9, 23.1, 20.6 ppm; HRMS (ESI) calcd for $C_{27}H_{30}O_5H^+$ [*M*+H^+] 435.2166, found 435.2162.



22 **24** **S8**

Quinomethide S8: Spirocycle **22** (200 mg, 0.392 mmol) was dissolved in MeOH:CH_2Cl_2 (1:1, 8 mL), and the solution was cooled to 0 °C. $PhI(OAc)_2$[8] (151 mg, 0.469 mmol, 1.2 equiv) was added and the reaction mixture was stirred for 30 minutes at 0 °C and 30 minutes at room temperature. The reaction was quenched with saturated aq. $NaHCO_3$ (20 mL) and extracted with EtOAc (2 × 20 mL). The combined organics were washed with brine (10 mL), dried over Na_2SO_4, and concentrated. The so-obtained crude ketal **24** was dissolved in CH_2Cl_2 (8 mL), and freshly crystallized CSA (6 mg, 0.03 mmol, 0.07 equiv) was added at 0 °C. The reaction mixture was stirred at that temperature for 5 minutes and was then quenched with saturated aq. $NaHCO_3$ solution (10 mL). The layers were separated, and the organic phase was dried over Na_2SO_4, filtered, and concentrated to give the crude product **S8**. Flash column chromatography (2%

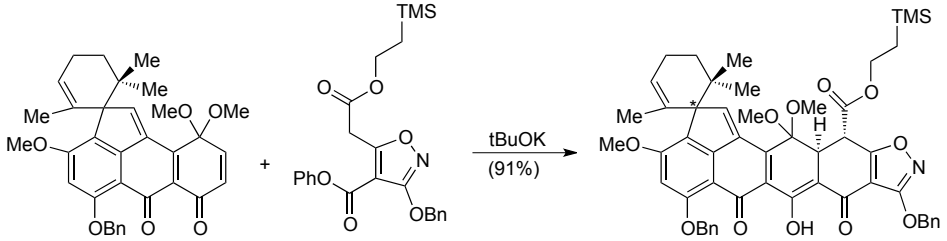
EtOAc:toluene) gave intermediate **S8** (169 mg, 0.332 mmol, 85% for 2 steps) as a red solid. **S8**: R_f = 0.7 (silica gel, EtOAc:hexanes 1:9); FT-IR (neat) ν_{max} = 2936, 2324, 2162, 2050, 1981, 1625, 1574, 1479, 1442, 1429, 1384, 1363, 1331, 1311, 1259, 1238, 1222, 1180, 1163, 1128, 1029, 931, 874, 829, 806, 735, 716, 696 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 13.98 (s, 1 H), 7.65 – 7.63 (m, 2 H), 7.60 (s, 1 H), 7.45 – 7.41 (m, 2 H), 7.34 (m, 1 H), 7.20 (d, *J* = 6.0 Hz, 1 H), 7.00 (d, *J* = 6.0 Hz, 1 H), 6.44 (s, 1 H), 5.74 (bs, 1 H), 5.38 (d, *J* = 12.8 Hz, 1 H, AB system), 5.35 (d, *J* = 12.8 Hz, 1 H, AB system), 3.97 (s, 3 H), 3.81 (s, 3 H), 2.31 – 2.22 (m, 2 H), 1.90 (ddd, *J* = 12.9, 5.6, 5.6 Hz, 1 H), 1.66 (ddd, *J* = 12.9, 6.5, 6.5 Hz, 1 H), 1.14 (s, 3 H), 0.85 (s, 6 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 188.5, 161.2, 159.8, 157.9, 152.4, 151.6, 150.4, 136.9, 131.7, 130.6, 128.8, 128.0, 126.9, 124.6, 124.1, 120.2, 118.1, 117.4, 116.8, 110.3, 96.0, 71.4, 66.9, 56.2, 55.5, 37.0, 35.8, 27.1, 26.8, 23.2, 19.8 ppm; HRMS (ESI) calcd for $C_{33}H_{32}O_5H^+$ [M+H^+] 509.2322, found 509.2323.



S8 **25**

Ketal 25: Quinomethide **S8** (2.60 g, 5.09 mmol) was dissolved in a mixture of CH_2Cl_2:methanol (1:10; 101 mL), and $PhI(OAc)_2$[8] (2.0 g, 6.2 mmol, 1.2 equiv) was added. The reaction mixture was stirred for 1.5 hours and was then quenched with saturated aq. $NaHCO_3$ (100 mL). The mixture was diluted with water and extracted with CH_2Cl_2 (200 mL), dried over Na_2SO_4, filtered, and concentrated. The crude residue was purified by flash column chromatography (4% acetone:toluene, 0.1% Et_3N) to give diketone ketal **25** (2.47 g, 4.58 mmol, 90% yield) as a yellow foam. **25**: R_f = 0.3 (silica gel, acetone:toluene 1:9); FT-IR (neat) ν_{max} = 2937, 2835, 1681,

1618, 1582, 1456, 1435, 1373, 1328, 1282, 1224, 1094, 1082, 1067, 846, 733 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 7.83 (s, 1 H), 7.65 – 7.62 (m, 2 H), 7.43 – 7.39 (m, 2 H), 7.32 (m, 1 H), 6.64 (d, *J* = 10.4 Hz, 1 H), 6.59 (d, *J* = 10.4 Hz, 1 H), 6.43 (s, 1 H), 5.76 (bs, 1 H), 5.30 (d, *J* = 12.0 Hz, 1 H, AB system), 5.26 (d, *J* = 12.0 Hz, 1 H, AB system), 3.82 (s, 3 H), 3.26 (s, 3 H), 3.17 (s, 3 H), 2.28 – 2.23 (m, 2 H), 1.94 (ddd, *J* = 13.1, 6.3, 6.3 Hz, 1 H), 1.61 (m, 1 H), 1.13 (bs, 3 H), 0.88 (s, 3 H), 0.82 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 183.3, 179.6, 161.6, 160.6, 159.2, 148.4, 147.1, 140.9, 136.7, 135.2, 130.5, 130.1, 130.0, 128.7, 127.9, 127.1, 125.0, 123.5, 112.2, 96.7, 96.5, 71.1, 68.6, 56.0, 51.7, 51.6, 37.5, 35.5, 27.1, 26.9, 23.1, 19.9 ppm; HRMS (ESI) calcd for $C_{34}H_{34}O_6H^+$ [*M*+H^+] 539.2428, found 539.2433.



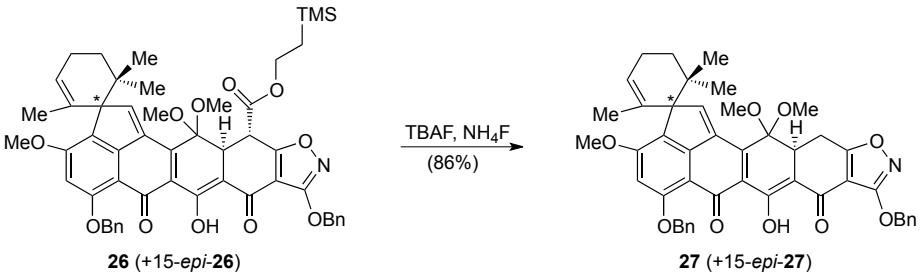
25 **8** **26** (+15-*epi*-**26**)

Heptacycle 26 (+ 15-*epi*-26): To a solution of pentacycle **25** (2.5 g, 4.6 mmol) and phenyl ester isoxazole **8** (2.3 g, 5.1 mmol, 1.1 equiv) in toluene (90 mL) was added potassium *tert*-butoxide (0.62 g, 5.6 mmol, 1.2 equiv), and the resulting solution was stirred for 15 minutes. The reaction was quenched with saturated aq. NH_4Cl (100 mL). The phases were separated, and the organic phase was dried over Na_2SO_4, filtered, and concentrated. The crude residue was purified by flash column chromatography (2→5% acetone:toluene) to give the product **26** (+ 15-*epi*-**26**) (3.8 g, 4.2 mmol, 91%, d.r. ca. 2:1) as a yellow foam. **26** (+ 15-*epi*-**26**): R_f = 0.6 (silica gel, EtOAc:hexanes 3:7); FT-IR (neat) ν_{max} = 2952, 1737, 1656, 1618, 1582, 1511, 1489, 1454, 1385, 1366, 1308, 1250, 1223, 1157, 1054, 1025, 932, 859, 838, 736, 696 cm^{-1}; ^1H NMR (C_6D_6,

600 MHz) δ = 16.78 (s, 1 H, major), 16.77 (s, 1 H, minor), 7.70 – 7.64 (m, 4 H, major + minor), 7.61 (s, 1 H, minor), 7.58 (s, 1 H, major), 7.39 – 7.35 (m, 4 H, major + minor), 7.21 – 7.17 (m, 4 H, major + minor), 7.12 – 7.07 (m, 6 H, major + minor), 7.06 – 7.02 (m, 2 H, major + minor), 6.22 – 6.19 (m, 2 H, major + minor), 5.72 (bs, 1 H, minor), 5.69 (bs, 1 H, major), 5.19 – 5.17 (m, 4 H, major + minor), 5.06 – 5.01 (m, 4 H, major + minor), 4.73 (d, *J* = 10.0 Hz, 1 H, major), 4.72 (m, 1 H, minor), 4.42 – 4.35 (m, 2 H, major + minor), 4.34 – 4.26 (m, 2 H, major + minor), 4.22 (d, *J* = 10.0 Hz, 1 H, major), 4.20 (m, 1 H, minor), 3.19 (s, 3 H, major), 3.18 (s, 3 H, minor), 3.13 (s, 3 H, major), 3.08 (s, 3 H, minor), 3.02 (s, 3 H, minor), 2.96 (s, 3 H, major), 2.26 – 2.18 (m, 2 H, major + minor), 2.14 – 2.07 (m, 2 H, major + minor), 1.96 (ddd, *J* = 13.2, 6.6, 6.6 Hz, 1 H, major), 1.89 (ddd, *J* = 13.2, 6.7, 6,7 Hz, 1 H, minor), 1.47 (ap ddd, *J* = 13.2, 6.7, 6.7 Hz, 2 H, major + minor), 1.24 (bs, 3 H, minor), 1.18 (bs, 3 H, major), 1.03 – 0.98 (m, 4 H, major + minor), 0.93 (s, 3 H, major), 0.91 (s, 3 H, minor), 0.87 (s, 3 H, major), 0.82 (s, 3 H, minor), –0.09 (s, 9 H, major), –0.11 (s, 9 H, minor) ppm; ^{13}C NMR (C_6D_6, 151 MHz) δ = 181.5 (major), 181.4 (minor), 178.7 (major), 178.3 (minor), 175.5 (major), 175.4 (minor), 171.6 (minor), 171.4 (major), 169.2 (major), 169.1 (minor), 168.4 (major + minor), 161.0 (minor), 160.5 (major), 159.1 (minor), 158.9 (major), 157.2 (major), 157.1 (minor), 148.7 (minor), 148.5 (major), 140.01 (minor), 139.95 (major), 137.4 (minor), 137.3 (major), 135.9 (major + minor), 134.9 (minor), 134.8 (major), 132.5 (major), 132.4 (minor), 130.8 (minor), 130.7 (major), 128.9*, 128.7*, 128.51*, 128.47*, 127.3*, 127.2*, 125.12 (minor), 125.08 (major), 123.5 (minor), 123.3 (major), 113.3 (major), 113.2 (minor), 106.3 (major + minor), 103.30 (major), 103.27 (minor), 102.6 (major), 102.5 (minor), 97.7 (minor), 97.4 (major), 72.3 (major + minor), 71.6 (minor), 71.4 (major), 68.4 (minor), 68.3 (major), 64.8 (major + minor), 54.9 (major + minor), 54.2 (major), 53.7 (minor), 52.8 (minor), 52.5 (major), 40.61 (minor), 40.58 (major), 40.2 (major + minor),

37.7 (major), 37.5 (minor), 35.8 (major + minor), 27.22 (major), 27.16 (minor), 27.14 (minor), 27.07 (major), 23.4 (major + minor), 20.3 (minor), 20.2 (major), 17.4 (major + minor), –1.66 (major), –1.67 (minor) ppm; HRMS (ESI) calcd for $C_{52}H_{55}NO_{11}SiH^+$ [M+H^+] 898.3617, found 898.3612.

*Due to overlapping ^{13}C resonances of each diastereomer with each other as well as with the NMR solvent, not all of the signals could be assigned.



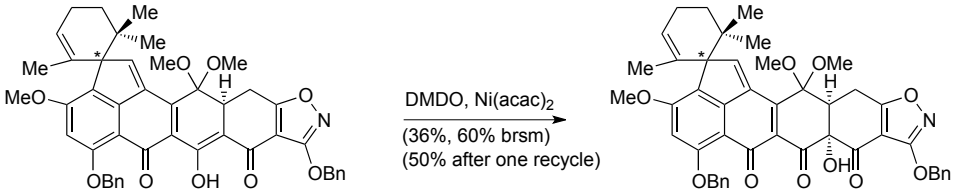
26 (+15-*epi*-**26**) **27** (+15-*epi*-**27**)

Heptacycle 27 (+ 15-*epi*-27): To a solution of Teoc-heptacycle **26** (+ 15-*epi*-**26**) (3.2 g, 3.6 mmol, d.r. ca. 2:1) in THF (400 mL) was added ammonium fluoride (2.7 g, 71 mmol, 20 equiv), and the solution was degassed with argon for 1 hour. The degassing was discontinued, and the reaction flask was shielded from light using aluminum foil. A freshly prepared solution of tetrabutylammonium fluoride (36 mL, 1 M solution in THF, 36 mmol, 10 equiv, prepared from TBAF trihydrate) was added in one portion. The reaction mixture was stirred for 5 minutes. The reaction was then quenched with brine (250 mL) and extracted with EtOAc (250 mL). The layers were separated, and the organic phase was washed with water (3 × 200 mL), dried over Na_2SO_4, and concentrated. The crude residue was purified by flash column chromatography (2→5% acetone:toluene) to give heptacycle **27** (+ 15-*epi*-**27**) (2.3 g, 3.1 mmol, 86%, d.r. ca. 2:1) as an orange solid. **27** (+ 15-*epi*-**27**): R_f = 0.5 (silica gel, acetone:toluene 1:9); FT-IR (neat) ν_{max} = 2956, 2927, 2855, 1711, 1653, 1618, 1582, 1509, 1455, 1365, 1311, 1258, 1219, 1157, 1075,

1052, 1027, 912, 814, 736, 697 cm^{-1}; ^{1}H NMR ($CDCl_3$, 600 MHz) δ = 15.60 (s, 1 H, major), 15.59 (s, 1 H, minor), 7.72 (s, 1 H, major), 7.70 (s, 1 H, minor), 7.61 – 7.57 (m, 4 H, major + minor), 7.52 – 7.49 (m, 4 H, major + minor), 7.41 – 7.36 (m, 8 H, major + minor), 7.35 – 7.29 (m, 4 H, major + minor), 6.45 (s, 1 H, minor), 6.44 (s, 1 H, major), 5.77 (bs, 1 H, minor), 5.76 (bs, 1 H, major), 5.40 (ap s, 4 H, major + minor), 5.33 (d, *J* = 12.7 Hz, 1 H, major, AB system), 5.30 – 5.25 (m, 3 H, major + minor), 3.91 (dd, *J* = 11.0, 8.4 Hz, 1 H, major), 3.86 (dd, *J* = 11.0, 8.5 Hz, 1 H, minor), 3.80 (s, 3 H, minor), 3.79 (s, 3 H, major), 3.46 – 3.40 (m, 2 H, major + minor), 3.45 (s, 3 H, major), 3.40 (s, 3 H, minor), 3.34 (s, 3 H, minor), 3.27 (s, 3 H, major), 3.03 – 2.94 (m, 2 H, major + minor), 2.26 (ap s, 4 H, major + minor), 1.99 (ap ddd, *J* = 13.2, 6.6, 6.6 Hz, 2 H, major + minor), 1.58 – 1.52 (m, 2 H, major + minor), 1.13 (s, 3 H, minor), 1.09 (s, 3 H, major), 0.92 (s, 3 H, major), 0.88 (s, 3 H, minor), 0.79 (s, 3 H, major), 0.77 (s, 3 H, minor) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 182.1 (major), 181.0 (minor), 180.1 (major), 179.8 (minor), 179.09 (major), 179.06 (minor), 169.9 (minor), 168.1 (major), 160.7 (minor), 160.3 (major), 159.39 (major), 159.35 (minor), 159.2 (minor), 159.1 (major), 148.2 (minor), 148.1 (major), 141.14 (minor), 141.13 (major), 136.79 (major), 136.77 (minor), 135.5 (major + minor), 132.89 (minor), 132.86 (major), 132.60 (major), 132.55 (minor), 130.0 (major + minor), 128.8*, 128.7*, 128.6*, 128.4*, 127.9*, 127.2 (minor), 127.1 (major), 125.24 (minor), 125.22 (major), 123.4 (minor), 123.2 (major), 112.3 (major), 112.2 (minor), 105.7 (major + minor), 103.42 (major), 103.37 (minor), 102.18 (major), 102.15 (minor), 97.1 (minor), 97.0 (major), 72.4 (major + minor), 71.4 (minor), 71.3 (major), 68.4 (minor), 68.3 (major), 55.6 (minor), 55.5 (major), 53.6 (major), 53.1 (minor), 52.9 (minor), 52.6 (major), 37.8 (major), 37.6 (minor), 37.0 (minor), 36.9 (major), 35.64 (major), 35.60 (minor), 27.30 (minor), 27.25 (major), 26.9 (minor), 26.8 (major),

23.13 (major), 23.10 (minor), 20.5 (major + minor), 20.03 (major), 20.00 (minor) ppm; HRMS (ESI) calcd for $C_{46}H_{43}NO_9H^+$ [M+H^+] 754.3010, found 754.3000.

*Due to overlapping ^{13}C resonances of each diastereomer with each other, not all of the signals could be assigned.



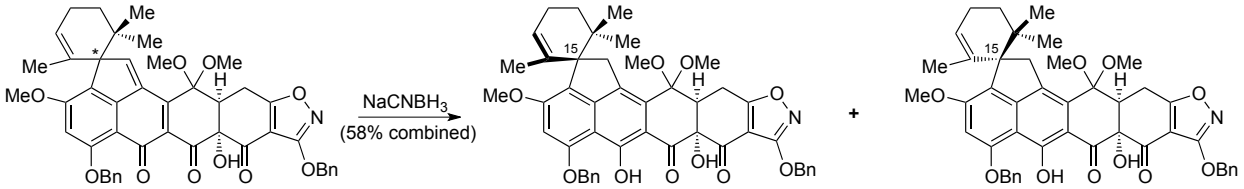
27 (+15-*epi*-**27**) **S9** (+15-*epi*-**S9**)

Alcohol S9 (+ 15-*epi*-S9): A solution of substrate **27** (+ 15-*epi*-**27**) (1.6 g, 2.1 mmol, d.r. ca. 2:1) in anhydrous CH_2Cl_2 (100 mL) was cooled to –78 °C, and $Ni(acac)_2$ (109 mg, 0.424 mmol, 0.2 equiv) was added. Then, DMDO[9] (56 mL of a ~0.08 M solution in acetone, 4.5 mmol, 2.1 equiv) was added. The reaction mixture was allowed to warm to –60 °C over 6.5 hours, during which two additional portions of DMDO (40 mL, 3.2 mmol, 1.5 equiv) and CH_2Cl_2 (20 mL each) were added every 2 hours. The reaction was then quenched by the addition of dimethylsulfide (5.0 mL, 4.2 g, 68 mmol), and the mixture was stirred at the same temperature for 15 minutes. Saturated aq. NH_4Cl solution was added, and the mixture was allowed to warm to room temperature. The mixture was diluted with water (150 mL) and extracted with CH_2Cl_2 (150 mL). The layers were separated, and the organic phase was washed with water (250 mL) and brine (250 mL), dried over Na_2SO_4, and concentrated. Purification by flash column chromatography (3→5→10% acetone:toluene) gave the hydroxylated product **S9** (+ 15-*epi*-**S9**) (575 mg, 0.747 mmol, 36%, 60% based on recovered starting material, d.r. ca. 2:1) as an orange solid and recovered starting material **27** (+ 15-*epi*-**27**) (630 mg, 0.837 mmol, 40%). The recovered starting material could be resubjected to the reaction conditions to give hydroxylated

product **S9** (+ 15-*epi*-**S9**) (0.800 g combined, 1.04 mmol, 50% combined, d.r. ca. 2:1) as an orange foam. **S9** (+ 15-*epi*-**S9**): R_f = 0.25 (silica gel, acetone:toluene 1:9); FT-IR (neat) ν_{max} = 3425, 2931, 2850, 1719, 1618, 1582, 1514, 1488, 1455, 1366, 1313, 1259, 1224, 1132, 1103, 1055, 991, 829, 735, 696 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 7.862 (s, 1 H, major), 7.855 (s, 1 H, minor), 7.61 – 7.58 (m, 4 H, major + minor), 7.44 – 7.37 (m, 8 H, major + minor), 7.35 – 7.29 (m, 8 H, major + minor), 6.45 (s, 1 H, major), 6.44 (s, 1 H, minor), 5.79 (bs, 2 H, major + minor), 5.28 – 5.20 (m, 8 H, major + minor), 5.04 (bs, 2 H, major + minor), 3.83 (s, 6 H, major + minor), 3.45 (s, 3 H, minor), 3.42 (s, 3 H, major), 3.39 (dd, *J* = 9.3, 6.2 Hz, 2 H, major + minor), 3.25 (s, 3 H, major), 3.24 – 3.19 (m, 2 H, major + minor), 3.16 (s, 3 H, minor), 2.95 (dd, *J* = 19.1, 6.4 Hz, 1 H, minor), 2.89 (dd, *J* = 19.1, 6.3 Hz, 1 H, major), 2.28 (bs, 4 H, major + minor), 1.96 – 1.87 (m, 2 H, major + minor), 1.64 – 1.58 (m, 2 H, major + minor), 1.10 (s, 3 H, major), 1.09 (s, 3 H, minor), 0.84 (bs, 6 H, major + minor), 0.83 (s, 3 H, minor), 0.82 (s, 3 H, major) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 191.7 (major), 191.5 (minor), 184.0 (minor), 183.9 (major), 180.0 (major), 179.9 (minor), 177.5 (minor), 177.3 (major), 167.81 (major), 167.79 (minor), 162.94 (minor), 162.87 (major), 160.9 (major), 160.7 (minor), 159.5 (major), 159.4 (minor), 148.6 (major), 148.5 (minor), 146.7 (major), 146.6 (minor), 136.5 (major + minor), 135.0 (major + minor), 132.6 (major), 132.4 (minor), 132.2 (major + minor), 130.1 (major), 129.9 (minor), 128.8*, 128.62*, 128.56*, 128.21*, 128.19*, 127.9*, 127.0*, 125.4 (minor), 125.2 (major), 123.5 (major), 123.4 (minor), 111.62 (major), 111.57 (minor), 106.4 (minor), 106.3 (major), 102.47 (major), 102.45 (minor), 96.8 (major), 96.6 (minor), 80.6 (minor), 80.4 (major), 72.5 (minor), 72.4 (major), 71.3 (major), 71.2 (minor), 68.50 (minor), 68.46 (major), 55.59 (major), 55.57 (minor), 51.9 (major), 51.7 (minor), 49.4 (major), 49.3 (minor), 44.4 (major + minor), 37.84 (major), 37.75 (minor), 35.8 (major), 35.6 (minor), 27.1 (major + minor), 26.93

(major), 26.90 (minor), 23.1 (major + minor), 22.7 (minor), 22.6 (major), 20.1 (major), 19.9 (minor) ppm; HRMS (ESI) calcd for $C_{46}H_{43}NO_{10}H^+$ [M+H^+] 770.2960, found 770.2953.

*Due to overlapping ^{13}C resonances of each diastereomer with each other, not all of the signals could be assigned.

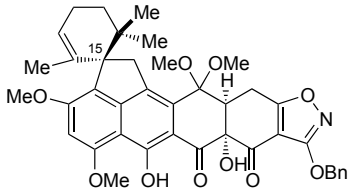


S9 (+15-*epi*-**S9**) **28** (39%) 15-*epi*-**28** (19%)

Alcohol 28 and 15-*epi*-28: A solution of alcohol **S9** (+ 15-*epi*-**S9**) (225 mg, 0.292 mmol, d.r. ca. 2:1) in THF (16 mL) was cooled to –78 °C to which was added $NaCNBH_3$ (182 mg, 2.90 mmol, 10 equiv). The solution was allowed to stir for 1.5 hours as it gradually warmed to –60 °C. The reaction mixture was quenched with saturated aq. NH_4Cl solution and allowed to warm to room temperature. The solution was diluted with water (20 mL) and extracted with EtOAc (30 mL). The layers were separated, and the aqueous phase was extracted once with EtOAc (20 mL). The combined organics were dried over Na_2SO_4, filtered, and concentrated. The crude residue was passed through a short column of silica (5→10% acetone:toluene) to remove residual cyanoborohydride reagent. The crude material was then purified by preparative TLC (acetone:toluene 1:9) to give naphthol **28** (88 mg, 0.11 mmol, 39%) and 15-*epi*-**28** (43 mg, 0.056 mmol, 19%) as yellow powders. **28**: R_f = 0.6 (silica gel, acetone:toluene 1:4); FT-IR (neat) ν_{max} = 3409, 2939, 1715, 1592, 1514, 1484, 1448, 1407, 1344, 1307, 1219, 1131, 1105, 1049, 994, 905, 735, 696 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 15.40 (s, 1 H), 7.62 – 7.56 (m, 2 H), 7.49 – 7.45 (m, 2 H), 7.42 – 7.39 (m, 2 H), 7.38 – 7.30 (m, 4 H), 6.66 (s, 1 H), 5.62 (bs, 1 H), 5.49 (bs, 1 H), 5.35 – 5.28 (m, 4 H), 3.84 (s, 3 H), 3.49 (d, J = 18.8 Hz, 1 H), 3.38 – 3.31 (m, 1 H), 3.35 (s, 3 H),

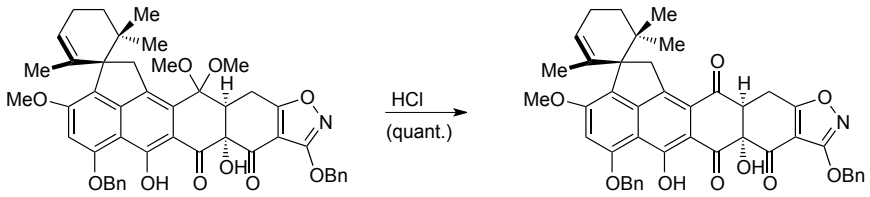
3.34 (s, 3 H), 3.16 (d, J = 18.8 Hz, 1 H), 3.09 (dd, J = 18.8, 7.4 Hz, 1 H), 2.82 (dd, J = 18.8, 8.4 Hz, 1 H), 2.23 (m, 1 H), 2.06 (m, 1 H), 1.79 (ddd, J = 12.3, 12.3, 6.2 Hz, 1 H), 1.46 (s, 3 H), 1.36 (dd, J = 12.3, 5.9 Hz, 1 H), 0.94 (s, 3 H), 0.48 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 193.8, 184.3, 179.3, 168.4, 168.0, 159.5, 159.3, 148.3, 137.4, 136.5, 135.2, 134.5, 128.8, 128.60, 128.55, 128.2, 128.0, 126.9, 123.6, 123.2, 120.8, 109.0, 107.7, 106.3, 102.4, 98.1, 78.3, 72.4, 71.5, 58.5, 55.5, 51.2, 48.2, 45.1, 43.8, 38.1, 34.2, 25.8, 24.7, 23.5, 23.0, 21.1 ppm; HRMS (ESI) calcd for $C_{46}H_{45}NO_{10}Na^+$ [M+Na^+] 794.2936, found 794.2919.

15-*epi*-28: R_f = 0.5 (silica gel, acetone:toluene 1:4); FT-IR (neat) ν_{max} = 3400, 2940, 2921, 1717, 1593, 1514, 1485, 1448, 1408, 1370, 1345, 1306, 1235, 1219, 1130, 1104, 1048, 998, 904, 820, 735, 696 cm^{-1}; ^{1}H NMR ($CDCl_3$, 600 MHz) δ = 15.55 (s, 1 H), 7.60 – 7.57 (m, 2 H), 7.49 – 7.47 (m, 2 H), 7.42 – 7.30 (m, 6 H), 6.65 (s, 1 H), 5.70 (s, 1 H), 5.52 (bs, 1 H), 5.33 (s, 2 H), 5.30 (s, 2 H), 3.85 – 3.80 (m, 4 H), 3.44 (s, 3 H), 3.35 (m, 1 H), 3.16 (dd, J = 19.0, 7.5 Hz, 1 H), 3.13 (s, 3 H), 2.97 (d, J = 18.3 Hz, 1 H), 2.87 (dd, J = 19.0, 10.0 Hz, 1 H), 2.23 (m, 1 H), 2.05 (m, 1 H), 1.84 (ddd, J = 12.6, 12.6, 6.1 Hz, 1 H), 1.51 (s, 3 H), 1.34 (dd, J = 12.6, 5.5 Hz, 1 H), 0.88 (s, 3 H), 0.42 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 193.4, 184.3, 179.2, 168.9, 168.0, 159.5, 159.3, 148.2, 137.2, 136.6, 135.14, 135.12, 128.8, 128.62, 128.60, 128.3, 128.0, 126.9, 123.5, 122.9, 121.3, 108.8, 107.3, 106.5, 102.5, 98.2, 78.4, 72.4, 71.6, 58.5, 55.5, 50.5, 48.0, 45.1, 43.4, 38.6, 34.1, 25.7, 24.01, 23.99, 23.0, 21.1 ppm; HRMS (ESI) calcd for $C_{46}H_{45}NO_{10}Na^+$ [M+Na^+] 794.2936, found 794.2944.



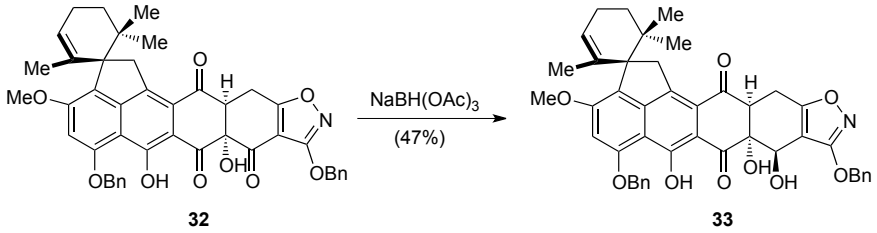
29

Heptacycle 29: Compound **29** was synthesized using an analogous procedure as above starting from the corresponding bis-methylated cyclic anhydride. This compound could be crystallized from EtOAc (slow evaporation) to give crystals suitable for X-ray crystallographic analysis (m.p. = 213–215 °C dec.). **29**: R_f = 0.4 (silica gel, acetone:toluene 1:4); FT-IR (neat) ν_{max} = 3413, 2926, 1716, 1593, 1514, 1484, 1406, 1370, 1344, 1308, 1216, 1184, 1130, 1104, 1049, 998, 903, 735 cm^{-1}; ^1H NMR (C_6D_6, 600 MHz) δ = 16.27 (s, 1 H), 7.35 – 7.33 (m, 2 H), 7.10 – 7.06 (m, 2 H), 7.02 (m, 1 H), 6.13 (s, 1 H), 5.62 (bs, 1 H), 5.45 (s, 1 H), 5.24 (d, *J* = 12.2 Hz, 1 H, AB system), 5.13 (d, *J* = 12.2 Hz, 1 H, AB system), 3.84 (d, *J* = 18.1 Hz, 1 H), 3.43 (s, 3 H), 3.26 (s, 3 H), 3.06 (d, *J* = 18.1 Hz, 1 H), 2.83 (s, 3 H), 2.78 (dd, *J* = 7.9, 7.9 Hz, 1 H), 2.63 – 2.52 (m, 5 H), 2.33 (m, 1 H), 2.06 (m, 1 H), 1.96 (ddd, *J* = 12.5, 12.5, 5.9 Hz, 1 H), 1.75 (s, 3 H), 1.36 (dd, *J* = 12.5, 6.1 Hz, 1 H), 1.11 (s, 3 H), 0.55 (s, 3 H) ppm; ^{13}C NMR (C_6D_6, 151 MHz) δ = 196.4, 184.7, 180.0, 170.0, 169.1, 161.7, 159.9, 149.1, 138.4, 136.5, 134.5, 129.2, 129.13, 129.06, 125.0, 123.1, 122.0, 110.0, 108.8, 107.4, 102.8, 96.5, 79.3, 72.8, 59.2, 56.5, 55.3, 50.6, 48.5, 46.0, 44.9, 39.3, 35.0, 26.6, 25.1, 24.1, 23.7, 22.0 ppm; HRMS (ESI) calcd for $C_{40}H_{41}NO_{10}Na^+$ [*M*+Na^+] 718.2623, found 718.2608.



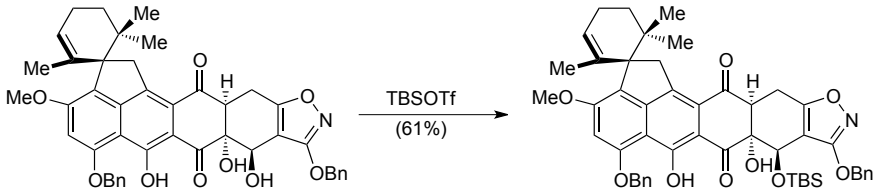
28 **32**

Triketone 32: To a solution of ketal **28** (23 mg, 0.029 mmol) in THF (2.3 mL) was added 2 N aq. HCl (0.25 mL). The reaction mixture was stirred at room temperature for 5 hours and was then diluted with water (5 mL) and extracted with EtOAc (10 mL). The organic phase was washed with water (10 mL) and brine (10 mL), and then dried over Na_2SO_4, filtered, and concentrated to give analytically pure triketone **32** (21 mg, 0.029 mmol, quant.) as a yellow solid. The triketone (**32**) was found to be unstable on silica gel and was used without further purification. **32**: R_f = 0.7 (silica gel, EtOAc:hexanes 2:3); FT-IR (neat) ν_{max} = 3448, 2962, 2918, 1696, 1609, 1585, 1513, 1481, 1446, 1402, 1344, 1327, 1292, 1258, 1199, 1158, 1132, 1108, 1037, 908, 825, 731, 696 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 13.91 (s, 1 H), 7.62 – 7.59 (m, 2 H), 7.46 – 7.42 (m, 2 H), 7.41 – 7.39 (m, 2 H), 7.36 (m, 1 H), 7.34 – 7.28 (m, 3 H), 6.77 (s, 1 H), 5.49 (bs, 1 H), 5.33 (s, 2 H), 5.29 (d, J = 12.0 Hz, 1 H, AB system), 5.26 (d, J = 12.0 Hz, 1 H, AB system), 4.94 (s, 1 H), 3.89 – 3.82 (m, 5 H), 3.66 (d, J = 20.0 Hz, 1 H), 3.33 (dd, J = 17.3, 4.8 Hz, 1 H), 3.15 (d, J = 20.0 Hz, 1 H), 2.19 (m, 1 H), 2.03 (m, 1 H), 1.80 (ddd, J = 12.7, 12.7, 6.2 Hz, 1 H), 1.45 (s, 3 H), 1.30 (dd, J = 12.7, 5.6 Hz, 1 H), 0.88 (s, 3 H), 0.30 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 195.4, 192.0, 184.8, 181.7, 168.2, 164.6, 159.4, 159.2, 147.7, 142.4, 136.3, 136.2, 135.0, 128.9, 128.61, 128.60, 128.24, 128.21, 127.2, 127.1, 121.8, 121.5, 110.2, 107.8, 105.3, 100.2, 78.5, 72.4, 71.7, 59.6, 55.6, 53.1, 45.5, 38.4, 34.1, 25.4, 24.3, 22.9, 21.0, 20.7 ppm; HRMS (ESI) calcd for $C_{44}H_{39}NO_9H^+$ [M+H^+] 726.2697, found 726.2683.



