Electronic Supplementary Information

Synthesis and glycosidase inhibition of conformationally locked DNJ and DMJ derivatives exploiting a 2-oxo-*C*-allyl iminosugar

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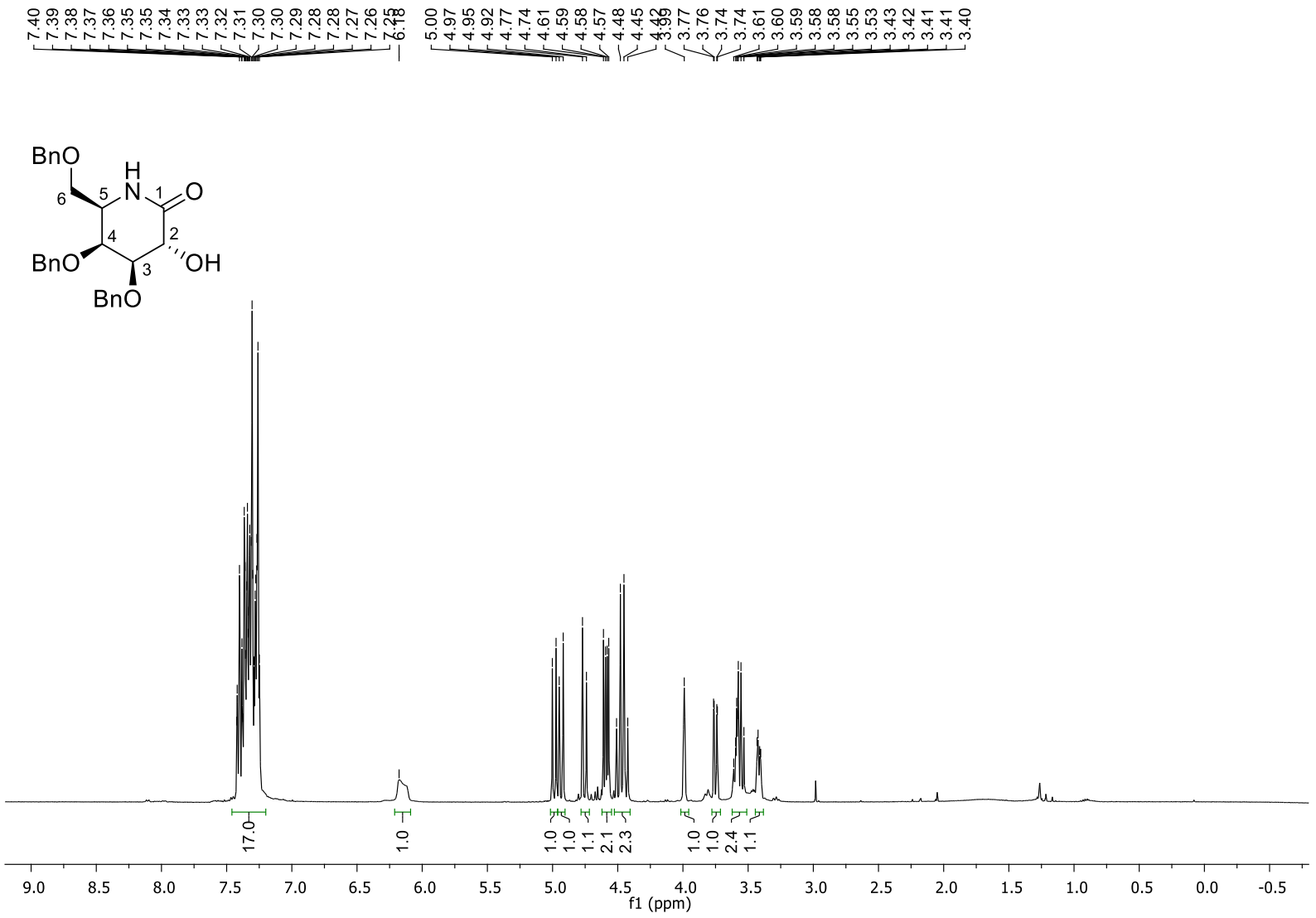
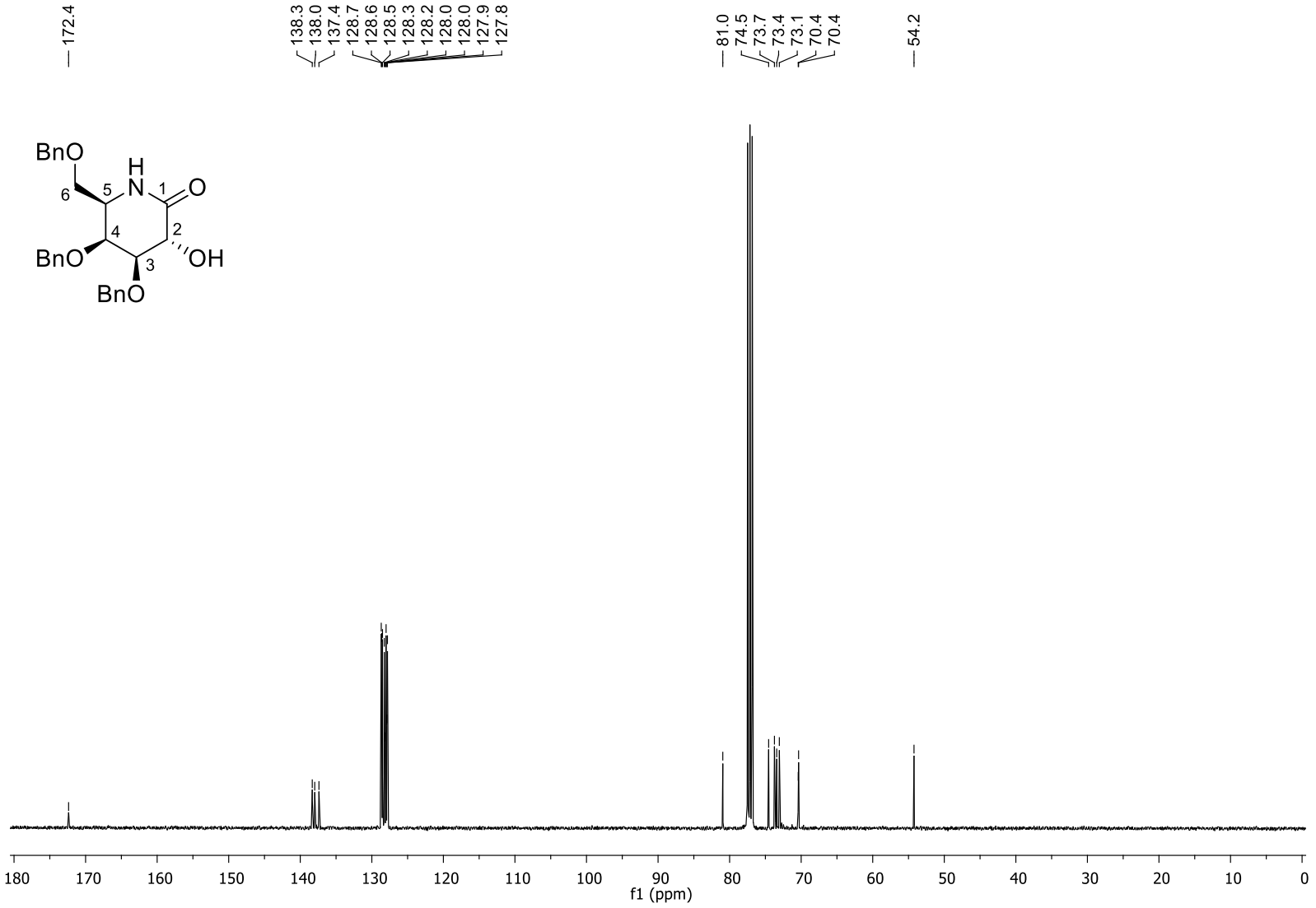
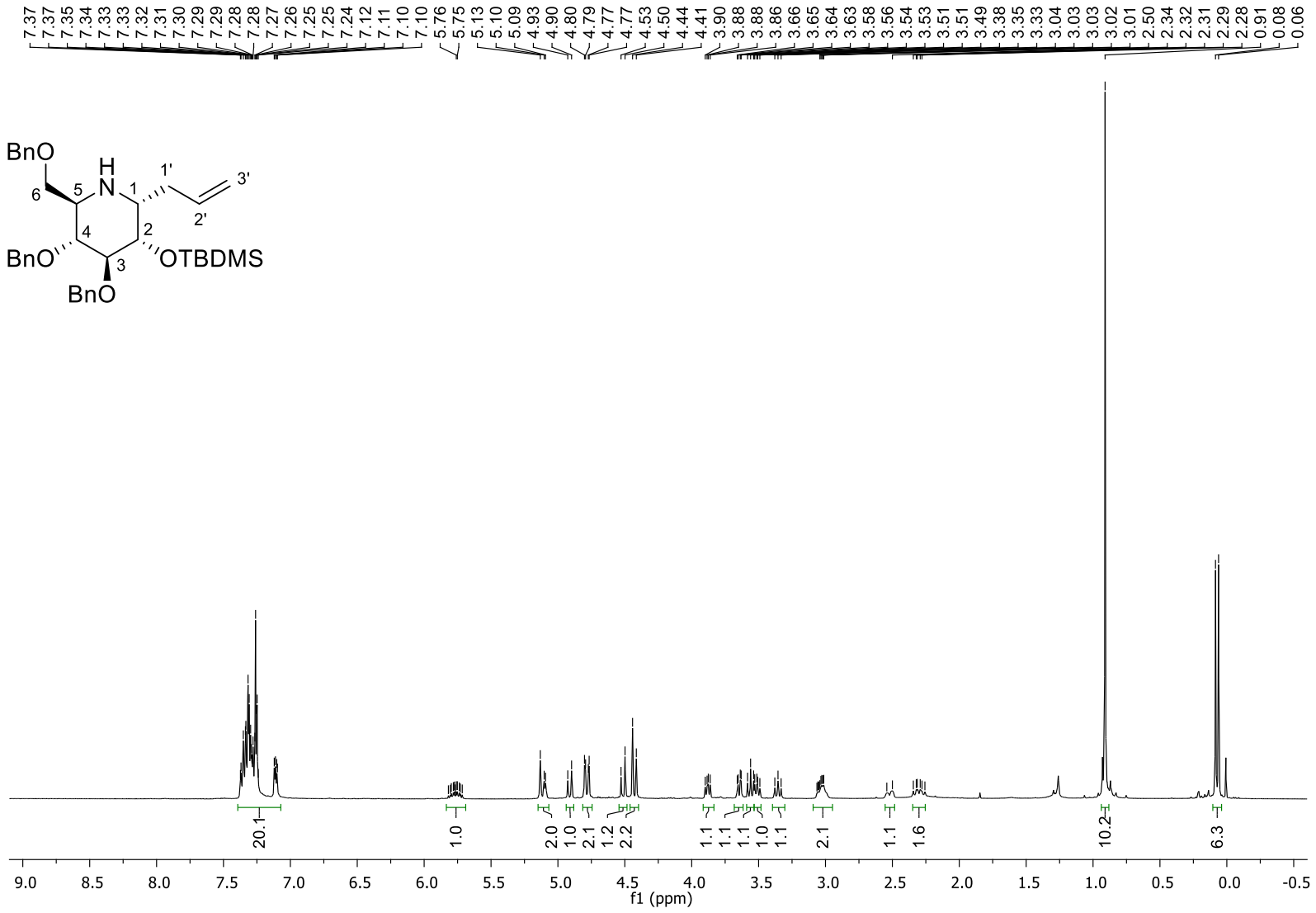
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **2b**.



