Supplemental Information

Highly stereoselective, Intermolecular Haloetherification and Haloesterification of Allyl Amides.

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Table of Contents:

I. General information

Commercially available reagents were purchased from Sigma-Aldrich or Alfa-Aesar and used as received. CH_2Cl_2 and acetonitrile were freshly distilled over CaH_2 prior to use. THF was distilled over sodium-benzophenone ketyl. All other solvents were used as purchased. ^{1}H and ^{13}C NMR were recorded on 500 MHz Varian NMR machines using $CDCl_3$ or CD_3CN as solvent and were referenced to residual solvent peaks. Flash silica gel (32-63 mm, Silicycle 60 Å) was used for column chromatography. Enantiomeric excess for all products was determined by HPLC analysis using DAICEL CHIRALCEL® OJ-H and OD-H or CHIRALPAK® IA and AD-H columns. Optical rotations of all products were measured in chloroform.

II. General Procedures

IIA. General procedure for optimization of catalytic asymmetric intermolecular haloetherification/haloesterification of unsaturated amides

The substrate (0.04 mmol, 1.0 equiv) was suspended in acetonitrile (MeCN, 2.8 mL) in a screw-capped vial equipped with a stir bar. The resulting suspension was cooled to -30 °C in an immersion cooler. $(DHQD)_2PHAL$ (3 mg, 10 mol%), 1.2 mL of methanol or acetic acid was then introduced. After stirring for 2 min DCDMH (15 mg, 0.08 mmol, 2.0 equiv) or NBS (14.3 mg, 2.0 equiv) was added. The stirring was continued at -30 °C till the reaction was complete (TLC). The reaction was quenched by the addition of saturated aq. Na_2SO_3 (1 mL) and diluted with DCM (3 mL). The organics were separated and the aqueous layer was extracted with DCM (3 × 3 mL). The combined organics were dried over anhydrous Na_2SO_4, concentrated and dissolved in $CDCl_3$ (1 mL). An equivalent amount (0.04 mmol) of MTBE was added and the solution was analyzed by NMR to obtain the NMR yield of the desired product. This solution was then concentrated in the presence of small quantity of silica gel. Column chromatography (SiO_2/EtOAc – Hexanes gradient elution) gave the desired product.

Following modifications were used for halohydrin synthesis: MeCN:H_2O ratio was 9:1; Reaction temperature: -10 °C.

IIB. General procedure for substrate scope analysis for catalytic asymmetric intermolecular haloetherification/haloesterification of unsaturated amides

The substrate (0.1 mmol, 1.0 equiv) was suspended in acetonitrile (MeCN, 7.0 mL) in a screw-capped vial equipped with a stir bar. The resulting suspension was cooled to -30 °C in an immersion cooler. $(DHQD)_2PHAL$ (7.8 mg, 10 mol%), 3.0 mL of methanol or acetic acid was then introduced. After stirring for 2 min DCDMH (39.4 mg, 0.2 mmol, 2.0 equiv) or NBS (35.6 mg, 2.0 equiv) was added. The stirring was continued at -30 °C till the reaction was complete (TLC). The reaction was quenched by the addition of saturated aq. Na_2SO_3 (4 mL) and diluted with DCM (3 mL). The organics were separated and the aqueous layer was extracted with DCM (3 × 3 mL). The combined organics were dried over anhyd. Na_2SO_4 and concentrated in the presence of small quantity of silica gel. Column chromatography (SiO_2/EtOAc – Hexanes gradient elution) gave the desired product.

Following modifications were used for halohydrin synthesis: MeCN:H_2O ratio was 9:1; Reaction temperature: -10 °C.

IIC. Procedure for gram scale catalytic asymmetric intermolecular haloetherification/haloesterification of unsaturated amides

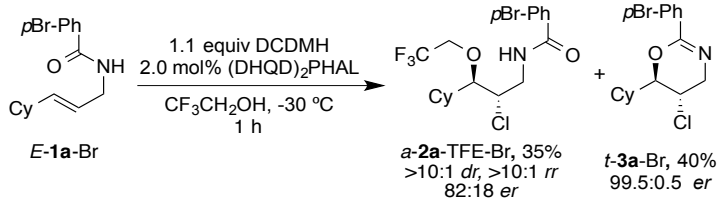
Z-**1c**-NO_2 (1.0 g, 4.0 mmol, 1.0 equiv) was suspended in acetonitrile (MeCN, 14.0 mL) in a screw-capped vial equipped with a stir bar. The resulting suspension was cooled to -30 °C in an immersion cooler. $(DHQD)_2PHAL$ (311.6 mg, 10 mol%), 7.0 mL of methanol was then introduced. After stirring for 2 min DCDMH (1500 mg, 8.0 mmol, 2.0 equiv) was added. The stirring was continued at -30 °C till the reaction was complete (TLC). The reaction was quenched by the addition of saturated aq. Na_2SO_3 (20 mL) and diluted with DCM (15 mL). The organics were separated and the aqueous layer was extracted with DCM (3 × 15 mL). The combined organics were dried over anhyd. Na_2SO_4 and concentrated in the presence of silica gel. Column chromatography (SiO_2/EtOAc – Hexanes gradient elution) gave the desired product.

Following modifications were used for gram scale synthesis of halohydrin *s*-***2c***-*OH*-NO_2: MeCN:H_2O ratio was 9:1 (20 mL); catalyst loading: 2 mol% $(DHQD)_2PHAL$, Reaction temperature: -10 °C.

III. Preliminary studies

In our prior work, we had demonstrated a highly diastereo- and enantioselective chlorocyclization of unsaturated amides to furnish dihydrooxazine and oxazoline heterocycles.[1] The use of CF_3CH_2OH as the reaction medium was crucial for obtaining high enantioselectivities. In the attempted chlorocyclization of *E*-**1a**-Br under optimized reaction conditions, *a*-**2a**-*TFE*-Br was isolated in 82:18 *er* and 35% yield (>10:1 *dr* and >10:1 *rr*) along with the desired product *t*-**3a**-Br (40%, 99.5:0.5 *er*; see Scheme S1). The reader is referred to reference 10 in the manuscript for a detailed explanation of our naming system for the starting materials and products in this manuscript. The rate of intramolecular nucleophilic capture of the putative chloriranium ion by the pendant amide nucleophile for this substrate is presumably slow enough to allow for a competing intermolecular nucleophilic capture even by the weakly nucleophilic CF_3CH_2OH. In the event, a simple solvent-switch from CF_3CH_2OH to *n*-$PrNO_2$ as the reaction medium alleviated the problem of chemodivergence, affording exclusively *t*-**3a**-Br in good yield and excellent enantioselectivity (77%, >99.5:0.5 *er*, result not shown).[1] While the

Scheme S1. Discovery of an asymmetric intermolecular chloroetherification of allyl amides

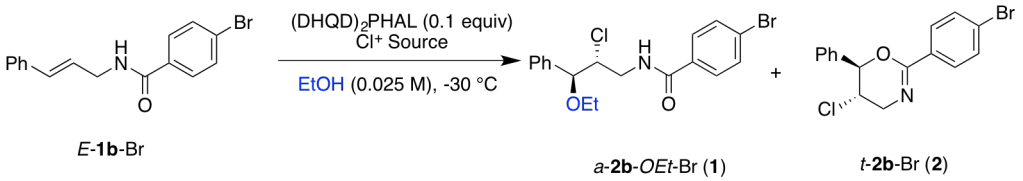


enantioselectivity and the yield of *a*-**2a**-*TFE*-Br were not synthetically useful, we were intrigued by the excellent diastereo- and regioselectivity of this by-product arising from the intermolecular nucleophilic capture of a sterically and electronically unbiased chloronium/chlorocarbenium ion intermediate. As such, this result represented a good starting point for developing a practical and general intermolecular chlorofunctionalization reaction of alkenes.

IV. Optimization of reaction variables

IV.A. Influence of the identity and stoichiometry of the chlorenium source on the stereoselectivity of the reaction.

Table S1: Chlorenium Source Optimization



E-**1b**-Br

a-**2b**-*OEt*-Br (**1**)

t-**2b**-Br (**2**)

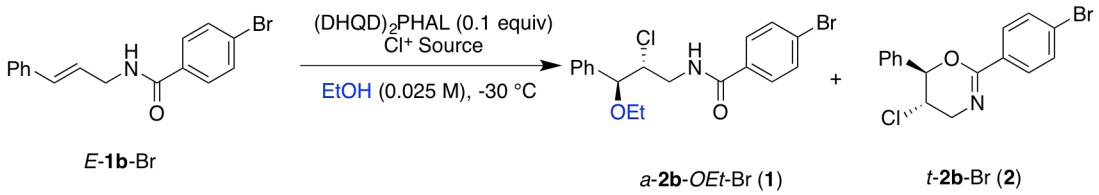
Entry	Source	equiv of Cl^+	Conv. %	Ratio[a] 1:2	*er* (1)[b,c]
1	DCDMH	1.1	100	6:4	80:20
2	DCDPH	1.1	100	6:4	80:20
3	NCP	1.1	0	nd	0
4	NCSach	1.1	100	6:4	78:22
5	**DCDMH**	**2**	**100**	**6:4**	**81:19**
6	DCDMH	5	100	6:4	78:22
7	DCDMH	10	100	6:4	78:22

[*a*] Determined by NMR; [*b*] Determined by chiral HPLC: [c] for compound *a*-2**b**-*OEt*-Br

With the exception of *N*-chlorophthalimide (NCP, entry 3), all other chlorenium sources gave complete conversion to products. The identity of the chlorenium source does not influence the ratio of **1:2** in a significant manner (ratio was ~6:4). Using 1.1 equivalent of DCDMH and DCDPH showed similar *er* (80:20) for product *a*-**2b**-*OEt*-Br (entries 1 and 2). Increasing the DCDMH loading to 2 equiv improved the enantiomeric ratio (entry 5). Further increase in the DCDMH loading to 5 or 10 equivalents did not lead to any improvement in the enantioselectivity (entries 5 and 6) for *a*-**2b**-*OEt*-Br**.**

IV.B. Influence of reaction solvent on the enantioselectivity of the reaction.

Table S2. Influence of co-solvent additives on the chemo- and stereoselectivity of the reaction



E-**1b**-Br

a-**2b**-*OEt*-Br (**1**)

t-**2b**-Br (**2**)

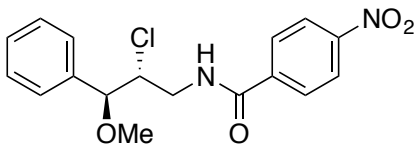
Entry	Temp	Solvent	Ratio of 1:2	*er* (**1**) [b,c]
1	-30	EtOH	6:4	81:19
2	-30	EtOH with 10 equiv TFE	6:4	77:23
3	-30	MeCN:EtOH(1:1)	6:4	81:19
4	rt	MeCN:EtOH (7:3)	1:1	82:18
5	-30	MeCN:EtOH (7:3)	1:1	84:16

[*a*] Determined by NMR; [*b*] Determined by chiral HPLC: [c] for compound *a*-**2b**-*OEt*-Br

Using ethanol as a solvent gave products *a*-**2b**-*OEt*-Br and *t*-**2b**-Br in the ratio of 6:4 and the enantiomeric ratio of 81:19 for *a*-**2b**-*OEt*-Br (entry 1). Adding 10 equivalents of TFE decreased the enantioselectivity (entry 2). A 1:1 MeCN-EtOH cosolvent mixture gave slightly improved enantioselectivity (entry 3). Changing the ratio of MeCN to EtOH to 7:3 produced both products in equimolar amounts, but with higher *er* (entry 4). Finally, decreasing the temperature to -30 °C gave higher enantioselectivity of 84:16 *er* (entry 5).

V. Analytical data for products

a-**2b**-*OMe*-NO_2**:** *N*-((2*R*,3*S*)-2-chloro-3-methoxy-3-phenylpropyl)-4-nitrobenzamide



R_f : 0.20 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.88 (d, *J* = 9.0 Hz, 2H), 7.40-7.33 (m, 5H), 6.82 (br s, 1H), 4.45 (d, *J* = 4.5 Hz, 1H), 4.25-4.22 (m, 1H), 4.11-4.06 (m, 1H), 3.66-3.61 (m, 1H), 3.34 (s, 3H)

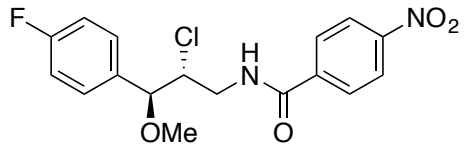
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.26, 149.64, 139.66, 136.87, 137.22, 128.76, 128.12, 127.18, 123.87, 86.33, 62.60, 57.98, 42.54

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{17}H_{18}ClN_2O_4$: 349.0955; Found: 349.0950

Resolution of enantiomers: DAICEL Chiralcel® Oj-H column, 20% IPA-Hexanes, 1.0 mL/min, 265 nm, RT1 (minor) = 27.0 min, RT2 (major) = 30.1 min

$[\alpha]_D^{20}$ = +46.7 (c 0.5, $CHCl_3$, *er* = 92:8)

a-**2d**-*OMe*-NO_2**:** *N*-((2*R*,3*S*)-2-chloro-3-(4-fluorophenyl)-3-methoxypropyl)-4-nitrobenzamide



R_f : 0.19 (30% EtOAc in hexanes, UV)

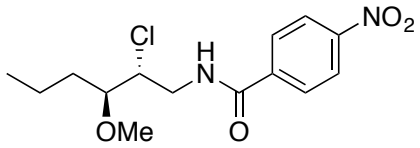
^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.91 (d, *J* = 9.0 Hz, 2H), 7.33-7.30 (m, 2H), 7.09-7.06 (m, 2H), 6.77 (br s, 1H), 4.38 (d, *J* = 4.5 Hz, 1H) 4.19-4.18 (m, 1H), 4.13-4.09 (m, 1H), 3.65-3.63 (m, 1H), 3.31 (s, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.32, 149.65, 139.81, 133.74, 129.08 (d, J_{CF} = 30 Hz) 128.12, 123.91, 115.81, 115.63, 85.55, 62.79, 57.79, 42.77

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{17}H_{17}ClFN_2O_4$: 367.0861; Found: 367.0844

Resolution of enantiomers: CHIRALCEL OJ-H 12% IPA-Hexane, 0.7 ml/min, RT1 (minor) = 64.6, RT2 (major) = 69.6; $[\alpha]_D^{20}$ = -5.0 (c 0.1, $CHCl_3$, *er* = 89:11)

a-**2c**-*OMe*-NO_2**:** *N*-((2*R*,3*S*)-2-chloro-3-methoxyhexyl)-4-nitrobenzamide



R_f : 0.38 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.93 (d, *J* = 9.0 Hz, 2H), 7.24 (br s, 1H), 4.16-4.10 (m, 2H), 3.60-3.56 (m, 1H), 3.49-3.47 (m, 4H), 1.68-1.62 (m, 2H), 1.54-1.35 (m, 2H), 0.95 (m, 3H)

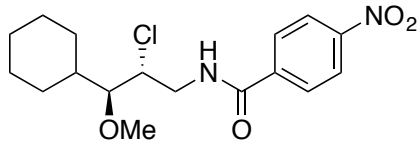
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.40, 149.70, 139.86, 128.14, 123.90, 83,90, 61.78, 59.37, 42.92, 33.69, 18.46, 14.09

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{14}H_{18}ClN_2O_4$: 313.0955; Found: 313.0953

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 7% IPA-Hexanes, 0.5 mL/min, 254 nm, RT1 (major) = 32.6 min, RT2 (major) = 34.7 min.

$[\alpha]_D^{20}$ = -30 (c 0.25, $CHCl_3$, *er* = 87:13)

a-**2a**-*OMe*-NO_2**:** *N*-((2*R*,3*S*)-2-chloro-3-cyclohexyl-3-methoxypropyl)-4-nitrobenzamide



R_f : 0.36 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.92 (d, *J* = 9.0 Hz, 2H), 7.00 (br s, 1H), 4.33-4.30 (m, 1H), 4.15-4.10 (m, 1H), 3.63-3.58 (m, 4H), 3.22-3.20 (dd, J =7.0, 4.0 Hz 1H), 1.94-1.91(m, 1H), 1.77-1.74 (m, 2H), 1.68-1.63 (m, 2H), 1.27-1.05 (m, 6H)

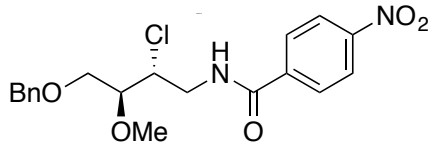
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.40, 149.69, 139.91, 128.12, 123.88, 89.50, 62.64, 60.87, 42.71, 41.32, 29.67, 28.70, 26.20, 25.99, 25.86

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{17}H_{22}ClN_2O_4$: 353.1268; Found: 353.1261

Resolution of enantiomers: DAICEL Chiralcel® OJ-H column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 11.8 min, RT2 (minor) = 16.1 min.

$[\alpha]_D^{20}$ = -4.0 (c 0.6, $CHCl_3$, *er* = 75:25)

a-**2e**-*OMe*-NO_2**:** *N*-((2*R*,3*S*)-4-(benzyloxy)-2-chloro-3-methoxybutyl)-4-nitrobenzamide



R_f: 0.16 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.25 (d, *J* = 9.0 Hz, 2H), 7.85 (d, *J* = 9.0 Hz, 2H), 7.35-7.29, (m, 5H), 6.87 (br s, 1H), 4.56 (d, *J* = 1 Hz, 2H), 4.36-4.33 (m, 1H), 3.99-3.95 (m, 1H), 3.83-3.79 (m, 1H), 3.75-3.72 (dd, *J*=10.0, 5.0 Hz, 1H), 3.69-3.66 (dd, *J*=10.0, 5.0 Hz, 1H), 3.49 (s, 3H)

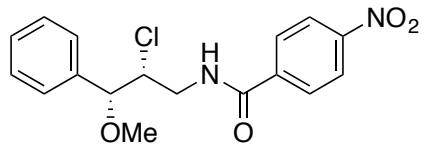
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.24, 149.60, 139.78, 137.45, 128.55, 128.11, 128.02, 127.83, 123.83, 82.33, 73.76, 68.17, 59.11, 59.08, 24.90

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{19}H_{20}ClN_2O_5$: 391.1061; Found: 391.1057

Resolution of enantiomers: DAICEL Chiralcel® IA column, 20% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 11.0 min, RT2 (minor) = 11.8 min.

$[\alpha]_D^{20}$ = +5.2 (c 0.5, $CHCl_3$, *er* = 88:12)

s-**2b**-*OMe*-NO_2**:** *N*-((2*R*,3*R*)-2-chloro-3-methoxy-3-phenylpropyl)-4-nitrobenzamide



R_f : 0.22 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.27 (d, *J* = 9.0 Hz, 2H), 7.86 (d, *J* = 9.0 Hz, 2H), 7.41-7.24 (m, 5H), 6.57 (br s, 1H), 4.41 (d, *J* = 4.5 Hz, 1H), 4.29-4.28 (m, 1H), 4.00-3.95 (m, 1H), 3.56-3.52 (m, 2H), 3.27(s, 3H)

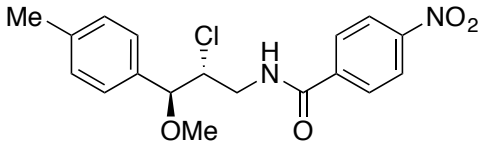
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.32, 149.75, 139.66, 136.83, 123.84, 128.68, 128.13, 127.49, 123.87, 85.03, 63.63, 57.44, 43.80

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{17}H_{18}ClN_2O_4$: 349.0955; Found: 349.0955

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 22.8 min, RT2 (minor) = 29.9 min.

$[\alpha]_D^{20}$ = -8.0 (c 0.1, $CHCl_3$, *er* = 99.5:0.5)

a-**2f**-*OMe*-NO_2**:** *N*-((2*R*,3*R*)-2-chloro-3-methoxy-3-(*p*-tolyl)propyl)-4-nitrobenzamide



R_f : 0.27 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.89 (d, *J* = 9.0 Hz, 2H), 7.22-7.18 (m, 4H), 6.86 (br s, 1H), 4.24 (d, *J* = 5.5 Hz, 1H), 4.23-4.20 (m, 1H), 4.10-4.05 (m, 1H), 3.65-3.60 (m, 1H), 3.33 (s, 3H), 2.34 (s, 3H)

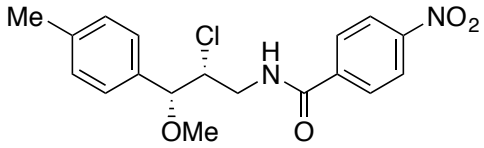
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.27, 149.67, 139.64, 138.74, 133.73, 129.41, 128.13, 127.38, 123.86, 84.94, 63.72, 57.29, 43.75, 21.21

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{18}H_{18}ClN_2O_4$: 361.0955; Found: 361.0955

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 15% IPA-Hexanes, 1.0 mL/min, 265 nm, RT1 (major) = 13.6 min, RT2 (minor) = 16.6 min.

$[\alpha]_D^{20}$ = +14.9 (c 0.7, $CHCl_3$, *er* = 97:3)

s-**2f**-*OMe*-NO_2**:** *N*-((2*R*,3*R*)-2-chloro-3-methoxy-3-(*p*-tolyl)propyl)-4-nitrobenzamide



R_f : 0.27 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.85 (d, *J* = 9.0 Hz, 2H), 7.22-7.10 (m, 4H), 6.55 (br s, 1H), 4.39 (d, *J* = 5.0 Hz, 1H), 4.38-4.24 (m, 1H), 3.95-3.94 (m, 1H), 3.55-3.50 (m, 1H), 3.30 (s, 3H), 2.35 (s, 3H)

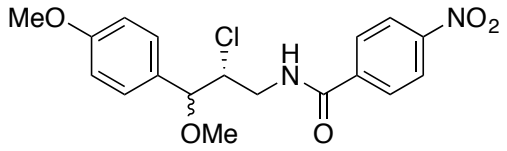
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.22, 149.63, 139.91, 138.63, 134.15, 129.46, 128.12, 127.10, 123.85, 86.22, 62.65, 57.86, 42.56, 21.19

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{18}H_{18}ClN_2O_4$: 361.0955; Found: 361.0955

Resolution of enantiomers: DAICEL Chiralcel® OD-H column, 15% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 17.8 min, RT2 (minor) = 25.0 min.

$[\alpha]_D^{20}$ = -7.1 (c 0.6, $CHCl_3$, *er* = 99:1)

2g-*OMe*-NO_2**:** *N*-2-chloro-3-methoxy-3-(4-methoxyphenyl)propyl)-4-nitrobenzamide (note: the relative stereochemistry of the two diastereomeric products below was not identified.)



R_f : 0.16 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.28 (d, *J* = 9.0 Hz, 2H), 7.87 (d, *J* = 9.0 Hz, 2H), 7.28 (d, *J* = 8 Hz, 2H), 6.92 (d, *J* = 8 Hz, 2H), 6.57 (br s, 1H), 4.37 (d, *J* = 5.5 Hz, 1H), 4.27-4.23 (m, 1H), 3.96-3.92 (m, 1H), 3.80 (s, 3H), 3.53-3.48 (m, 1H), 3.29 (s, 3H)

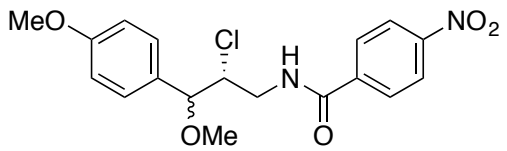
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.24, 159.87, 149.64, 139.89, 129.09, 128.44, 128.13, 123.87, 114.10, 85.91, 62.79, 57.70, 55.28, 42.67

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{18}H_{18}ClN_2O_5$ 377.0904; Found: 377.0899

Resolution of enantiomers: DAICEL Chiralcel® OD-H column, 2% IPA-Hexanes, 01.0 mL/min, 254 nm, RT1 (minor) = 21.6 min, RT2 (major) = 25.7 min.

$[\alpha]_D^{20}$ = +17 (c 0.25, $CHCl_3$, *er* = 99:1)

epi-**2g**-*OMe*-NO_2**:,** *N*-((2*R*,3*R*)-2-chloro-3-methoxy-3-(4-methoxyphenyl)propyl)-4-nitrobenzamide



R_f : 0.16 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.90 (d, *J* = 9.0 Hz, 2H), 7.26 (d, *J* = 8.0 Hz, 2H), 6.91 (d, *J* = 8.0 Hz, 2H), 6.85 (br s, 1H), 4.39 (d, *J* = 6.0 Hz, 1H) 4.22-4.18 (m, 1H), 4.11-4.06 (m, 1H), 3.80 (s, 3H), 3.65-3.60 (m, 1H), 3.31 (s, 3H)

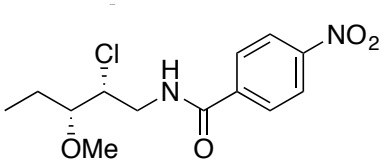
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.27, 159.97, 149.68, 139.63, 128.69, 128.12, 123.86, 114.08, 84.66, 63.83, 57.18, 55.27, 43.71

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{18}H_{18}ClN_2O_5$ 377.0904; Found: 377.0901

Resolution of enantiomers: DAICEL Chiralcel® IA column, 20% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 11.9 min, RT2 (minor) = 13.8 min.

$[\alpha]_D^{20}$ = -13.0 (c 0.25, $CHCl_3$, *er* = 92:8)

s-**2h**-*OMe*-NO_2**:** *N*-((2*R*,3*R*)-2-chloro-3-methoxypentyl)-4-nitrobenzamide



R_f : 0.20 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.30 (d, *J* = 9.0 Hz, 2H), 7.94 (d, *J* = 9.0 Hz, 2H), 6.83 (br s, 1H), 4.28-4.25 (m, 1H), 4.14-4.09 (m, 1H), 3.60-3.51 (m, 1H), 3.46 (s, 3H), 3.61-3.34 (m, 1H), 1.75-1.69 (m, 2H), 0.98 (t, *J* = 7.5 Hz, 3H)

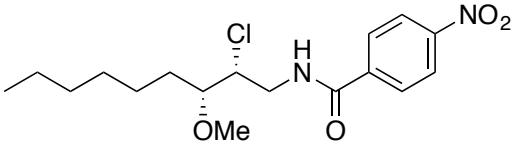
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.49, 149.69, 139.69, 128.16, 123.90, 84.10, 60.96, 58.21, 43.92, 22.90, 9.92

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{13}H_{16}ClN_2O_4$ 299.0799; Found: 299.0796

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 7% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (minor) = 22.2 min, RT2 (major) = 24.7 min.

$[\alpha]_D^{20}$ = +30.0 (c 0.39, $CHCl_3$, *er* = 98:2)

s-**2i**-*OMe*-NO_2**:** *N*-((2*R*,3*R*)-2-chloro-3-methoxynonyl)-4-nitrobenzamide



R_f : 0.30 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.33 (d, *J* = 9.0 Hz, 2H), 7.97 (d, *J* = 9.0 Hz, 2H), 6.85 (br s, 1H), 4.30-4.27 (m, 1H), 4.16-4.15 (m, 1H), 3.64-3.58 (m, 1H), 3.45 (s, 3H), 3.44-3.41 (m, 1H), 1.72-1.68 (m, 2H), 1.39-1.25 (m, 8H), 0.90 (t, *J* = 7.0 Hz, 3H)

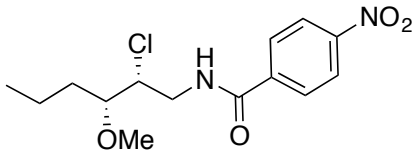
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.46, 149.70, 139.70, 128.15, 123.91, 82.90, 61.09, 58.25, 43.82, 31.68, 29.92, 29.25, 25,57, 22.55, 14.06

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{16}H_{22}ClN_2O_4$: 341.1268; Found: 341.1272

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 10.5 min, RT2 (minor) = 12.7 min.

$[\alpha]_D^{20}$ = +16.5 (c 0.6, $CHCl_3$, *er* = 95:5)

s-**2c**-*OMe*-NO_2**:** *N*-((2*R*,3*R*)-2-chloro-3-methoxyhexyl)-4-nitrobenzamide



R_f : 0.25 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.93 (d, *J* = 9.0 Hz, 2H), 6.79 (br s, 1H), 4.25-4.23 (m, 1H), 4.13-4.08 (m, 1H), 3.61-3.55 (m, 1H), 3.45 -3.41(m, 4H), 1.68-1.62 (m, 2H), 1.54-1.35 (m, 2H), 0.95 (t, *J* = 7.5 Hz, 3H)

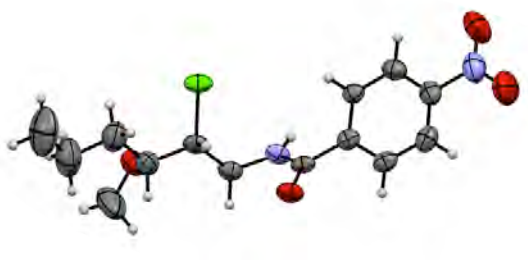
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.44, 149.74, 139.73, 128.14, 123.90, 82,70, 61.04, 58.27, 43.78, 32.08, 18.90, 14.04

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{14}H_{20}ClN_2O_4$: 315.1112; Found: 315.1116

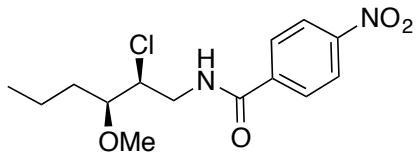
Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 12.1 min, RT2 (minor) = 14.0 min.

$[\alpha]_D^{20}$ = +19.0 (c 0.1, $CHCl_3$, *er* = 99.5:0.5)

Absolute stereochemistry was determined by single crystal X-ray diffraction (XRD). Crystals for XRD were obtained by crystallization from CH_2Cl_2 layered with hexanes in a silicone-coated vial.



epi-s-**2c**-*OMe*-NO_2**:** *N*-((2*S*,3*S*)-2-chloro-3-methoxyhexyl)-4-nitrobenzamide



R_f : 0.25 (30% EtOAc in hexanes, UV) 64% yield with $(DHQ)_2PHAl$

^1H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.93 (d, *J* = 9.0 Hz, 2H), 6.79 (br s, 1H), 4.25-4.23 (m, 1H), 4.13-4.08 (m, 1H), 3.61-3.55 (m, 1H), 3.45 -3.41(m, 4H), 1.68-1.62 (m, 2H), 1.54-1.35 (m, 2H), 0.95 (t, *J* = 7.5 Hz, 3H)

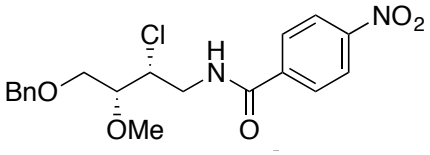
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.44, 149.74, 139.73, 128.14, 123.90, 82,70, 61.04, 58.27, 43.78, 32.08, 18.90, 14.04

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{14}H_{20}ClN_2O_4$: 315.1112; Found: 315.1116

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (minor) = 11.4 min, RT2 (major) = 14.4 min.

$[\alpha]_D^{20}$ = -19.8 (c = 0.5, $CHCl_3$, *er* = 95.0:5.0)

s-**2e**-*OMe*-NO_2**:** *N*-((2*R*,3*R*)-4-(benzyloxy)-2-chloro-3-methoxybutyl)-4-nitrobenzamide



R_f : 0.23 (30% EtOAc in hexanes, UV)

^1H NMR (500 MHz, $CDCl_3$) δ 8.25 (d, *J* = 9.0 Hz, 2H), 7.85 (d, *J* = 9.0 Hz, 2H), 7.34-7.32 (m, 5H), 6.79 (br s, 1H), 4.55 (s, 2H), 4.38-4.35 (m, 1H), 4.17-4.03 (m, 1H), 3.80-3.77 (dd, *J* = 9.5, 4.5 Hz, 1H), 3.78-3.67 (m, 3H), 3.48 (s, 3H)

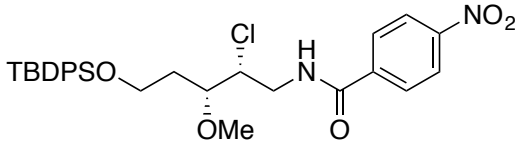
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.40, 149.60, 139.76, 137.46, 128.53, 128.01, 127.82, 123.83, 81.28, 73.82, 68.40, 59.72, 58.85, 43.76

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{19}H_{20}ClN_2O_5$: 391.1061; Found: 391.1060

Resolution of enantiomers: DAICEL Chiralcel® IA column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (minor) = 24.6 min, RT2 (major) = 26.8 min.

$[\alpha]_D^{20}$ = +4.1 (c 0.45, $CHCl_3$, *er* = 99:1)

s-**2j**-*OMe*-NO_2**:** *N*-((2*R*,3*R*)-5-((*tert*-butyldiphenylsilyl)oxy)-2-chloro-3-methoxypentyl)-4-nitrobenzamide



R_f : 0.38 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.28 (d, *J* = 9.0 Hz, 2H), 7.92 (d, *J* = 9.0 Hz, 2H), 7.65-7.63 (m, 5H), 7.41-7.37 (m, 5H), 6.77 (br s, 1H), 4.27 (m, 1H) 4.10-4.07 (m, 1H), 3.81-3.76 (m, 3H), 3.61-3.58 (m, 1H), 3.42 (s, 3H), 1.99-1.94 (m, 1H), 1.81-1.78 (m, 1H), 1.25-1.21 (m,2H), 1.04 (s, 9H)

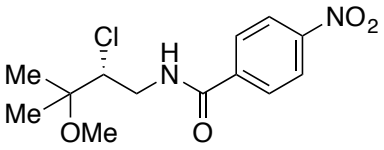
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.37, 149.73, 139.76, 135.54, 133.49, 133.44, 129.77, 128.13, 127.74, 123.90, 79.76, 61.18, 59.98, 58.42, 43.73, 32.90, 26.86, 19.18

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{29}H_{36}ClN_2O_5Si$: 555.2082; Found: 555.2089

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 3% IPA-Hexanes, 0.7 mL/min, 254 nm, RT1 (minor) = 34.3 min, RT2 (major) = 37.0 min.

$[\alpha]_D^{20}$ = +17.0 (c 0.1, $CHCl_3$, *er* = 99.5:0.5)

2k-*OMe*-NO_2**:** (*R*)-*N*-(2-chloro-3-methoxy-3-methylbutyl)-4-nitrobenzamide



R_f : 0.20 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.93 (d, *J* = 9.0 Hz, 2H), 6.93(br s, 1H), 4.23-4.19 (m, 1H) 4.07-4.054 (m, 1H), 3.25-3.48 (m, 1H), 3.56-3.52 (m, 1H), 3.30 (s, 3H), 1.35 (s, 3H), 1.32 (s, 3H)

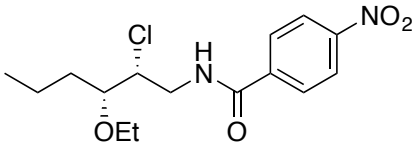
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.32, 149.68, 139.89, 128.10, 123.86, 77.38, 66.77, 49.95, 42.89, 22.97, 21.09

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{13}H_{18}ClN_2O_4$: 301.0955; Found: 301.0959

Resolution of enantiomers: DAICEL Chiralcel® OJ-H column, 5% IPA-Hexanes, 0.7 mL/min, 254 nm, RT1 (minor) = 28.3 min, RT2 (major) = 31.0 min.

$[\alpha]_D^{20}$ = +14.0 (c 0.1, $CHCl_3$, *er* = 99.5:0.5)

s-**2c**-*OEt*-NO_2**:** *N*-((2*R*,3*R*)-2-chloro-3-ethoxyhexyl)-4-nitrobenzamide



R_f : 0.25 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 8.5 Hz, 2H), 7.94 (d, *J* = 8.5 Hz, 2H), 6.92 (br s, 1H), 4.25-4.24 (m, 1H), 4.12-4.07 (m, 1H), 3.64-3.57 (m, 3H), 3.55-3.52 (m, 1H), 1.72-1.66 (m, 1H), 1.61-1.55 (m, 1H), 1.55-1.43 (m, 1H), 1.43-1.35 (m, 1H), 1.20 (t, *J* = 6.5 Hz 3H), 0.95 (t, *J* = 7.5 Hz, 3H)

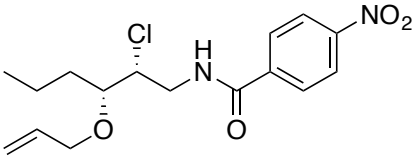
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.35, 149.68, 139.75, 128.15, 123.90, 81.33, 66.15, 60.75, 43.70, 32.30, 19.03, 15.61, 14.05

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{15}H_{22}ClN_2O_4$: 329.1268; Found: 329.1273

Resolution of enantiomers: DAICEL Chiralcel® IA column, 5% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 20.3 min, RT2 (minor) = 22.0 min.

$[\alpha]_D^{20}$ = +21.3 (c 0.7, $CHCl_3$, *er* = 99.5:0.5)

s-**2c**-*OAllyl*-NO_2**:** *N*-((2*R*,3*R*)-3-(allyloxy)-2-chlorohexyl)-4-nitrobenzamide



R_f : 0.40 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.28 (d, *J* = 9.0 Hz, 2H), 7.93 (d, *J* = 8.5 Hz, 2H), 6.87 (br s, 1H), 5.94-5.87 (m, 1H), 5.30 (dd, *J* = 15.0, 1.5 Hz, 1H), 5.21 (dd, *J* = 15.0, 1.5 Hz,

1H), 4.26-4.23 (m, 1H), 4.12-4.06 (m, 3H), 3.64-3.59 (m, 2H), 1.72-1.70 (m, 1H), 1.64-1.57 (m, 1H), 1.54-1.37 (m, 2H), 0.93 (t, *J* = 9 Hz, 3H)

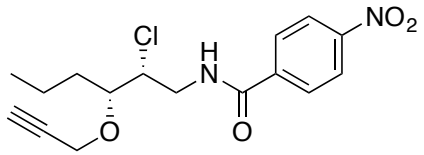
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.36, 149.69, 139.65, 134.22, 128.20, 123.86, 118.10, 80.57, 71.44, 60.62, 43.70, 32.20, 18.97, 14.04

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{16}H_{20}ClN_2O_4$: 339.1112; Found: 339.1107

Resolution of enantiomers: DAICEL Chiralcel® IA column, 7% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (minor) = 16.9 min, RT2 (major) = 17.8 min.

$[\alpha]_D^{20}$ = +13.7 (c 0.5, $CHCl_3$, *er* = 99.5:0.5)

s-**2c**-*OPropargyl*-NO_2**:** *N*-((2*R*,3*R*)-2-chloro-3-(prop-2-yn-1-yloxy)hexyl)-4-nitrobenzamide



R_f : 0.40 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.28 (d, *J* = 9.0 Hz, 2H), 7.93 (d, *J* = 8.5 Hz, 2H), 6.87 (br s, 1H), 4.36-4.33 (dd, *J* = 16.5, 2.5 Hz, 1H), 4.32-4.29 (m,1H), 4.25-4.21 (dd, *J* = 16.5, 2.5 Hz, 1H), 4.10-4.05 (m, 1H), 3.83-3.80 (m, 1H), 3.69-3.64 (m, 1H), 1.72-1.70 (m, 1H), 1.64-1.57 (m, 1H), 1.54-1.37 (m, 2H), 0.96 (t, *J* = 9 Hz, 3H)

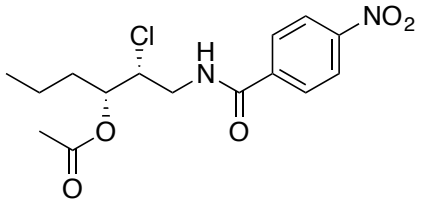
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.49, 149.72, 139.70, 128.21, 123.88, 79.61, 79.02, 75.15, 60.60, 56.67, 43.70, 31.90, 18.72, 14.05

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{16}H_{18}ClN_2O_4$: 337.0955; Found: 337.0951

Resolution of enantiomers: DAICEL Chiralcel® IA column, 10% IPA-Hexanes, 1.0 mL/min, 265 nm, RT1 (minor) = 18.8 min, RT2 (major) = 20.3 min.

$[\alpha]_D^{20}$ = +14.0 (c 0.1, $CHCl_3$, *er* = 98:2)

s-**2c**-*OAc*-NO_2**:** (2*R*, 3R)-2-chloro-1-(4-nitrobenzamido)hexan-3-yl acetate



R_f : 0.30 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.30 (d, *J* = 8.5 Hz, 2H), 7.97 (d, *J* = 8.5 Hz, 2H), 7.10 (br s, 1H), 5.17-5.14 (m, 1H), 4.16-4.13 (m, 1H), 4.00-3.95 (m, 1H), 3.36-3.24 (m, 1H), 2.17 (s, 3H), 1.84-1.81 (m, 1H), 1.63-1.61 (m, 1H), 1.35-1.31 (m, 2H), 0.91 (t, *J* = 7.5, 3H)

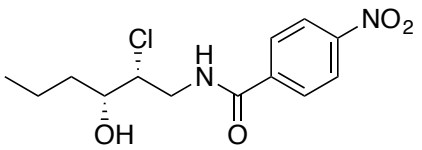
^{13}C NMR (125 MHz, $CDCl_3$) δ 172.10, 165.13, 149.83, 139.21, 128.20, 123.92, 72.11, 60.32, 42.70, 33.68, 20.92, 18.65, 13.64

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{15}H_{20}ClN_2O_5$: 343.1061; Found: 343.1062

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 7% IPA-Hexanes, 01.0 mL/min, 254 nm, RT1 (major) = 17.6 min, RT2 (minor) = 18.9 min.

$[\alpha]_D^{20}$ = -8.0 (c 0.1, $CHCl_3$, *er* = 98:2)

s-**2c**-*OH*-NO_2**:** *N*-((2*R*,3*R*)-2-chloro-3-hydroxyhexyl)-4-nitrobenzamide



R_f : 0.12 (30% EtOAc in hexanes, UV)

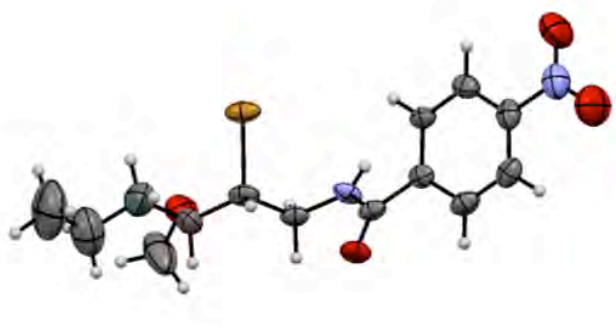
^{1}H NMR (500 MHz, CD_3CN) δ 8.28 (d, *J* = 9.0 Hz, 2H), 7.98 (d, *J* = 8.5 Hz, 2H), 6.93 (br s, 1H), 4.14-4.11 (dt, *J* = 7.0, 2.0 Hz, 2H), 3.90-3.84 (m, 1H), 3.79-3.76 (m, 1H), 3.60-3.55 (m,1H) 3.41 (d, *J* = 6.5 Hz, 1H), 1.60-1.56 (m, 1H), 1.53-1.42 (m, 2H), 1.36-1.31 (m, 1H), 0.91 (t, *J* = 7.5 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 166.39, 150.08, 140.11, 128.83, 124.02, 70.37, 65.07, 43.79, 36.47, 19.04, 13.61

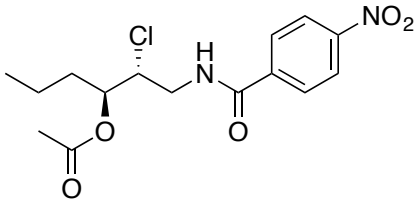
HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{13}H_{16}ClN_2O_4$: 299.0799; Found: 299.0796

Resolution of enantiomers: DAICEL Chiralcel® IA column, 15% IPA-Hexanes, 1.0 mL/min, 265 nm, RT1 (major) = 12.3 min, RT2 (minor) = 13.8 min.

$[\alpha]_D^{20}$ = +14.6 (c 0.9, $CHCl_3$, *er* = 99:1)



a-**2c**-*OAc*-NO_2**:** (2*R*,3*S*)-2-chloro-1-(4-nitrobenzamido)hexan-3-yl acetate



R_f : 0.28 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.30 (d, *J* = 9.0 Hz, 2H), 7.94 (d, *J* = 9.0 Hz, 2H), 6.65 (br s, 1H), 5.13 (m, 1H), 4.19 (m, 2H), 3.49 (m, 1H), 2.19 (s, 3H), 1.79-1.70 (m, 2H), 1.42-1-33 (m, 2H), 0.95 (t, *J* = 7.5 Hz, 3H)

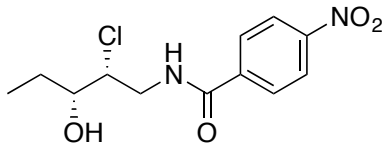
^{13}C NMR (125 MHz, $CDCl_3$) δ 170.81, 165.26, 149.73, 139.60, 128.20, 123.93, 73.53, 61.47, 42.00, 33.34, 20.95, 18.34, 13.77

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{15}H_{18}ClN_2O_5$: 341.0904; Found: 341.0903

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 12.95 min, RT2 (minor) = 13.9 min.

$[\alpha]_D^{20}$ = +14.0 (c 0.15, $CHCl_3$, *er* = 93:7)

s-**2h**-*OH*-NO_2**:** *N*-((2*R*,3*R*)-2-chloro-3-hydroxypentyl)-4-nitrobenzamide



R_f : 0.20 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, CD_3CN) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.99 (d, *J* = 9.0 Hz, 2H), 7.60 (br s, 1H), 4.17-4.14 (dt, *J* = 6.5, 1.5 Hz, 1H), 3.90-3.85 (m, 1H), 3.70-3.65 (m, 1H), 3.61-3.55 (m, 1H), 3.42 (d, *J* = 6.5 Hz, 1H), 1.66-1.54 (m, 2H), 0.93 (t, *J* = 8.0 Hz, 3H)

^{13}C NMR (125 MHz, CD_3CN) δ 166.38, 150.10, 140.12, 128.84, 124.03, 72.10, 64.63, 43.77, 27.37, 9.87

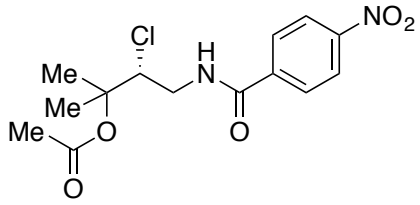
HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{12}H_{14}ClN_2O_4$: 285.0642; Found: 285.0645

Resolution of enantiomers: DAICEL Chiralcel® IA column, 15% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (minor) = 13.7 min, RT2 (major) = 15.2 min.

$[\alpha]_D^{20}$ = +6.0 (c 0.45, $CHCl_3$, *er* = 99:1)

Absolute stereochemistry was determined by single crystal X-ray diffraction (XRD). Crystals for XRD were obtained by crystallization from CH_2Cl_2 layered with hexanes in a silicone-coated vial.

2k-*OAc*-NO_2**:** ((*R*)-3-chloro-2-methyl-4-(4-nitrobenzamido)butan-2-yl acetate



R_f : 0.20 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.30 (d, *J* = 9.0 Hz, 2H), 7.93 (d, *J* = 8.5 Hz, 2H), 6.54 (br s, 1H), 4.60-4.58 (dd, *J* =10.0, 2.5 Hz, 1H) 4.31-4.26 (m, 1H), 3.39-3.33 (m, 1H), 2.03 (s, 3H), 1.62 (s, 3H),1.60 (s, 3H)

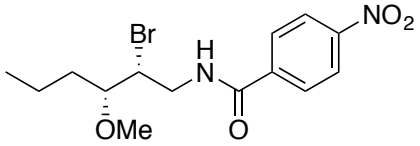
^{13}C NMR (125 MHz, $CDCl_3$) δ 170.04, 165.45, 149.80, 139.57, 128.19, 123.93, 82.13, 66.63, 42.44, 23.62, 22.78, 22.17

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{14}H_{17}ClN_2O_5$: 329.0904; Found: 304.0906

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 22.1 min, RT2 (minor) = 24.4 min.

$[\alpha]_D^{20}$ = +39.2 (c 0.7, $CHCl_3$, *er* = 98:2)

***s*-2c'-*OMe*-NO_2:** *N*-((2*R*,3*R*)-2-bromo-3-methoxyhexyl)-4-nitrobenzamide



R_f : 0.20 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.30 (d, *J* = 9.0 Hz, 2H), 7.94 (d, *J* = 8.5 Hz, 2H), 6.84 (br s, 1H), 4.38-4.35 (m, 1H), 4.19-4.12 (m, 1H), 3.73-3.68 (m, 1H), 3.39-3.36 (m, 1H), 1.79-1.73 (m, 2H), 1.45-1.39 (m, 2H), 0.98 (t, *J* = 8.0 Hz, 3H)

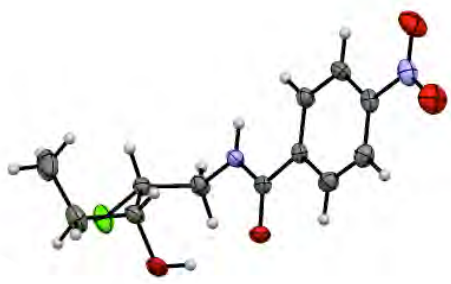
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.33, 149.70, 139.70, 128.14, 123.92, 82.75, 58.12, 54.75, 44.23, 32.99,18.90,14.02

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{14}H_{29}BrN_2O_4$: 359.0606; Found: 359.0604

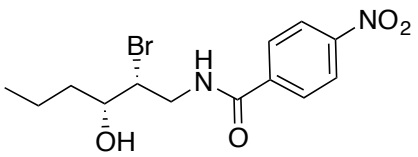
Resolution of enantiomers: DAICEL Chiralcel® IA column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 11.9 min, RT2 (minor) = 12.6 min.

