A Heterogeneous Reductive Isomerization Reaction Using Catalytic Pd/C and H_2

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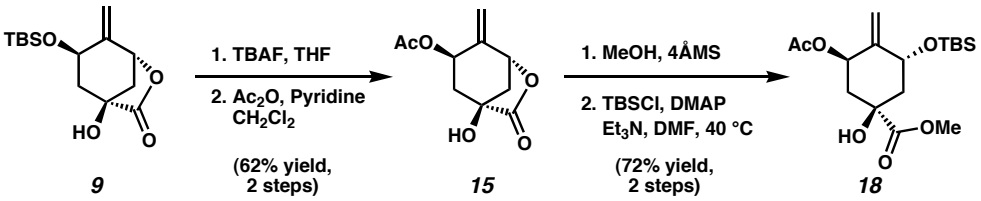
Supporting Information

Materials and Methods. Unless stated otherwise, reactions were conducted in flame-dried glassware under an atmosphere of nitrogen using anhydrous solvents (either freshly distilled or passed through activated alumina columns). 10% Pd/C was purchased from Aldrich Chemical Company, Inc. (20,569-9). All commercially obtained reagents were used as received. Reaction temperatures were controlled using an IKAmag temperature modulator, and unless stated otherwise, reactions were performed at 23 °C. Thin-layer chromatography (TLC) was conducted with E. Merck silica gel 60 F254 pre-coated plates, (0.25 mm) and visualized using a combination of UV, anisaldehyde, ceric ammonium molybdate, and potassium permanganate staining. ICN silica gel (particle size 0.032-0.063 mm) was used for flash column chromatography. ^{1}H NMR spectra were recorded on a Varian Mercury 300 (at 300 MHz) and are reported relative to Me_4Si (δ 0.0). Data for ^{1}H NMR spectra are reported as follows: chemical shift (δ ppm), multiplicity, coupling constant (Hz) and integration. ^{13}C NMR spectra were recorded on a Varian Mercury 300 (at 75 MHz), or a Varian Inova 500 (at 125 MHz) and are reported relative to Me_4Si (δ 0.0). Data for ^{13}C NMR spectra are reported in terms of chemical shift. NOESY-1D, gCOSY, and homodecoupling NMR experiments were performed on a Varian Inova 300 (at 300 MHz) or a Varian Mercury 600 (at 600 MHz). IR spectra were recorded on a Perkin Elmer Spectrum BXII spectrometer and are reported in terms of frequency of absorption (cm^{-1}). Optical rotations were measured with a Jasco P-1010 polarimeter. High resolution mass spectra were obtained from the California Institute of Technology Mass Spectral Facility. Analytical chiral HPLC was performed on a Chiralcel AD column (4.6 mm x 25 cm) obtained from Daicel Chemical Industries, Ltd.

Note: Supporting information for compounds **9** and **14** has been previously reported as part of the (+)-dragmacidin F synthesis.[1a] Supporting information for: **10**, **11**, **17**, **20**, **22-27**, **38**, and **39** has been previously reported as part of an enantiodivergent approach to (+)- and (–)-dragmacidin F.[1b]



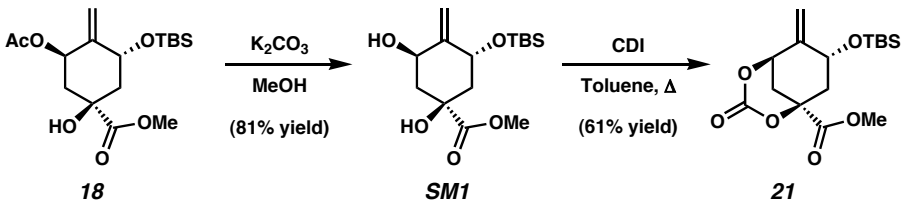
9 ***15*** ***18***

Methyl Ester 18. To lactone **9**[1a] (510.1 mg, 1.80 mmol) in THF (25 mL) and freshly distilled AcOH (300 μL, 5.24 mmol) was added TBAF (1.0 M in THF, 4.0 mL, 4.0 mmol) in a dropwise fashion over 3 min. The reaction was stirred for 16 h, and then the solvent was evaporated *in vacuo*. R_f 0.25 (3:1 EtOAc:hexanes). This crude material was dissolved in CH_2Cl_2 (17 mL) and pyridine (1.02 mL, 12.6 mmol) was added. A solution of Ac_2O (355 μL, 3.76 mmol) in CH_2Cl_2 (355 μL) was added via syringe pump at a rate of 170 μL/hr. After the addition was complete, the reaction was quenched by the addition of 10% *(w/v)* aq. citric acid (35 mL). The layers were separated and the aqueous layer was extracted with CH_2Cl_2 (2 x 50 mL). The combined organic extracts were dried over $MgSO_4$, and the solvent was evaporated under reduced pressure. The crude product was purified by flash chromatography (3:2 hexanes:EtOAc eluent) to provide acetoxylactone **15** (235 mg, 62% yield, 2 steps) as a white crystalline solid. R_f 0.52 (3:1 EtOAc:hexanes); mp 87-89 °C; ^{1}H NMR (300 MHz, $CDCl_3$): δ 5.54-5.44 (m, 1H), 5.16 (d, J = 2.4 Hz, 1H), 5.09-5.04 (comp. m, 2H), 3.26 (br s, 1H), 2.70 (ddd, J = 11.4, 6.1, 2.9 Hz, 1H), 2.52-2.42 (m, 1H), 2.14-2.08 (m, 1H), 2.12 (s, 3H), 1.87 (dd, J = 12.0, 10.4 Hz, 1H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 177.7, 169.9, 140.4, 111.6, 79.2, 72.9, 67.4, 44.2, 40.3, 21.0; IR (film) 3441 (br), 1790, 1743, 1240, 1128, 1042 cm^{-1}; HRMS-EI (*m/z*): $[M + H]^+$ calc'd for $C_{10}H_{13}O_5$, 213.0763; found, 213.0769; $[\alpha]^{25}_D$ -229.70° (*c* 1.0, C_6H_6).

To acetoxylactone **15** (310 mg, 1.46 mmol) and oven-dried powdered 4ÅMS (220 mg) was added MeOH (20 mL). The suspension was stirred for 1 h, and then filtered over Celite (EtOAc eluent). The filtrate was evaporated *in vacuo*, and was subsequently passed over a plug

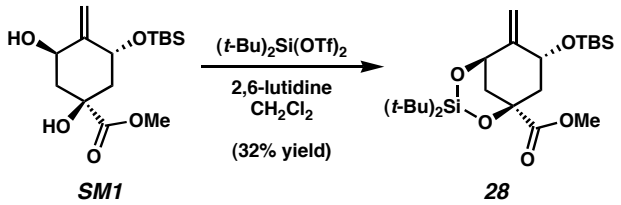
[1] a) Garg, N. K.; Caspi, D. D.; Stoltz, B. M. *J. Am. Chem. Soc.* **2005**, *126*, 9552-9553. b) Garg, N. K.; Caspi, D. D.; Stoltz, B. M. *J. Am. Chem. Soc.* **2005**, *127*, 5970-5978.

of SiO_2 gel (EtOAc eluent). Following evaporation of the solvent under reduced pressure, this material was used in the next step without further purification. R_f 0.33 (3:1 EtOAc:hexanes). To this crude material in DMF (7.3 mL) was added Et_3N (1.63 mL, 11.7 mmol) and DMAP (17.8 mg, 0.15 mmol). TBSCl (880 mg, 5.84 mmol) was added, and the solution was warmed to 40 °C. After stirring for 1 h, the solution was allowed to cool to 23 °C and quenched by the addition of 10% (*w/v*) aq. citric acid (10 mL). The reaction mixture was poured over H_2O (10 mL) and Et_2O (40 mL), and the phases were partitioned. The aqueous phase was extracted with Et_2O (2 x 30 mL), and the combined organic extracts were washed with brine (15 mL) and dried over $MgSO_4$. Following evaporation of the solvent *in vacuo*, the crude product was purified by flash chromatography (2:1 hexanes:EtOAc eluent) to afford methyl ester **18** (376 mg, 72% yield, 2 steps) as a white solid. R_f 0.53 (1:1 hexanes:EtOAc); ^{1}H NMR (300 MHz, $CDCl_3$): δ 5.62 (app. t, J = 3.7 Hz, 1H), 5.24 (app. t, J = 1.9 Hz, 1H), 5.10 (app. t, J = 1.7 Hz, 1H), 4.73-4.63 (m, 1H), 3.74 (s, 3H), 3.16 (br s, 1H), 2.14 (dd, J = 14.9, 4.3 Hz, 1H), 2.09-2.00 (comp. m, 2H), 2.03 (s, 3H), 1.90 (dd, J = 12.5, 10.6 Hz, 1H), 0.88 (s, 9H), 0.05 (s, 6H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 175.5, 170.2, 146.6, 111.7, 75.3, 74.0, 66.8, 53.2, 45.7, 38.8, 26.0 (3C), 21.5, 18.4, -4.8, -4.9; IR (film) 3481 (br), 2955, 2930, 2858, 1734 (br), 1372, 1251, 1237, 1124, 1108, 1069, 1016 cm^{-1}; HRMS-FAB (*m/z*): $[M + H]^+$ calc'd for $C_{17}H_{31}O_6Si$, 359.1890; found, 359.1894; $[\alpha]^{26}_D$ -7.32° (*c* 1.0, $CHCl_3$).



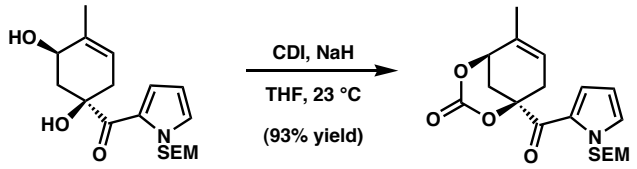
TBS Carbonate 21. To methyl ester **18** (201 mg, 0.56 mmol) in MeOH (5 mL) was added powdered K_2CO_3 (150 mg, 1.09 mmol). After stirring 10 min, the MeOH was evaporated *in vacuo* and the residue was diluted in Et_2O (50 mL) and saturated aq. NH_4Cl (25 mL). The layers were partitioned, and the aqueous phase was extracted with Et_2O (25 mL). The combined organics were successively washed with H_2O (15 mL) and brine (15 mL), and dried over $MgSO_4$. The solvent was evaporated *in vacuo*, and *syn*-diol **SM1** (143.9 mg, 81% yield) was carried on to the next step without further purification. R_f 0.38 (1:1 hexanes:EtOAc).

To *syn*-diol **SM1** (48.9 mg, 0.15 mmol) in toluene (3 mL) was added 1,1'-carbonyldiimidazole (80 mg, 0.50 mmol), and the reaction mixture was heated to reflux for 2.5 h. After cooling to 23 °C, the residue was chromatographed directly (7:3 hexanes:EtOAc eluent) to afford TBS carbonate **21** (32.2 mg, 61% yield). R_f 0.47 (1:1 hexanes:EtOAc); ^{1}H NMR (300 MHz, $CDCl_3$): δ 5.34 (dd, *J* = 2.2, 1.1 Hz, 1H), 5.21-5.19 (m, 1H), 5.15 (dd, *J* = 4.0, 1.8 Hz, 1H), 4.55-4.47 (m, 1H), 3.82 (s, 3H), 2.62 (ddd, *J* = 13.6, 6.2, 2.6 Hz, 1H), 2.45 (ddd, *J* = 14.2, 4.1, 2.7 Hz, 1H), 2.26 (dd, *J* = 14.2, 1.8 Hz, 1H), 1.92 (dd, *J* = 13.5, 10.7 Hz, 1H), 0.90 (s, 9H), 0.08 (s, 3H), 0.07 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 168.6, 147.2, 144.9, 113.4, 82.1, 79.9, 65.7, 53.6, 43.5, 33.0, 25.9 (3C), 18.3, -4.7, -4.9; IR (film) 2957, 2930, 2857, 1748 (br), 1254, 1178, 1103, 1054 cm^{-1}; HRMS-FAB (*m/z*): $[M + H]^+$ calc'd for $C_{16}H_{27}O_6Si$, 343.1577; found, 343.1592; $[\alpha]^{26}_D$ -81.11° (*c* 1.0, C_6H_6).