32 **33**

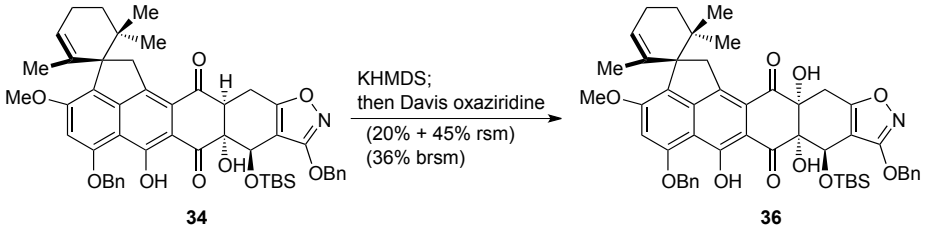
Diol 33: To a solution of triketone **32** (98 mg, 0.14 mmol) in anhydrous EtOAc:acetone (1:1, 13.4 mL) at room temperature was added sodium triacetoxyborohydride (34 mg, 0.16 mmol, 1.2 equiv) and the solution was warmed to 40 °C for 1 hour and 45 minutes. The reaction mixture was then allowed to cool to room temperature, diluted with water (15 mL) and extracted with EtOAc (20 mL). The organic phase was washed with water (10 mL), brine (10 mL), dried over Na_2SO_4, filtered, and concentrated. The residue was purified by preparative TLC (EtOAc:hexanes 3:7) to give the diol **33** (46 mg, 0.063 mmol, 47%) as a yellow foam. **33**: R_f = 0.5 (silica gel, EtOAc:hexanes 3:7); FT-IR (neat) ν_{max} = 3475, 2961, 2920, 2855, 1693, 1662, 1586, 1512, 1483, 1446, 1403, 1341, 1293, 1260, 1199, 1162, 1132, 1113, 1036, 908, 732, 696 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 14.41 (s, 1 H), 7.62 – 7.60 (m, 2 H), 7.46 – 7.43 (m, 2 H), 7.40 – 7.31 (m, 6 H), 6.73 (s, 1 H), 5.49 (bs, 1 H), 5.36 (d, *J* = 12.1 Hz, 1 H, AB system), 5.33 (d, *J* = 12.1 Hz, 1 H, AB system), 5.27 (d, *J* = 11.7 Hz, 1 H, AB system), 5.23 (d, *J* = 11.7 Hz, 1 H, AB system), 4.59 (d, *J* = 3.9 Hz, 1 H), 4.17 (s, 1 H), 3.85 (s, 3 H), 3.82 (d, *J* = 17.6 Hz, 1 H), 3.67 (d, *J* = 6.9 Hz, 1 H), 3.54 (d, *J* = 19.5 Hz, 1 H), 3.24 (d, *J* = 19.5 Hz, 1 H), 2.92 (dd, *J* = 17.6, 6.9 Hz, 1 H), 2.19 (m, 1 H), 2.03 (m, 1 H), 1.82 (ddd, *J* = 12.7, 12.7, 6.0 Hz, 1 H), 1.68 (d, *J* = 3.9 Hz, 1 H), 1.46 (s, 3 H), 1.29 (dd, *J* = 12.7, 6.0 Hz, 1 H), 0.87 (s, 3 H), 0.31 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 201.0, 193.0, 169.6, 169.3, 164.8, 159.4, 159.3, 148.0, 138.8, 136.5, 136.4, 135.7, 128.9, 128.70, 128.68, 128.5, 128.2, 127.1, 126.5, 124.2, 121.5, 110.0, 109.9, 103.8, 99.5, 77.1, 71.8, 71.7, 68.5, 59.6, 55.6, 50.5, 44.9, 38.5, 34.0, 25.5, 24.2, 23.0, 21.0, 18.7 ppm; HRMS (ESI) calcd for $C_{44}H_{41}NO_9H^+$ [*M*+H^+] 728.2854, found 728.2828.



33 **34**

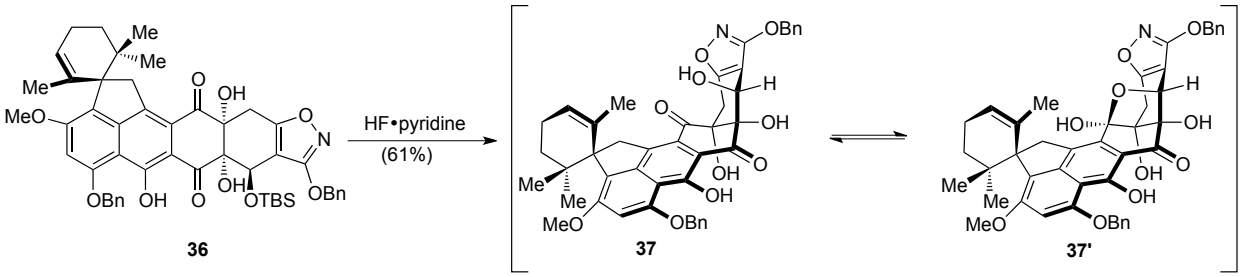
TBS ether 34: To a solution of diol **33** (33 mg, 0.045 mmol) in CH_2Cl_2 (1.7 mL) was added freshly distilled 2,6-lutidine (80 μL, 0.68 mmol, 15 equiv). The reaction mixture was cooled to 0 °C, and freshly distilled TBSOTf (0.10 mL, 0.45 mmol, 10 equiv) was added. The reaction mixture was allowed to warm to room temperature and stirred for 15 minutes. Three additional portions of lutidine (80 μL, each) and TBSOTf (0.10 mL, each) were added to the reaction flask in 15 minute intervals and the mixture was stirred for an additional 30 minutes. The reaction was then quenched with saturated aq. $NaHCO_3$ solution (5 mL) (vigorous bubbling) and extracted with CH_2Cl_2 (2 × 5 mL). The combined organics were dried over Na_2SO_4, filtered, and concentrated. Residual volatiles were then azeotropically removed with toluene (twice). The crude material was then purified by preparative TLC (5% acetone:toluene) to give the TBS ether **34** (23 mg, 0.027 mmol, 61%) as a yellow solid. **34**: R_f = 0.4 (silica gel, 5% acetone:toluene); FT-IR (neat) ν_{max} = 3479, 2927, 2856, 1697, 1656, 1605, 1589, 1510, 1473, 1448, 1405, 1343, 1295, 1260, 1205, 1166, 1135, 1082, 1048, 838, 779, 736, 697 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 14.52 (s, 1 H), 7.61 – 7.57 (m, 2 H), 7.44 – 7.39 (m, 4 H), 7.37 – 7.31 (m, 4 H), 6.72 (s, 1 H), 5.49 (bs, 1 H), 5.35 (d, *J* = 12.1 Hz, 1 H, AB system), 5.32 (d, *J* = 12.1 Hz, 1 H, AB system), 5.28 (d, *J* = 11.5 Hz, 1 H, AB system), 5.21 (d, *J* = 11.5 Hz, 1 H, AB system), 4.55 (s, 1 H), 4.01 (s, 1 H), 3.91 (d, *J* = 17.9 Hz, 1 H), 3.84 (s, 3 H), 3.59 (d, *J* = 7.4 Hz, 1 H), 3.56 (d, *J* = 19.9 Hz, 1 H), 3.20 (d, *J* = 19.9 Hz, 1 H), 2.86 (dd, *J* = 17.9, 7.4 Hz, 1 H), 2.19 (m, 1 H), 2.03 (m, 1 H), 1.84 (m, 1 H), 1.44 (s, 3 H), 1.27 (m, 1 H), 0.88 (s, 3 H), 0.31 (s, 3 H), 0.30 (s, 9 H), –0.27 (s, 3 H), –0.54 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 202.2, 191.8, 169.5, 169.4,

165.1, 159.3, 159.2, 147.9, 138.5, 136.6, 136.4, 135.5, 129.0, 128.8, 128.7, 128.6, 128.1, 127.1, 126.4, 124.5, 121.4, 110.4, 109.7, 104.5, 99.8, 77.8, 71.9, 71.8, 69.2, 59.6, 55.5, 50.2, 45.1, 38.5, 34.0, 25.5, 25.2, 24.2, 23.0, 20.9, 18.4, 17.7, –5.47, –5.50 ppm; HRMS (ESI) calcd for $C_{50}H_{55}NO_9SiH^+$ [M+H^+] 842.3719, found 842.3705.



Diol 36: A solution of TBS ether **34** (50 mg, 0.059 mmol) in THF (1.1 mL) was cooled to –78 °C, and KHMDS solution (1 M in THF, 0.20 mL, 0.20 mmol, 3.4 equiv) was added dropwise. After stirring for 1 hour at –78 °C, freshly recrystallized (EtOAc) (±)-*trans*-2-(phenylsulfonyl)-3-phenyloxaziridine[10] (60 mg, 0.23 mmol, 3.9 equiv) in THF (0.3 mL) was added, and the mixture was stirred for 1 hour and 40 minutes at –78 °C. The reaction was quenched by addition of MeOH (0.2 mL), followed by dimethyl sulfide (0.1 mL) and saturated aq. NH_4Cl solution (2.0 mL). The mixture was extracted with CH_2Cl_2 (3 × 15 mL), and the combined organic layers were dried over $MgSO_4$, filtered, and concentrated. Purification by preparative TLC (silica gel, acetone:toluene 1:9, then 1.25% acetone:CH_2Cl_2 for the recovered starting material and 5% acetone:CH_2Cl_2 for the product) afforded diol **36** (10 mg, 0.012 mmol, 20%) as an orange solid and recovered starting material **34** (23 mg, 0.027 mmol, 45%). **36**: R_f = 0.4 (silica gel, acetone:toluene 1:9); FT-IR (neat) ν_{max} = 3460, 2921, 2856, 1702, 1606, 1588, 1509, 1473, 1447, 1403, 1340, 1320, 1267, 1205, 1136, 1050, 910, 838, 780, 734, 696 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz) δ = 14.10 (s, 1 H), 7.59 – 7.57 (m, 2 H), 7.45 – 7.39 (m, 4 H), 7.38 – 7.33 (m, 4 H), 6.72 (s, 1 H), 5.50 (bs, 1 H), 5.36 (d, J = 12.4 Hz, 1 H, AB system), 5.33 (d, J =

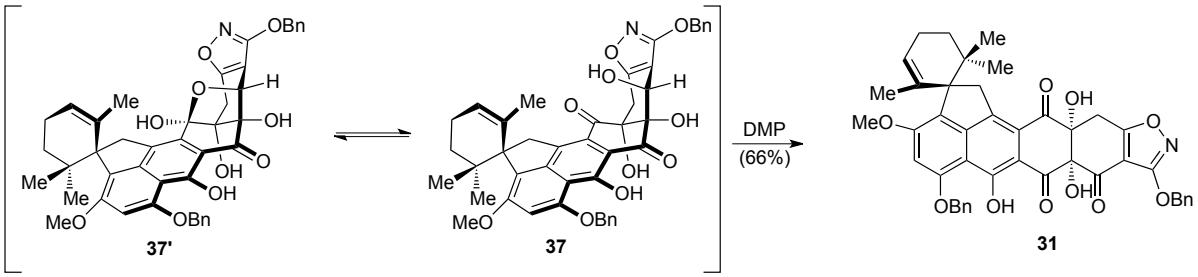
12.4 Hz, 1 H, AB system), 5.28 (d, J = 11.4 Hz, 1 H, AB system), 5.20 (d, J = 11.4 Hz, 1 H, AB system), 4.62 (s, 1 H), 4.30 (s, 1 H), 4.15 (d, J = 17.6 Hz, 1 H), 3.84 (s, 3 H), 3.55 (d, J = 19.4 Hz, 1 H), 3.22 (d, J = 19.4 Hz, 1 H), 3.01 (s, 1 H), 2.68 (d, J = 17.6 Hz, 1 H), 2.19 (m, 1 H), 2.03 (m, 1 H), 1.84 (m, 1 H), 1.46 (s, 3 H), 1.28 (m, 1 H), 0.88 (s, 3 H), 0.35 (s, 3 H), 0.31 (s, 9 H), –0.26 (s, 3 H), –0.54 (s, 3 H) ppm; ^{13}C NMR ($CDCl_3$, 151 MHz) δ = 200.8, 190.2, 169.7, 169.1, 164.2, 159.2, 159.1, 147.8, 140.4, 136.6, 136.4, 135.4, 129.1, 128.81, 128.76, 128.6, 128.1, 127.1, 126.5, 123.2, 121.4, 110.6, 109.8, 104.3, 100.1, 80.8, 77.5, 72.0, 71.8, 68.5, 59.7, 55.5, 44.9, 38.6, 34.0, 28.7, 25.4, 25.2, 24.2, 23.0, 20.9, 17.7, –5.4, –5.6 ppm; HRMS (ESI) calcd for $C_{50}H_{55}NO_{10}SiH^+$ [M+H^+] 858.3668, found 858.3664.



Triol 37: Diol **36** (13.3 mg, 15.5 μmol) was dissolved in MeCN (0.4 mL) in a plastic vial and cooled to 0 °C. HF•pyridine (70% HF in pyridine, 0.02 mL) was added, and the mixture was warmed to 50–55 °C. After 1 hour, 14 hours, and 20 hours, additional portions of HF•pyridine (70% HF in pyridine, 0.05 mL each) were added. After 25 hours the reaction was allowed to cool to room temperature, diluted with EtOAc, and carefully quenched with saturated aq. $NaHCO_3$ solution. The organic phase was separated, and the aqueous phase was extracted with EtOAc (2 × 15 mL). The combined organic phases were dried over $MgSO_4$, filtered, and concentrated. Purification by preparative TLC (silica gel, acetone:toluene 1:4) afforded triol **37** (7.1 mg, 9.5 μmol, 61%) as a yellow solid.* **37**: R_f = 0.4 (silica gel, acetone:toluene 1:9); FT-IR (neat)

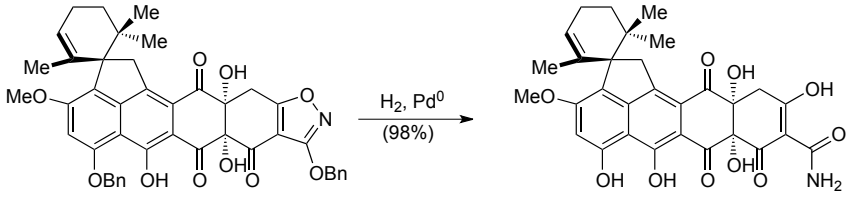
ν_{max} = 3460, 2923, 1698, 1590, 1513, 1483, 1448, 1403, 1341, 1323, 1264, 1205, 1134, 1044, 816, 738, 697 cm^{-1}; ^1H NMR ($CDCl_3$, 600 MHz, 298 K) δ = 14.01 (bs, 1 H), 7.61 – 7.58 (m, 2 H), 7.46 – 7.28 (m, 8 H), 6.73 (s, 1 H), 5.49 (bs, 1 H), 5.34 (d, *J* = 12.1 Hz, 1 H, AB system), 5.31 (d, *J* = 12.1 Hz, 1 H, AB system), 5.35 – 5.10 (m, 2 H), 4.68 (bs, 1 H), 4.43 (bs, 1 H), 3.99 (bs, 1 H), 3.85 (s, 3 H), 3.52 (bs, 1 H), 3.22 (bs, 1 H), 3.08 (bs, 1 H), 2.76 (d, *J* = 17.3 Hz, 1 H), 2.19 (m, 1 H), 2.03 (m, 1 H), 1.83 (m, 1 H), 1.46 (s, 3 H), 1.29 (m, 1 H), 0.87 (s, 3 H), 0.35 (bs, 3 H) ppm; ^1H NMR ($CDCl_3$, 500 MHz, 233 K) δ = 14.27 (s, 1 H, B), 14.02 (s, 1 H, A), 7.62 – 7.28 (m, 10 H, A + 10 H, B), 6.76 (s, 1 H, B), 6.68 (s, 1 H, A), 5.50 (bs, 1 H, B), 5.45 (bs, 1 H, A), 5.40 – 4.40 (m), 4.01 (d, *J* = 17.6 Hz, 1 H, A), 3.97 (d, *J* = 19.7 Hz, 1 H, B), 3.91 (s, 3 H, B), 3.83 (s, 3 H, A), 3.48 (d, *J* = 19.8 Hz, 1 H, A), 3.34 (bs), 3.23 (d, *J* = 19.8 Hz, 1 H, A), 3.05 (d, *J* = 18.5 Hz, 1 H, B), 2.99 (d, *J* = 19.7 Hz, 1 H, B), 2.88 (bs), 2.80 (d, *J* = 18.5 Hz, 1 H, B), 2.77 (d, *J* = 17.6 Hz, 1 H, A), 2.24 – 1.70 (m), 1.57 – 1.52 (m), 1.45 (s, 3 H, B), 1.39 (s, 3 H, A), 1.34 – 1.28 (m), 0.89 (s, 3 H, B), 0.82 (s, 3 H, A), 0.37 (s, 3 H, B), 0.27 (s, 3 H, A) ppm; ^{13}C NMR (151 MHz, $CDCl_3$, 298 K) δ = 199.7, 169.3, 159.2, 147.7, 136.4, 128.9, 128.7, 128.5, 128.2, 127.0, 121.6, 109.9, 99.7, 71.8, 71.6, 59.7, 55.6, 44.6, 38.5, 33.9, 33.5, 32.1, 29.6, 29.5, 29.4, 29.2, 25.5, 24.8, 24.2, 22.93, 22.85, 21.0 ppm; HRMS (ESI) calcd for $C_{44}H_{41}NO_{10}H^+$ [M+H^+] 744.2803, found 744.2794.

*Hydroxy ketone **37** exists in equilibrium with its cyclic hemiacetal isomer **37′**. At T = 298 K, slow interconversion between these two species is observed in $CDCl_3$, which results in broad signals in the ^1H and ^{13}C NMR spectra. Due to signal broadening, not all the ^{13}C signals could be identified. The signals become sharper and split into two sets when the sample is cooled to T = 233 K. Wherever possible, the signals observed in the ^1H NMR at T = 233 K are reported with their corresponding integrals and assigned to signal set A or B.



Triketone 31: A solution of triol **37** (7.1 mg, 9.6 μmol) in DCE (0.5 mL) was cooled to 0 °C, and Dess–Martin periodinane[11] (4.6 mg, 11 μmol, 1.2 equiv) was added. After stirring for 30 minutes at 0 °C, the mixture was stirred at room temperature for 1.5 hours. The reaction mixture was then warmed up to 50 °C, and three additional portions of Dess–Martin periodinane (2.3 mg, 5.4 mmol, 0.6 equiv each) were added in 1 hour intervals. After 5 hours at 50 °C, TLC analysis indicated complete conversion. The reaction mixture was allowed to cool to room temperature and quenched with $NaHCO_3$(aq):$Na_2S_2O_3$(aq) (1:1). The phases were separated, and the aqueous phase was extracted with CH_2Cl_2 (2 × 10 mL). The combined organic phases were washed with brine, dried over $MgSO_4$, filtered, and concentrated. Purification by preparative TLC (silica gel, 5% acetone:CH_2Cl_2) afforded triketone **31** (4.7 mg, 6.3 μmol, 66%) as a yellow powder. **31**: R_f = 0.5 (silica gel, acetone:toluene 1:9); FT-IR (neat) ν_{max} = 3451, 2919, 1715, 1613, 1586, 1516, 1485, 1447, 1403, 1342, 1274, 1203, 1186, 1140, 1091, 1027, 965, 737, 696 cm^{-1}; ^1H NMR (CD_2Cl_2, 600 MHz) δ = 14.11 (s, 1H), 7.61 – 7.58 (m, 2 H), 7.54 – 7.42 (m, 2 H), 7.47 – 7.39 (m, 5 H), 7.36 (m, 1 H), 6.85 (s, 1 H), 5.54 (bs, 1 H), 5.40 – 5.35 (m, 2 H), 5.35 – 5.30 (m, 2 H), 4.63 (bs, 1 H), 4.29 (bs, 1 H), 4.04 (d, *J* = 19.8 Hz, 1 H), 3.90 (s, 3 H), 3.42 (d, *J* = 18.4 Hz, 1 H), 3.16 (d, *J* = 18.4 Hz, 1 H), 3.06 (d, *J* = 19.8 Hz, 1 H), 2.24 (m, 1 H), 2.08 (m, 1 H), 1.89 (ddd, *J* = 12.9, 12.9, 6.2 Hz, 1 H), 1.49 (s, 3 H), 1.40 (dd, *J* = 12.9, 5.7 Hz, 1H), 0.94 (s, 3 H), 0.46 (s, 3 H) ppm; ^{13}C NMR (CD_2Cl_2, 151 MHz) δ = 194.9, 194.7, 185.1, 179.1, 167.9, 166.8, 160.4, 159.8, 147.8, 143.7, 136.7, 136.4, 135.4, 129.2, 129.04, 129.03, 128.96, 128.4, 127.5, 127.4, 122.0,

118.2, 110.4, 108.6, 106.4, 100.6, 83.9, 81.0, 73.1, 71.9, 60.2, 56.0, 44.5, 38.6, 34.8, 34.4, 25.6, 24.4, 23.3, 20.9 ppm; HRMS (ESI) calcd for $C_{44}H_{39}NO_{10}H^+$ [M+H^+] 742.2647, found 742.2648.



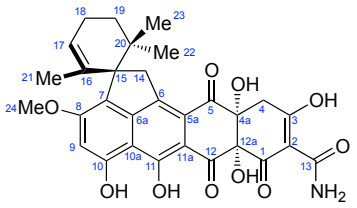
31

(±)-**38**: viridicatumtoxin B
(revised structure)

Synthetic viridicatumtoxin B [(±)-38]: Using a procedure similar to the one reported by Myers,[12] triketone **31** (4.7 mg, 6.3 μmol) was dissolved in freshly distilled 1,4-dioxane:methanol (1:1, 1.2 mL) under argon and Pd black (3.3 mg, 31 μmol, 4.9 equiv) was added. The suspension was degassed, placed under a hydrogen atmosphere, and stirred for 8 minutes at room temperature, after which the hydrogen was removed by flushing the flask with argon. The suspension was then filtered (Celite®; MeOH:CH_2Cl_2 1:9), and the filtrate was concentrated to afford analytically pure synthetic viridicatumtoxin B [(±)-**38**] (3.5 mg, 6.2 μmol, 98%) as a yellow solid. (±)-**38**: R_f = 0.1 (silica gel, MeOH:CH_2Cl_2 1:9); FT-IR (neat) ν_{max} = 3423, 2921, 2855, 1623, 1587, 1491, 1449, 1400, 1260, 1190, 1142, 1089, 798 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ = 17.92 (s, 1 H), 14.72 (s, 1 H), 9.20 (s, 1 H), 8.74 (s, 1 H), 6.80 (s, 1 H), 5.97 (s, 1 H), 5.53 (s, 1 H), 4.89 (s, 1 H), 4.18 (s, 1 H), 4.03 (d, J = 19.8 Hz, 1 H), 3.90 (s, 3 H), 3.11 (bd, J = 18.8 Hz, 1H), 3.04 (d, J = 19.8 Hz, 1 H), 2.81 (bd, J = 18.8 Hz, 1 H), 2.22 (m, 1 H), 2.07 (m, 1 H), 1.86 (m, 1 H), 1.46 (s, 3 H), 1.40 (m, 1 H), 0.93 (s, 3 H), 0.46 (s, 3 H) ppm; ^{13}C NMR (151 MHz, $CDCl_3$) δ = 195.2, 194.3, 192.8, 188.7, 173.0, 165.4, 161.3, 158.4, 146.4, 144.8, 135.8, 127.3, 122.0, 117.0, 107.3, 106.8, 102.6, 99.7, 80.7, 77.7, 60.6, 55.8, 44.6, 42.1,

38.5, 34.2, 25.6, 24.4, 23.0, 20.9 ppm; HRMS (ESI) calcd for $C_{30}H_{29}NO_{10}H^+$ [M+H^+] 564.1864, found 564.1865.

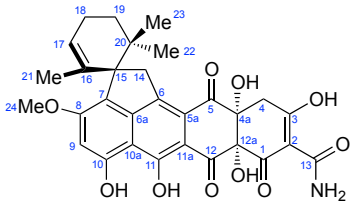
III) Comparison of NMR Spectroscopic Data of Natural and Synthetic Viridicatumtoxin B [(±)-38]



*^{1}H NMR spectroscopic data from reference [13] compared to those of synthetic **38**:*

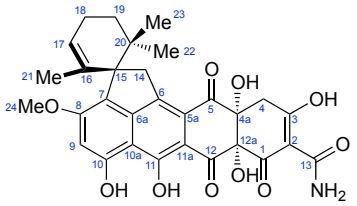
Proton	Natural viridicatumtoxin B ($CDCl_3$, 500 MHz)[13]*	Synthetic viridicatumtoxin B [$CDCl_3$, 600 MHz, δ($CHCl_3$) = 7.26 ppm]	Δ (ppm)
C3-OH	–	17.92 (bs, 1 H)	–
C11-OH	–	14.72 (bs, 1 H)	–
C13-NH	–	9.20 (bs, 1 H)	–
C10-OH	–	8.74 (bs, 1 H)	–
H9	6.79 (s, 1 H)	6.80 (s, 1 H)	–0.01
C13-NH′	–	5.97 (bs, 1 H)	–
H17	5.52 (m, 1 H)	5.53 (bs, 1 H)	–0.01
C12a-OH	–	4.89 (bs, 1 H)	–
C4a-OH	–	4.18 (bs, 1 H)	–
H14	4.02 (d, *J* = 19.8 Hz, 1 H)	4.03 (d, *J* = 19.8 Hz, 1 H)	–0.01
H24	3.89 (s, 3 H)	3.90 (s, 3 H)	–0.01
H4	3.12 (d, *J* = 20.4 Hz, 1 H)	3.11 (bd, *J* = 18.8 Hz, 1 H)	0.01
H14′	3.01 (d, *J* = 19.8 Hz, 1 H)	3.04 (d, *J* = 19.8 Hz, 1 H)	–0.03
H4′	2.84 (d, *J* = 20.4 Hz, 1 H)	2.81 (bd, *J* = 18.8 Hz, 1 H)	0.03
H18	2.25 (m, 1 H)	2.22 (m, 1 H)	0.03
H18′	2.08 (m, 1 H)	2.07 (m, 1 H)	0.01
H19	1.88 (m, 1 H)	1.86 (m, 1 H)	0.02
H21	1.46 (s, 3 H)	1.46 (s, 3 H)	0.00
H19′	1.41 (m, 1 H)	1.40 (m, 1 H)	0.01
H22	0.92 (s, 3 H)	0.93 (s, 3 H)	–0.01
H23	0.46 (s, 3 H)	0.46 (s, 3 H)	0.00

*The chemical shifts of hydroxyl and amide protons are not reported in reference [13]. For a comparison of ^{1}H NMR spectra of natural viridicatumtoxin B ($CDCl_3$, 300 MHz, kindly provided by Professor W.-G. Kim) and synthetic viridicatumtoxin B ($CDCl_3$, 600 MHz), see S78–S79.



*^{13}C NMR spectroscopic data from reference [13] compared to those of synthetic **38**:*

Carbon	**Natural viridicatumtoxin B ($CDCl_3$, 226 MHz)**[13]	**Synthetic viridicatumtoxin B ($CDCl_3$, 151 MHz) $\delta(CDCl_3)$ = 77.16 ppm**	**Δ (ppm)**
C12	195.1	195.2	–0.1
C5 (*observed*)	–	194.3	–
C3	192.9	192.8	0.1
C1	188.6	188.7	–0.1
C13	172.9	173.0	–0.1
C11	165.3	165.4	–0.1
C8	161.2	161.3	–0.1
C10	158.4	158.4	0.0
C6a	146.0	146.4	–0.4
C5a	144.8	144.8	0.0
C16	135.7	135.8	–0.1
C10a	127.2	127.3	–0.1
C17	121.9	122.0	–0.1
C6	116.9	117.0	–0.1
C5 (*reported*)	116.4	–	–
C7	106.8	107.3	–0.5
C11a	106.6	106.8	–0.2
C9	102.5	102.6	–0.1
C2	99.9	99.7	0.2
C12a	80.7	80.7	0.0
C4a	77.8	77.7	0.1
C15	60.6	60.6	0.0
C24	55.7	55.8	–0.1
C14	44.5	44.6	–0.1
C4	42.1	42.1	0.0
C20	38.4	38.5	–0.1
C19	34.1	34.2	–0.1
C23	25.5	25.6	–0.1
C22	24.3	24.4	–0.1
C18	22.8	23.0	–0.2
C21	21.0	20.9	0.1



*^{13}C NMR spectroscopic data from the authentic spectrum compared to those of synthetic **38**:*

Carbon	Natural viridicatumtoxin B ($CDCl_3$, 226 MHz)[†]	Synthetic viridicatumtoxin B ($CDCl_3$, 151 MHz) δ($CDCl_3$) = 77.018 ppm	Δ (ppm)
C12	195.10*	195.08	0.0
C5	*not reported*	194.13	–
C3	192.9	192.70	0.2
C1	188.62*	188.61	0.0
C13	172.90*	172.89	0.0
C11	165.3	165.23	0.1
C8	161.20*	161.18	0.0
C10	158.26*	158.23	0.0
C6a	146.28*	146.27	0.0
C5a	144.8	144.66	0.1
C16	135.62*	135.61	0.0
C10a	127.21*	127.18	0.0
C17	121.86*	121.83	0.0
C6	116.9	116.90	0.0
C7	107.18*	107.15	0.0
C11a	106.73*	106.71	0.0
C9	102.46*	102.44	0.0
C2	99.9	99.55	0.4
C12a	80.54*	80.53	0.0
C4a	77.8	77.58	0.2
C15	60.50*	60.47	0.0
C24	55.70*	55.70	0.0
C14	44.5	44.47	0.0
C4	42.03*	42.00	0.0
C20	38.32*	38.31	0.0
C19	34.1	34.03	0.1
C23	25.48*	25.48	0.0
C22	24.32*	24.30	0.0
C18	22.84*	22.83	0.0
C21	20.76*	20.77	0.0

[†]Chemical shifts marked with * were taken from a scanned authentic ^{13}C NMR spectrum of viridicatumtoxin B kindly provided by Prof. W.-G. Kim (see S80). The provided spectrum was referenced to 77.018 ppm and contained a partial peak listing. Chemical shifts without * were not included in this peak listing and are taken from reference [13]. Some discrepancies between the tabulated data in reference [13] and the chemical shifts in the authentic ^{13}C NMR spectrum were observed. In particular, although the crucial ^{13}C NMR signal of C5 near 194 ppm was visible in the authentic ^{13}C NMR spectrum, its chemical shift was not reported.

IV) References

[1] A. B. Pangborn, M. A. Giardello, R. H. Grubbs, R. K. Rosen, F. J. Timmers, *Organometallics* **1996**, *15*, 1518–1520.

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[9] *Org. Synth.* **1998**, *Coll. Vol. 9*, 288; **1997**, *74*, 91.

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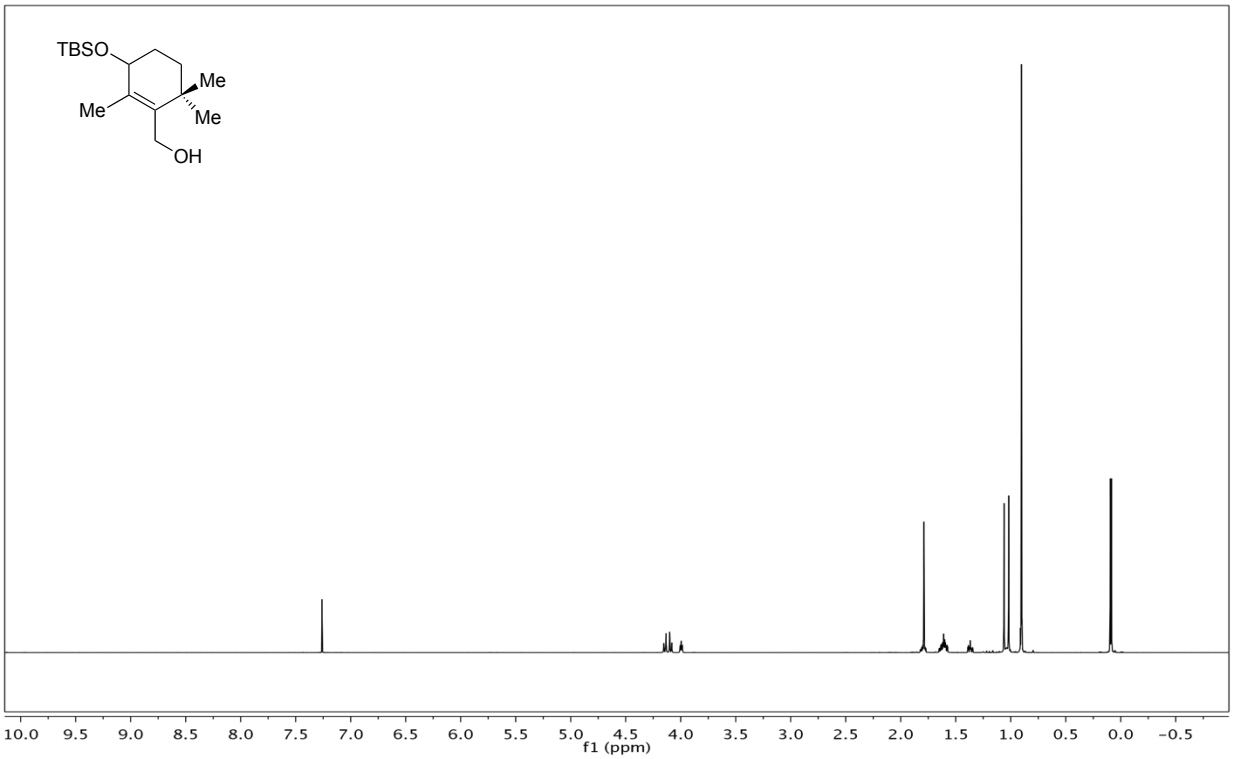
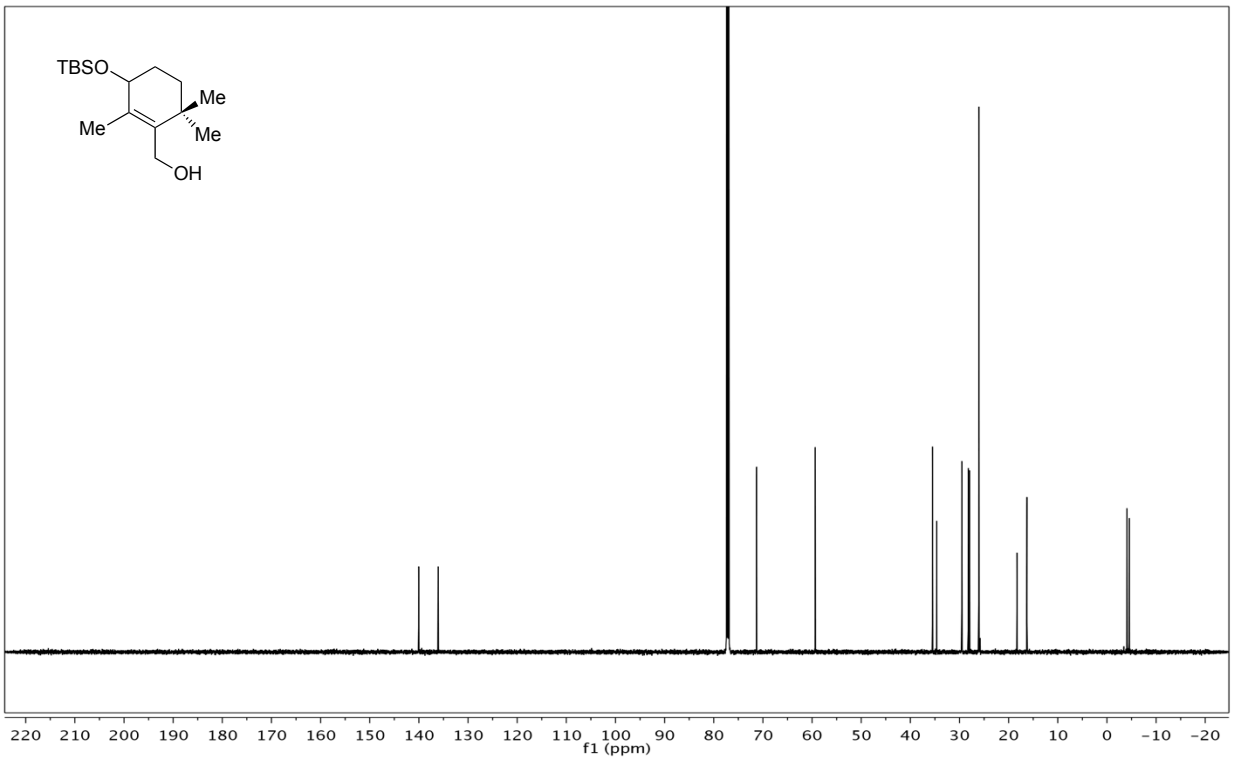
V) ^{1}H, ^{13}C, and selected 2D NMR Spectra

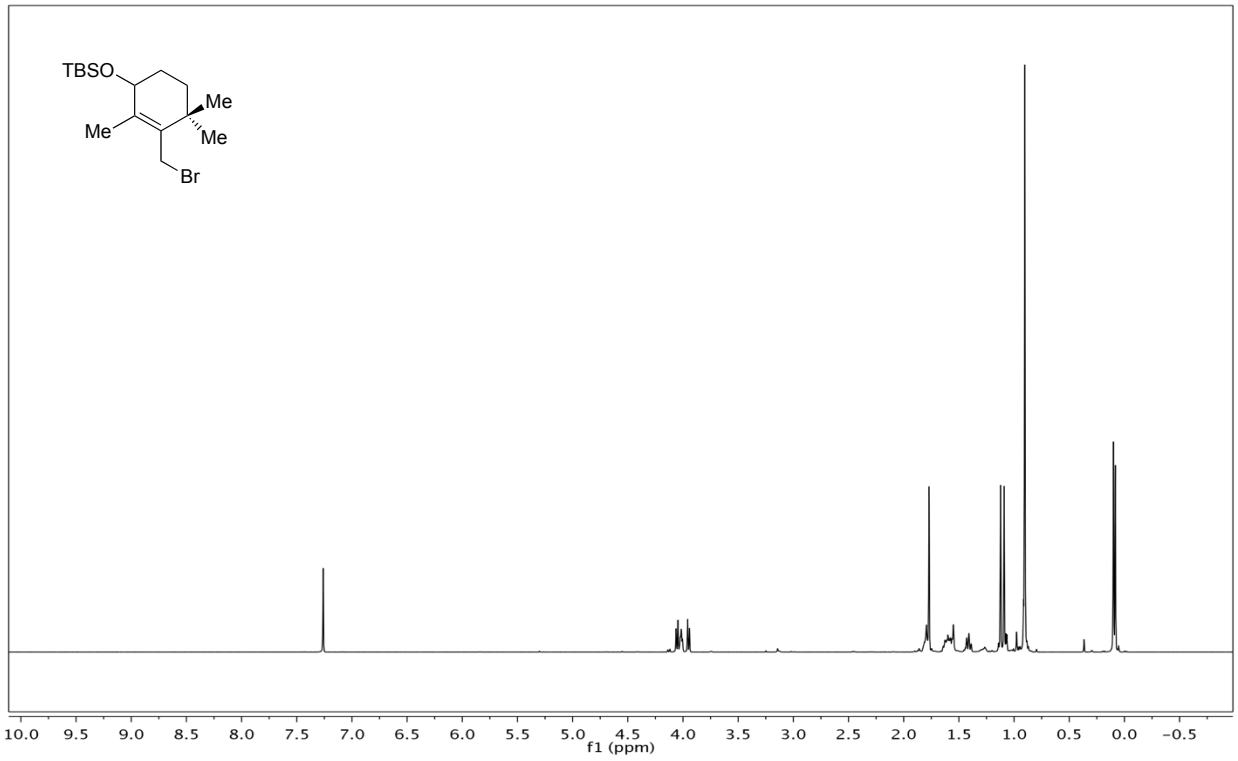
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **11**.