$[\alpha]_D^{20}$ = +24.4 (c 0.9, $CHCl_3$, *er* = 99:1)

Absolute stereochemistry was determined by single crystal X-ray diffraction (XRD). Crystals for XRD were obtained by crystallization from CH_2Cl_2 layered with hexanes in a silicone-coated vial.



s-**2c'**-*OH*-NO_2**:** *N*-((2*R*,3*R*)-2-bromo-3-hydroxyhexyl)-4-nitrobenzamide



R_f : 0.15 (30% EtOAc in hexanes, UV) 62 % yield

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.94 (d, *J* = 9.0 Hz, 2H), 6.89 (br s, 1H), 4.30-4.27 (m, 1H), 4.22-4.16 (m, 1H), 3.75-3.70 (m, 1H), 3.65 -3.62 (m, 4H), 2.17 (d, *J* = 8 Hz), 1.70-1.63 (m, 1H), 1.58-1.35 (m, 3H), 0.95 (t, *J* = 7.0 Hz, 3H)

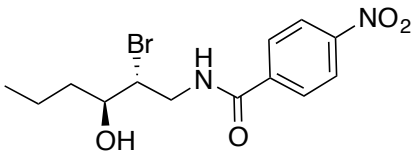
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.82, 149.78, 139.39, 128.21, 123.94, 71.79, 60.17, 45.04, 38.31, 18.73, 13.88

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{13}H_{18}BrN_2O_4$: 345.0450; Found: 345.0434

Resolution of enantiomers: DAICEL Chiralcel® Ia column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 22.9 min, RT2 (minor) = 24.7 min.

$[\alpha]_D^{20}$ = +11.6 (c = 0.5, $CHCl_3$, *er* = 99.5:0.5)

a-**2c'**-*OH*-NO_2: *N*-((2*R*,3*S*)-2-bromo-3-hydroxyhexyl)-4-nitrobenzamide



R_f : 0.20 (30% EtOAc in hexanes, UV) 51% yield

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.32 (d, *J* = 9.0 Hz, 2H), 7.97 (d, *J* = 9.0 Hz, 2H), 6.89 (br s, 1H), 4.39-4.32 (ddd, *J* = 15.5, 7.5, 4.0 Hz, 1H), 4.14 (d, *J* = 4.0 Hz 1H), 407-4.04 (m, 1H), 3.73 -3.68 (ddd, J = 15.0, 5.5, 3.5 Hz, 1H), 3.66-3.63 (m, 1H), 1.82-1.77 (m, 1H), 1.61-1.49 (m, 2H), 1.41-1.35 (m, 1H), 0.93 (t, *J* = 7.0 Hz, 3H)

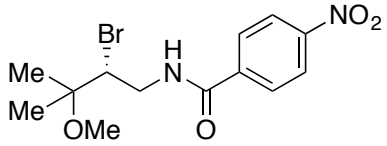
^{13}C NMR (125 MHz, $CDCl_3$) δ 166.88, 149.94, 138.89, 128.34, 124.01, 72.00, 58.49, 42.87, 35.90, 18.94, 13.94

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{13}H_{18}BrN_2O_4$: 345.0450; Found: 345.0439

Resolution of enantiomers: DAICEL Chiralcel® OD-H column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (minor) = 24.5 min, RT2 (major) = 29.7 min.

$[\alpha]_D^{20}$ = -15.6 (c = 0.6, $CHCl_3$, *er* = 85.0:15.0)

2k'-*OMe*-NO_2**:** (*S*)-*N*-(2-bromo-3-methoxy-3-methylbutyl)-4-nitrobenzamide



R_f : 0.25 (30% EtOAc in hexanes, UV) 62% yield

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.33 (d, *J* = 9.0 Hz, 2H), 7.97 (d, *J* = 9.0 Hz, 2H), 6.99 (br s, 1H), 4.31-4.23 (m, 2H), 3.65-3.60 (m, 1H), 3.33 (s, 3H), 1.42 (d, *J* = 8.5 Hz, 6H)

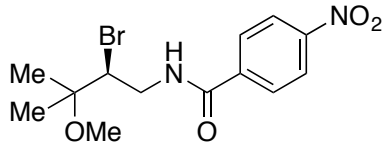
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.22, 149.66, 139.86, 128.12, 123.91, 77.06, 61.19, 50.05, 43.45, 23.41,22.42

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{13}H_{18}ClN_2O_4$: 345.0450; Found: 345.0441

Resolution of enantiomers: DAICEL Chiralcel® OJ-H column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (minor) = 28.8 min, RT2 (major) = 33.9 min.

$[\alpha]_D^{20}$ = +23.8 (c = 0.7, $CHCl_3$, *er* = 99.5:0.5)

epi-**2k'**-*OMe*-NO_2**:** (*S*)-*N*-(2-bromo-3-methoxy-3-methylbutyl)-4-nitrobenzamide



R_f : 0.25 (30% EtOAc in hexanes, UV) 59% yield with $(DHQ)_2PHAll$

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.33 (d, *J* = 9.0 Hz, 2H), 7.97 (d, *J* = 9.0 Hz, 2H), 6.99 (br s, 1H), 4.31-4.23 (m, 2H), 3.65-3.60 (m, 1H), 3.33 (s, 3H), 1.42 (d, *J* = 8.5 Hz, 6H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.22, 149.66, 139.86, 128.12, 123.91, 77.06, 61.19, 50.05, 43.45, 23.41,22.42

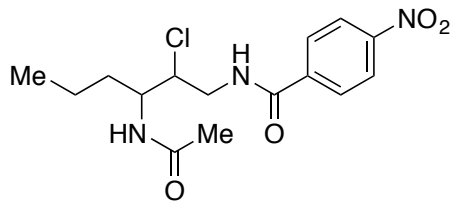
HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{13}H_{18}ClN_2O_4$: 345.0450; Found: 345.0439

Resolution of enantiomers: DAICEL Chiralcel® OJ-H column, 10% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 27.8 min, RT2 (minor) = 32.4 min.

$[\alpha]_D^{20}$ = -33.8 (c = 1.0, $CHCl_3$, *er* = 99.5:0.5)

V.A. Analytical data for byproduct

2c-*NHAc*-NO_2: *N*-(3-acetamido-2-chlorohexyl)-4-nitrobenzamide



Note: Relative and absolute stereochemistry was not established.

R_f : 0.10 (20% EtOAc in hexanes, UV)

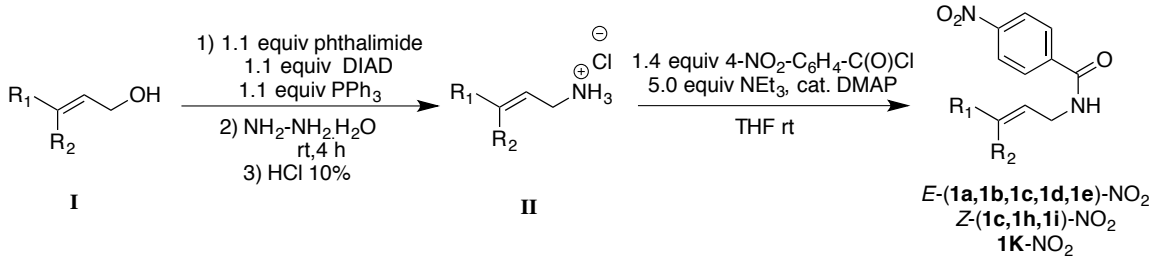
^{1}H NMR (500 MHz, $CDCl_3$) δ 8.30 (d, *J* = 9.0 Hz, 2H), 8.25 (br s, 1H), 8.07 (d, *J* = 9.0 Hz, 2H), 5.58 (d, *J* = 9.5 Hz, 1H), 4.34-4.26 (m, 2H), 4.13-4.09 (m, 1H), 2.93-2.87 (m, 1H), 2.85 (s, 3H), 1.67-1.53 (m, 2H), 1.37-1.32 (m, 2H), 0.88 (t, *J* = 7.5 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 172.09, 164.76, 149.71, 139.19, 128.35, 123.85, 61.12, 49.31, 42.35, 34.75, 23.29, 19.24, 13.65

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{15}H_{21}ClN_3O_4$: 342.1221; Found: 342.1229

VI. Synthesis of unsaturated amide substrates for chlorofunctionalization[2-3]

General procedure for synthesis of substrates



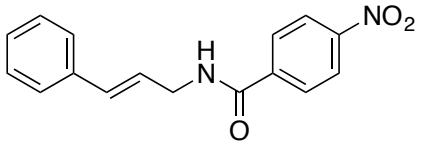
Allyl alcohols **I** were synthesized from the corresponding aldehydes or ketone by a Horner-Wadsworth-Emmons (HWE) olefination reaction follow by DIBAL reduction of resulting ester.

Allyl alcohols **I** (1.0 equiv), phthalimide (1.1 equiv) and PPh_3 (1.1 equiv) was added to the reaction vessel and dissolved in THF (5 mL/mmol). The flask was immersed in an ice bath and DIAD (1.1 equiv) was added drop wise. After TLC analysis revealed the complete consumption of starting material (~ 30 min), 3 equivalents of hydrazine hydrate was added to the reaction vessel and the resulting suspension was stirred overnight at room temprature. The reaction was diluted with water, concentrated HCl (3 mL) was added, and the resulting suspension was stirred for further 30 min at ambient temperature. The precipitated solids were filtered and the filter cake was washed with 10% aq. HCl (2 × 2 mL). The combined filtrates were washed with ether (3 × 5 mL) and the aqueous phase was concentrated under reduced pressure giving the amine salts **II**, which were used in the next reaction without any purification.

A solution of crude ammonium chloride salt **II** from the previous step (1 equiv), triethyl amine (5 equiv) and catalytic amount of DMAP in THF (20 mL) were cooled in an ice bath. To this suspension was added *p*-nitro benzoyl chloride (1.5 equiv). After the addition was completed, the reaction was warmed to room temperature. After 3 h, the reaction was quenched with methanol (1.0 mL) and then diluted with an equal amount of water, concentrated under reduced pressure, and extracted with DCM (3 × 25 mL). The combined organic layer was washed with brine (1 × 20 mL), dried over anhyd. Na_2SO_4 and concentrated under reduced pressure in the presence of silica gel. Column

chromatography (EtOAC-Hexanes gradient elution) gave the desired products (*E*-(**1a,1b,1c,1d,1e**)-NO_2, *Z*-(**1c.1h,1i**)-NO_2, **1k**-NO_2).

E-**1b**-NO_2**:** *N*-cinnamyl-4-nitrobenzamide



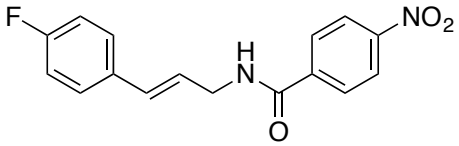
R_f : 0.31 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.28 (d, *J* = 8.5 Hz, 2H), 7.95 (d, *J* = 8.5 Hz, 2H), 7.34-7.25 (m, 5H), 7.23(d, *J* =16.0 Hz, 1H), 6.62 (br s, 1H), 6.59-6.23 (m, 1H), 4.25 (t, *J* = 6.5 Hz, 2H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.25, 149.57, 139.90, 136.11, 133.26, 128.65, 128.14, 128.02, 126.39, 124.42, 123.83, 42.44

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{16}H_{15}N_2O_3$: 283.1083; Found: 283.1085

E-**1d**-NO_2: (*E*)-*N*-(3-(4-fluorophenyl)allyl)-4-nitrobenzamide



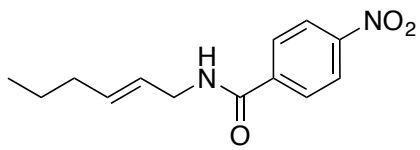
R_f : 0.30 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.32 (d, *J* = 8.5 Hz, 2H), 7.98 (d, *J* = 8.5 Hz, 2H), 7.34-7.31 (m, 2H), 7.01-6.97 (m, 1H), 7.58 (d, *J* =15.5 Hz, 1H), 6.28 (br s, 1H), 6.21-6.15 (m, 1H), 4.25 (t, *J* = 6.0 Hz, 2H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.23, 149.69, 139.91, 132.18, 128.14, 128.02 (d, J_{CF} = 30 Hz) , 124.26 (d, J_{CF} = 7.5 Hz) 123.89, 115.70, 115.53, 42.39

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{16}H_{14}FN_2O_3$: 301.0988; Found: 301.0991

E-**1c**-NO_2: (*E*)-*N*-(hex-2-en-1-yl)-4-nitrobenzamide



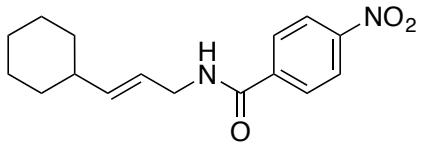
R_f : 0.30 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.27 (d, *J* = 9.0 Hz, 2H), 7.92 (d, *J* = 9.0 Hz, 2H), 6.14 (br s, 1H), 5.72-5.68 (m, 1H) 5.55-5.51 (m, 1H), 4.02 (t, *J* = 6.0 Hz, 2H), 2.03-1.995 (m, 2H), 1.41-1.37 (m, 2H), 0.89 (t, *J* = 7.0 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.09, 149.58, 140.21, 134.96, 128.08, 124.90, 123.81, 42.35, 34.30, 22.19, 13.65

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{13}H_{17}N_2O_3$: 249.1239; Found: 249.1243

E-**1a-**NO_2: (*E*)-*N*-(3-cyclohexylallyl)-4-nitrobenzamide



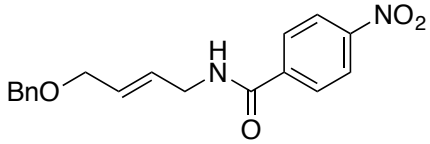
R_f : 0.44 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.27 (d, *J* = 9.0 Hz, 2H), 7.92 (d, *J* = 9.0 Hz, 2H), 6.12 (br s, 1H), 5.67-5.50 (m, 1H), 5.48-5.44 (m, 1H), 4.02 (t, *J* = 6.0 Hz, 2H), 1.94 (m, 1H), 1.71-1.54 (m, 5H), 1.28-1.041 (m, 5H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.07, 140.86, 140.22, 128.09, 123.80, 122.26, 116.59, 42.47, 40.36, 32.71, 26.06, 25.93

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{16}H_{21}N_2O_3$: 289.1552; Found: 289.1541

E-**1e-**NO_2: (*E*)-*N*-(4-(benzyloxy)but-2-en-1-yl)-4-nitrobenzamide



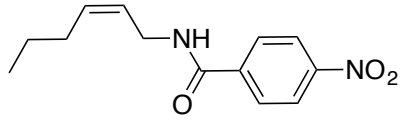
R_f : 0.20 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.26 (d, *J* = 8.0 Hz, 2H), 7.91 (d, *J* = 8.0 Hz, 2H), 7.32-7.26 (m, 4H), 6.27 (br s, 1H), 5.83 (m, 2H), 4.51 (s, 2H), 4.10-4.01(m, 4H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.18, 149.62, 139.91, 137.96, 129.87, 128.42, 128.11, 127.99, 127.76, 127.75, 123.82, 72.66, 69.91, 41.67

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{18}H_{19}N_2O_4$: 327.1345; Found: 327.1336

Z-**1c-**NO_2: (*Z*)-*N*-(hex-2-en-1-yl)-4-nitrobenzamide



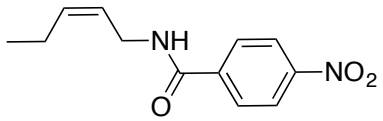
R_f : 0.33 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.25 (d, *J* = 9.0 Hz, 2H), 7.92 (d, *J* = 9.0 Hz, 2H), 6.17 (br s, 1H), 5.63-5.60 (m, 1H), 5.51-5.46 (m, 1H), 4.01 (t, *J* = 6.0 Hz, 2H), 2.12-2.077 (m, 2H), 1.42-1.39 (m, 2H), 0.90 (t, *J* = 7.0 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 158.14, 142.24, 133.03, 127.60, 120.97, 117.17, 116.67, 30.34, 22.31, 15.46, 6.57

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{13}H_{17}N_2O_3$: 249.1239; Found: 249.1244

Z-**1h-**NO_2: (*Z*)-4-nitro-*N*-(pent-2-en-1-yl)benzamide



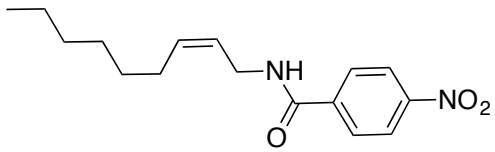
R_f : 0.35 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.28 (d, *J* = 9.0 Hz, 2H), 7.92 (d, *J* = 9.0 Hz, 2H), 6.08 (br s, 1H), 5.66-5.62 (m, 1H), 5.47-5.43 (m, 1H), 4.12 (t, 6.0 Hz, 2H), 2.17-2-19 (m, 2H), 1.02 (t, *J* = 8.0 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.27, 149.50, 140.10, 136.47, 128.09, 123.79, 123.49, 37.35, 20.76, 14.13

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{12}H_{25}N_2O_3$: 235.1083; Found: 235.1079

Z-**1i-**NO_2: (*Z*)-4-nitro-*N*-(non-2-en-1-yl)benzamide



R_f : 0.27 (30% EtOAc in hexanes, UV)

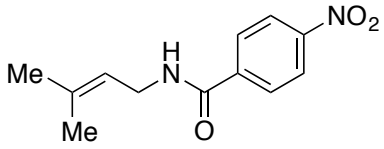
^{1}H NMR (500 MHz, $CDCl_3$) δ 8.27 (d, *J* = 9.0 Hz, 2H), 7,92 (d, *J* = 9.0 Hz, 2H), 6.08 (br s, 1H), 5.65-6.61 (m, 1H), 5.50-5.47 (m, 1H), 4.11 (t, *J* =5.5 Hz, 2H), 2.14 (dd, *J* = 14.0,

7.0 Hz, 2H), 3.46-3.43 (m, 1H), 1.72-1.68 (m, 2H), 1.39-1.25 (m, 8H,) 0.90 (t, *J* = 7.0 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.25, 149.54, 140.11, 135.13, 128.07, 123.99, 123.88, 73.45, 31.67, 29.41, 28.92, 27.46, 22.60, 14.07

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{16}H_{23}N_2O_3$: 291.1709; Found: 291.1708

1k-NO_2: *N*-(3-methylbut-2-en-1-yl)-4-nitrobenzamide



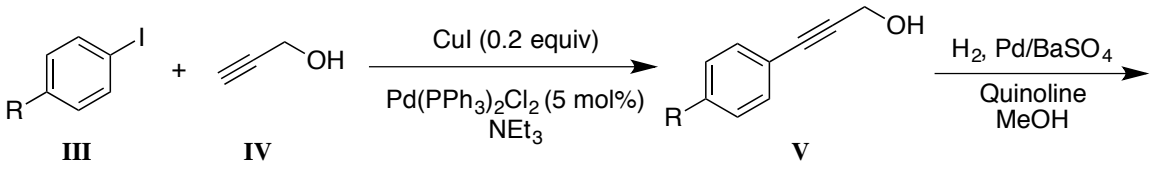
R_f : 0.30 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.26 (d, *J* = 7.5 Hz, 2H), 7.91 (d, *J* = 7.5 Hz, 2H), 6.08 (br s, 1H), 5.28 (t, *J* = 5.5 Hz, 1H), 4.03 (t, *J* = 5.5 Hz, 2H), 1.74 (s, 3H), 1.71 (s, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.95, 149.53, 140.24, 137.71, 128.73, 123.33, 119.29, 38.38, 25.67, 17.96

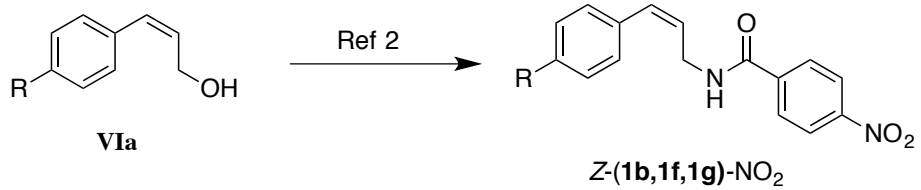
HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{12}H_{15}ClN_2O_3$: 235.1083; Found: 235.1085

General procedure for synthesis of aromatic *Z*-allyl amides



III **IV** **V**

R = H, Me, OCH_3



VIa *Z*-(**1b,1f,1g**)-NO_2

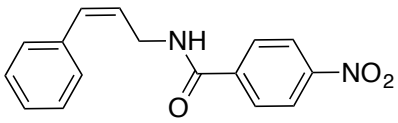
Iodo benzene **III (**1.0 equiv) and propargyl alcohol was dissolved in triethylamine (10 mL/mmol) at room temperature after which CuI (0.2 equiv) and $Pd(PPh_3)Cl_2$ (5 mol%) were added to reaction vessel. After TLC analysis revealed consumption of starting

material, the reaction was diluted with water, concentrated under reduced pressure, and extracted with DCM (3 × 25 mL). The combined organic layer was washed with brine (1 × 20 mL), dried over anhyd. Na_2SO_4 and concentrated under reduced pressure in the presence of silica gel. Column chromatography (20% EtOAC-Hexanes gradient elution) gave the desired products **V**. (70-85 % yield for different substrates)

3-Phenylprop-2-yn-1-ol **V** (1.0 equiv), palladium on barium sulfate (10 wt%) and quinoline were dissolved in methanol (10 mL/mmol). The reaction vessel was purged with hydrogen gas and then stirred under balloon pressure of H_2. When GC analysis revealed complete consumption of starting material, the catalyst was filtered and the filtrate was concentrated. Column chromatography (EtOAC-Hexanes gradient elution) gave the desired products (**VIa**).

Allyl amides *Z*-(**1b,1f,1g**)-NO_2 were synthesized as reported previously.[1]

Z-**1b-**NO_2: (*Z*)-4-nitro-*N*-(3-phenylallyl)benzamide



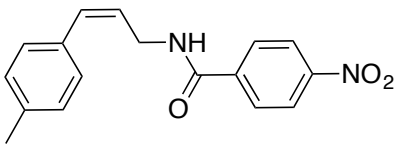
R_f : 0.31 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.25 (d, *J* = 9.0 Hz, 2H), 7.86 (d, *J* = 9.0 Hz, 2H), 7.37-7.26 (m, 5H), 6.41 (d, *J* = 11.5 Hz, 1H), 6.22 (br s, 1H), 5.78-5.73 (m, 1H) 4.39-4.36 (m, 2H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.25, 149.62, 139.94, 136.09, 123.62, 128.71, 128.47, 128.08, 127.55, 126.85, 123.81, 38.60

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{16}H_{15}N_2O_3$: 283.1083; Found: 283.1091

Z-**1f-**NO_2: (*Z*)-4-nitro-*N*-(3-(*p*-tolyl)allyl)benzamide



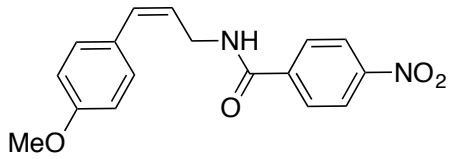
R_f : 0.32 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.26 (d, *J* = 9 Hz, 2H), 7.87 (d, *J* = 9 Hz, 2H), 7.17-7.13 (m, 4H), 6.64 (d, *J* = 12.0 Hz, 1H), 6.17 (br s, 1H), 5.73-5.68 (m, 1H) 4.39-4.36 (m, 1H), 2.34 (s, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.29, 149.47, 139.89, 137.39, 133.13, 132.31, 129.10, 128.62, 128.09, 126.12, 123.17, 38.66, 21.15

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{117}H_{17}N_2O_3$: 297.1239; Found: 297.1234

Z-**1g-**NO_2: (*Z*)-*N*-(3-(4-methoxyphenyl)allyl)-4-nitrobenzamide



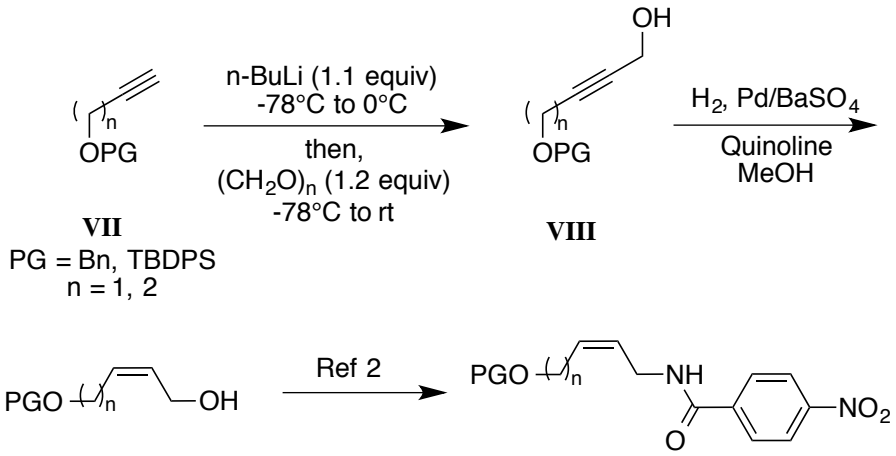
R_f : 0.25 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.27 (d, *J* = 9.0 Hz, 2H), 7.89 (d, *J* = 9.0 Hz, 2H), 7.20 (d, *J* = 8.0 Hz, 2H), 6.90 (d, *J* = 8.0 Hz, 2H), 6.61 (d, *J* = 11.5 Hz), 6.17 (br s, 1H), 5.68-5.63 (m, 1H), 4.39-4.36 (m, 2H), 3.80 (s, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.29, 158.96, 149.54, 139.94, 132.08, 130.04, 128.59, 128.13, 125.10, 123.80, 113.85, 55.28, 38.68

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{17}H_{15}N_2O_4$: 311.1032; Found: 311.1027

General procedure Synthesis of substrates *Z*-1e-NO_2 – *Z*-1j-NO_2



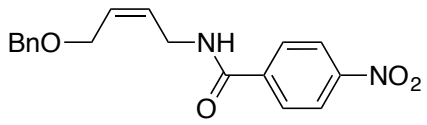
Z-**1e**-NO_2, *Z*-**1j**-NO_2

Alkyne **VII** (1.0 equiv) was dissolved in THF in a flamed dried round bottom flask. *n*-BuLi (1.1 equiv) was added to cooled solution at -78 °C. The reaction was then warmed to 0 °C. After 30 min paraformaldehyde (1.2 equiv) was added in a single portion at -78 °C and the reaction was warmed to room temperature. After 2 h, reaction was quenched with sat. aq. NH_4Cl solution (15.0 mL). The mixture was diluted with water and concentrated under reduced pressure and then extracted with DCM (3 × 10 mL). The combined organic layer was washed with brine (1 × 10 mL), dried over anhyd. Na_2SO_4, and concentrated under reduced pressure in the presence of silica gel. Column chromatography (EtOAC-Hexanes gradient elution) gave the desired products **VIII**.

The *Z* allylic alcohol was synthesized from alkynol **VIII** by a Lindlar reduction that was reported in page **S23**.

Allyl amides *Z*-**1e**-NO_2, *Z*-**1j**-NO_2 were synthesized as reported previously.[1]

Z-**1e**-NO_2: (*Z*)-*N*-(4-(benzyloxy)but-2-en-1-yl)-4-nitrobenzamide



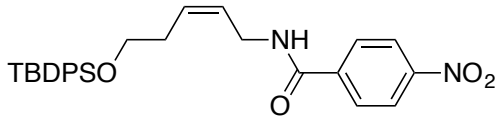
R_f : 0.27 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.15 (d, *J* = 9.0 Hz, 2H), 7.73 (d, *J* = 9.0 Hz, 2H), 7.33-7.28 (m, 5H), 6.47 (br s, 1H), 5.92-5-80 (m, 2H), 4.53 (s, 2H), 4.17 (d, *J* = 16.0 Hz, 2H), 4.11 (t, 2H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 164.96, 149.43, 139.82, 137.63, 130.36, 129.22, 128.60, 128.06, 128.04, 128.00, 123.71, 73.00, 65.85, 37.22

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{18}H_{19}N_2O_4$: 327.1345; Found: 327.1350

Z-**1j-**NO_2: (*Z*)-*N*-(5-((*tert*-butyldiphenylsilyl)oxy)pent-2-en-1-yl)-4-nitrobenzamide



R_f : 0.35 (30% EtOAc in hexanes, UV)

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.18 (d, *J* = 8.0 Hz, 2H), 7.76 (d, *J* = 8.0 Hz, 2H), 7.66-7.63 (m, 5H), 7.37-7.24 (m, 5H), 6.02 (br s, 1H), 5.70-5.67 (m, 1H) 5.62-5.60 (m, 1H) 4.06 (t, *J* = 6.5 Hz, 2H), 3.74 (t, *J* =6.5 Hz, 2H), 2.40 (dt, *J* = 6.5 Hz, 2H), 1.03 (s, 9H)

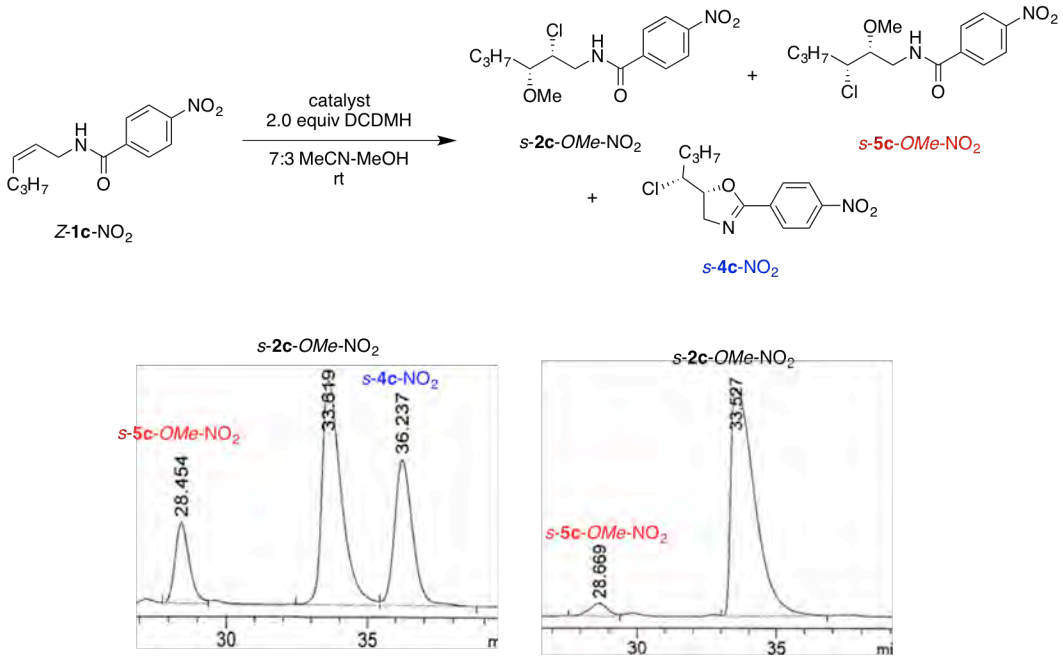
^{13}C NMR (125 MHz, $CDCl_3$) δ 165.22, 149.47, 140.02, 135.53, 135.48, 133.75, 131.24, 129.72, 128.02, 127.70, 126.16, 123.80, 123.72, 63.21, 37.41, 30.85, 26.87, 26.77, 19.28

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{28}H_{33}N_2O_4Si$: 489.2210; Found: 489.2214

VII. Product distribution arising due to substrate-control and catalyst-control for the intermolecular chloroetherification reaction.

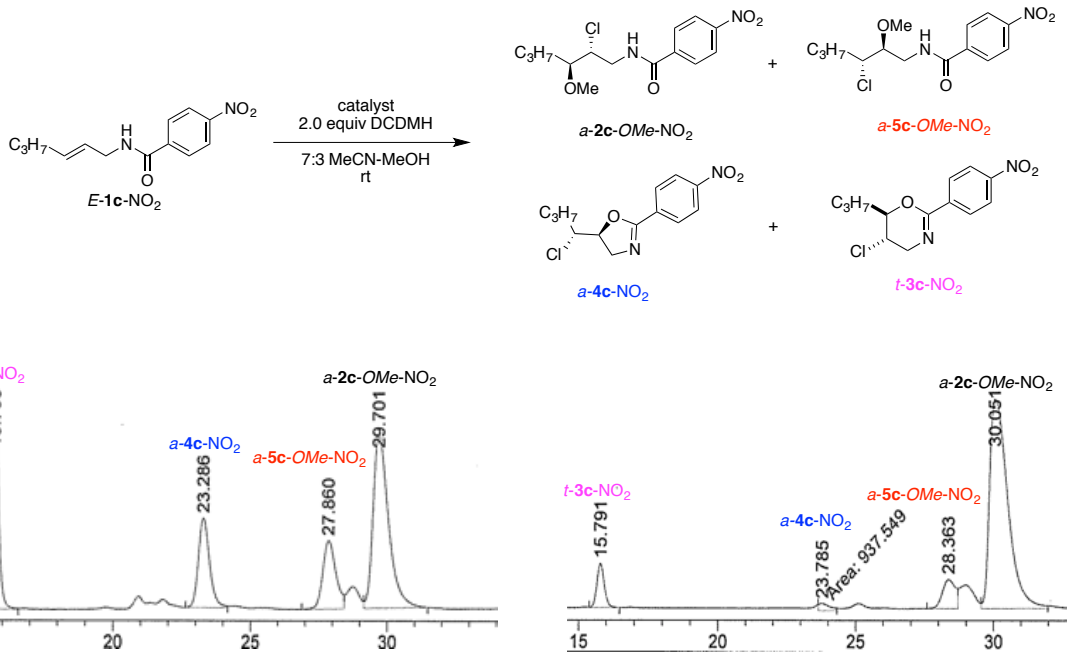
Reactions run in the absence of any catalyst gave a mixture of numerous products in the attempted intermolecular chloroetherification reaction of both *E*- and *Z*- allyl amides. In contrast, reactions run in the presence of $(DHQD)_2PHAL$ gave predominantly, the desired chloroether product. The numerous products seen in these reactions were meticulously isolated and characterized. The *Z*-**1c**-NO_2 gave 3 major products. As seen from the HPLC trace of the crude reaction mixture, along with the desired product s-**2c**-

Figure S1: Products distribution For *Z*-allyl amides



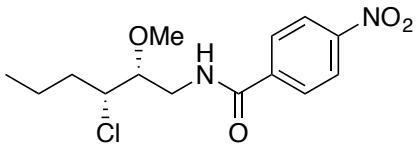
OMe-NO_2, the constitutional isomer *s*-**5c**-*OMe*-NO_2 as well as the cyclized oxazoline product *s*-**4c**-NO_2 were seen. Under optimized reaction conditions that employed $(DHQD)_2PHAL$, the major product was the chloroether s-**2c**-*OMe*-NO_2. Small amount of the constitutional isomer *s*-**5c**-*OMe*-NO_2 was seen; no cyclized products were observed. A similar analysis was also performed with the *E*-**1c**-NO_2. As seen from the scheme below, the non-catalyzed reaction gave 2 constitutional isomers for both the chloroether product as well as the cyclized product. Although all these compounds were seen in the $(DHQD)_2PHAL$ catalyzed reaction as well, the selectivity for the desired chloroether product was significantly higher.

Figure S2: Products distribution For *E*-allyl amides



VIIa. Analytical data for different products of chloroetherification reaction without catalyst

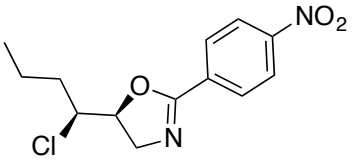
s-**5c**-*OMe*-NO_2: 3-chloro-2-methoxyhexyl)-4-nitrobenzamide



^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.93 (d, *J* = 9.0 Hz, 2H), 6.52 (br s, 1H), 4.05-4.02 (m, 1H), 3.92-3.86 (m, 1H), 3.63-3.54 (m, 2H), 3.51 (s, 3H), 1.87-1.72 (m, 2H), 1.66-1.59 (m, 1H), 1.47-1.38 (m, 1H), 0.95 (t, *J* = 7.5 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.49, 149.73, 139.79, 128.11, 123.92, 81,53, 62.18, 59.22, 40.56, 35.49, 19.93, 13.45

s-**4c**-NO_2: 1-chlorobutyl-2-(4-nitrophenyl)-4,5-dihydrooxazole

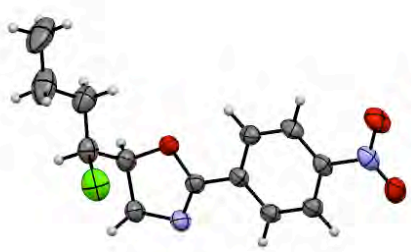


^{1}H NMR (500 MHz, $CDCl_3$) δ 8.27 (d, *J* = 8.5 Hz, 2H), 8.12 (d, *J* = 8.5 Hz, 2H), 4.93-4.89 (m, 1H), 4.22 (dd, *J* = 15.0, 10.0 Hz, 1H), 4.17 (dd, *J* = 15.0, 10.0 Hz, 1H), 3.99-3.97 (m, 1H), 1.85-1.71 (m, 2H), 1.69-1.63 (m, 1H), 1.51-1.45 (m, 1H), 0.97 (t, *J* =7.5 Hz, 3H)

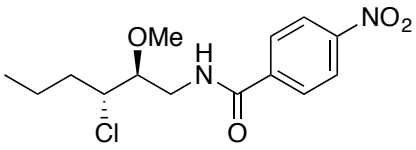
^{13}C NMR (125 MHz, $CDCl_3$) δ 162.22, 149.57, 132.98, 129.27, 123,59, 81.69, 62.92, 57.85, 35.51, 19.66, 13.45

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{13}H_{16}N_2O_3Cl$: 283.0849; Found: 283.0861

Relative stereochemistry was determined by single crystal X-ray diffraction (XRD). Crystals for XRD were obtained by crystallization from CH_2Cl_2 layered with hexanes in a silicone-coated vial.



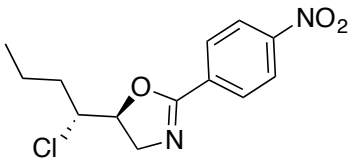
a-**5c**-*OMe*-NO_2: 3-chloro-2-methoxyhexyl)-4-nitrobenzamide



^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.93 (d, *J* = 9.0 Hz, 2H), 6.55 (br s, 1H), 4.11-4.07 (m, 1H), 3.99-3.95 (m, 1H), 3.56-3.51 (m, 1H), 3.50-3.47 (m, 4H), 1.84 -1.79 (m, 1H), 1.69-1.63 (m, 1H), 1.48-1.41 (m, 2H), 0.97 (t, *J* = 7.5 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 165.46, 149.63, 139.86, 128.12, 123.89, 81.70, 61.21, 57.93, 39.79, 36.26, 19.96, 13.53

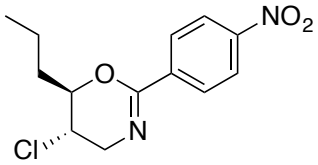
a-**4c**-NO_2: chlorobutyl-2-(4-nitrophenyl)-4,5-dihydrooxazole



^{1}H NMR (500 MHz, $CDCl_3$) δ 8.26 (d, *J* = 8.5 Hz, 2H), 8.10 (d, *J* = 8.5 Hz, 2H), 4.82-4.77 (m, 1H), 4.21 (dd, *J* = 16.0, 10.0 Hz, 1H), 4.09-4.03 (m, 2H), 1.85-1.83 (m, 1H), 1.69-1.66 (m, 2H), 1.47-1.43 (m, 1H), 0.98 (t, *J* =7.5 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 161.86, 149.54, 133.11, 129.19, 123.59, 82.03, 63.02, 57.96, 35.85, 19.28, 13.49

t-**3c**-NO_2: 5-chloro-2- (4-nitrophenyl)-6-propyl-5,6-dihydro-4*H*-1,3-oxazine

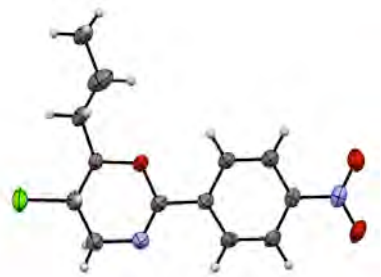


^{1}H NMR (500 MHz, $CDCl_3$) δ 8.21 (d, *J* = 8.5 Hz, 2H), 8.06 (d, *J* = 8.5 Hz, 2H), 4.26 (dt, *J* = 8.5, 3.0 Hz, 1H), 3.02-3.94 (m, 2H), 3.70 (dd, *J* = 16.5, 7.0 Hz, 1H), 1.99-194 (m, 1H), 1.71-1.64 (m, 2H), 1.55-1.51 (m, 1H), 1.03 (t, *J* =7.5 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 153.32, 149.22, 138.64, 128.19, 123.30, 78.85, 52.44, 50.48, 34.48, 18.02, 13.84

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{13}H_{16}N_2O_3Cl$: 283.0849; Found: 283.0863

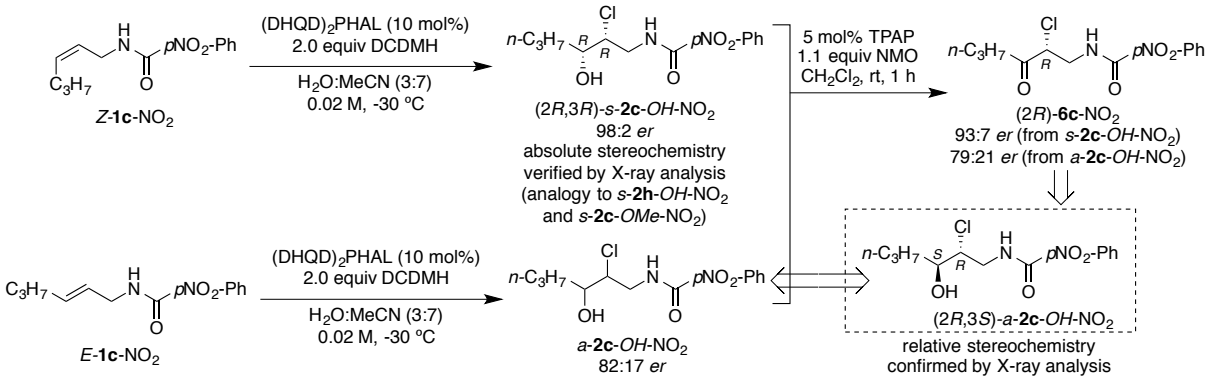
Relative stereochemistry was determined by single crystal X-ray diffraction (XRD). Crystals for XRD were obtained by crystallization from CH_2Cl_2 layered with hexanes in a silicone-coated vial.



VIII. Absolute stereochemistry of chloroetherification products derived from *E*-alkene:

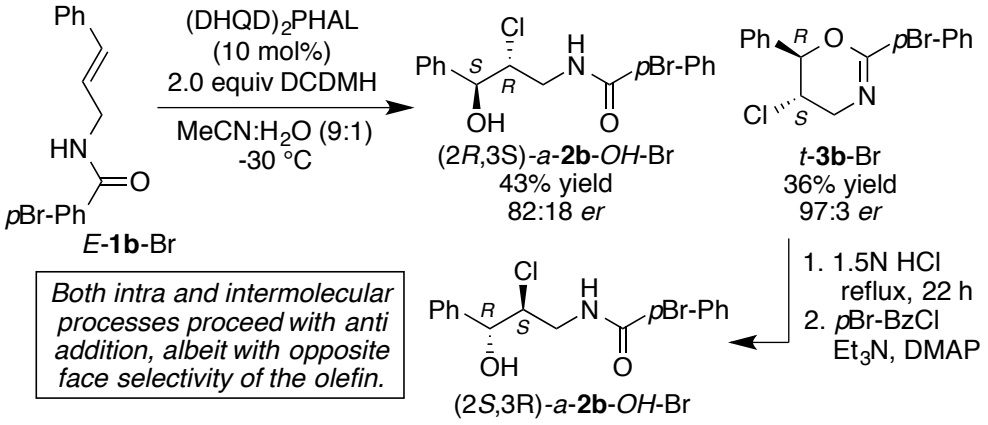
Attention must be drawn to the fact that the Cl bearing stereocenter has the same chirality for products derived from either the *cis* or *trans*-alkene substrates. The absolute stereochemistry of *s*-**2h**-*OH*-NO_2 and *s*-**2c**-*OMe*-NO_2, and the relative stereochemistry of *a*-**2c**-*OH*-NO_2 were established by single crystal X-ray diffraction. Since the absolute stereochemistry of *a*-**2c**-*OH*-NO_2 could not be determined from X-ray analysis, we resorted to the chemical transformations detailed in Figure S3 for proof of structure. This was verified by the TPAP-NMO mediated oxidation of the diastereomeric chlorohydrins *s*-**2c**-*OH*-NO_2 and *a*-**2c**-*OH*-NO_2, derived from substrates *Z*-**1c**-NO_2 and *E*-**1c**-NO_2, respectively (see Figure S3). Both substrates gave the chloroketone product with the same absolute stereochemistry (verified by both, HPLC and optical rotation). This is only possible if the face selectivity of the chlorenium delivery was the same for these two classes of substrates.

Figure S3: Determination of absolute stereochemistry of Cl-bearing stereocenter



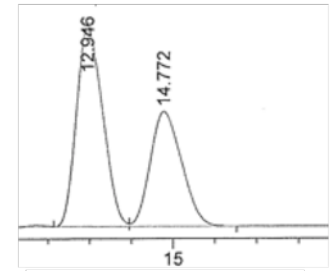
The intermolecular chloroetherification reaction of many substrates gave variable amounts of the chlorocyclized products in addition to the desired products. Intriguingly, the Cl-bearing stereocenter of both these products formed in the same reaction had the opposite stereochemistry based on chemical transformations and corroborating crystallographic evidence detailed below. While the chloroether product had an *R*-configuration for the Cl-bearing stereocenter, the chlorocyclized product had an *S*-configuration. With crystallographic evidence supporting the latter observation, we sought to unequivocally establish this divergence in stereoselectivity by chemical derivatization. An attempted synthesis of halohydrin *a*-**2b**-*OH*-Br from substrate *E*-**1b**-Br gave the chlorocyclized product *t*-**3b**-Br (36%, 97:3 *er*) in addition to the desired product *a*-**2b**-*OH*-Br (43%, 82:18 *er*). The stereochemistry of the Cl bearing stereocenter of *t*-**3b**-Br was assigned as *S* based on our prior studies.[1] The absolute stereochemistry of the Cl-bearing stereocenter in *a*-**2b**-*OH*-Br**,** on the other hand was inferred to be *R* (based on the crystal structures of *s*-**2c**-*OMe*-NO_2 and *s*-**2h**-*OH*-NO_2 and chemical transformations illustrated in Figure S4). In order to unequivocally establish this stereodivergence, *t*-**3b**-Br was transformed to *a*-**2b**-*OH*-Br by means of a two-step transformation shown in Figure S4. Optical rotation as well as HPLC co-injection confirmed that it was indeed the enantiomer of *a*-**2b**-*OH*-Br that had resulted from this transformation (Figure S5). These results lead us to conclude that two distinct mechanisms are in play that leads to either the cyclized dihydrooxazine products or the

Figure S4. Stereodivergence in the formation of halohydrin and oxazoline products

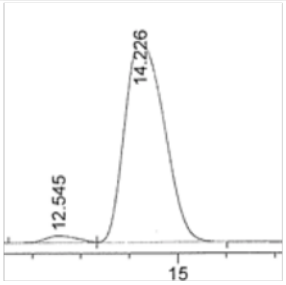


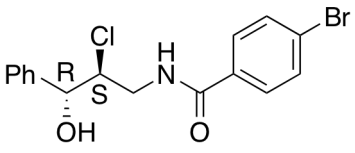
desired intermolecular addition of the nucleophile and halenium ion across the alkene in the *same* reaction.

Figure S5: HPLC trace for halohydrins

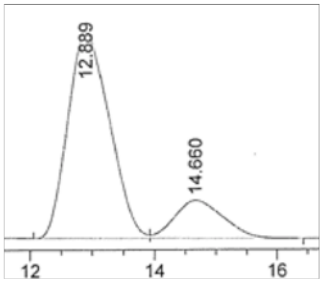


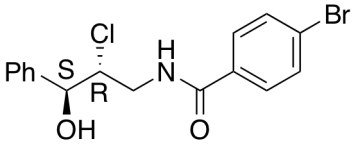
(±)-*a*-**2b**-*OH*-Br





(2*R*,3*S*)-*a*-**2b**-*OH*-Br
97:3 er

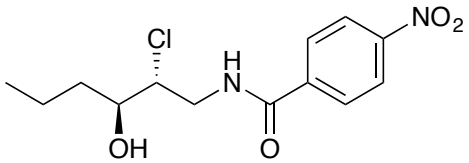




(2*S*,3*R*)-*a*-**2b**-*OH*-Br
82:18 er

VIIIa. Analytical data for determination of chlorine face selectivity of *E*-alkene

a-**2c**-*OH*-NO_2: *N*-((2*R*,3*S*)-2-chloro-3-hydroxyhexyl)-4-nitrobenzamide



^{1}H NMR (500 MHz, $CDCl_3$ δ 8.31 (d, J = 8 Hz, 2H), 7.97 (d, J = 8.0 Hz, 2H), 6.83 (br s, 1H), 4.29-4.23 (m, 1H), 4.08 (br s, 1H), 3.94-3.92 (m, 1H), 3.68-3.63 (ddd, J = 15.0, 5.0, 3.5 Hz, 1H), 1.78-1.73 (m, 1H), 1.63-1.56 (m, 1H), 1.51-1.45 (m, 1H), 1.40-1.34 (m, 1H), 0.93 (t, J = 7.5 Hz, 3H)

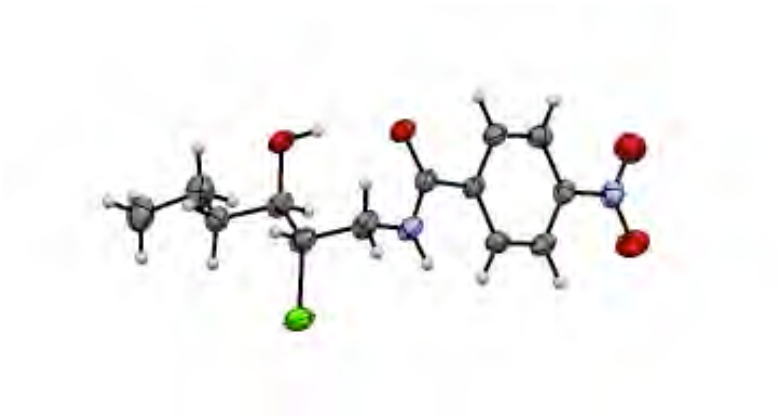
^{13}C NMR (125 MHz, $CDCl_3$) δ 167.02, 149.92, 138.88, 128.35, 123.99, 71.84, 64.41, 42.63, 35.29, 18.84, 13.97

HRMS analysis (ESI): Calculated for $[M-H]^-$: $C_{13}H_{16}ClN_2O_4$: 299.0799; Found: 299.0795

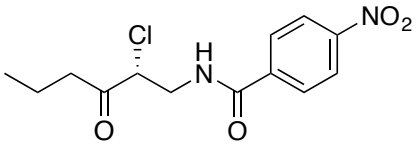
Resolution of enantiomers: DAICEL Chiralcel® OJ-H column, 7% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (minor) = 11.9 min, RT2 (major) = 13.3 min.