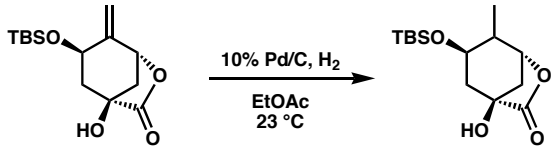
SM1 ***28***

Dioxasilylcyclohexane 28. To *syn*-diol **SM1** (19.3 mg, 0.06 mmol) in CH_2Cl_2 (1.2 mL) was added 2,6-lutidine (30 μL, 0.26 mmol) followed by rapid dropwise addition of (*t*-Bu)$_2$Si(OTf)$_2$ (30 μL, 0.08 mmol) over 1 min. The reaction was stirred for 16 h at 23 °C, and then quenched by the addition of saturated aq. NH_4Cl (1 mL). The phases were partitioned, and the aqueous phase was extracted with CH_2Cl_2 (3 x 1 mL). The combined organic extracts were dried over $MgSO_4$, and evaporated *in vacuo*. Purification by preparative thin-layer chromatography (11:2 hexanes:EtOAc eluent) afforded dioxasilylcyclohexane **28** (9.0 mg, 32% yield) as a colorless oil. R_f 0.50 (4:1 hexanes:EtOAc); ^{1}H NMR (300 MHz, $CDCl_3$): δ 5.17 (app. t, *J* = 1.9 Hz, 1H), 5.14-5.06 (comp. m, 2H), 4.78 (dd, *J* = 3.8, 2.1 Hz, 1H), 3.73 (s, 3H), 2.71 (app. dt, *J* = 9.1, 4.9 Hz, 1H), 2.42 (ddd, *J* = 13.1, 7.2, 2.9 Hz, 1H), 2.00-1.80 (comp. m, 2H), 1.08 (s, 9H), 1.07 (s, 9H), 0.89 (s, 9H), 0.06 (s, 6H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 173.6, 150.2, 110.6, 76.8, 74.9, 66.6, 52.6, 45.4, 39.1, 29.2 (3C), 28.7 (3C), 26.0 (3C), 21.7, 21.6, 18.3, -4.3, -4.5; IR (film) 2937, 2860, 1758, 1739, 1473, 1243, 1112 cm^{-1}; HRMS-EI (*m/z*): $[M]^+$ calc'd for $C_{23}H_{44}O_5Si_2$, 456.2727; found, 456.2740; $[\alpha]^{21}_D$ -47.35° (*c* 1.0, C_6H_6).



SM2 ***30***

Pyrrolocarbonate 30. To diol **SM2**[1b] (114.5 mg, 0.33 mmol) in THF (6 mL) at 23 °C was added 1,1'-carbonyldiimidazole (86.9 mg, 0.54 mmol) followed by NaH (60% dispersion in mineral oil, 55.2 mg, 1.38 mmol). After stirring for 40 min at 23 °C, saturated aq. NH_4Cl (10 mL) was added to quench the reaction and EtOAc (50 mL) was added. The phases were partitioned, and the aqueous layer was further extracted with EtOAc (2 x 75 mL). The combined organic layers were successively washed with H_2O (15 mL) and brine (15 mL), dried over $MgSO_4$, and evaporated under reduced pressure. The residue was purified by flash chromatography (4:1 hexanes:EtOAc eluent) to provide pyrrolocarbonate **30** (114.3 mg, 93% yield) as a pale yellow oil. R_f 0.53 (1:1 hexanes:EtOAc); ^{1}H NMR (300 MHz, C_6D_6): δ 7.85 (dd, J = 4.1, 1.4 Hz, 1H), 6.70 (dd, J = 2.7, 1.8 Hz, 1H), 6.04 (dd, J = 4.1, 2.7 Hz, 1H), 5.52 (d, J = 9.9 Hz, 1H), 5.48 (d, J = 10.0 Hz, 1H), 4.91-4.86 (m, 1H), 3.78 (app. t, J = 3.0 Hz, 1H), 3.41 (t, J = 7.8 Hz, 2H), 2.42-2.37 (comp. m, 2H), 1.97 (ddd, J = 14.1, 3.3, 1.0 Hz, 1H), 1.83 (dd, J = 14.2, 2.3 Hz, 1H), 1.40 (app. q, J = 2.0 Hz, 3H), 0.83 (t, J = 7.8 Hz, 2H), -0.07 (s, 9H); ^{13}C NMR (75 MHz, C_6D_6): δ 187.6, 147.5, 132.6, 131.9, 127.1, 125.1, 122.6, 110.2, 85.9, 78.7, 73.8, 66.5, 37.9, 30.4, 21.0, 18.3, -1.0 (3C); IR (film) 2952, 1751, 1643, 1413, 1178, 1093 cm^{-1}; HRMS-EI (*m/z*): $[M]^+$ calc'd for $C_{19}H_{27}NO_5Si$, 377.1658; found, 377.1655; $[\alpha]^{24}_D$ +2.72° (*c* 1.0, C_6H_6).

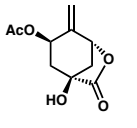
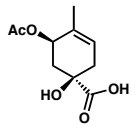
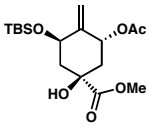
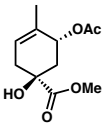
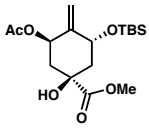
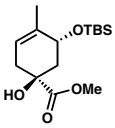
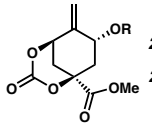
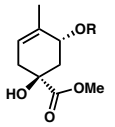
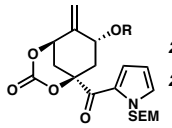
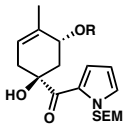
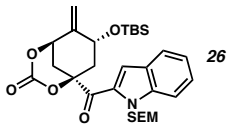
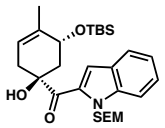
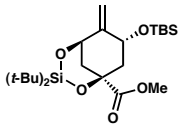
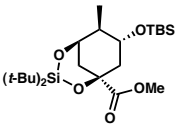
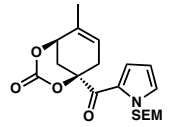
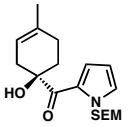


9 ***36***
1:1 dr

Reduced Lactone 36. A mixture of methylene lactone **9**[1a] (63.1 mg, 0.22 mmol) and 10% Pd/C (39.8 mg, 0.04 mmol) in EtOAc (2 mL) was evacuated and back-filled with H_2 (3x). After 7 min at 23 °C, the mixture was filtered over a pad of Celite (EtOAc eluent) and the solvent was evaporated *in vacuo*. The crude product was purified by flash chromatography (2:1 hexanes:EtOAc eluent) to provide reduced lactone **36** (8.7 mg, 14% yield) as a white amorphous

solid and a 1:1 mixture of diastereomers. R_f 0.59 (1:1 hexanes:EtOAc); ^{1}H NMR (300 MHz, $CDCl_3$, 1:1 mixture of diastereomers): δ 4.68-4.63 (m, 1H), 4.51 (d, *J* = 6.4 Hz, 1H), 4.04-3.94 (m, 1H), 3.45 (ddd, *J* = 12.9, 6.2, 4.1 Hz, 1H), 2.63 (app. d, *J* = 10.1 Hz, 1H), 2.49 (ddd, *J* = 11.2, 6.4, 3.2 Hz, 1H), 2.44-2.33 (m, 1H), 2.29-2.22 (comp. m, 2H), 2.14 (ddd, *J* = 12.1, 6.6, 2.9 Hz, 1H), 2.08 (app. d, *J* = 11.2 Hz, 1H), 2.00-1.82 (comp. m, 3H), 1.65-1.54 (comp. m, 2H), 1.12 (d, *J* = 6.9 Hz, 3H), 0.92 (d, *J* = 7.4 Hz, 3H), 0.86 (s, 9H), 0.85 (s, 9H), 0.03-0.02 (comp. m, 6H), 0.02-0.01 (comp. m, 6H); ^{13}C NMR (75 MHz, $CDCl_3$, 1:1 mixture of diastereomers): δ 178.5, 178.2, 80.4, 80.0, 73.5, 72.8, 71.4, 67.0, 44.8, 43.6, 41.9, 41.4, 37.4, 35.9, 25.9 (6C), 18.2, 18.1, 16.1, 10.7, -4.0, -4.6, -4.6, -4.8; IR (film) 3424 (br), 2930, 1787, 1099 cm^{-1}; HRMS-EI (*m/z*): $[M]^+$ calc'd for $C_{14}H_{26}O_4Si$, 286.1600; found, 286.1612; $[\alpha]^{25}_D$ -64.48° (*c* 1.0, C_6H_6).

Table 1. Reductive isomerization reaction[a]

entry	*substrate*	*product*		*time*	*yield*[b]
1	 *15*	 *16*		15 min	71%
2[c]	 *10*	 *17*		1 h 35 min	3%[d] 10%[e,f]
3[c,e]	 *18*	 *19*		1.5 h	27%
4	 *20*	 *17*	R = Ac	1 h	81%
5	*21*	*19*	R = TBS	8 min	94%
6	 *22*	 *23*	R = Ac	20 min	94%
7	*24*	*25*	R = H	15 min	80%
8	 *26*	 *27*		4 h	90%
9	 *28*	 *29*		1 h	68%
10[g]	 *30*	 *31*		1.3 h	91%

[a] Standard conditions: H_2 (balloon, 1 atm), 10% Pd/C (2 mol % Pd), MeOH, 0 °C. [b] Isolated yield. [c] Yield based on ^{1}H NMR integration. [d] 10% Pd/C (0.5 mol % Pd). [e] 10% Pd/C (1 mol % Pd). [f] Reaction performed at 23 °C. [g] Product formed in 7.2% ee.

Representative Procedure for Reductive Isomerizations (Table 1, Entry 10 is used as an example):

A mixture of pyrrolocarbonate **30** (41.6 mg, 0.11 mmol) and 10% Pd/C (2.3 mg, 0.002 mmol) in MeOH (2.0 mL) was cooled to 0 °C. The reaction vessel was then evacuated and back-filled with H_2 (3x). After 1.3 hr at 0 °C, the reaction mixture was filtered over a Celite plug (MeOH eluent)

and the solvent was evaporated in vacuo. The residue was by purified by preparative thin-layer chromatography (13:4:3 hexanes:EtOAc:CH_2Cl_2 eluent) to afford pyrrolocyclohexene **31** (33.5 mg, 91% yield) as a colorless oil.

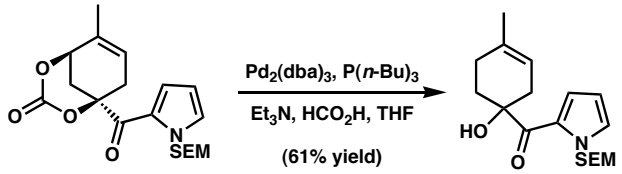
Entry 1. Purified by preparative thin-layer chromatography (19:1:1 EtOAc:MeOH:AcOH eluent). R_f 0.53 (19:1:1 EtOAc:MeOH:AcOH); ^{1}H NMR (300 MHz, $CDCl_3$): δ 7.31 (br s, 1H), 5.66-5.60 (m, 1H), 5.39-5.32 (m, 1H), 2.68-2.54 (m, 1H), 2.39-2.23 (comp. m, 2H), 2.14-2.00 (m, 1H), 2.06 (s, 3H), 1.74-1.69 (m, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 178.9, 170.7, 130.8, 123.7, 72.5, 68.9, 36.6, 35.7, 21.4, 20.6; IR (film) 3440 (br), 2938, 1728, 1242 cm^{-1}; HRMS-FAB (*m/z*): $[M + Na]^+$ calc'd for $C_{10}H_{14}O_5Na$, 237.0739; found, 237.0744; $[\alpha]^{25}_D$ +83.74° (*c* 1.0, $CHCl_3$).

Entries 3 and 5. Purified by flash chromatography (7:3 hexanes:EtOAc eluent). R_f 0.62 (1:1 hexanes:EtOAc); ^{1}H NMR (300 MHz, $CDCl_3$): δ 5.38-5.31 (m, 1H), 4.44-4.34 (m, 1H), 3.78 (s, 3H), 3.10 (br s, 1H), 2.65-2.53 (m, 1H), 2.08-1.89 (comp. m, 3H), 1.74-1.70 (m, 3H), 0.88 (s, 9H), 0.08 (s, 3H), 0.06 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 176.9, 137.2, 119.0, 74.5, 68.2, 53.2, 40.8, 35.8, 26.1 (3C), 20.1, 18.3, -4.1, -4.6; IR (film) 3492 (br), 2954, 2857, 1730, 1249, 1095 cm^{-1}; HRMS-FAB (*m/z*): $[M + H]^+$ calc'd for $C_{15}H_{29}O_4Si$, 301.1835; found, 301.1841; $[\alpha]^{24}_D$ +29.49° (*c* 1.0, C_6H_6).