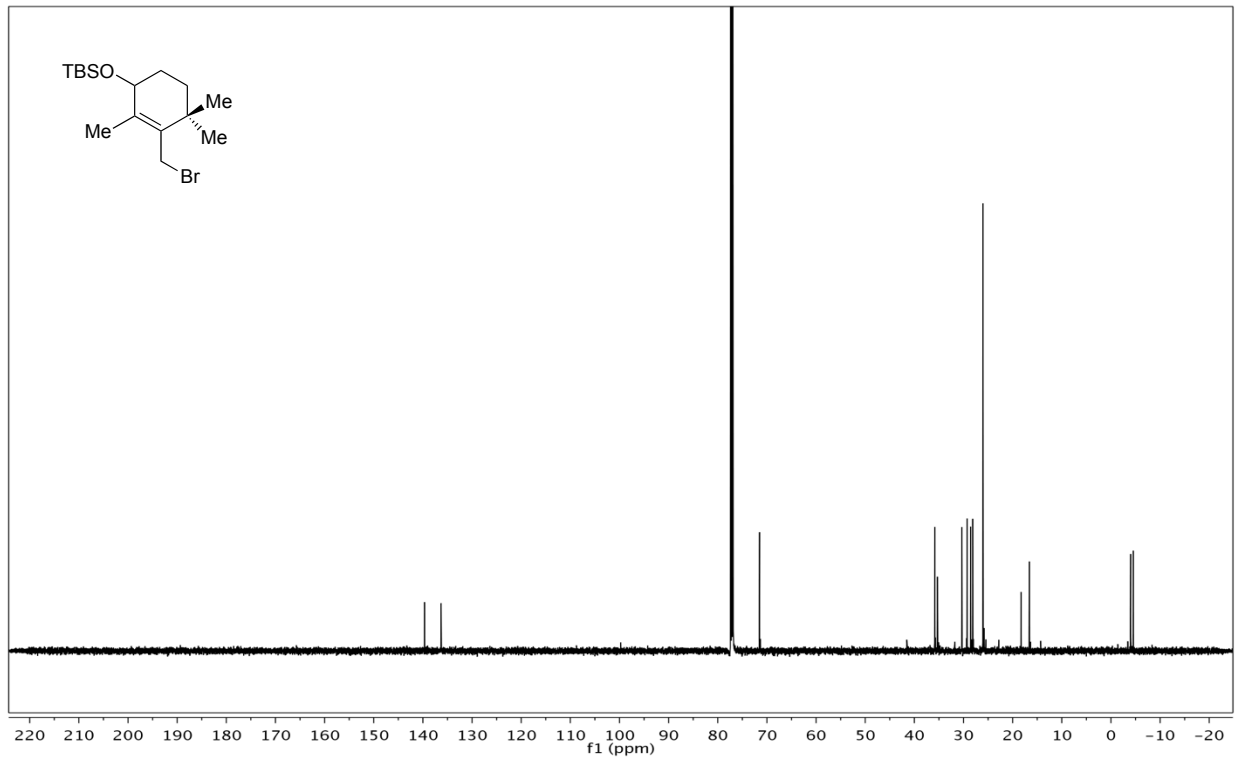
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **11**.



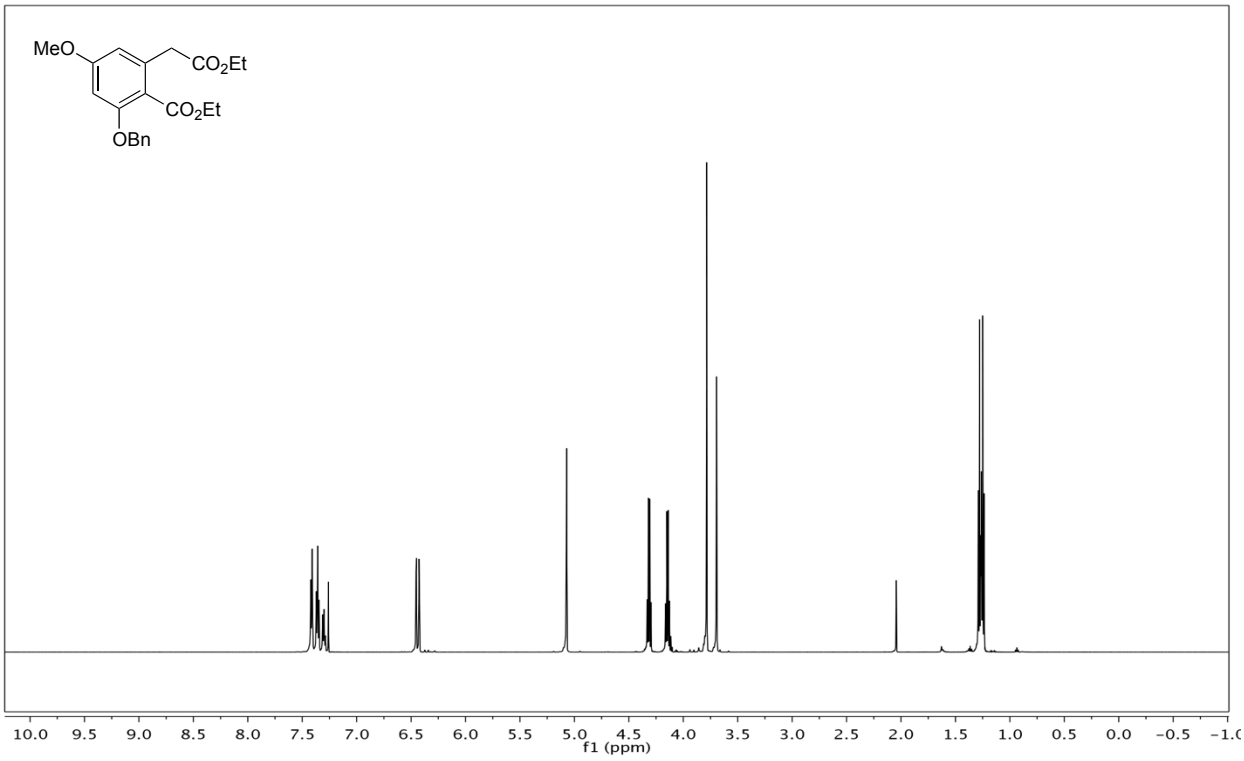
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **5**.



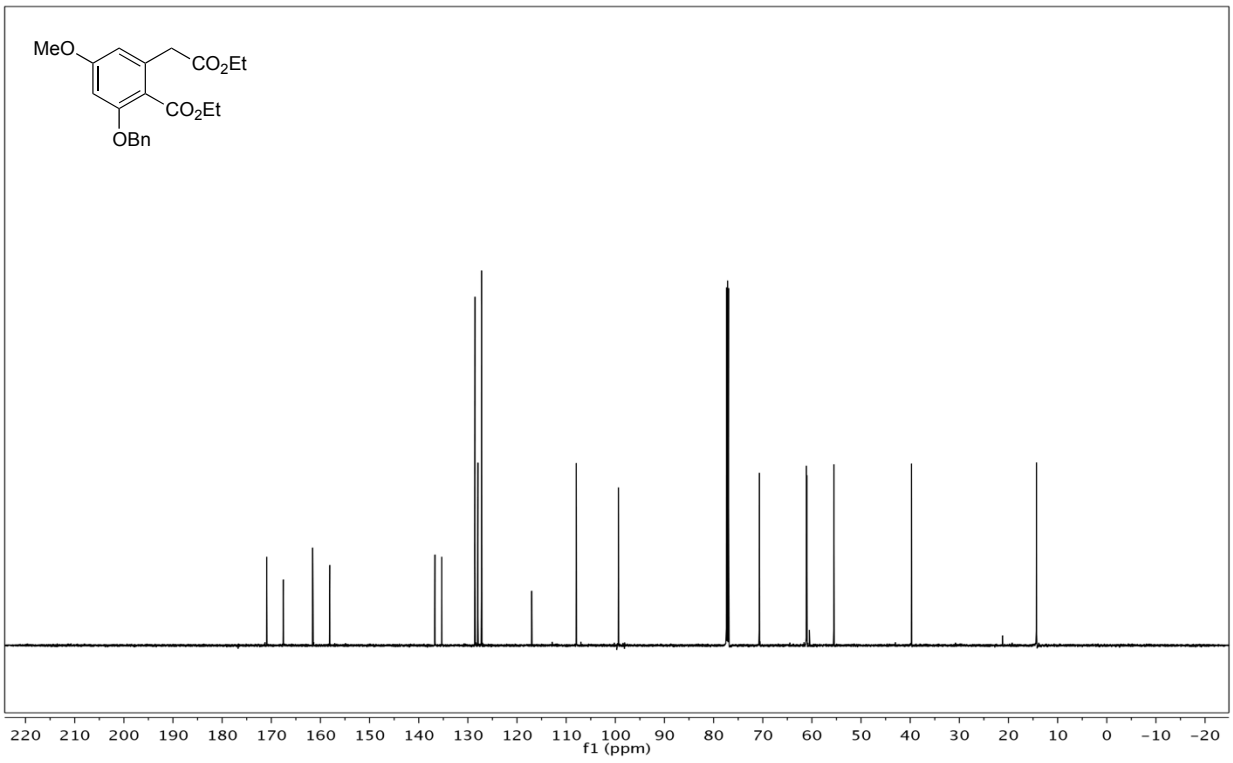
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **5**.



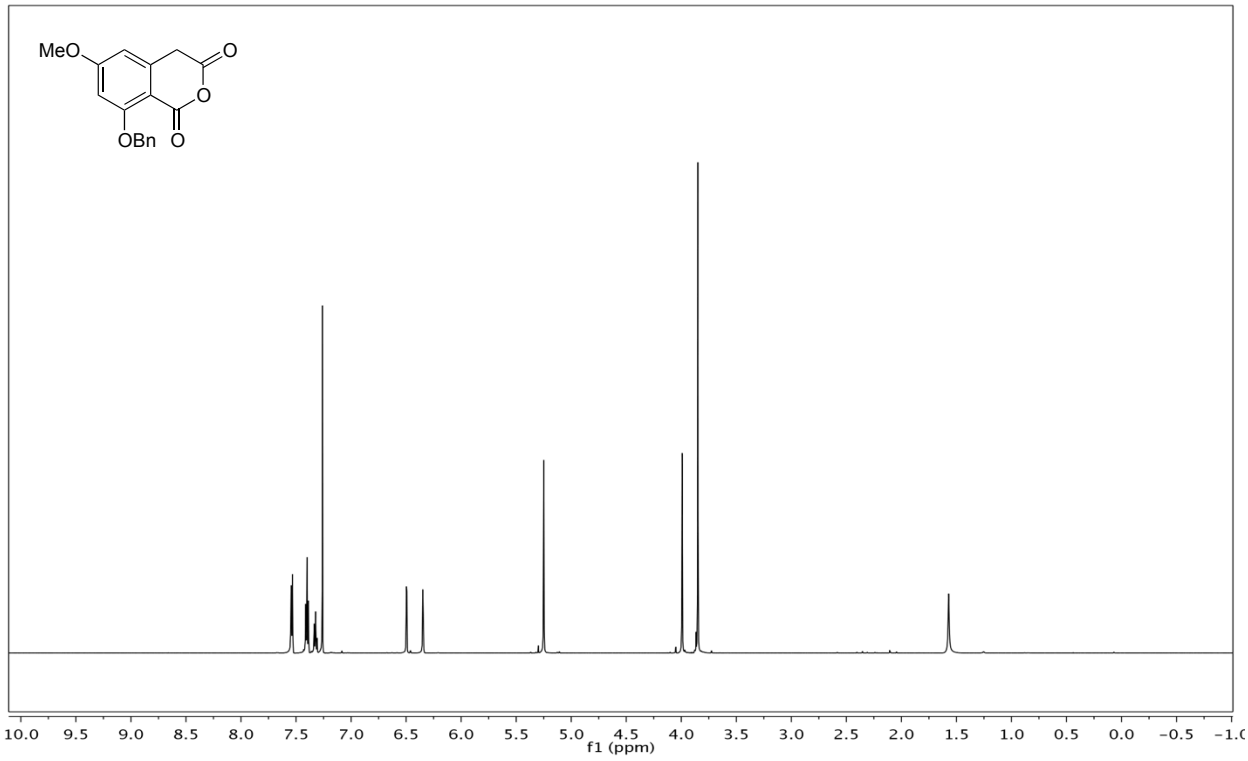
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **14**.



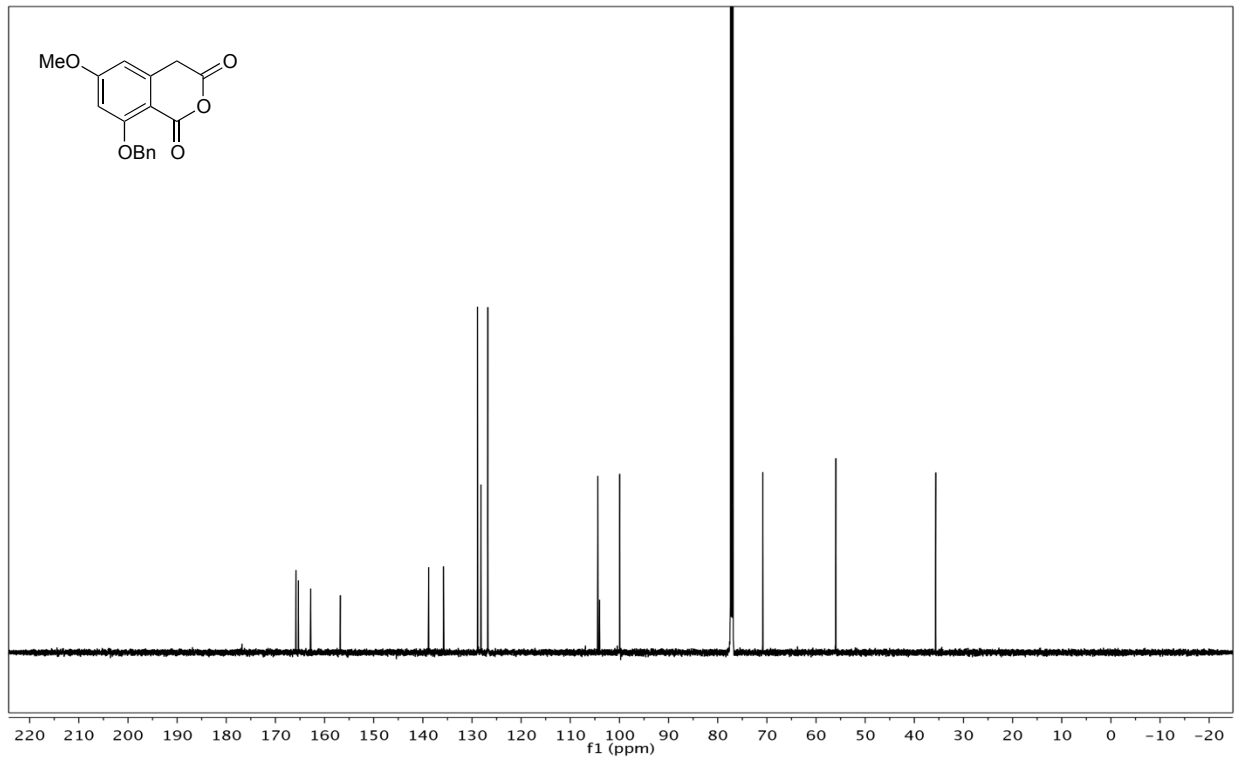
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **14**.



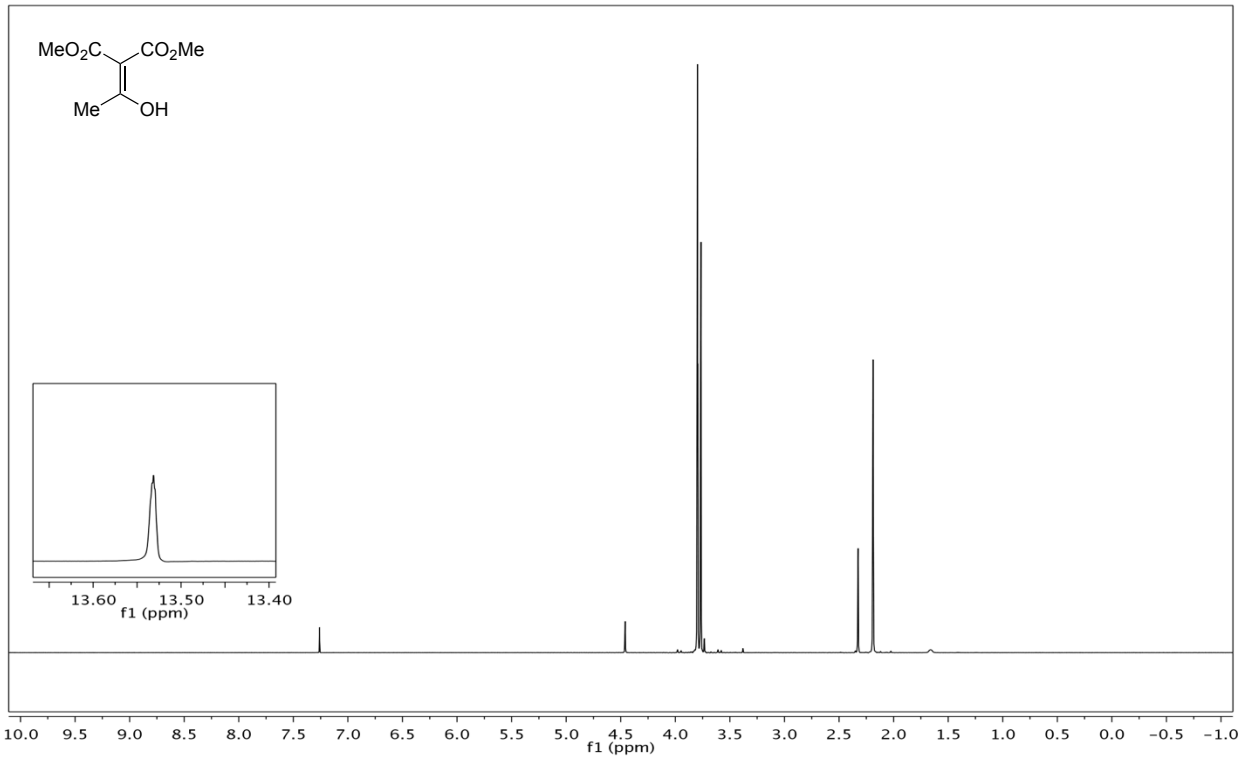
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **6**.



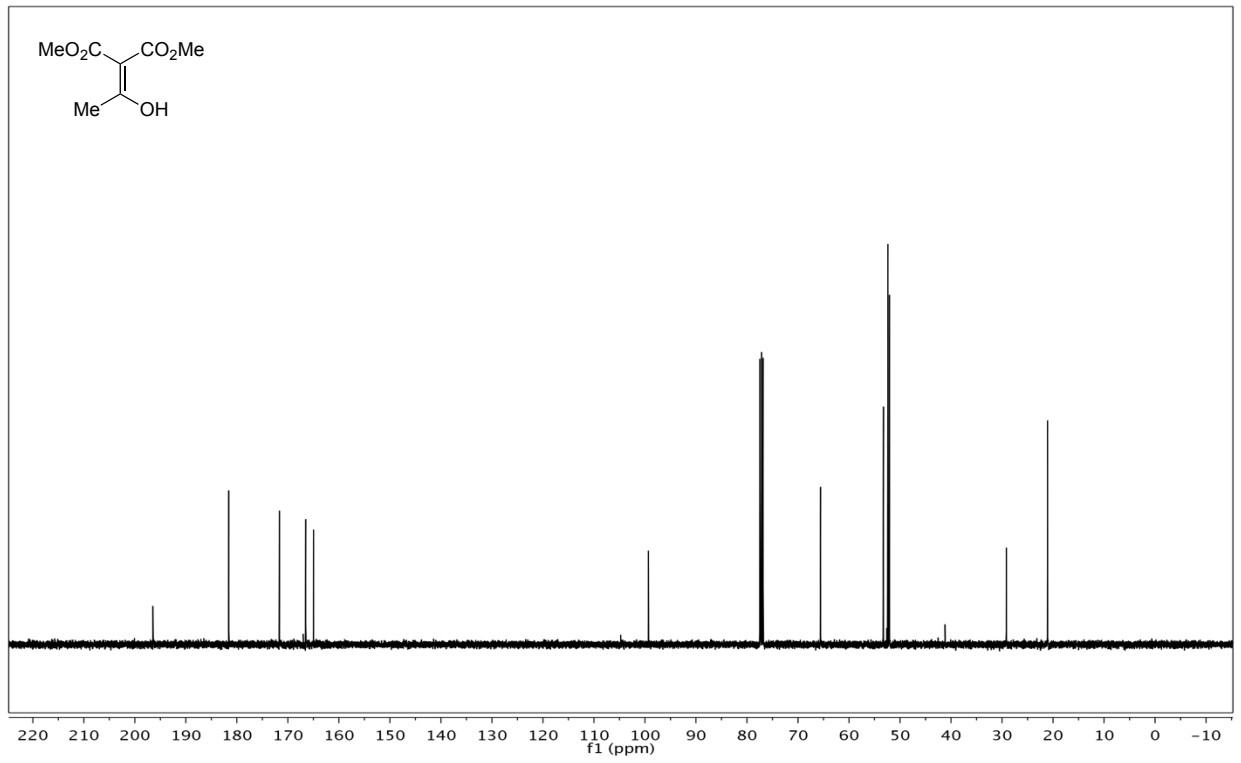
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **6**.



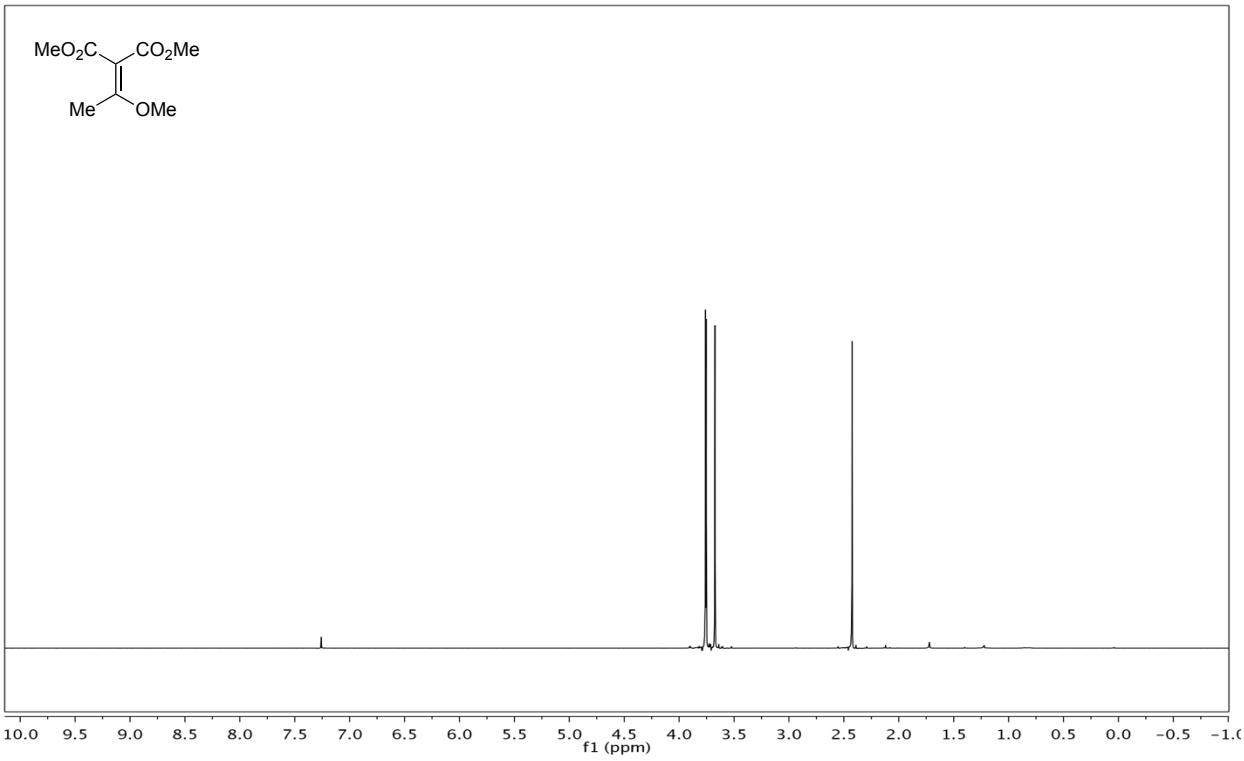
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **S4**.



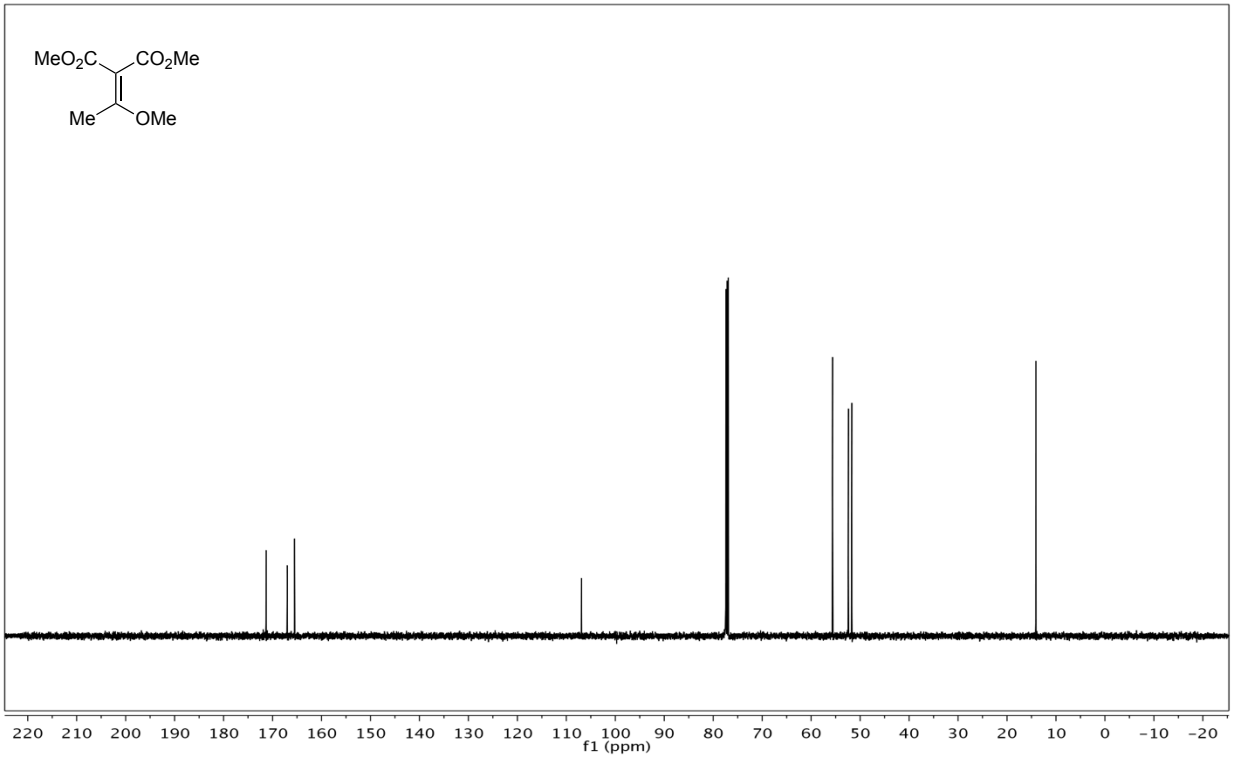
^{13}C NMR spectrum ($CDCl_3$, 101 MHz) of compound **S4**.



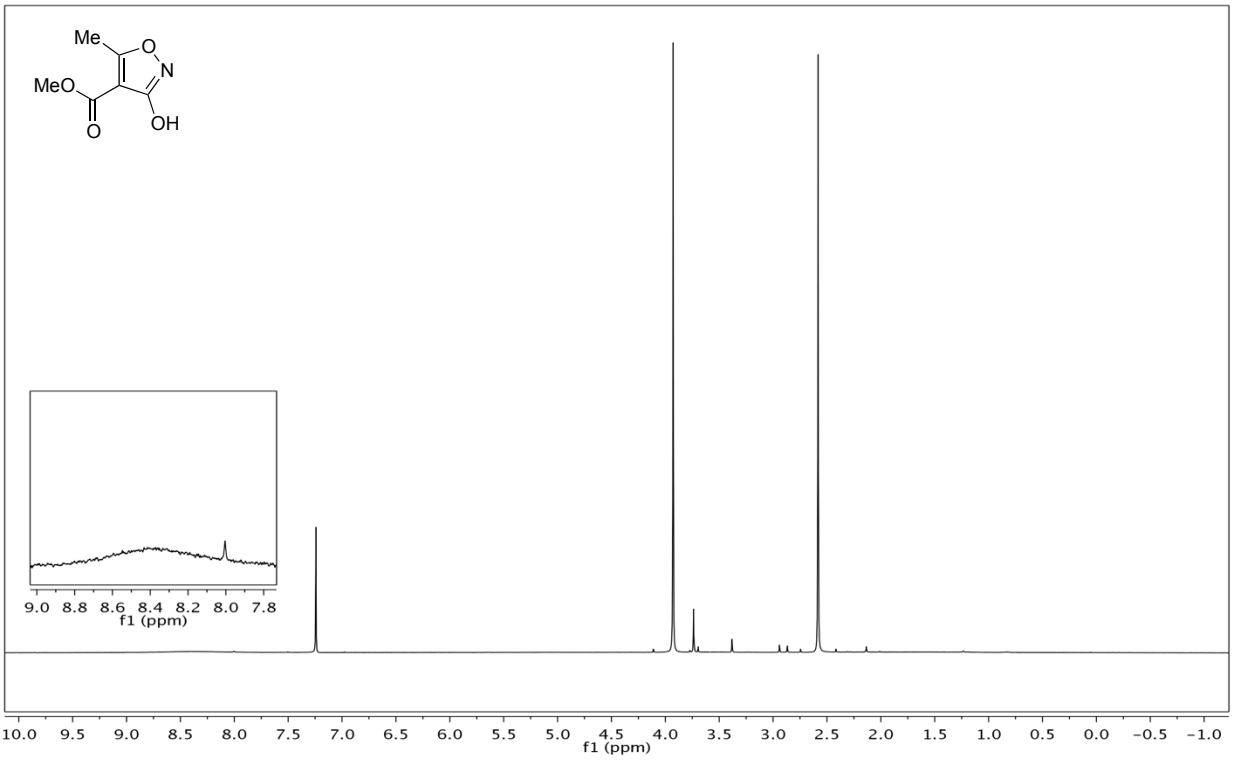
^{1}H NMR spectrum ($CDCl_3$, 500 MHz) of compound **S5**.



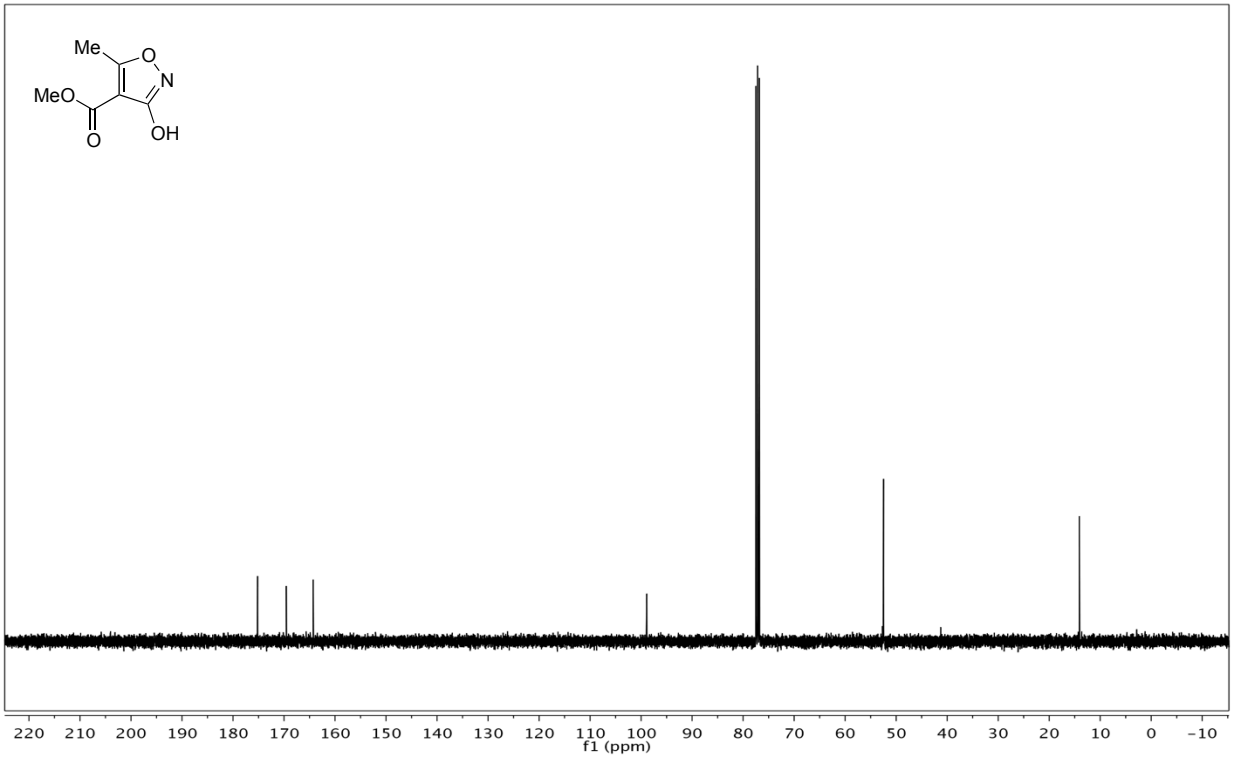
^{13}C NMR spectrum ($CDCl_3$, 126 MHz) of compound **S5**.



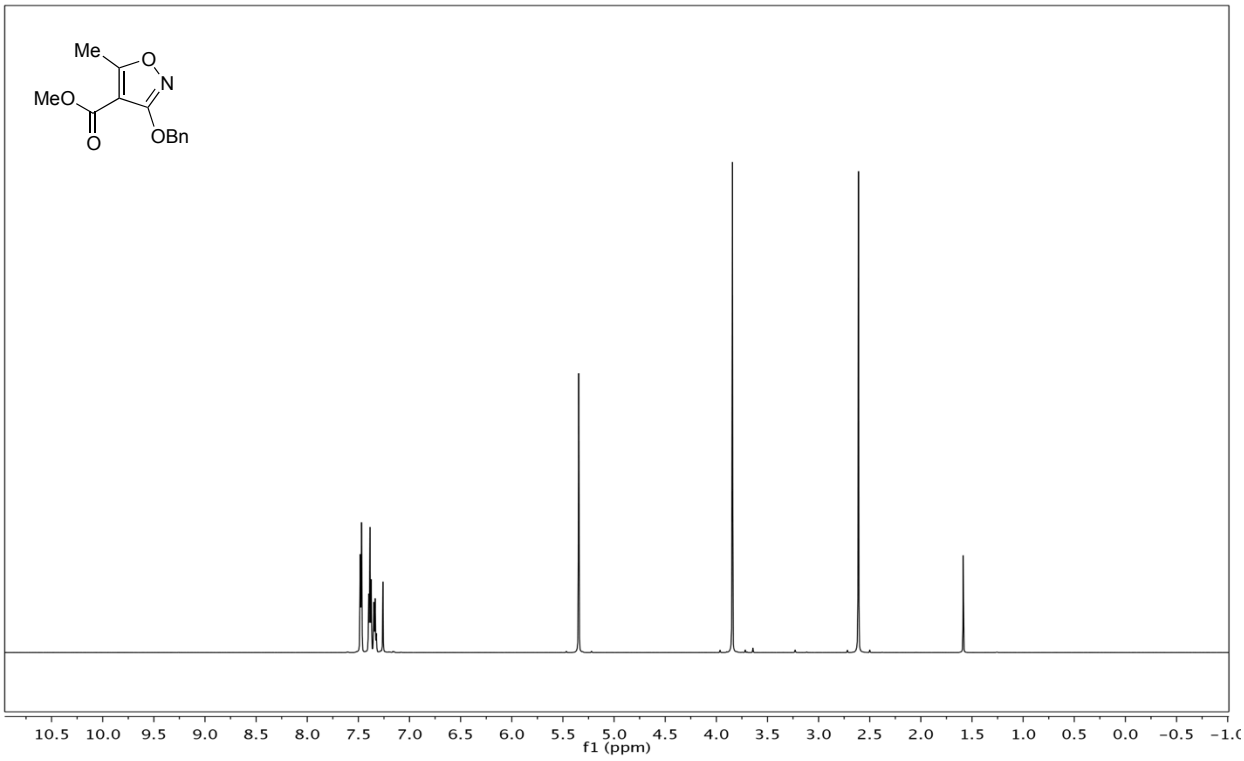
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **S6**.