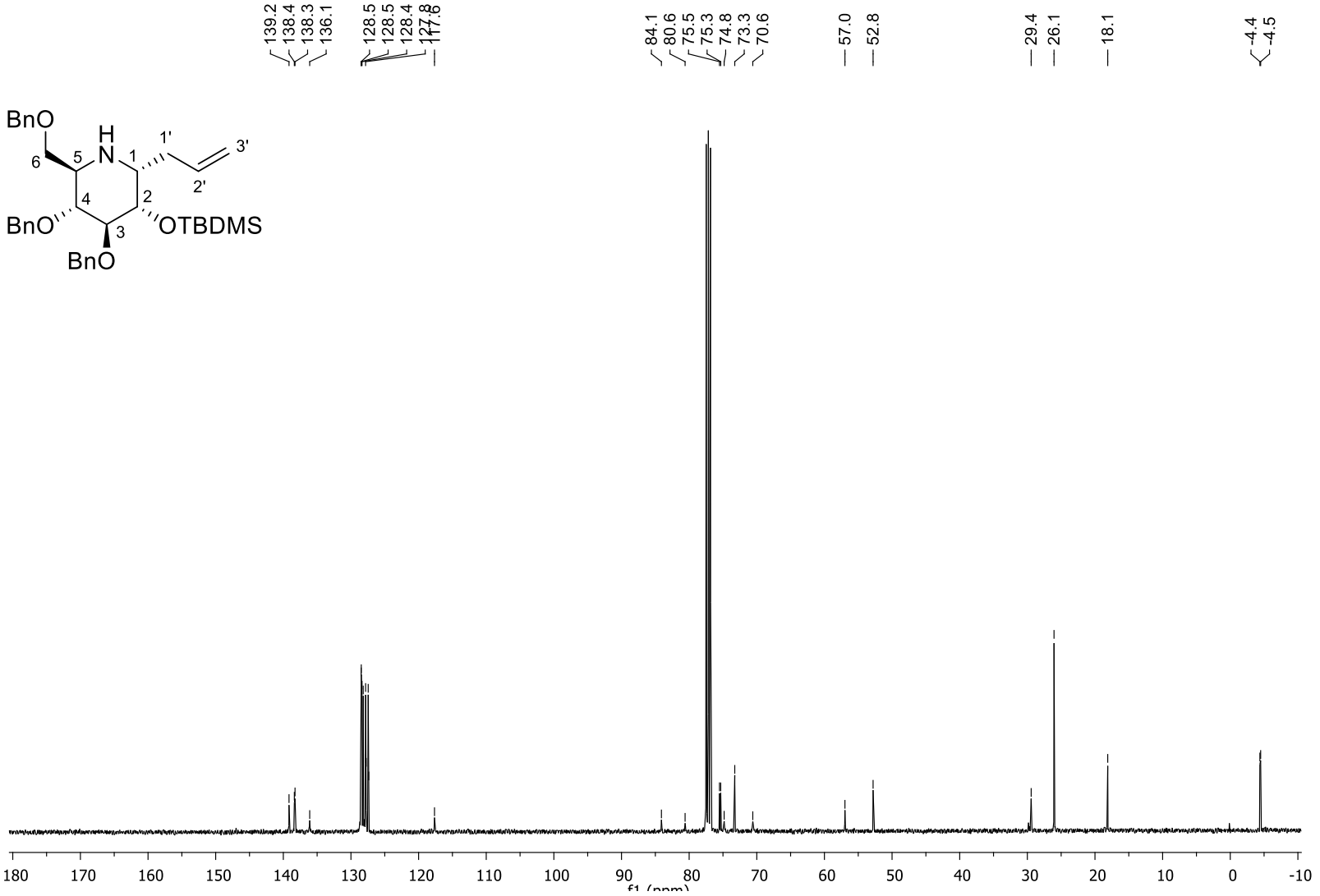
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **2b**.