$[\alpha]_D^{20}$ = -19.7 (c 0.6, $CHCl_3$, *er* = 85:15)

Relative stereochemistry was determined by single crystal X-ray diffraction (XRD). Crystals for XRD were obtained by crystallization from CH_2Cl_2 layered with hexanes in a silicone-coated vial.



(2*R*)-**6c**-NO_2: (*R*)-*N*-(2-chloro-3-oxohexyl)-4-nitrobenzamide



^{1}H NMR (500 MHz, $CDCl_3$) δ 8.29 (d, *J* = 9.0 Hz, 2H), 7.90 (d, *J* = 9.0 Hz, 2H), 6.70 (br, 1H), 4.53 (t, *J* = 6 Hz, 1H), 3.98-3.87 (m, 2H), 2.83-2.76 (m, 1H), 2.60-2.53 (m, 1H), 1.66-1.60 (m, 2H), 0.94 (t, *J* = 8 Hz, 3H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 204.45, 165.52, 149.80, 139.23, 128.20, 123.92, 58.61, 41.93, 41.82, 17.07, 13.52

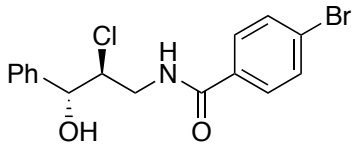
(ESI): Calculated for $[M-H]^-$: $C_{13}H_{14}N_2O_4Cl$: 297.0642; Found: 297.0644

Resolution of enantiomers: DAICEL Chiralcel® IA column, 20% IPA- HRMS analysis Hexanes, 1.0 mL/min, 250 nm, RT1 (major) = 8.2 min, RT2 (minor) = 8.9 min.

$[\alpha]_D^{20}$ = +17.2 (c 0.35, $CHCl_3$, *er* = 93:7) from *cis* halohydrin

$[\alpha]_D^{20}$ = +13.0 (c 0.24, $CHCl_3$, *er* = 82:18) from *trans* halohydrin

(2*S*,3*R*)-*a*-**2b**-*OH*-Br: 4-bromo-*N*-((2*S*,3*R*)-2-chloro-3-hydroxy-3-phenylpropyl)benzamide



^{1}H NMR (500 MHz, $CDCl_3$) δ 7.67 (d, *J* = 9.0 Hz, 2H), 7.61 (d, *J* = 9.0 Hz, 2H), 7.30-7.31 (m, 4H), 6.65 (br s, 1H), 4.70 (d, *J* = 4.5 Hz, 1H) 4.61 (dd, *J* = 8.0, 4.0 Hz 1H), 4.22-4.19 (m, 1H), 3.66-3.61 (m, 1H)

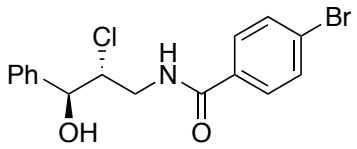
^{13}C NMR (125 MHz, $CDCl_3$) δ 168.19, 139.61, 132.03, 132.00, 128.74, 128.43, 128.32, 127.03, 126.89, 74.64, 64.65, 42.42

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{16}H_{16}ClBrNO_2$: 368.0053; Found: 368.0053

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 15% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (minor) = 12.5 min, RT2 (major) = 14.5 min.

$[\alpha]_D^{20}$ = -2.0 (c 0.3, $CHCl_3$, *er* = 97:3)

(2*R*,3*S*)-*a*-**2b**-*OH*-Br: 4-bromo-*N*-((2*R*,3*S*)-2-chloro-3-hydroxy-3-phenylpropyl)benzamide



^{1}H NMR (500 MHz, $CDCl_3$) δ 7.67 (d, *J* = 9.0 Hz, 2H), 7.61 (d, *J* = 9.0 Hz, 2H), 7.30-7.31 (m, 4H), 6.65 (br s, 1H), 4.70 (d, *J* = 4.5 Hz, 1H) 4.61 (dd, *J* = 8.0, 4.0 Hz 1H), 4.22-4.19 (m, 1H), 3.66-3.61 (m, 1H)

^{13}C NMR (125 MHz, $CDCl_3$) δ 168.19, 139.61, 132.03, 132.00, 128.74, 128.43, 128.32, 127.03, 126.89, 74.64, 64.65, 42.42

HRMS analysis (ESI): Calculated for $[M+H]^+$: $C_{16}H_{16}ClBrNO_2$: 368.0053; Found: 368.0053

Resolution of enantiomers: DAICEL Chiralcel® AD-H column, 15% IPA-Hexanes, 1.0 mL/min, 254 nm, RT1 (major) = 12.5 min, RT2 (minor) = 14.5 min.

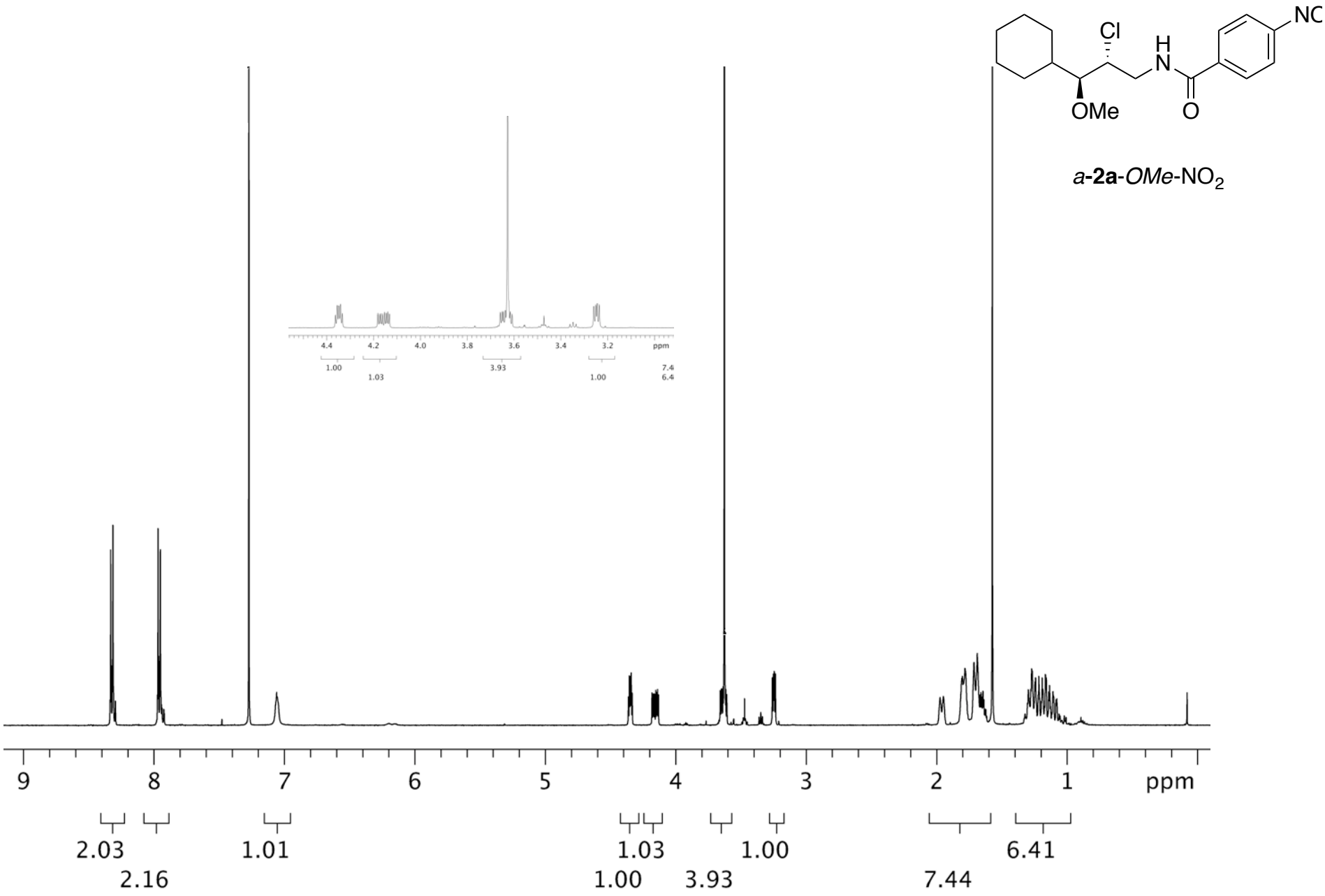
$[\alpha]_D^{20}$ = +2.3 (c 0.57, $CHCl_3$, *er* = 82:18)

IX. References

(1) Jaganathan, A.; Garzan, A.; Whitehead, D. C.; Staples, R. J.; Borhan, B. *Angew. Chem. Int. Ed.* **2011**, *50*, 2593.

(2) Panzik, H. L.; Mulvaney, J. E. *Journal of Polymer Science Part A-1: Polymer Chemistry* **1972**, *10*, 3469.

(3) Lei, A.; Wu, S.; He, M.; Zhang, X. *J. Am. Chem. Soc.* **2004**, *126*, 1626.



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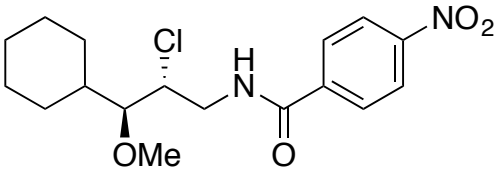
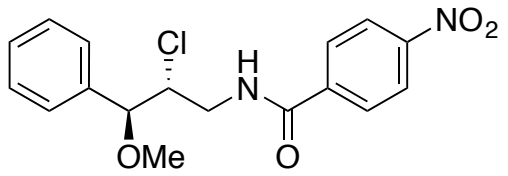


a-**2a**-*OMe*-NO_2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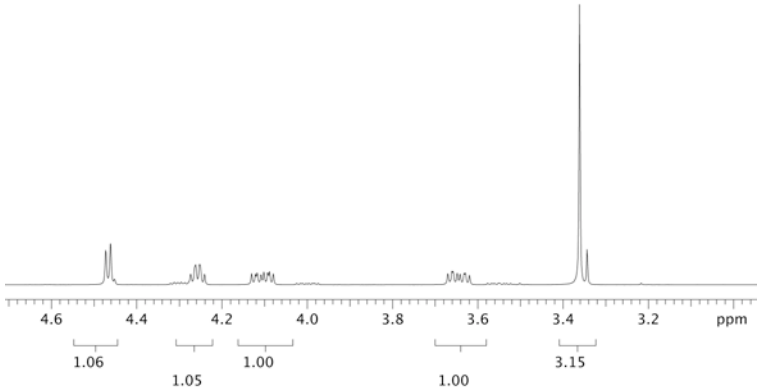
N
NO2
OMe
O

a-**2b**-*OMe*-NO_2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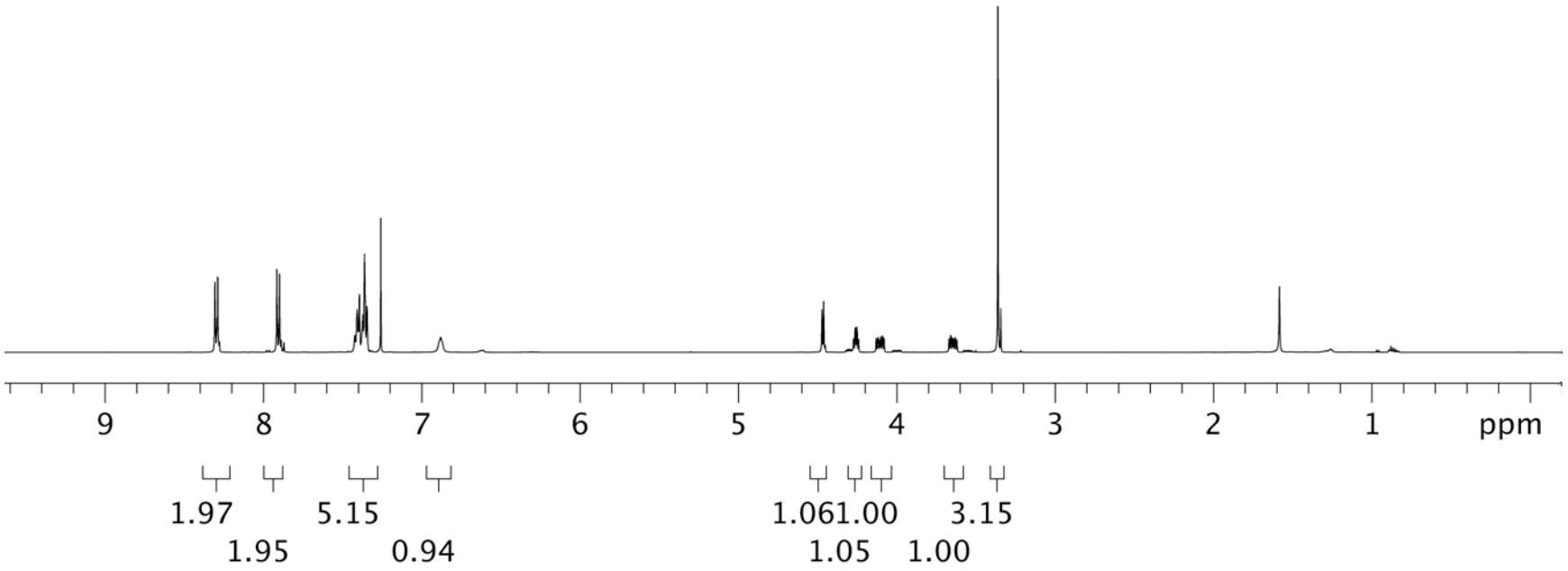
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7
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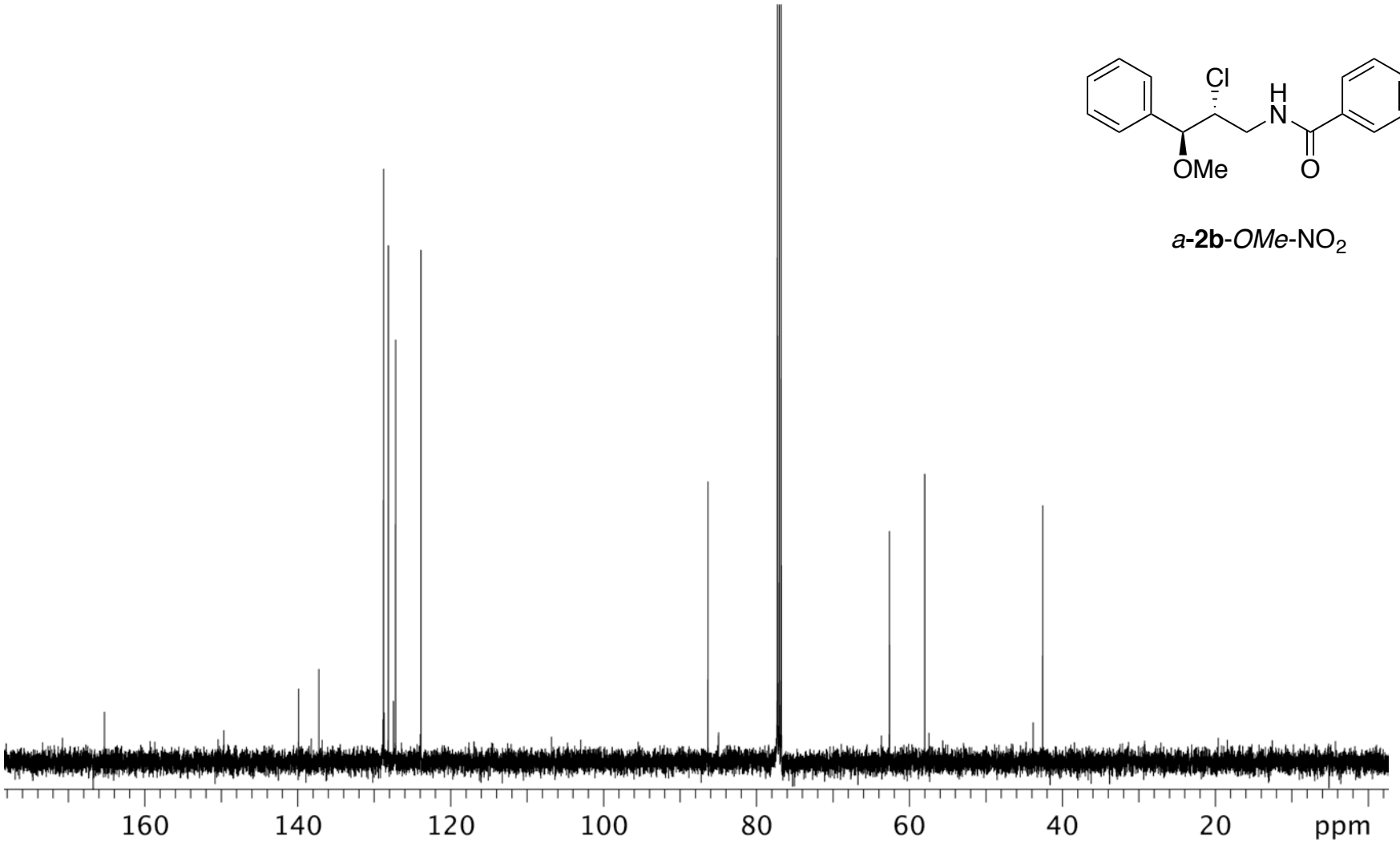
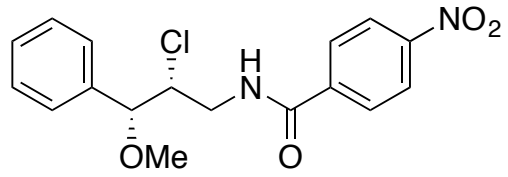
3.15



a-**2b**-*OMe*-NO_2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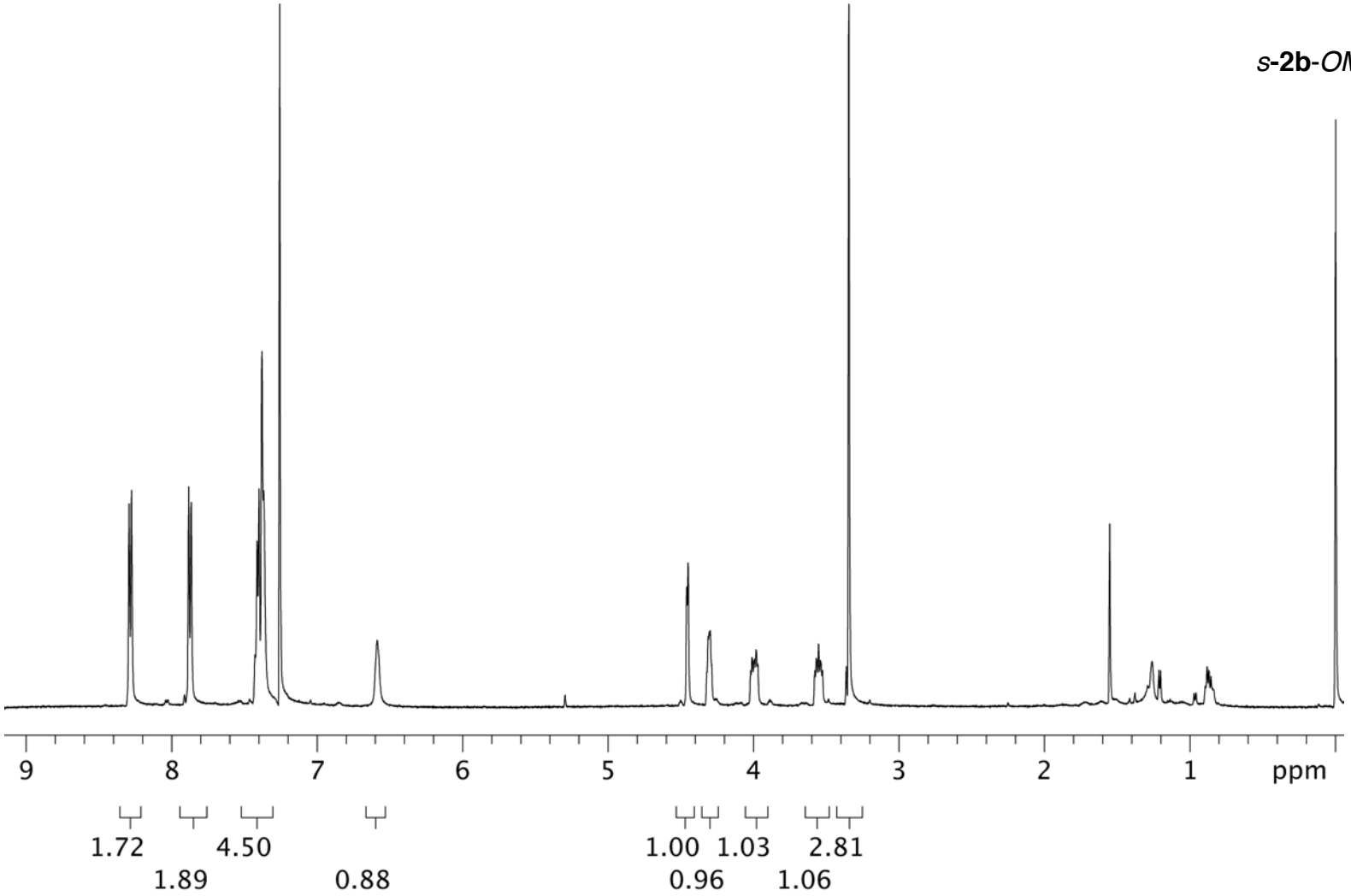
H
N
NO2
OMe
O

s-**2b**-*OMe*-NO_2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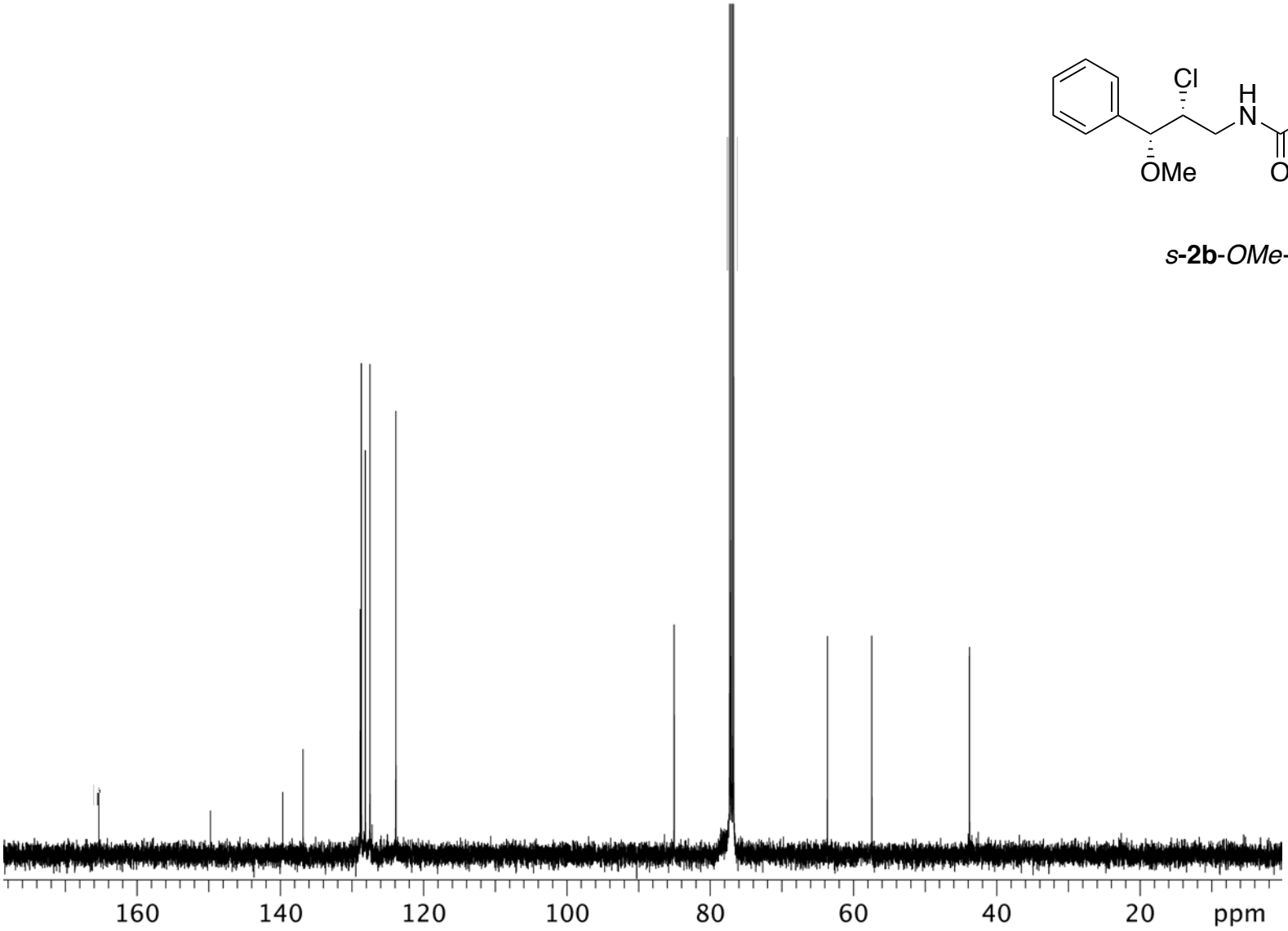
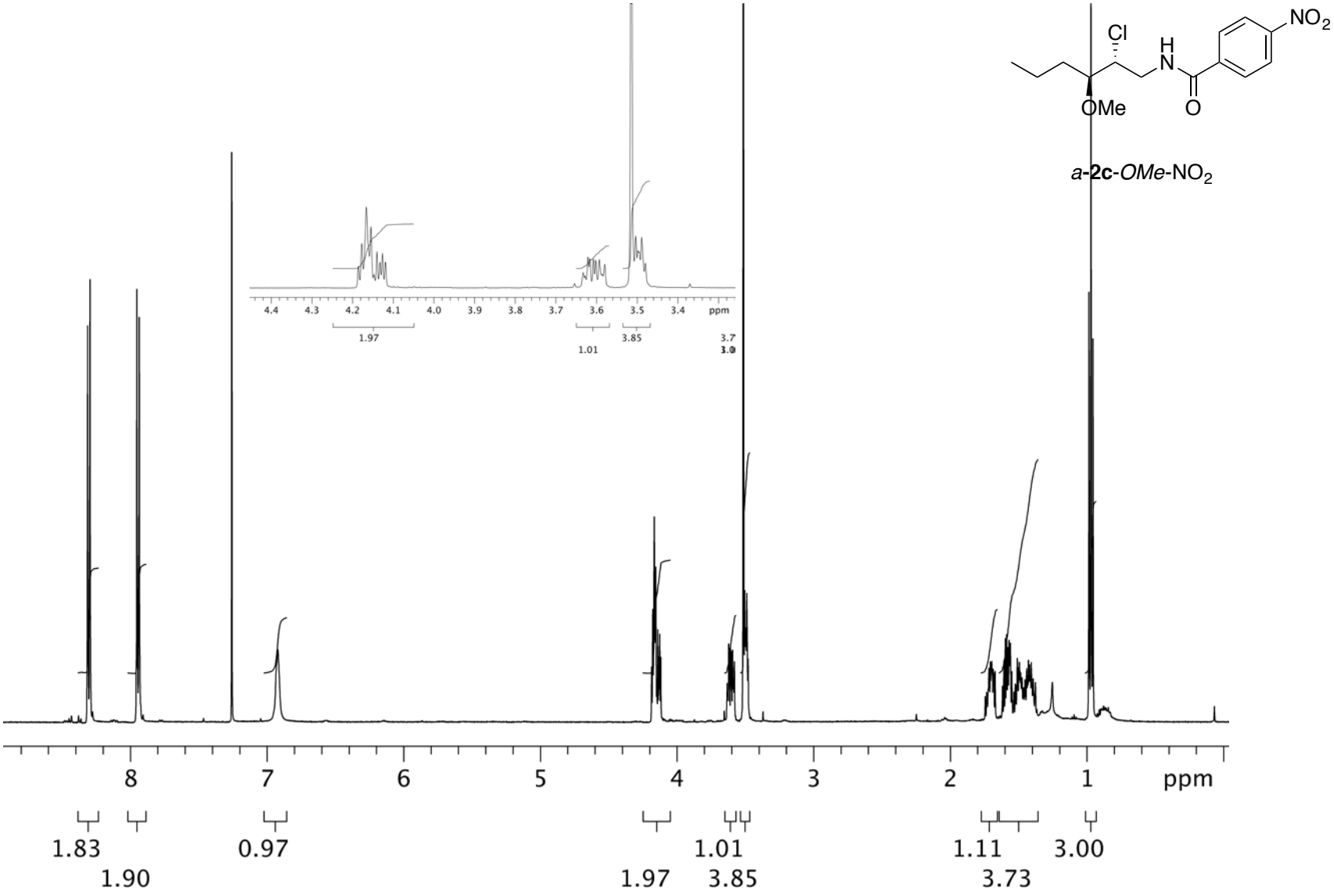
1.06



s-**2b**-*OMe*-NO_2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1.11
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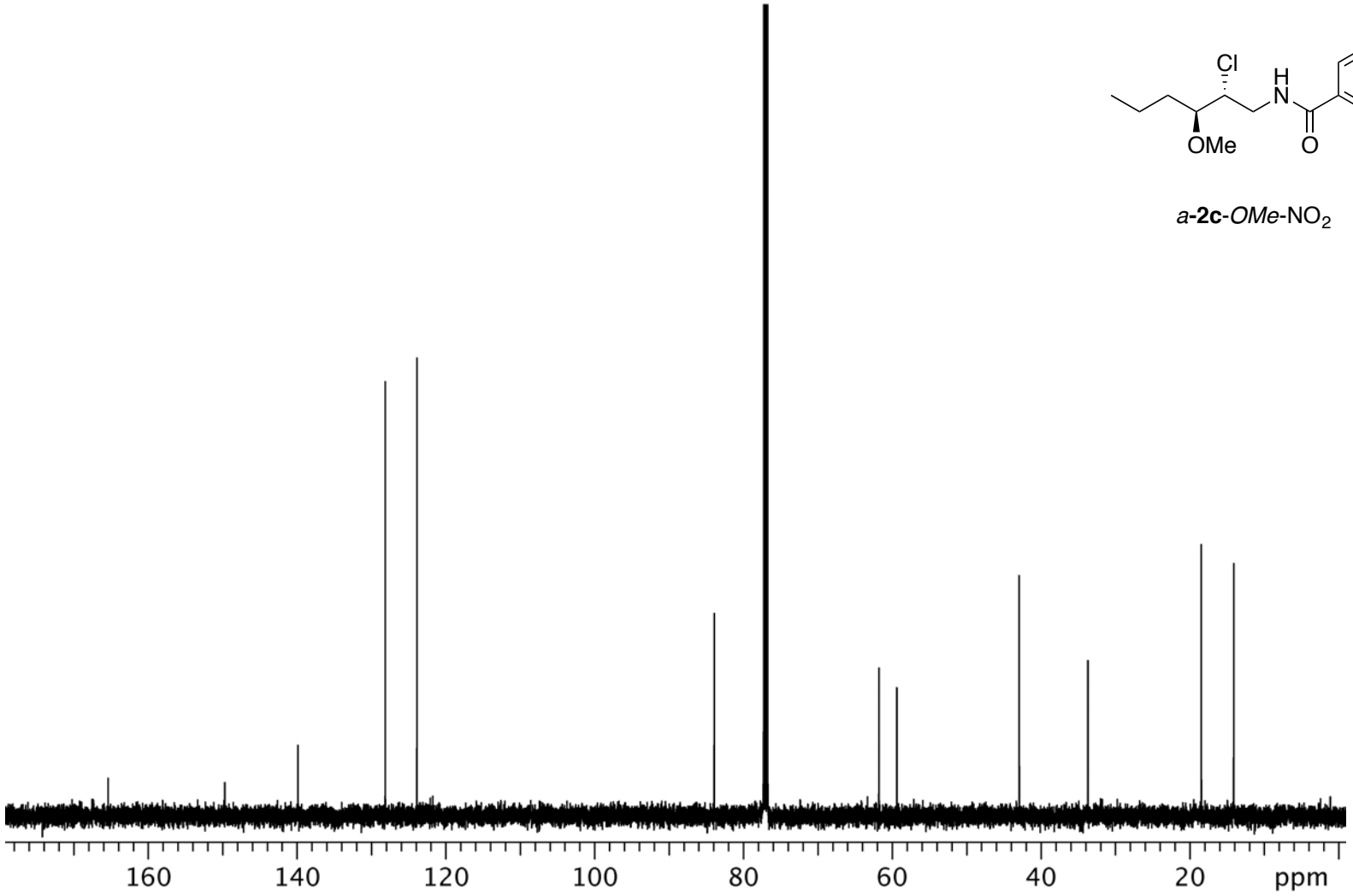
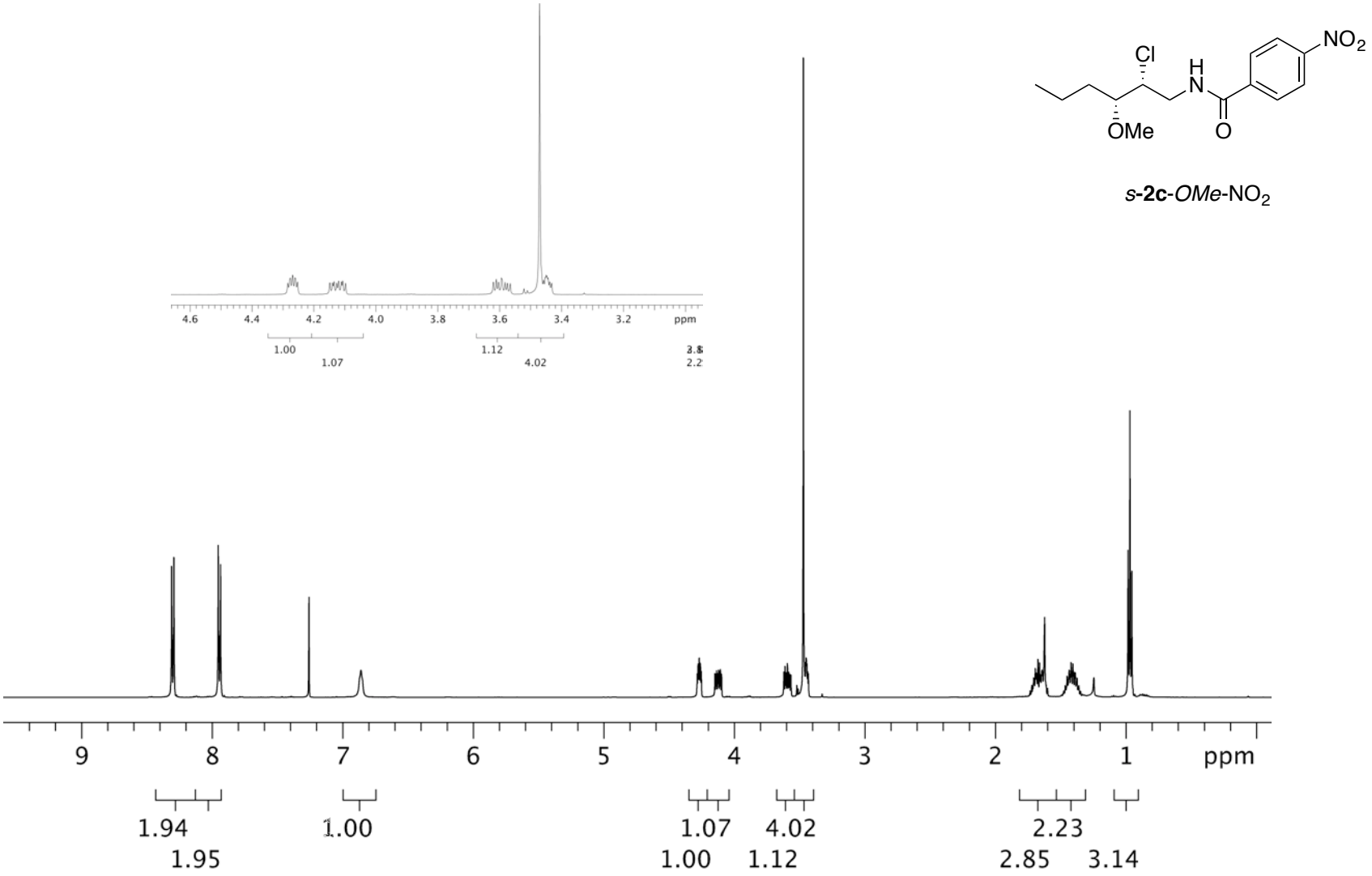
3.00



a-**2c**-*OMe*-NO_2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H
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OMe
O
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3.2
ppm
1.00
1.07
1.12
4.02
9
8
7
6
5
4
3
2
1
ppm
1.94
1.95
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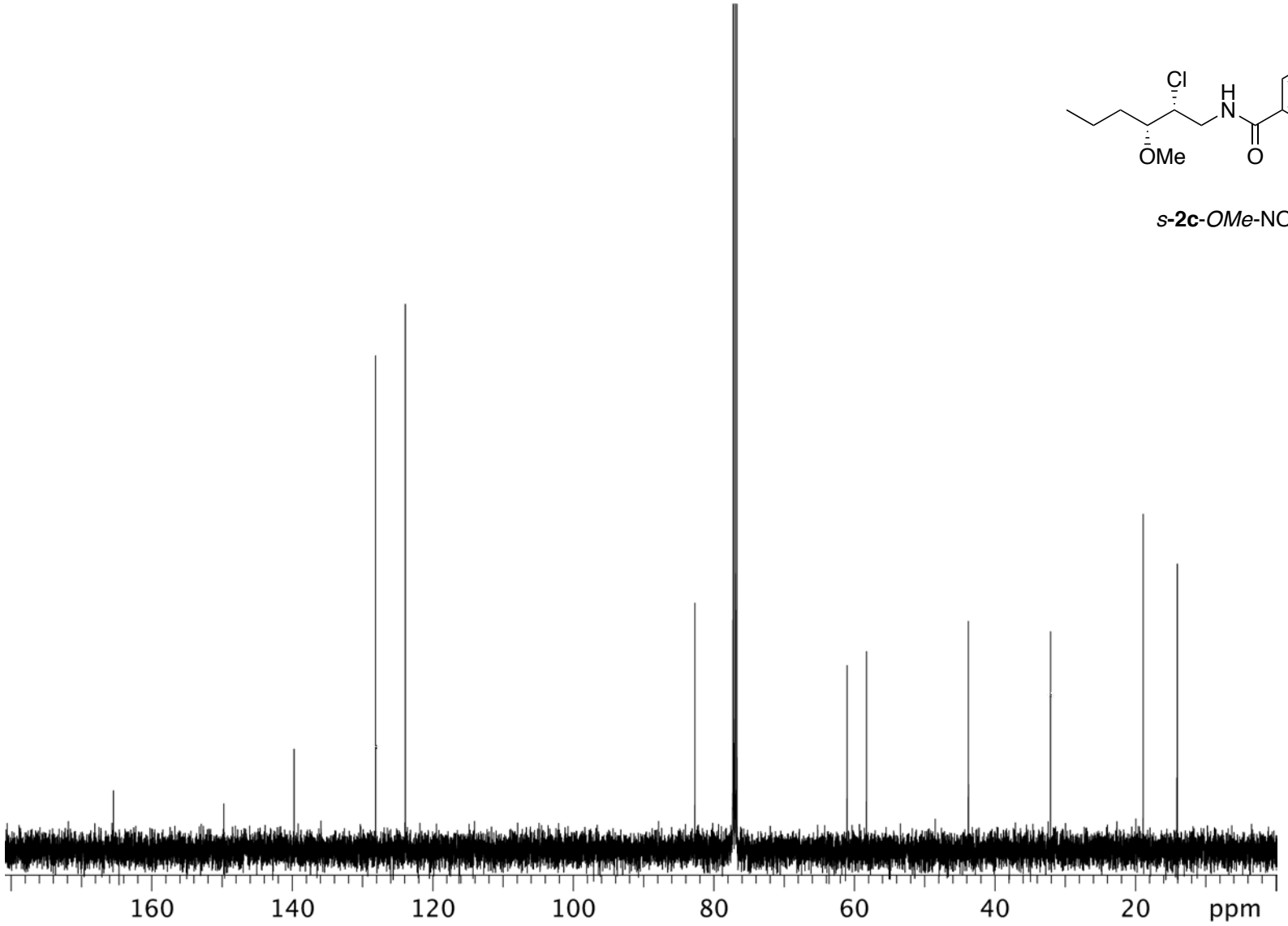
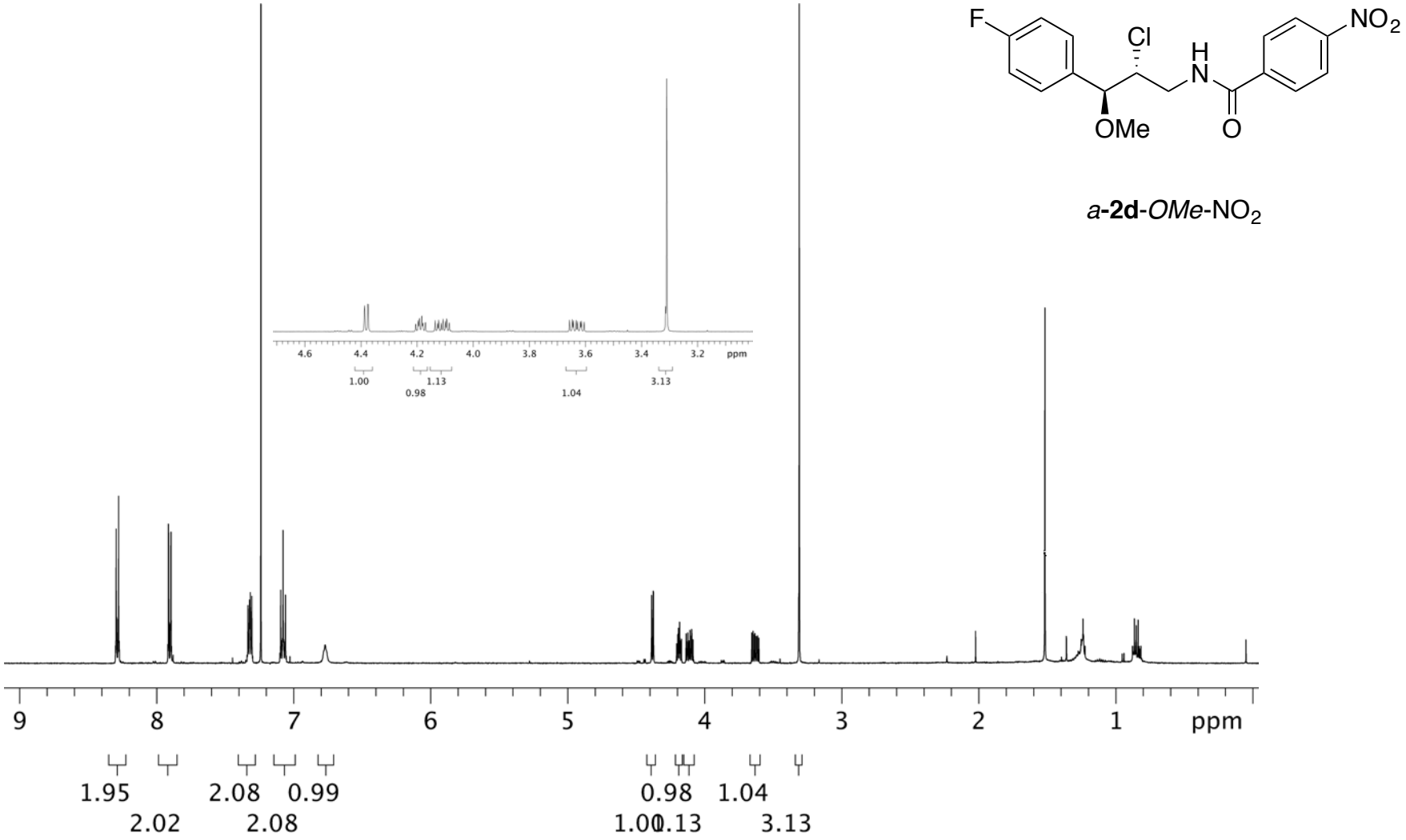
1.07
1.00
4.02
1.12
2.23
2.85
3.14

s-**2c**-*OMe*-NO_2



s-**2c**-*OMe*-NO_2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N
NO2
OMe
O
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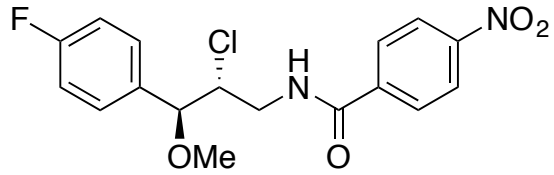
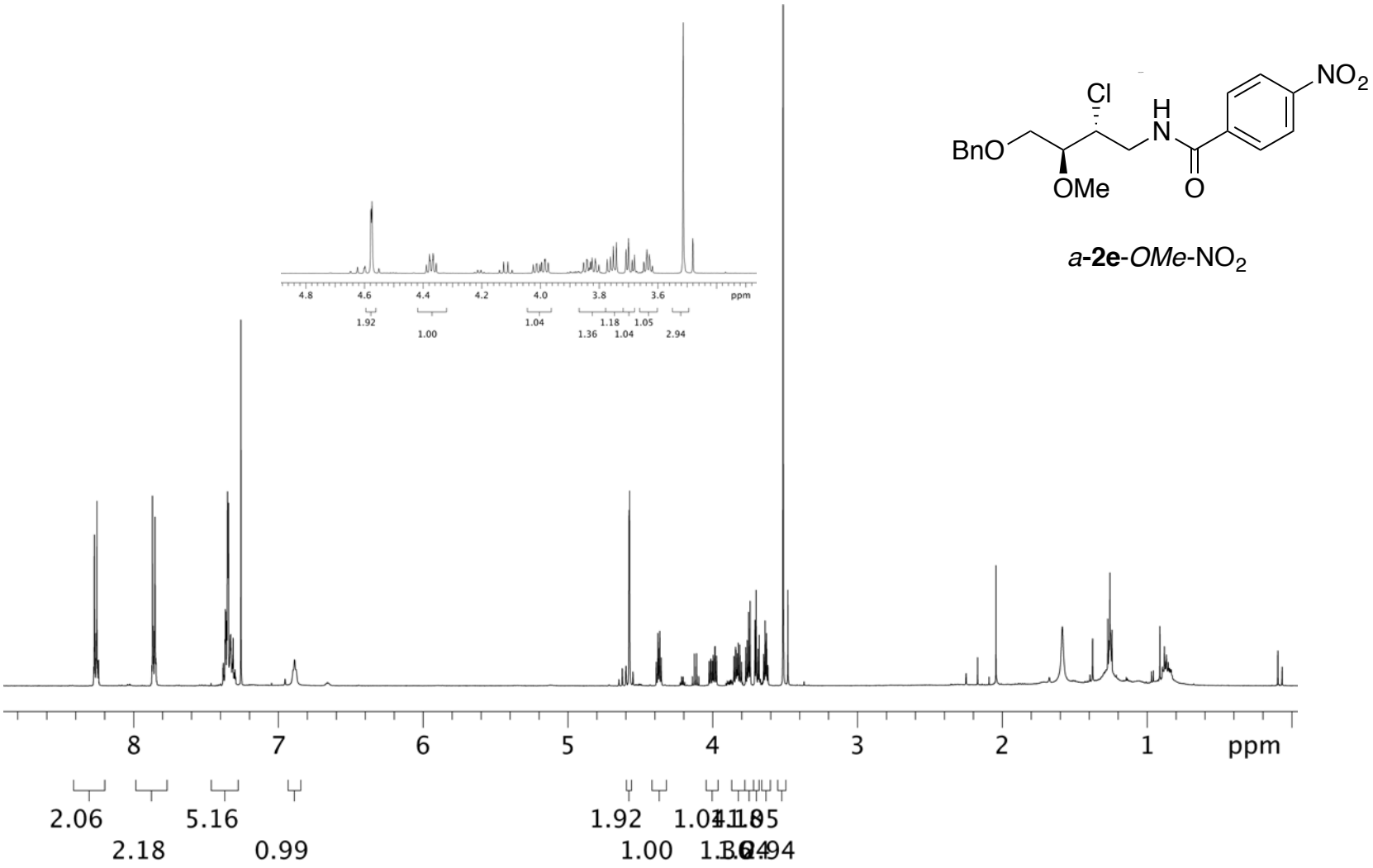
3.6
3.4
3.2
ppm
1.00
1.13
0.98
1.04
3.13
9
8
7
6
5
4
3
2
1
ppm
1.95
2.02
2.08
2.08
0.99
0.98
1.00
1.13
1.04
3.13