Entry 9. Purified by preparative thin-layer chromatography (4:1 hexanes:EtOAc eluent). R_f 0.82 (1:1 hexanes:EtOAc); ^{1}H NMR (300 MHz, $CDCl_3$): δ 4.30-4.19 (comp. m, 2H), 3.73 (s, 3H), 2.64 (ddd, *J* = 14.5, 4.0, 3.1 Hz, 1H), 2.29 (ddd, *J* = 13.4, 5.9, 2.9 Hz, 1H), 1.88-1.72 (comp. m, 2H), 1.53-1.43 (m, 1H), 1.15 (d, *J* = 6.6 Hz, 3H), 1.09 (s, 9H), 1.06 (s, 9H), 0.86 (s, 9H), 0.02 (s, 3H), 0.02 (s, 3H); ^{1}H NMR (300 MHz, C_6D_6): δ 4.47 (app. dt, *J* = 9.9, 5.6 Hz, 1H), 3.97-3.92 (m, 1H), 3.32 (s, 3H), 2.71-2.58 (comp. m, 2H), 1.99 (dd, *J* = 13.3, 10.3 Hz, 1H), 1.63 (dd, *J* = 14.4, 1.7 Hz, 1H), 1.44-1.31 (m, 1H), 1.28 (d, *J* = 6.4 Hz, 3H), 1.20 (s, 9H), 1.19 (s, 9H), 1.00 (s, 9H), 0.14 (s, 3H), 0.10 (s, 3H); ^{13}C NMR (75 MHz, C_6D_6): δ 173.7, 77.6, 74.1, 70.1, 52.1, 45.9, 44.8, 38.6, 29.8 (3C), 29.4 (3C), 26.4 (3C), 22.2, 22.1, 18.5, 15.9, -3.2, -3.8; IR (film) 2954, 2936, 2895, 2860, 1757, 1739, 1258, 1146, 1100, 1081 cm^{-1}; HRMS-EI (*m/z*): $[M]^+$ calc'd for $C_{23}H_{46}O_5Si_2$, 458.2884; found, 458.2886; $[\alpha]^{25}_D$ -52.92° (*c* 1.0, $CHCl_3$).

Entry 10. Purified by preparative thin-layer chromatography (13:4:3 hexanes:EtOAc:CH_2Cl_2 eluent). R_f 0.64 (13:7 hexanes:EtOAc); ^{1}H NMR (300 MHz, C_6D_6): δ 7.16 (dd, *J* = 4.0, 1.5 Hz, 1H), 6.72 (dd, *J* = 2.7, 1.6 Hz, 1H), 6.02 (dd, *J* = 4.0, 2.7 Hz, 1H), 5.56 (s, 2H), 5.35-5.28 (m, 1H), 3.98 (s, 1H), 3.43 (t, *J* = 7.8 Hz, 2H), 2.98-2.85 (m, 1H), 2.51-2.33 (m, 1H), 2.24-2.10 (comp. m, 2H), 1.88-1.73 (comp. m, 2H), 1.67-1.63 (m, 3H), 0.82 (t, *J* = 7.8 Hz, 2H), -0.08 (s, 9H); ^{13}C NMR (75 MHz, C_6D_6): δ 195.5, 134.0, 130.6, 127.3, 123.1, 118.5, 109.3, 78.7, 76.8, 66.5, 38.4, 34.2, 27.2, 24.1, 18.3, -1.0 (3C); IR (film) 3441 (br), 2957, 1727, 1632, 1413, 1084 cm^{-1}; HRMS-FAB (*m/z*): $[M + H]^+$ calc'd for $C_{18}H_{30}NO_3Si$, 336.1995; found, 336.1993; $[\alpha]^{24}_D$ -0.02° (*c* 1.0, C_6H_6); 7.2% ee as measured by chiral HPLC (2% EtOH:hexanes eluent). Retention times: 13.9 min, 15.6 min.

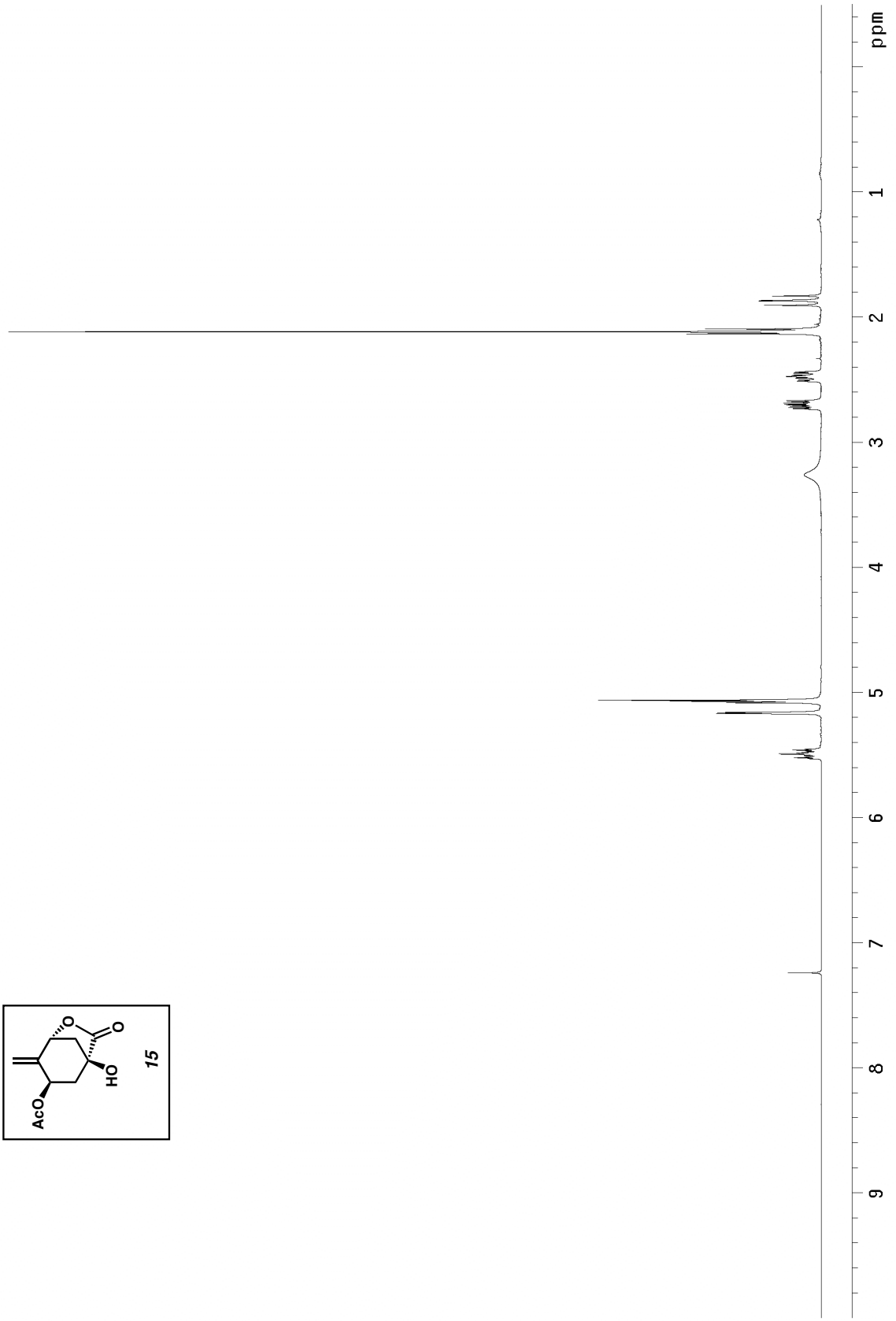
A racemic sample was prepared as follows:



30 ***31 racemic***

To carbonate **30** (9.9 mg, 0.03 mmol) and $Pd_2(dba)_3$ (2.7 mg, 0.003 mmol) was added THF (800 μL) followed by P(*n*-Bu)$_3$ (2.8 μL, 0.011 mmol), Et_3N (5.2 μL, 0.04 mmol) and formic acid (1.6 μL, 0.04 mmol).[2] The solution was stirred at 23 °C for 3 h, and was then heated to 70 °C for 70 min. The reaction was cooled to 23 °C, and purified directly by preparative thin-layer chromatography (4:1 hexanes:EtOAc eluent). The crude product was then re-purified by preparative thin-layer chromatography (13:4:3 hexanes:EtOAc:CH_2Cl_2 eluent) to provide an a racemic, analytical sample of **31** (5.4 mg, 61% yield).