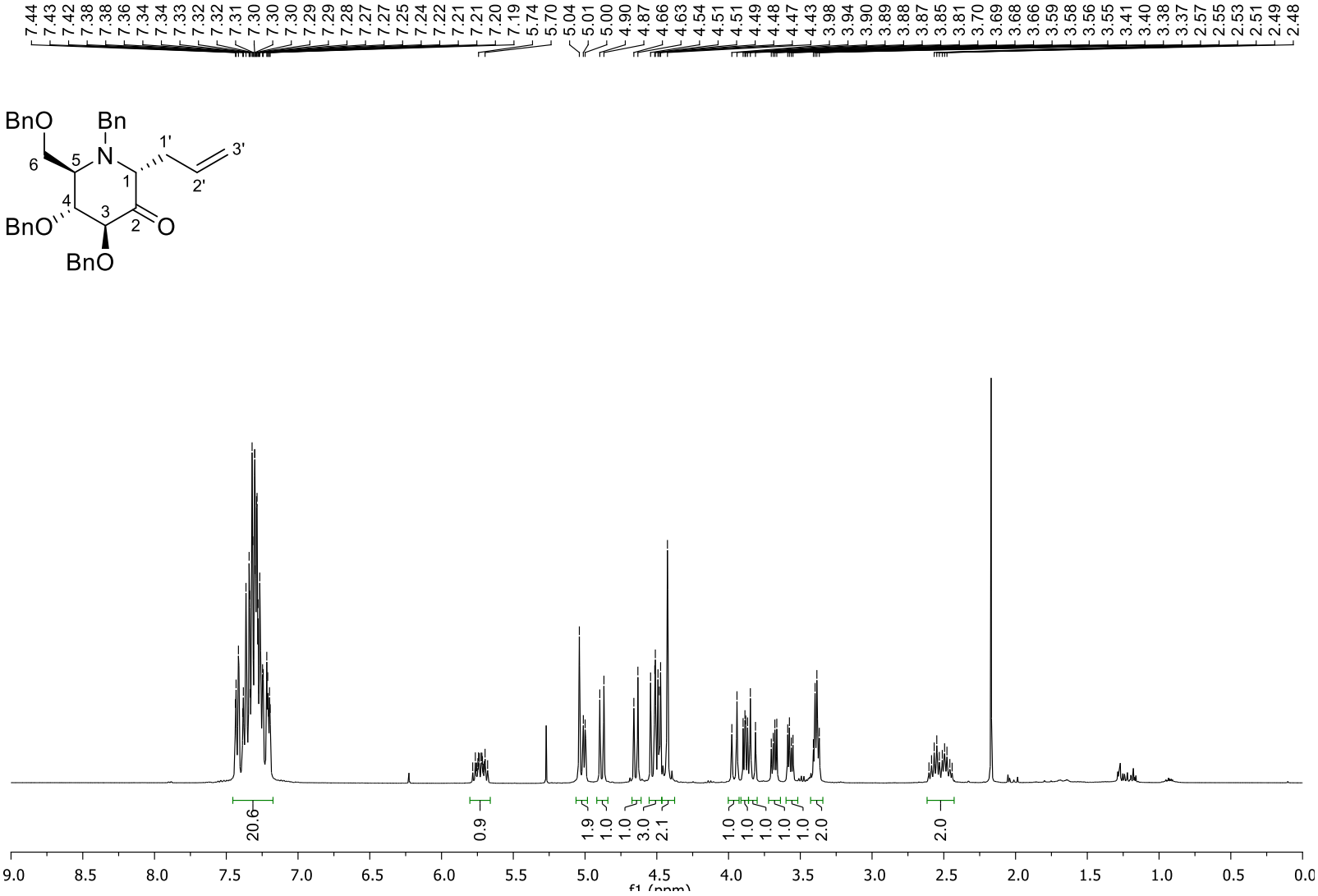
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **4**.



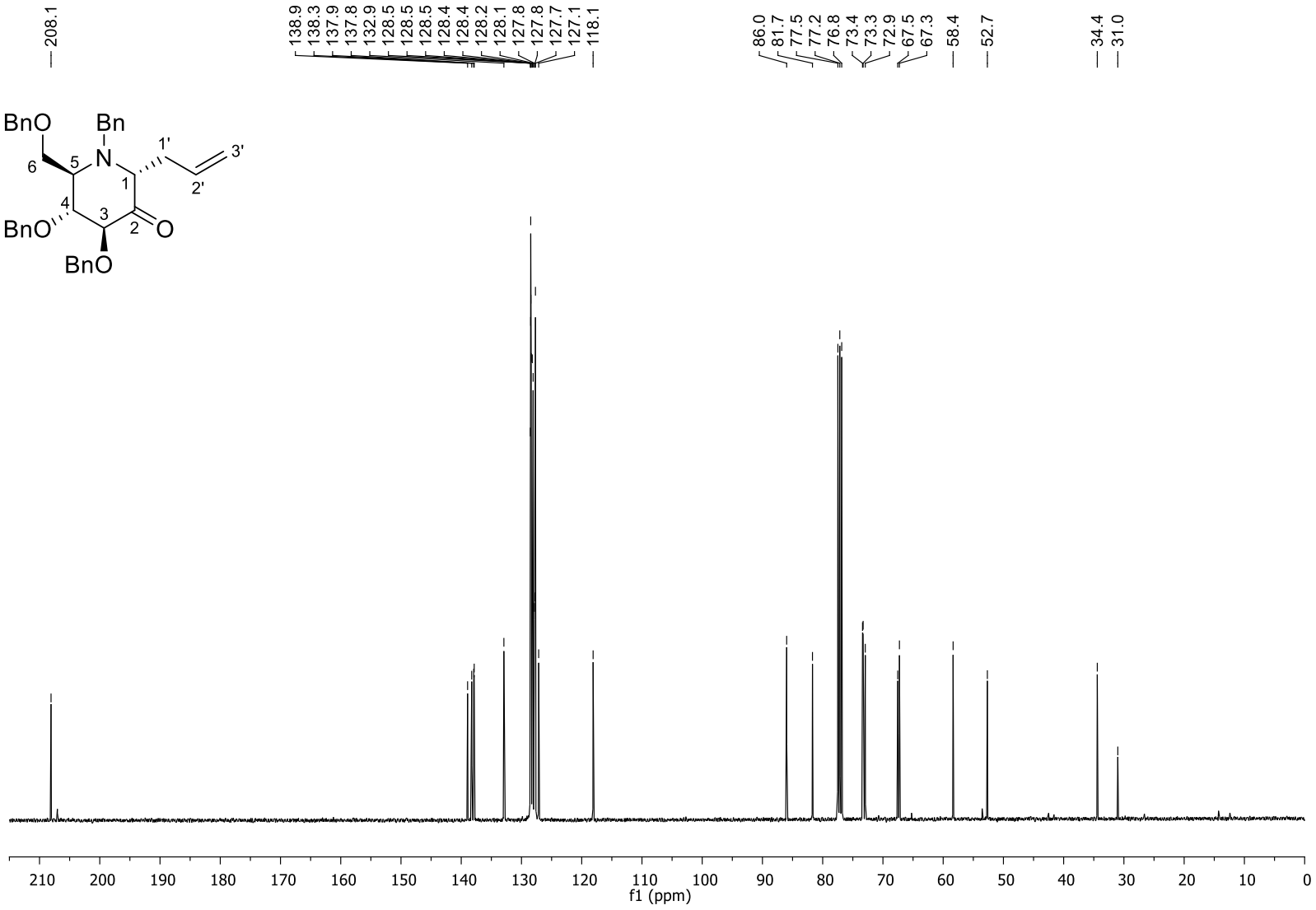
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **4**.



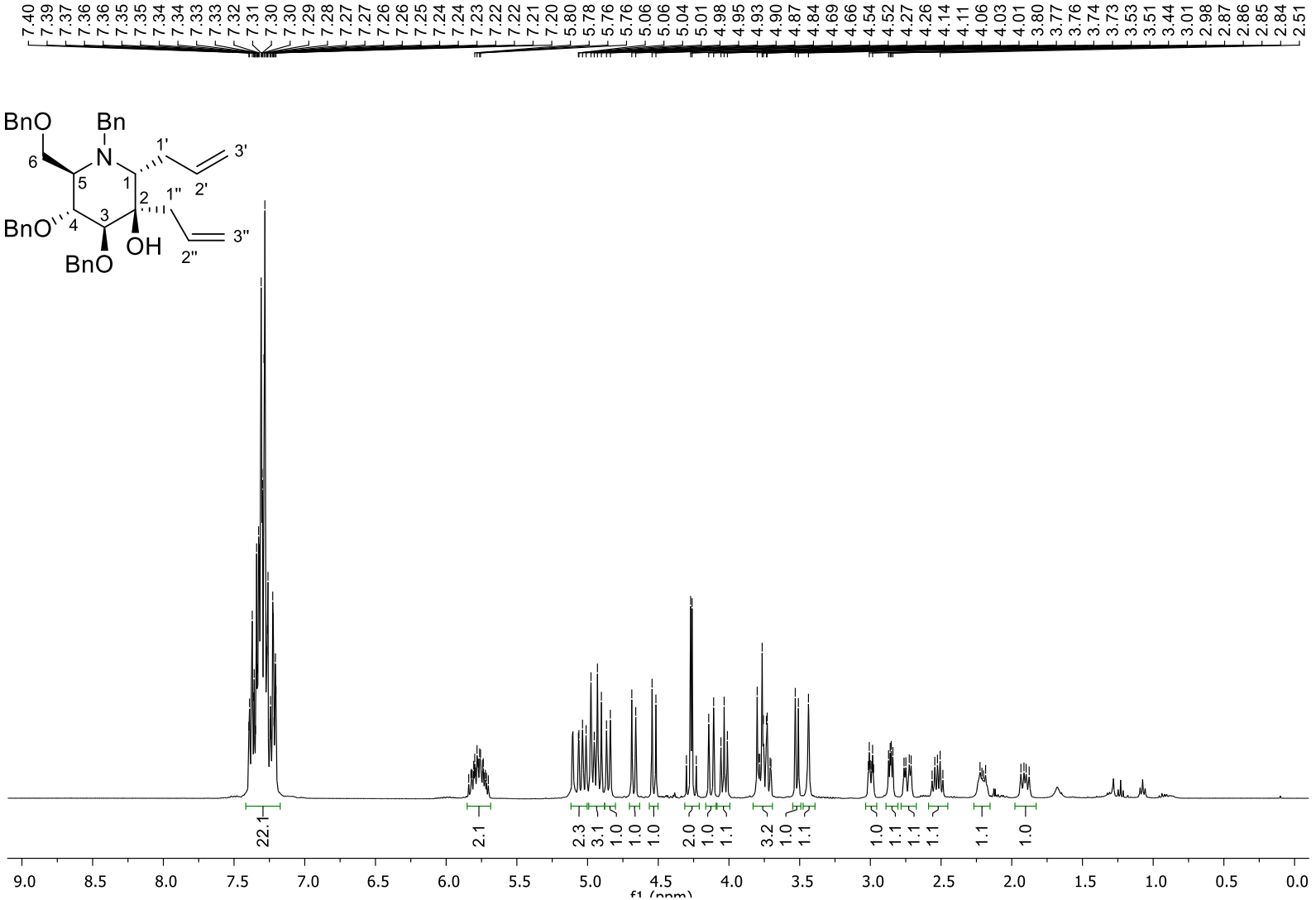
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **7**.