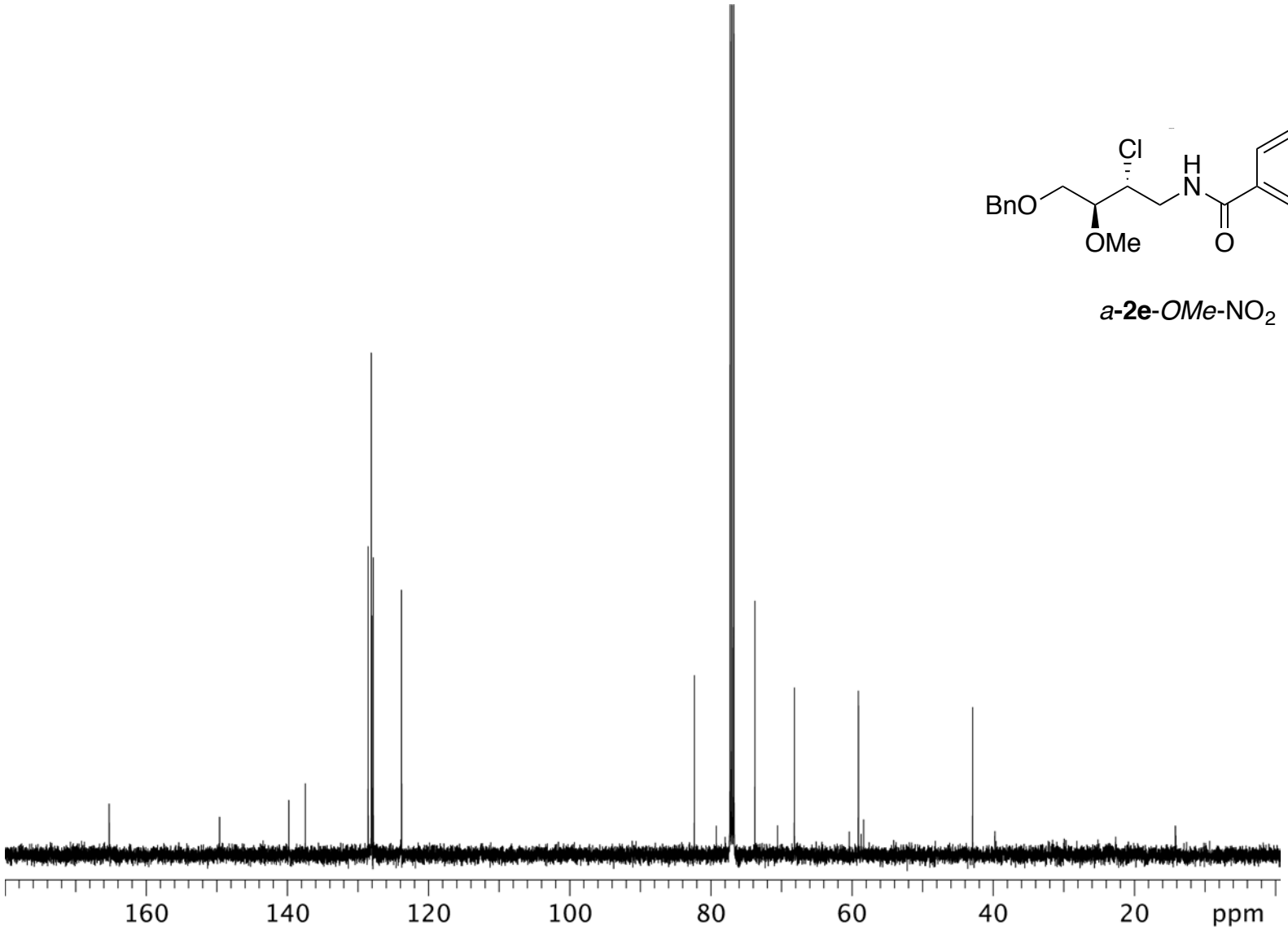
a-**2d**-*OMe*-NO_2



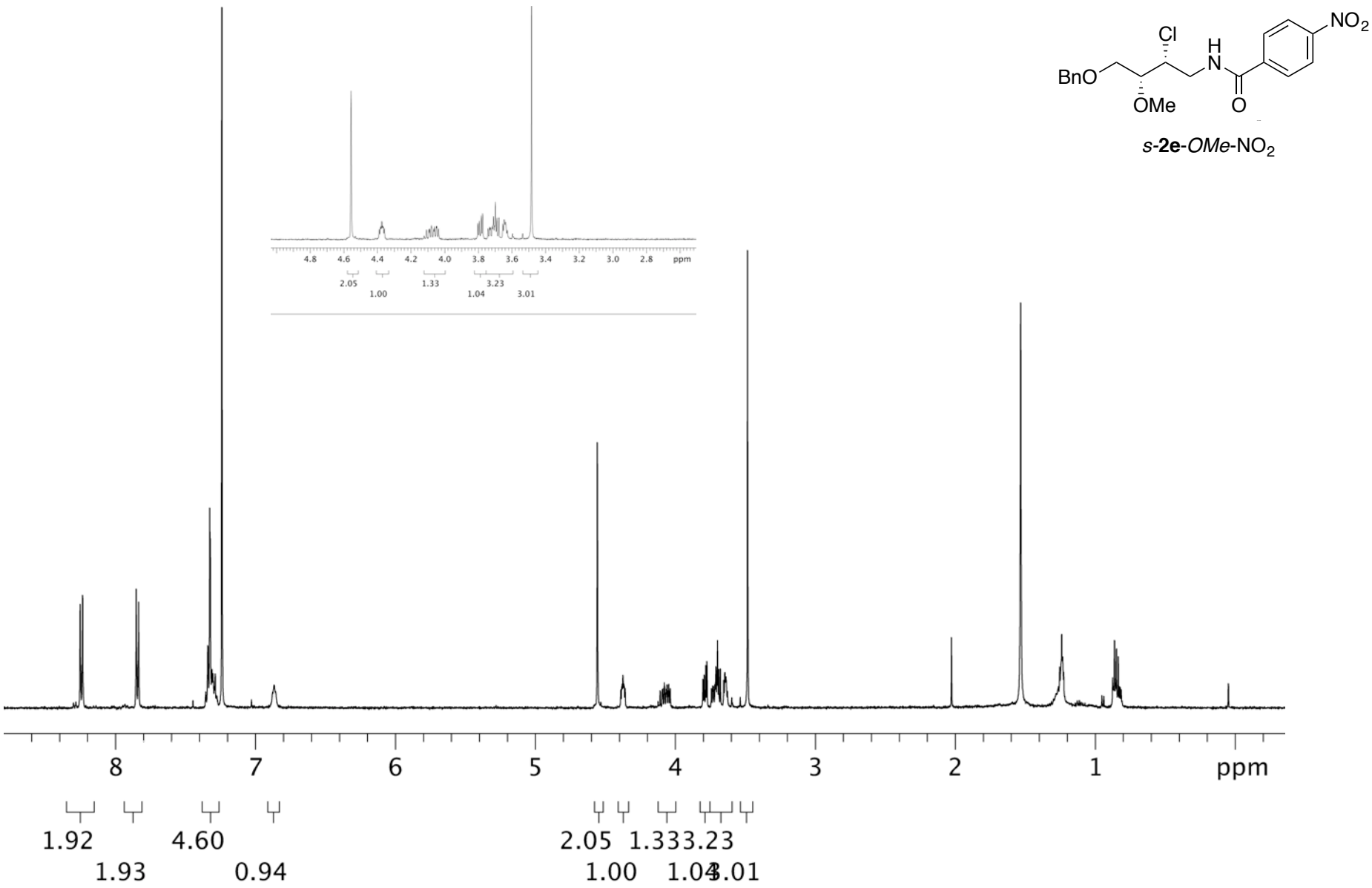
a-**2d**-*OMe*-NO_2

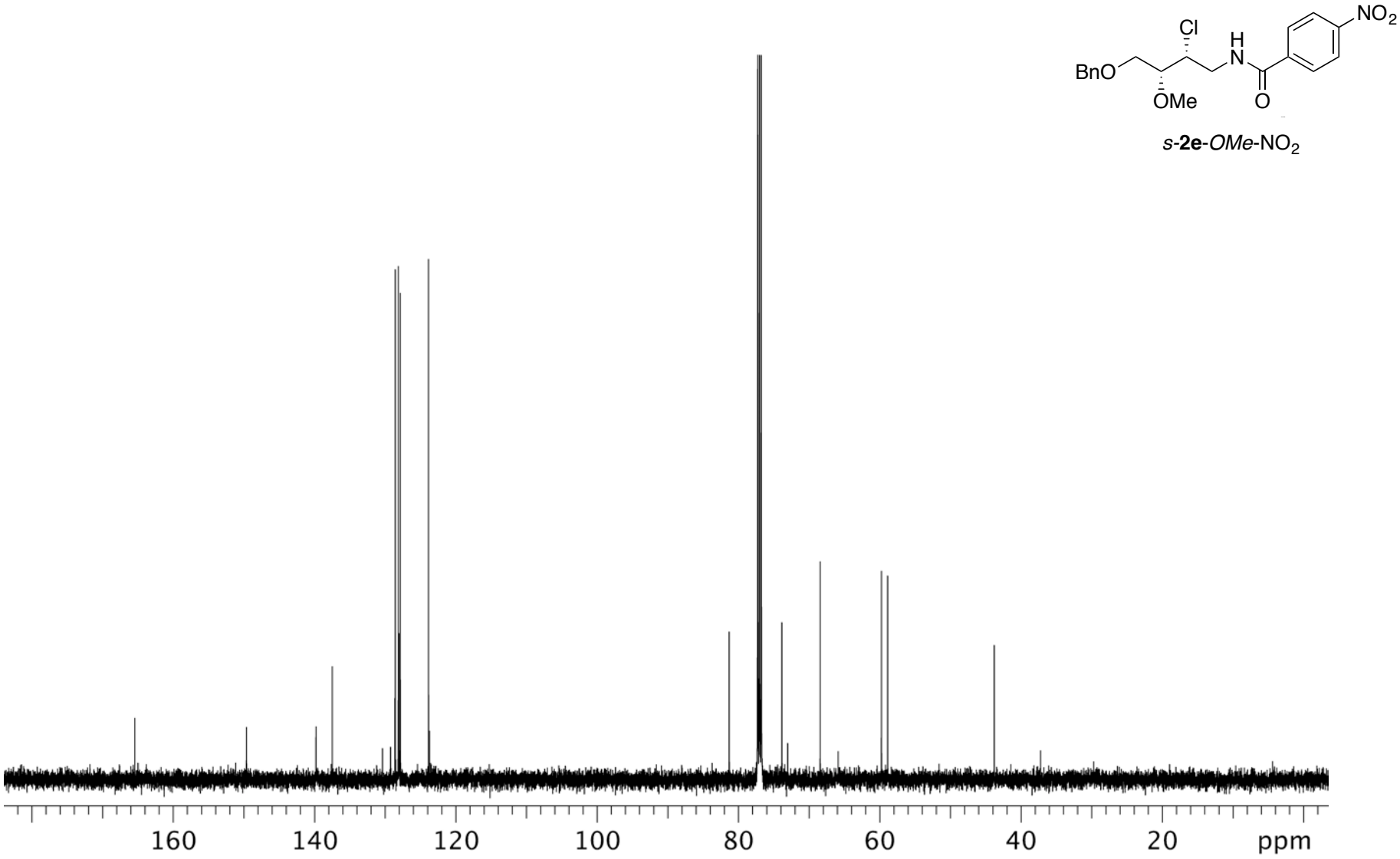


a-**2e**-*OMe*-NO_2

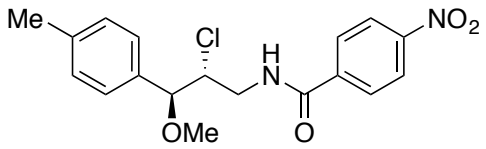


a-**2e**-*OMe*-NO_2


Cl
H
N
BnO
OMe
O
NO2
s-2e-OMe-NO2
4.8 4.6 4.4 4.2 4.0 3.8 3.6 3.4 3.2 3.0 2.8 ppm
2.05 1.00 1.33 3.23 1.04 3.01
8 7 6 5 4 3 2 1 ppm
1.92 1.93 4.60 0.94 2.05 1.00 1.33 1.04 3.23 3.01

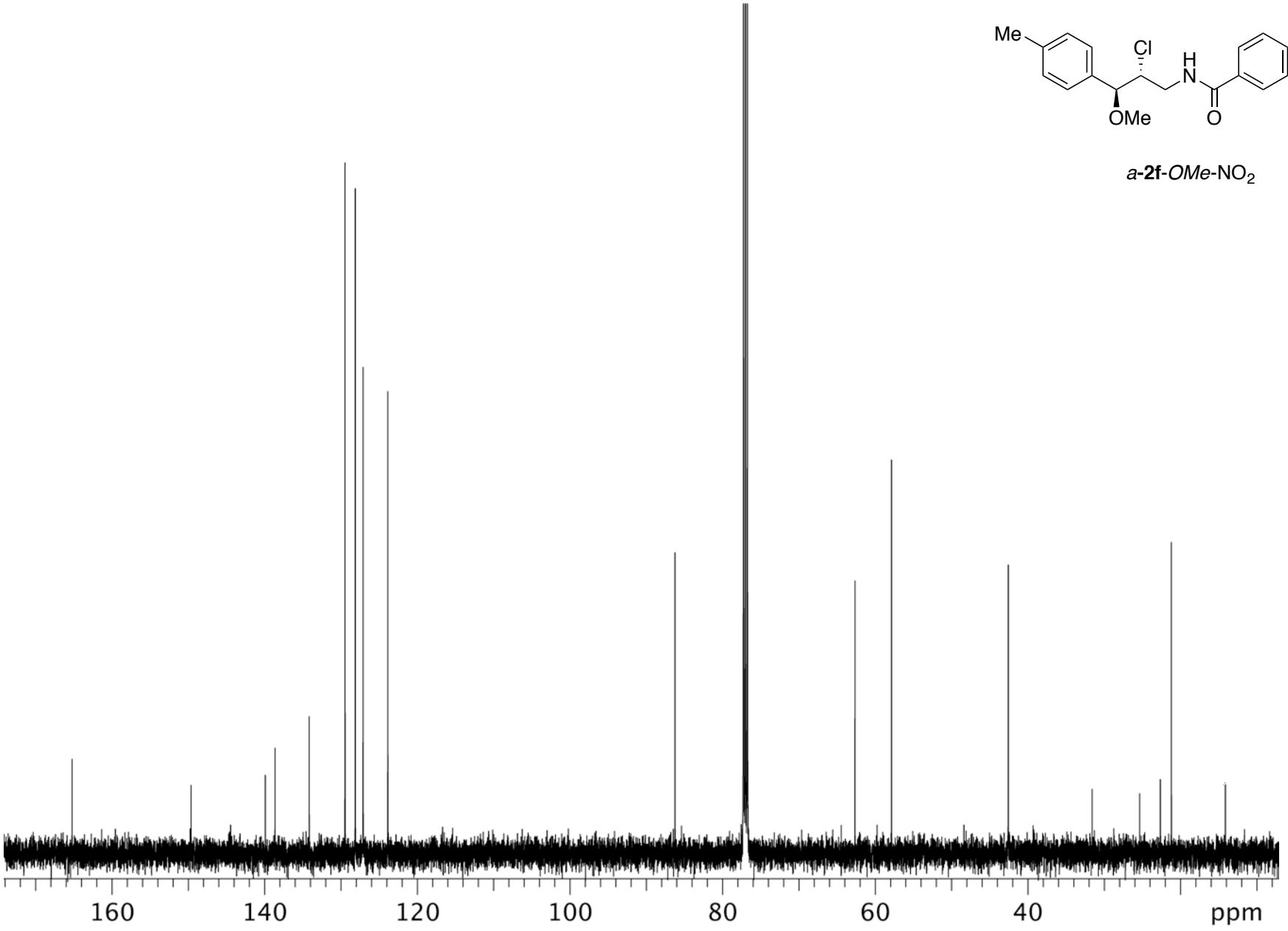


s-**2e**-*OMe*-NO_2

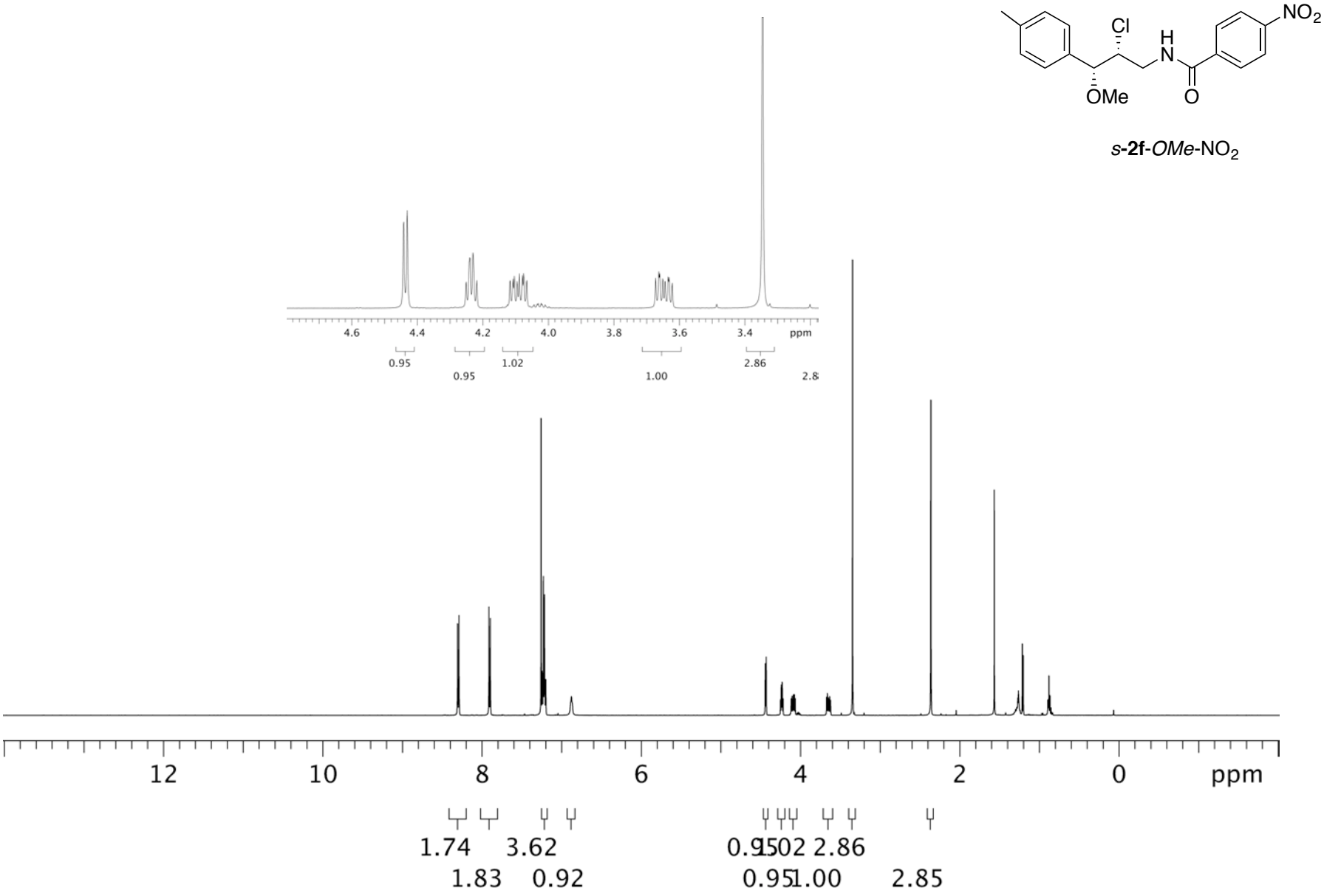

Me
Cl
H
N
NO2
OMe
O

a-**2f**-*OMe*-NO_2

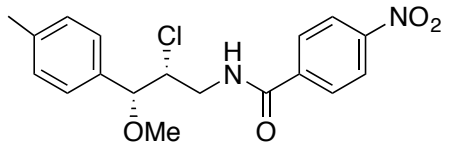
4.4 4.3 4.2 4.1 4.0 3.9 3.8 3.7 3.6 3.5 3.4 3.3 ppm
1.00 0.97 1.10 1.10 2.83
9 8 7 6 5 4 3 2 1 ppm
1.75 1.90 4.55 0.98 1.00 0.97 1.10 1.10 2.83 2.98



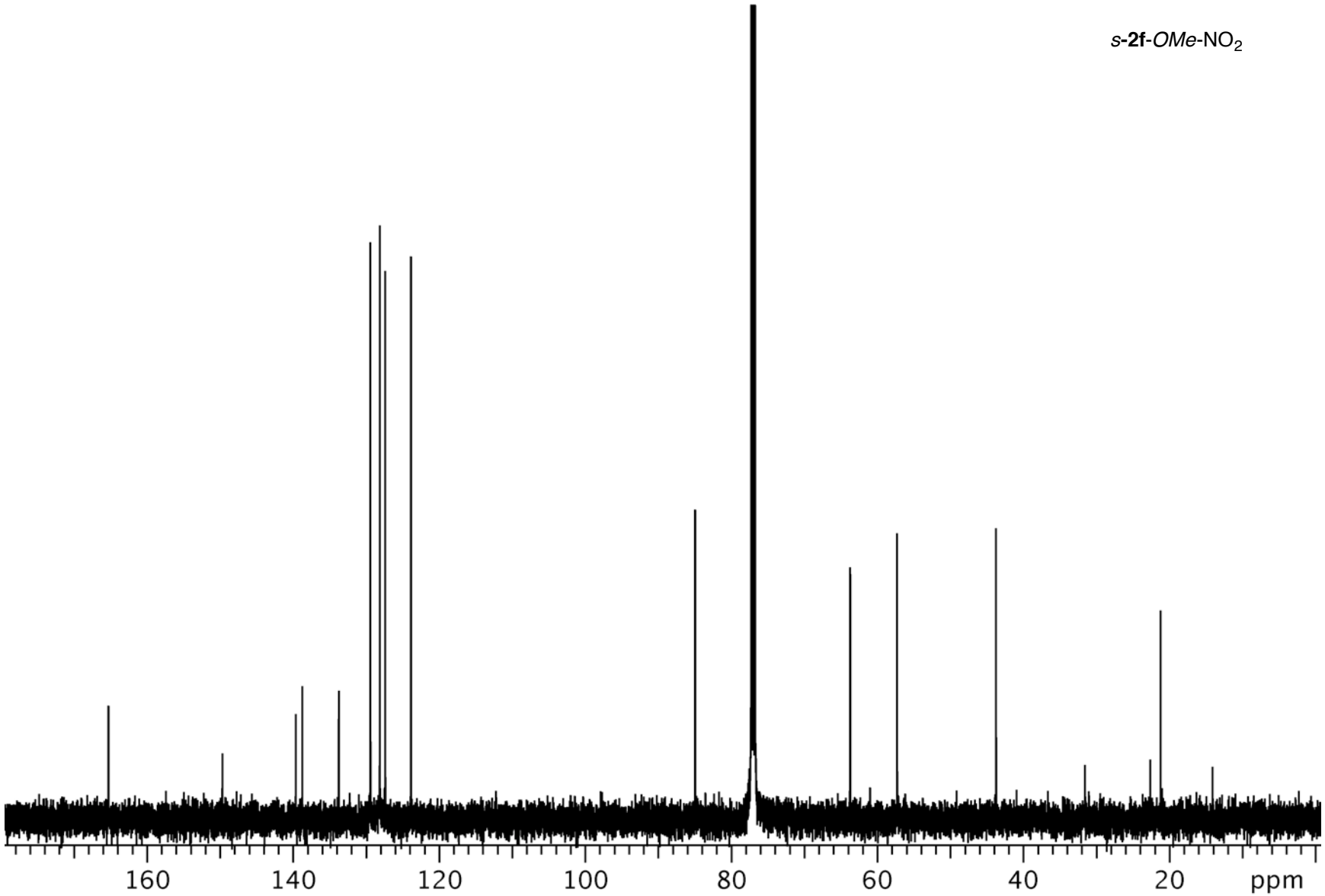
a-**2f**-*OMe*-NO_2

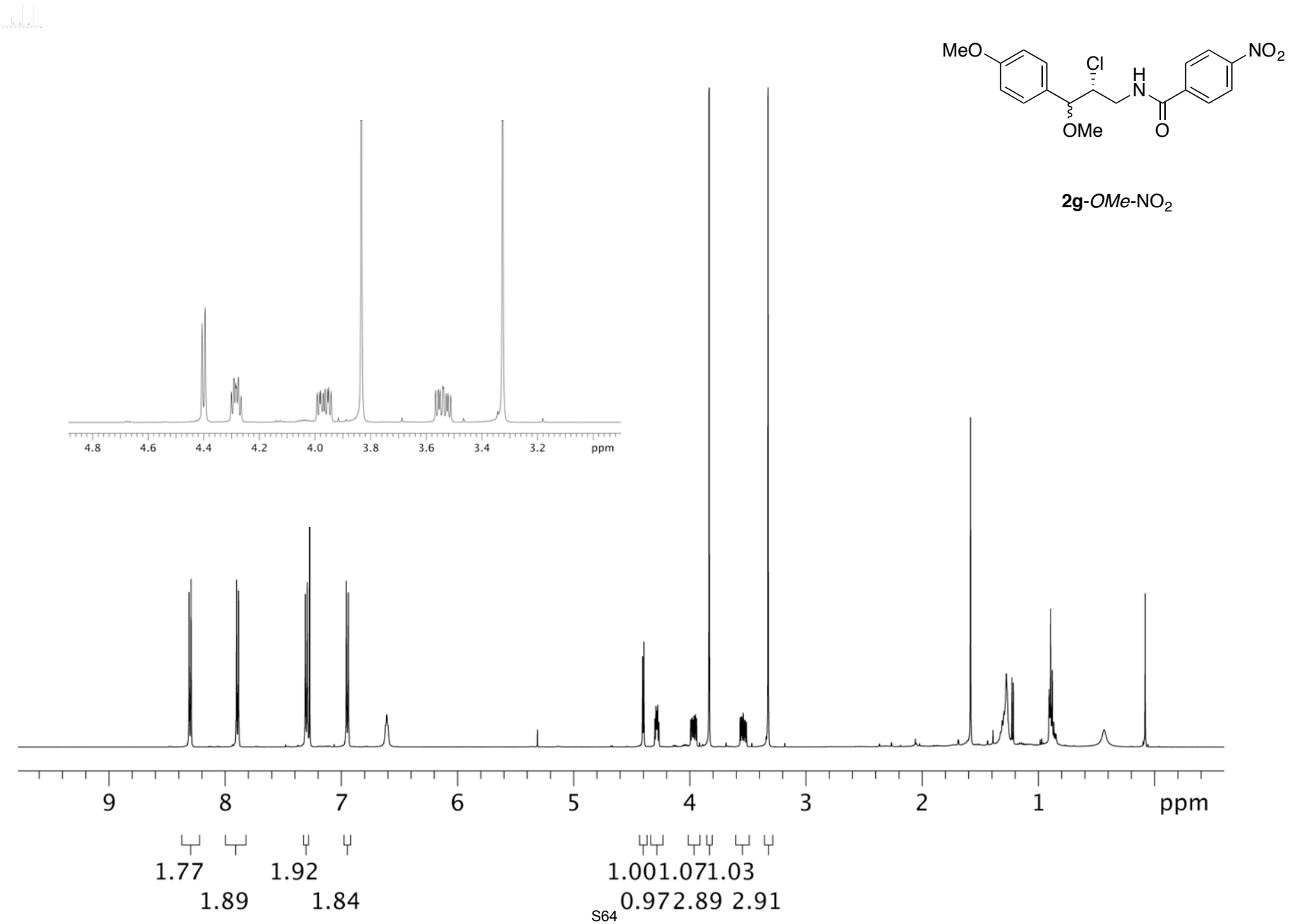

Cl
H
N
NO2
OMe
O
4.6
4.4
4.2
4.0
3.8
3.6
3.4
ppm
0.95
0.95
1.02
1.00
2.86
12
10
8
6
4
2
0
ppm
1.74
1.83
3.62
0.92
0.95
1.00
2.86
2.85

s-**2f**-*OMe*-NO_2

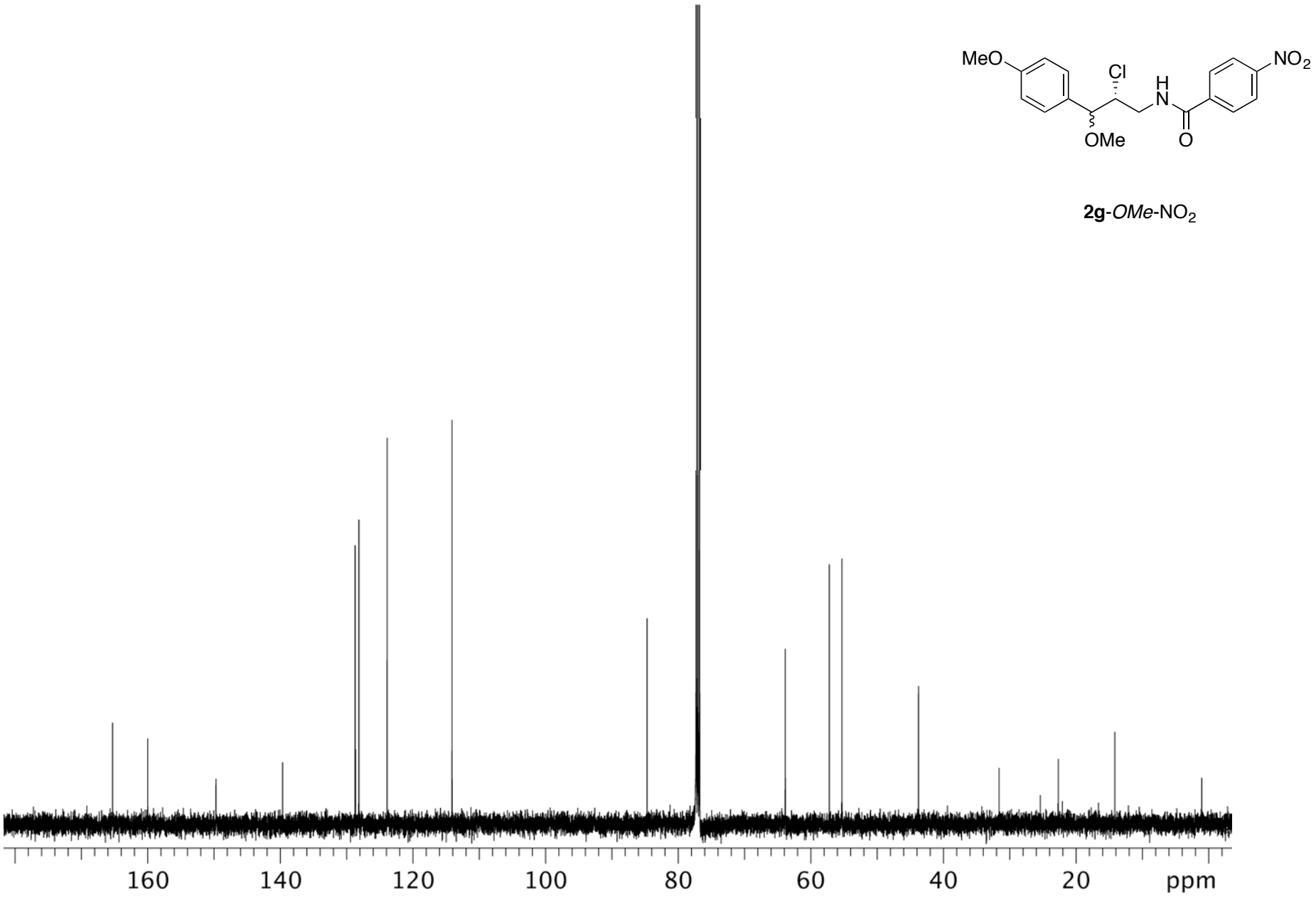


s-**2f**-*OMe*-NO_2

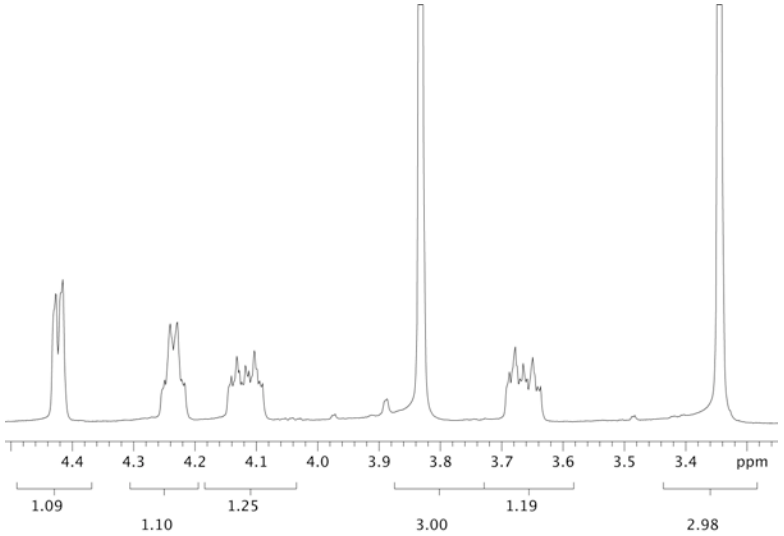


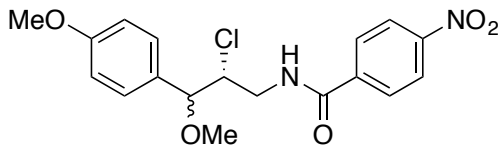

MeO
Cl
H
N
NO2
OMe
O
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
ppm
9
8
7
6
5
4
3
2
1
ppm
1.77
1.89
1.92
1.84
1.00
1.07
1.03
0.97
2.89
2.91

2g-*OMe*-NO_2

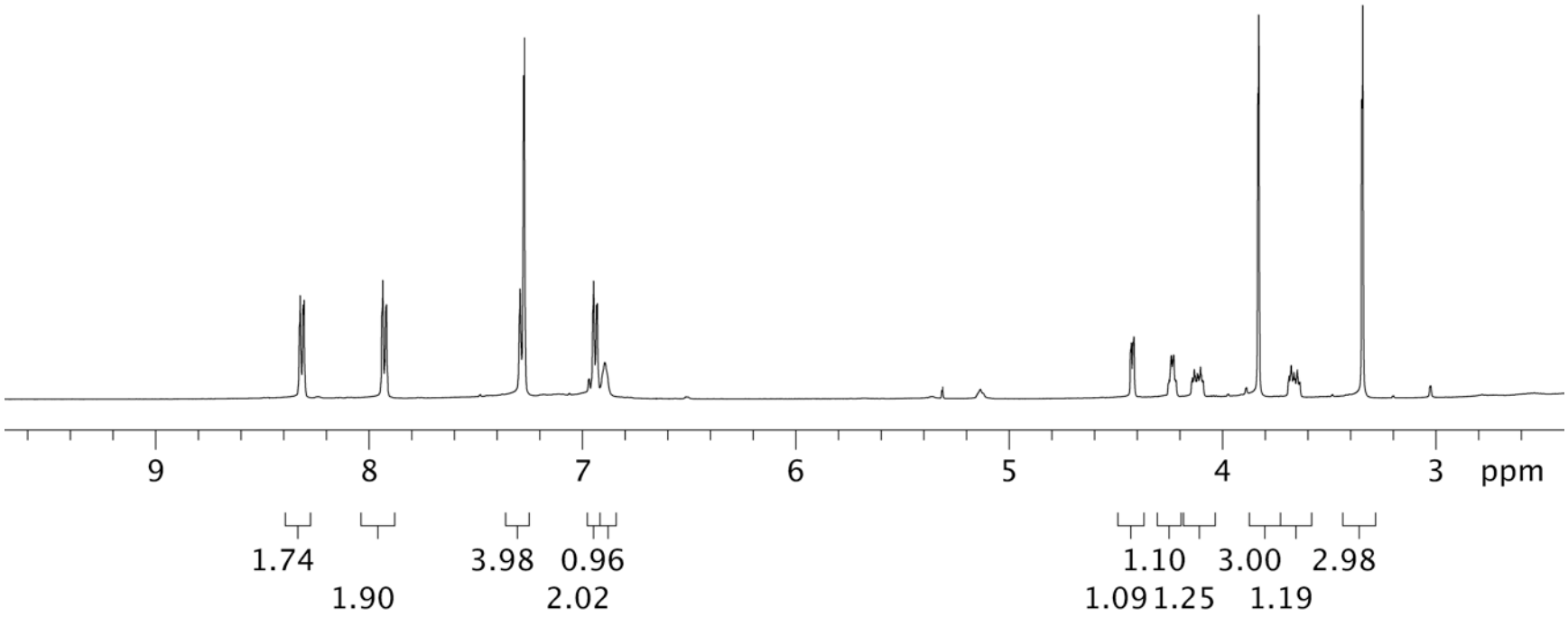


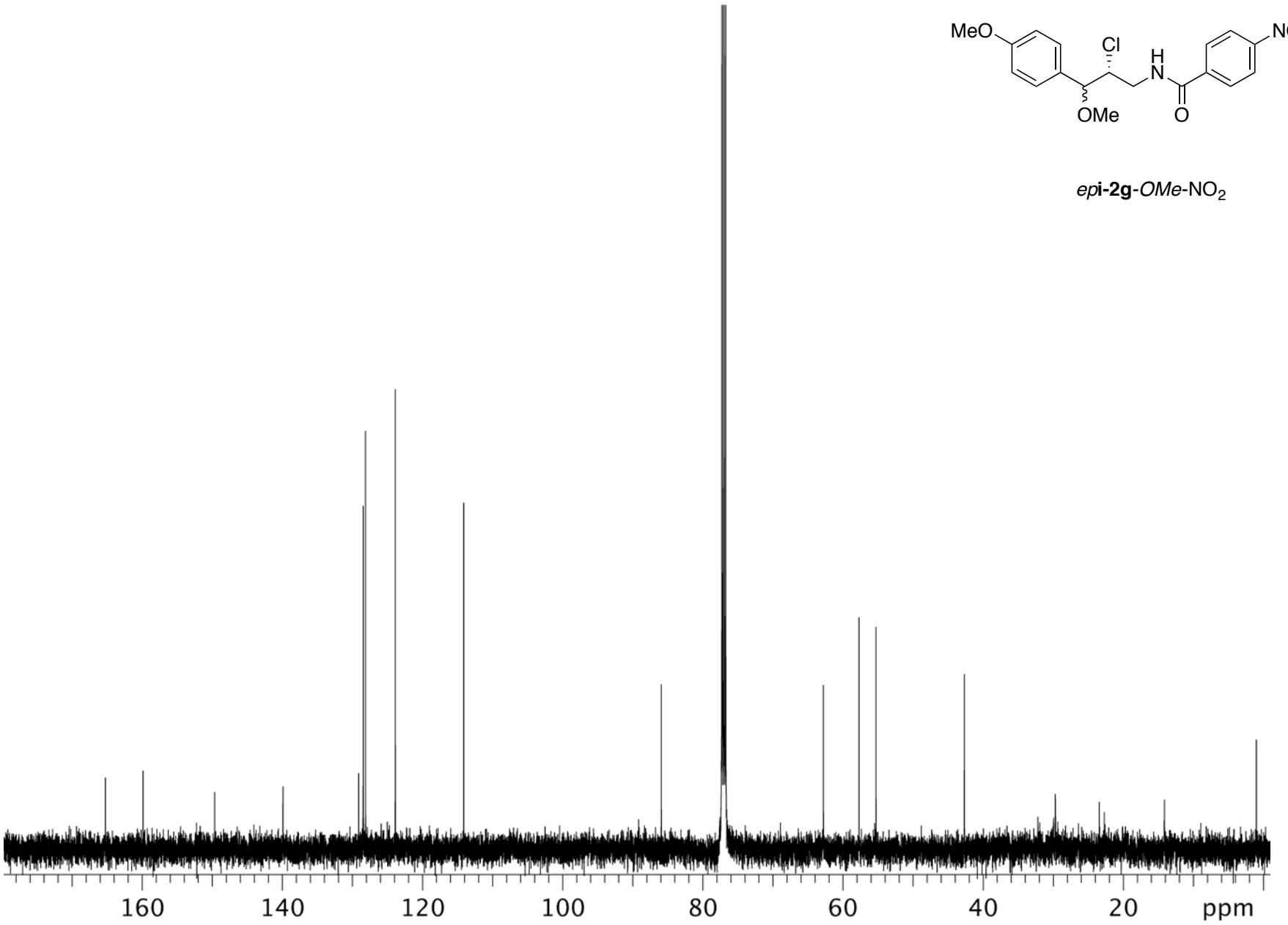
2g-*OMe*-NO_2



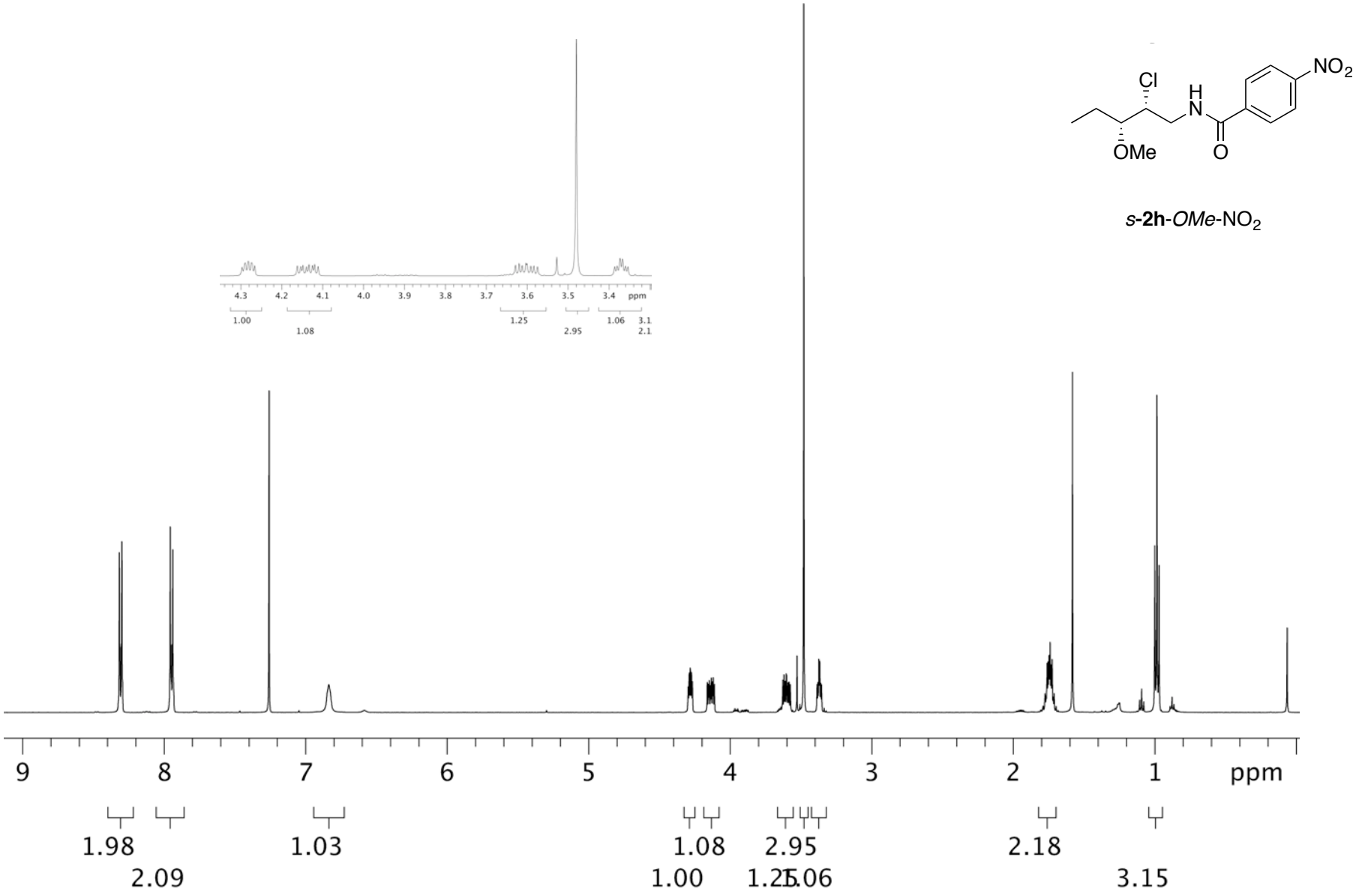


epi-**2g**-*OMe*-NO_2

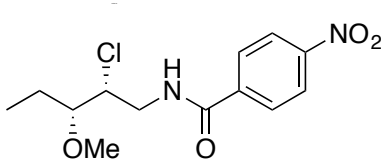




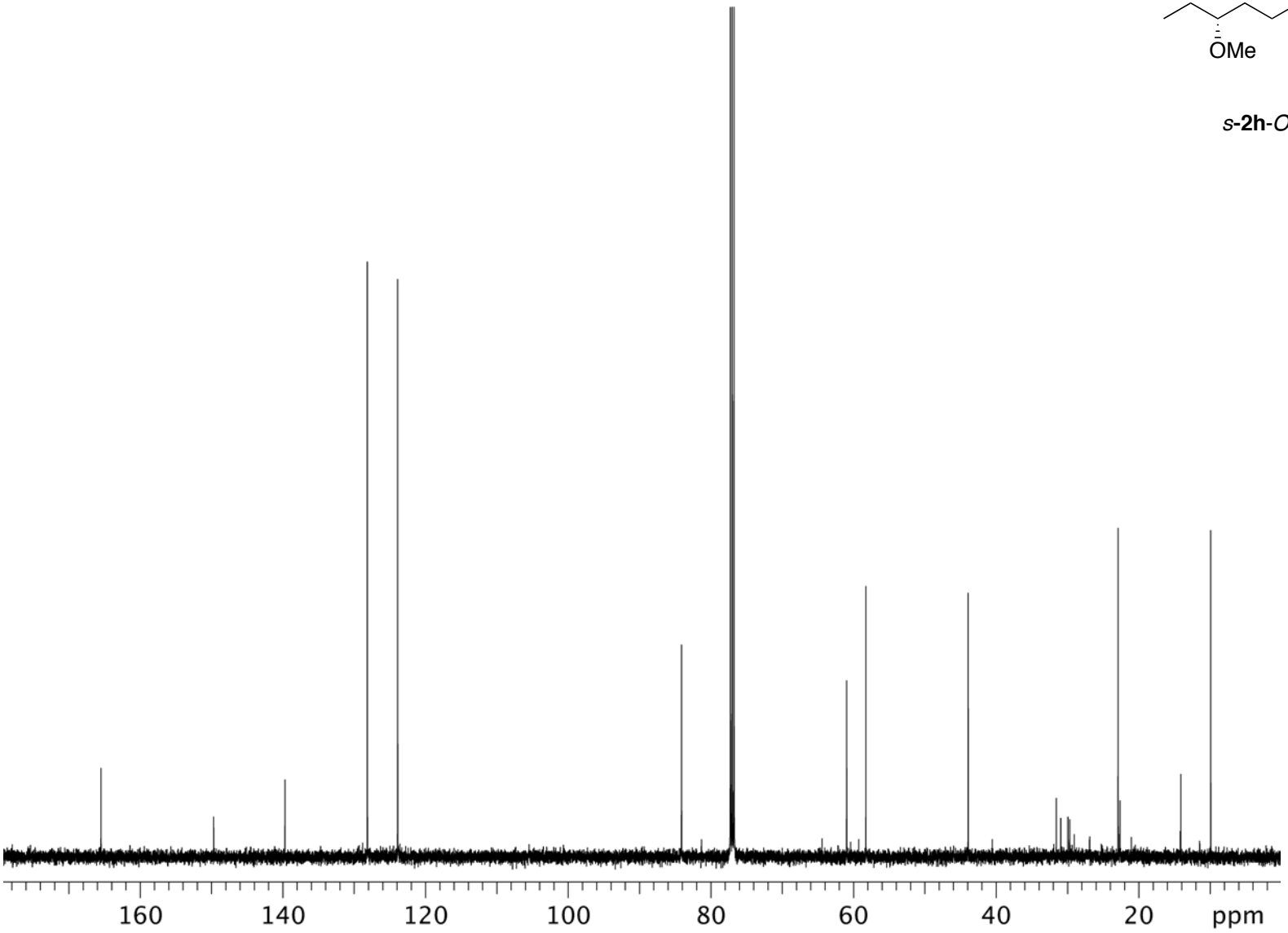
epi-**2g**-*OMe*-NO_2

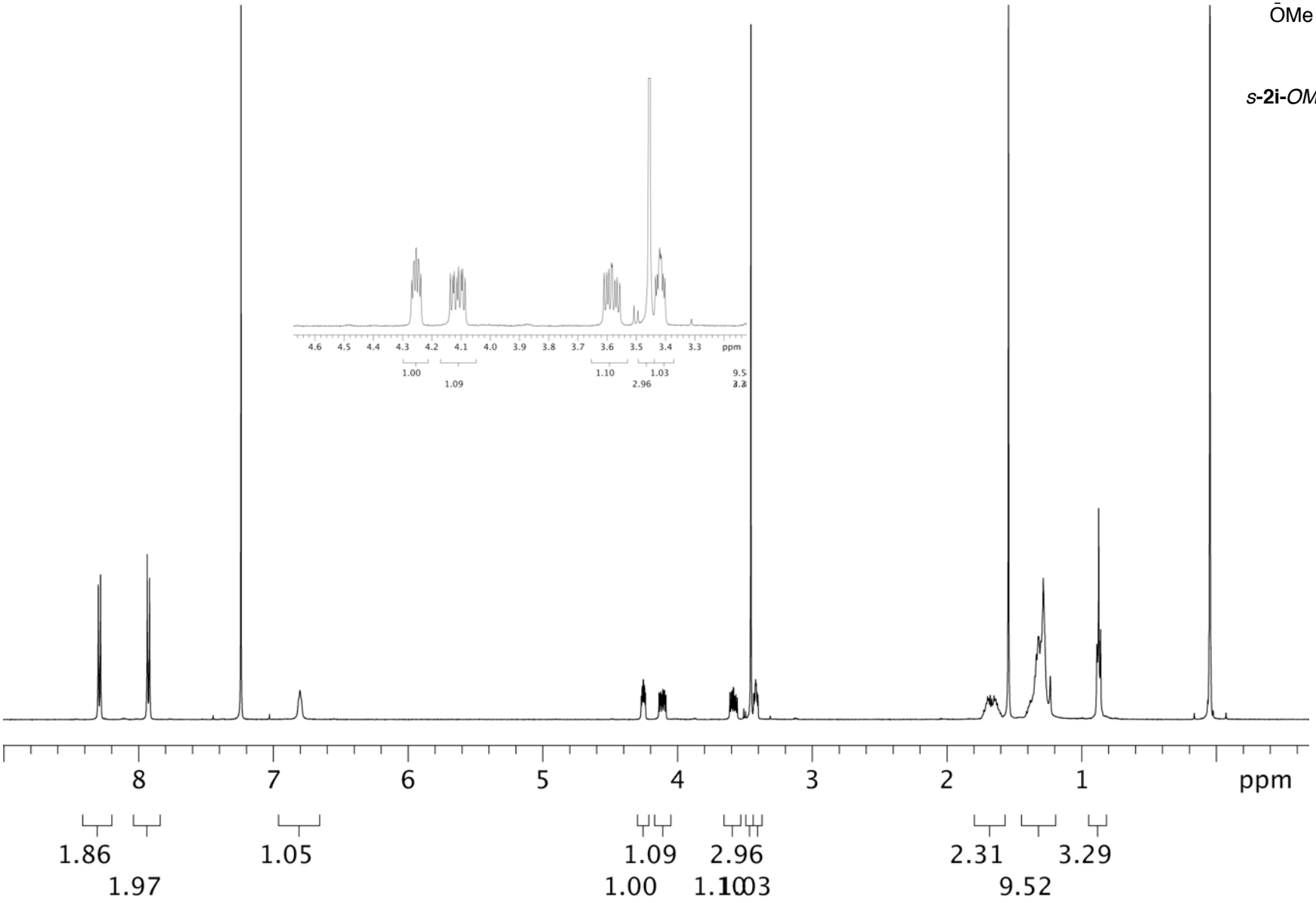

Cl
H
N
O
OMe
NO2
4.3
4.2
4.1
4.0
3.9
3.8
3.7
3.6
3.5
3.4
ppm
1.00
1.08
1.25
2.95
1.06
9
8
7
6
5
4
3
2
1
ppm
1.98
2.09
1.03
1.08
1.00
2.95
1.25
5.06
2.18
3.15