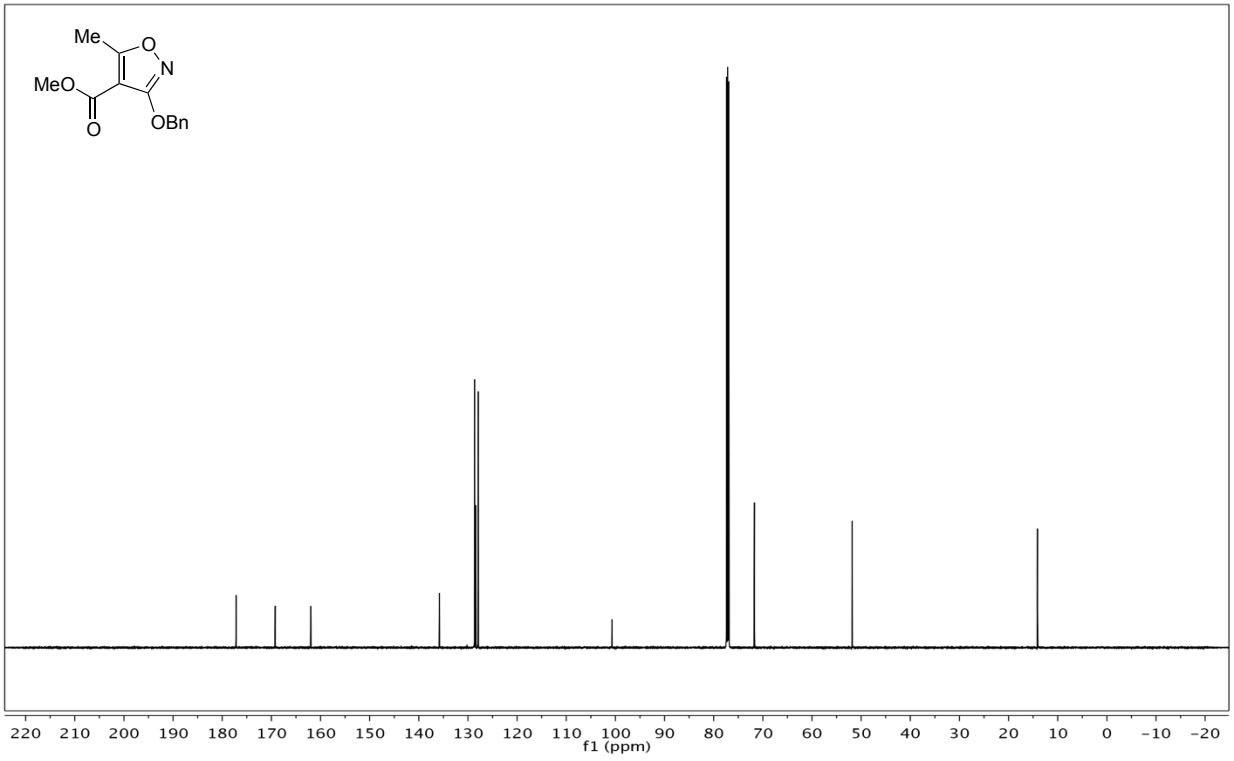
^{13}C NMR spectrum ($CDCl_3$, 101 MHz) of compound **S6**.



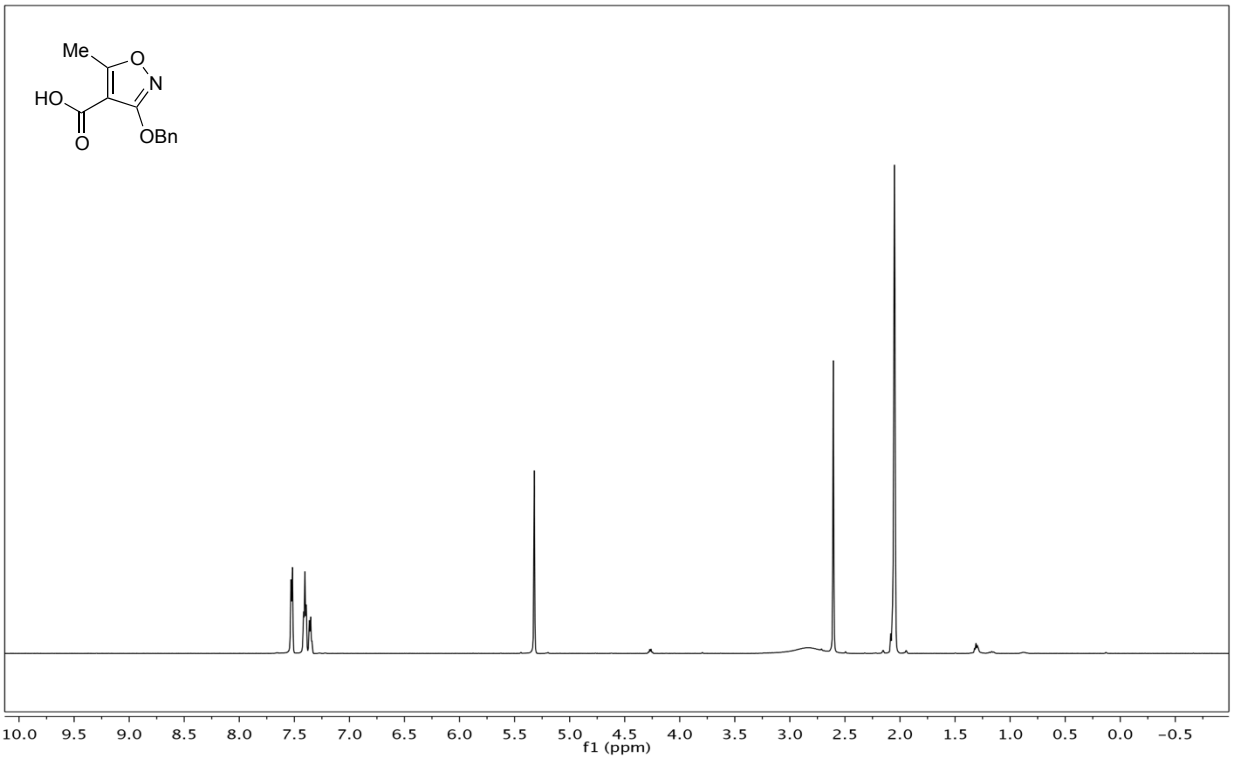
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **16**.



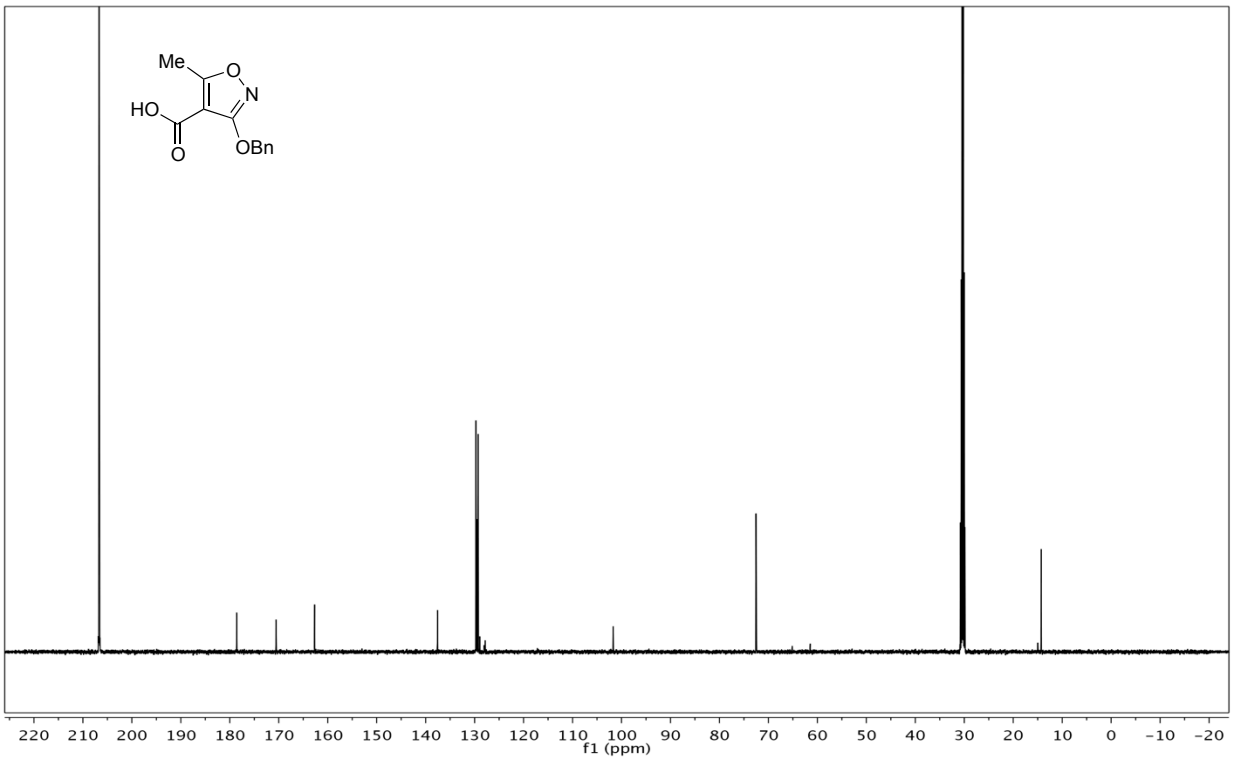
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **16**.



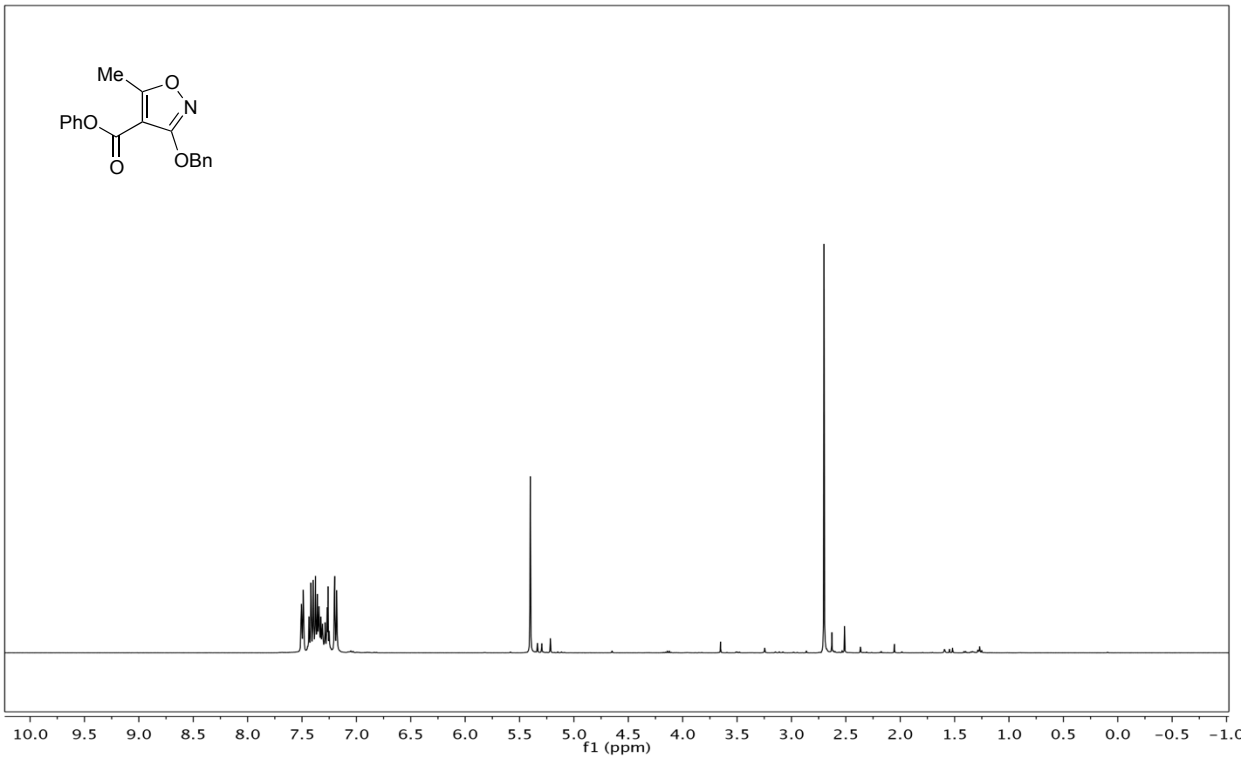
^{1}H NMR spectrum (d_6-acetone, 600 MHz) of compound **17**.



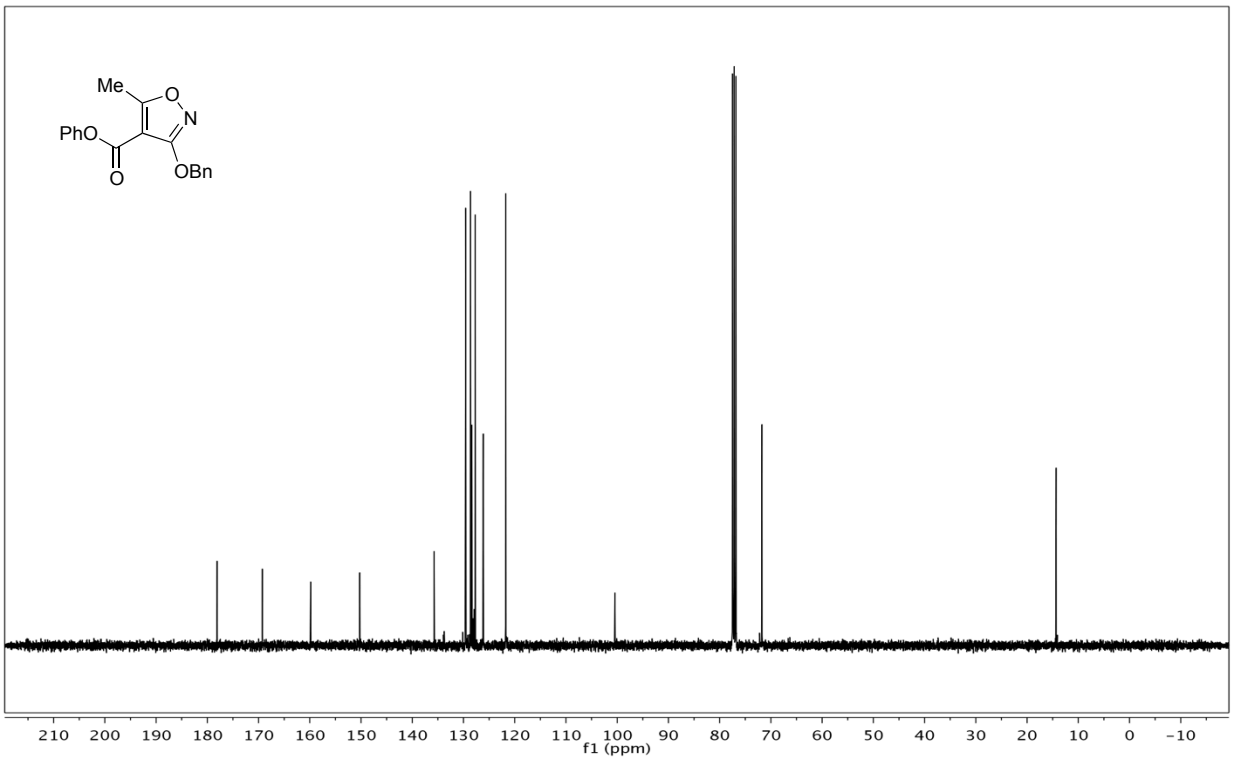
^{13}C NMR spectrum (d_6-acetone, 151 MHz) of compound **17**.



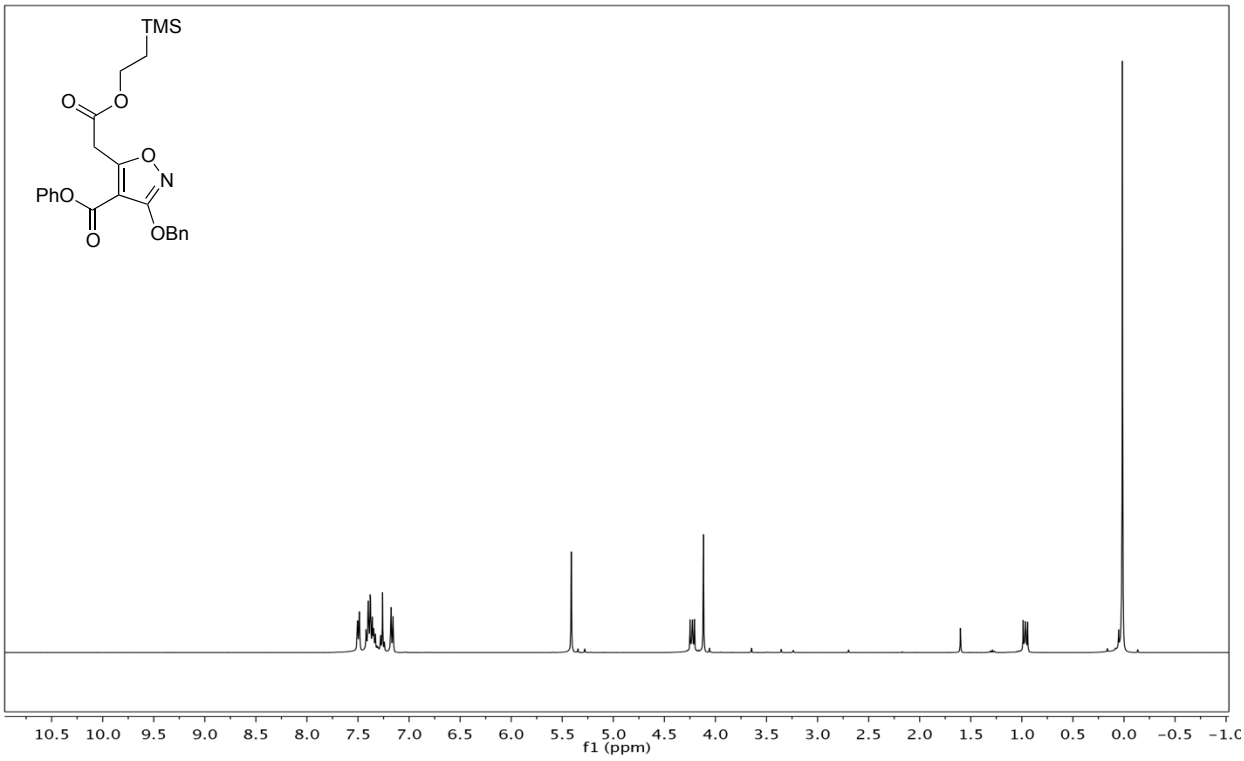
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **18**.



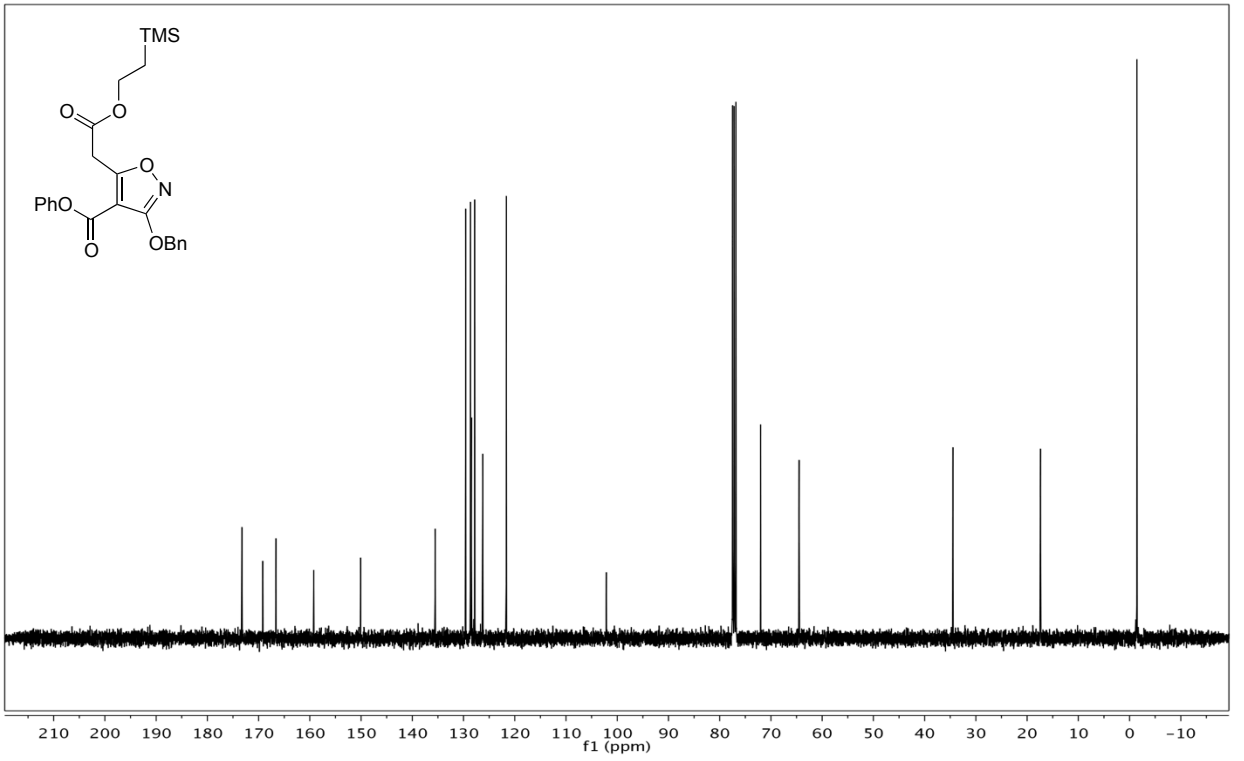
^{13}C NMR spectrum ($CDCl_3$, 101 MHz) of compound **18**.



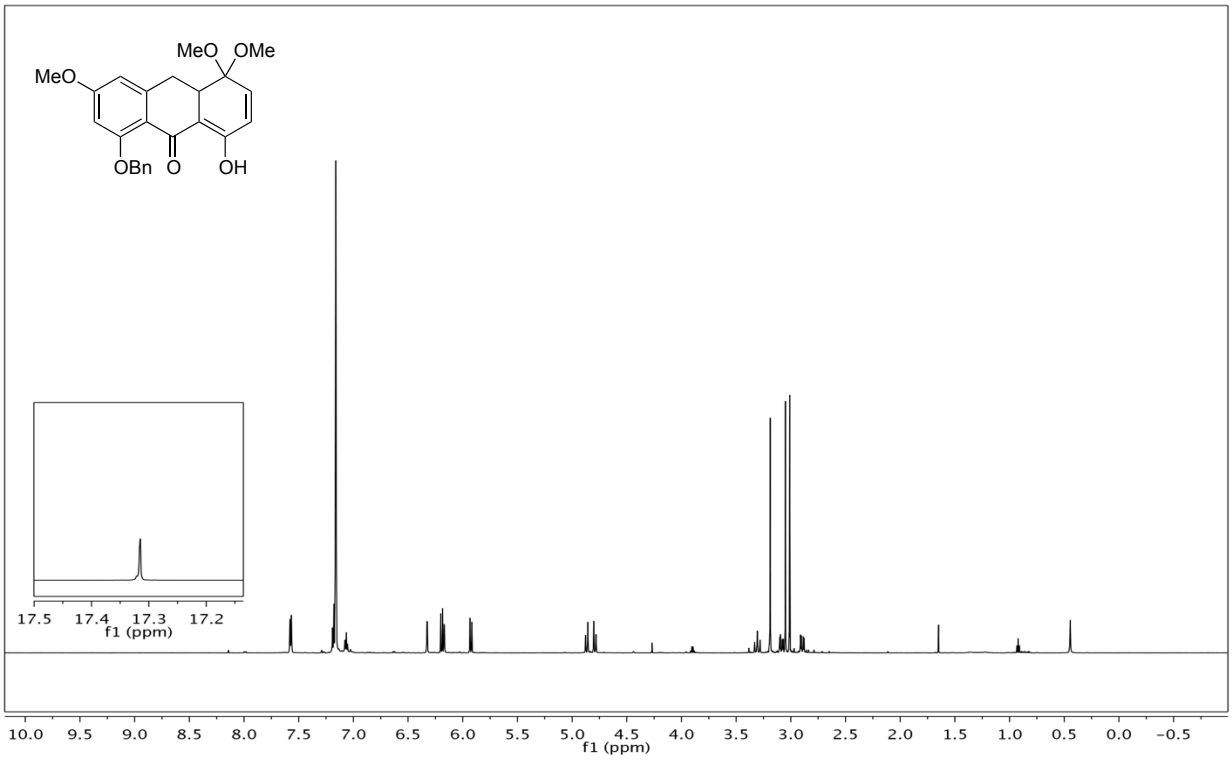
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **8**.



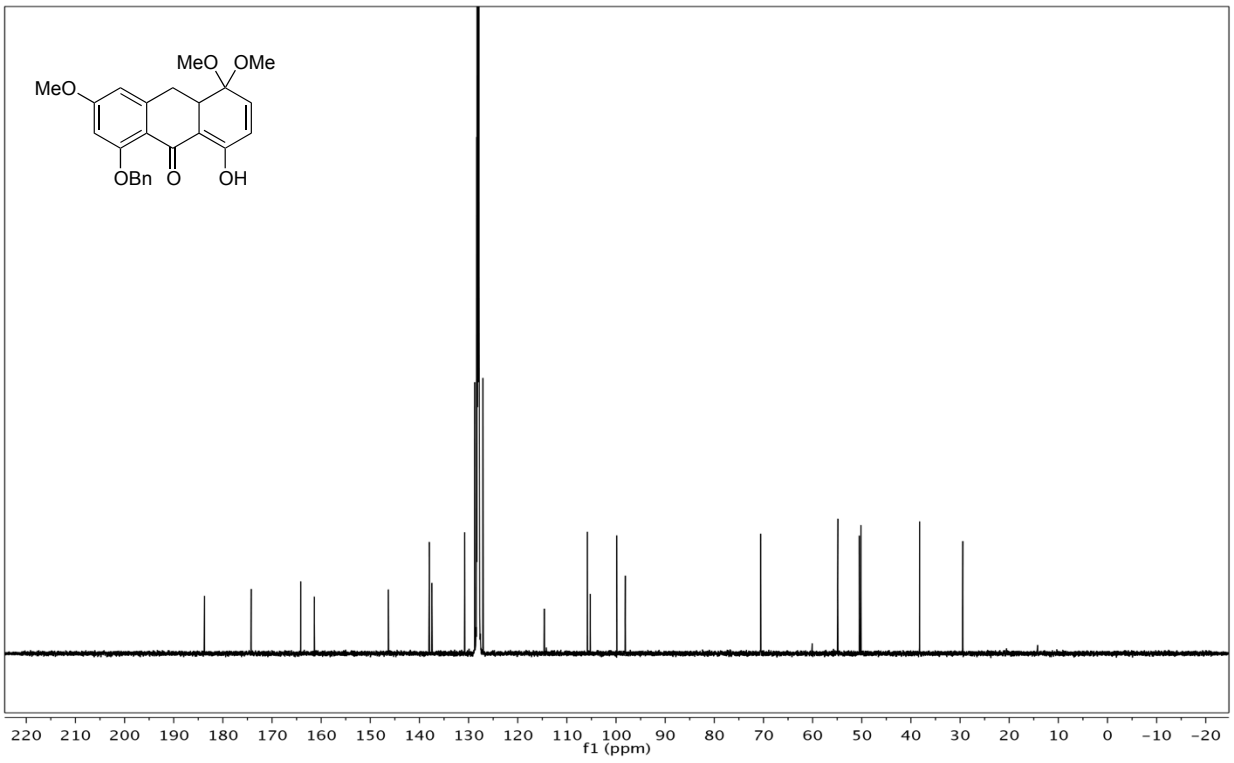
^{13}C NMR spectrum ($CDCl_3$, 101 MHz) of compound **8**.



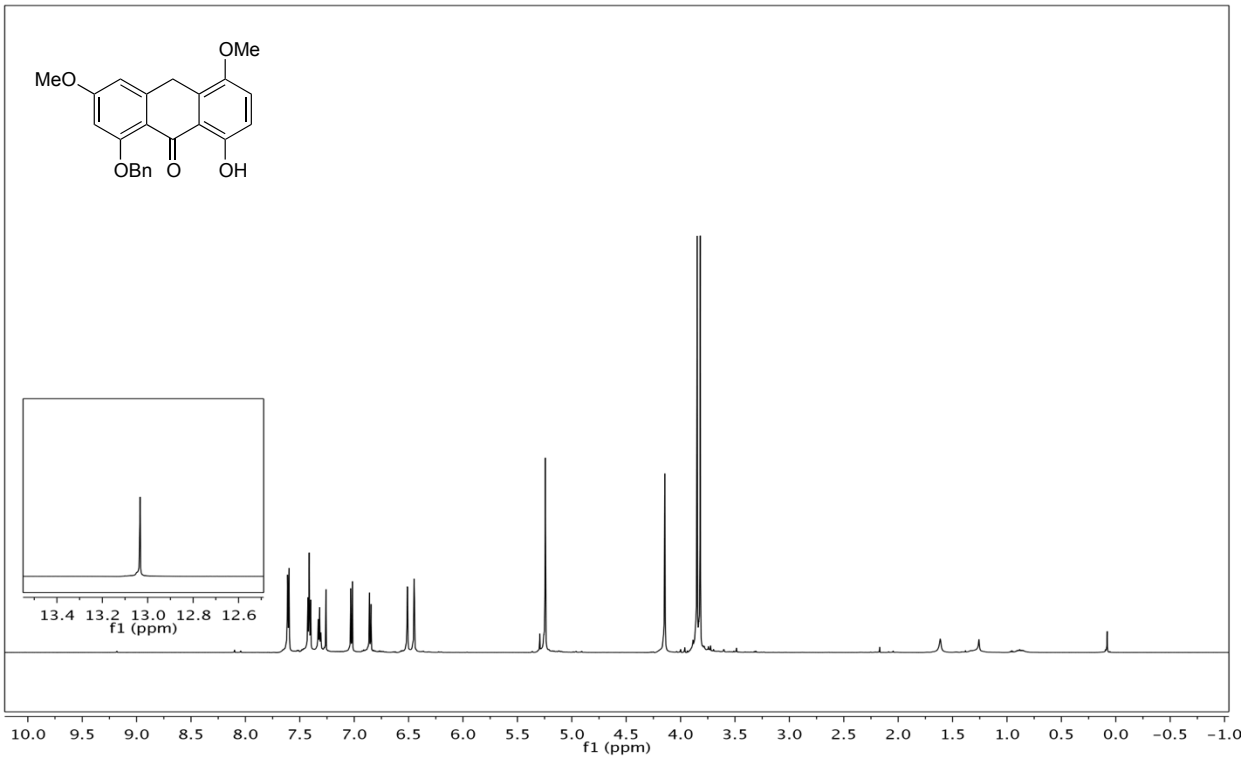
^{1}H NMR spectrum (C_6D_6, 600 MHz) of compound **19**.



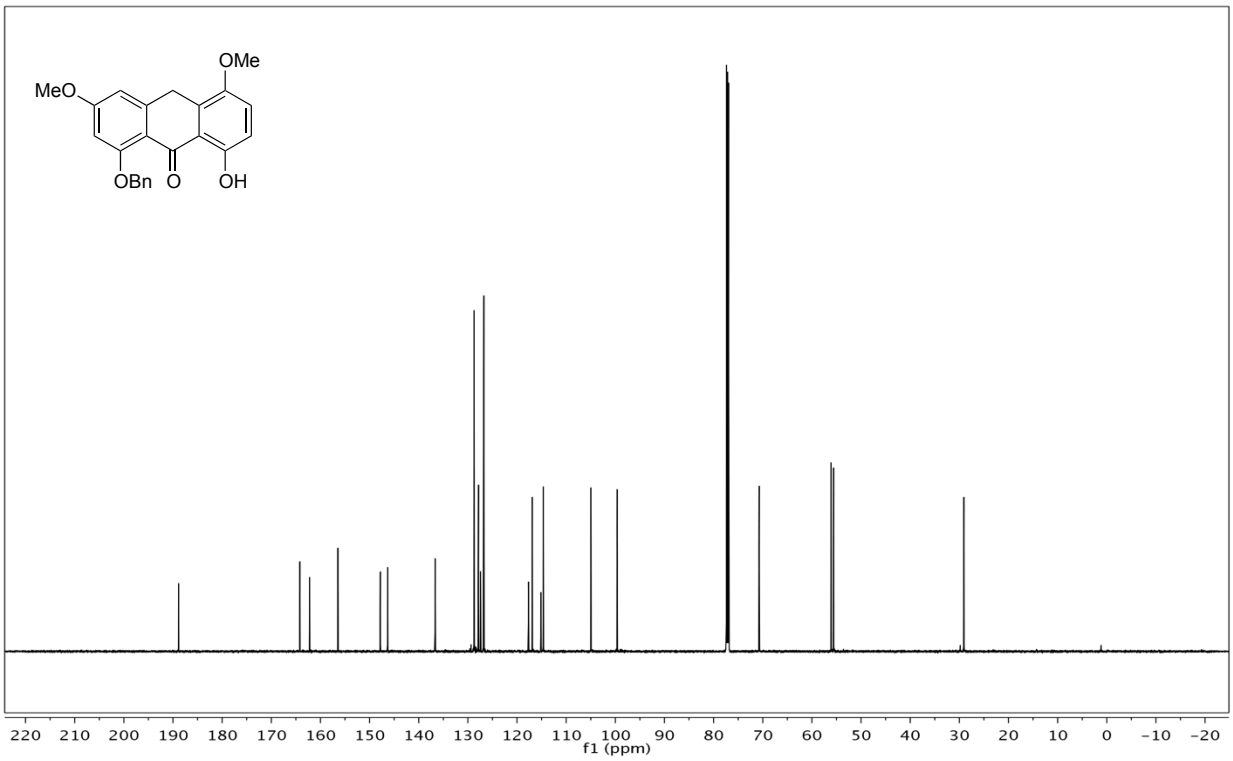
^{13}C NMR spectrum (C_6D_6, 151 MHz) of compound **19**.



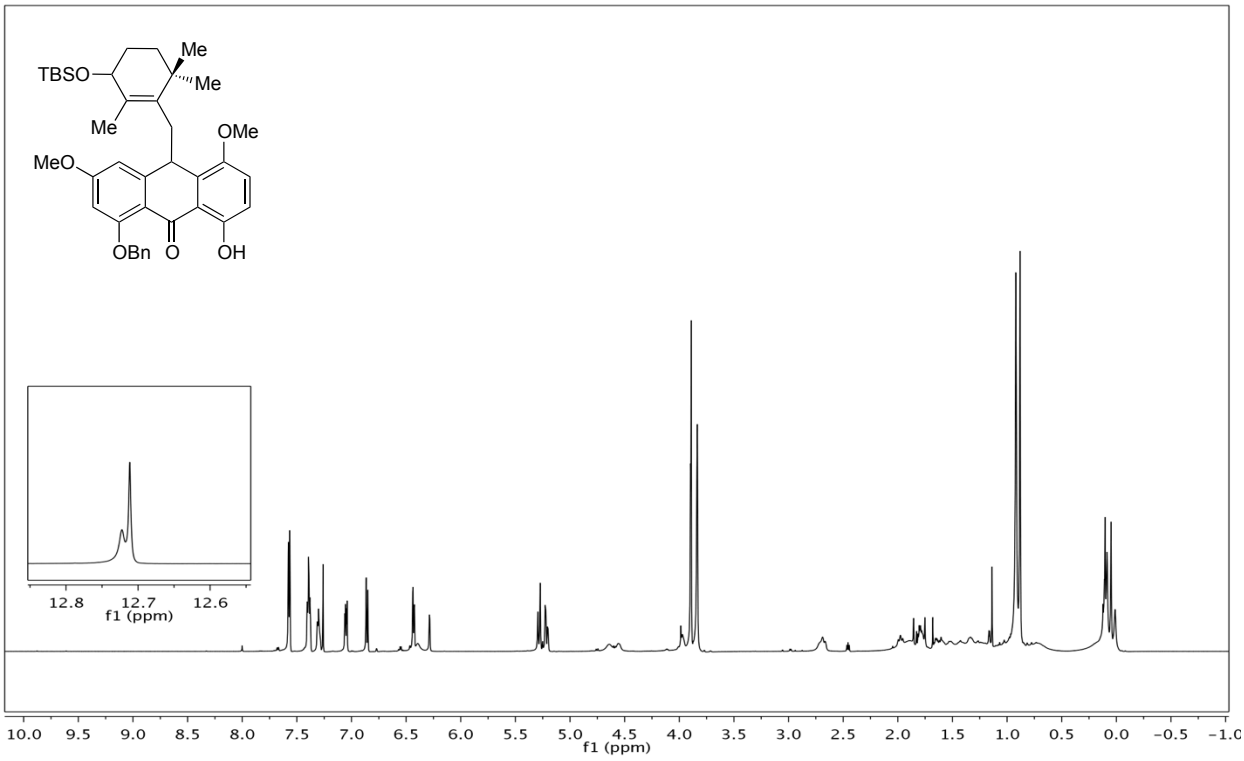
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **S7**.