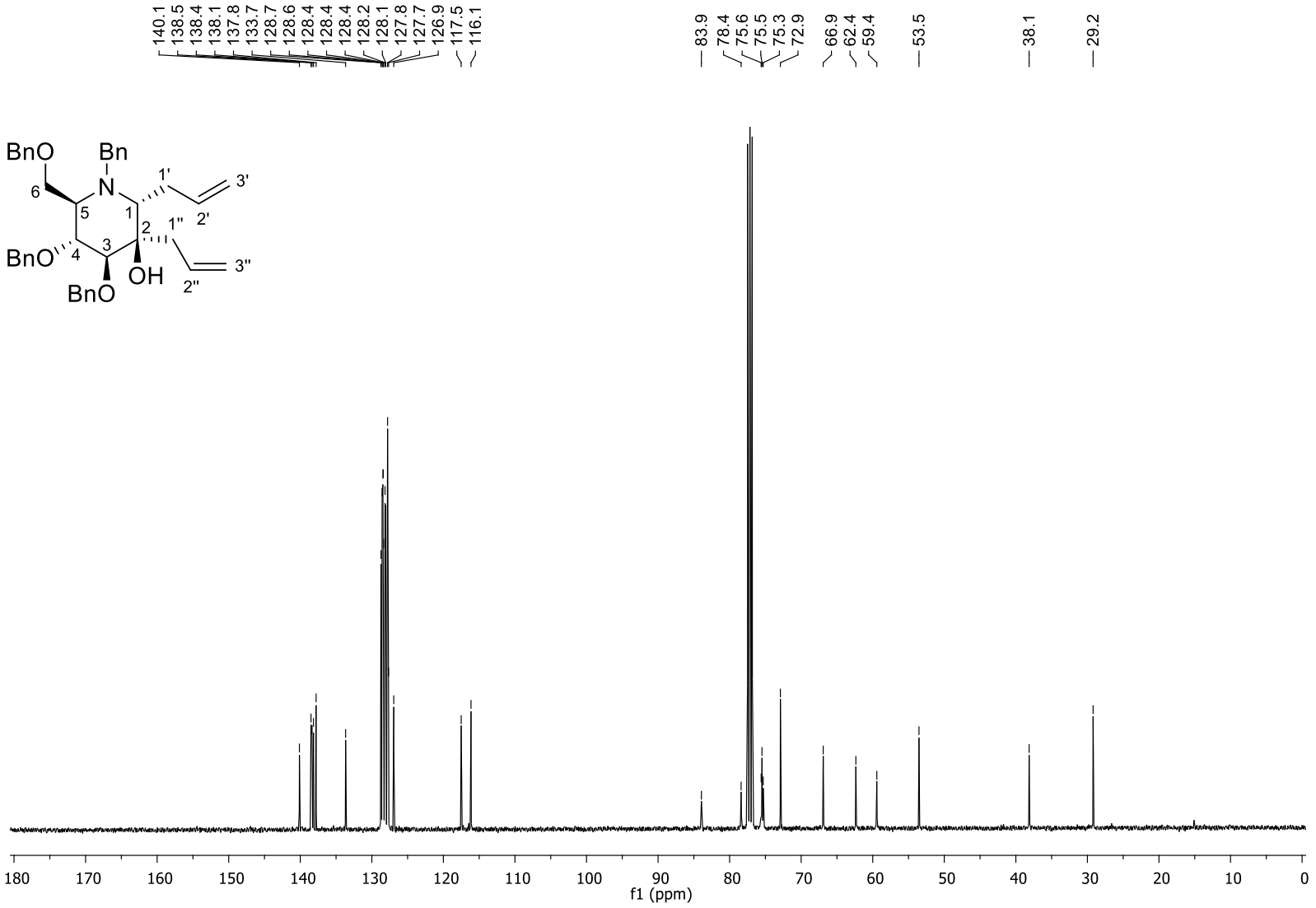
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **7**.



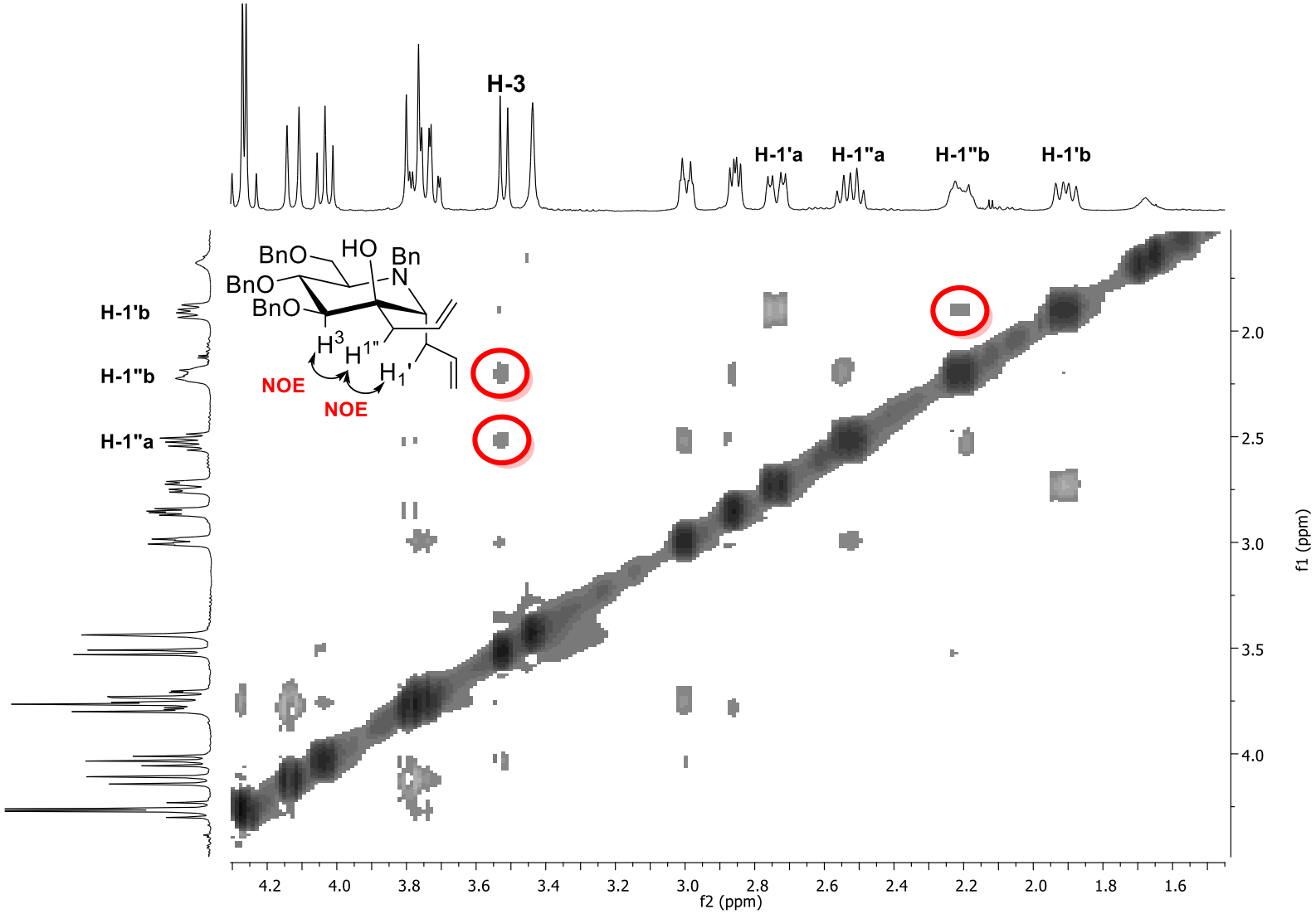
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **8a**.