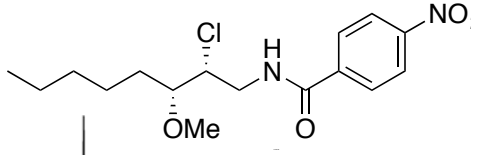
s-**2h**-*OMe*-NO_2



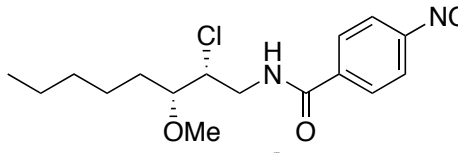
s-**2h**-*OMe*-NO_2



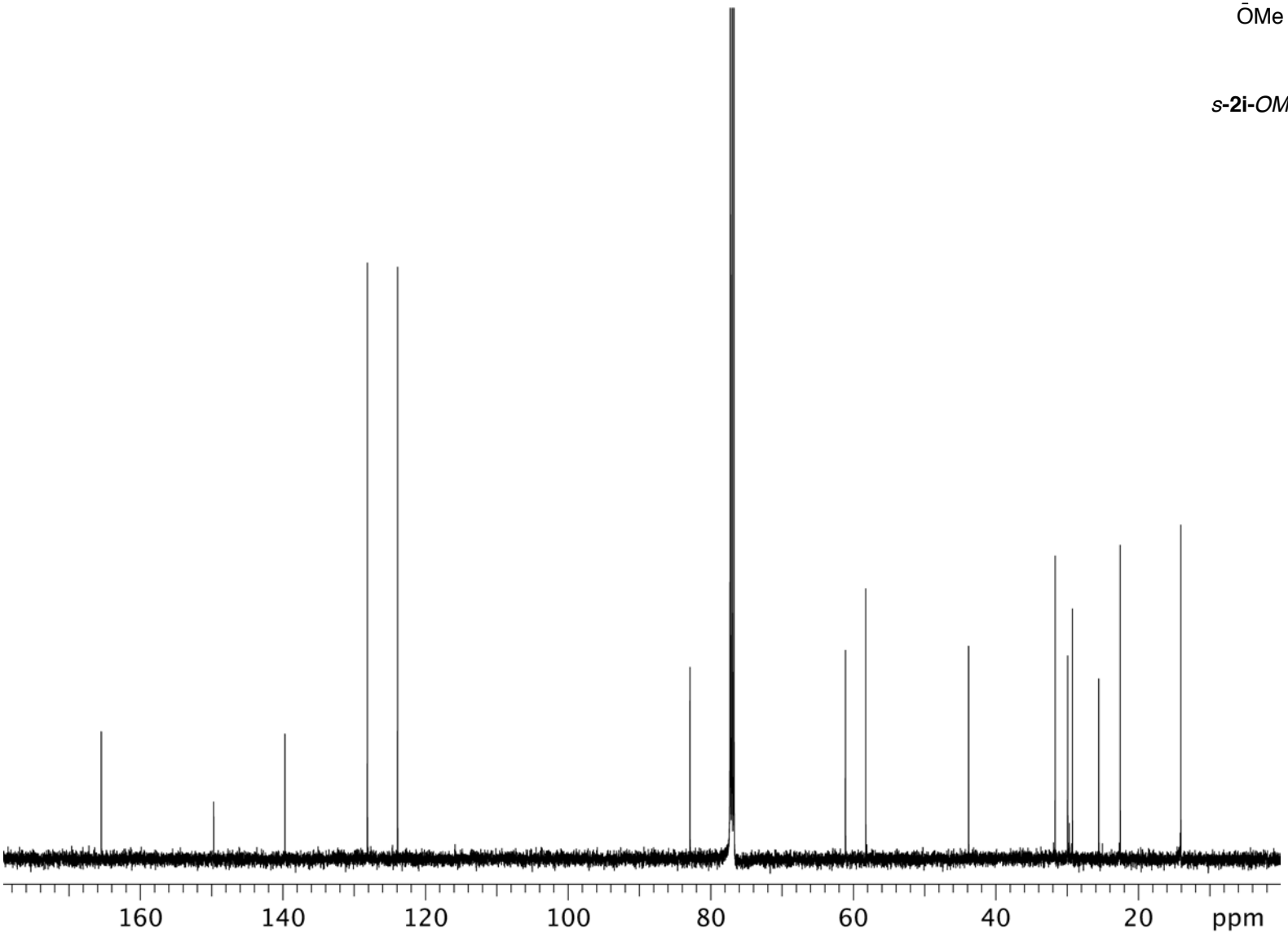

8
7
6
5
4
3
2
1
ppm
1.86
1.97
1.05
1.09
1.00
2.96
1.10
1.03
2.31
9.52
3.29

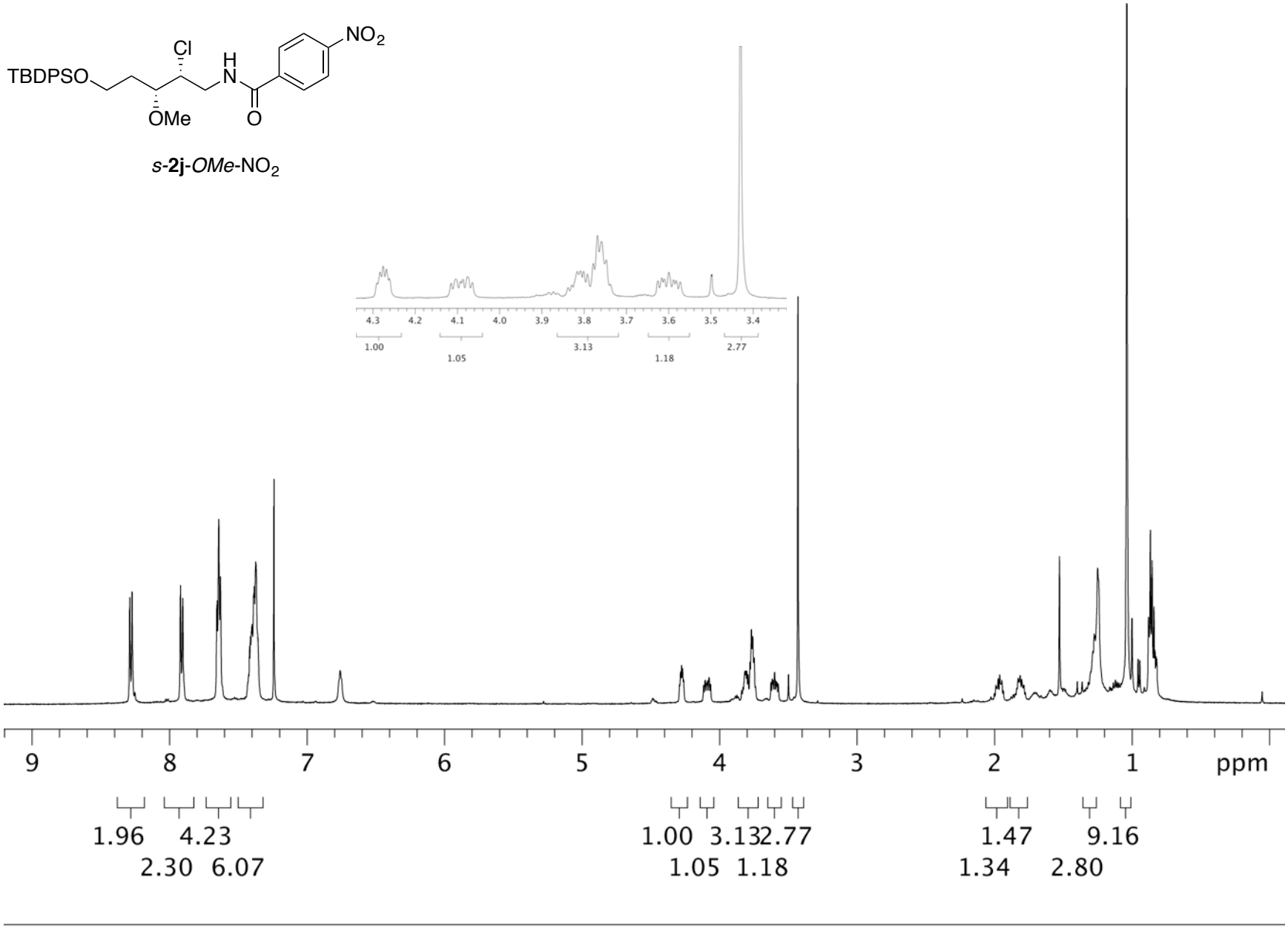

Cl
H
N
OMe
O
NO

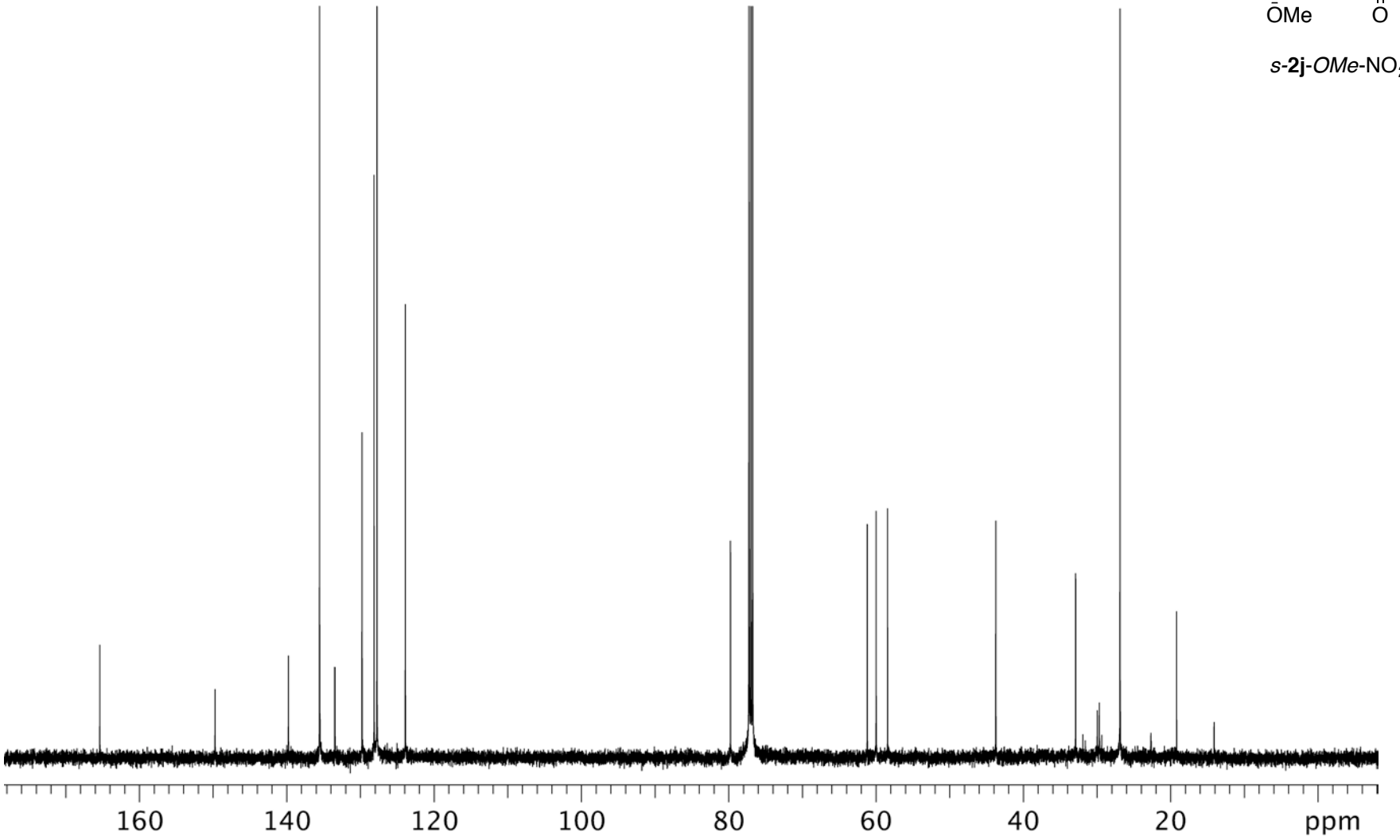
s-**2i**-*OMe*-NO_2



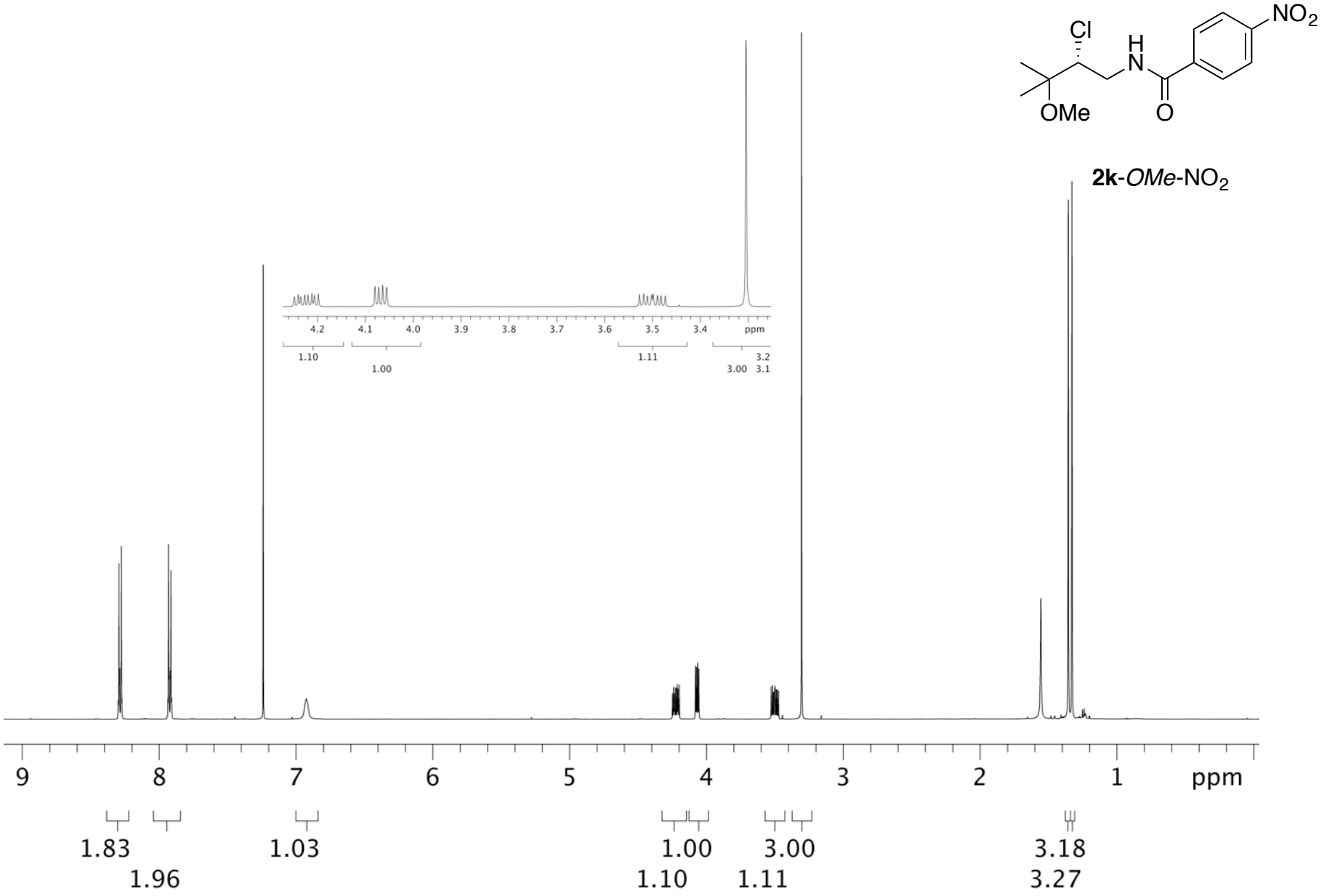
s-**2i**-*OMe*-NO_2

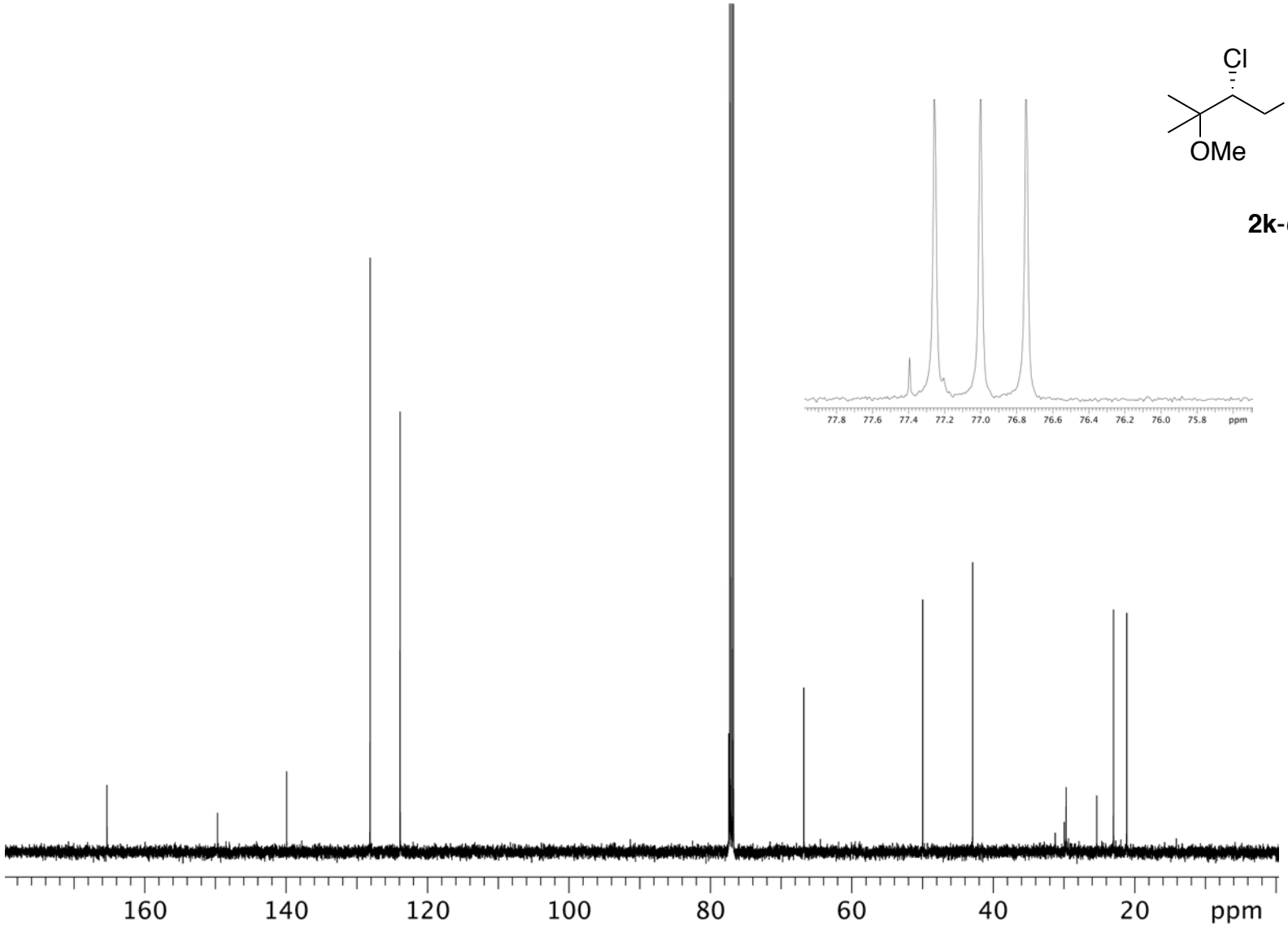



TBDPSO
Cl
H
N
O
NO2
OMe
s-2j-OMe-NO2
4.3 4.2 4.1 4.0 3.9 3.8 3.7 3.6 3.5 3.4
1.00 1.05 3.13 1.18 2.77
9 8 7 6 5 4 3 2 1 ppm
1.96 4.23 2.30 6.07
1.00 3.13 2.77 1.05 1.18
1.47 9.16 1.34 2.80

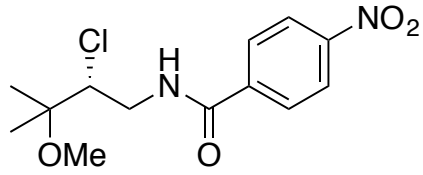


s-**2j**-*OMe*-NO_2

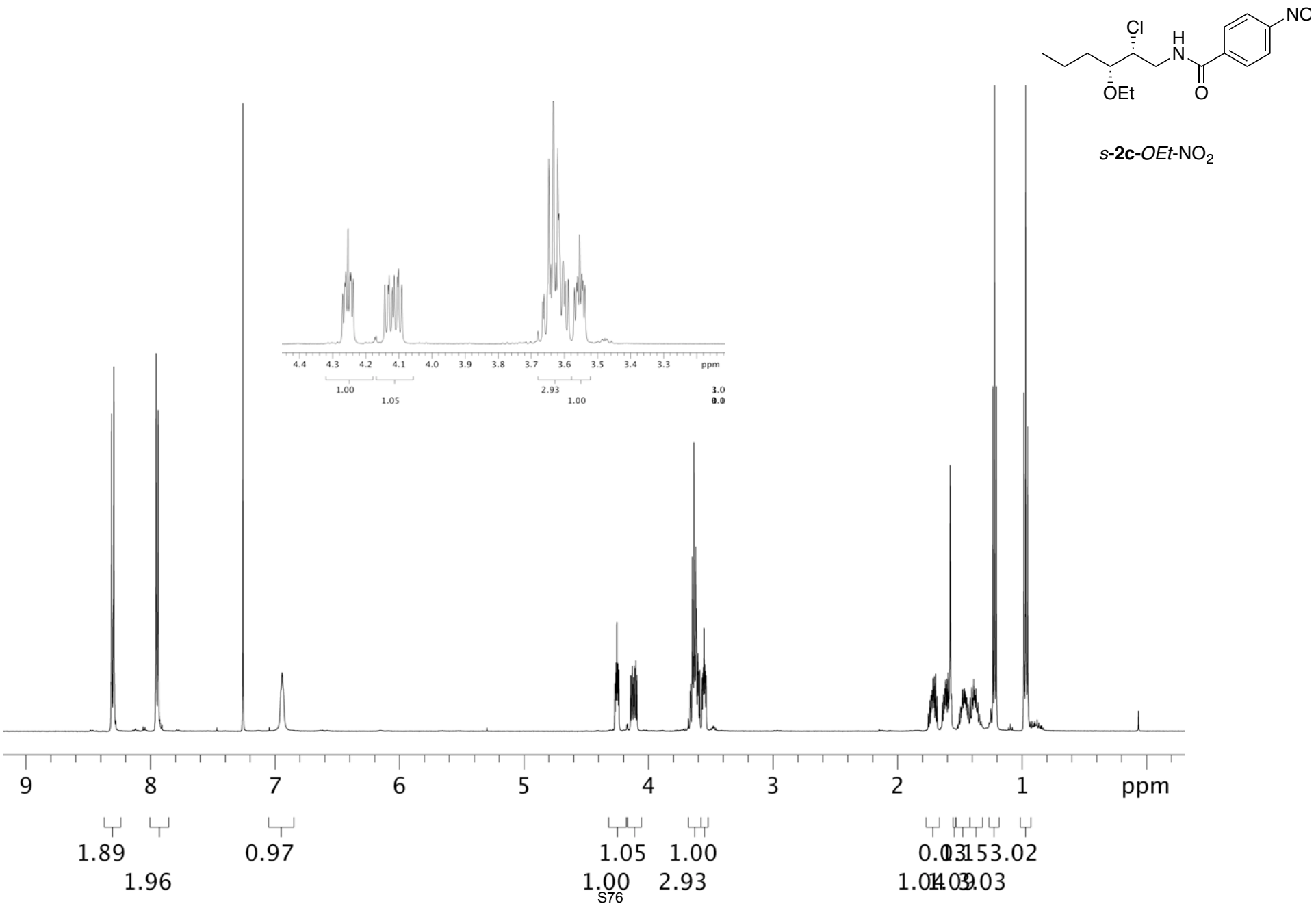

Cl
H
N
NO2
OMe
O
2k-OMe-NO2
4.2
4.1
4.0
3.9
3.8
3.7
3.6
3.5
3.4
ppm
1.10
1.00
1.11
3.00
3.2
3.1
9
8
7
6
5
4
3
2
1
ppm
1.83
1.96
1.03
1.00
1.10
3.00
1.11
3.18
3.27

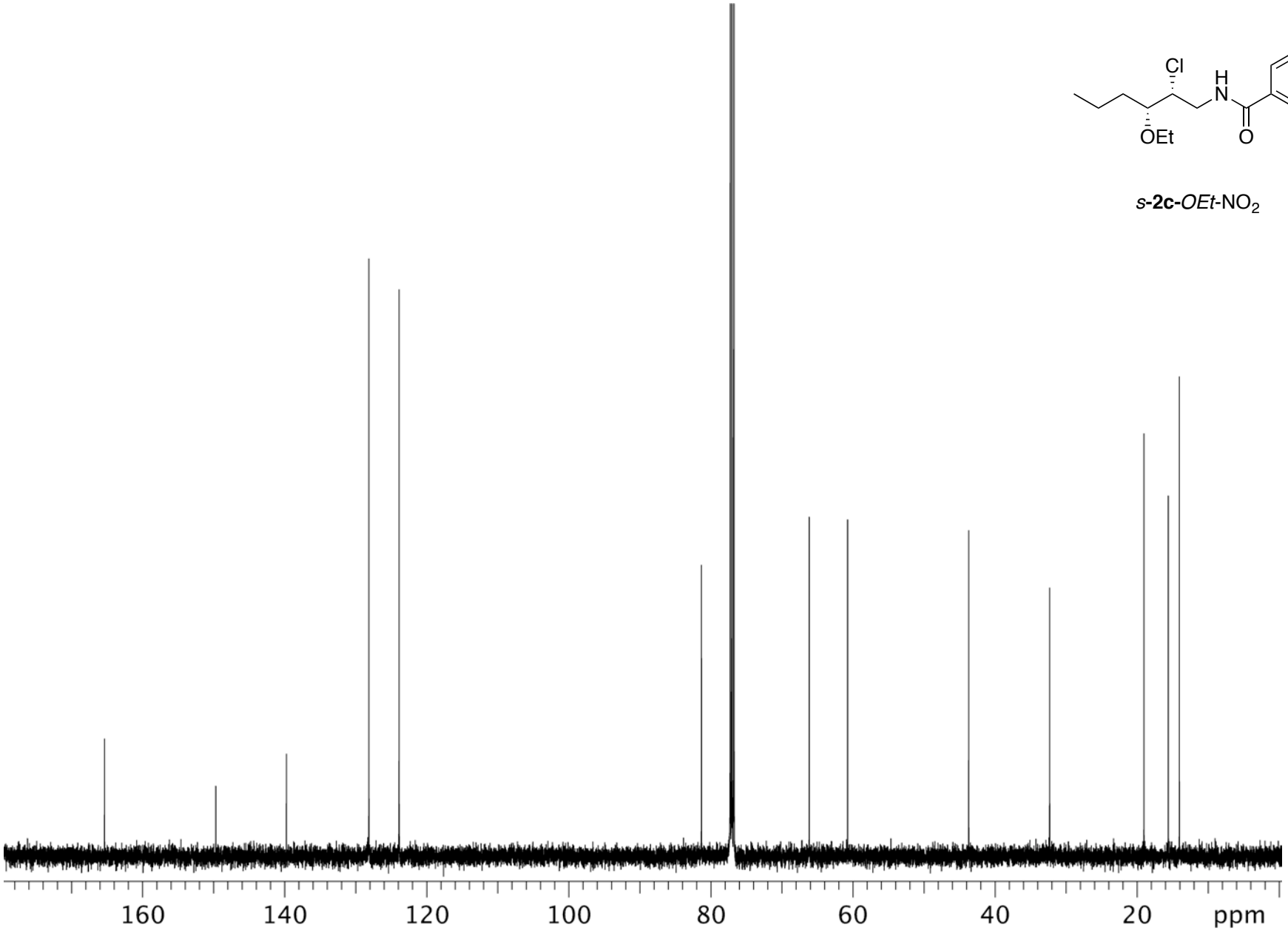

160
140
120
100
80
60
40
20
ppm

77.8
77.6
77.4
77.2
77.0
76.8
76.6
76.4
76.2
76.0
75.8
ppm

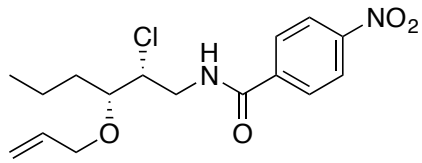

Cl
H
N
O
OMe
NO2

2k-*OMe*-NO_2

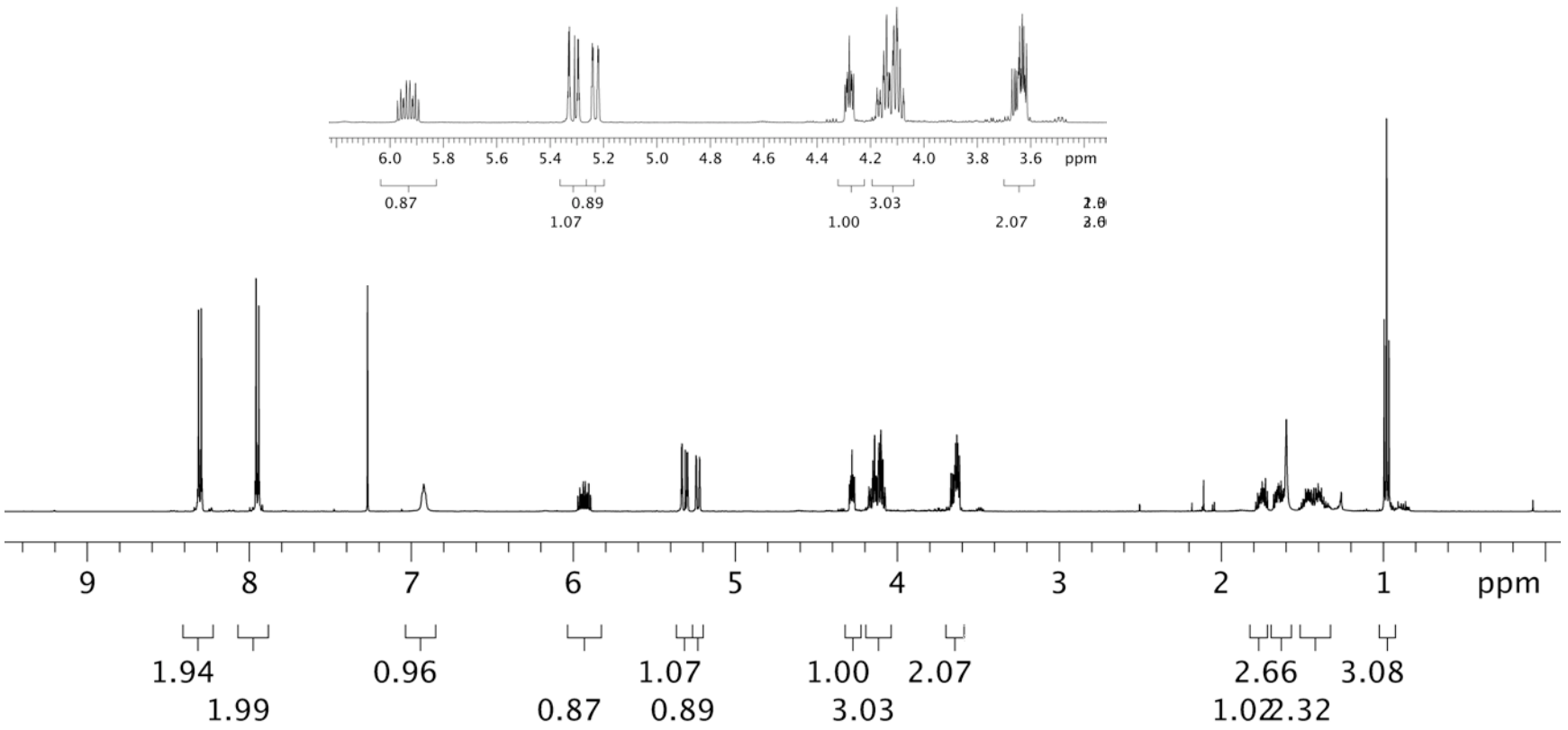

Cl
H
N
OEt
O
NO
s-2c-OEt-NO2
4.4 4.3 4.2 4.1 4.0 3.9 3.8 3.7 3.6 3.5 3.4 3.3 ppm
1.00
1.05
2.93
1.00
9 8 7 6 5 4 3 2 1 ppm
1.89
1.96
0.97
1.05
1.00
1.00
2.93
3.02
1.03

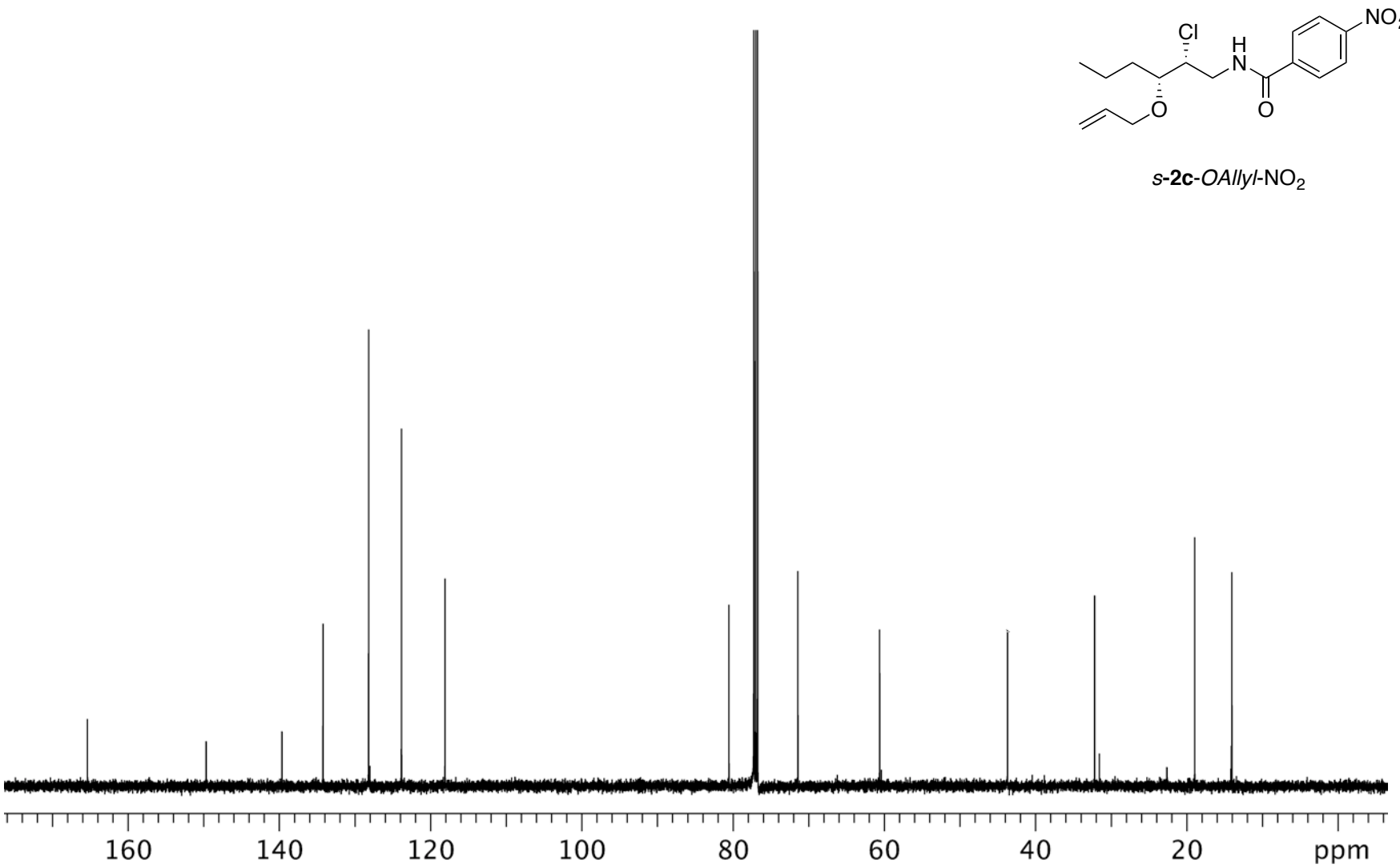


s-**2c**-*OEt*-NO_2

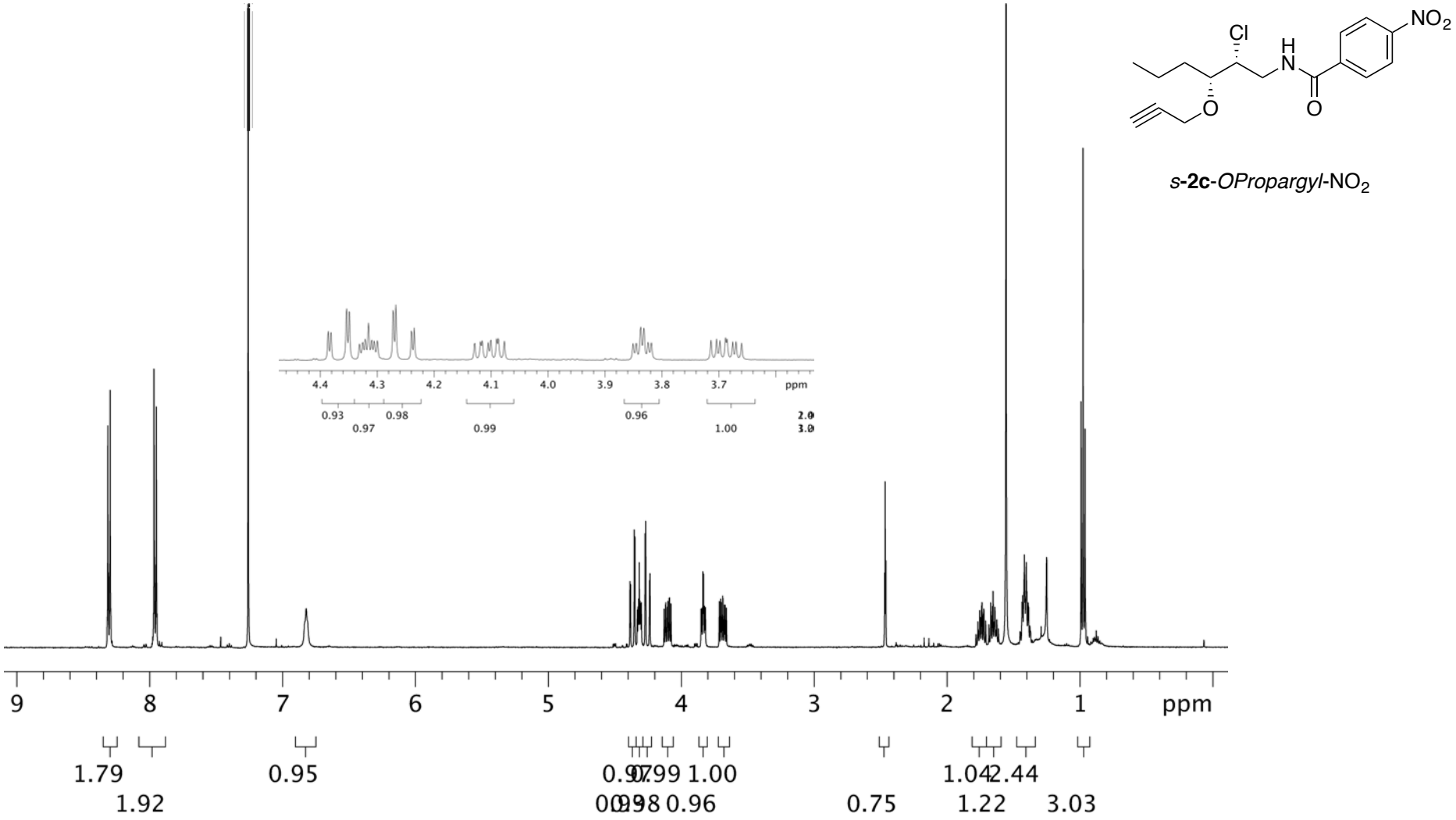


s-**2c**-*OAllyl*-NO_2

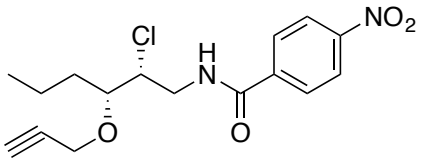




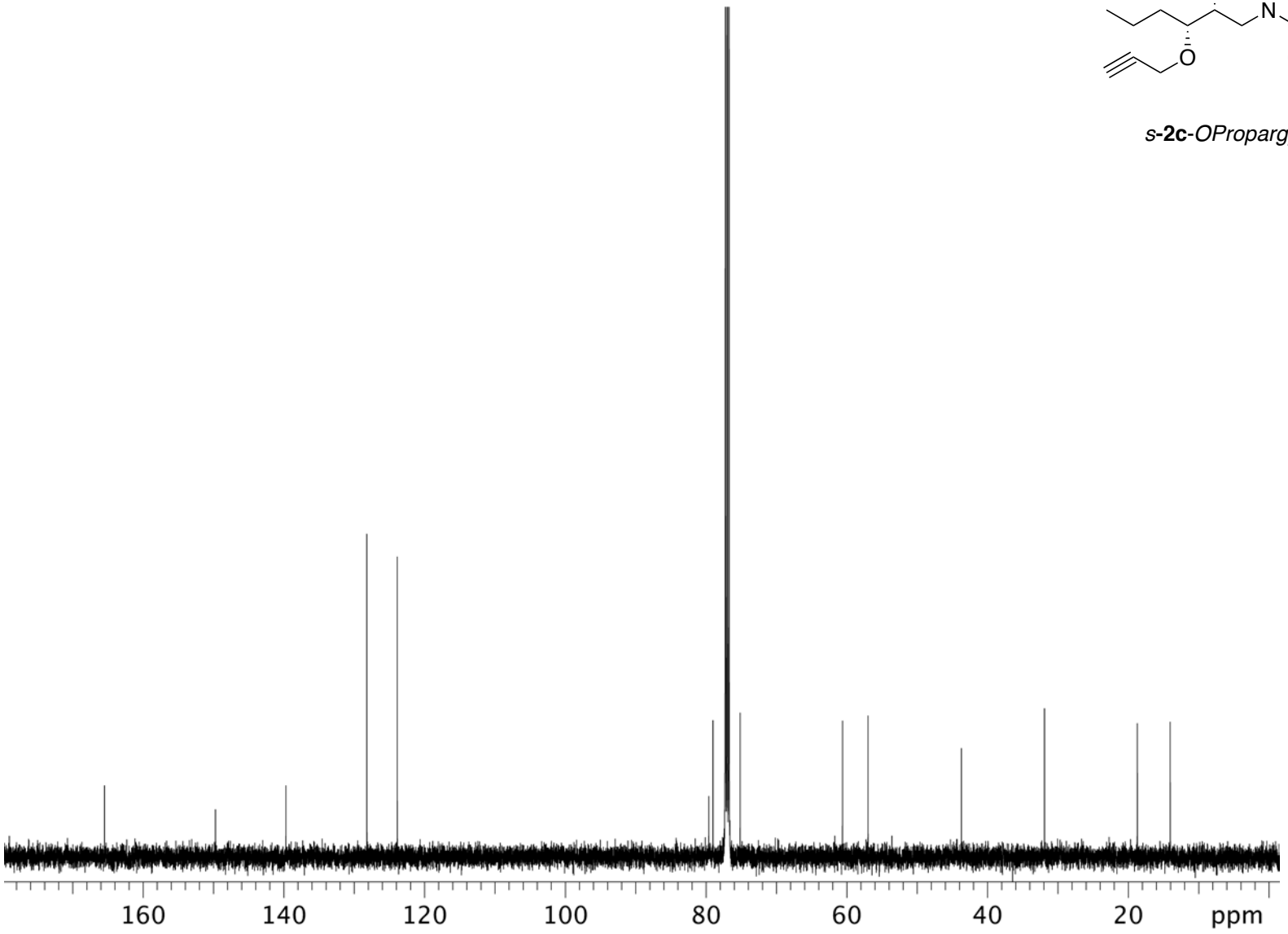
s-**2c**-*OAllyl*-NO_2

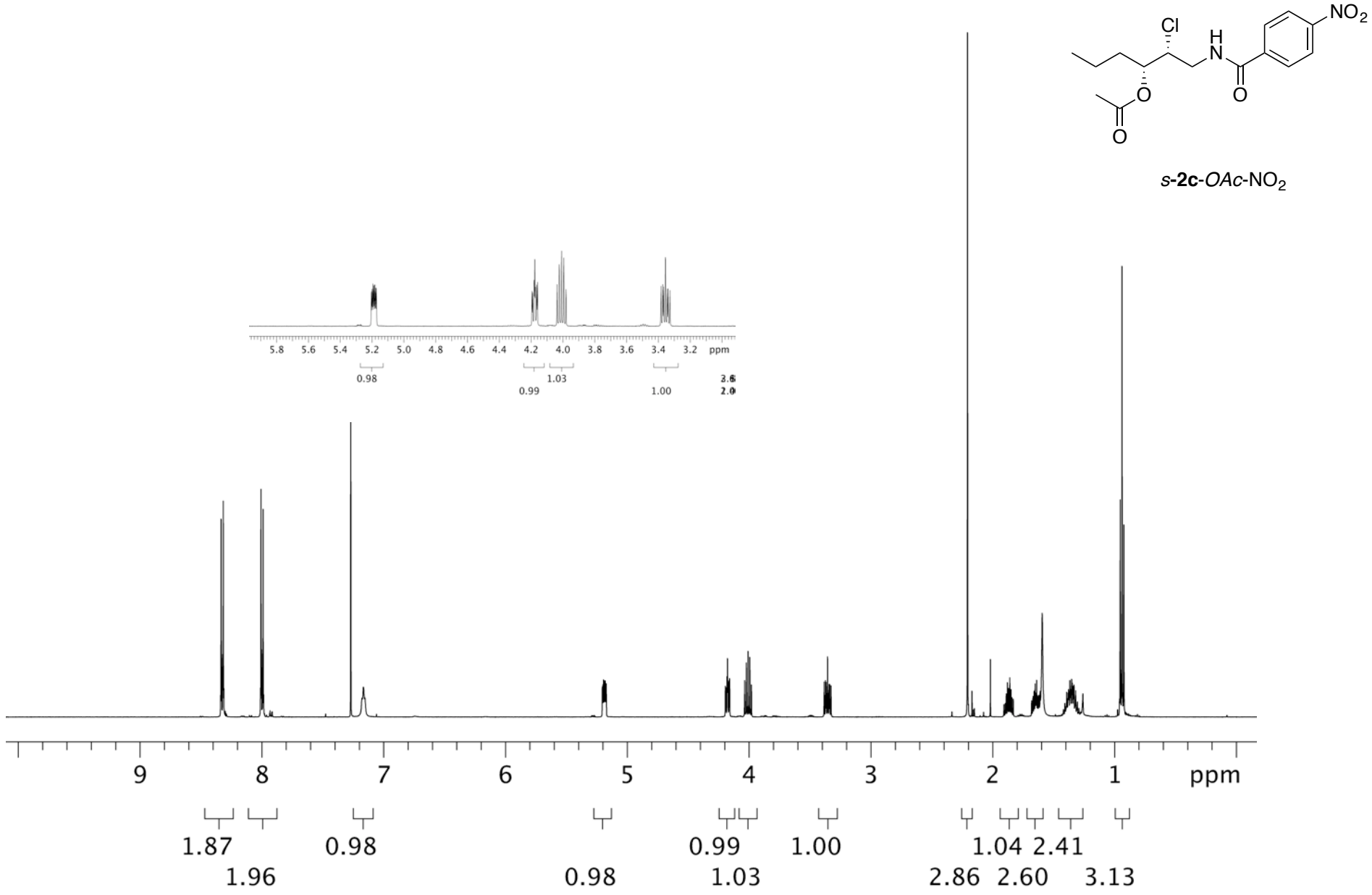


s-**2c**-*OPropargyl*-NO_2

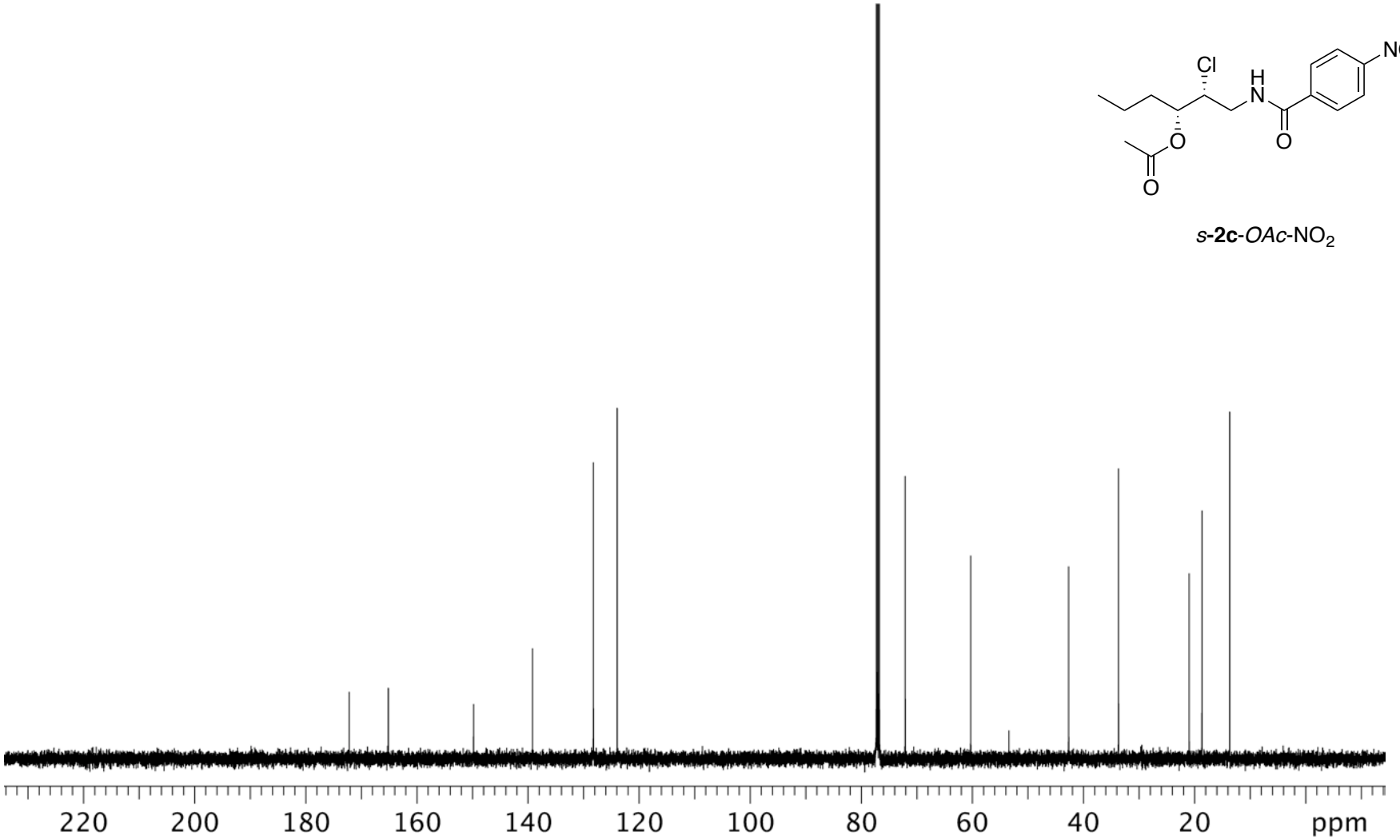


s-**2c**-*OPropargyl*-NO_2

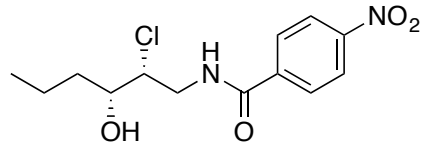



Cl
H
N
O
O
O
O
NO2
5.8 5.6 5.4 5.2 5.0 4.8 4.6 4.4 4.2 4.0 3.8 3.6 3.4 3.2 ppm
0.98
1.03
0.99
1.00
9 8 7 6 5 4 3 2 1 ppm
1.87
1.96
0.98
0.98
0.99
1.03
1.00
1.04
2.41
2.86
2.60
3.13