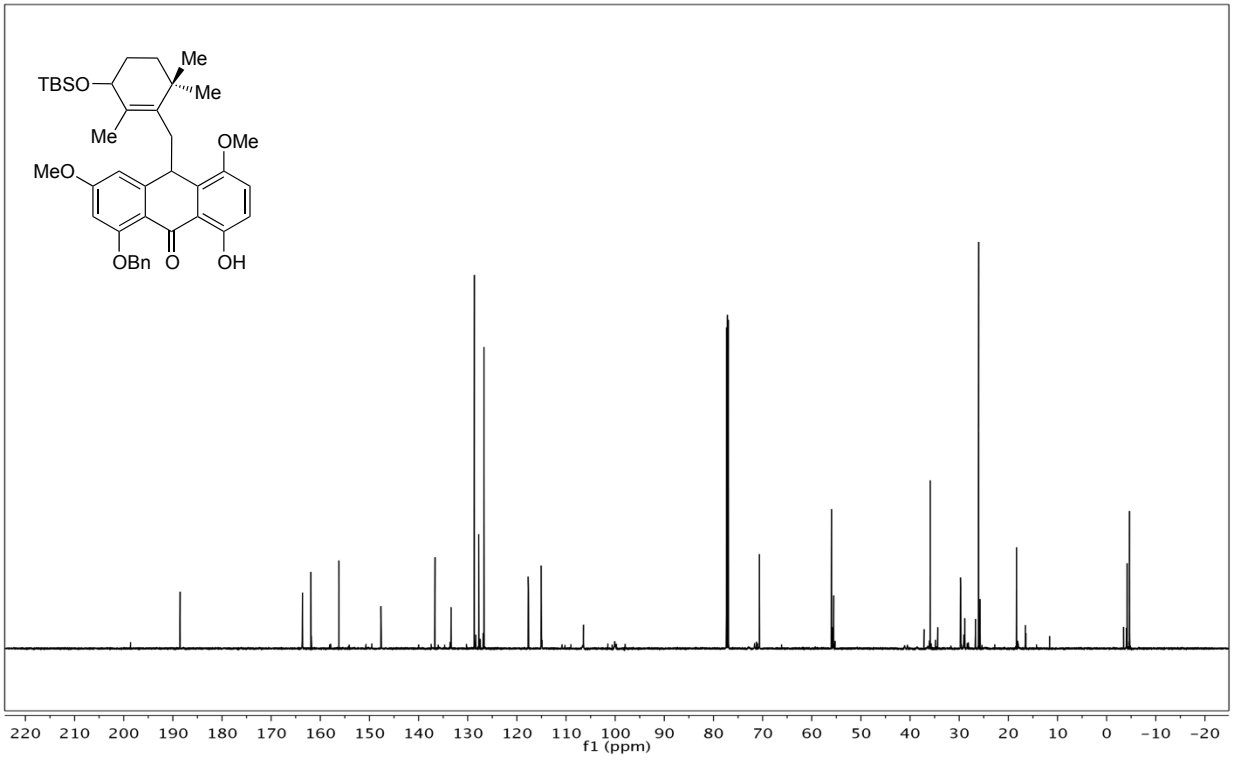
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **S7**.



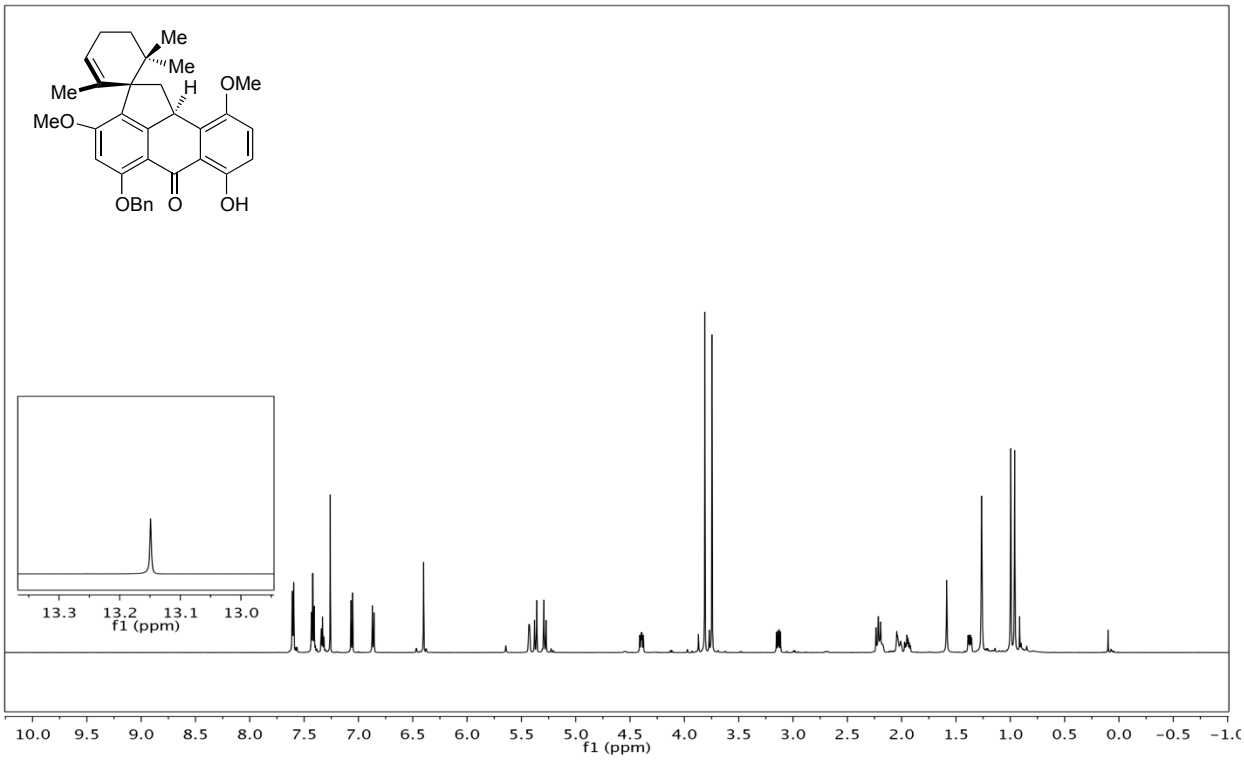
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **20**.



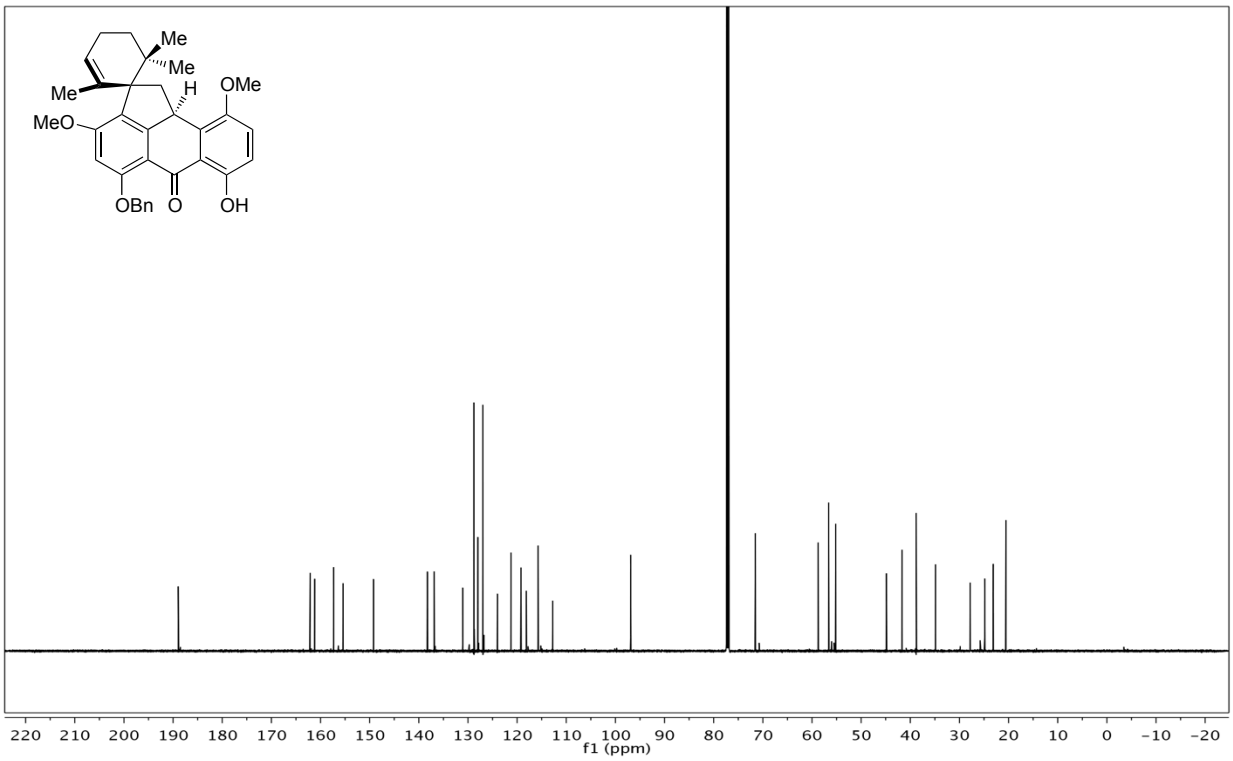
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **20**.



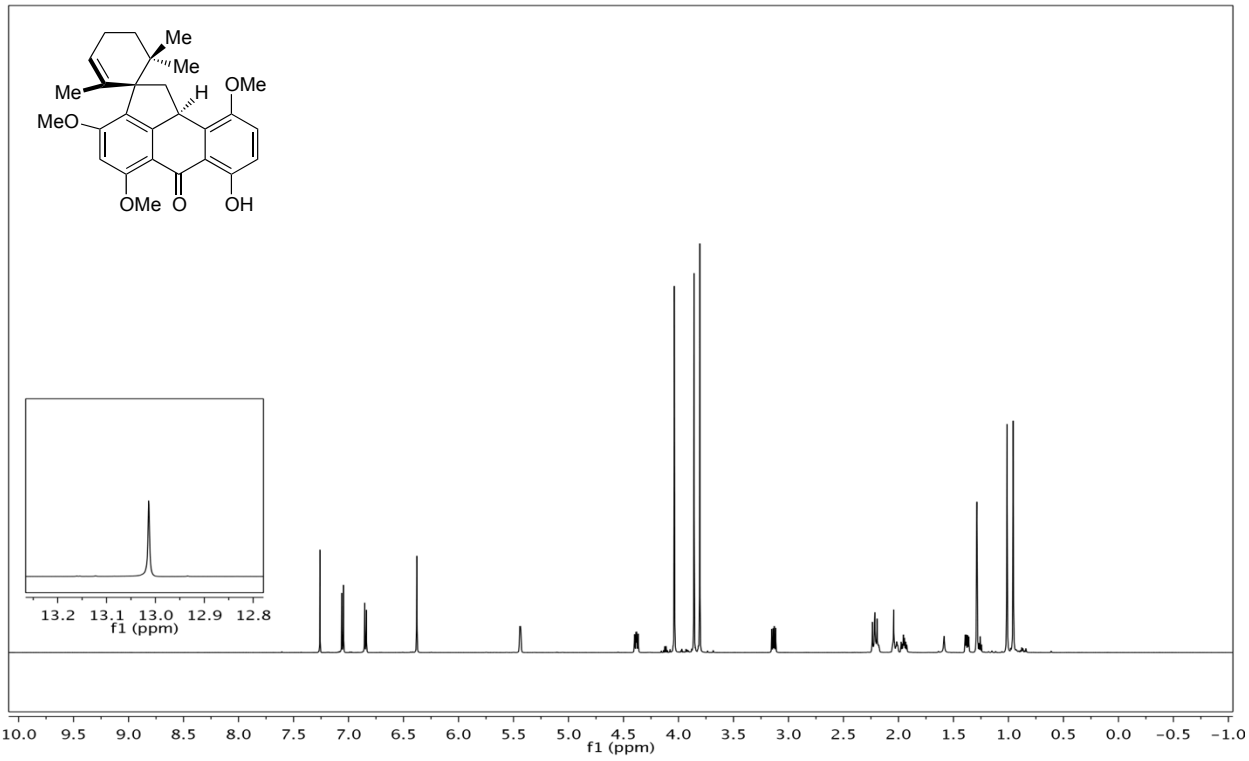
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **22**.



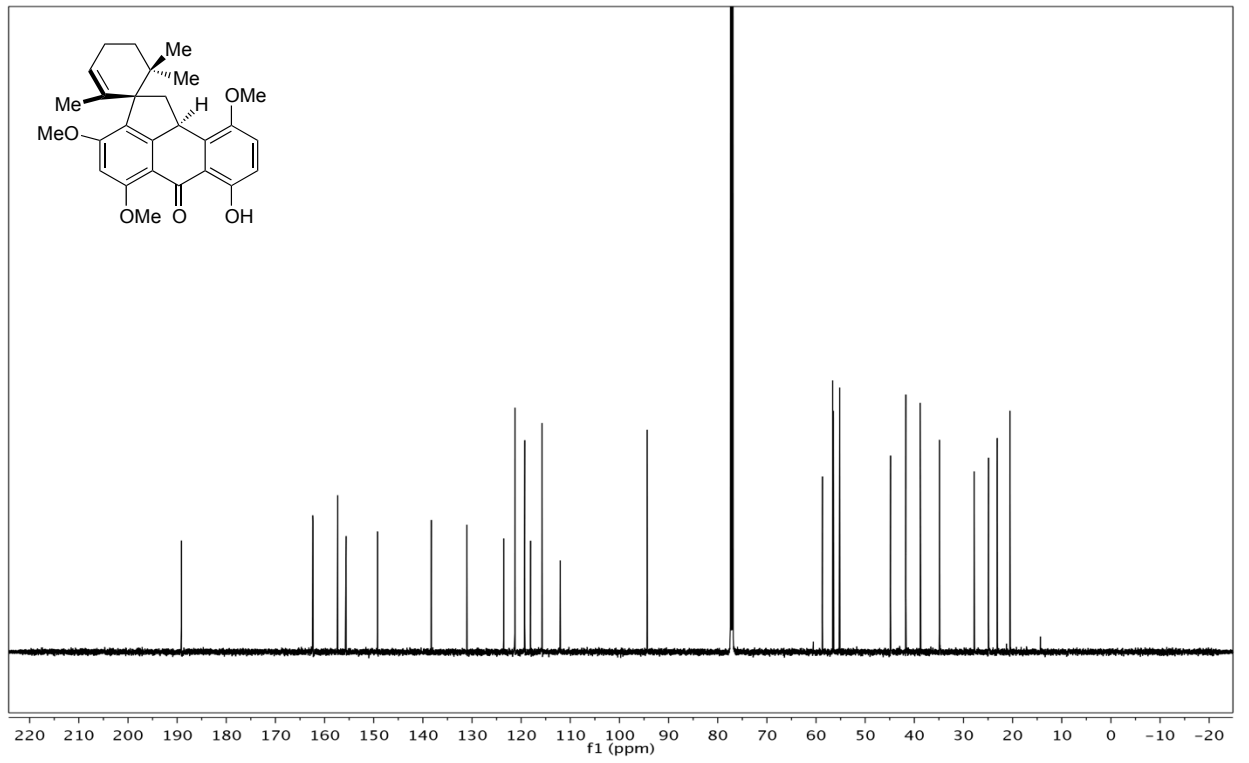
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **22**.



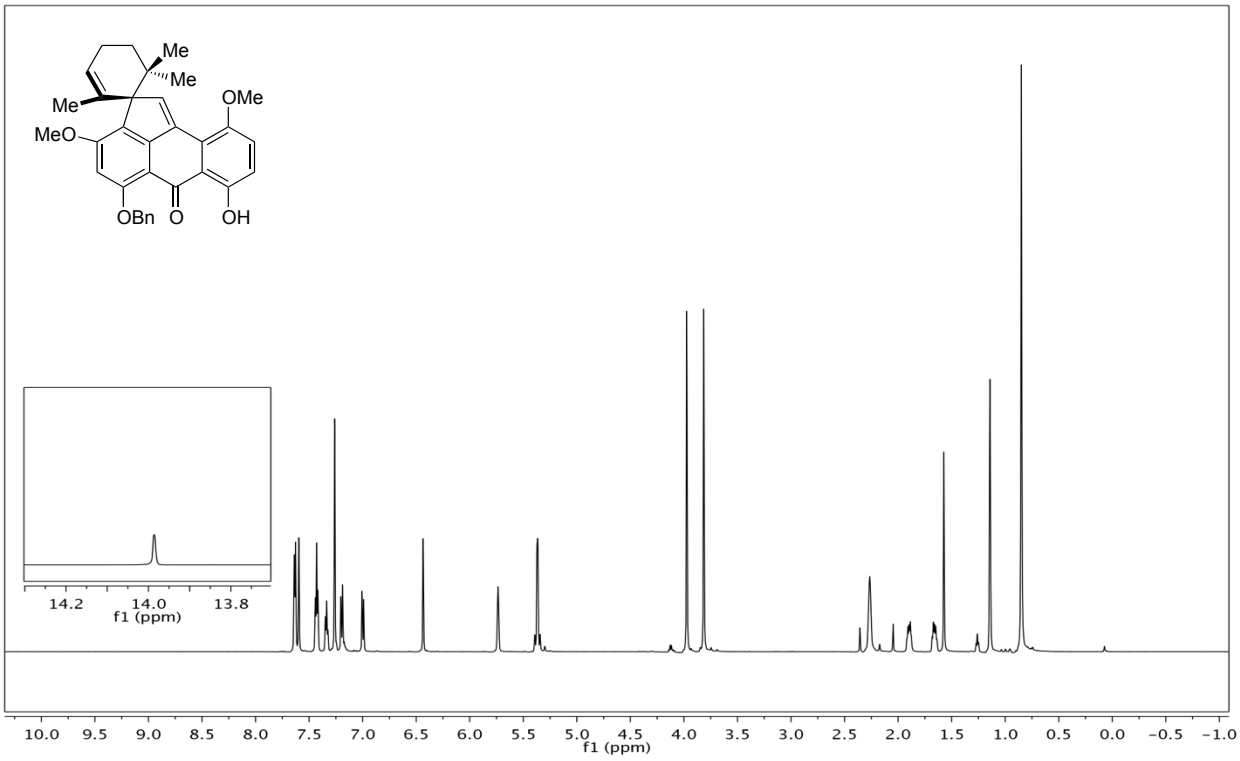
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **23**.



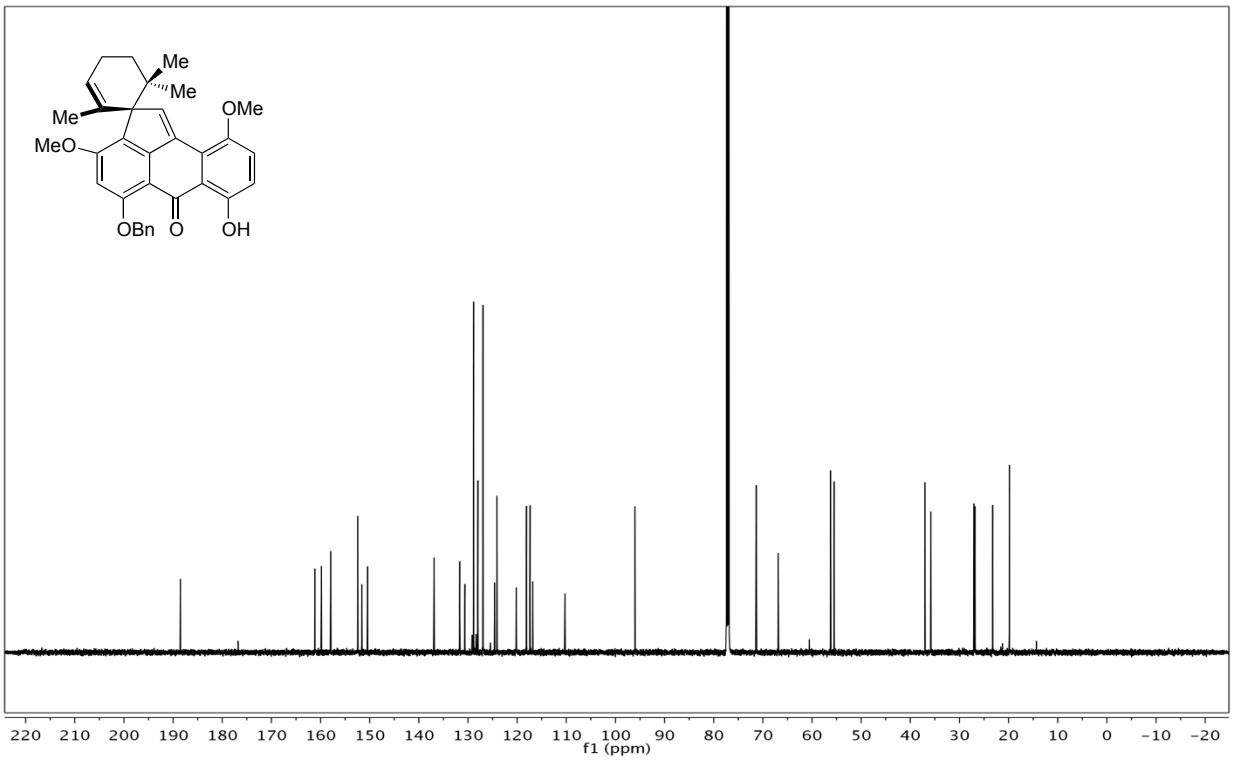
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **23**.



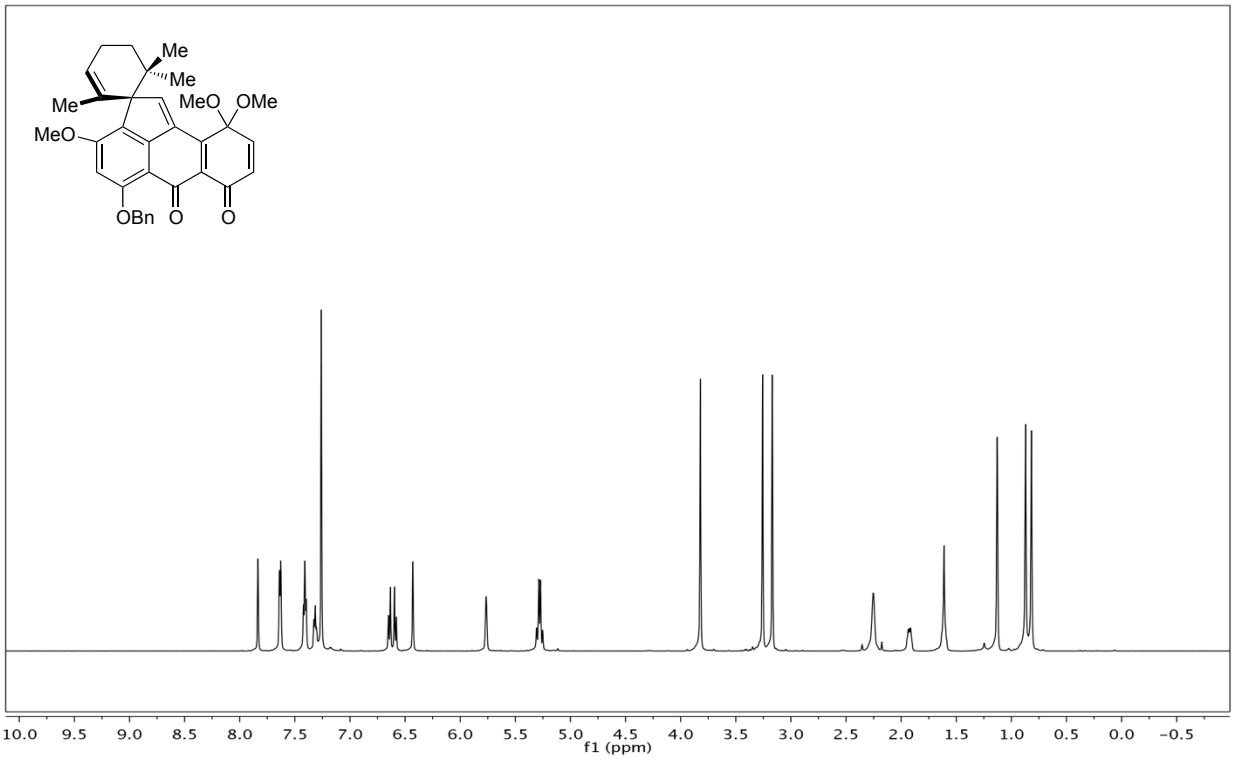
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **S8**.



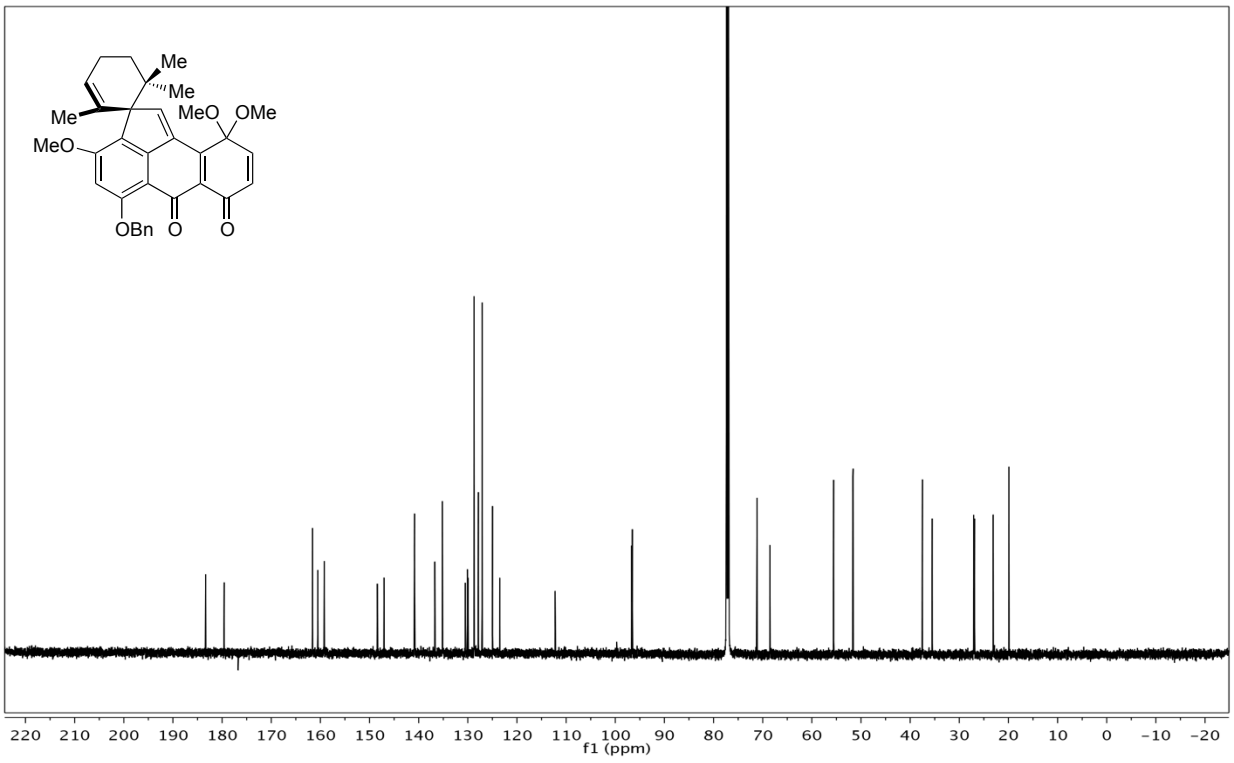
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **S8**.



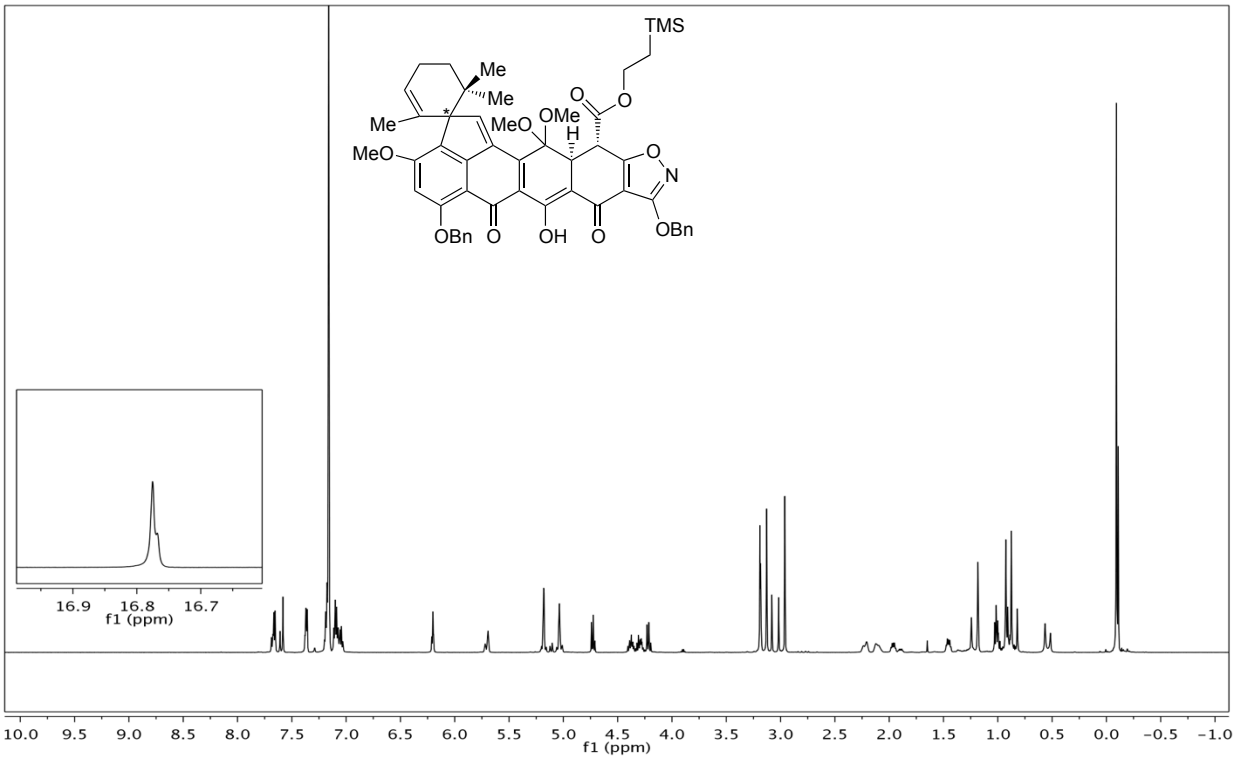
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **25**.



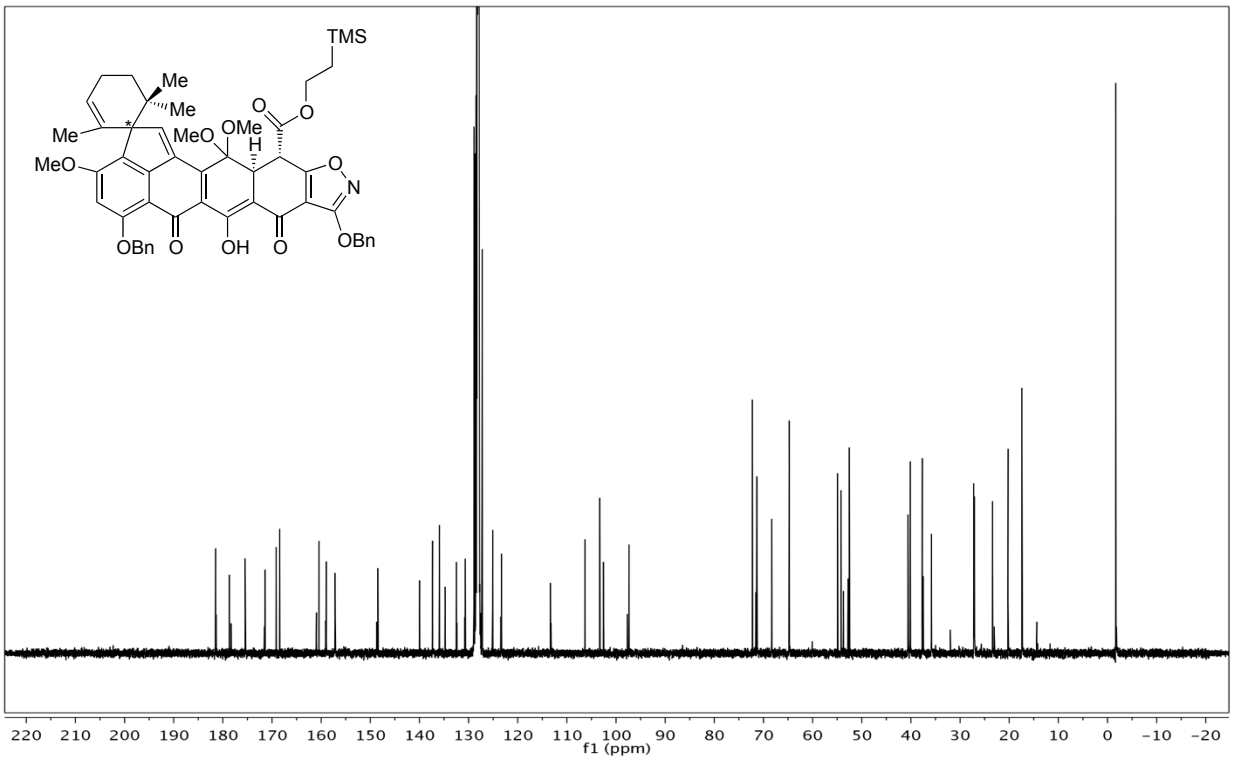
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **25**.



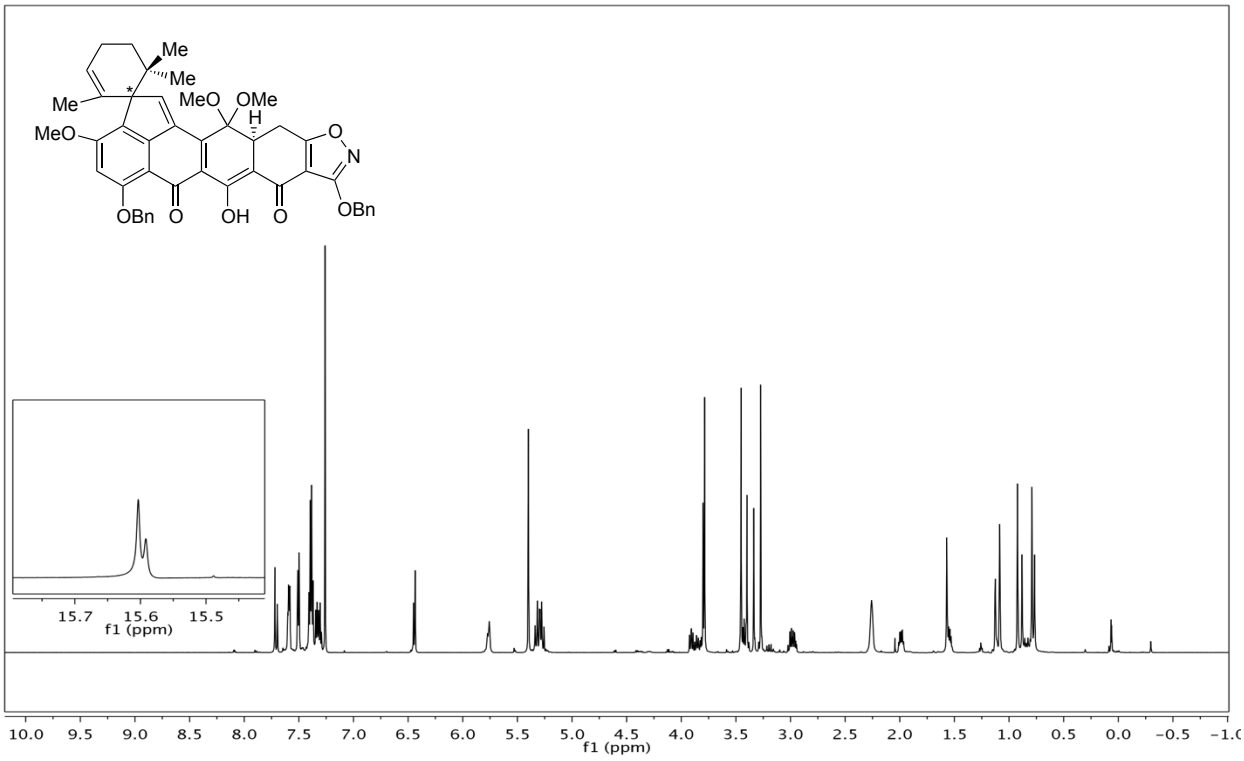
^{1}H NMR spectrum (C_6D_6, 600 MHz) of compound **26** (+ 15-*epi*-**26**).