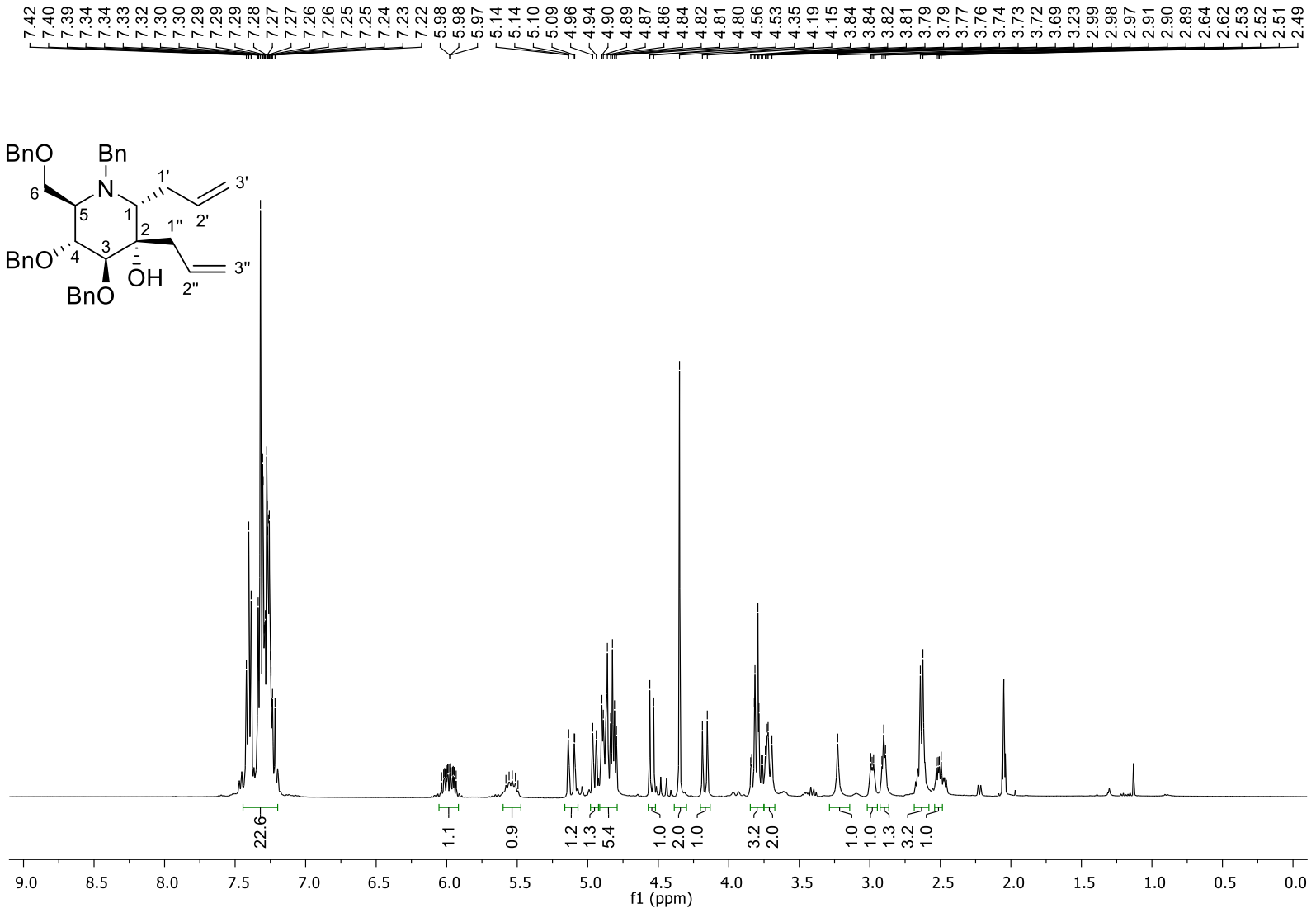
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **8a**.



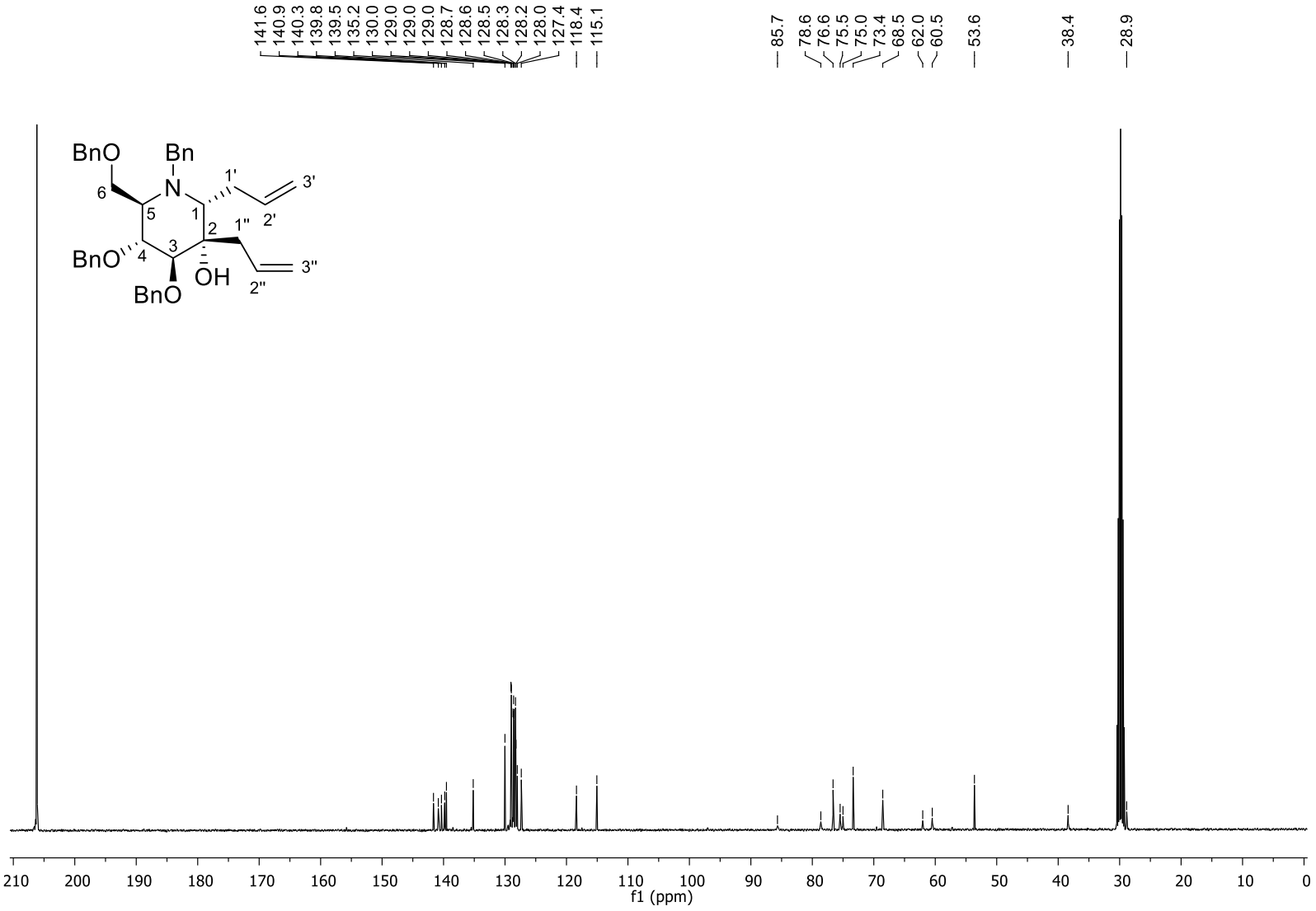
2D NOESY ^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **8a**.