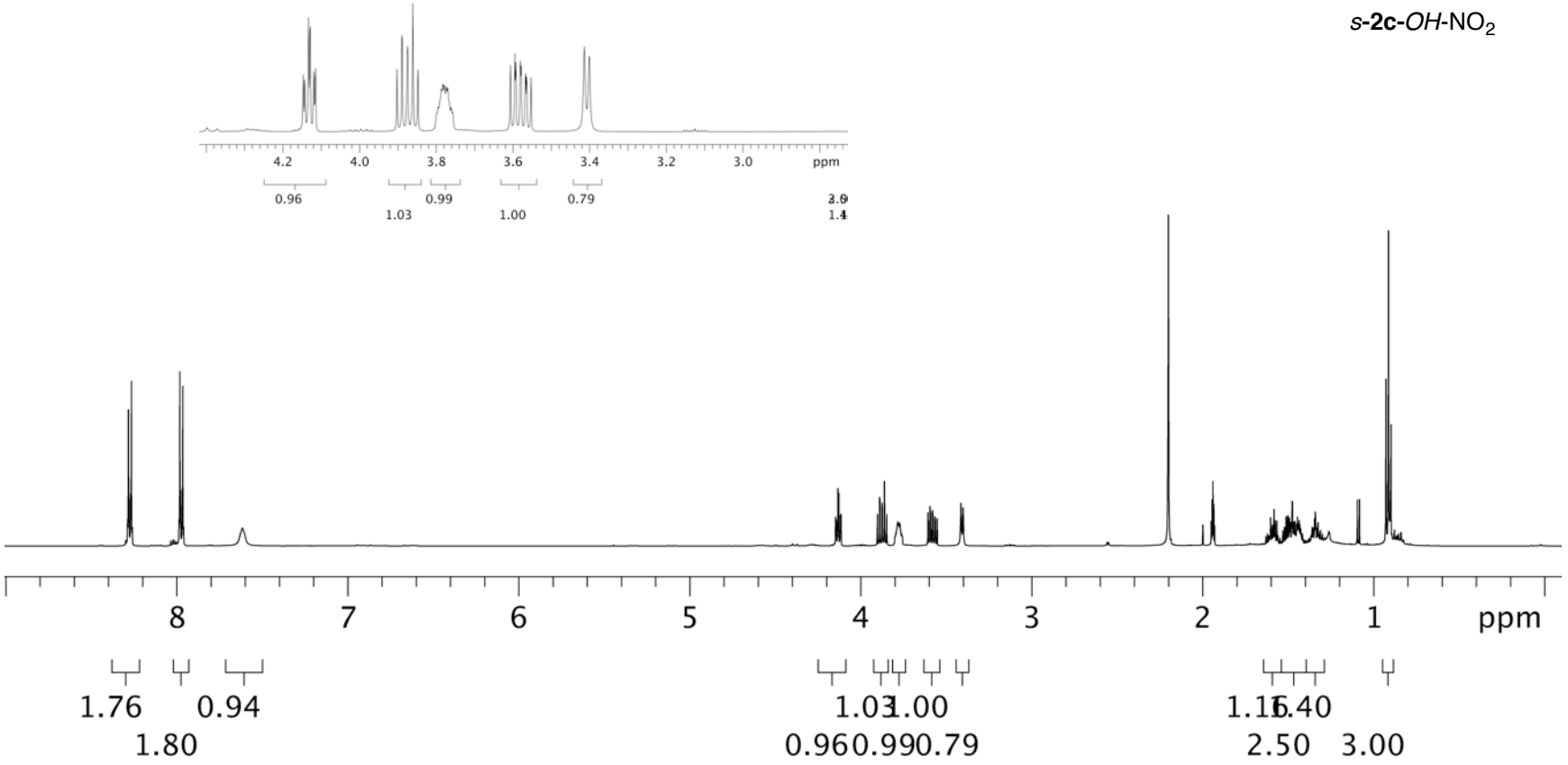
s-**2c**-*OAc*-NO_2

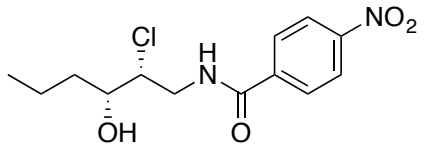


s-**2c**-*OAc*-NO_2

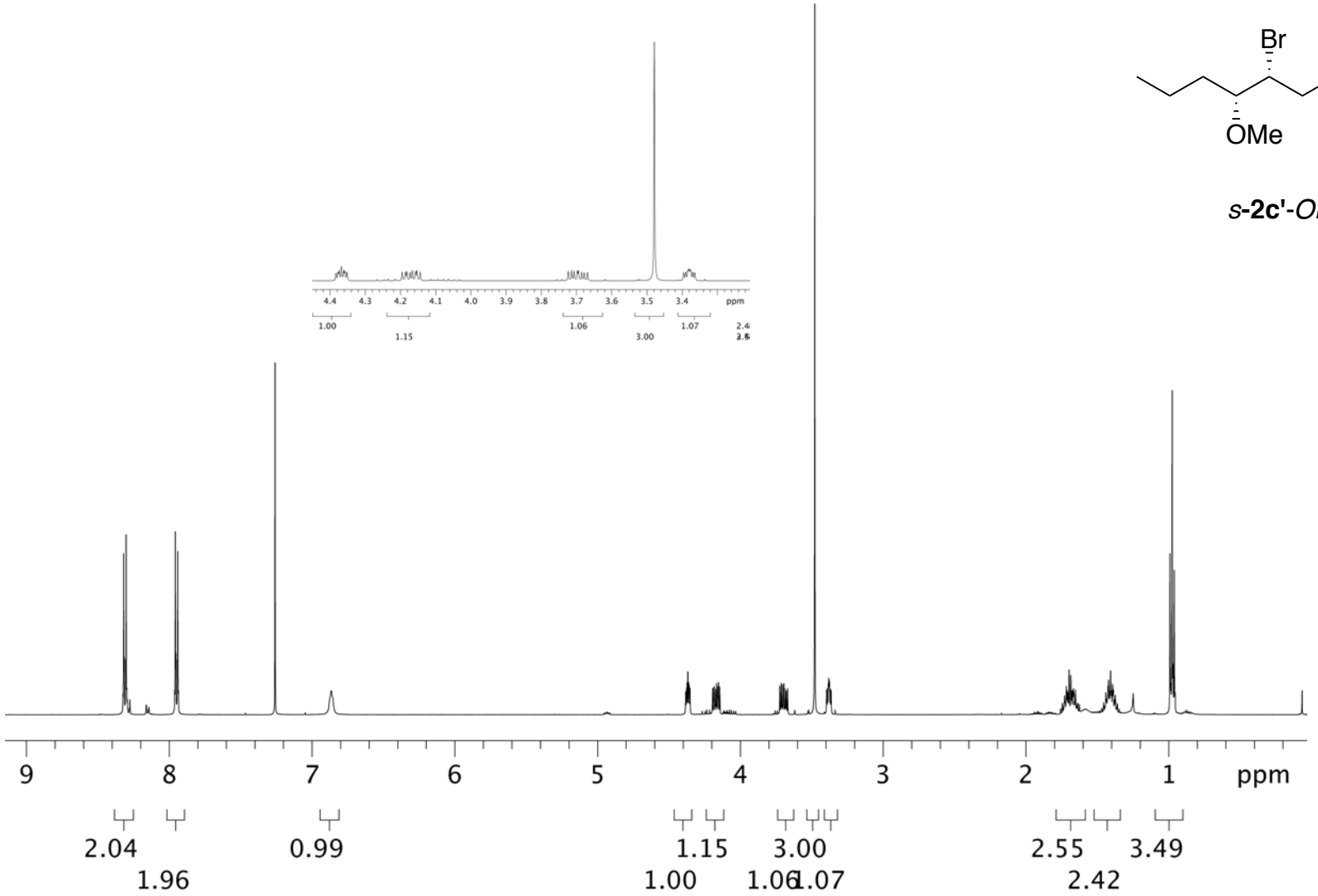

Cl
H
N
NO2
OH
O

s-**2c**-*OH*-NO_2

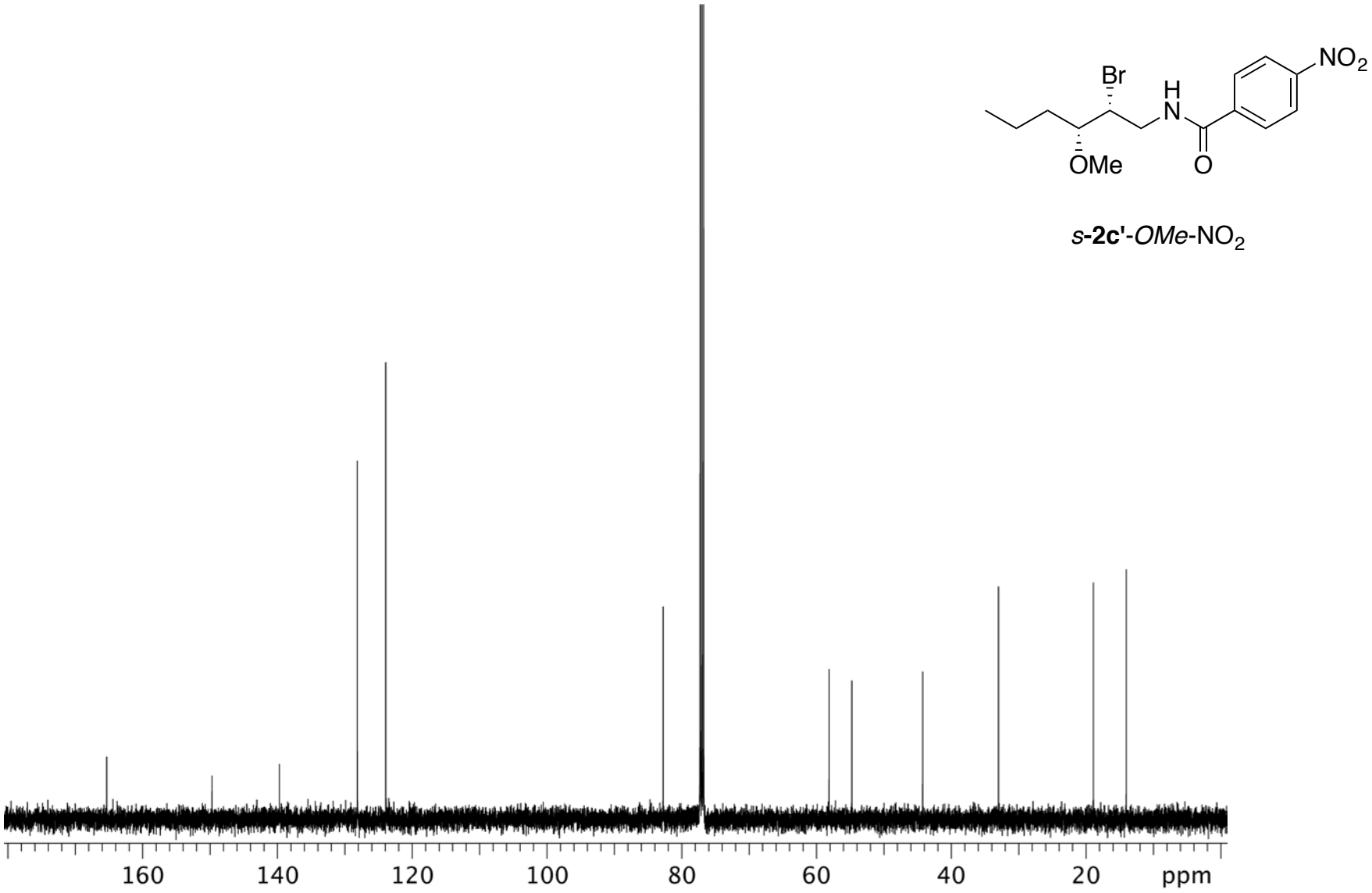

4.2
4.0
3.8
3.6
3.4
3.2
3.0
ppm
0.96
1.03
0.99
1.00
0.79
8
7
6
5
4
3
2
1
ppm
1.76
0.94
1.80
1.03
1.00
0.96
0.99
0.79
1.16
6.40
2.50
3.00



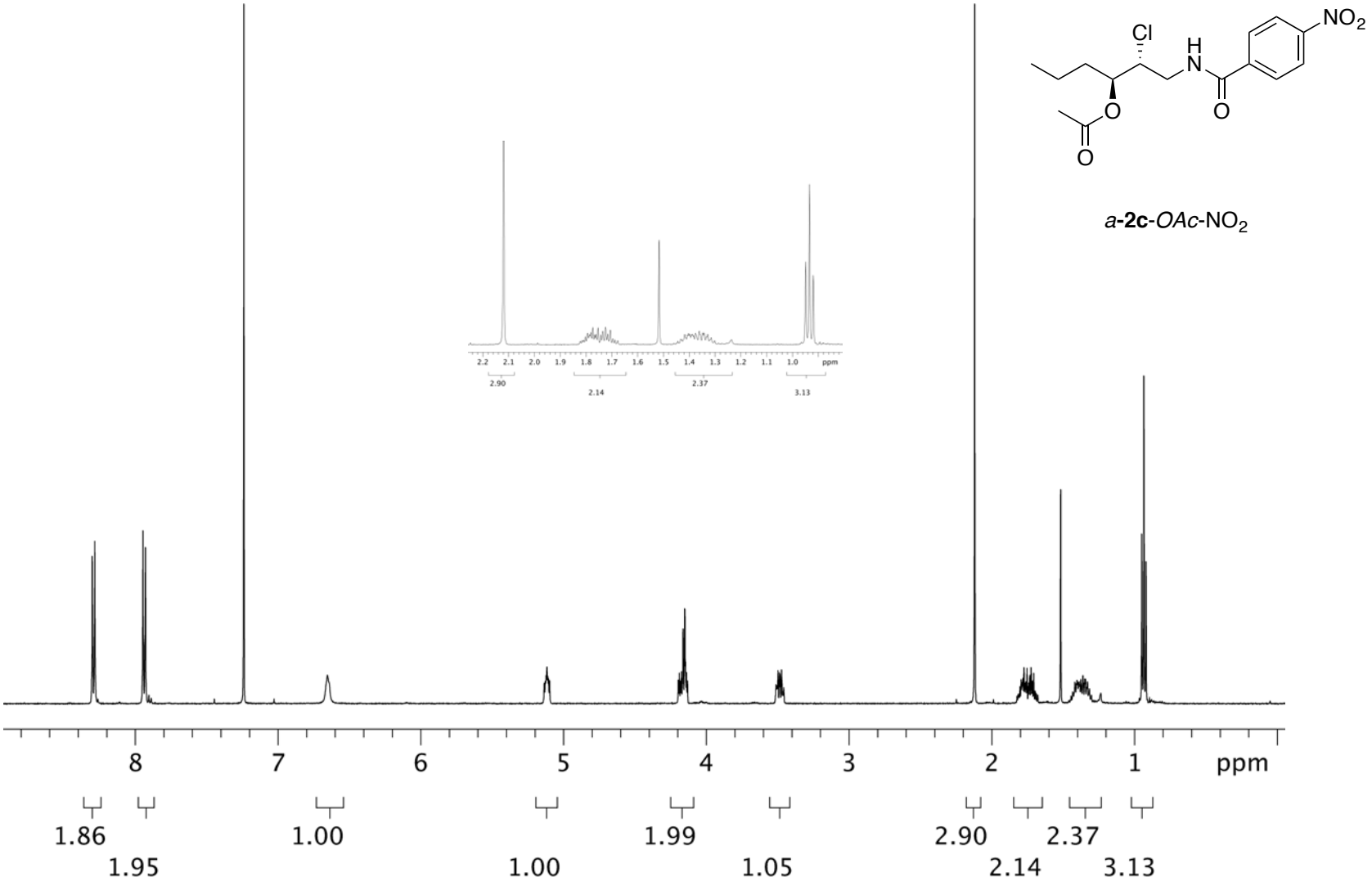
s-**2c**-*OH*-NO_2

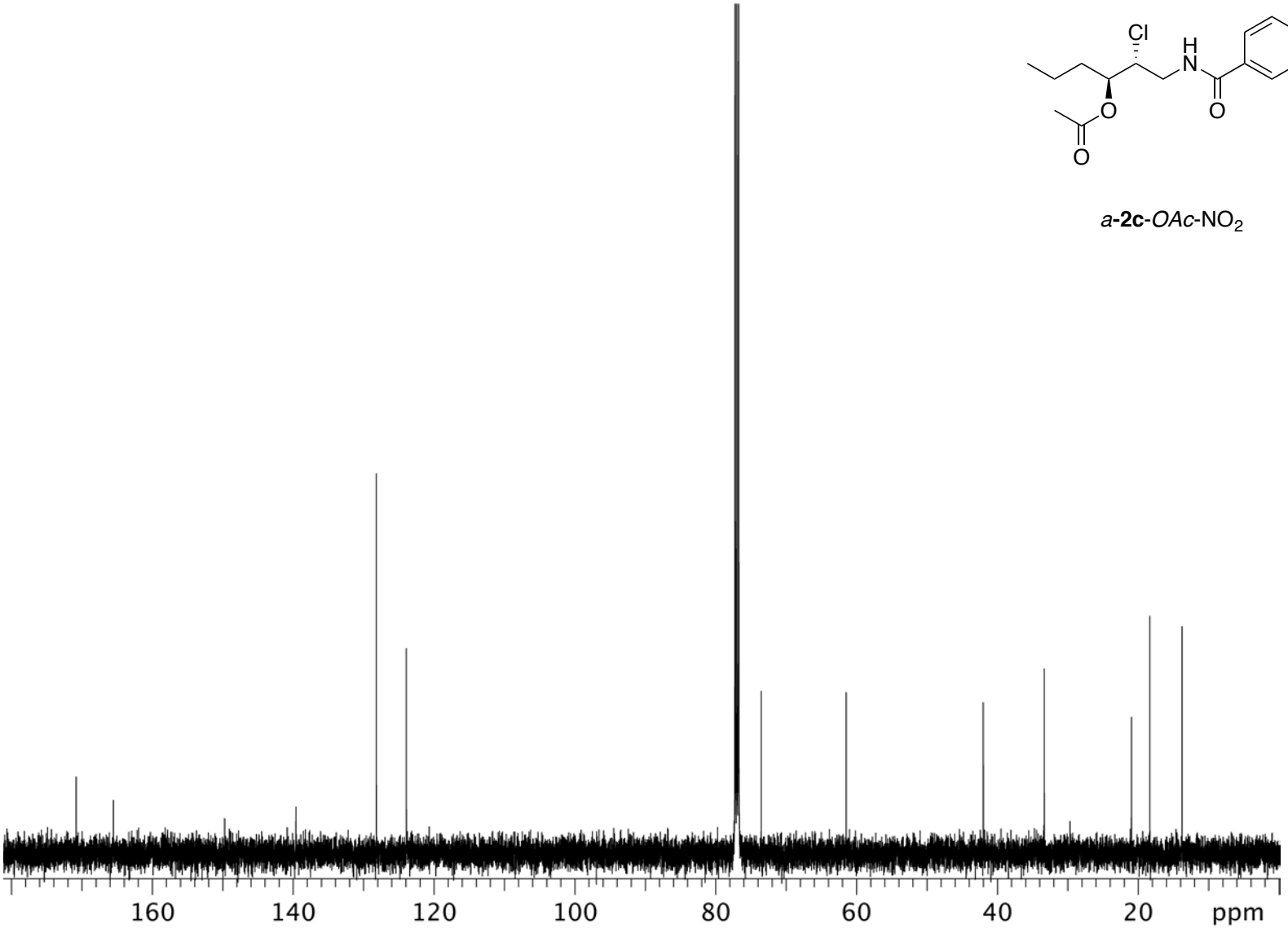

Br
H
N
NO2
OMe
O
4.4 4.3 4.2 4.1 4.0 3.9 3.8 3.7 3.6 3.5 3.4 ppm
1.00 1.15 1.06 3.00 1.07
9 8 7 6 5 4 3 2 1 ppm
2.04 1.96 0.99 1.00 1.15 1.06 3.00 1.07 2.55 2.42 3.49

s-**2c'**-*OMe*-NO_2

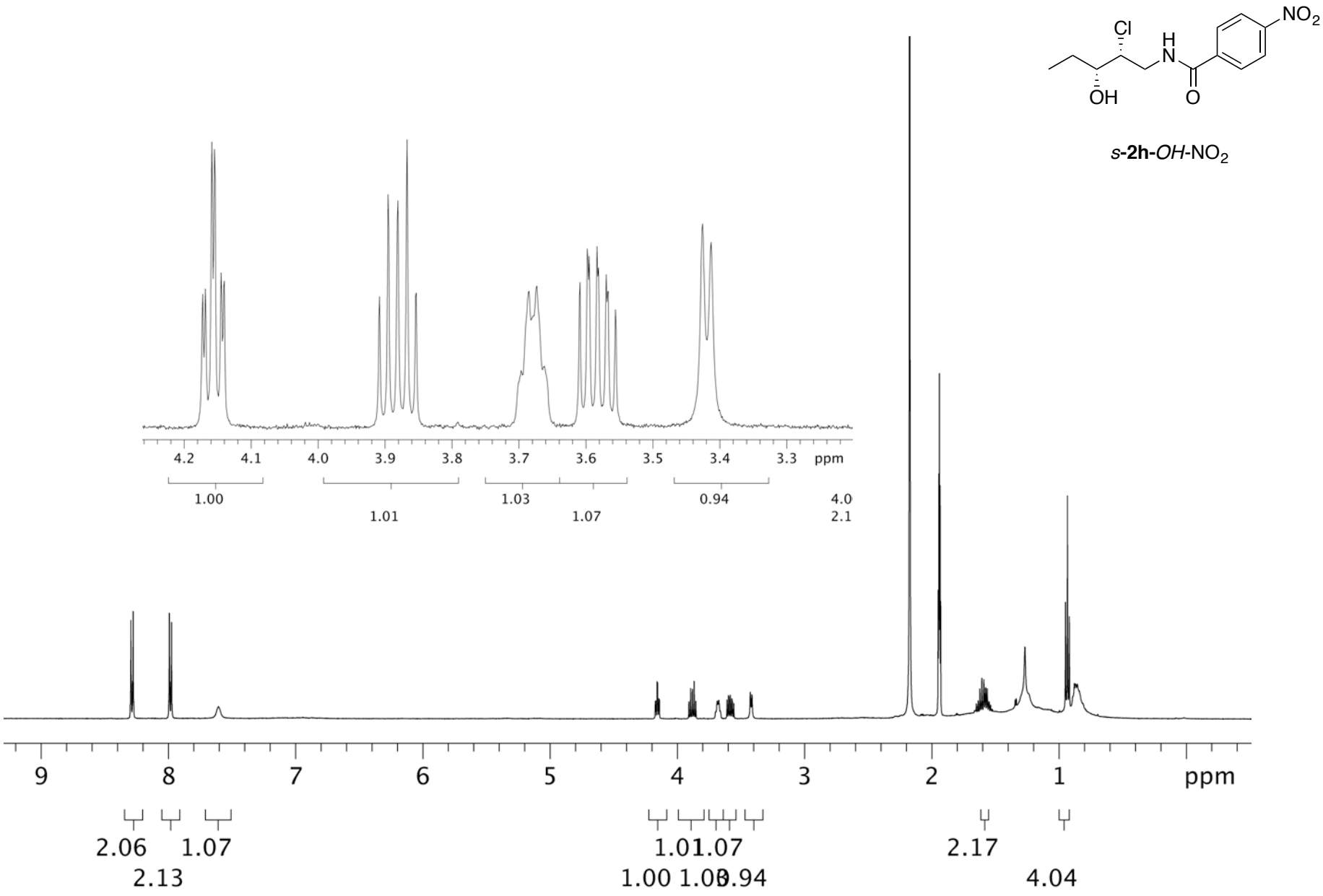


s-**2c'**-*OMe*-NO_2

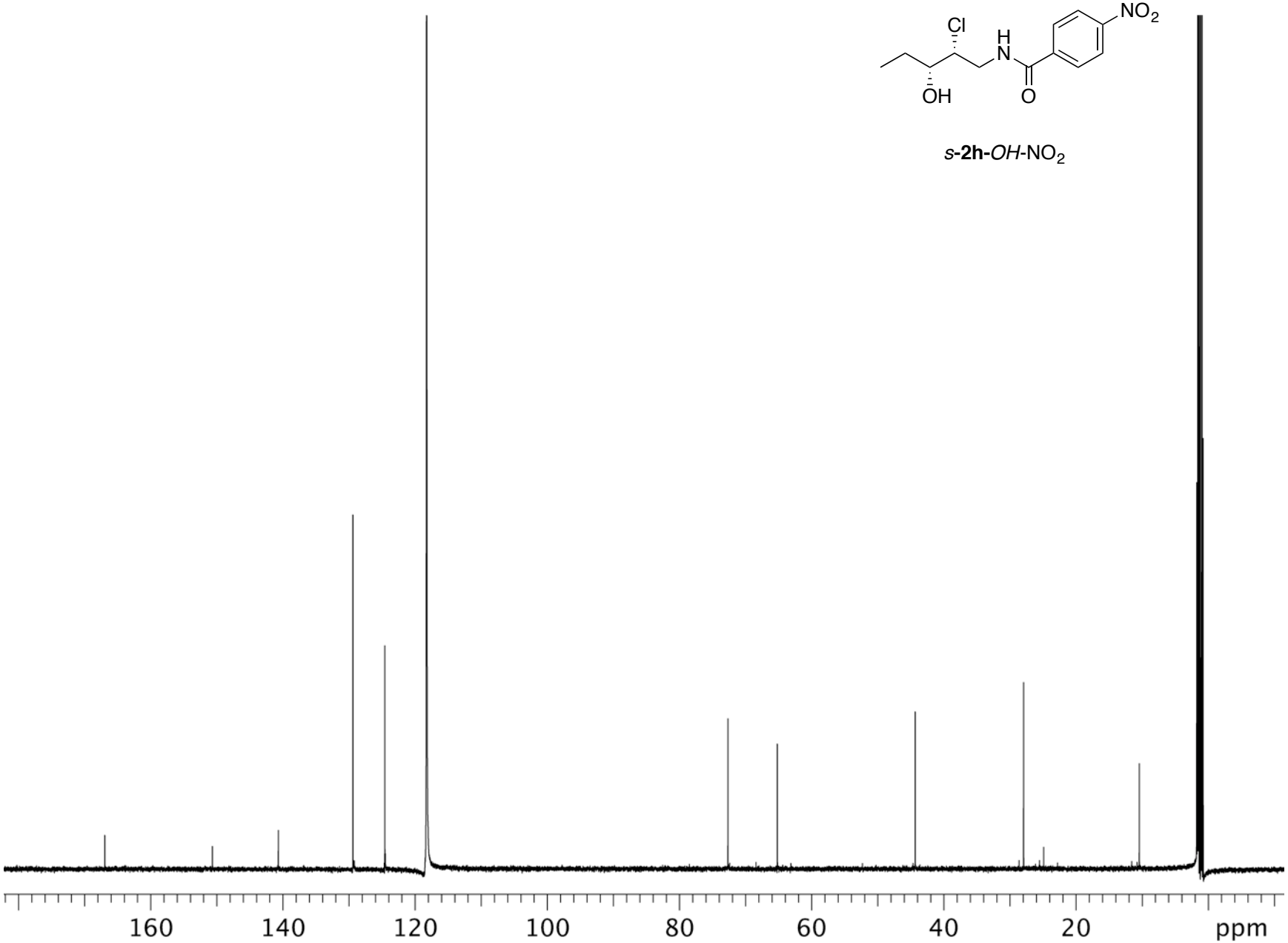

Cl
H
N
O
O
O
NO2
a-2c-OAc-NO2
8
7
6
5
4
3
2
1
ppm
1.86
1.95
1.00
1.00
1.99
1.05
2.90
2.14
2.37
3.13



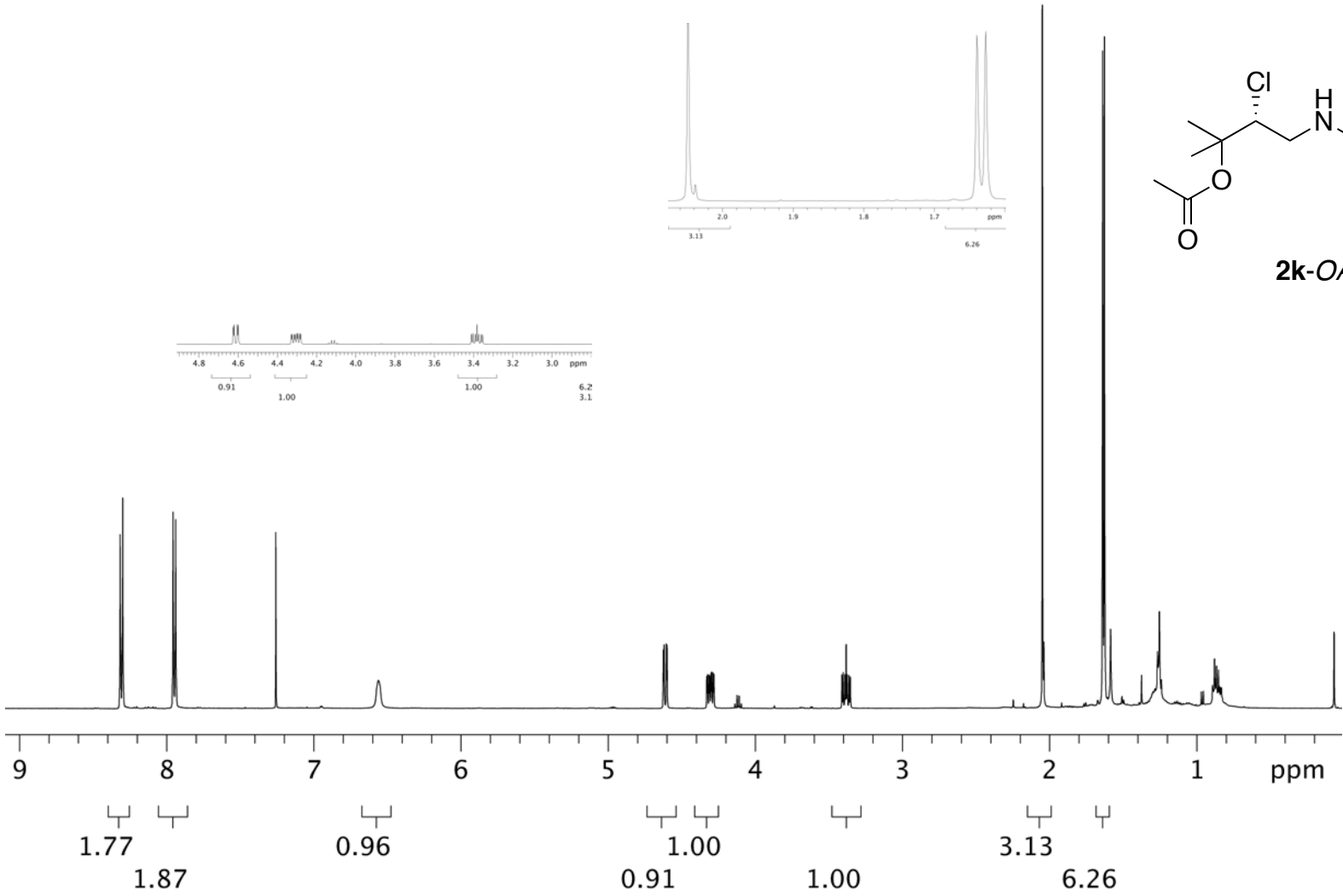
a-**2c**-*OAc*-NO_2


Cl
H
N
NO2
OH
O
4.2 4.1 4.0 3.9 3.8 3.7 3.6 3.5 3.4 3.3 ppm
1.00 1.01 1.03 1.07 0.94 4.0 2.1
9 8 7 6 5 4 3 2 1 ppm
2.06 1.07 2.13
1.01 1.07 1.00 1.08 0.94
2.17 4.04

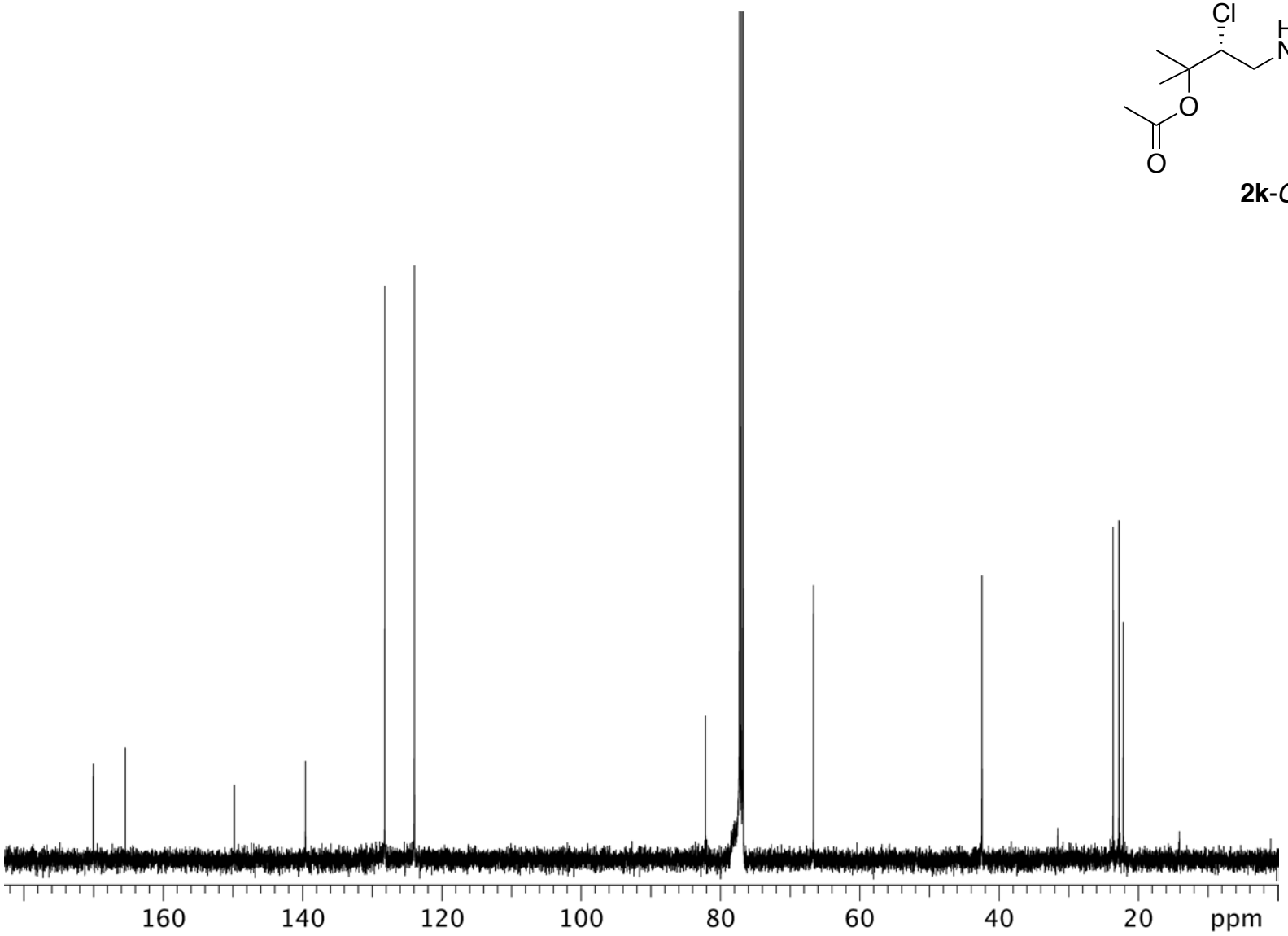
s-**2h**-*OH*-NO_2



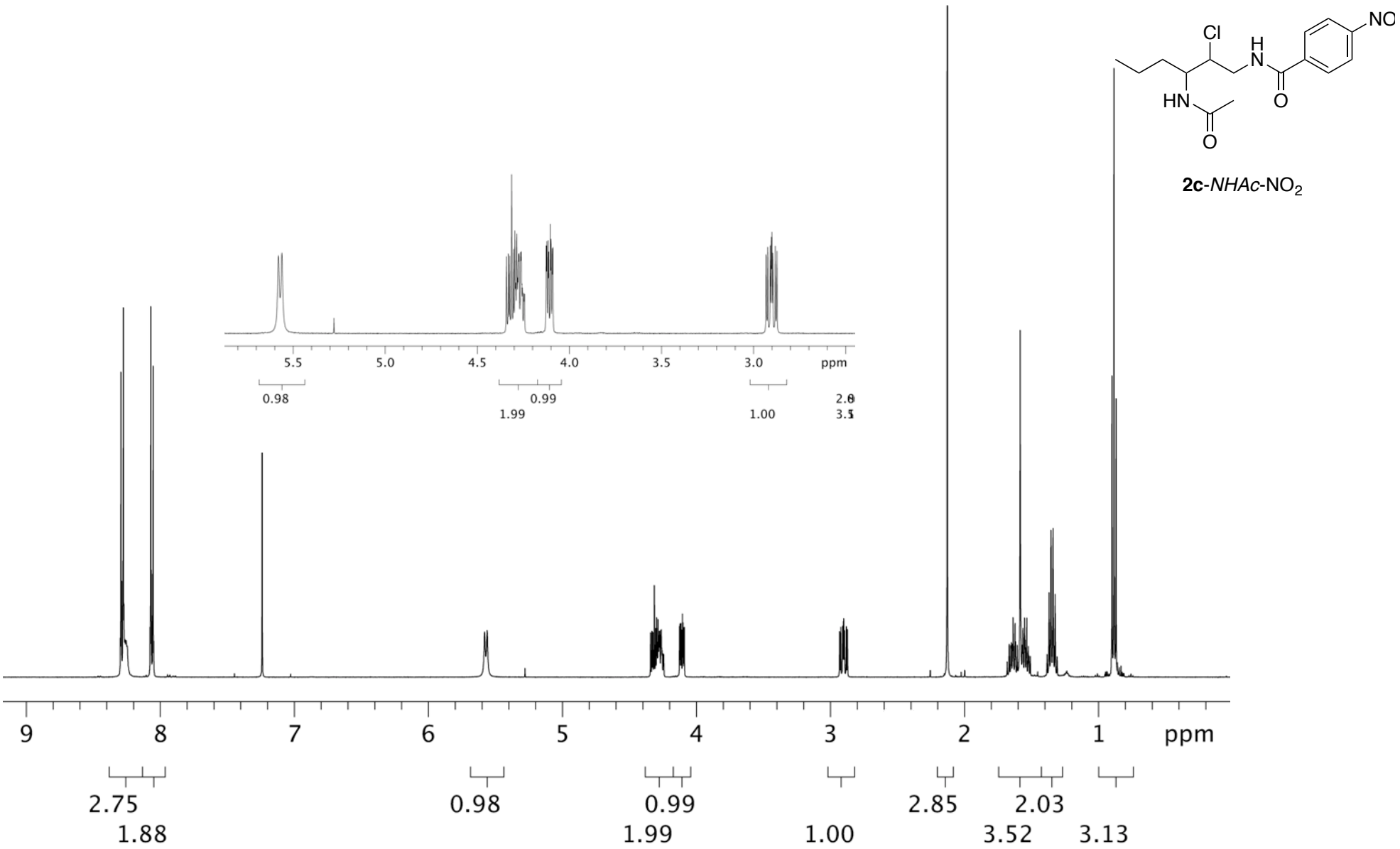
s-**2h**-*OH*-NO_2



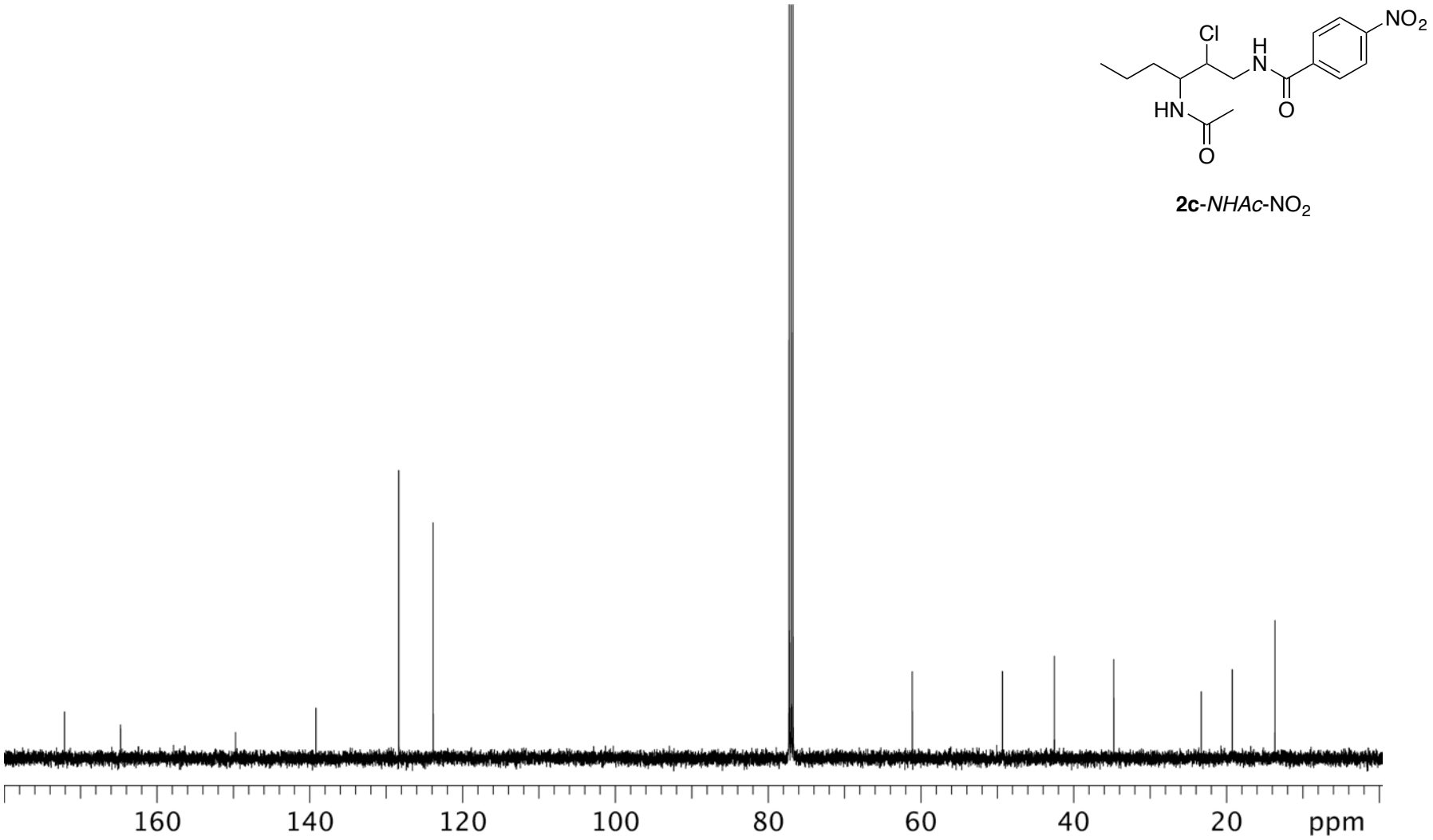
2k-*OAc*-NO_2



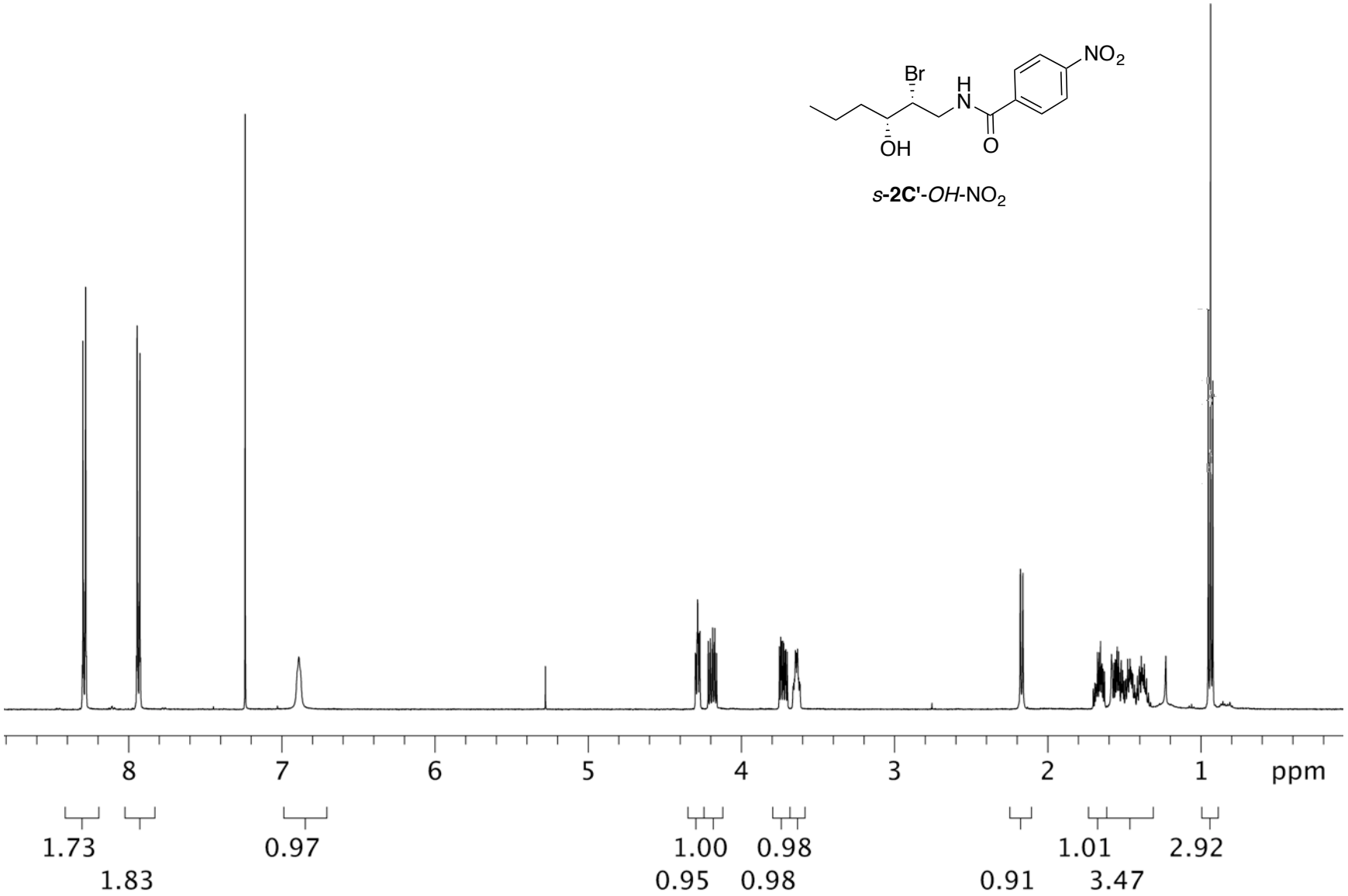
2k-*OAc*-NO_2


Cl
H
N
HN
O
O
NO
5.5
5.0
4.5
4.0
3.5
3.0
ppm
0.98
0.99
1.99
1.00
9
8
7
6
5
4
3
2
1
ppm
2.75
1.88
0.98
0.99
1.99
1.00
2.85
2.03
3.52
3.13