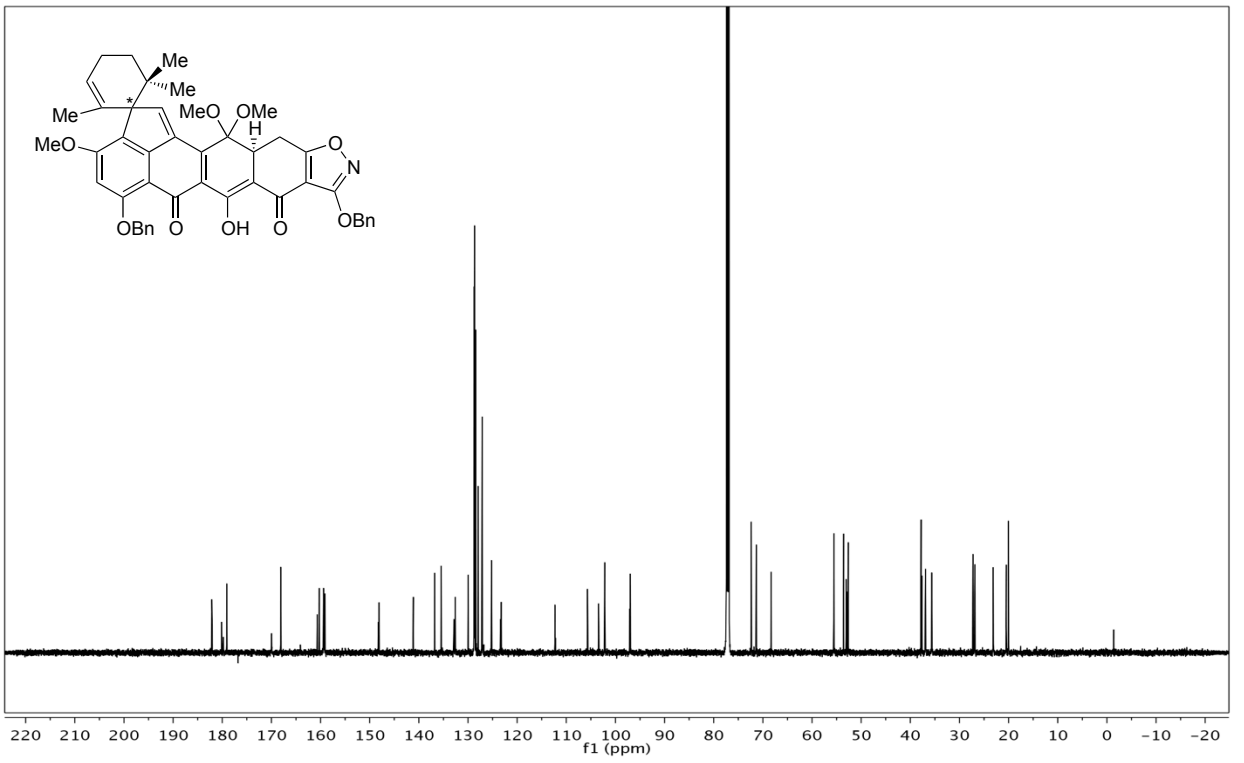
^{13}C NMR spectrum (C_6D_6, 151 MHz) of compound **26** (+ 15-*epi*-**26**).



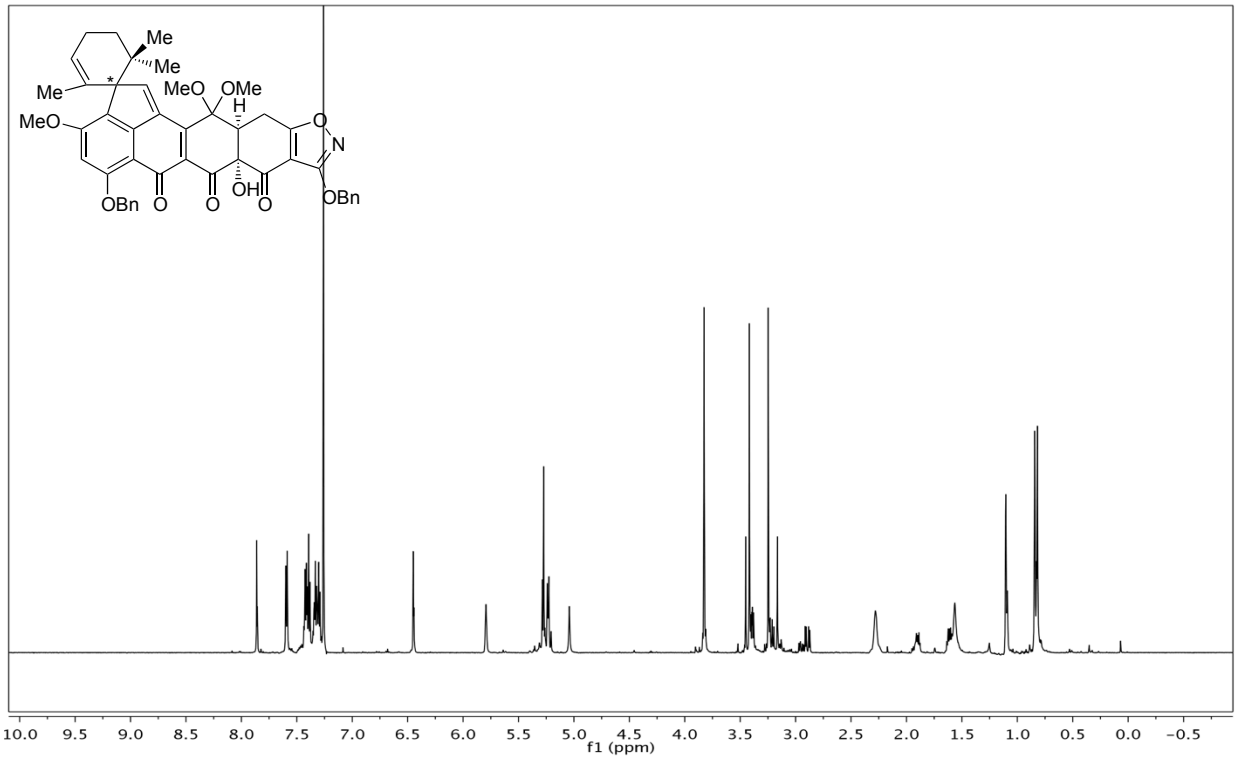
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **27** (+ 15-*epi*-**27**).



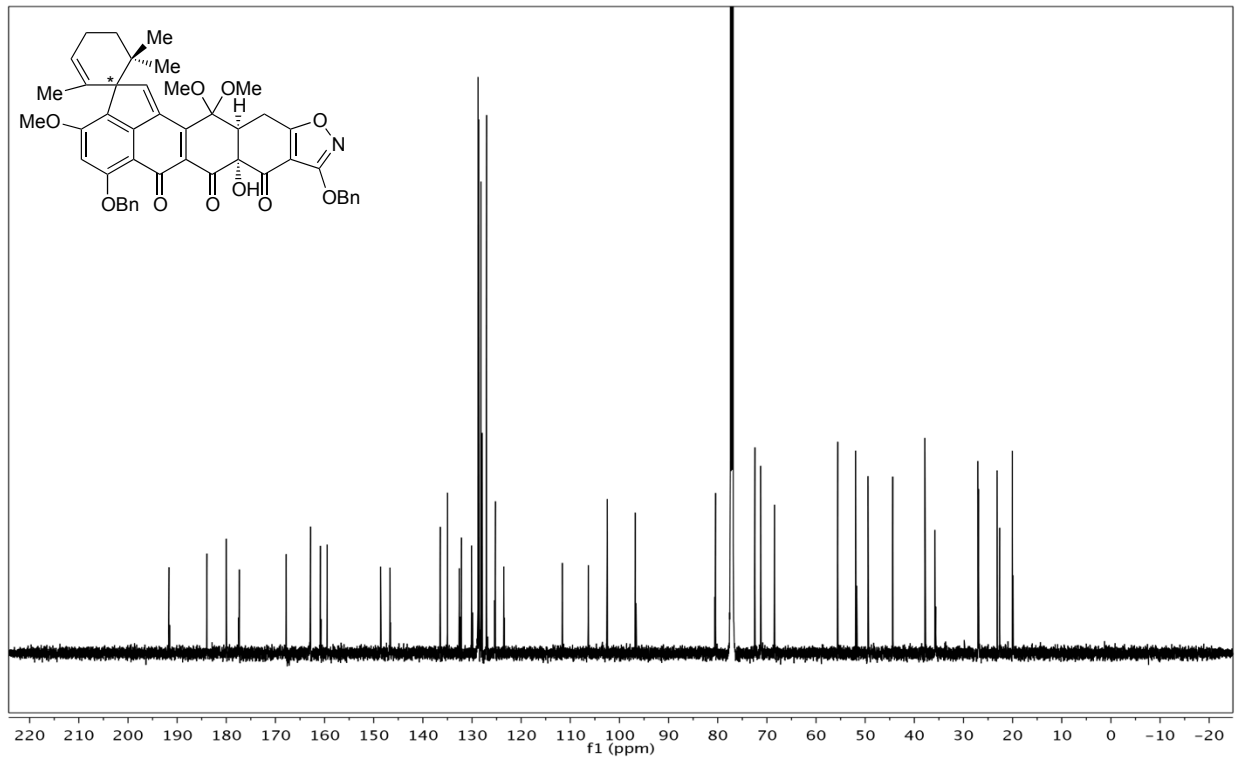
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **27** (+ 15-*epi*-**27**).



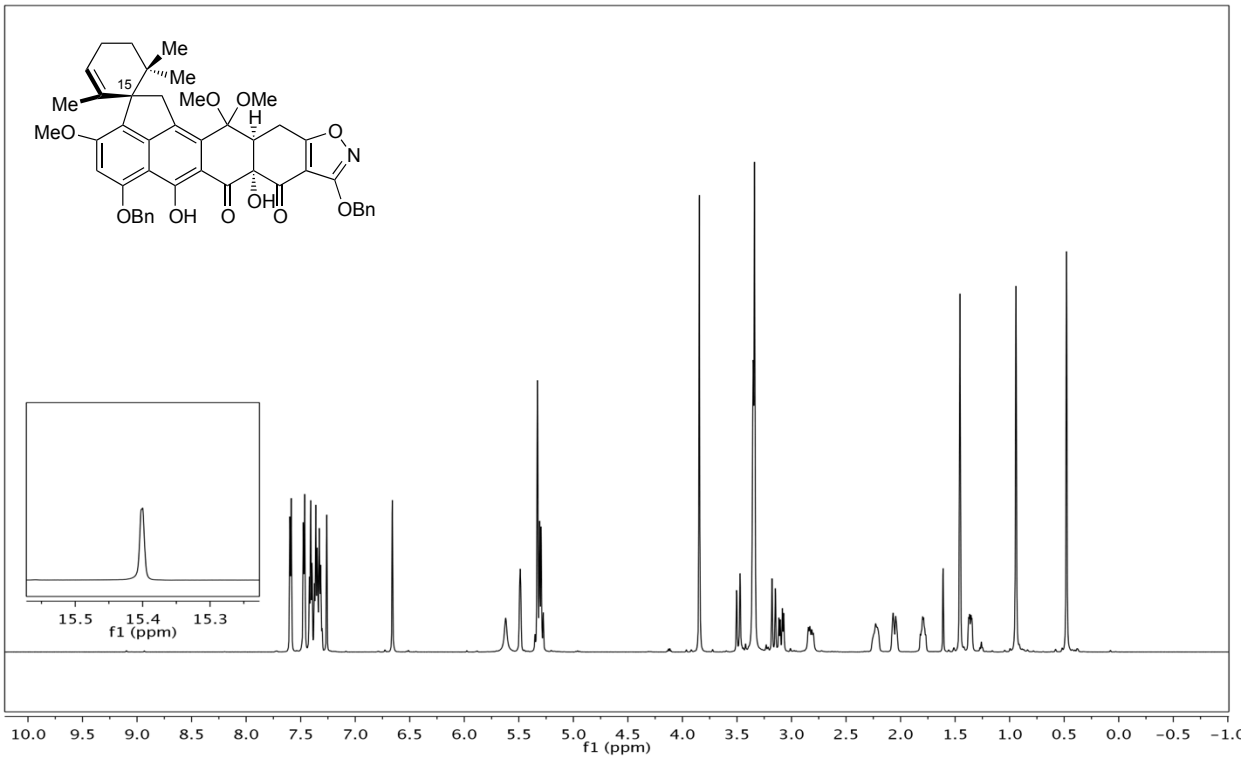
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **S9** (+ 15-*epi*-**S9**).



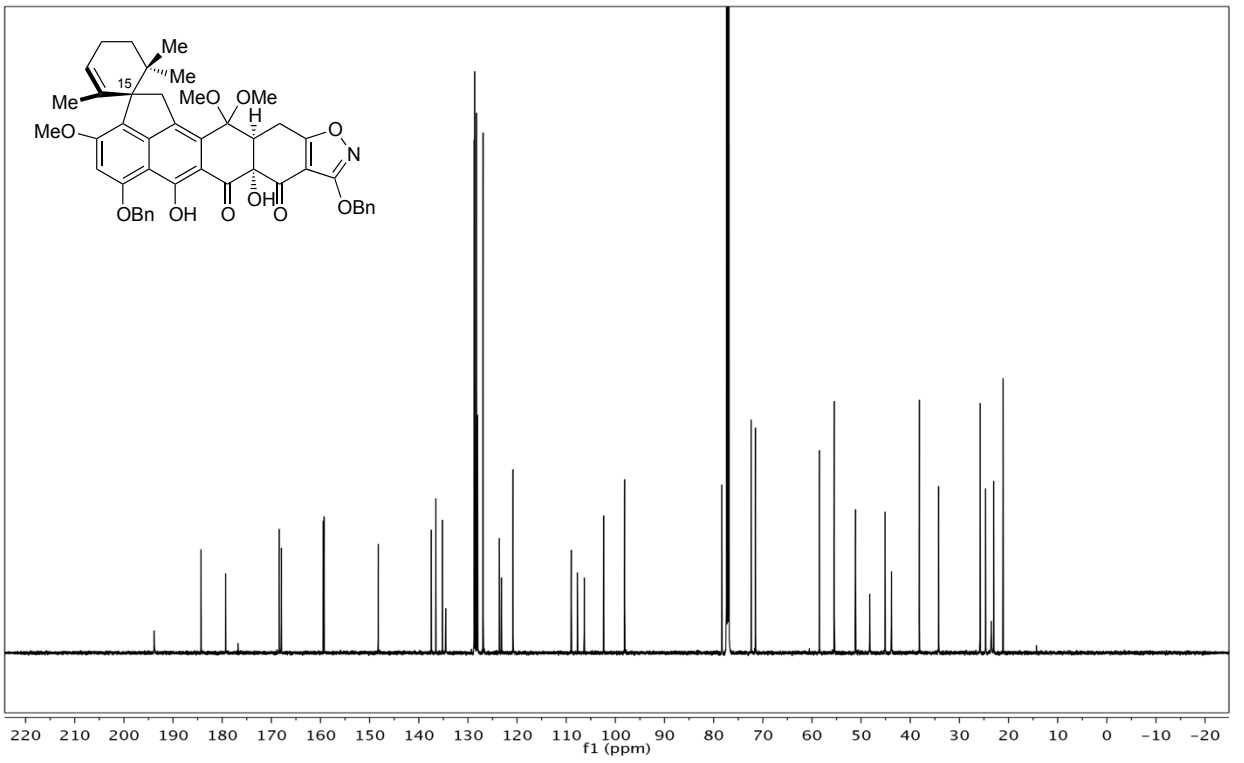
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **S9** (+ 15-*epi*-**S9**).



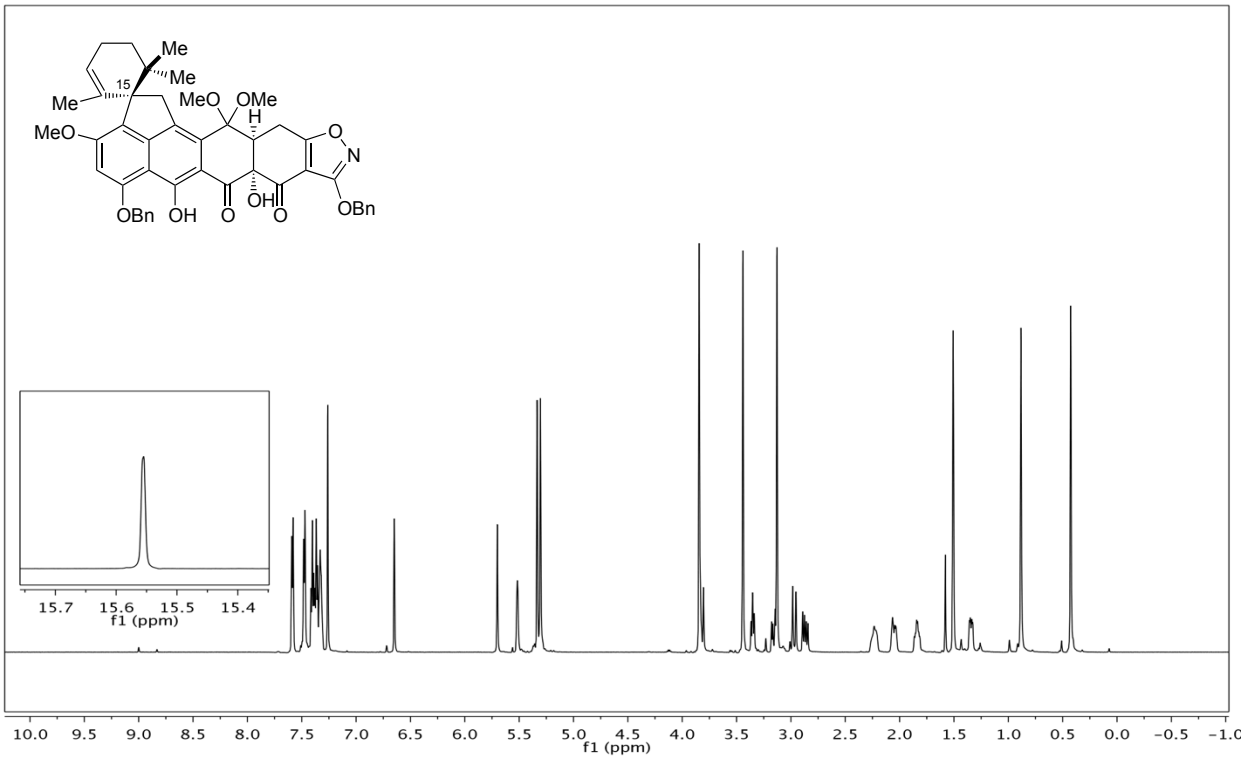
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **28**.



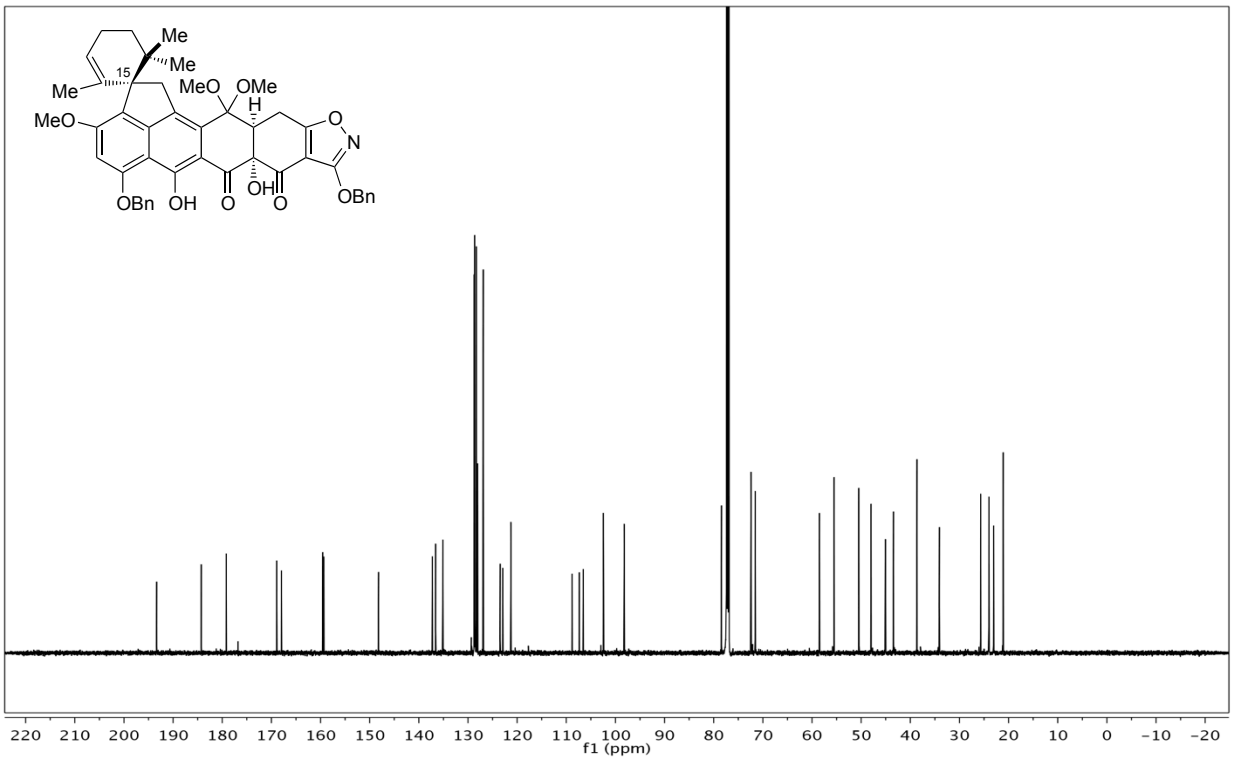
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **28**.



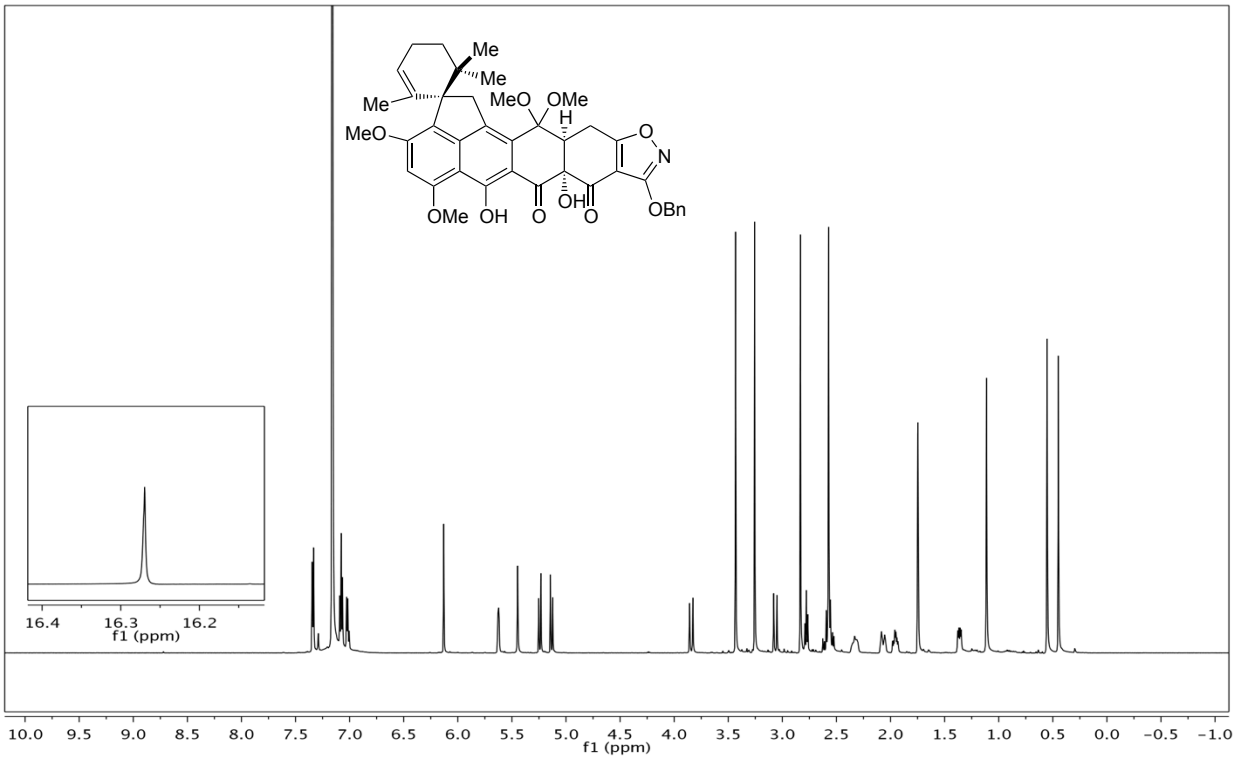
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound 15-*epi*-**28**.



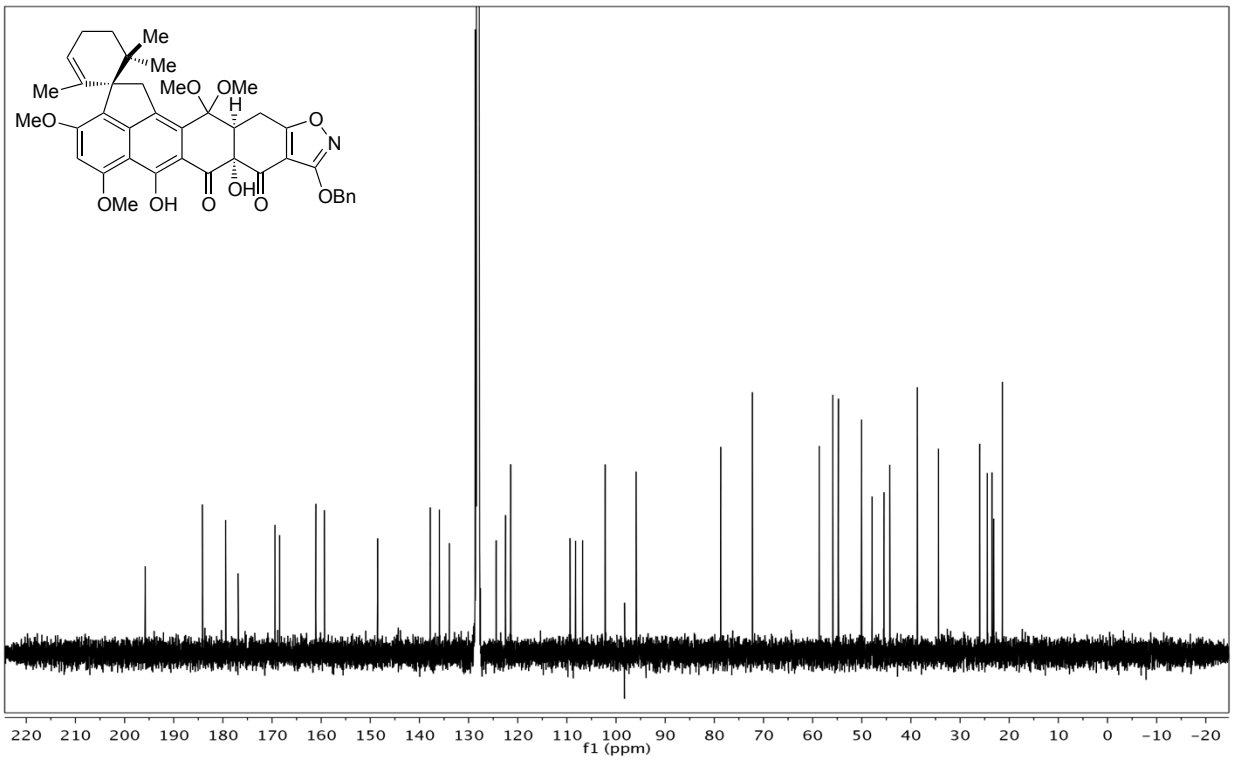
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound 15-*epi*-**28**.



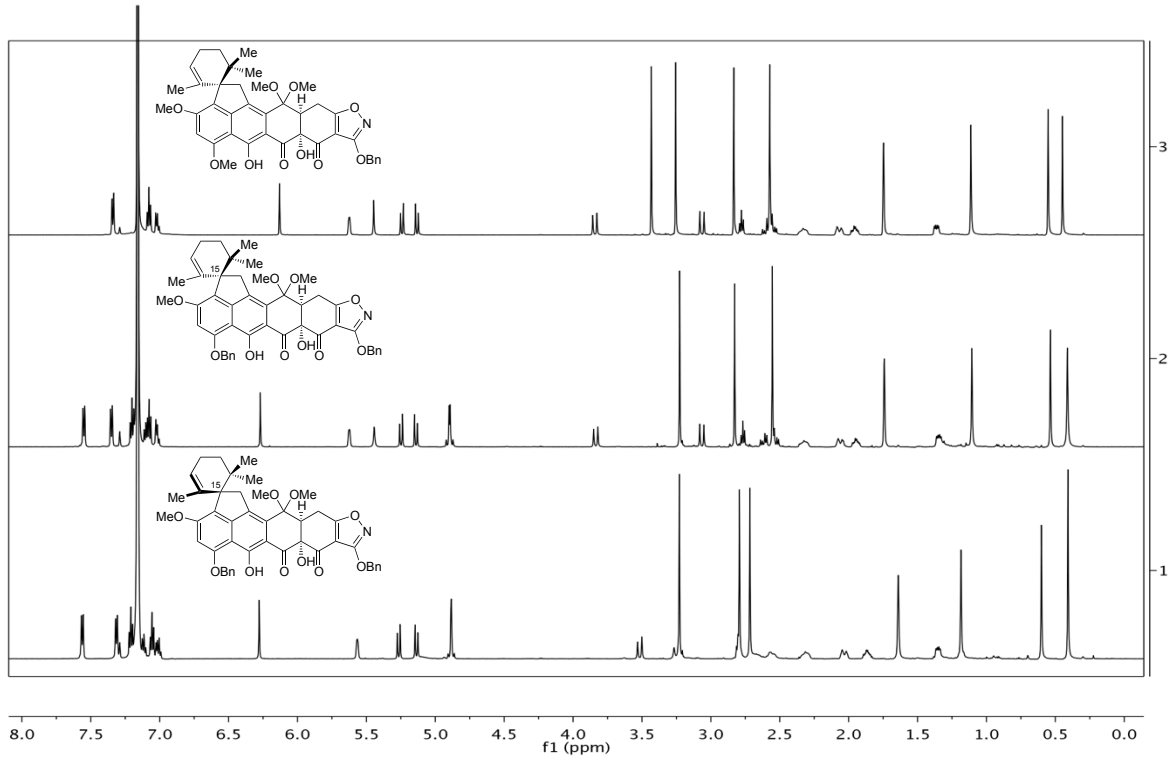
^{1}H NMR spectrum (C_6D_6, 600 MHz) of compound **29**.



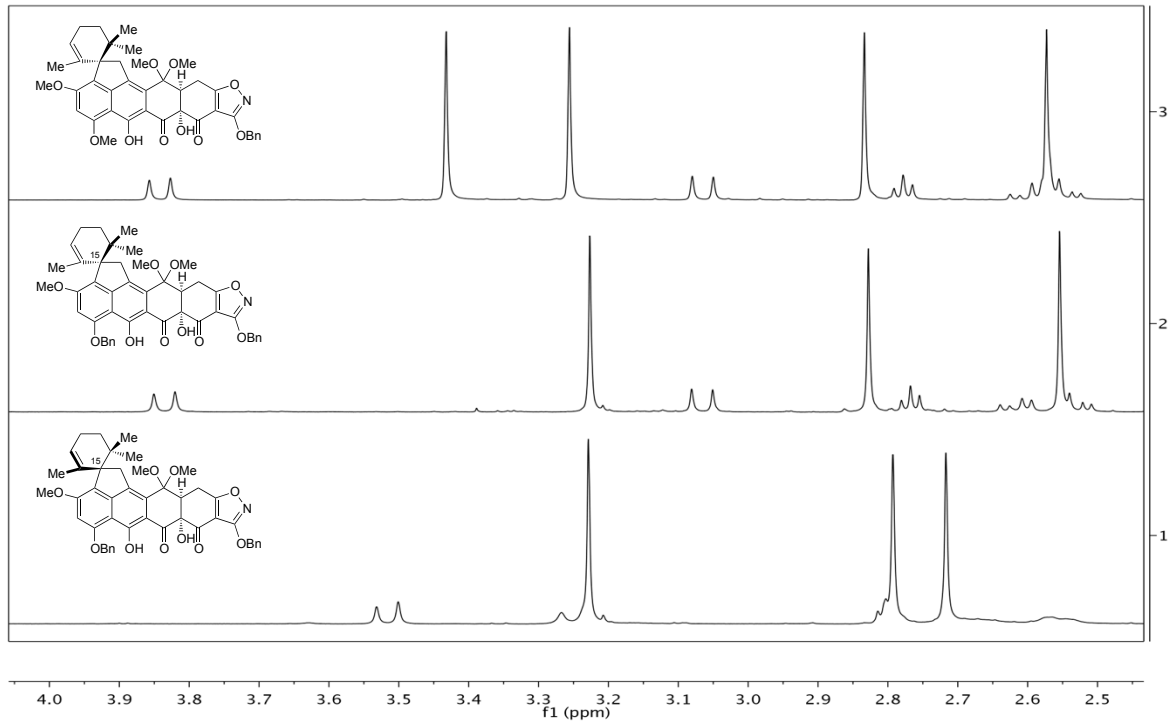
^{13}C NMR spectrum (C_6D_6, 151 MHz) of compound **29**.