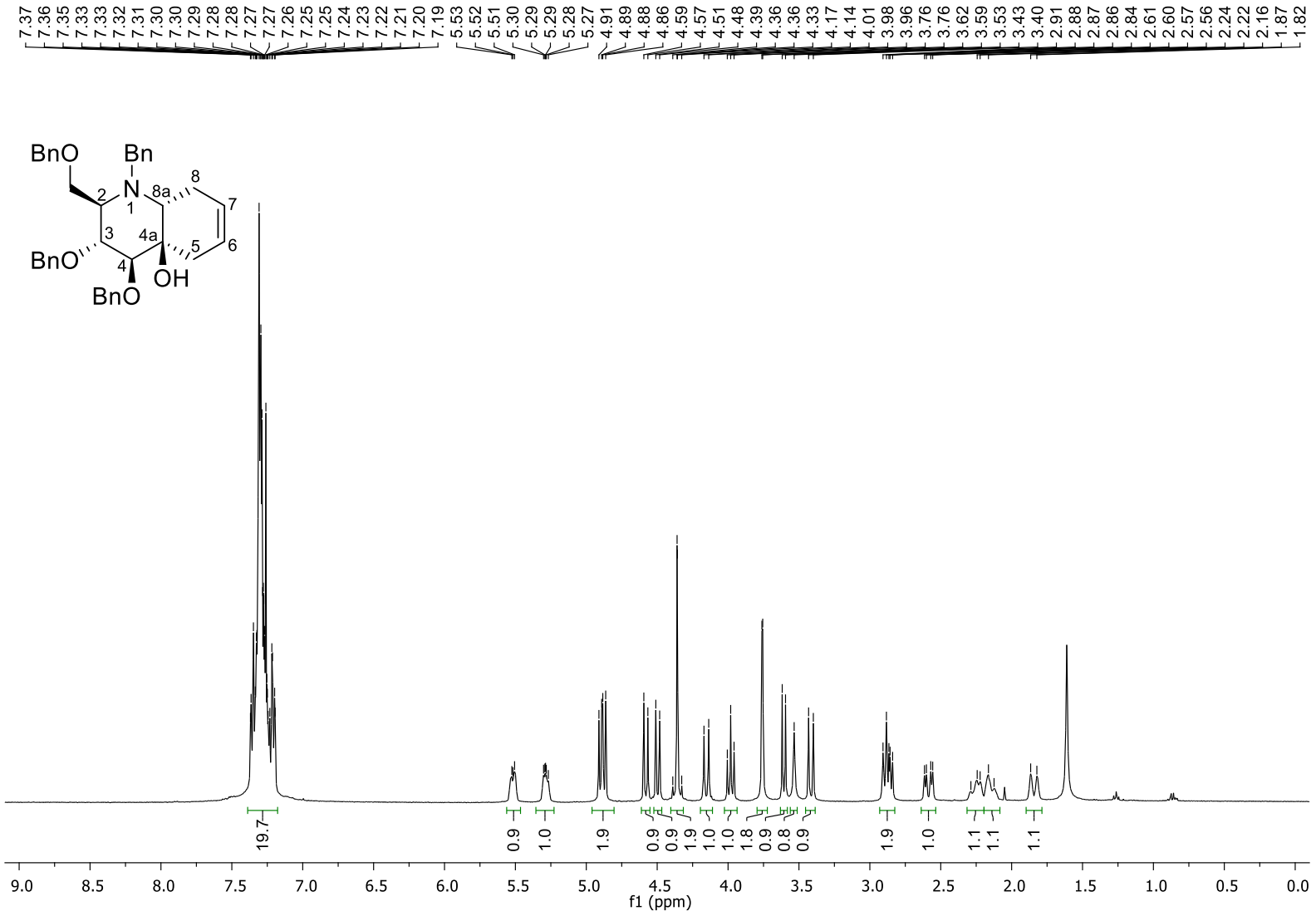
^{1}H NMR spectrum (Acetone-d6, 400 MHz) of compound **8b**.



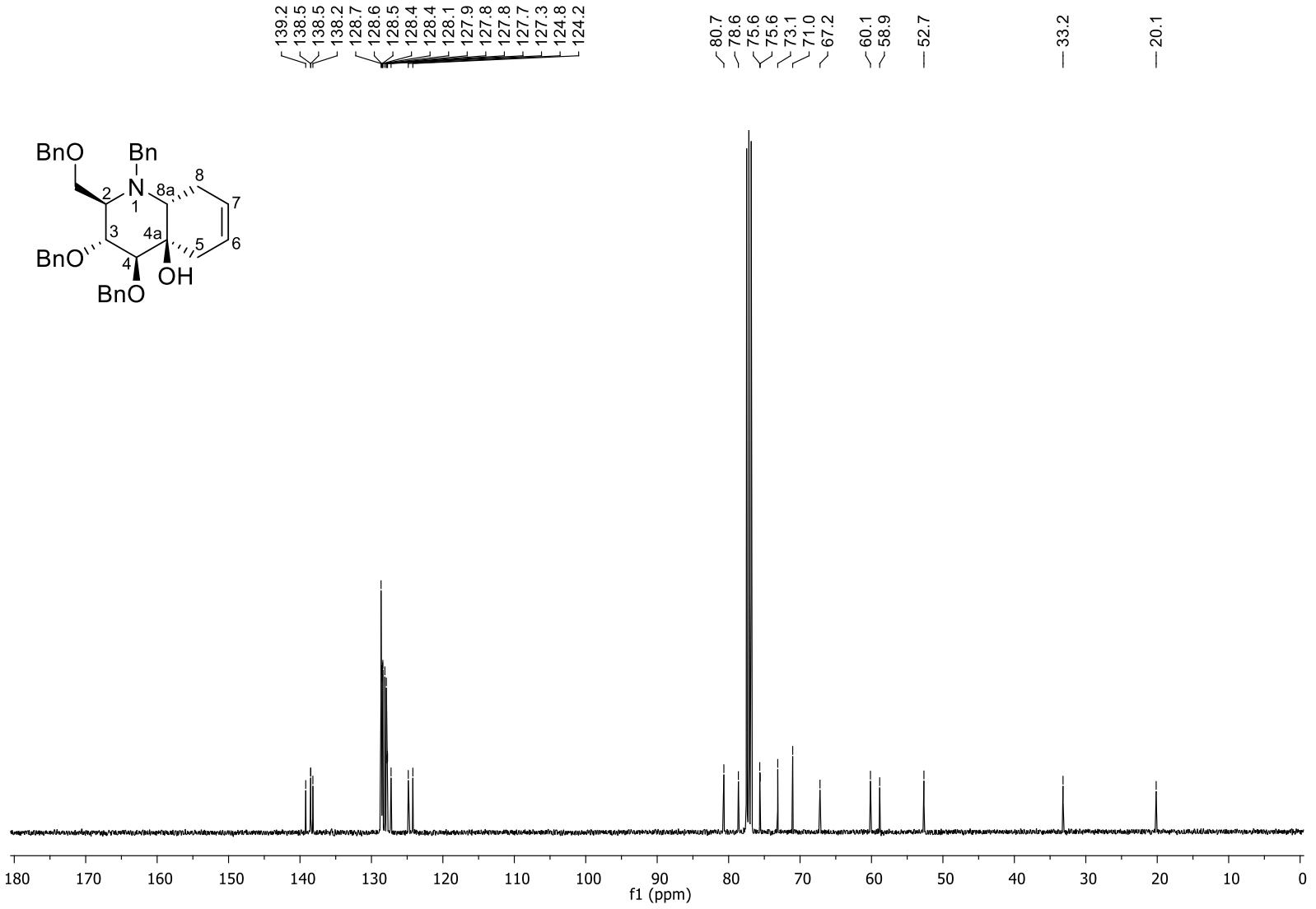
^{13}C NMR spectrum (Acetone-d6, 100 MHz) of compound **8b**.