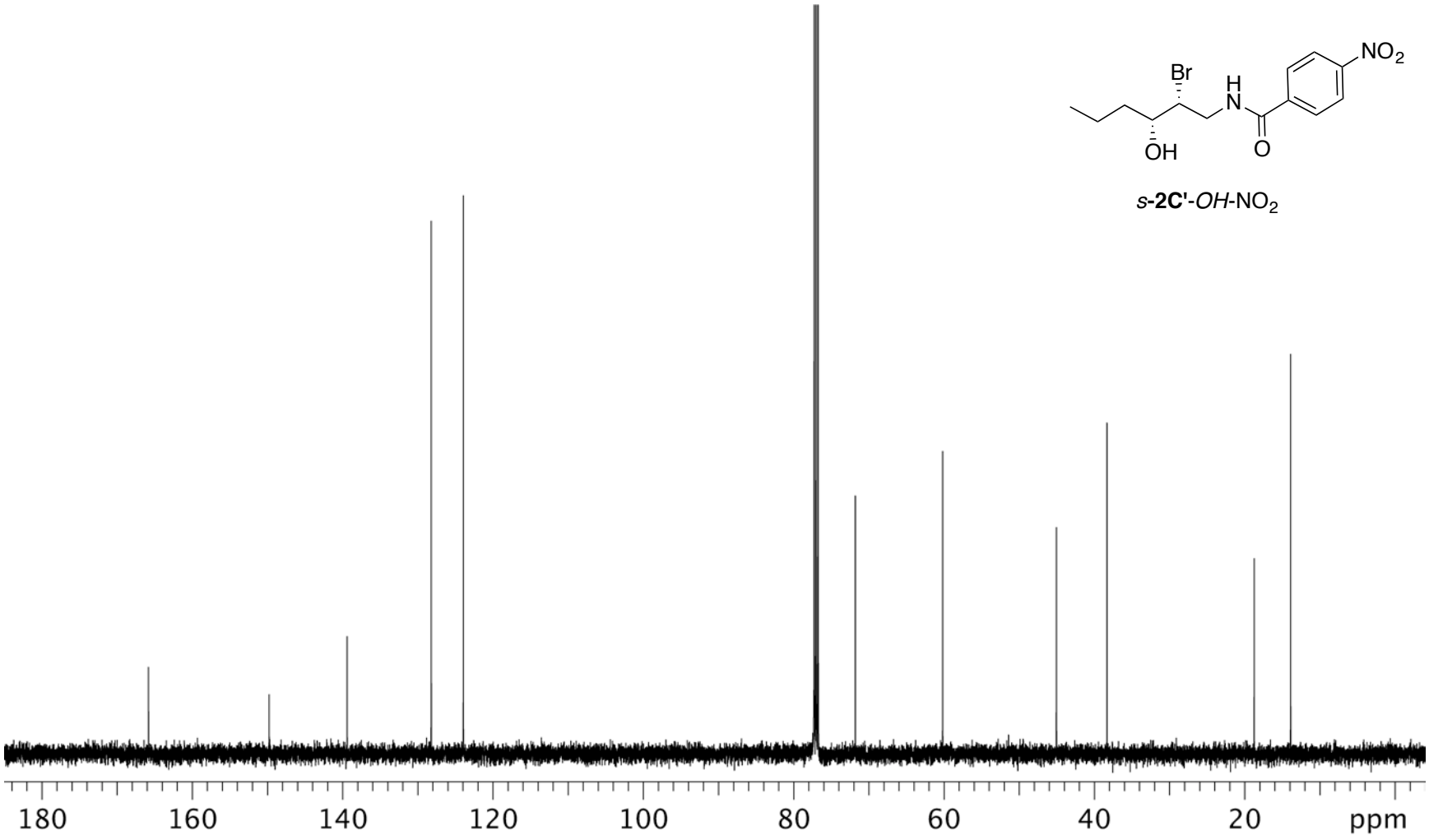
2c-*NHAc*-NO_2



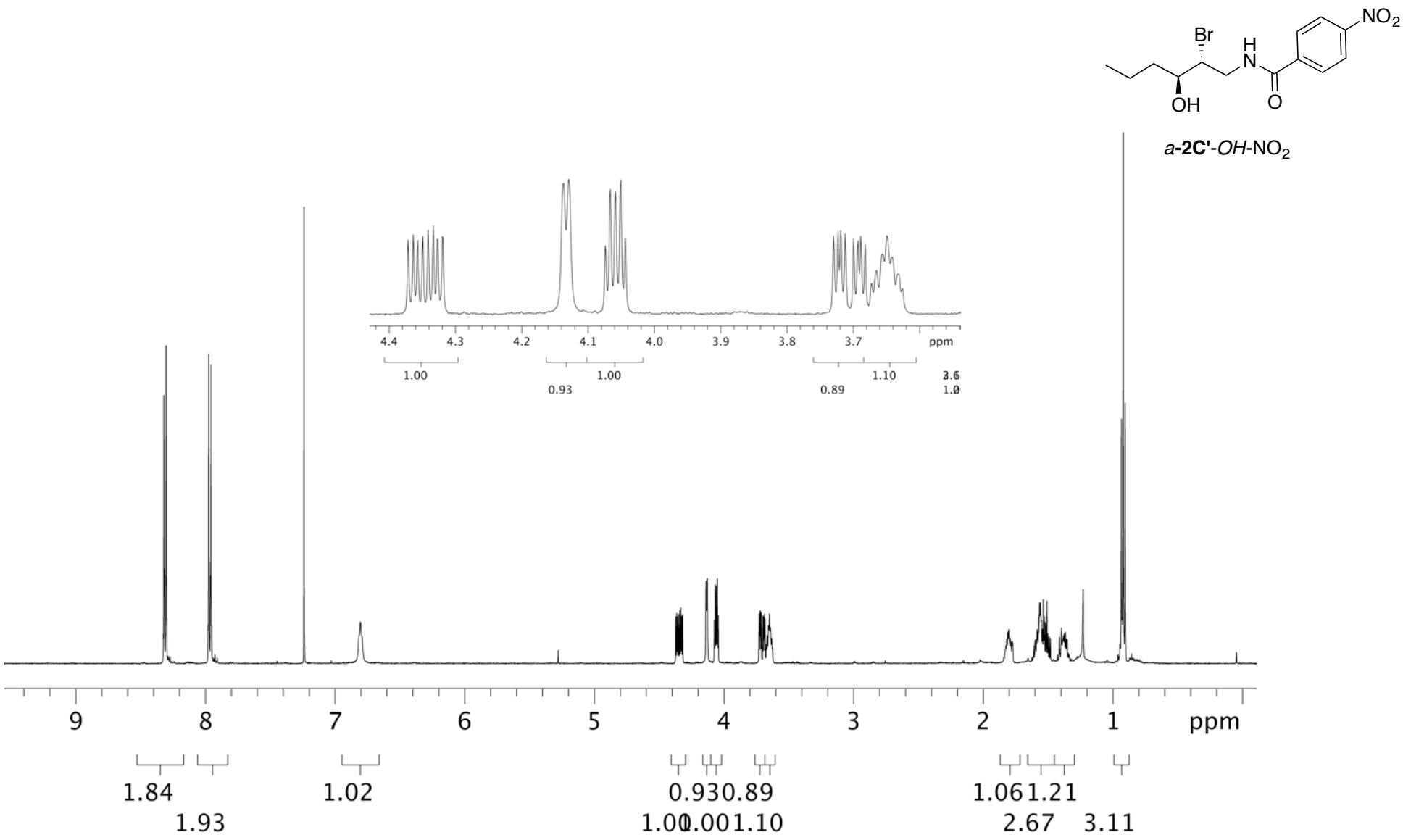
2c-*NHAc*-NO_2


Br
H
N
O
OH
NO2
ppm
8
7
6
5
4
3
2
1
1.73
1.83
0.97
1.00
0.95
0.98
0.98
0.91
1.01
3.47
2.92

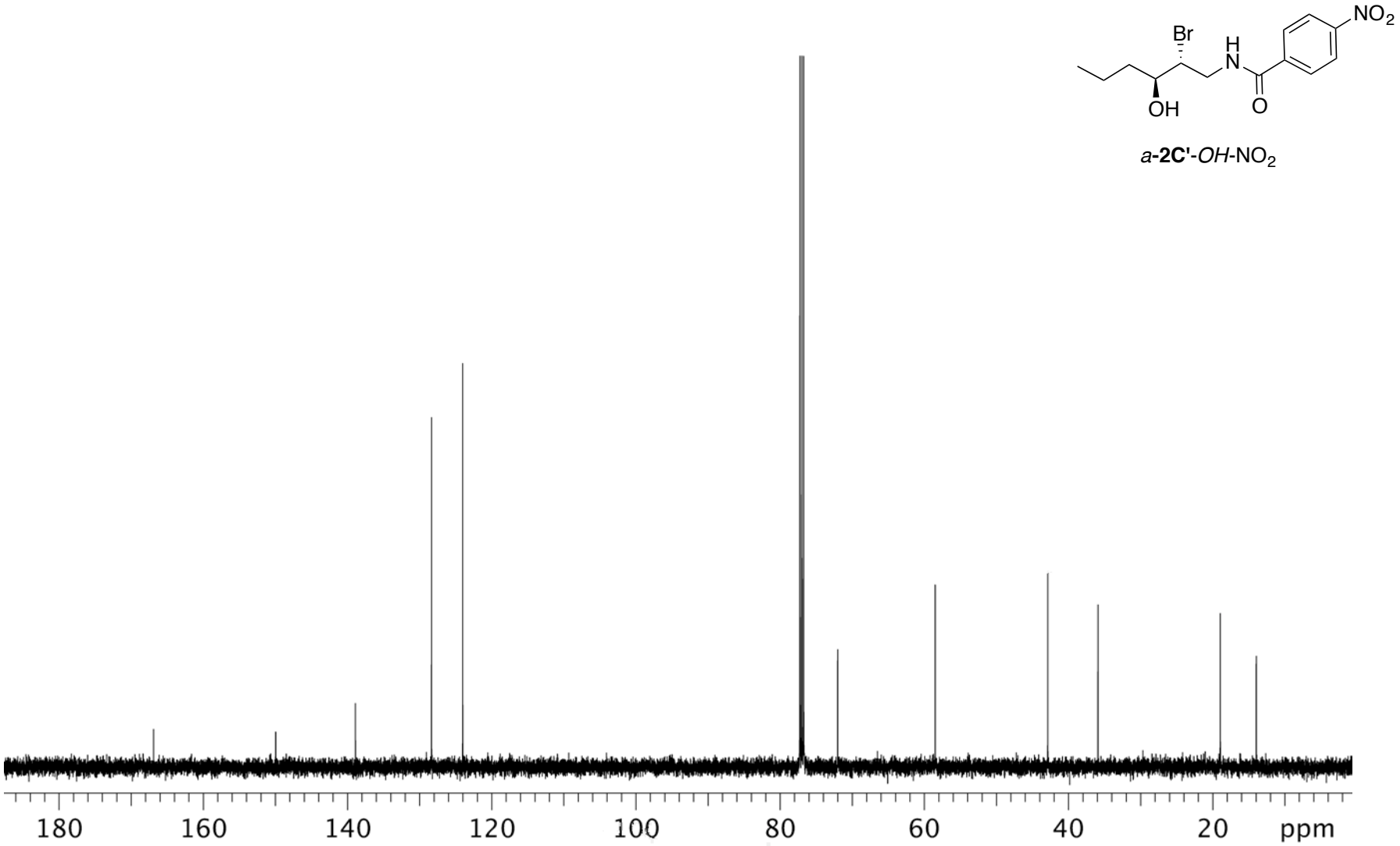
s-**2C'**-*OH*-NO_2



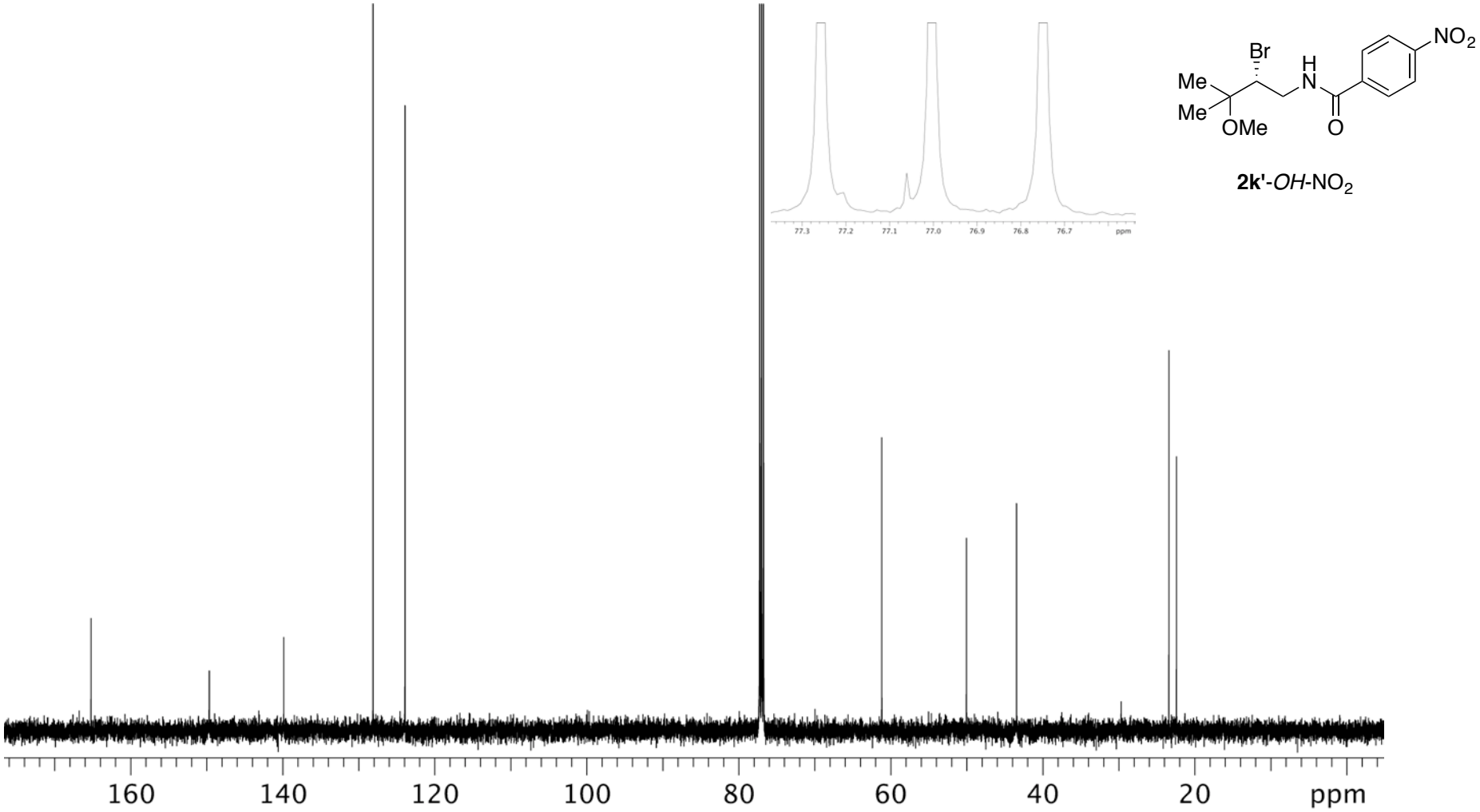
***s*-2C'-*OH*-NO_2**


Br
H
N
O
OH
NO2
4.4
4.3
4.2
4.1
4.0
3.9
3.8
3.7
ppm
1.00
0.93
1.00
0.89
1.10
9
8
7
6
5
4
3
2
1
ppm
1.84
1.93
1.02
0.93
0.89
1.06
1.21
2.67
3.11

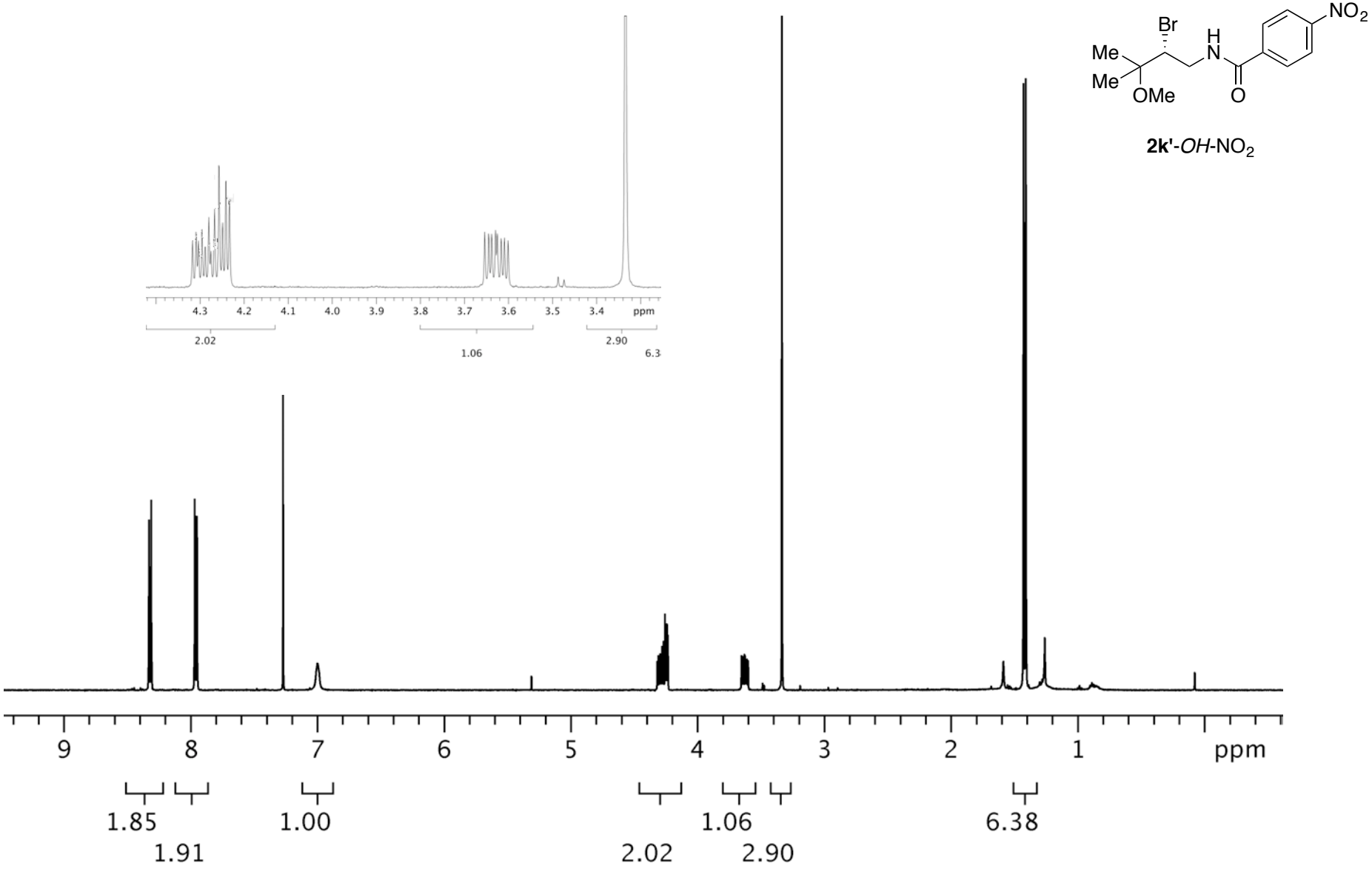
a-**2C'**-*OH*-NO_2

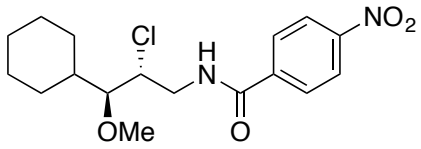


a-**2C'**-*OH*-NO_2

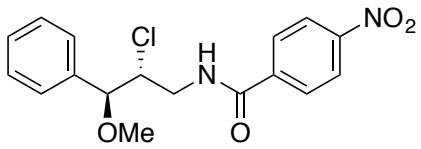

Br
H
N
Me
Me
OMe
O
NO2
77.3
77.2
77.1
77.0
76.9
76.8
76.7
ppm
160
140
120
100
80
60
40
20
ppm

2k'-*OH*-NO_2

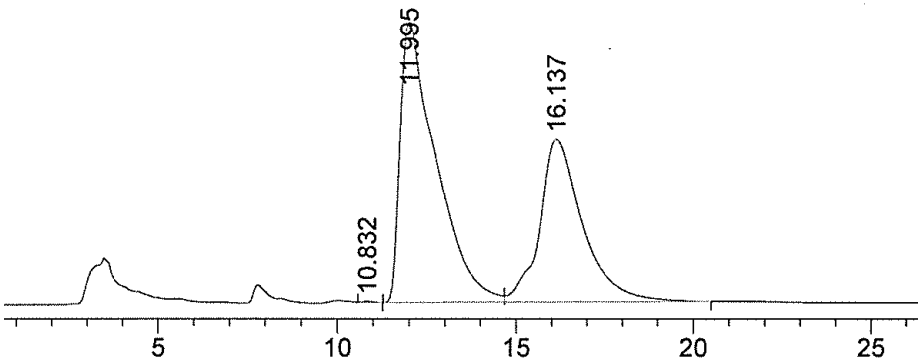

Br
H
N
Me
Me
OMe
O
NO2
2k'-OH-NO2
4.3
4.2
4.1
4.0
3.9
3.8
3.7
3.6
3.5
3.4
ppm
2.02
1.06
2.90
6.3
9
8
7
6
5
4
3
2
1
ppm
1.85
1.91
1.00
2.02
1.06
2.90
6.38

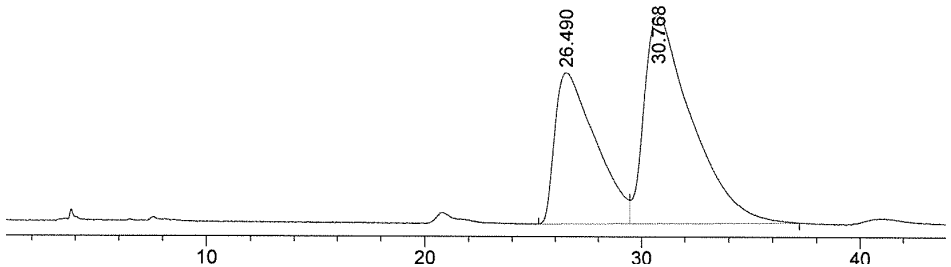


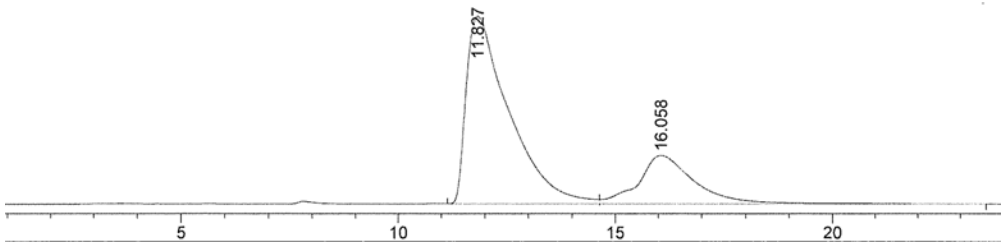
a-**2a**-*OMe*-NO_2

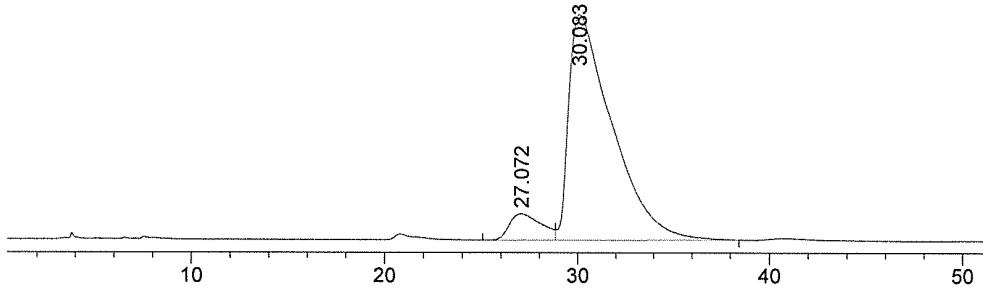


a-**2b**-*OMe*-NO_2







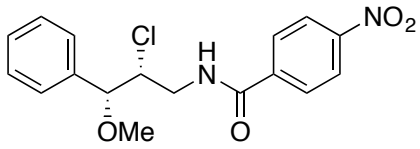


Signal 1: DAD1 A, Sig=254,8 Ref=700,100

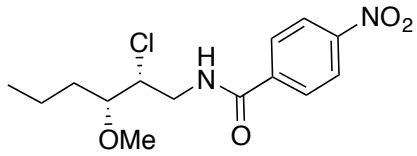
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.827	VV	0.9788	1.27801e5	1861.94678	74.5447
2	16.058	VB	1.2995	4.36412e4	480.53467	25.4553

Signal 2: DAD1 B, Sig=265,16 Ref=700,100

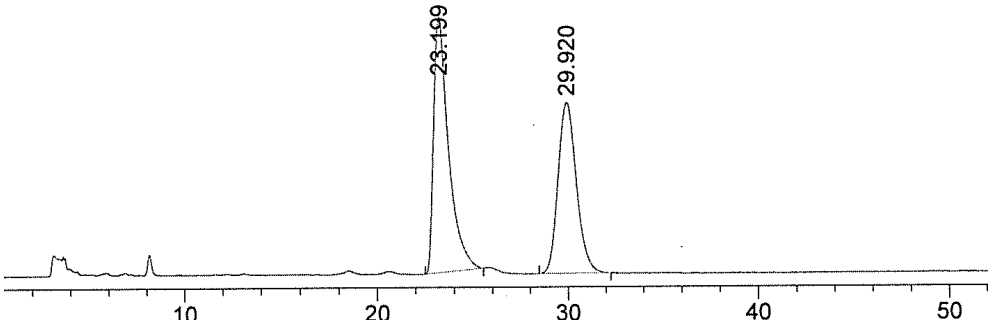
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	27.072	BV	1.3808	3583.96069	30.90754	7.9210
2	30.083	VB	2.1271	4.16622e4	262.58087	92.0790

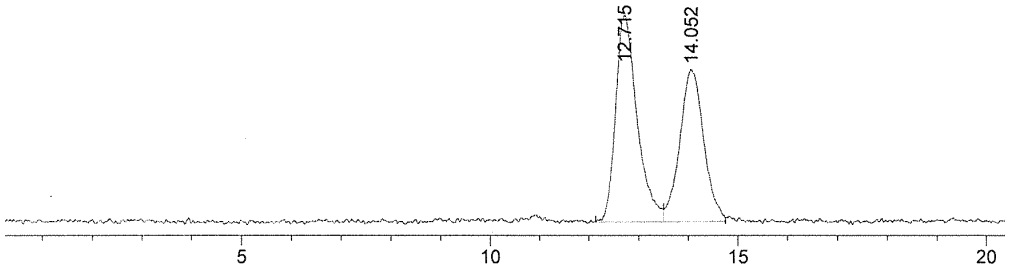


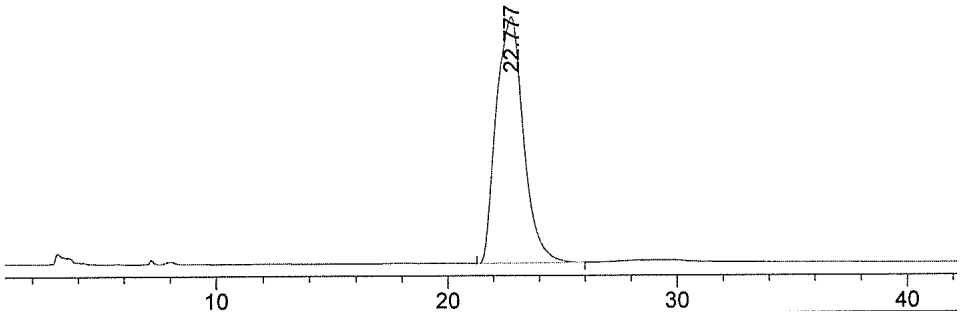
s-**2b**-*OMe*-NO_2

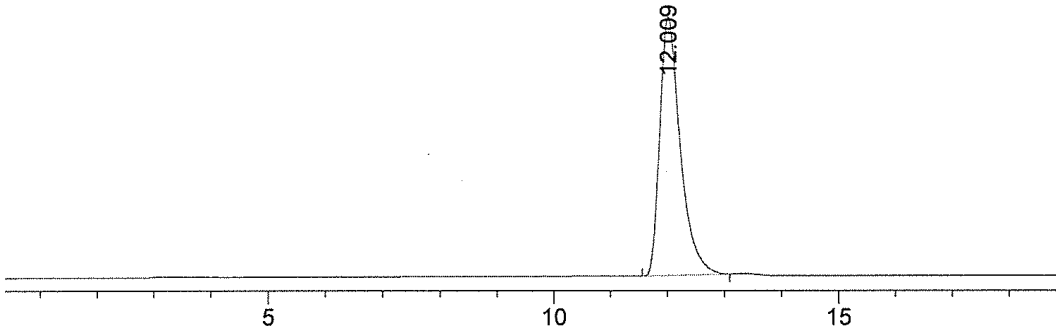


s-**2c**-*OMe*-NO_2







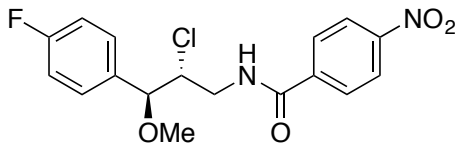


Signal 2: DAD1 B, Sig=220,4 Ref=700,100

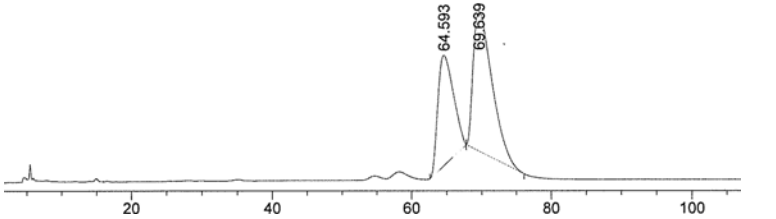
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.777	BB	1.3413	1.08349e4	130.68146	100.0000

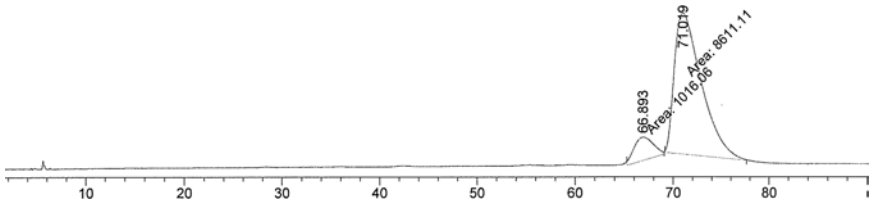
Signal 2: DAD1 B, Sig=220,4 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.009	BB	0.3774	2051.94751	81.60533	100.0000



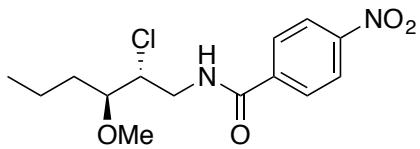
a-**2d**-*OMe*-NO_2



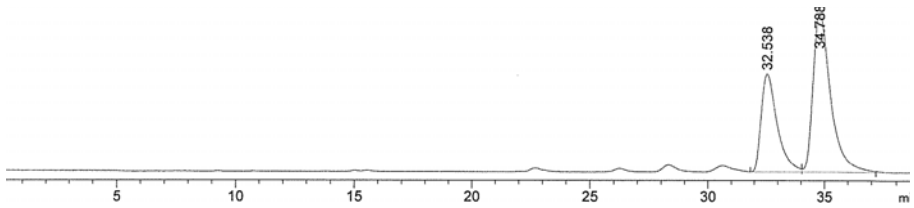


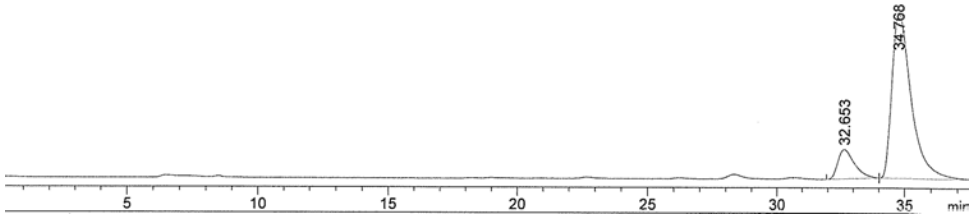
Signal 1: DAD1 A, Sig=280,4 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	66.893	MM	1.6267	1016.05615	7.34504	10.5541
2	71.019	MM	3.2316	8611.11133	44.41131	89.4459



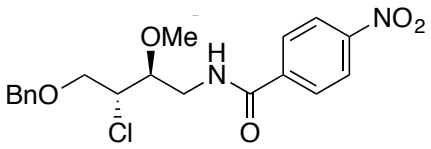
s-**2c**-*OMe*-NO_2



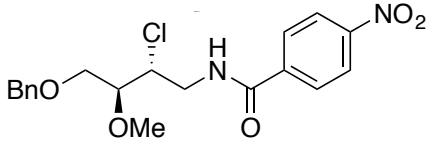


Signal 1: DAD1 A, Sig=254,8 Ref=700,100

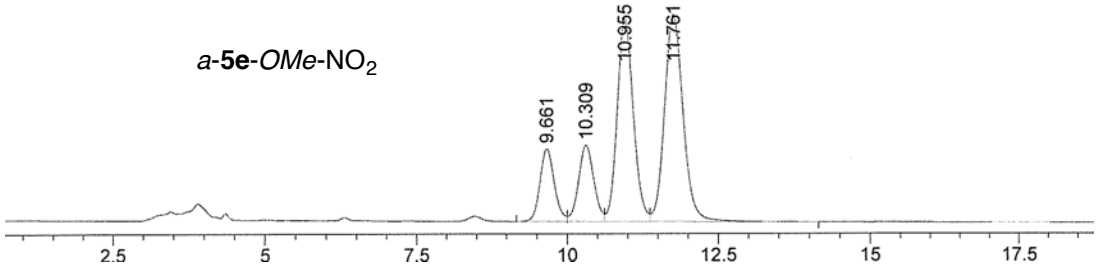
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	32.653	BB	0.5996	3359.80298	74.01774	13.3955
2	34.768	BBA	0.7351	2.17218e4	421.60617	86.6045

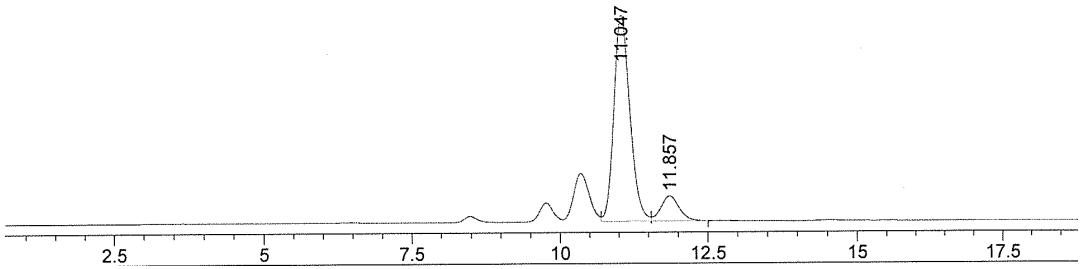


a-**2e**-*OMe*-NO_2



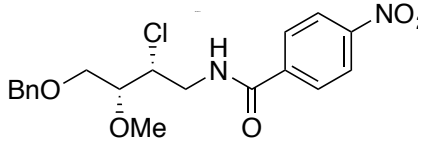
a-**5e**-*OMe*-NO_2



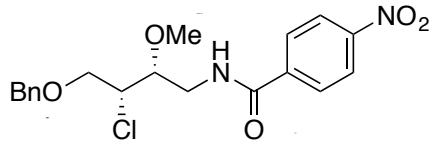


Signal 1: DAD1 A, Sig=254,16 Ref=700,100

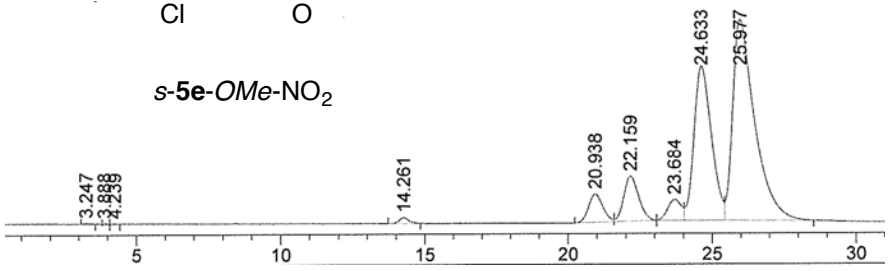
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.047	VV	0.2915	1.93092e4	1017.04584	87.9529
2	11.857	VB	0.3252	2644.81445	123.80856	12.0471

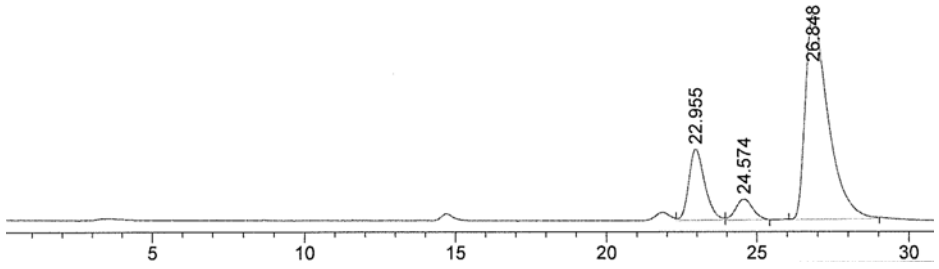


s-**2e**-*OMe*-NO_2



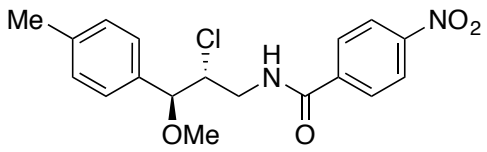
s-**5e**-*OMe*-NO_2



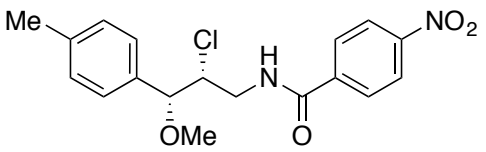


Signal 1: DAD1 A, Sig=254,4 Ref=700,100

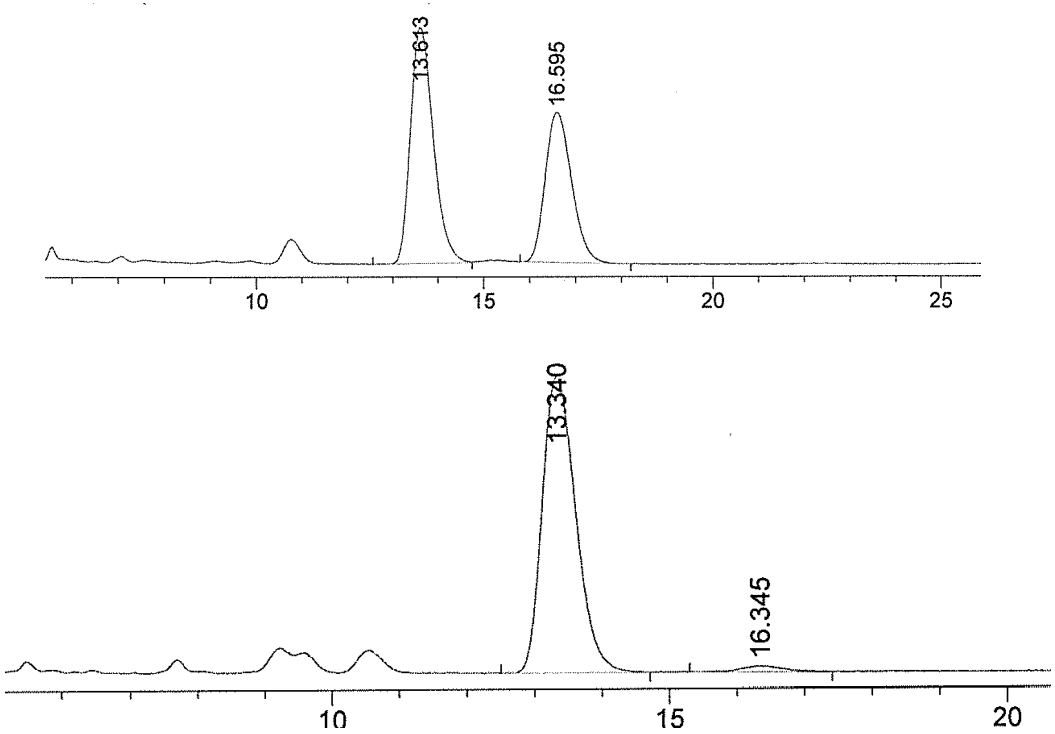
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.955	VV	0.5400	8302.54883	224.20834	18.5846
2	24.574	VV	0.5132	2593.12012	65.31544	5.8045
3	26.848	VV	0.6881	3.37787e4	645.96802	75.6109

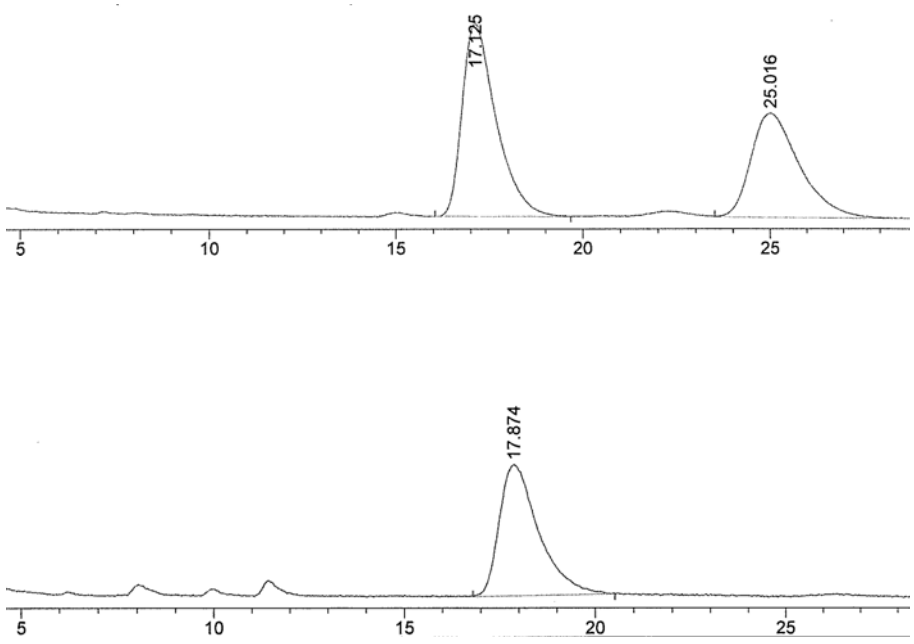


a-**2f**-*OMe*-NO_2



s-**2f**-*OMe*-NO_2



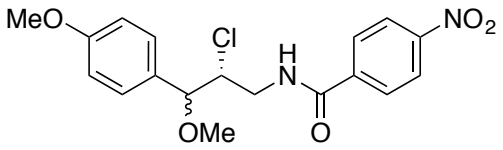


Signal 2: DAD1 B, Sig=265,16 Ref=700,100

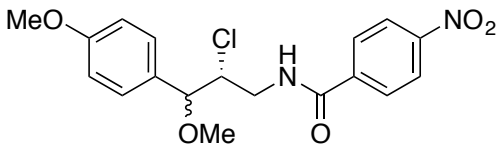
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.340	BB	0.5440	7391.94189	213.46135	97.4614
2	16.345	BB	0.5881	192.54341	4.18983	2.5386

Signal 3: DAD1 C, Sig=220,4 Ref=360,100

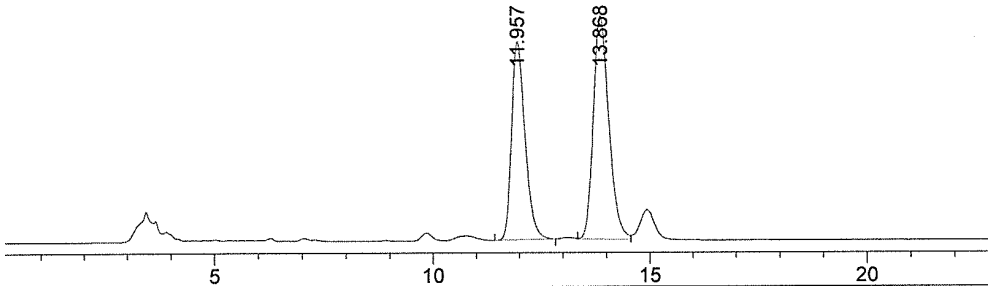
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	17.874	BB	0.8762	9850.87695	136.77840	100.0000