[2] Tsuji, J; Minami, I; Shimizu, I. *Synthesis* **1986**, 623-627.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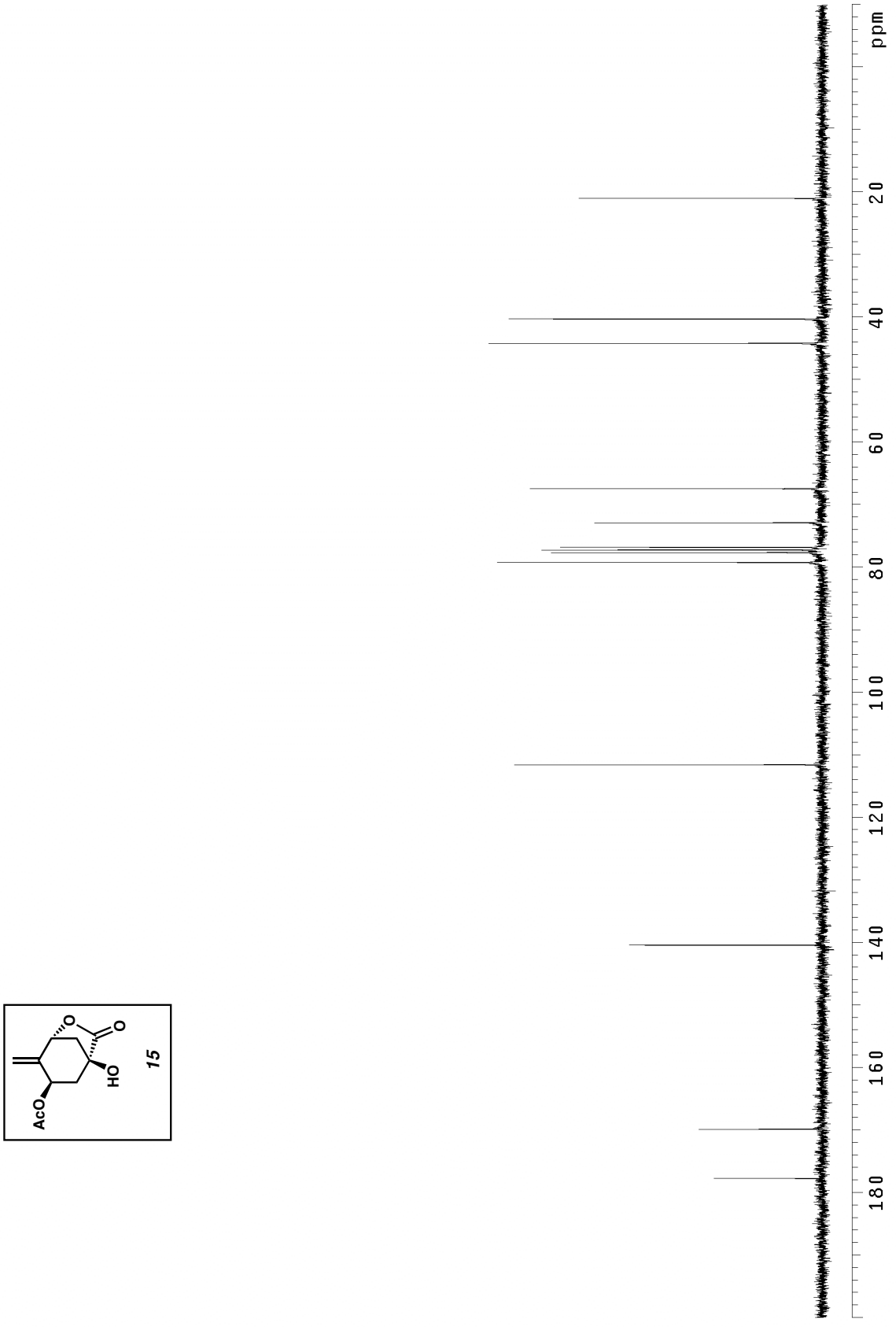
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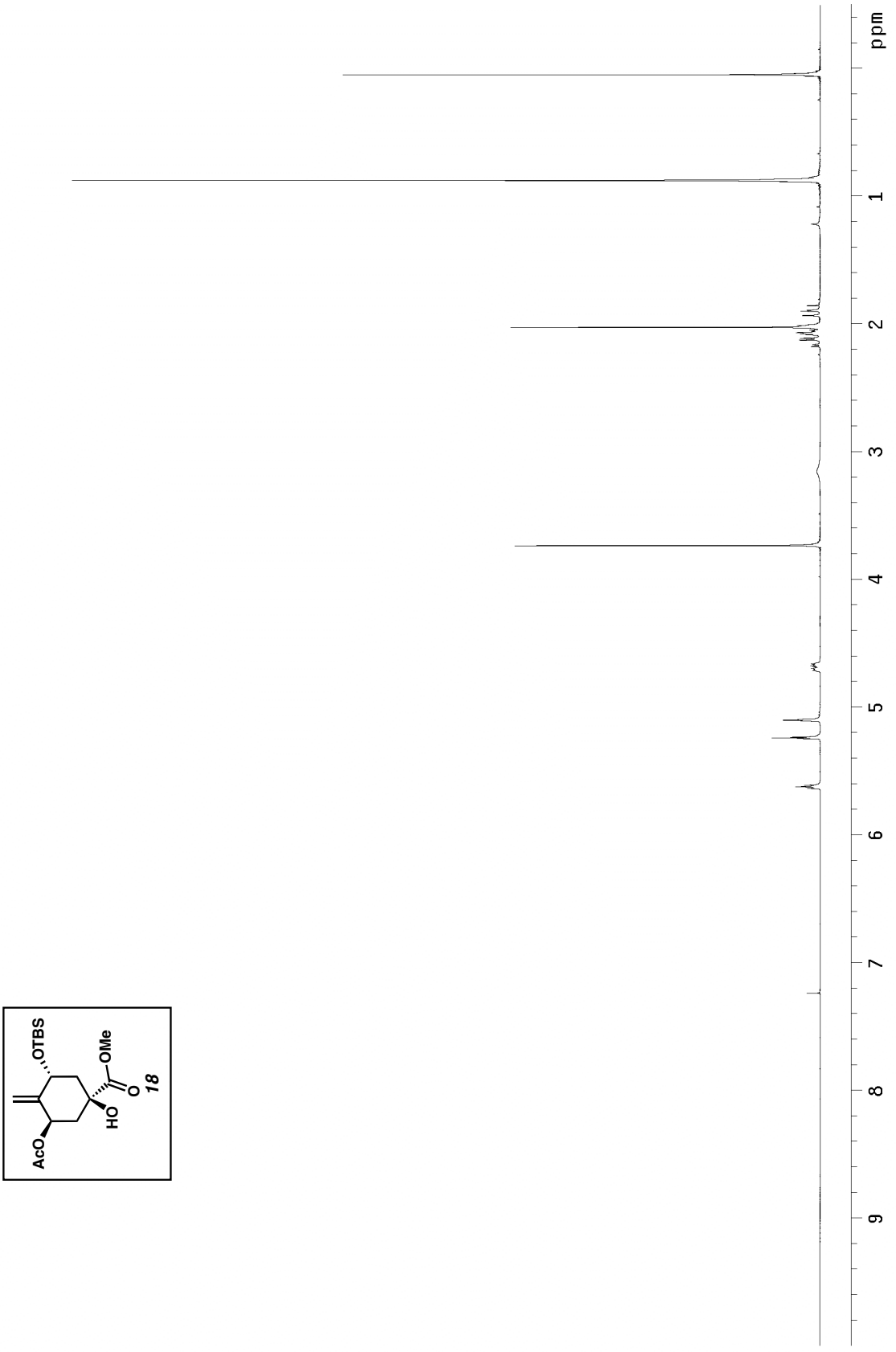
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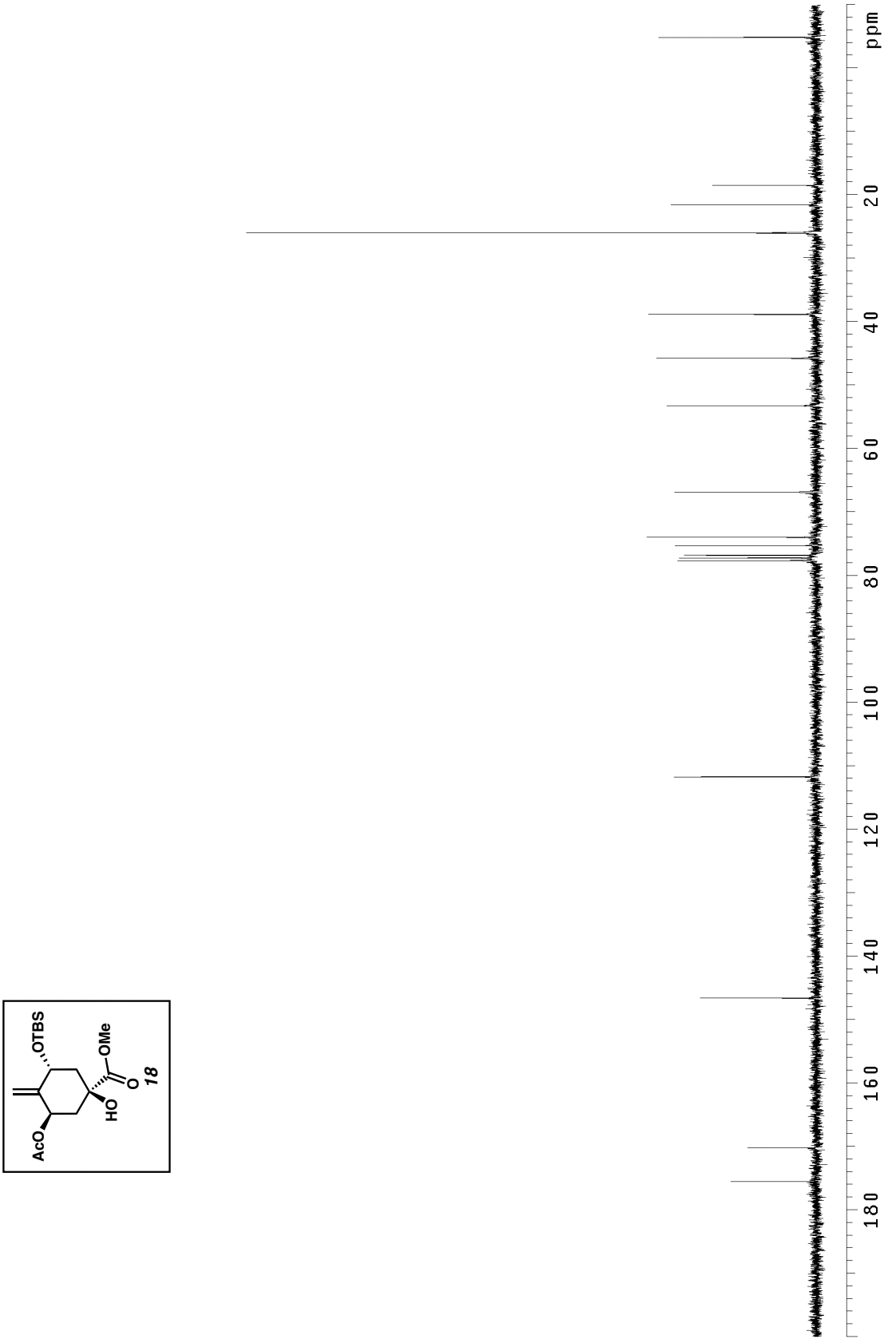
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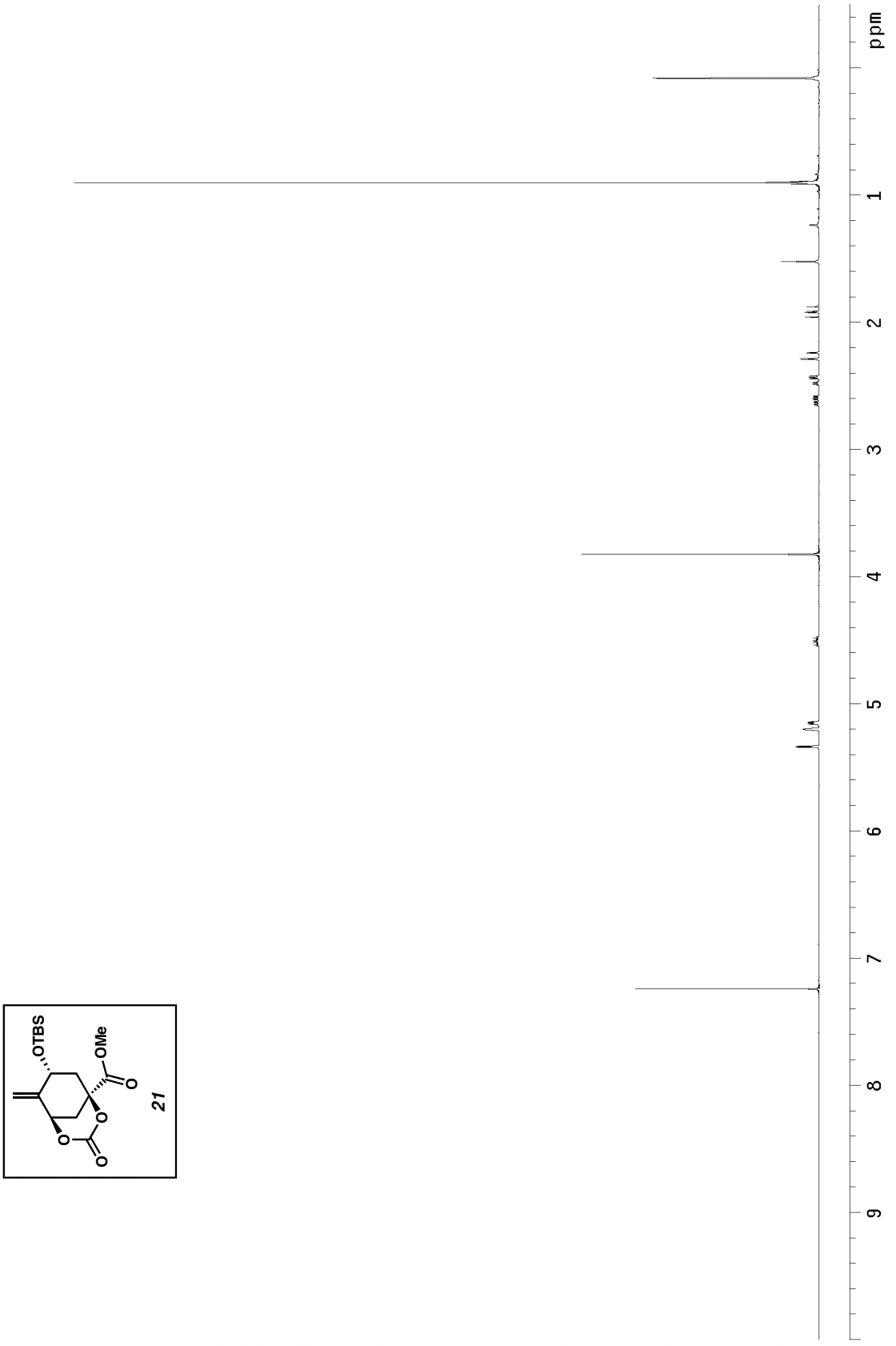