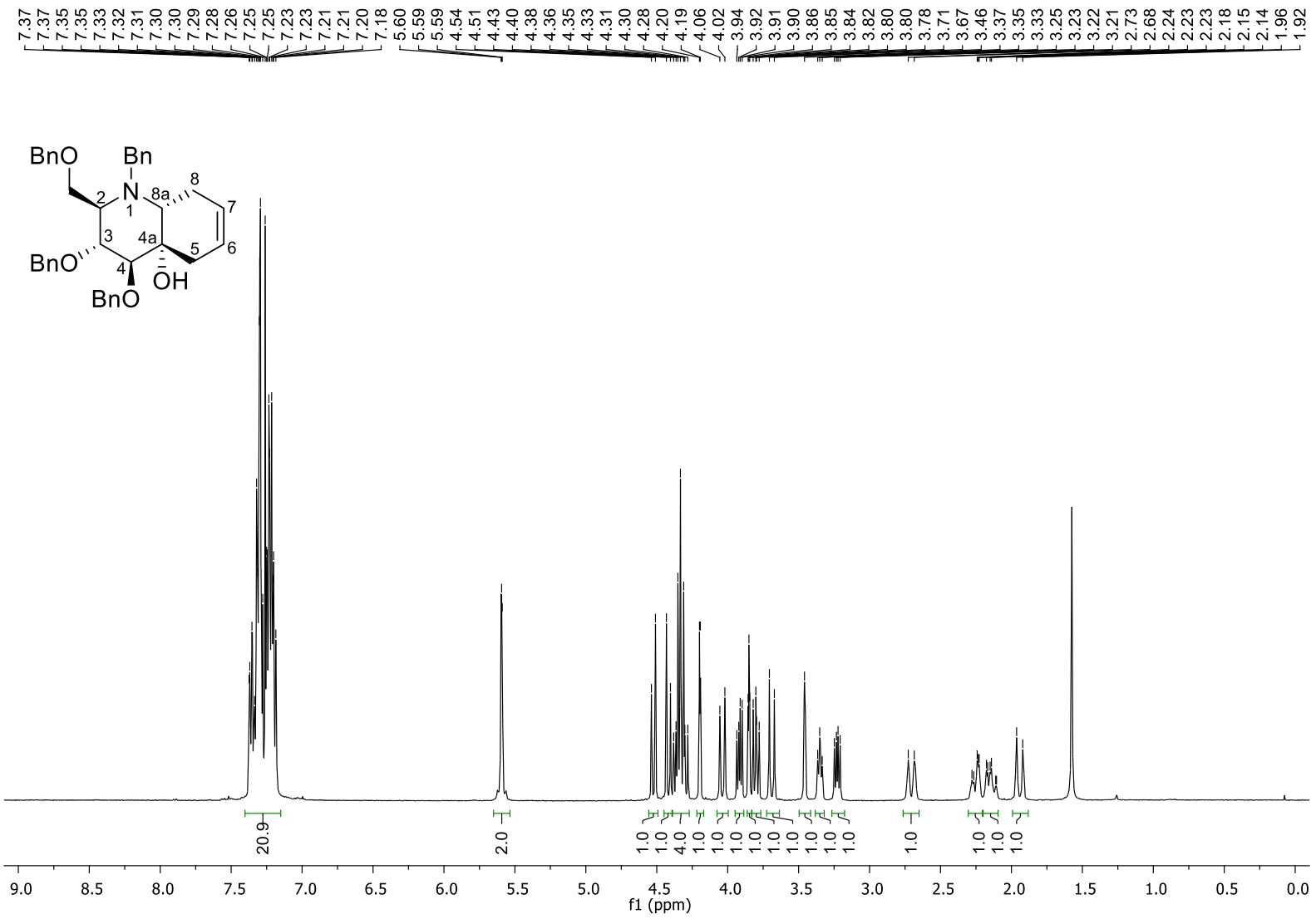
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **9a**.



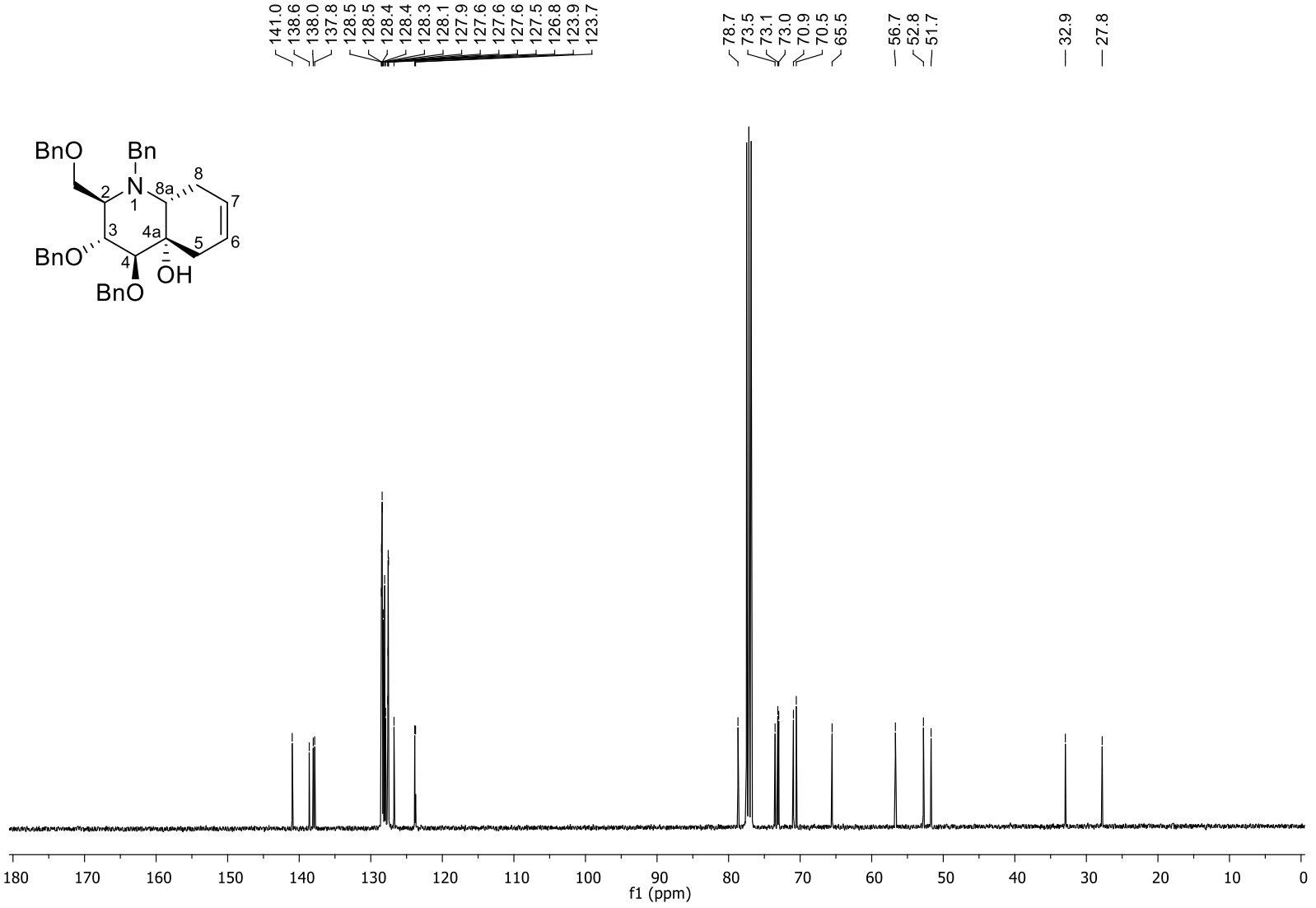
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **9a**.



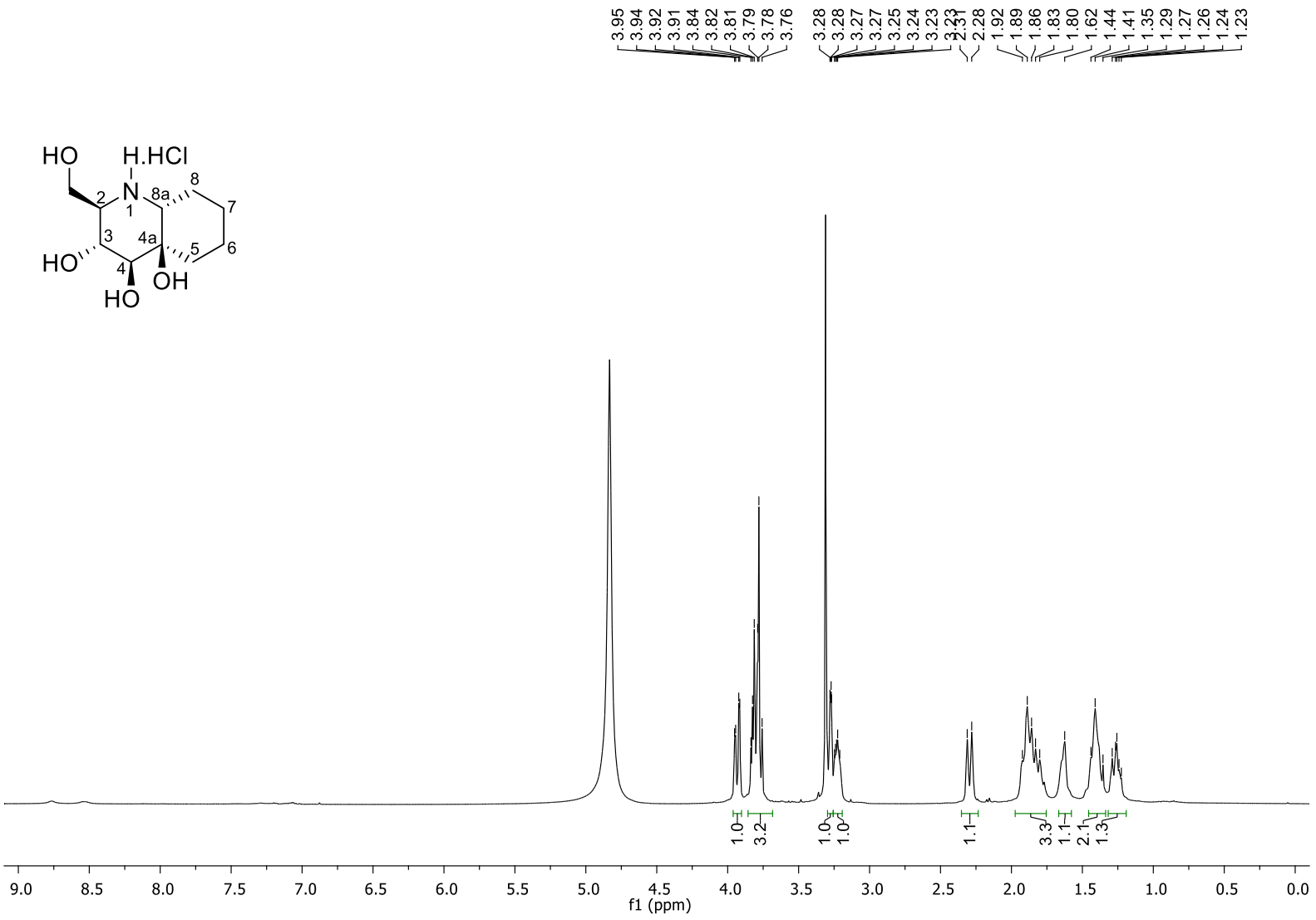
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **9b**.