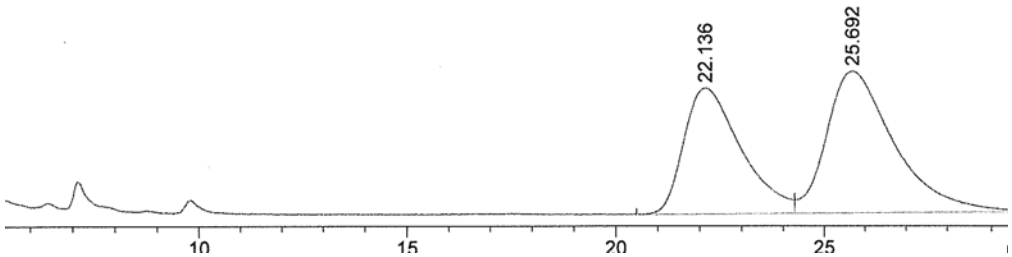


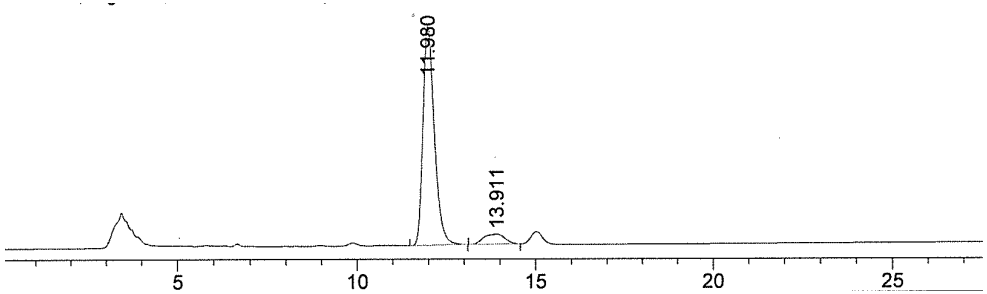
epi-**2g**-*OMe*-NO_2

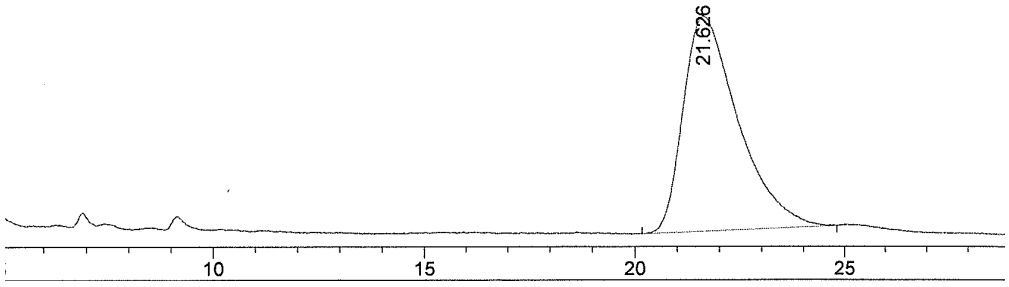


2g-*OMe*-NO_2







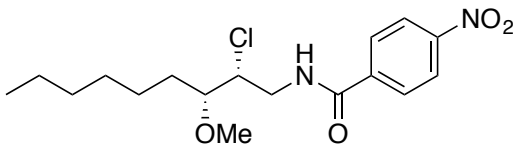


Signal 1: DAD1 A, Sig=254,16 Ref=700,100

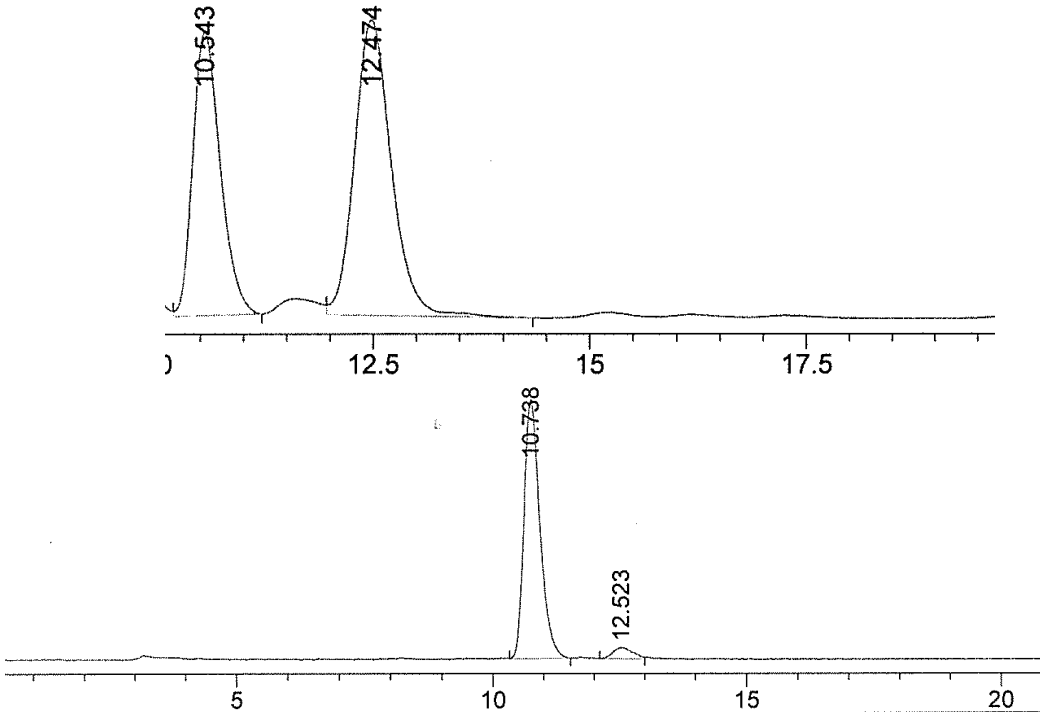
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.980	BB	0.3369	6613.10547	298.01282	92.1757
2	13.911	BB	0.5752	561.34766	13.55463	7.8243

Signal 3: DAD1 C, Sig=220,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.670	BB	1.0479	7231.27100	81.44363	100.0000
Totals :				7231.27100	81.44363	

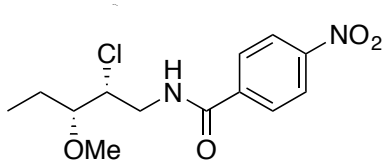


s-**2i**-*OMe*-NO_2

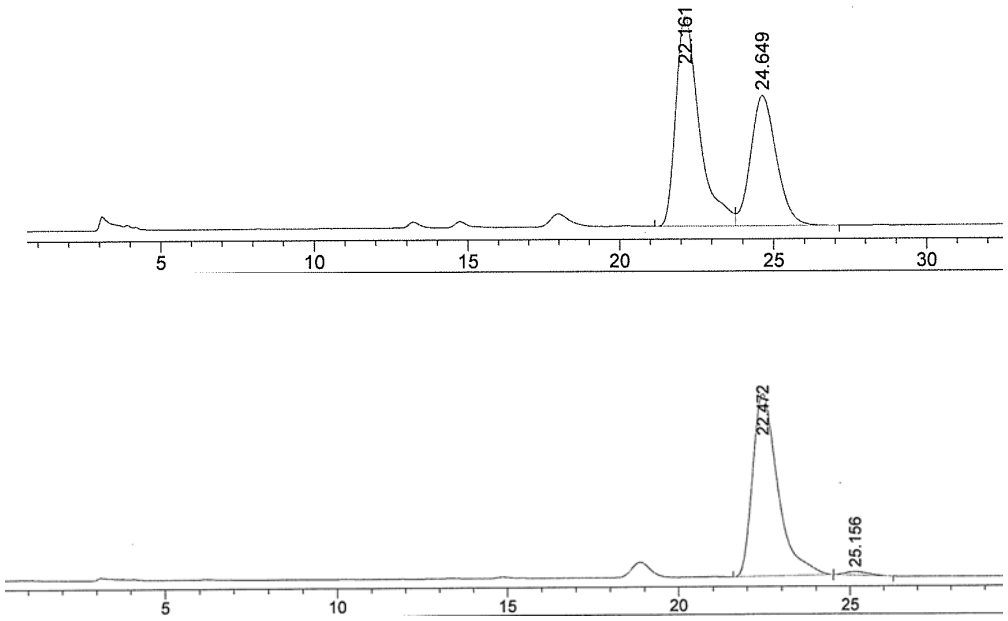


Signal 1: DAD1 A, Sig=254,4 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.738	VV	0.3362	7509.45557	341.92676	94.9794
2	12.523	BV	0.3249	396.94955	14.52227	5.0206

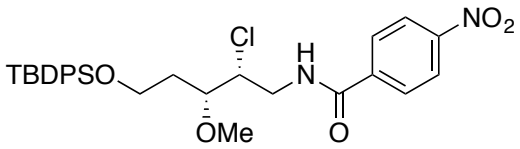


s-**2h**-*OMe*-NO_2

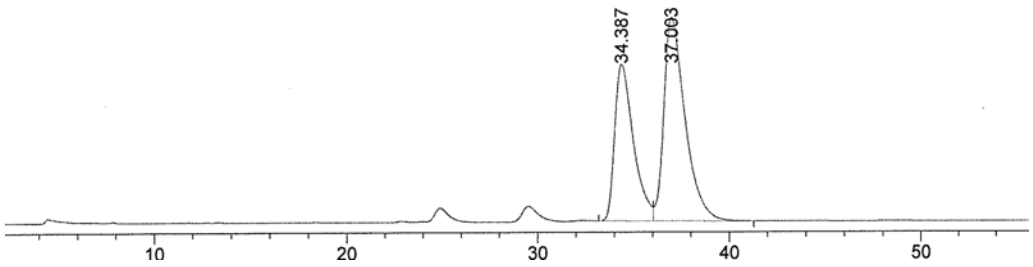


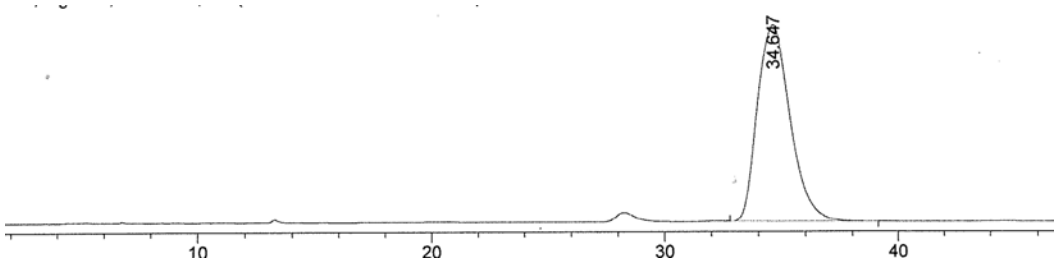
Signal 1: DAD1 A, Sig=254,16 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.472	BB	0.7736	1.30288e4	256.06775	98.2845
2	25.156	BB	0.6053	227.41432	4.76081	1.7155



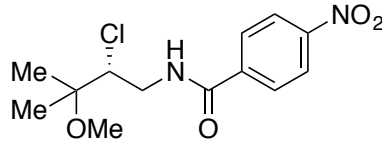
s-**2j**-*OMe*-NO_2



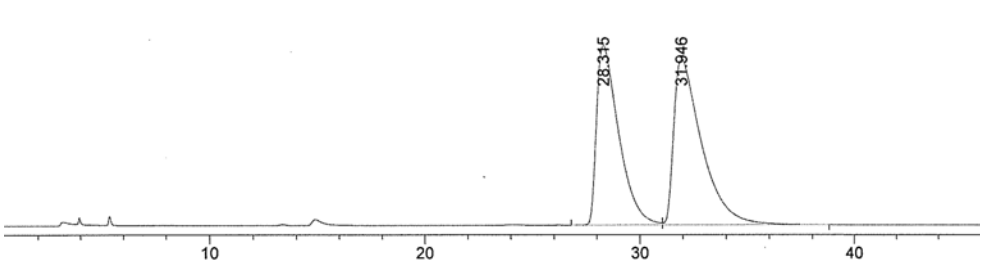


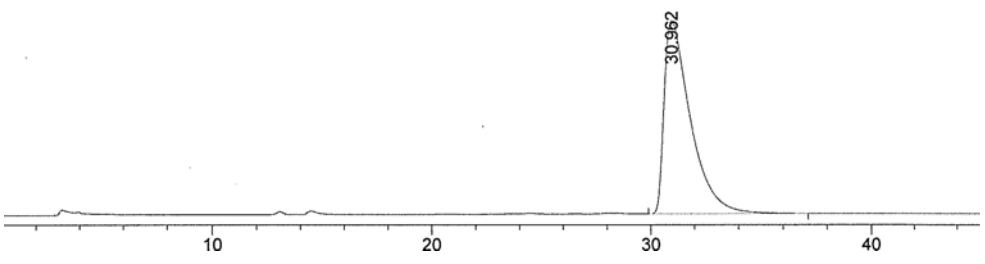
Signal 1: DAD1 A, Sig=254,8 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	34.647	BB	1.5367	3.59170e4	371.92026	100.0000



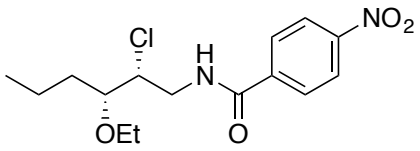
2k-*OMe*-NO_2



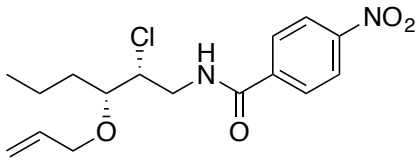


Signal 2: DAD1 B, Sig=254,4 Ref=500,100

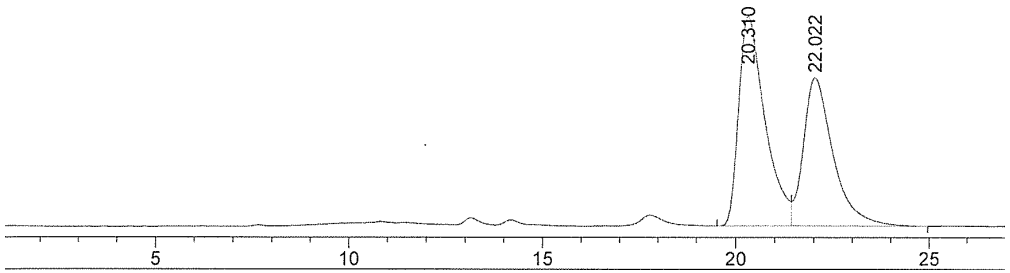
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	30.962	BB	1.2273	1.46345e4	175.77739	100.0000
Totals :				1.46345e4	175.77739	

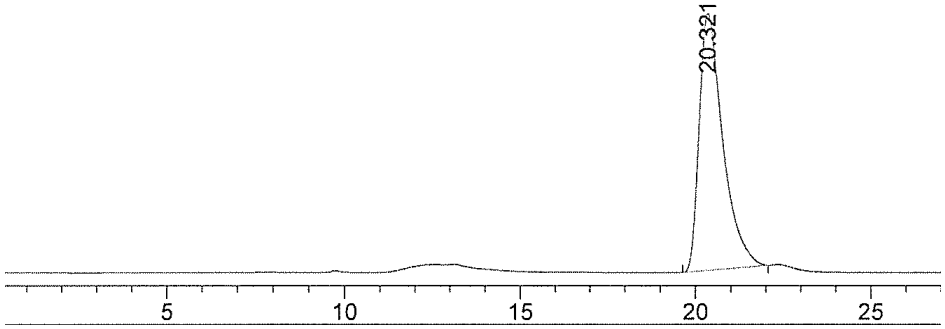


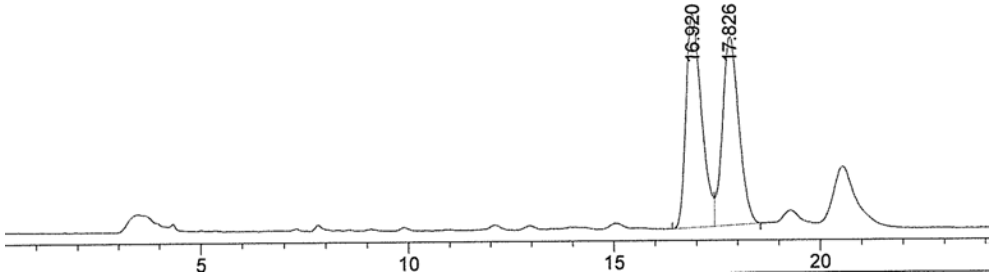
s-**2c**-*OEt*-NO_2

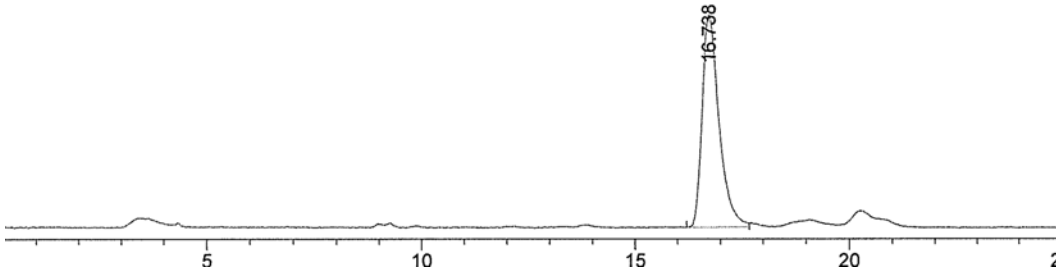


s-**2c**-*OAllyl*-NO_2







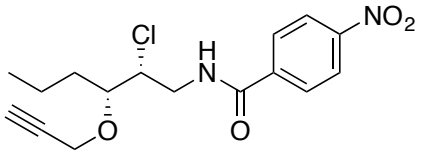


Signal 1: DAD1 A, Sig=254,16 Ref=700,100

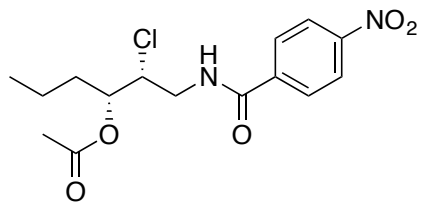
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.321	BB	0.6999	1.00796e4	215.42938	100.0000

Signal 1: DAD1 A, Sig=254,4 Ref=700,100

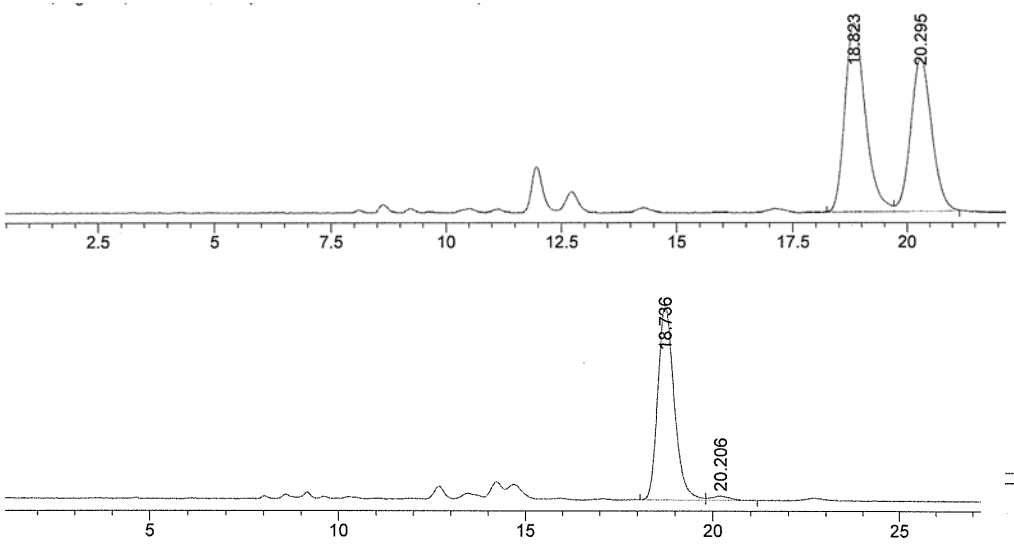
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.738	BV	0.4009	8924.97559	324.47839	100.0000
Totals :				8924.97559	324.47839	

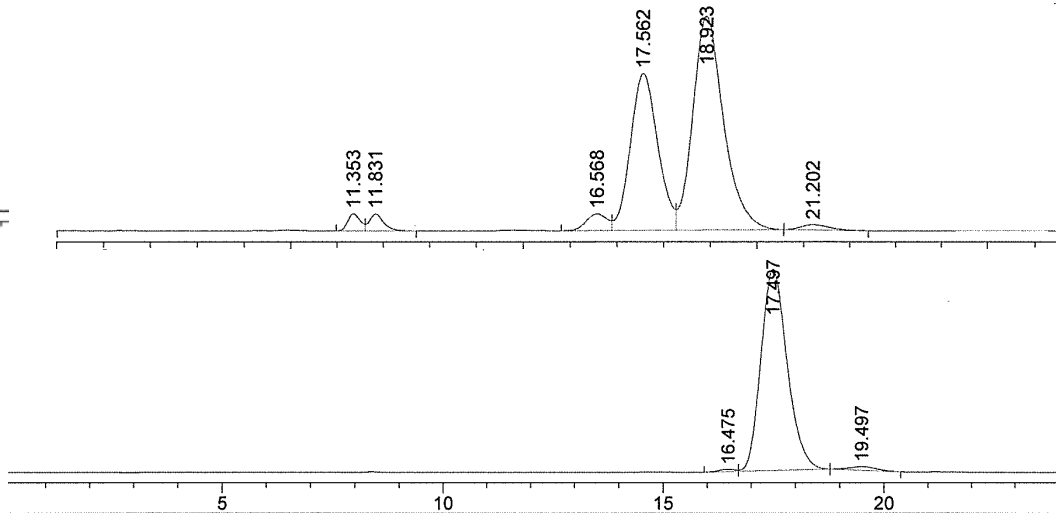


s-**2c**-*OPropargyl*-NO_2



s-**2c**-*OAc*-NO_2



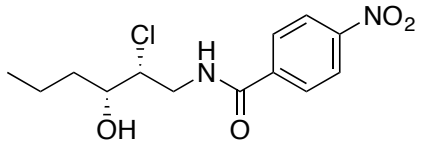


Signal 2: DAD1 B, Sig=265,16 Ref=700,100

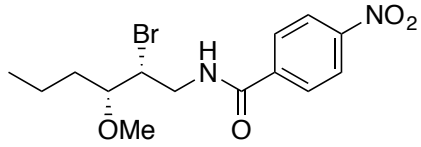
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.736	BV	0.4690	5499.04688	181.74376	97.5875
2	20.206	VB	0.4256	135.94344	3.90987	2.4125

Signal 1: DAD1 A, Sig=254,8 Ref=700,100

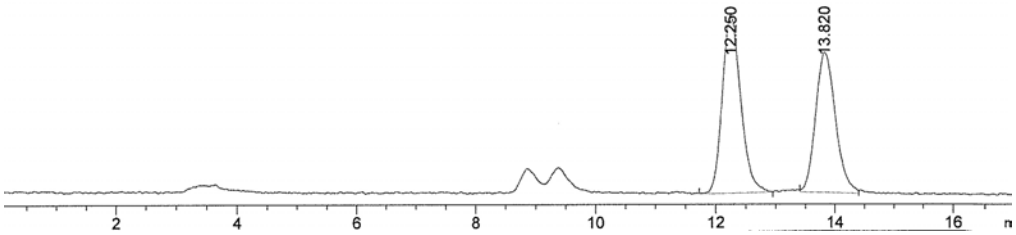
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.475	BV	0.3564	77.77691	2.98071	0.7018
2	17.497	VB	0.6431	1.08075e4	260.98962	97.5218
3	19.497	BB	0.5882	196.86147	4.66645	1.7764

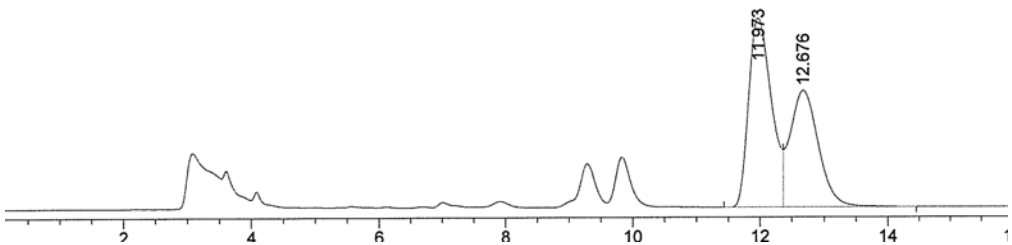


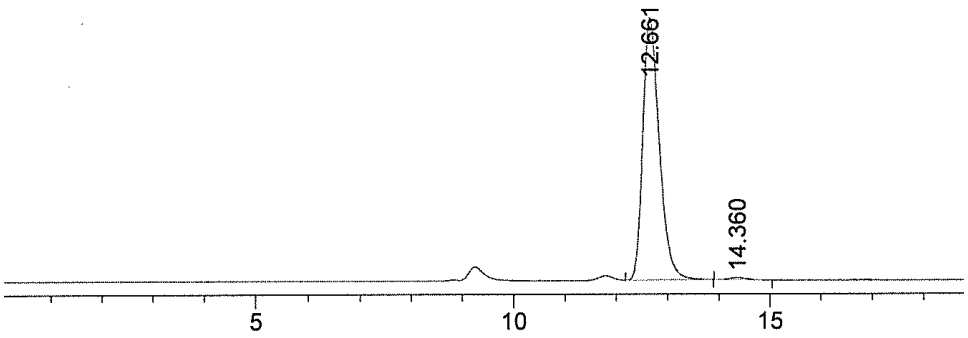
s-**2C**-*OH*-NO_2

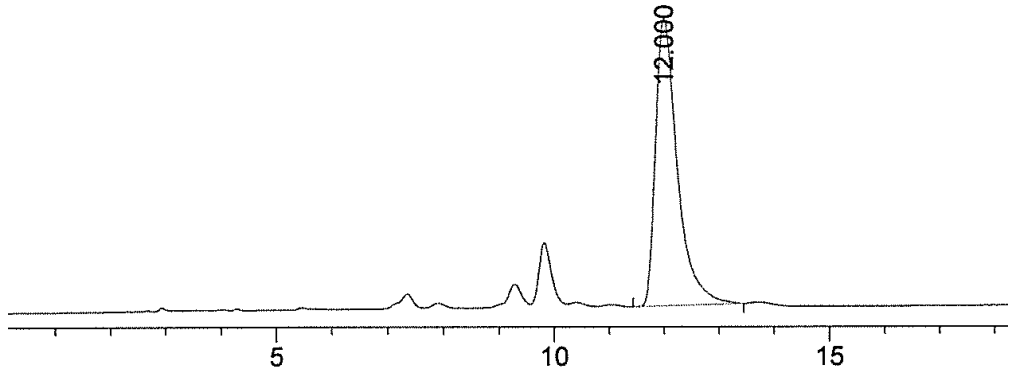


c-**2c'**-*OMe*-NO_2







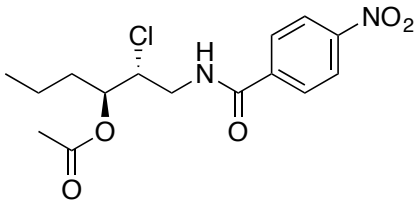


Signal 2: DAD1 B, Sig=265,16 Ref=700,100

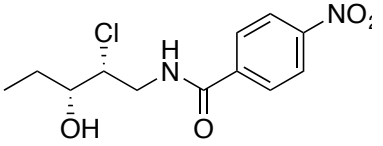
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.661	BB	0.3456	1.23137e4	549.18805	99.0693
2	14.360	BB	0.3584	115.68494	4.99141	0.9307

Signal 1: DAD1 A, Sig=254,16 Ref=700,100

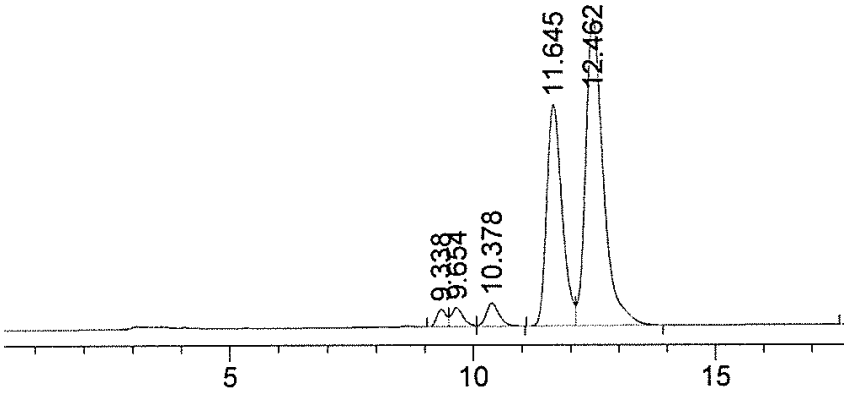
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.000	BB	0.4219	3592.17529	129.38919	100.0000

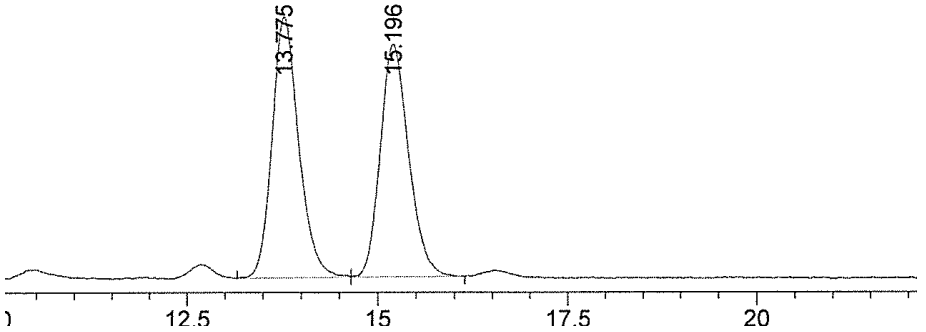


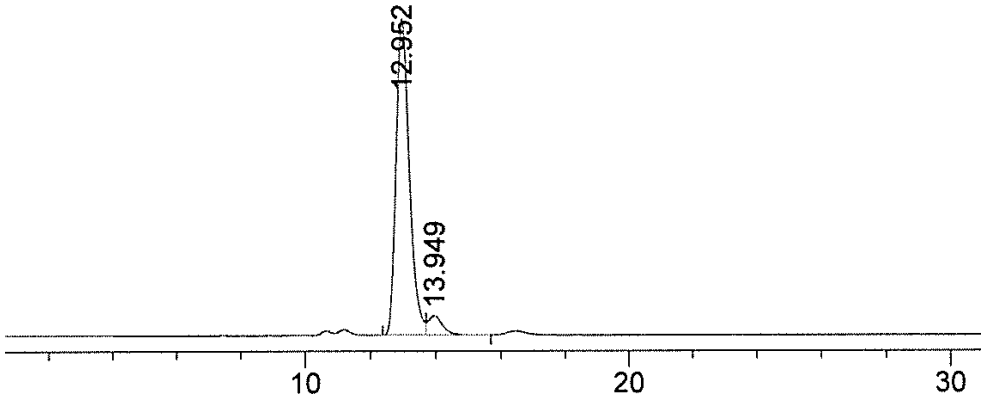
a-**2c**-*OAc*-NO_2

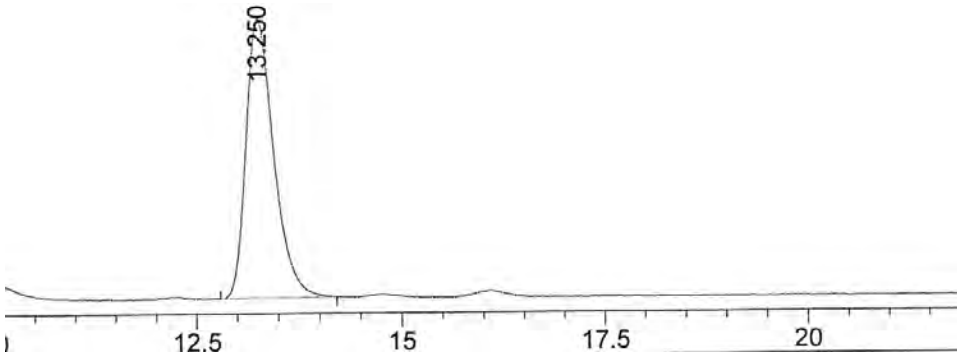


s-**2h**-*OH*-NO_2







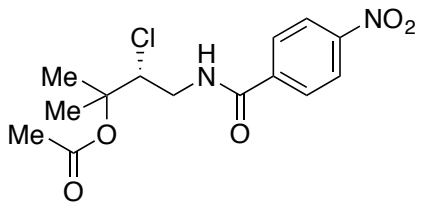


Signal 1: DAD1 A, Sig=254,8 Ref=700,100

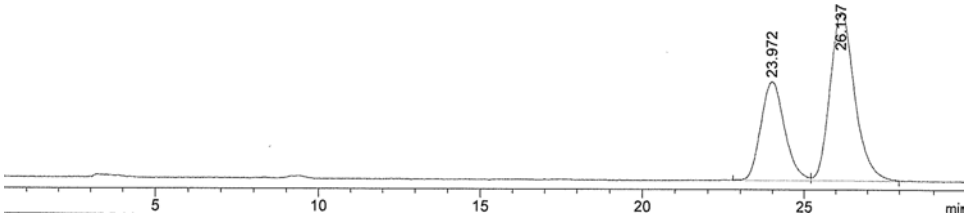
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.952	BV	0.4381	2.36494e4	825.77203	93.7902
2	13.949	VB	0.4508	1565.82568	51.19651	6.2098

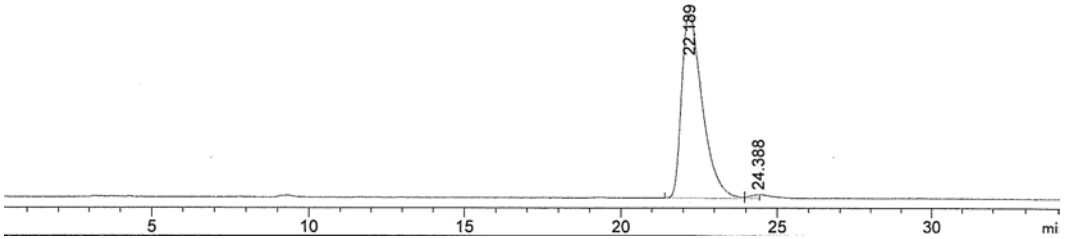
Signal 1: DAD1 A, Sig=254,4 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.250	BV	0.3563	9204.58887	391.53445	100.0000
Totals :				9204.58887	391.53445	



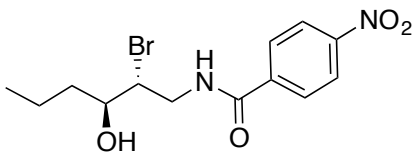
2k-*OAc*-NO_2



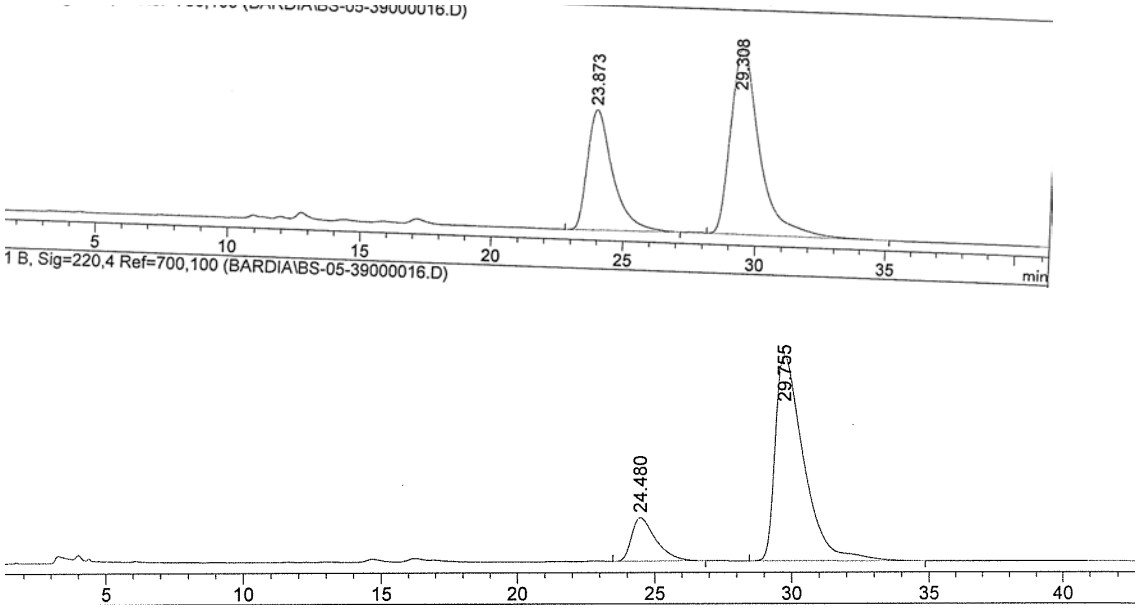


Signal 2: DAD1 B, Sig=265,16 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.186	BV	0.6601	2.63117e4	572.59424	98.0673
2	24.424	VV	0.5649	518.55438	10.98230	1.9327
Totals :				2.68302e4	583.57654	

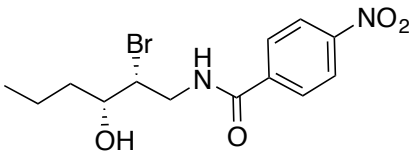


a-**2c'**-*OH*-NO_2

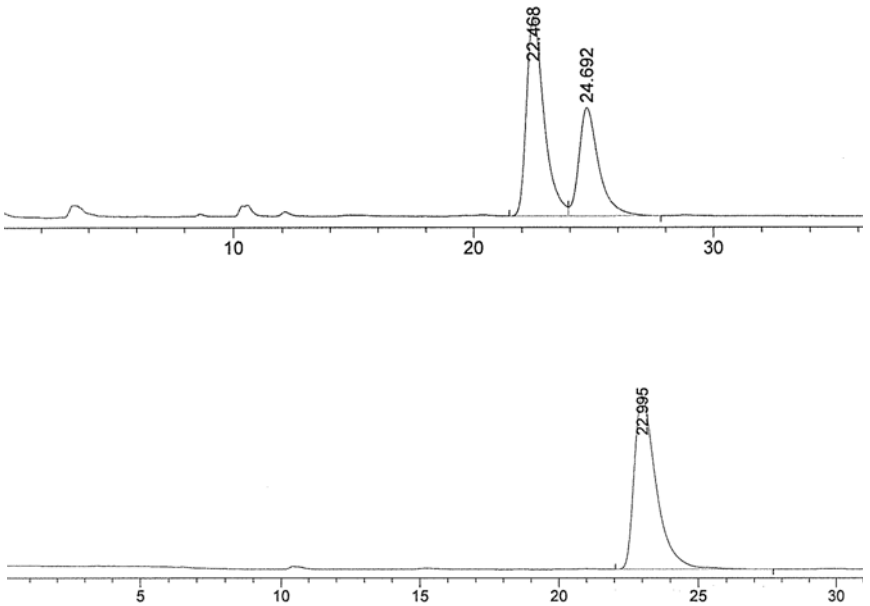


Signal 1: DAD1 A, Sig=254,16 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	24.480	BB	0.9026	1773.56372	28.95623	15.1845
2	29.755	BB	1.0716	9906.49902	137.32425	84.8155
Totals :				1.16801e4	166.28048	

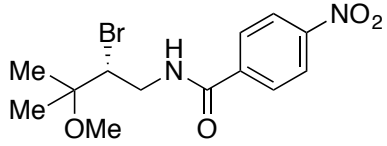


s-**2c'**-*OH*-NO_2

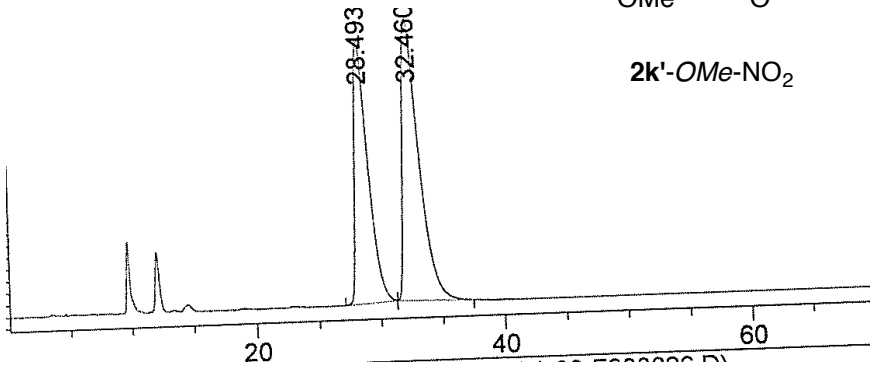


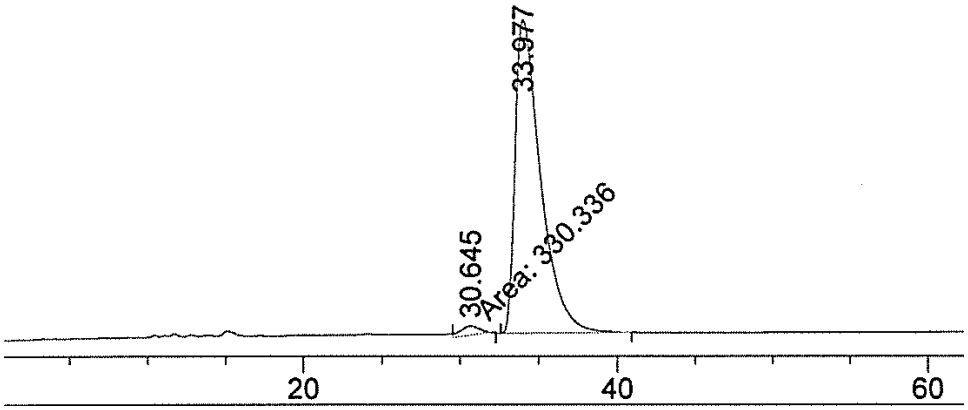
Signal 1: DAD1 A, Sig=254,8 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.995	BB	0.8157	2.71079e4	497.53333	100.0000
Totals :				2.71079e4	497.53333	

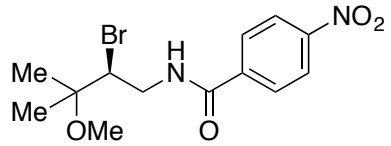


2k'-*OMe*-NO_2

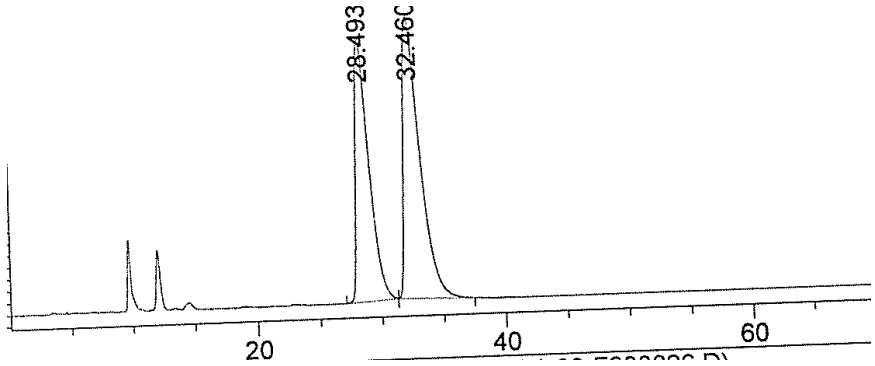


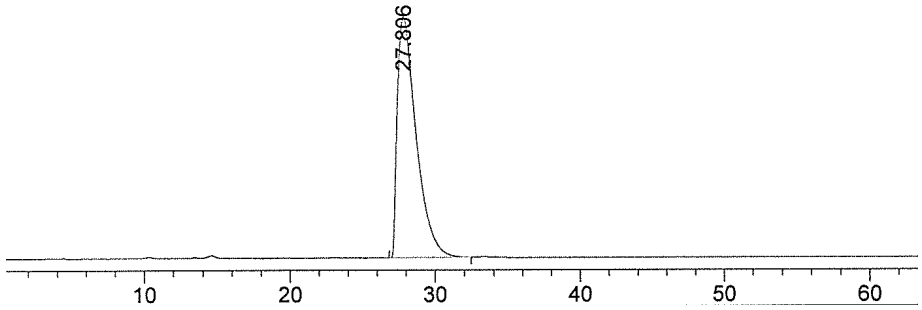


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	30.645	MM	1.0235	330.33600	3.89891	2.1124
2	33.977	BB	1.6344	1.53073e4	135.45303	97.8876



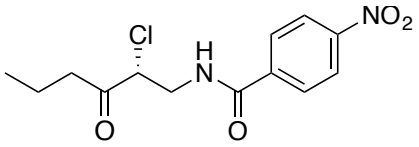
epi-**2k'**-*OMe*-NO_2



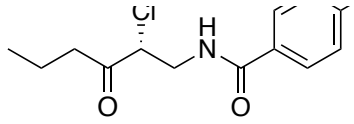


Signal 1: DAD1 A, Sig=254,16 Ref=700,100

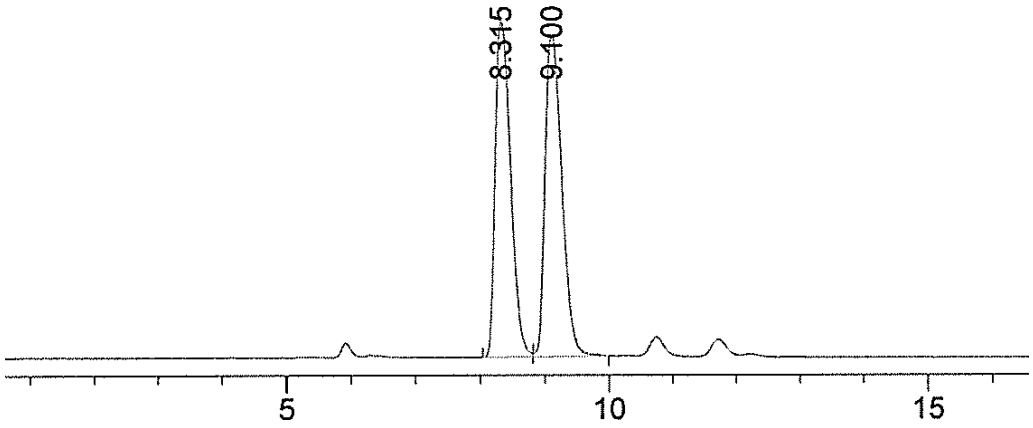
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	27.806	BB	1.3771	3.65608e4	404.26642	100.0000
Totals :				3.65608e4	404.26642	

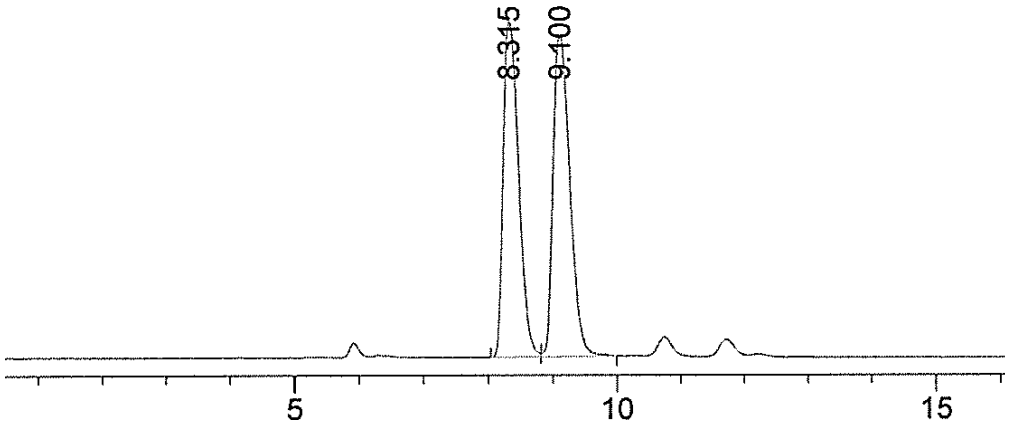


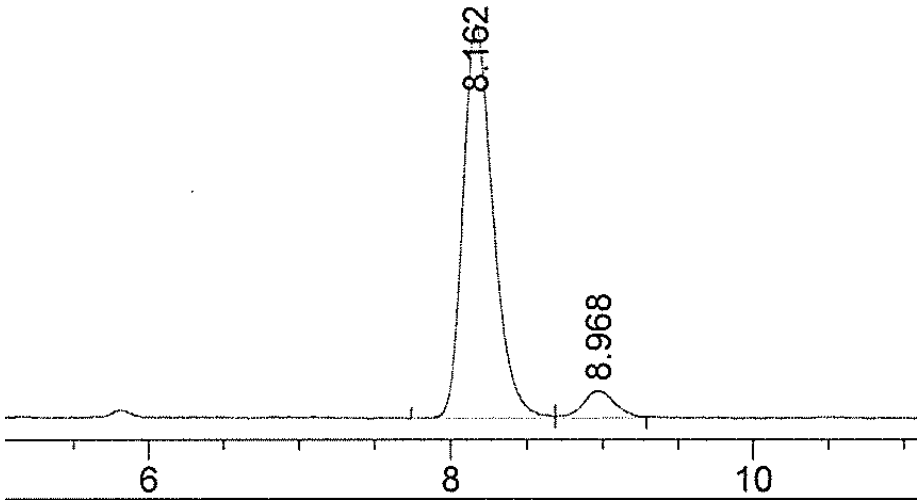
(2*R*)-**6c**-NO_2
from *Z*-**1c**-NO_2

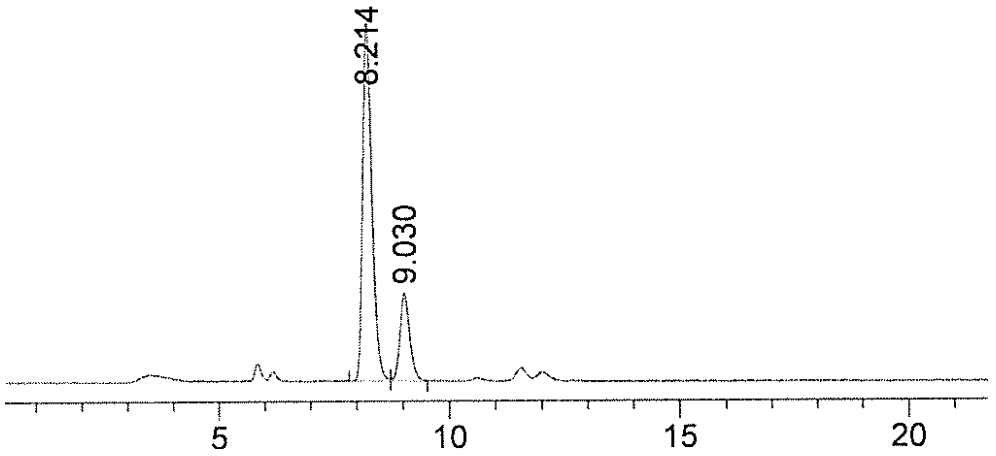


(2*R*)-**6c**-NO_2
from *E*-**1c**-NO_2









Signal 1: DAD1 A, Sig=250,4 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.162	BV	0.2083	6037.53516	439.51782	92.8504
2	8.968	VV	0.2282	464.89636	30.42916	7.1496

Signal 1: DAD1 A, Sig=250,4 Ref=700,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.214	BV	0.2150	7363.65869	527.14642	79.2426
2	9.030	VV	0.2302	1928.88879	129.15938	20.7574