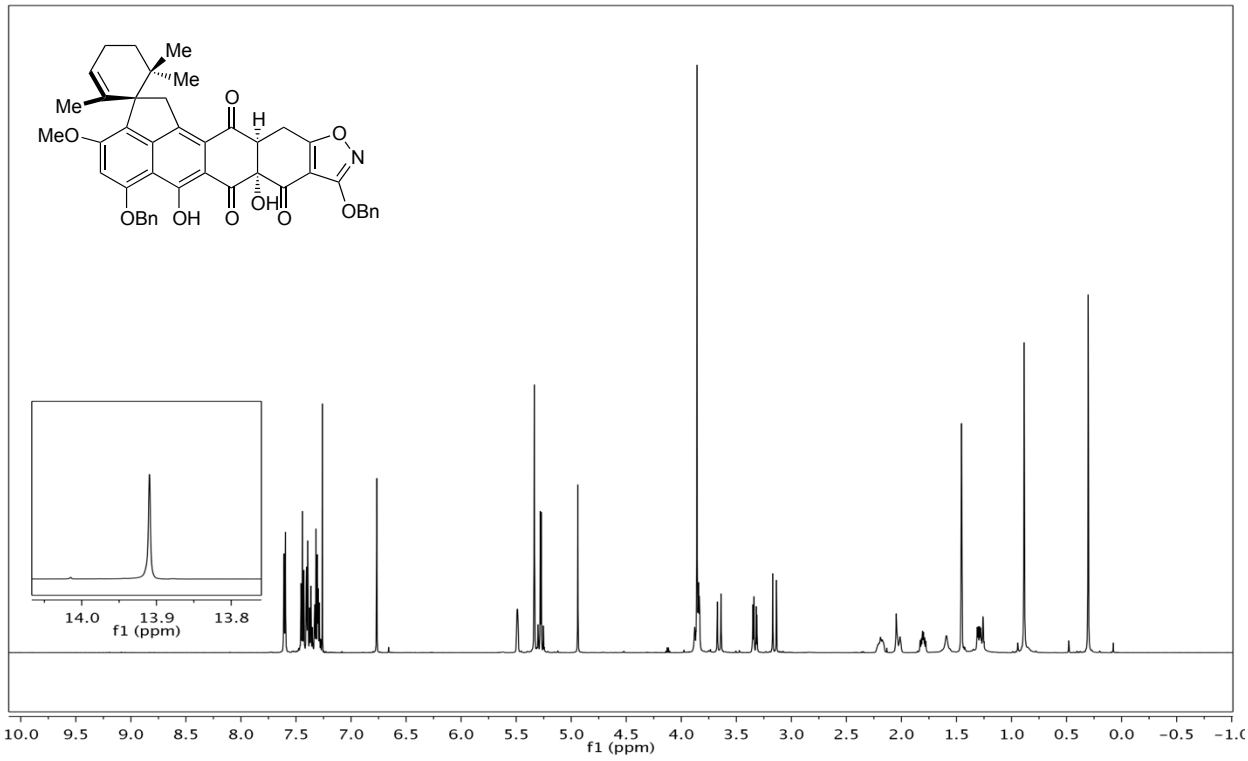
^{1}H NMR spectra (C_6D_6, 600 MHz) of compounds **28**, 15-*epi*-**28**, and **29**. (0 – 8 ppm)



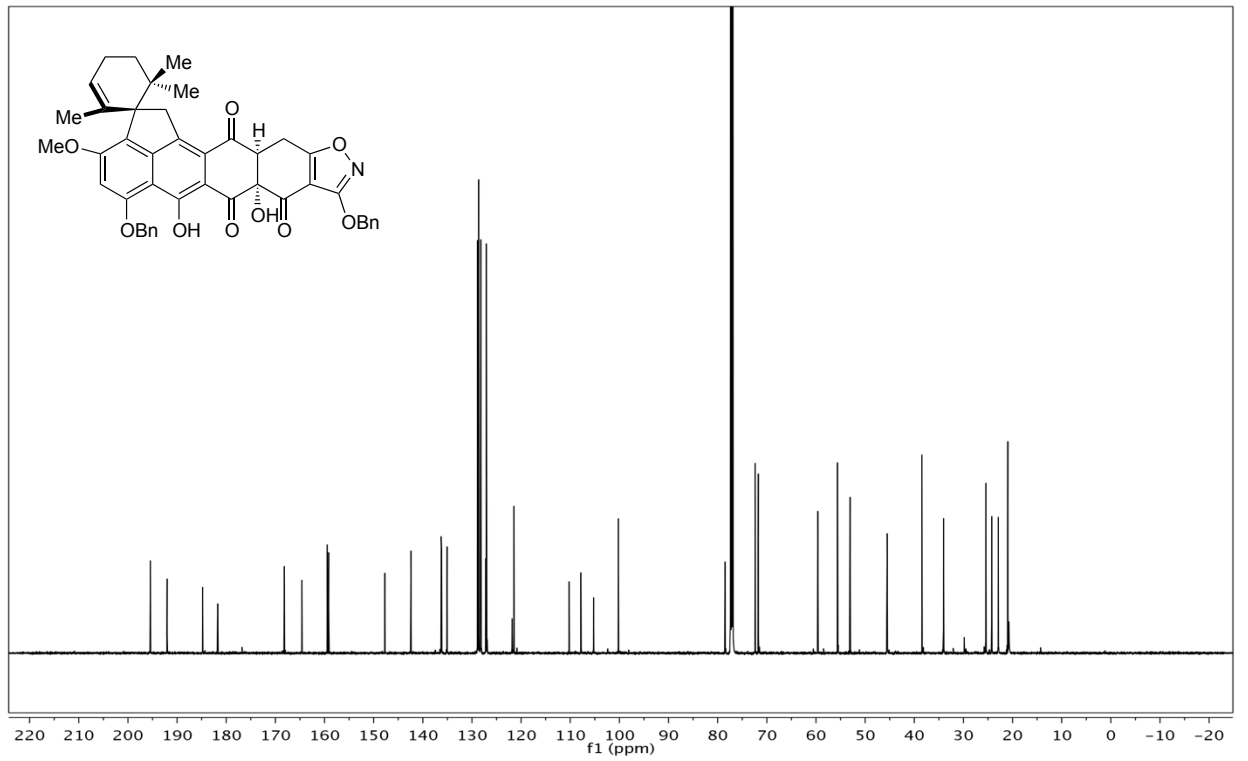
^{1}H NMR spectra (C_6D_6, 600 MHz) of compounds **28**, 15-*epi*-**28**, and **29**. (2.5 – 4 ppm)



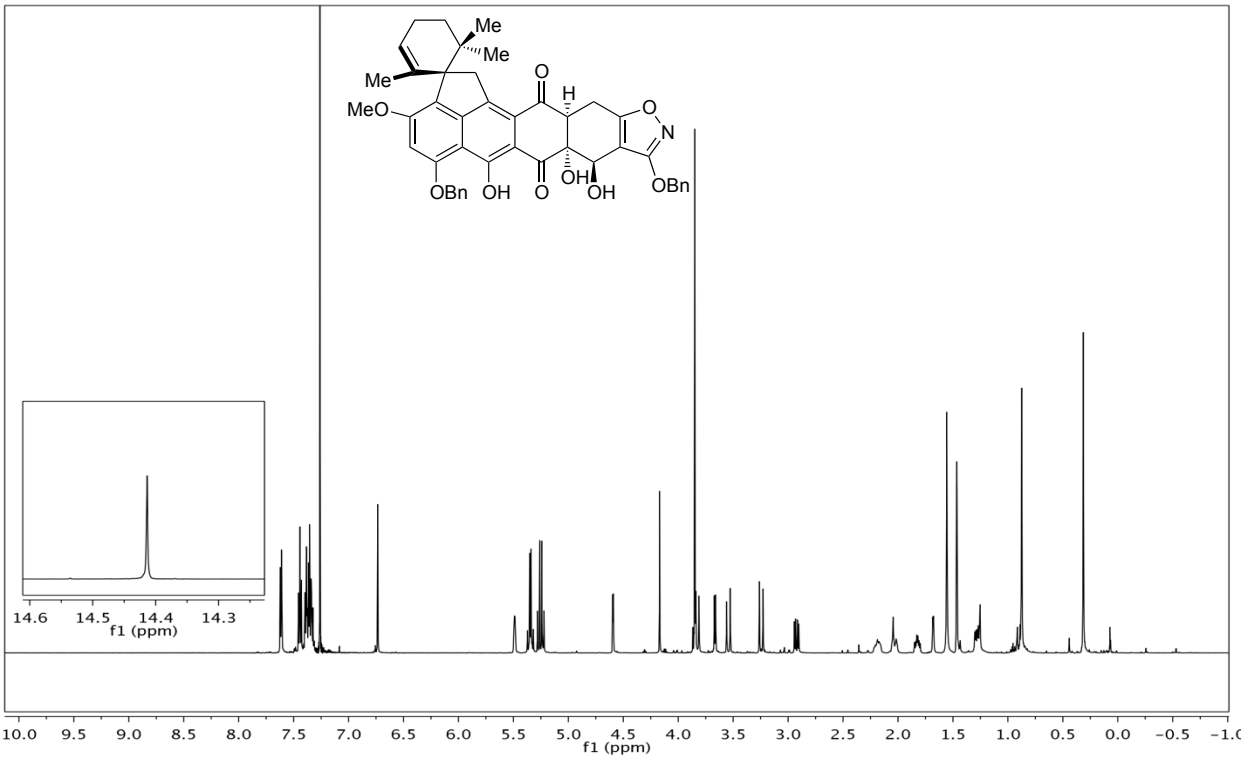
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **32**.



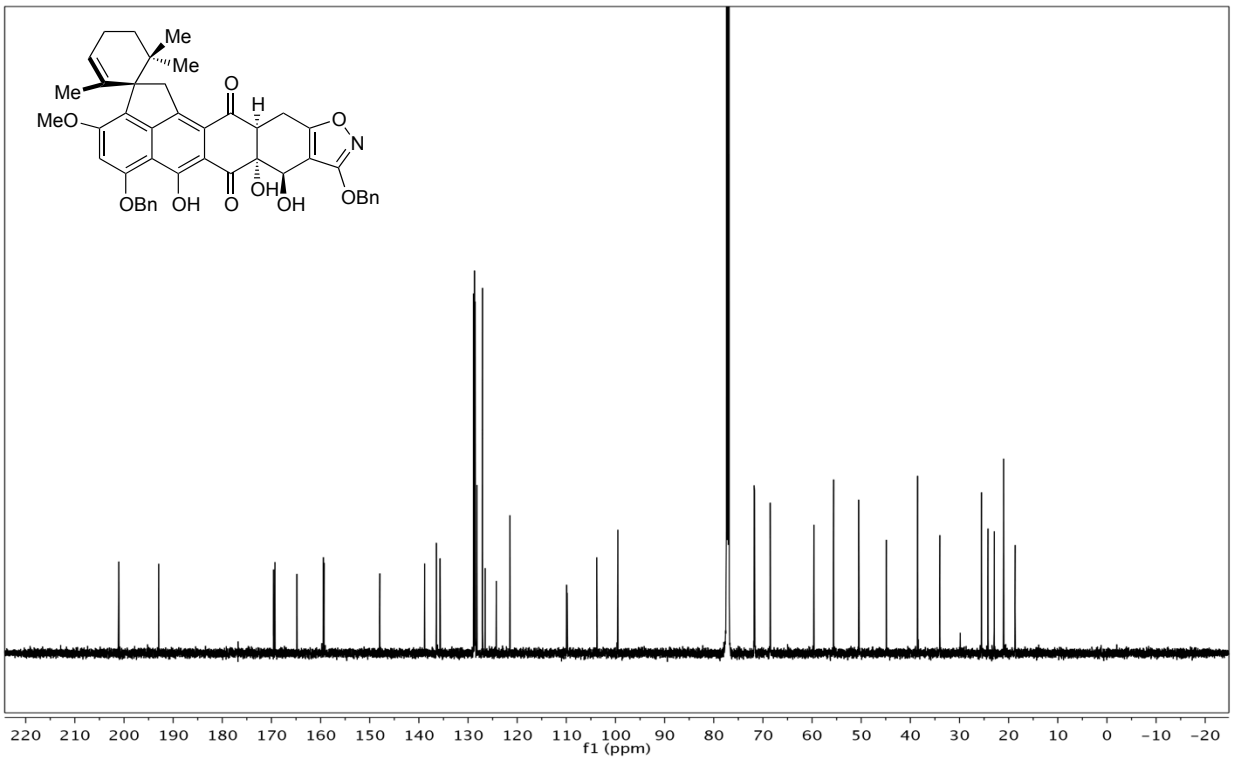
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **32**.



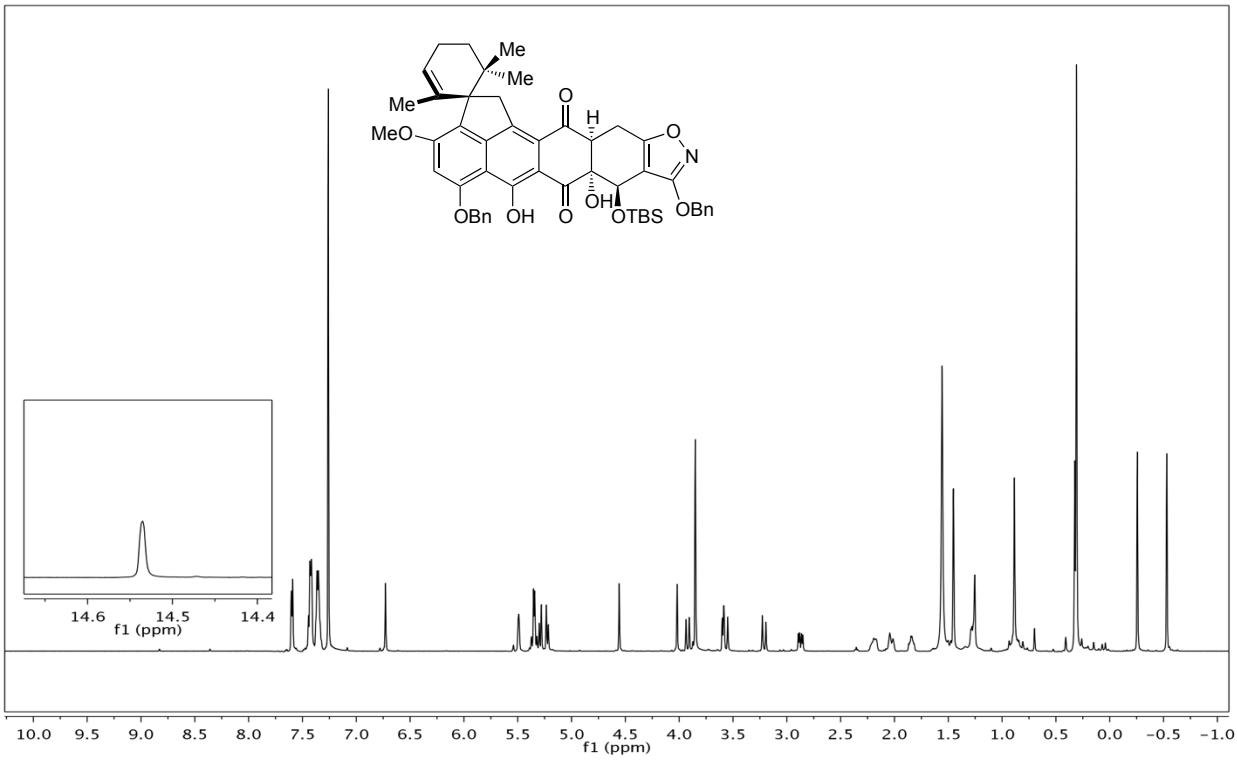
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **33**.



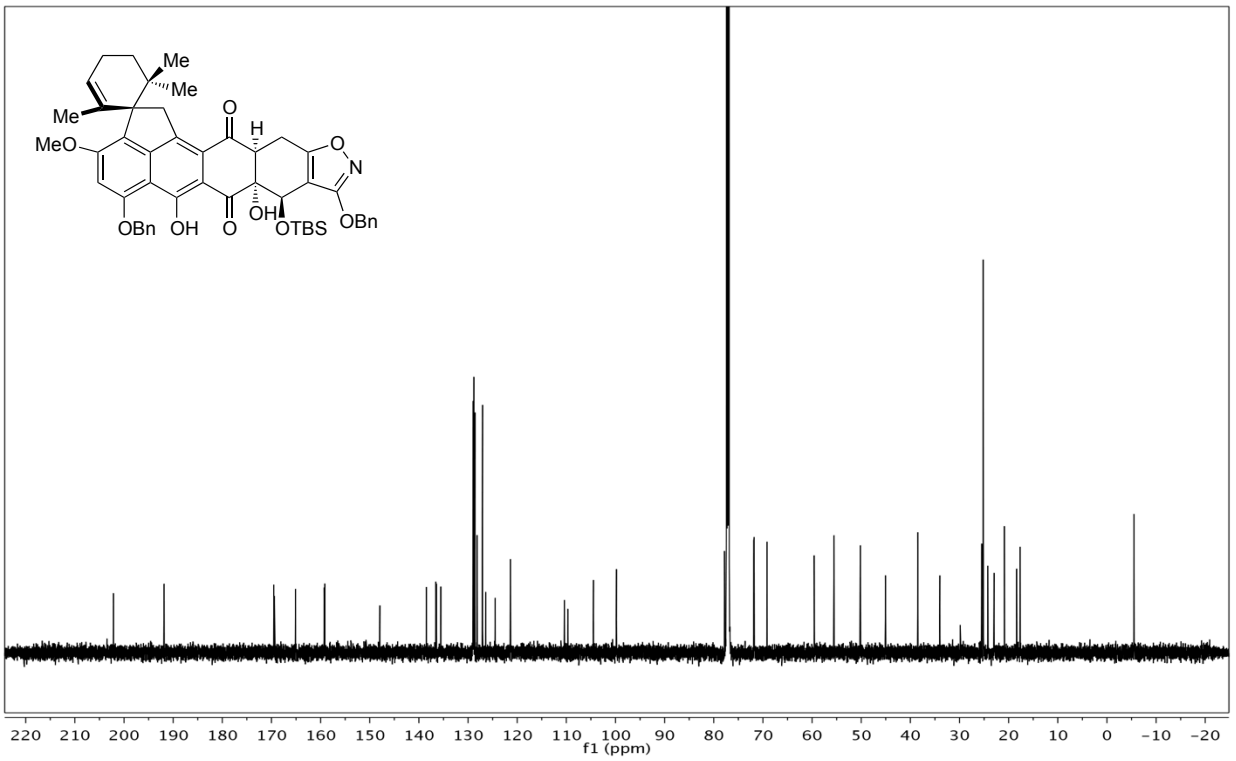
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **33**.



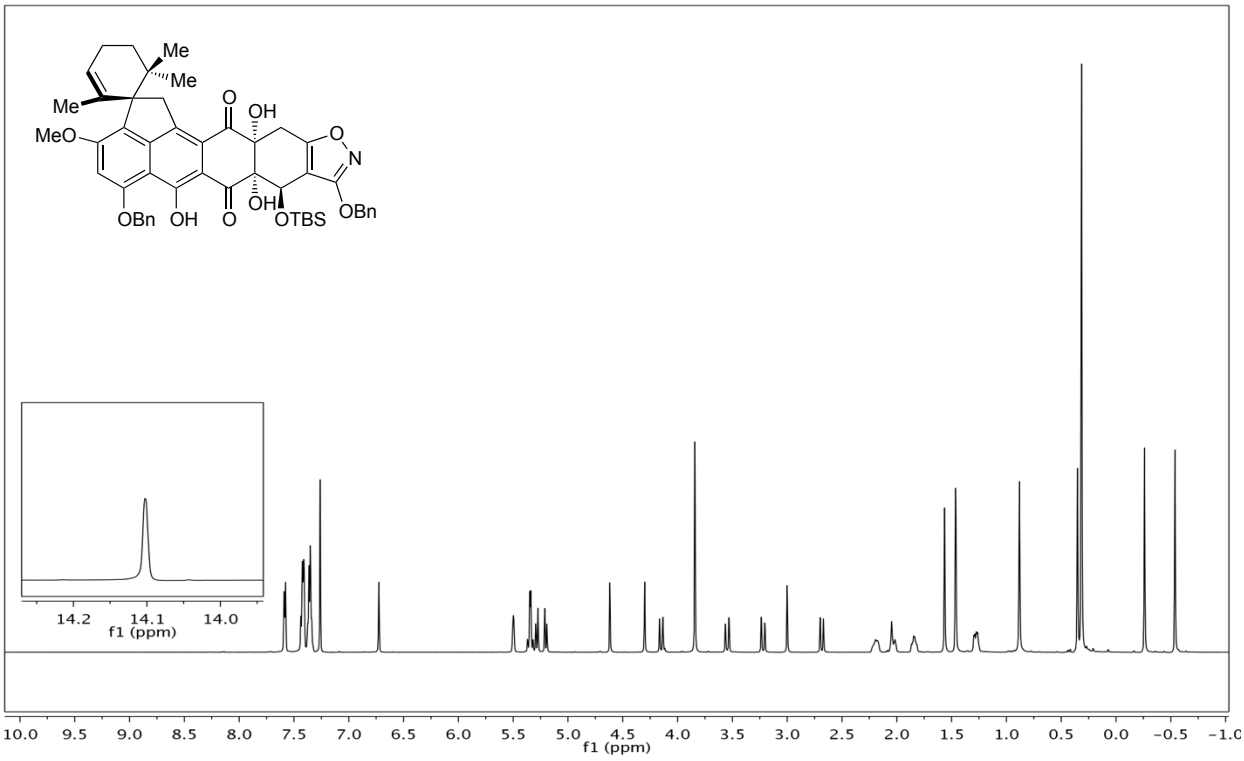
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **34**.



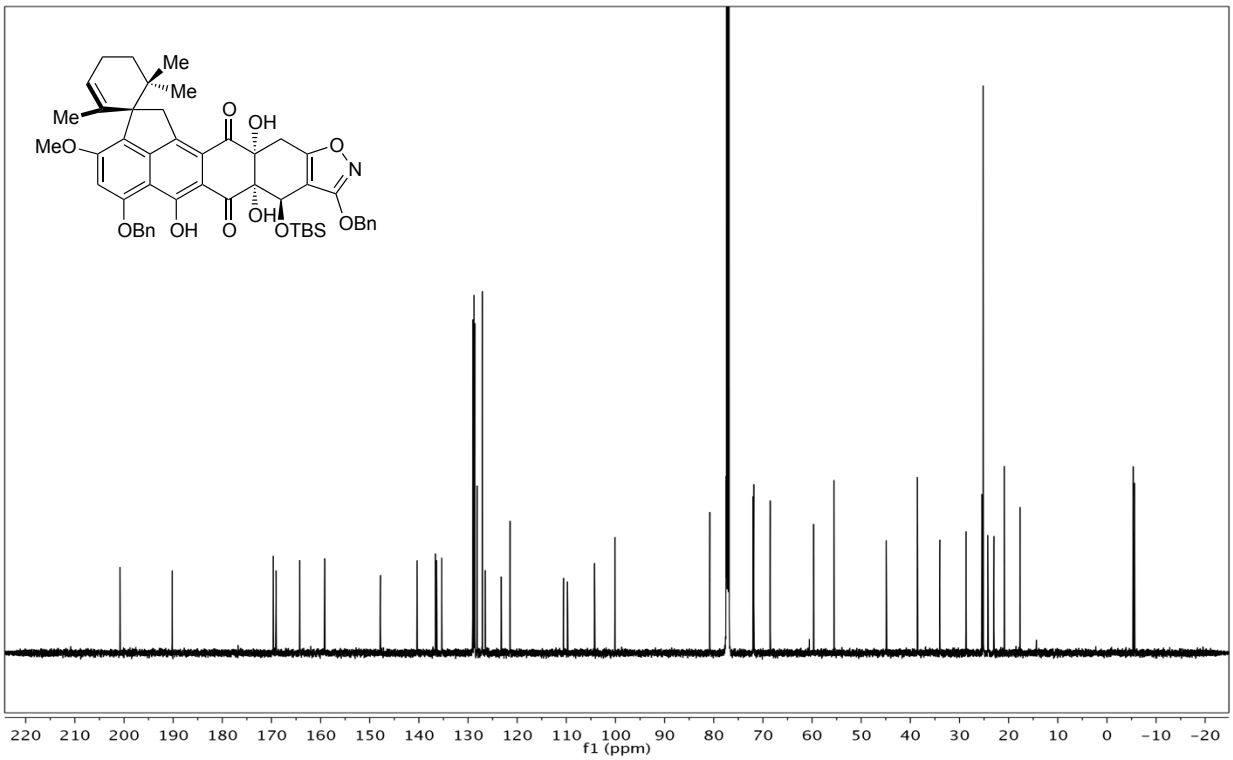
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **34**.



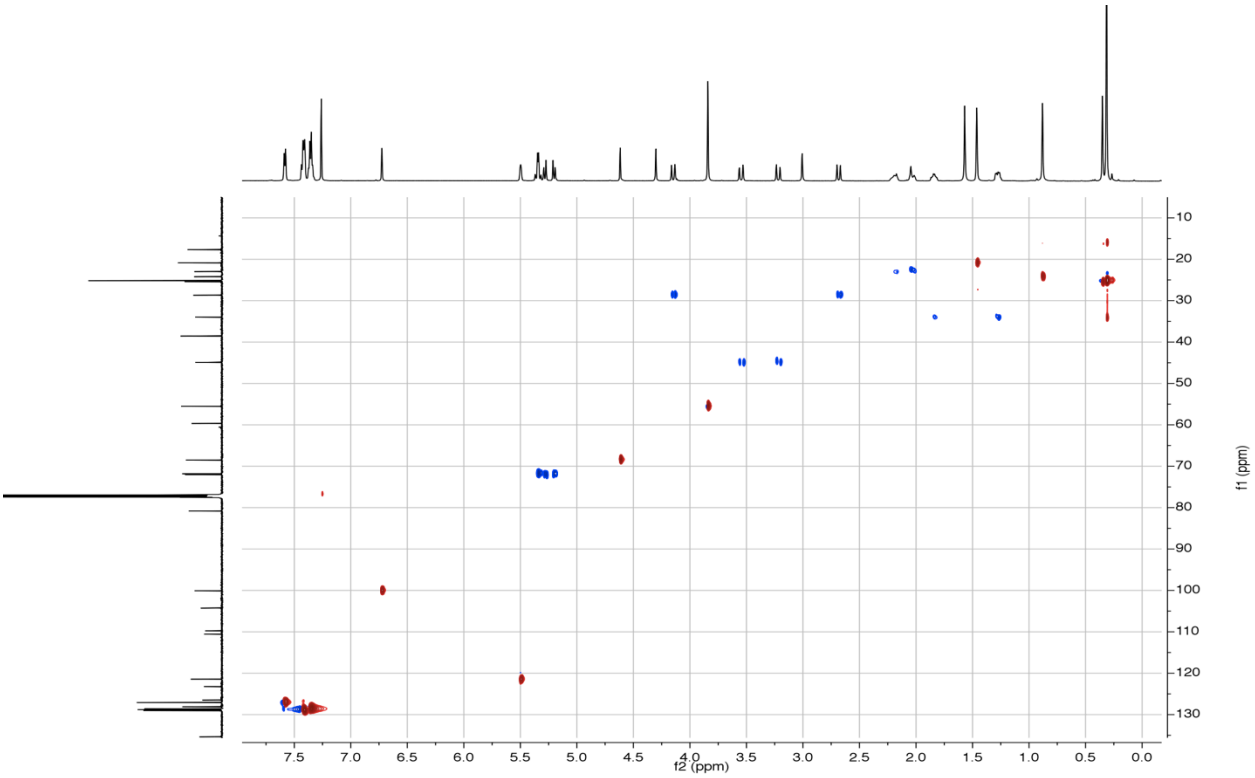
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of compound **36**.



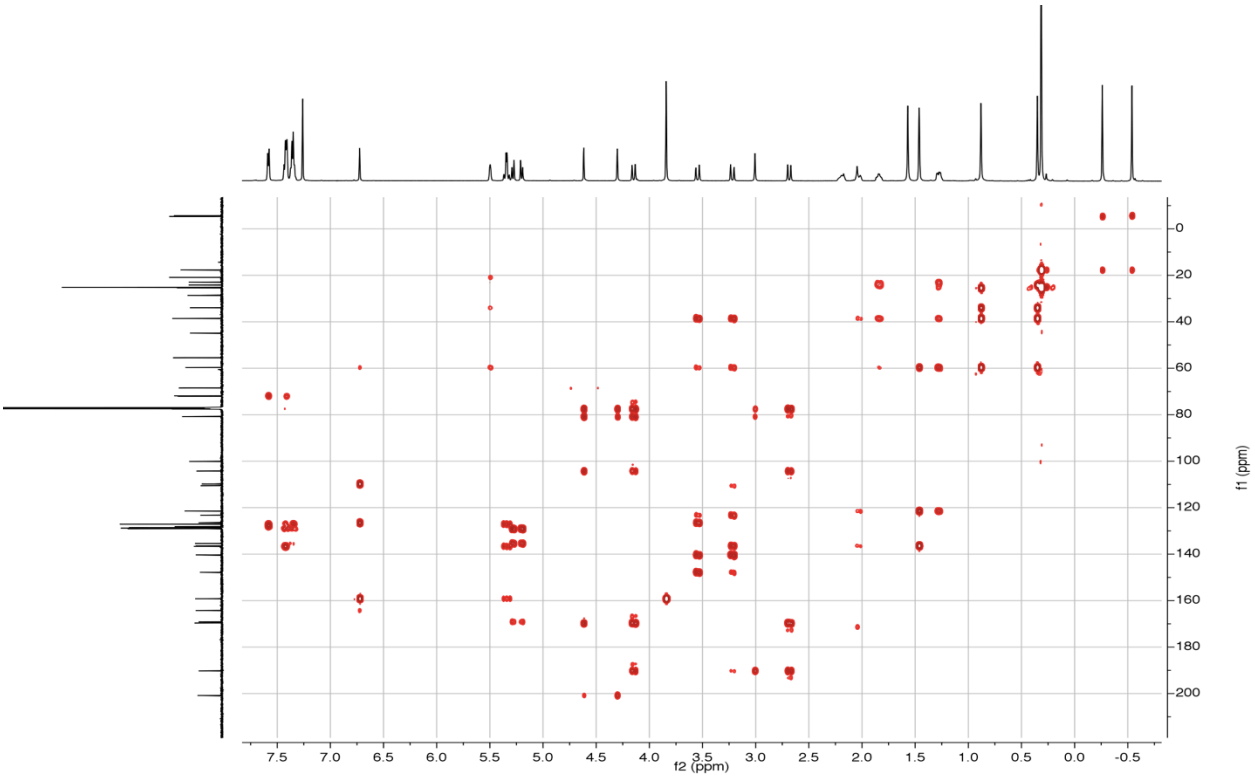
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of compound **36**.



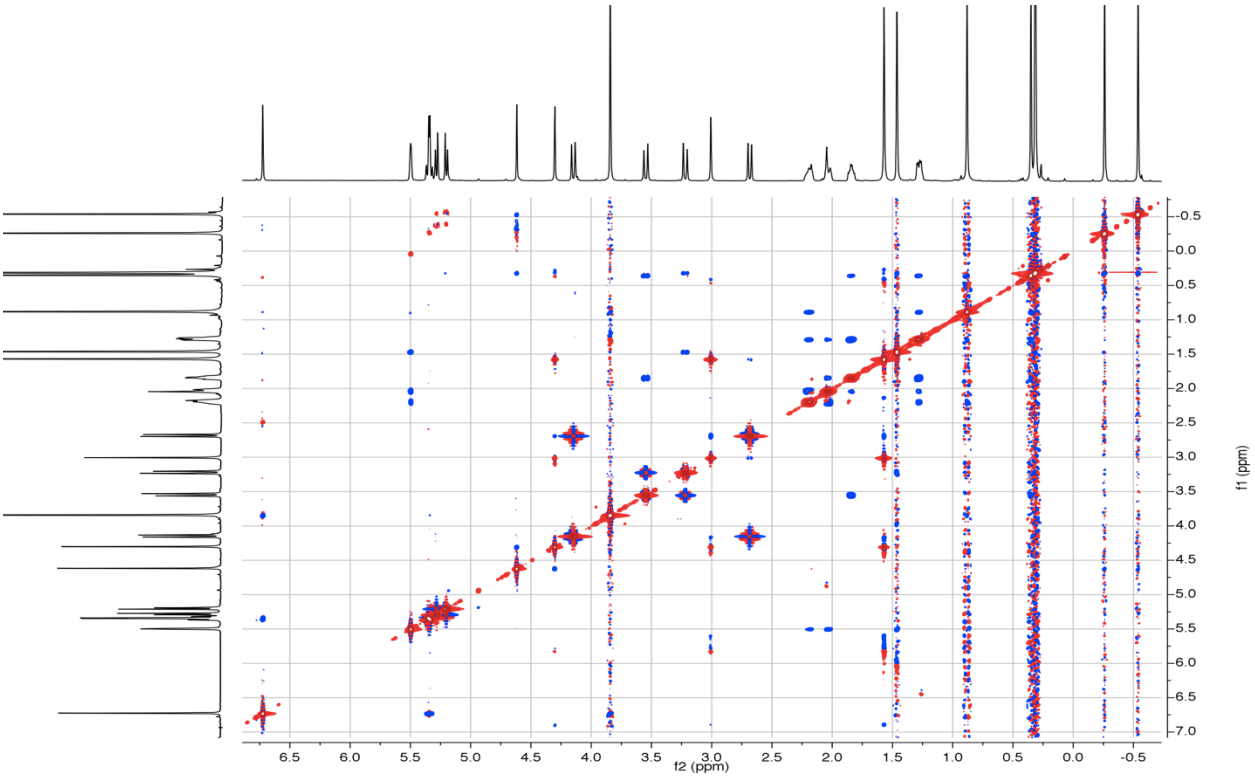
HSQC spectrum ($CDCl_3$, 600 MHz/151 MHz) of compound **36**.

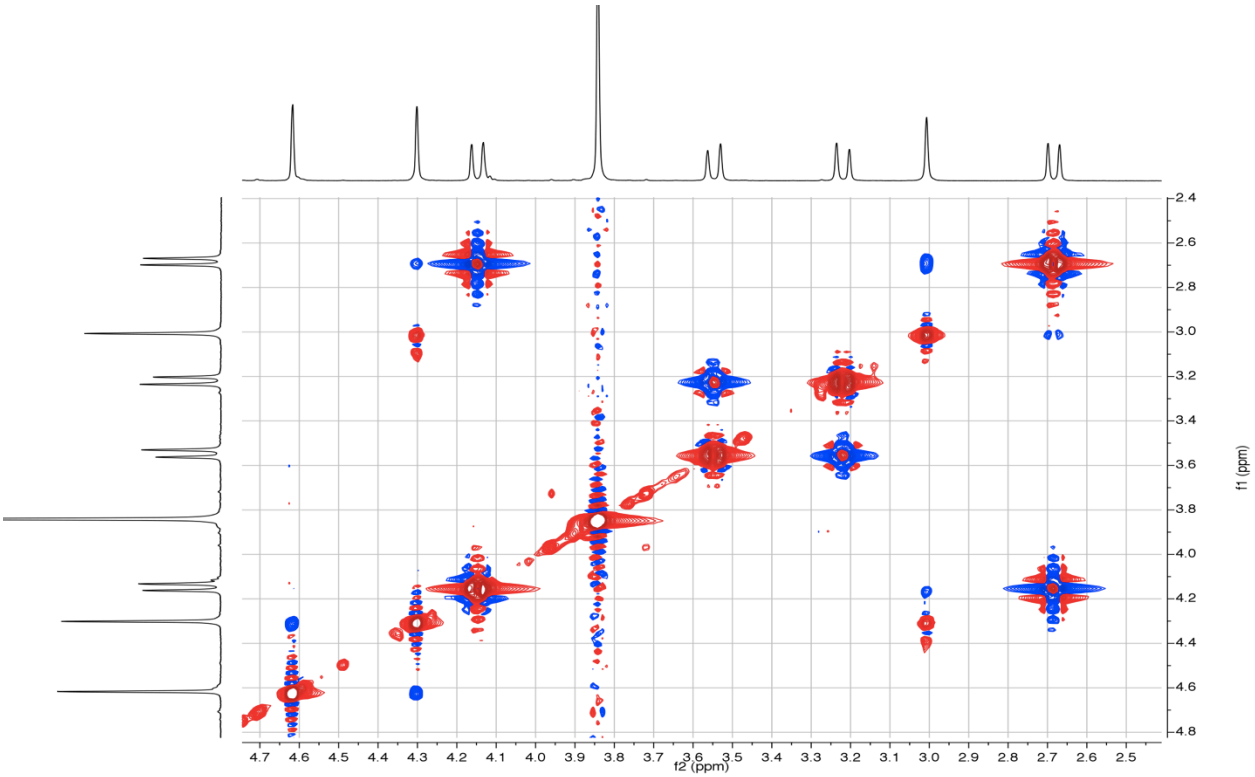


HMBC spectrum ($CDCl_3$, 600 MHz/151 MHz) of compound **36**.

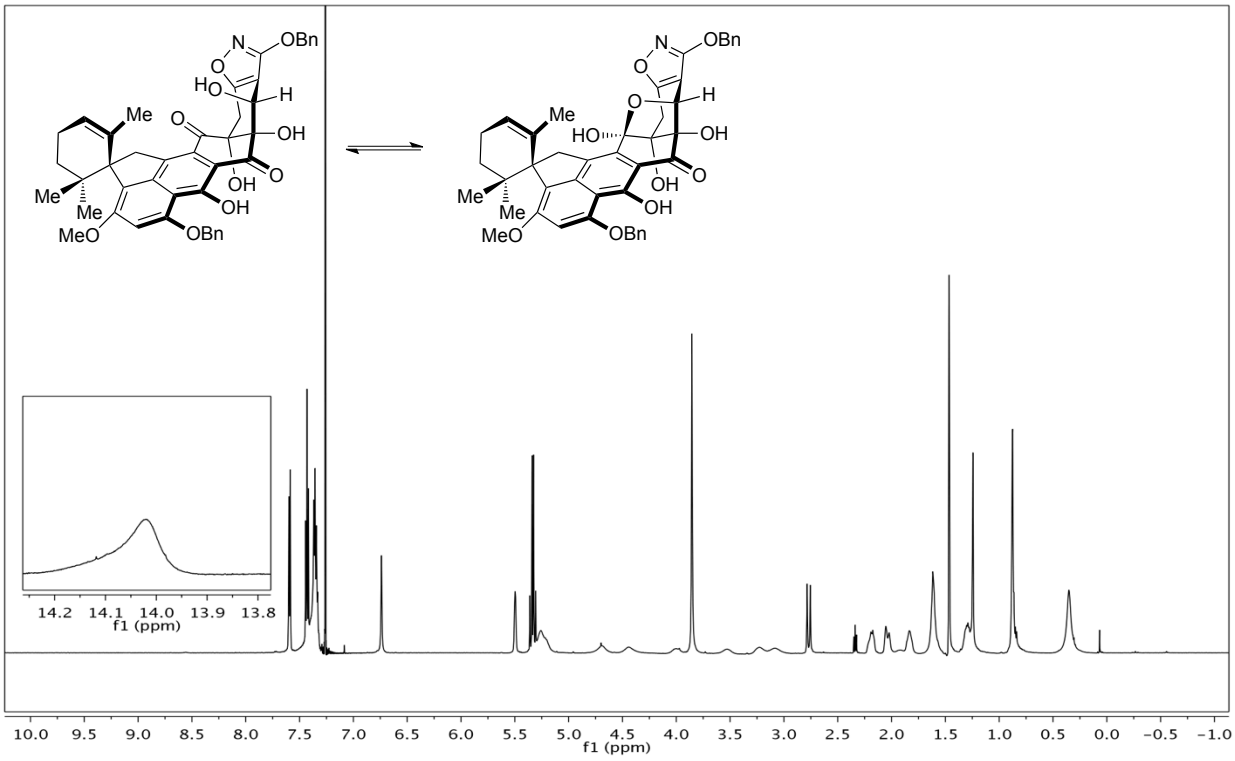


NOESY spectrum ($CDCl_3$, 600 MHz/600 MHz) of compound **36**.