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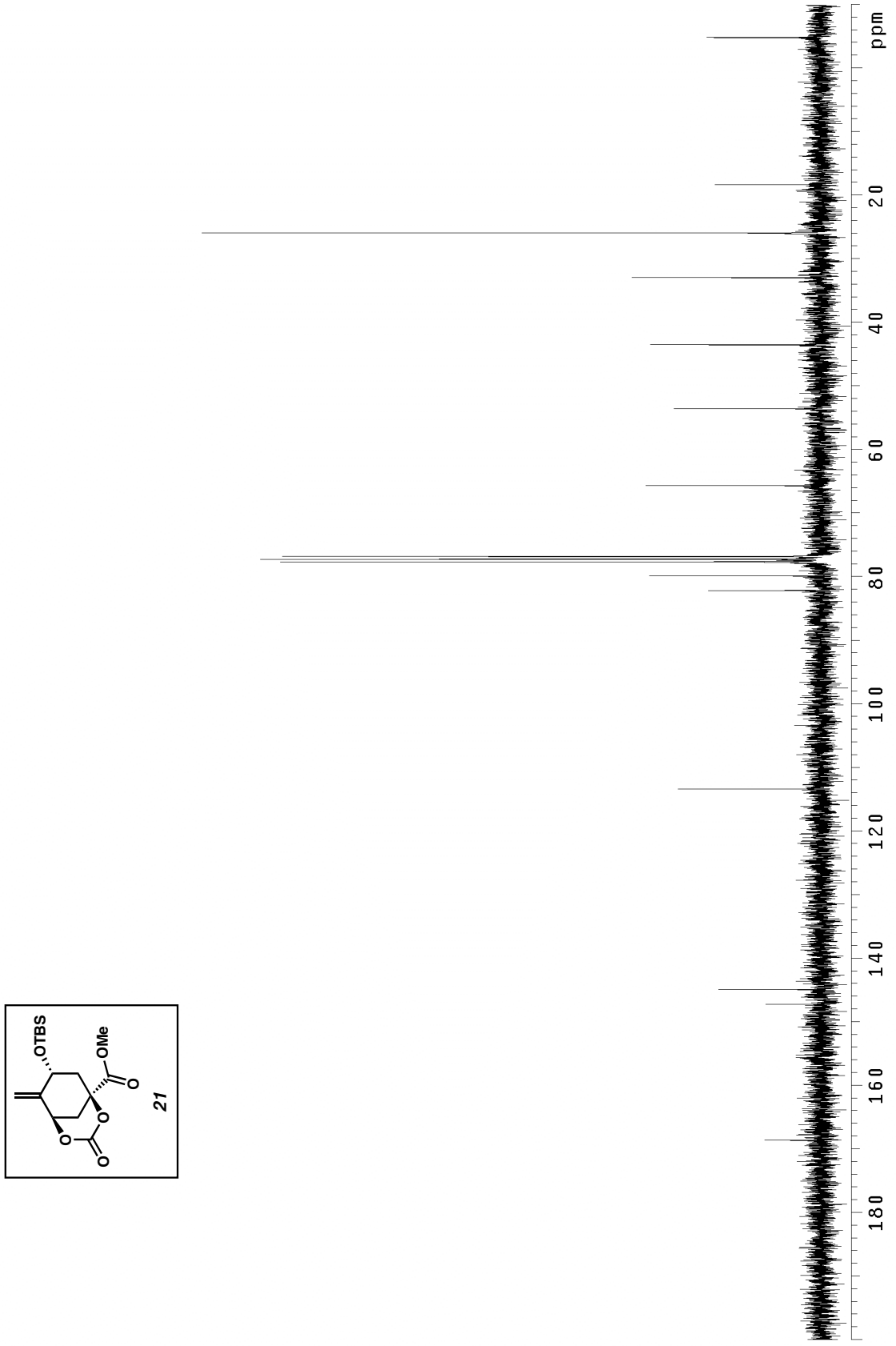
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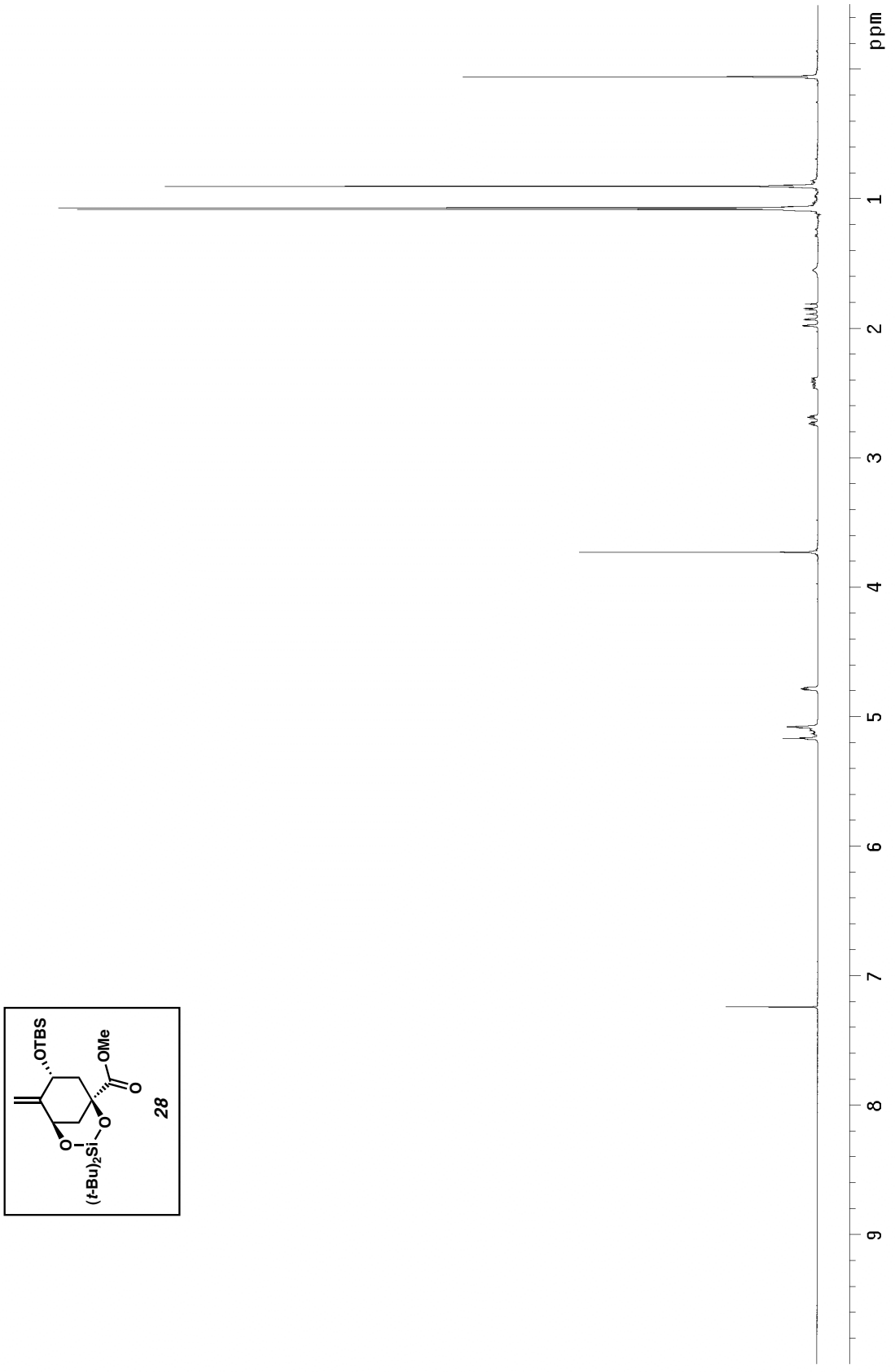
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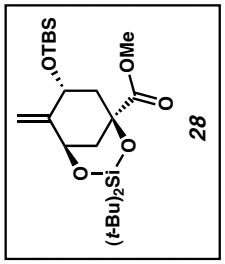
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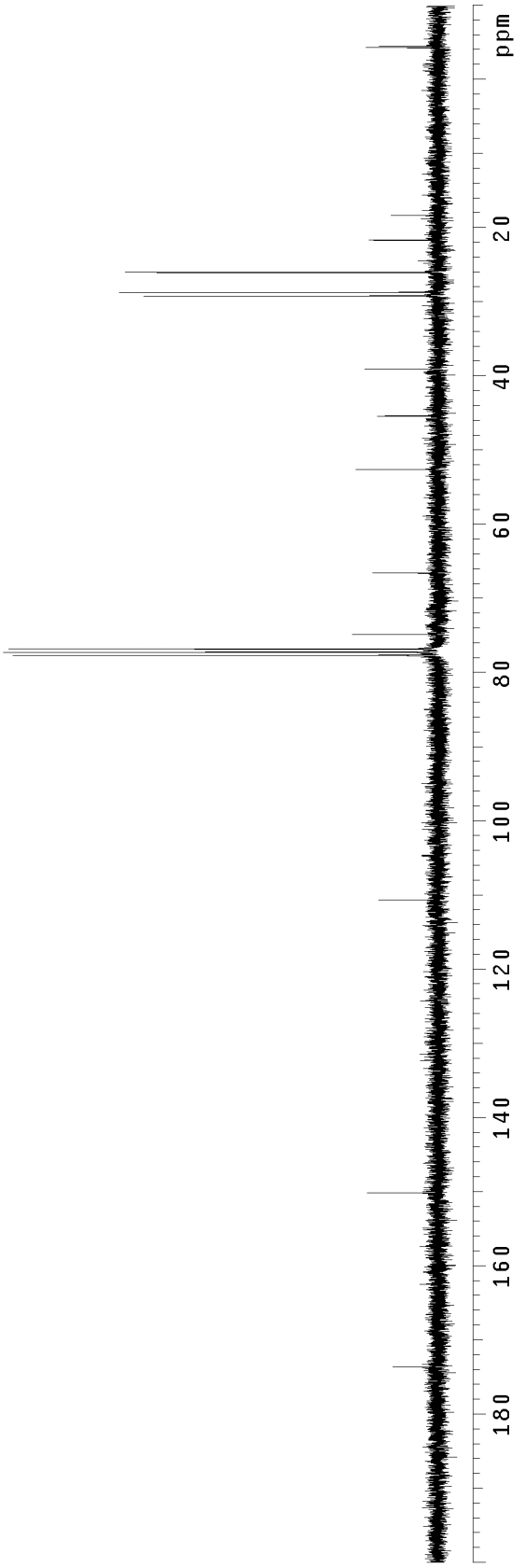
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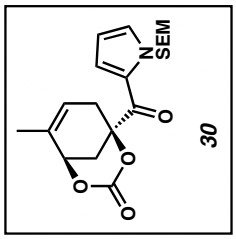

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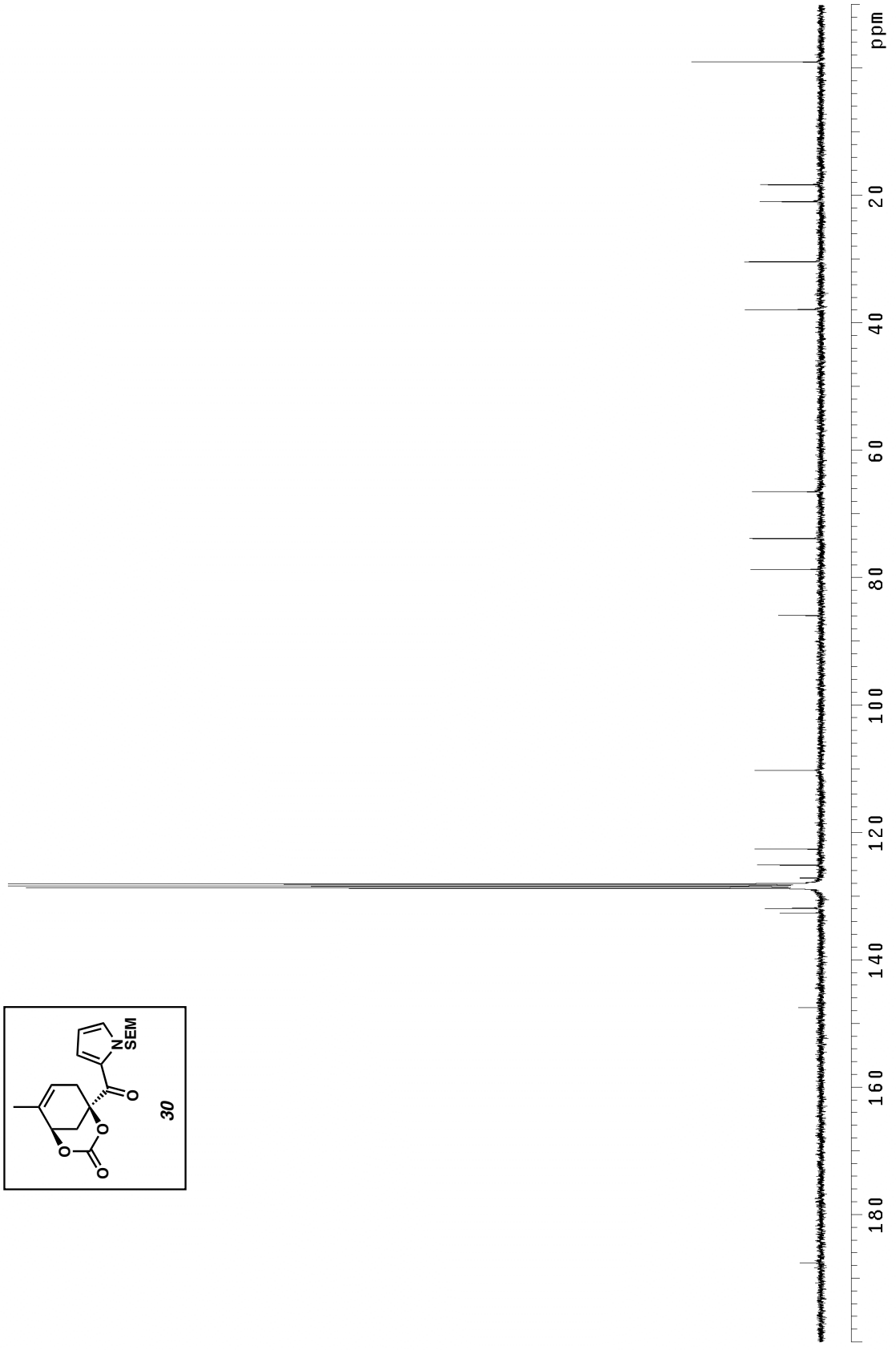
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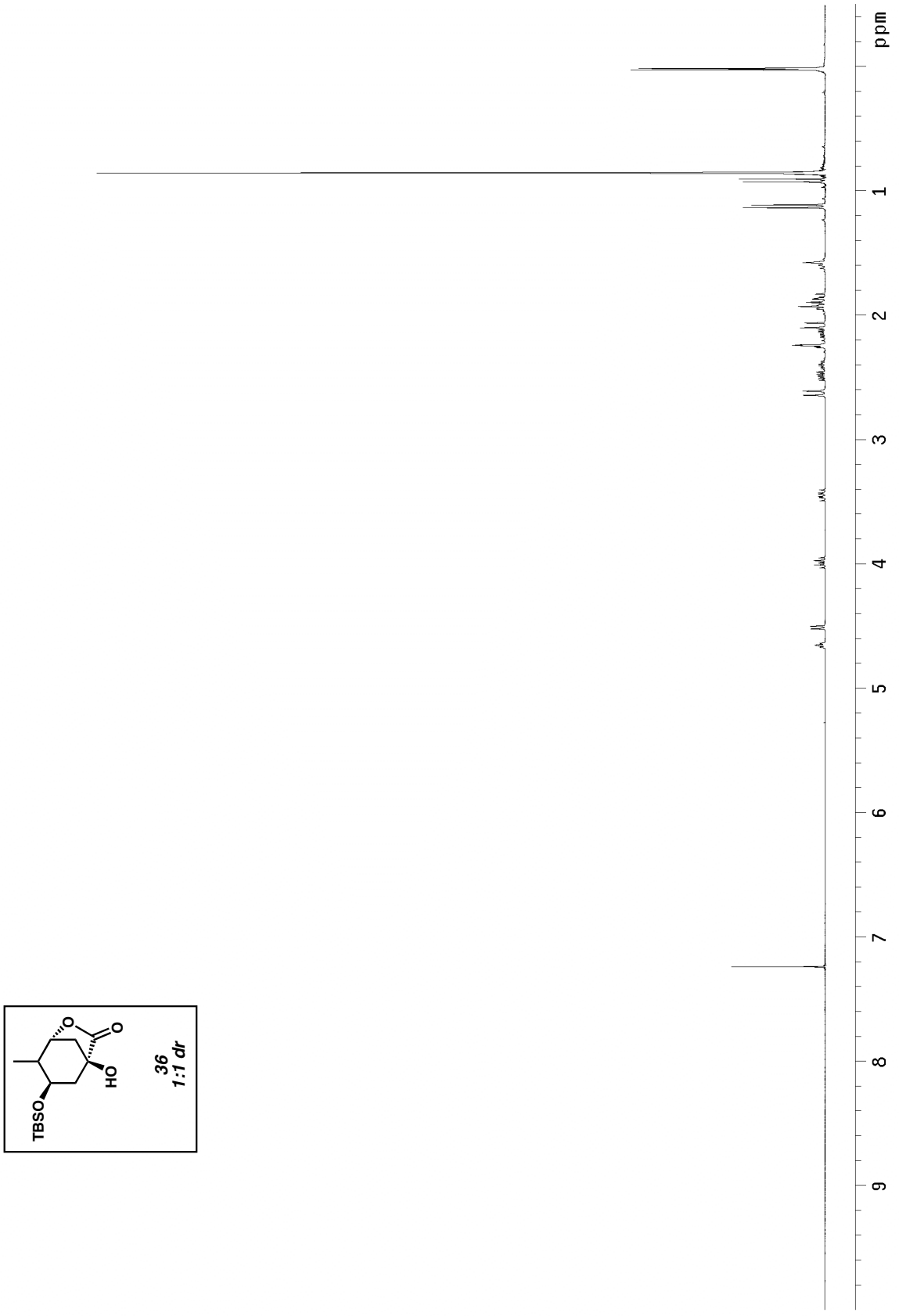
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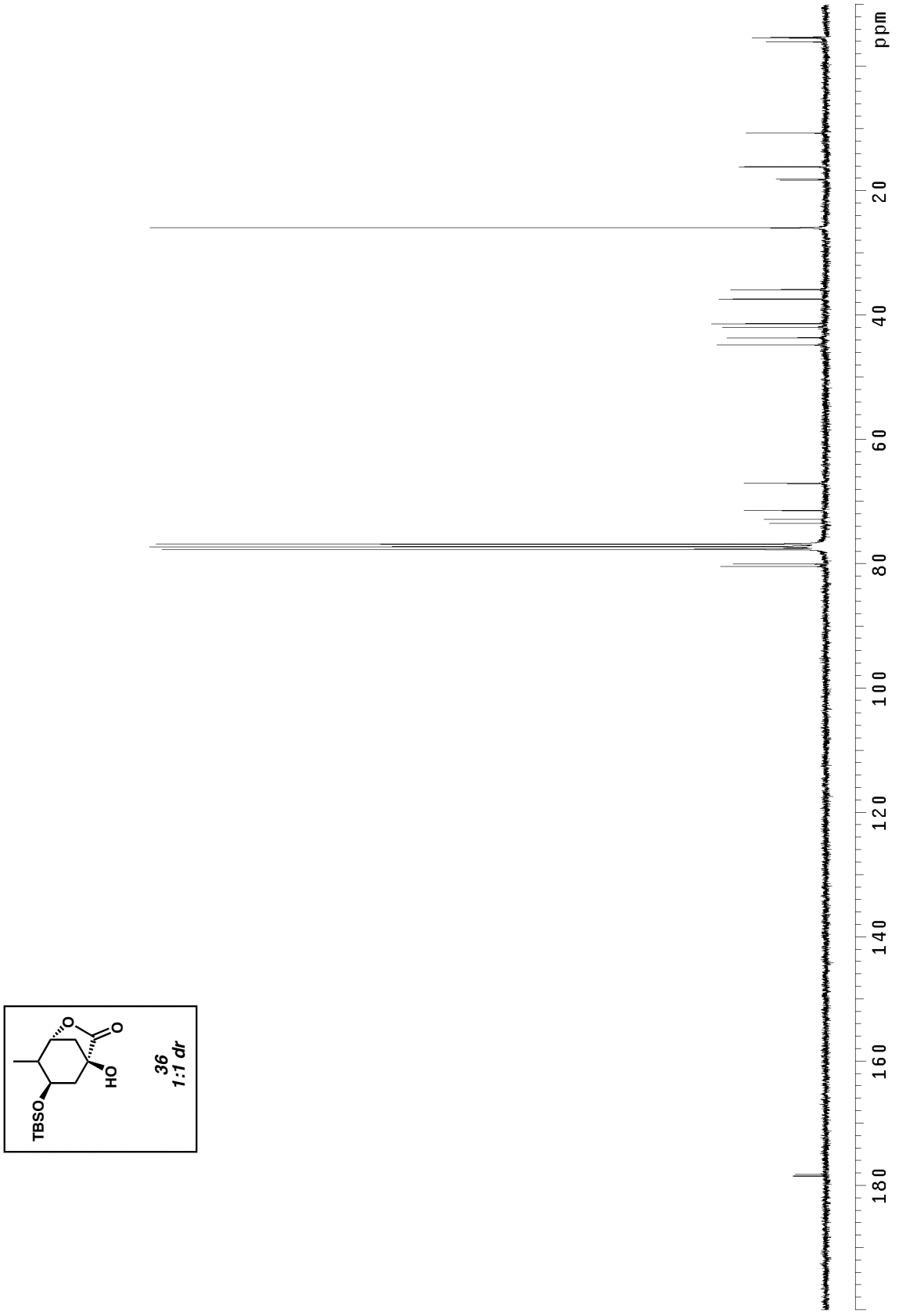
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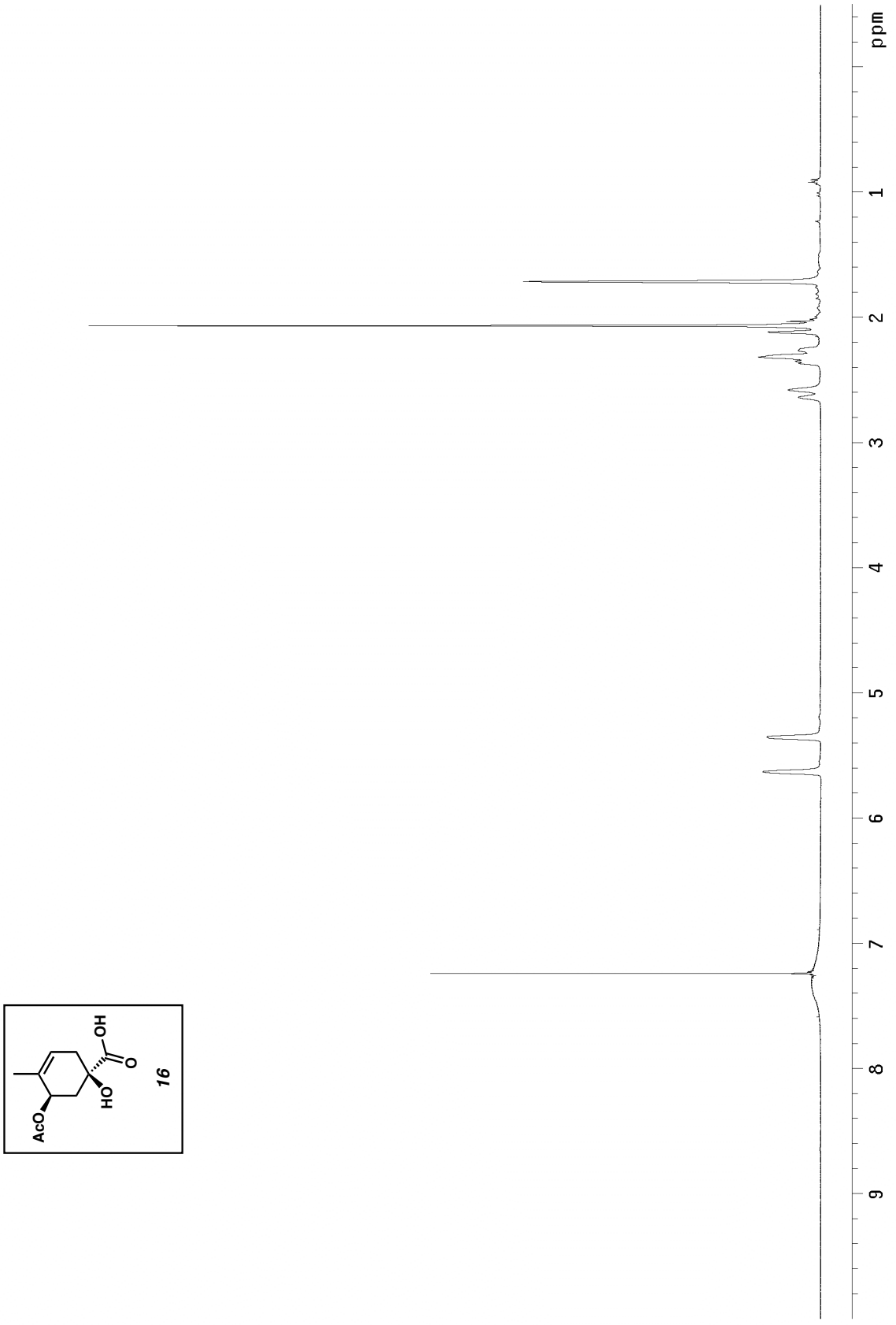