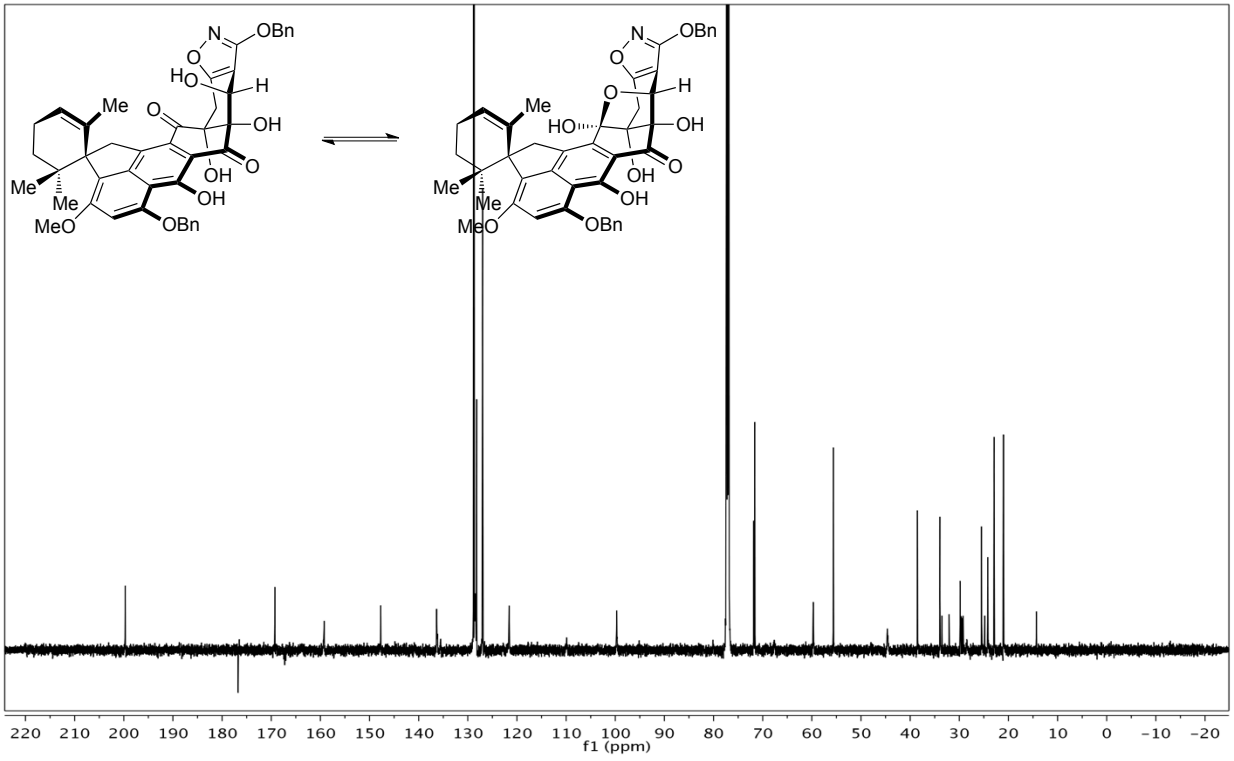




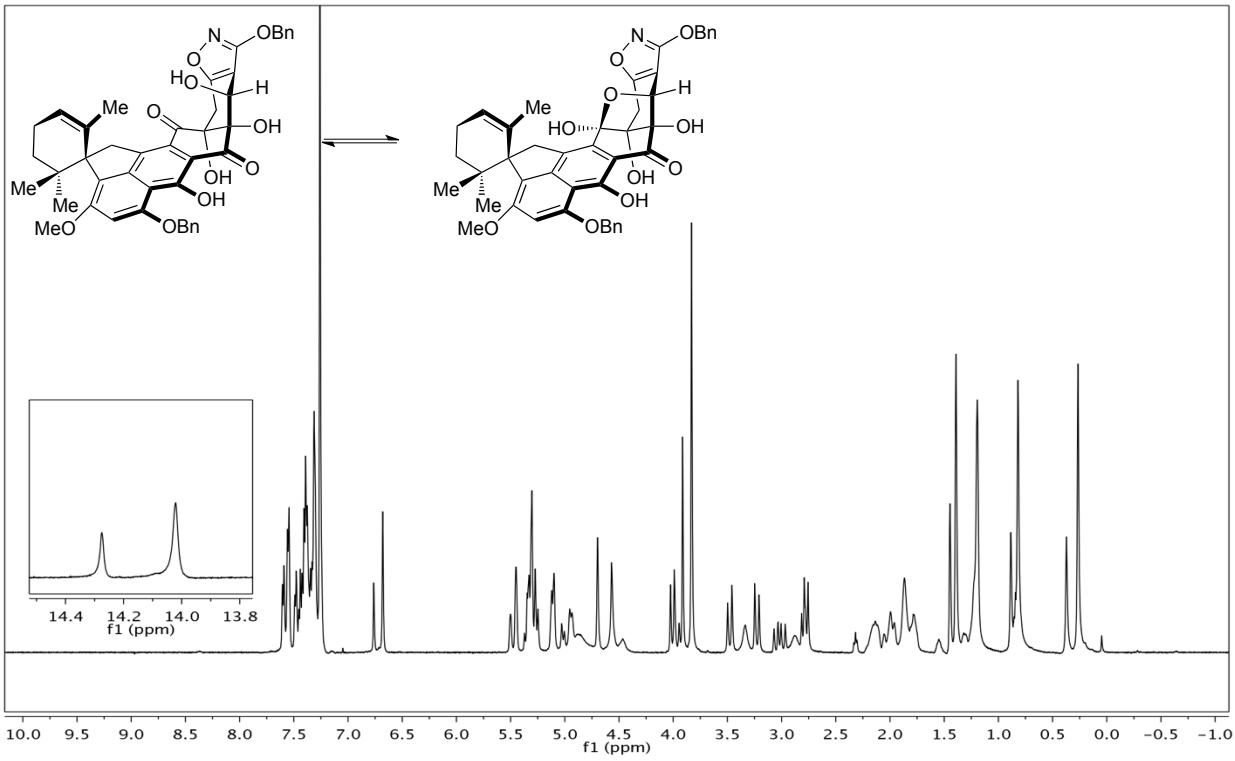
^{1}H NMR spectrum ($CDCl_3$, 600 MHz, 298 K) of compound **37**.



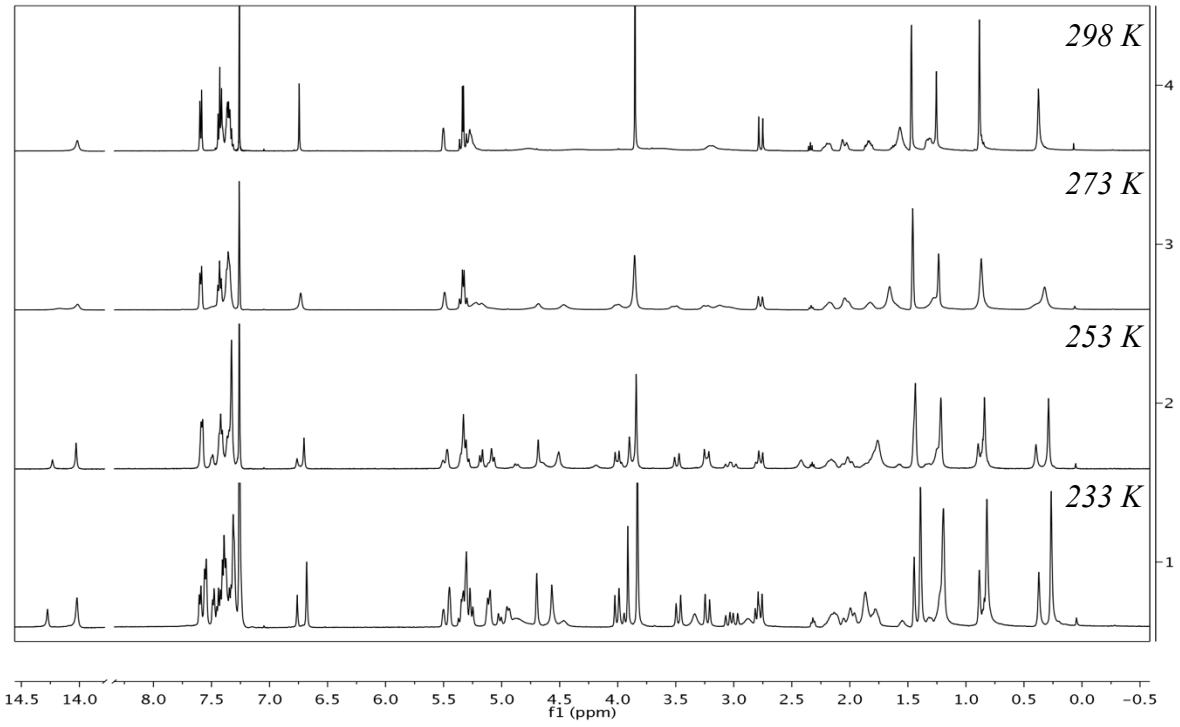
^{13}C NMR spectrum ($CDCl_3$, 151 MHz, 298 K) of compound **37**.



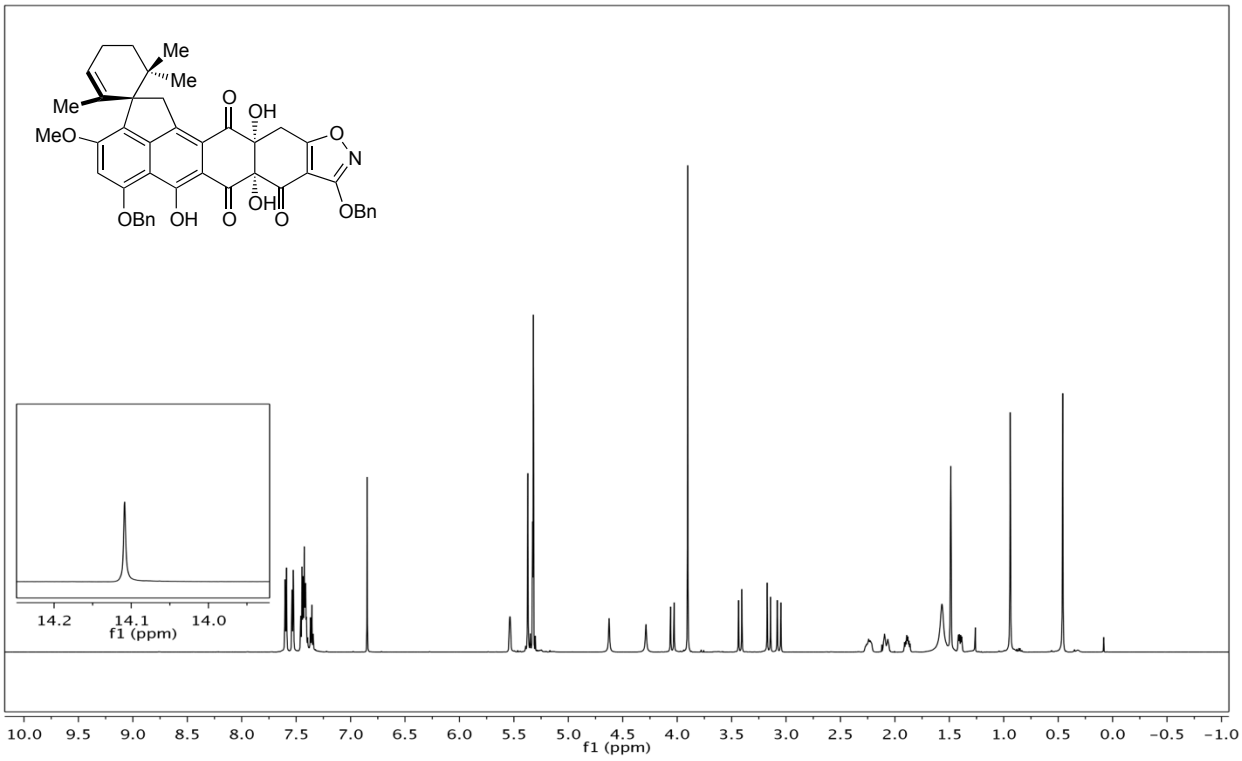
^{1}H NMR spectrum ($CDCl_3$, 500 MHz, 233 K) of compound **37**.



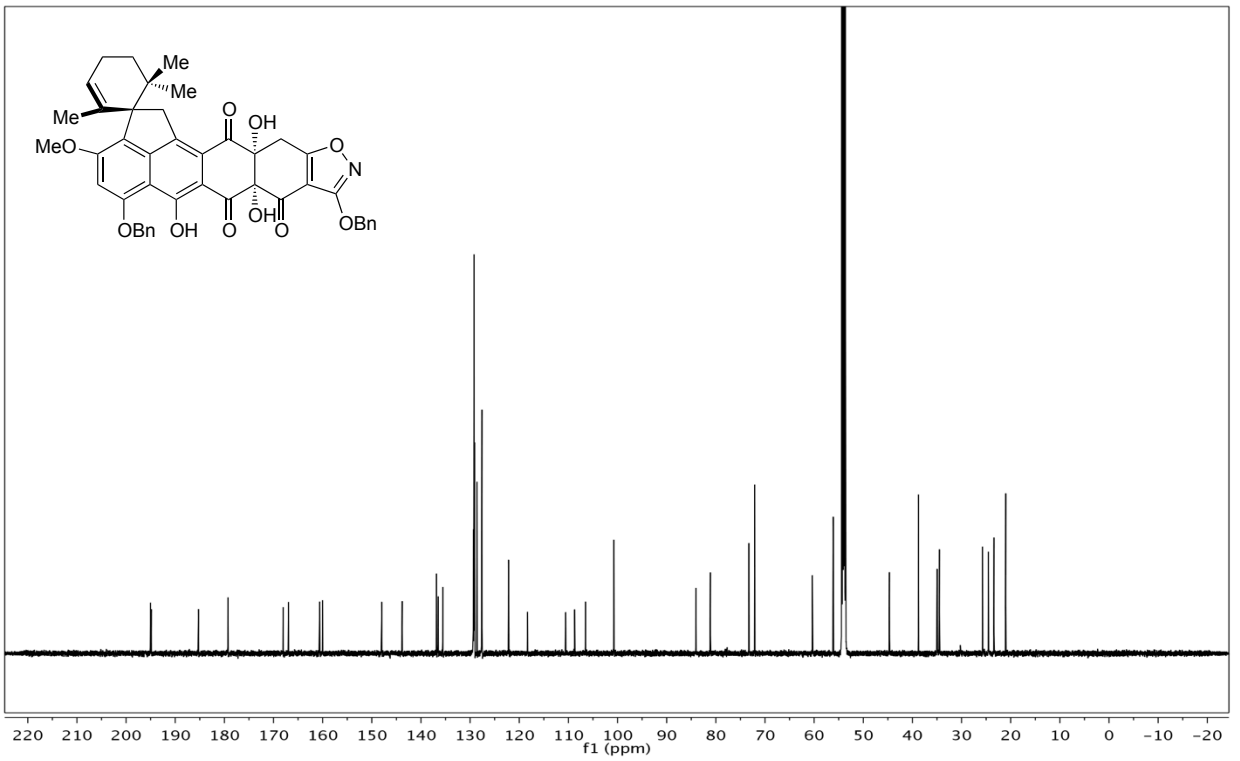
^{1}H NMR spectra ($CDCl_3$, 500 MHz, 233, 253, 273, and 298 K) of compound **37**.



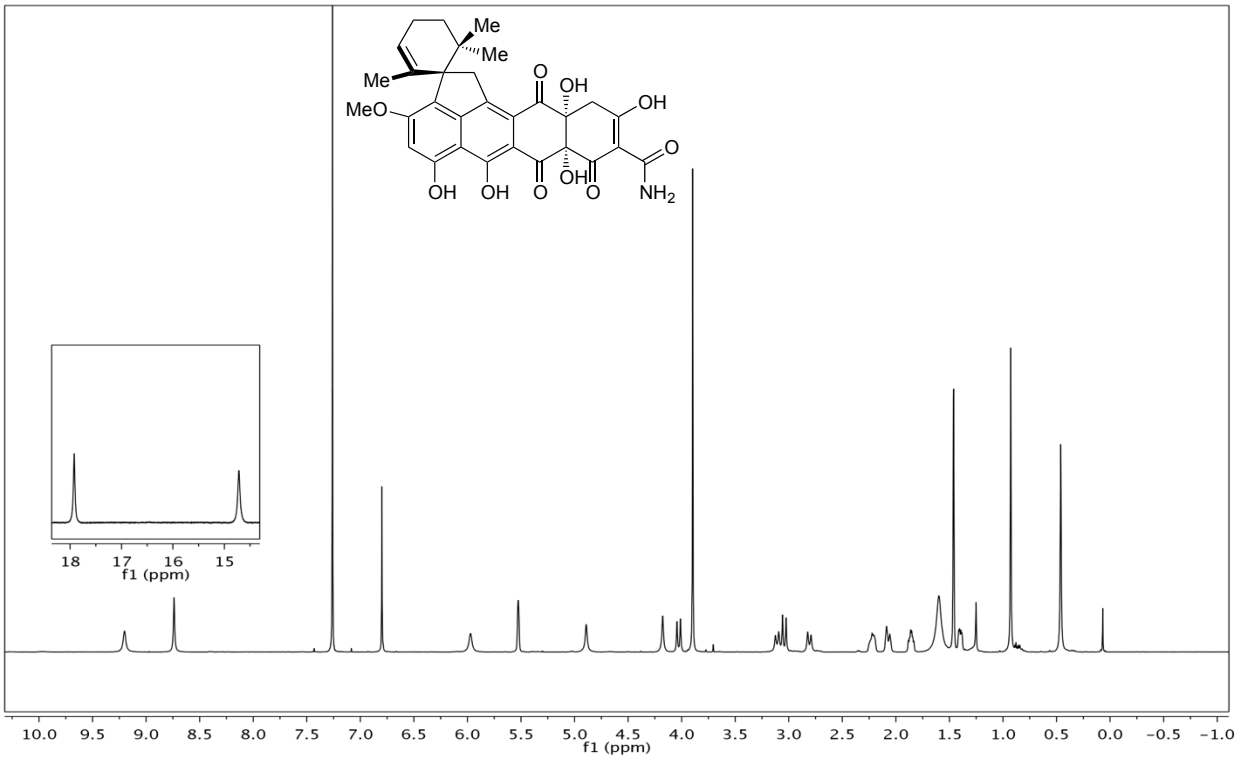
^{1}H NMR spectrum (CD_2Cl_2, 600 MHz) of compound **31**.



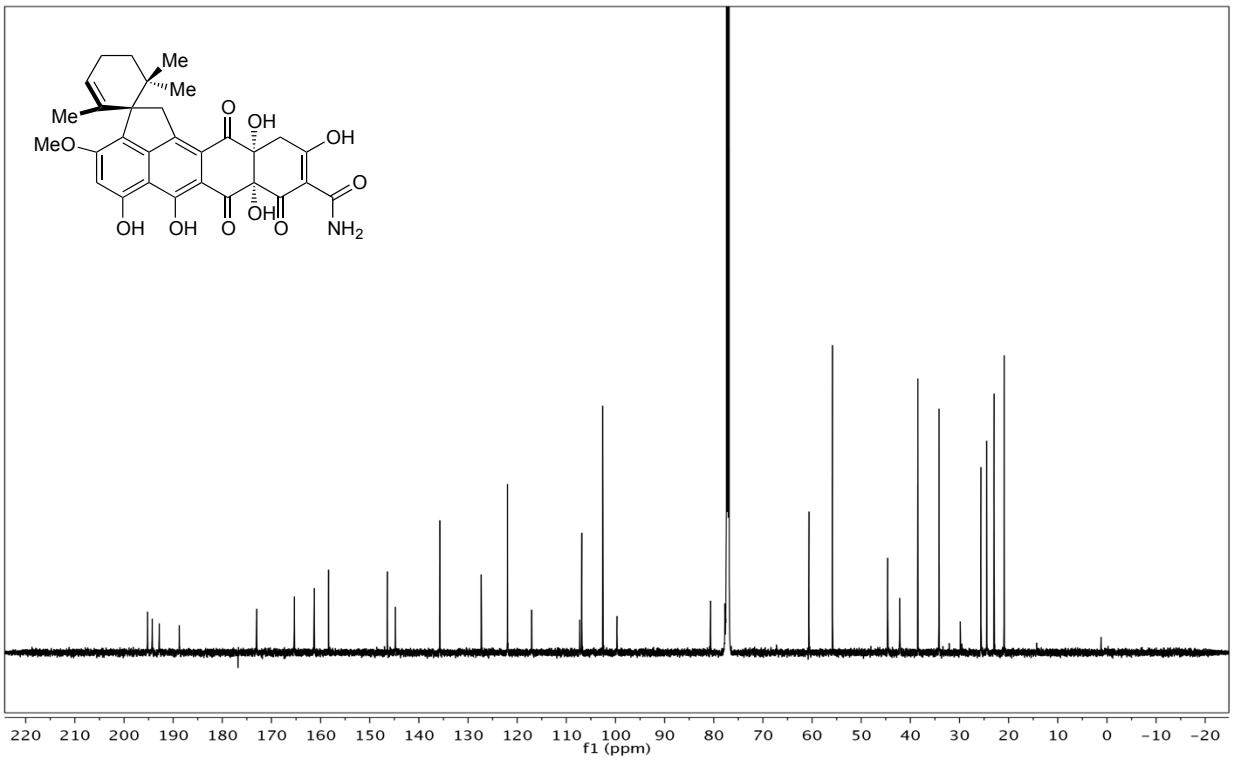
^{13}C NMR spectrum (CD_2Cl_2, 151 MHz) of compound **31**.

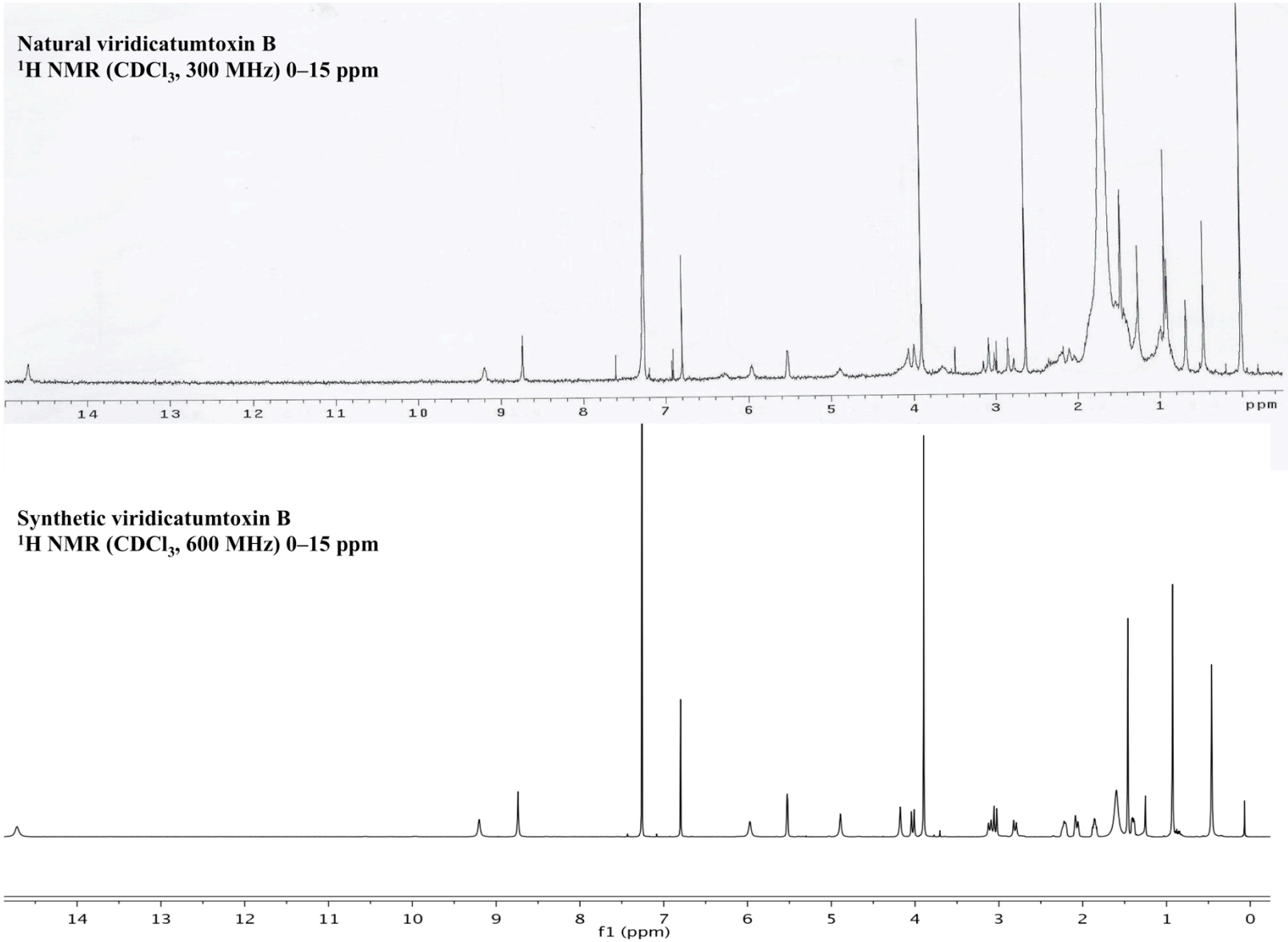


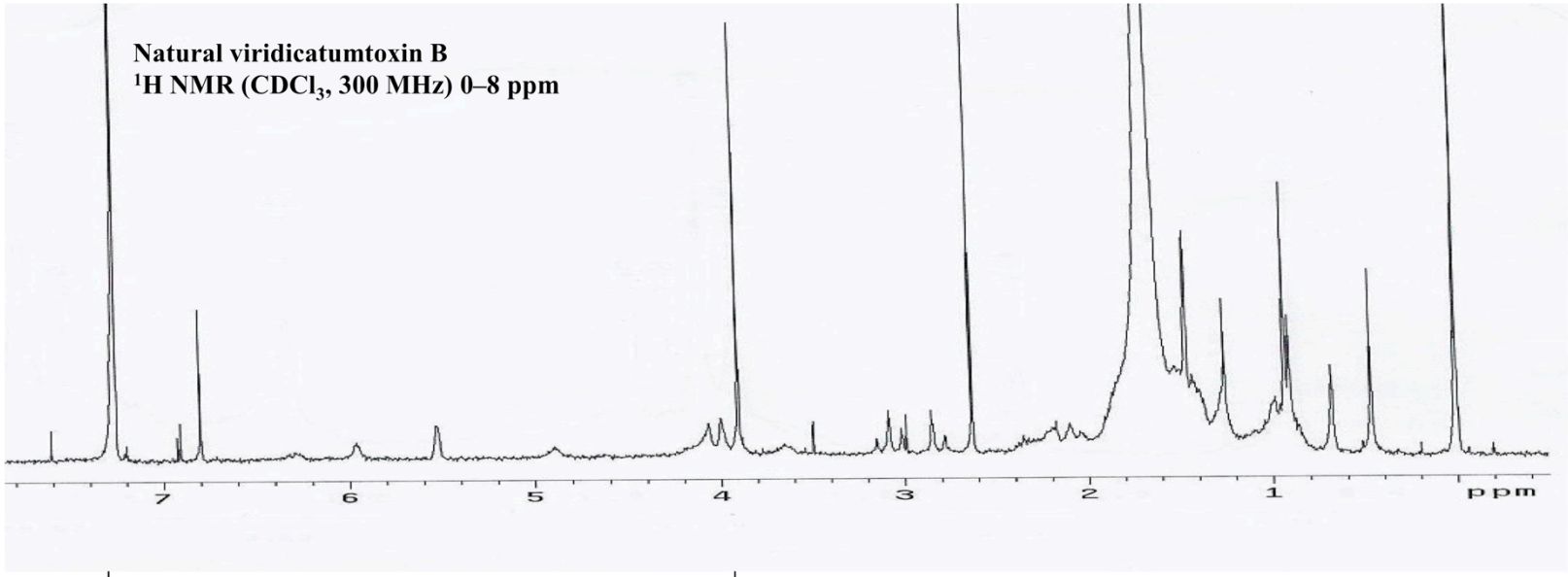
^{1}H NMR spectrum ($CDCl_3$, 600 MHz) of synthetic viridicatumtoxin B [(±)-**38**].

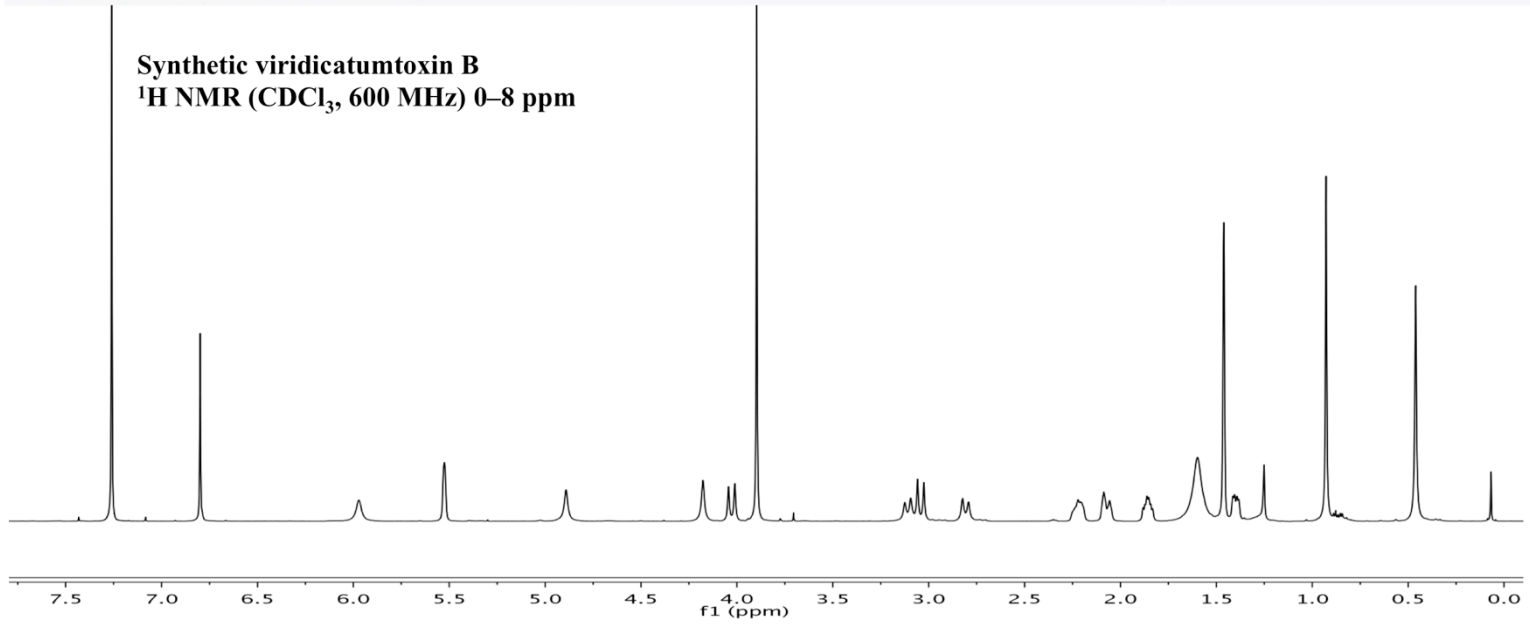


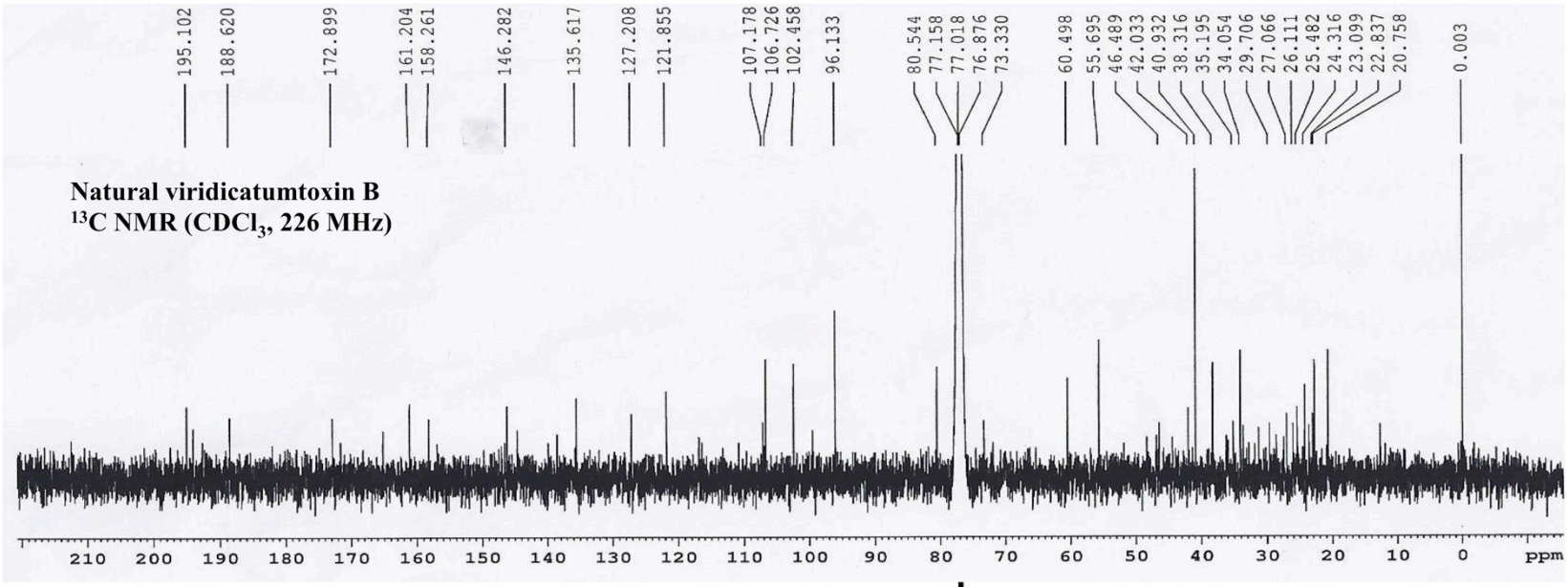
^{13}C NMR spectrum ($CDCl_3$, 151 MHz) of synthetic viridicatumtoxin B [(±)-**38**].

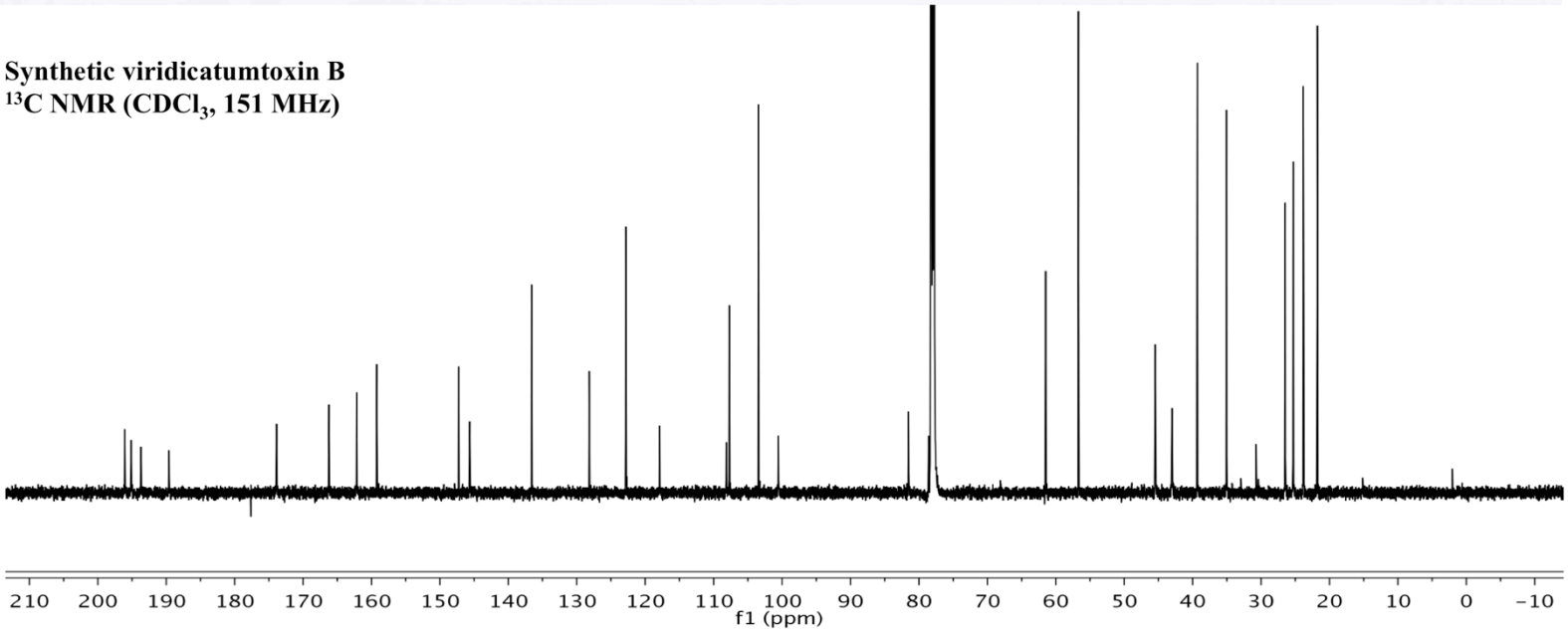



Natural viridicatumtoxin B
^{1}H NMR ($CDCl_3$, 300 MHz) 0–15 ppm
14 13 12 11 10 9 8 7 6 5 4 3 2 1 ppm
Synthetic viridicatumtoxin B
^{1}H NMR ($CDCl_3$, 600 MHz) 0–15 ppm
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)


Natural viridicatumtoxin B
^{1}H NMR ($CDCl_3$, 300 MHz) 0–8 ppm
7
6
5
4
3
2
1
ppm


Synthetic viridicatumtoxin B
^{1}H NMR ($CDCl_3$, 600 MHz) 0–8 ppm
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
f1 (ppm)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


195.102
188.620
172.899
161.204
158.261
146.282
135.617
127.208
121.855
107.178
106.726
102.458
96.133
80.544
77.158
77.018
76.876
73.330
60.498
55.695
46.489
42.033
40.932
38.316
35.195
34.054
29.706
27.066
26.111
25.482
24.316
23.099
22.837
20.758
0.003
Natural viridicatumtoxin B
13C NMR (CDCl3, 226 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


Synthetic viridicatumtoxin B
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)