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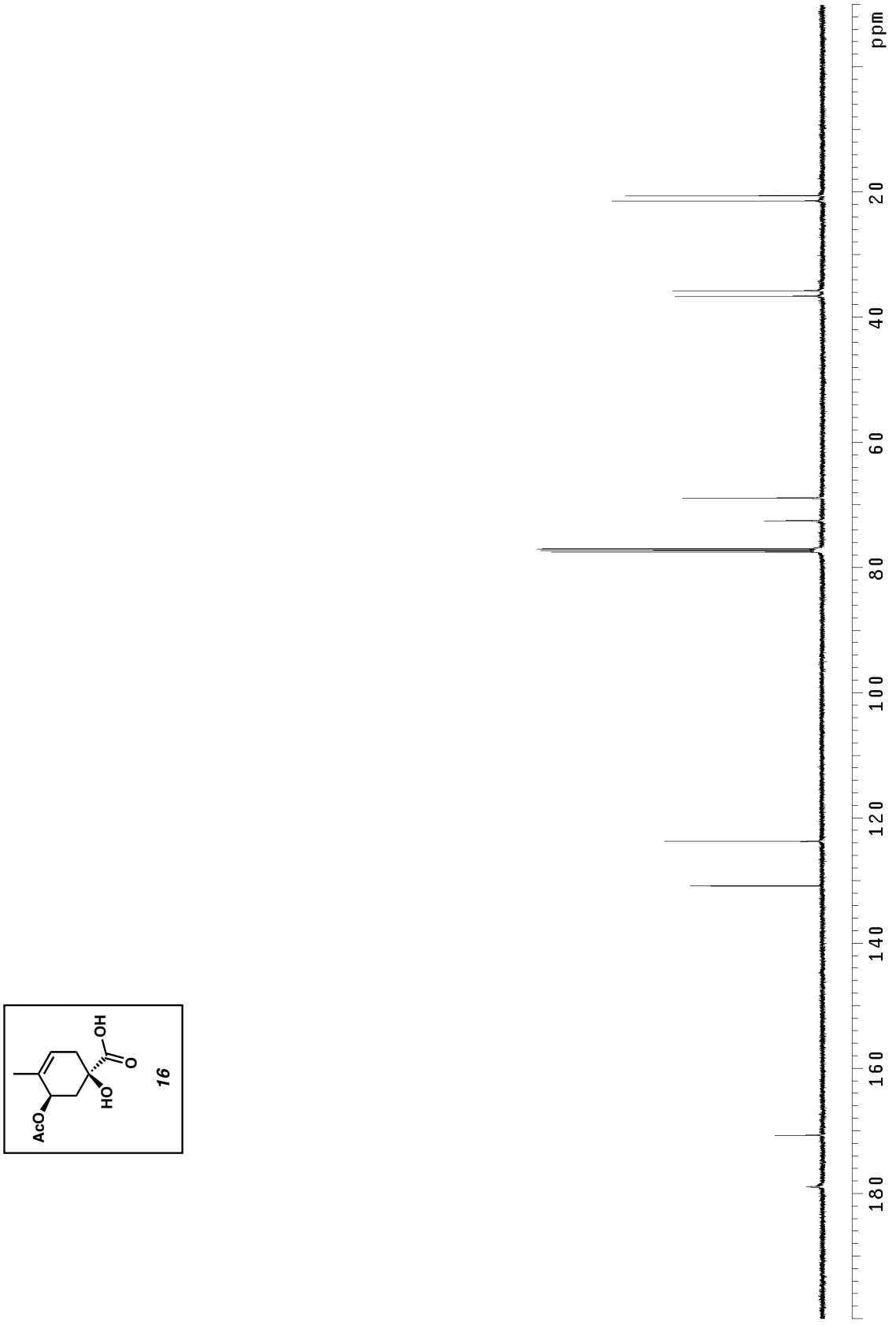
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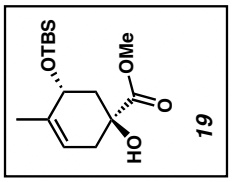
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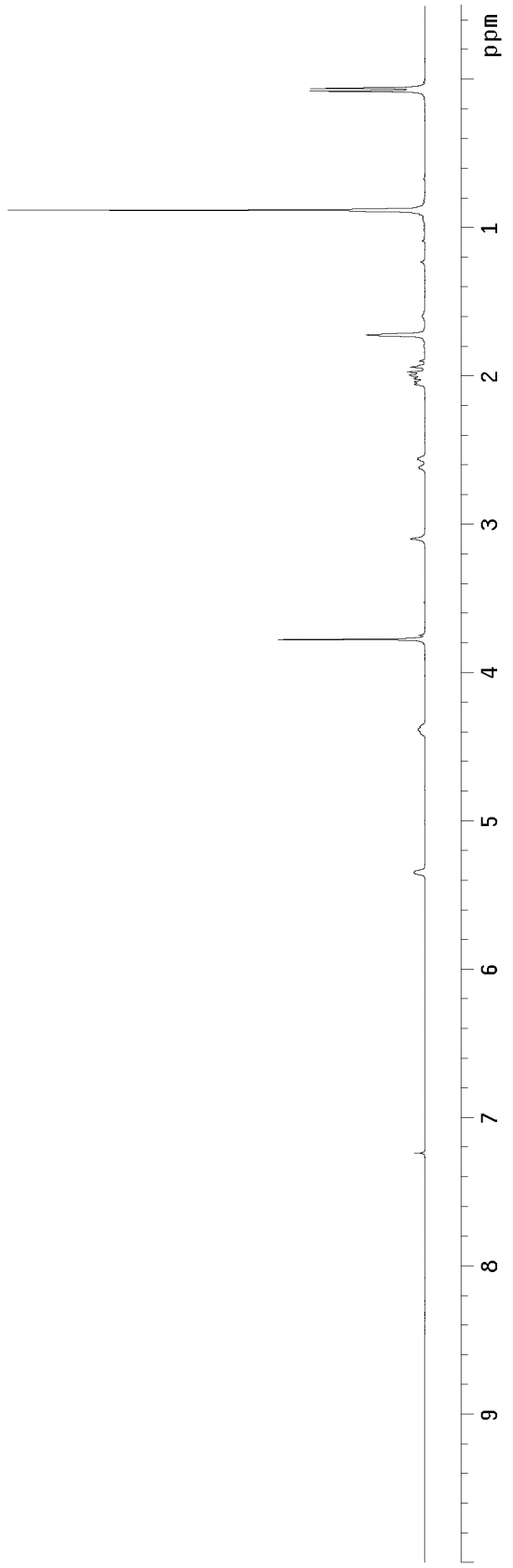
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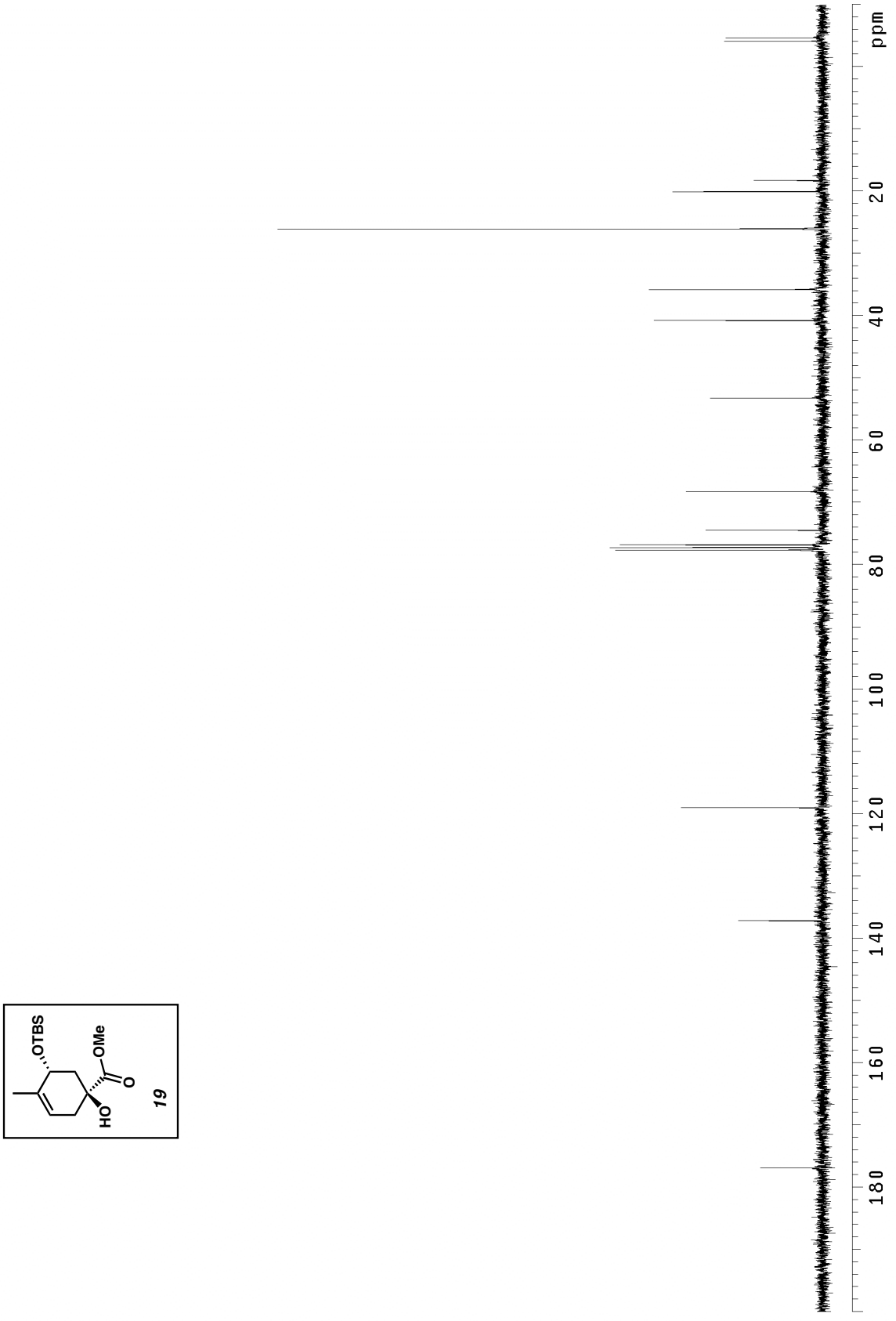
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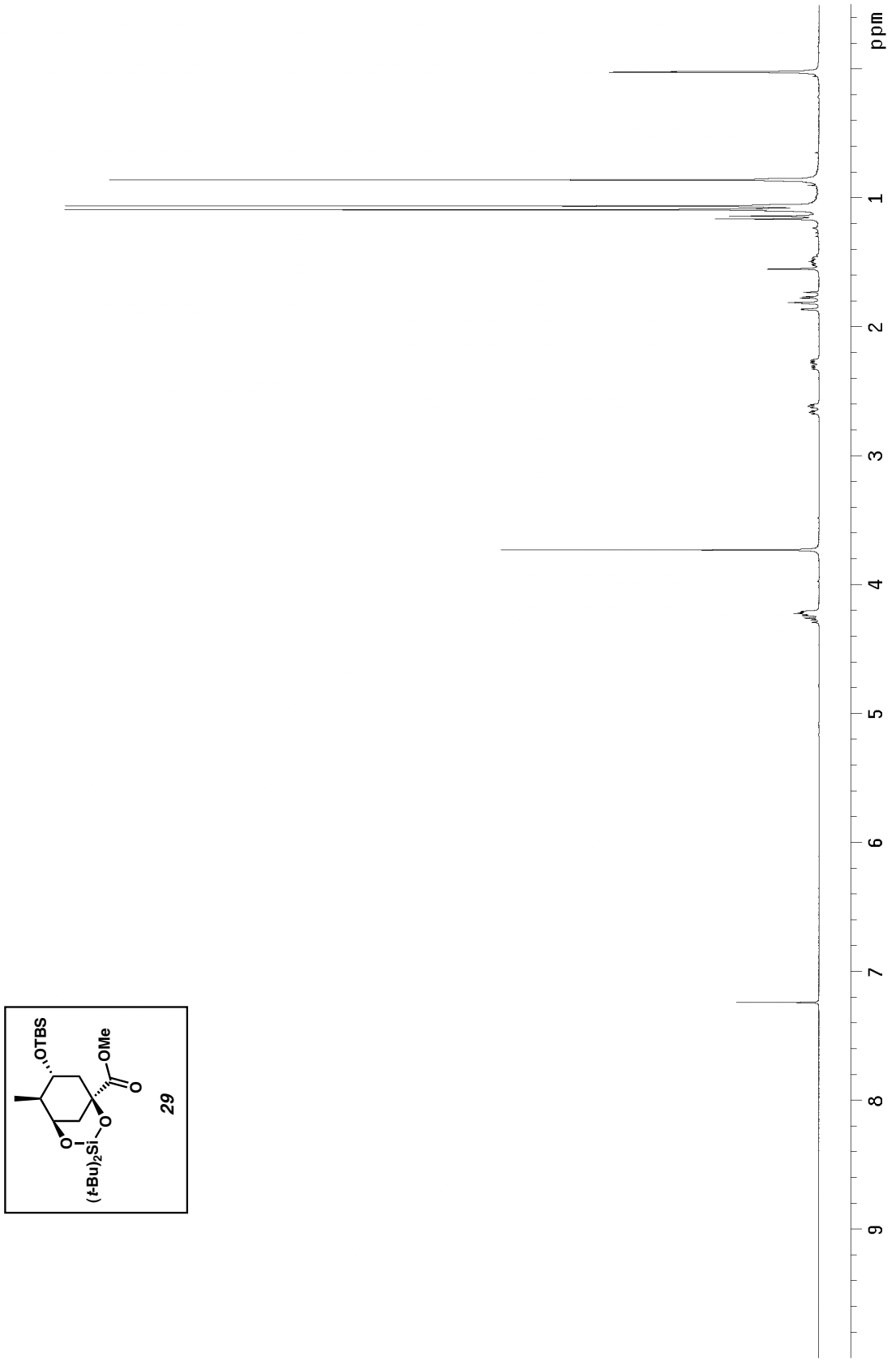
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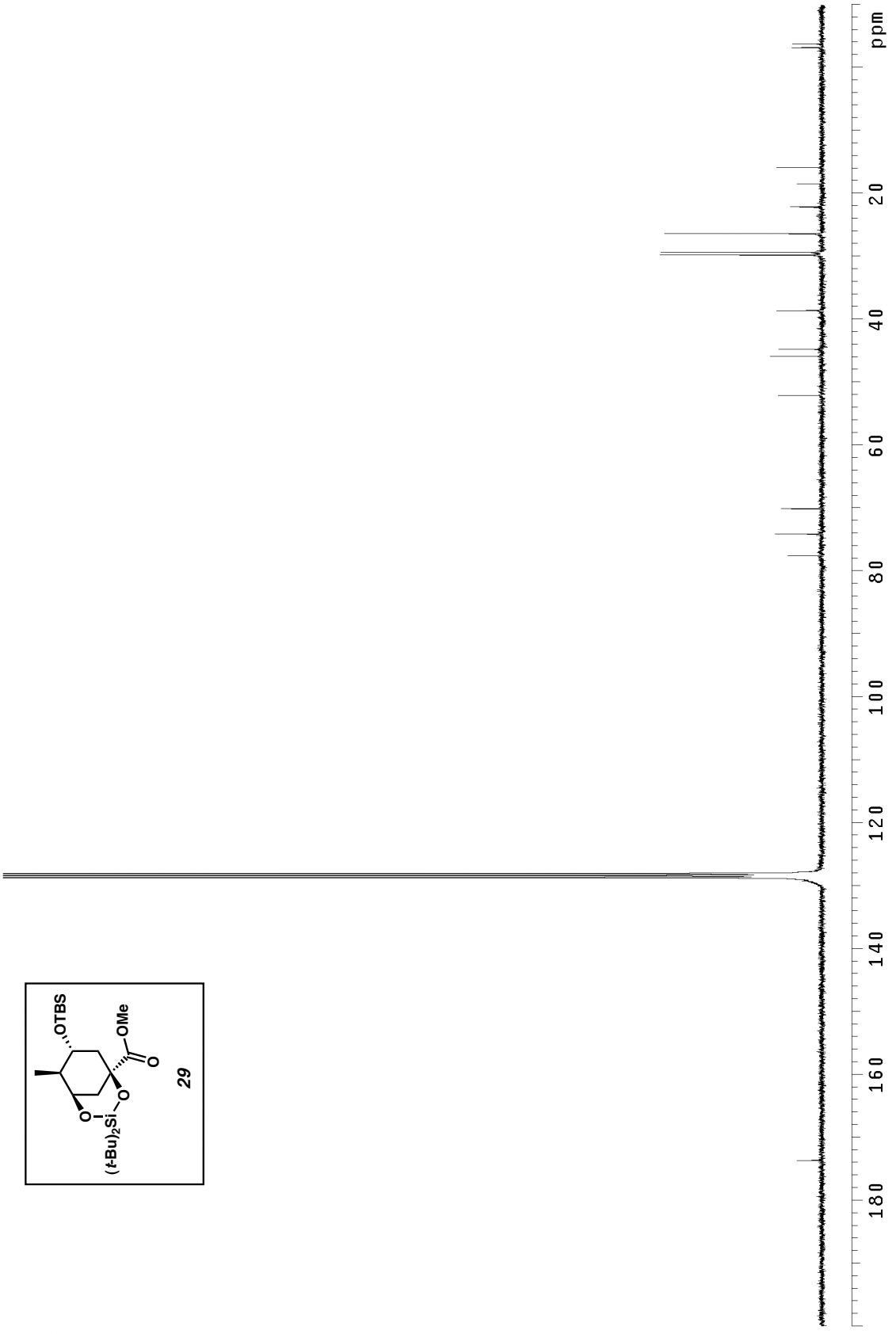
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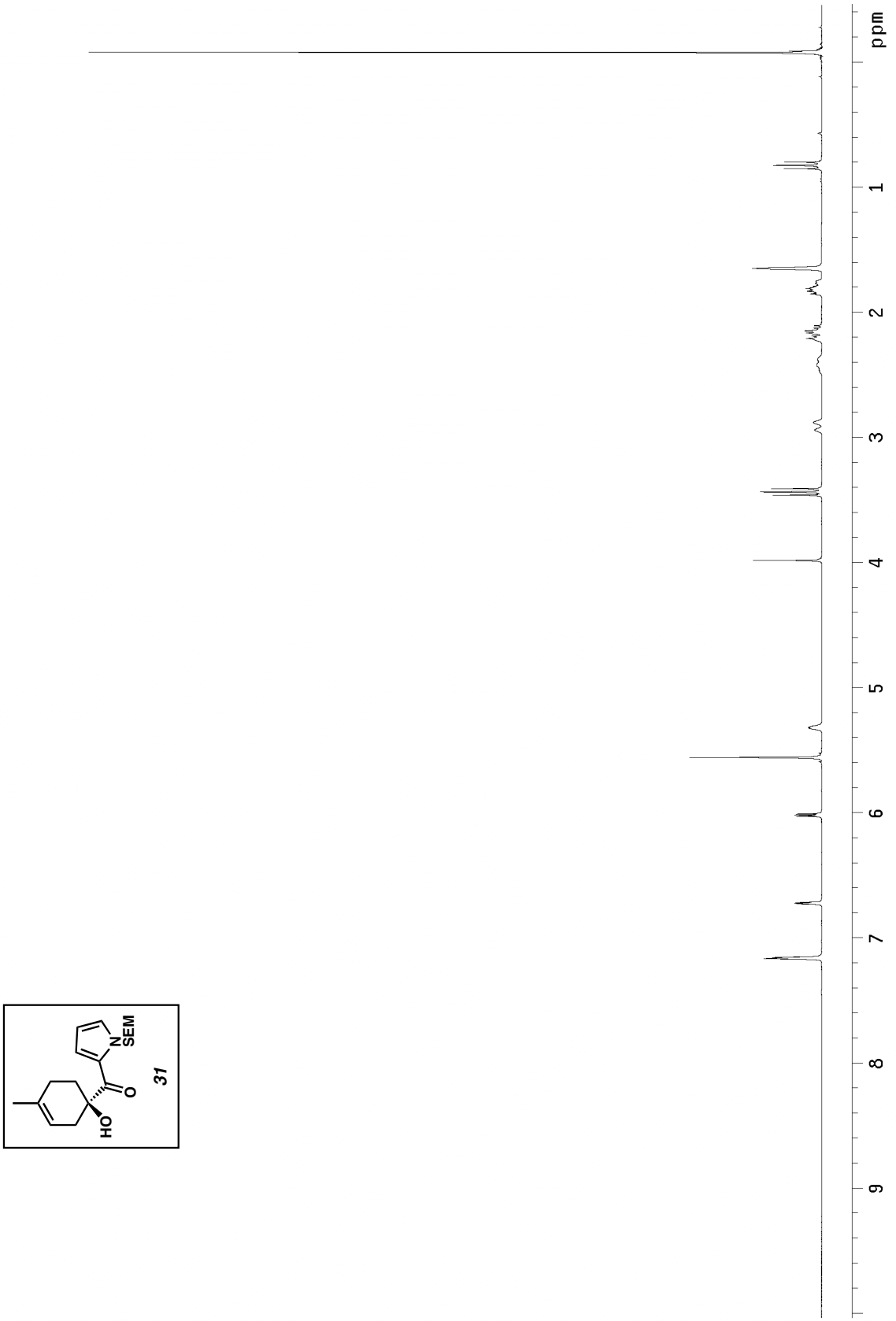
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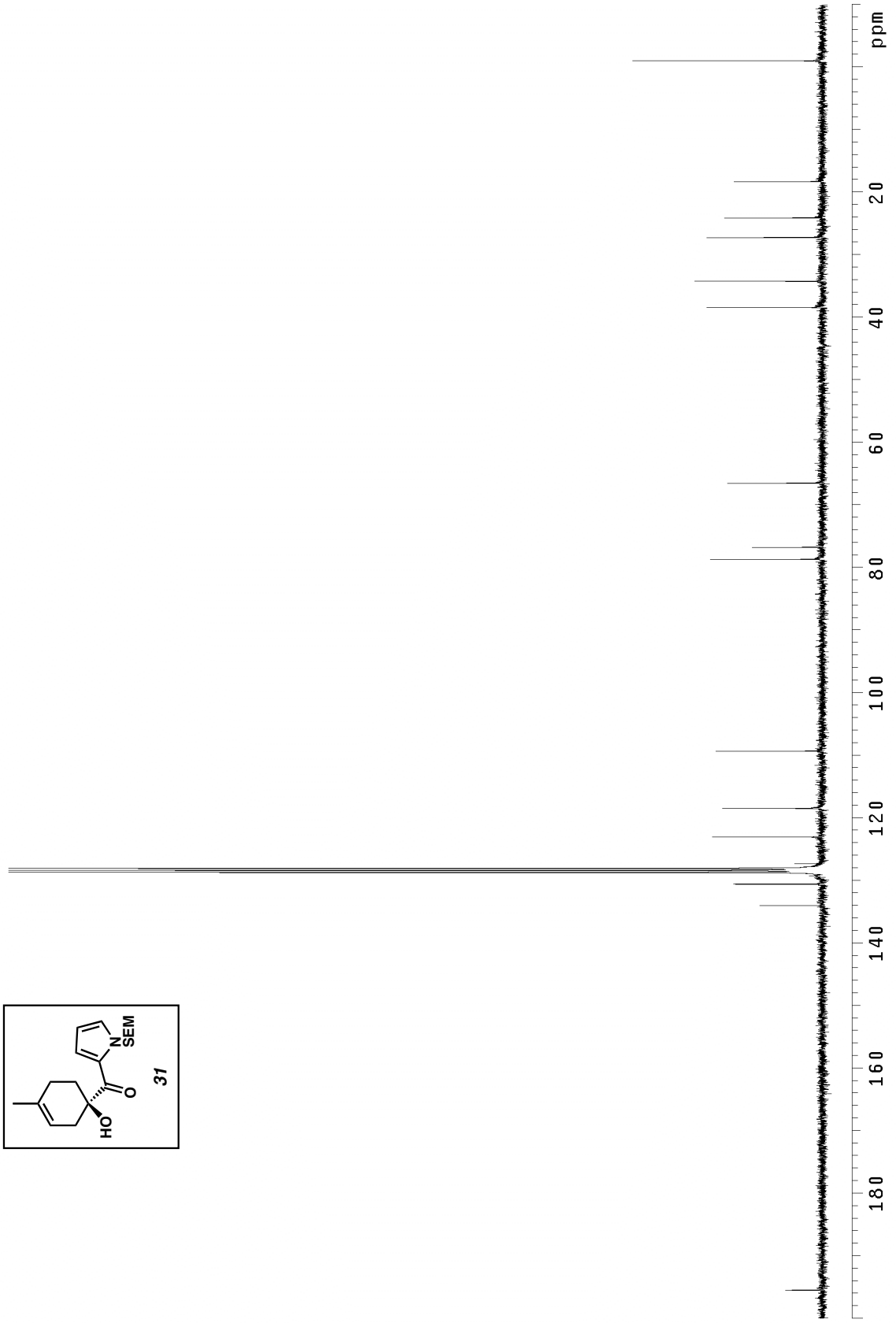
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