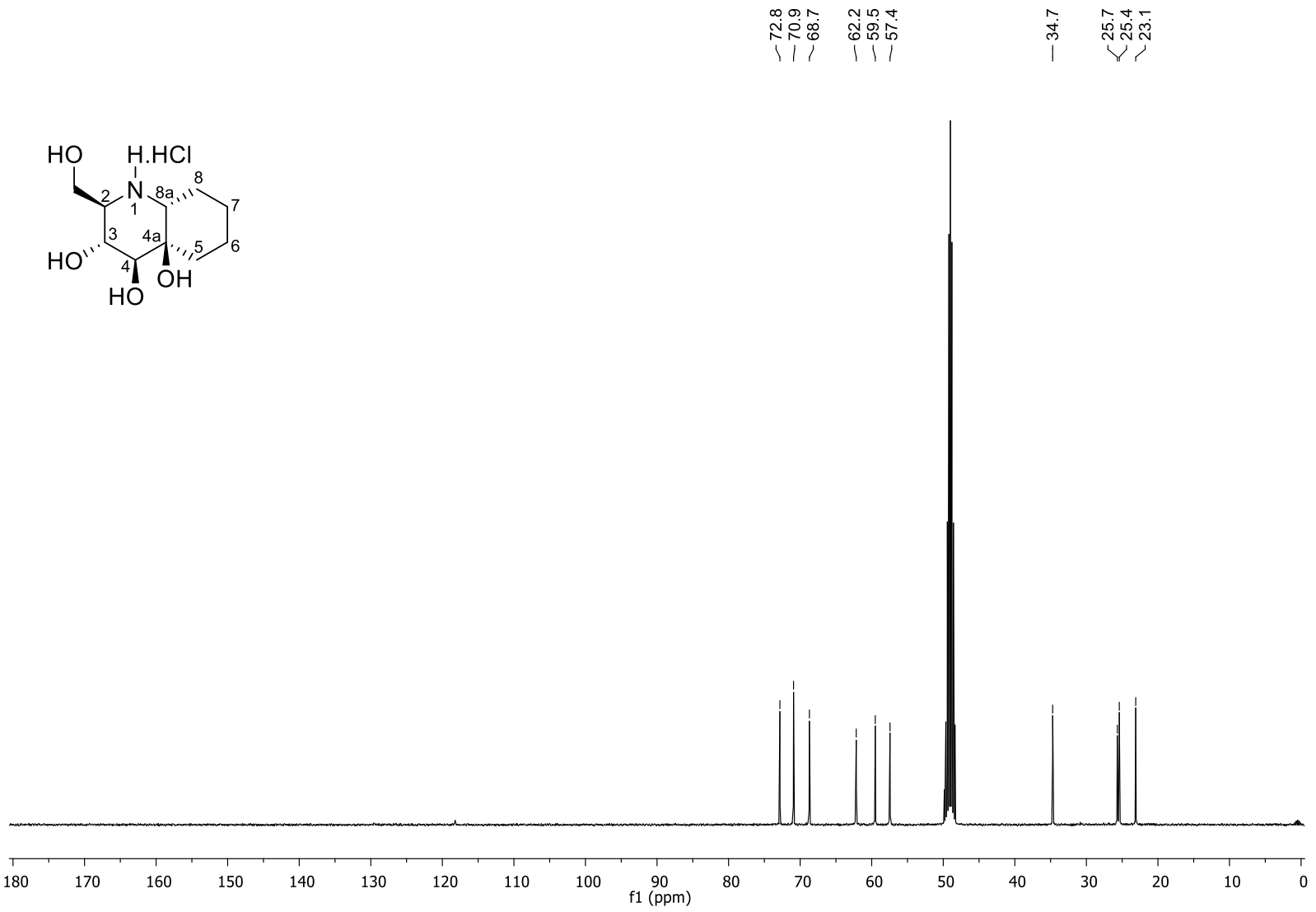
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **9b**.



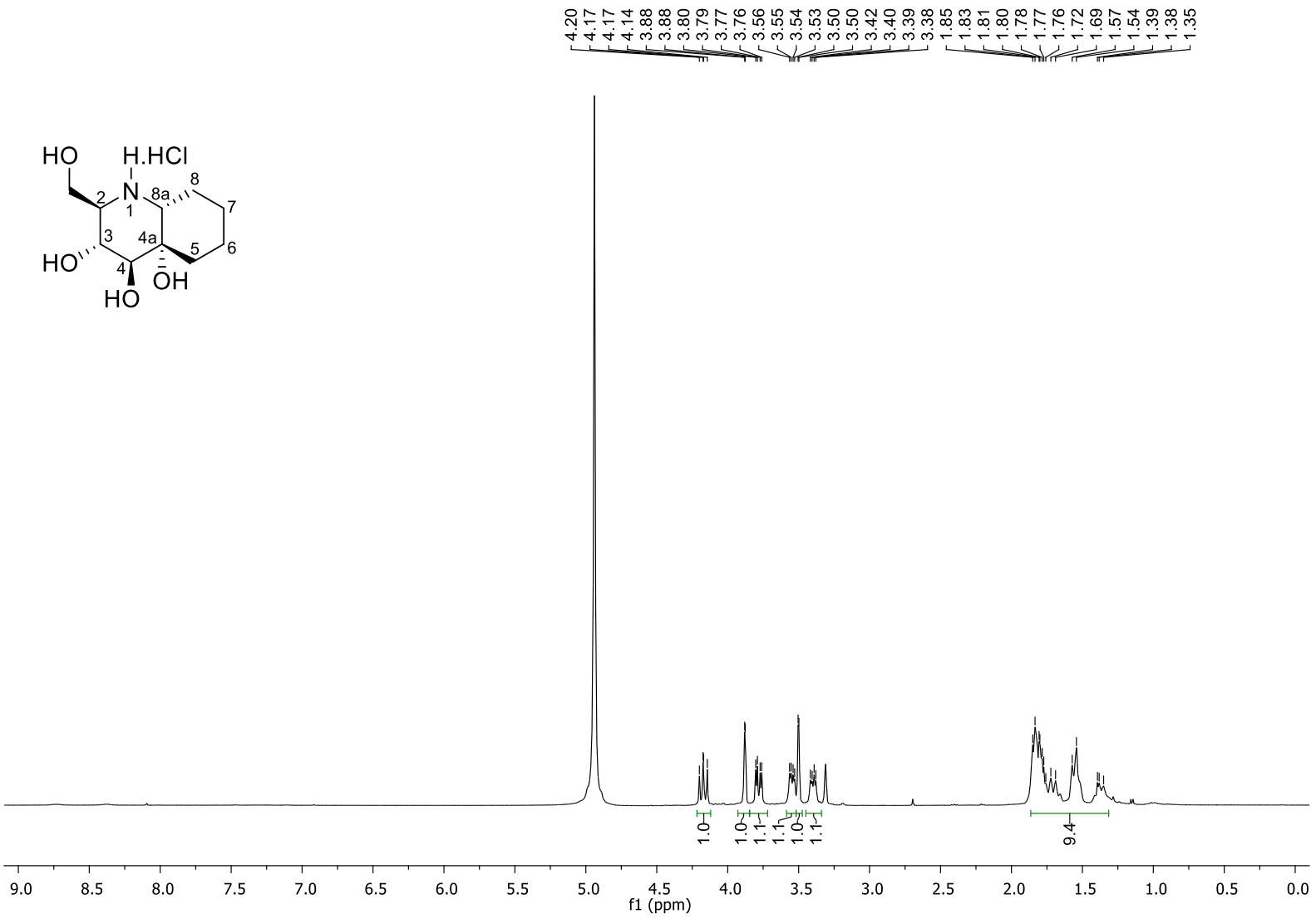
^{1}H NMR spectrum (Methanol-d4, 400 MHz) of compound **10a**.



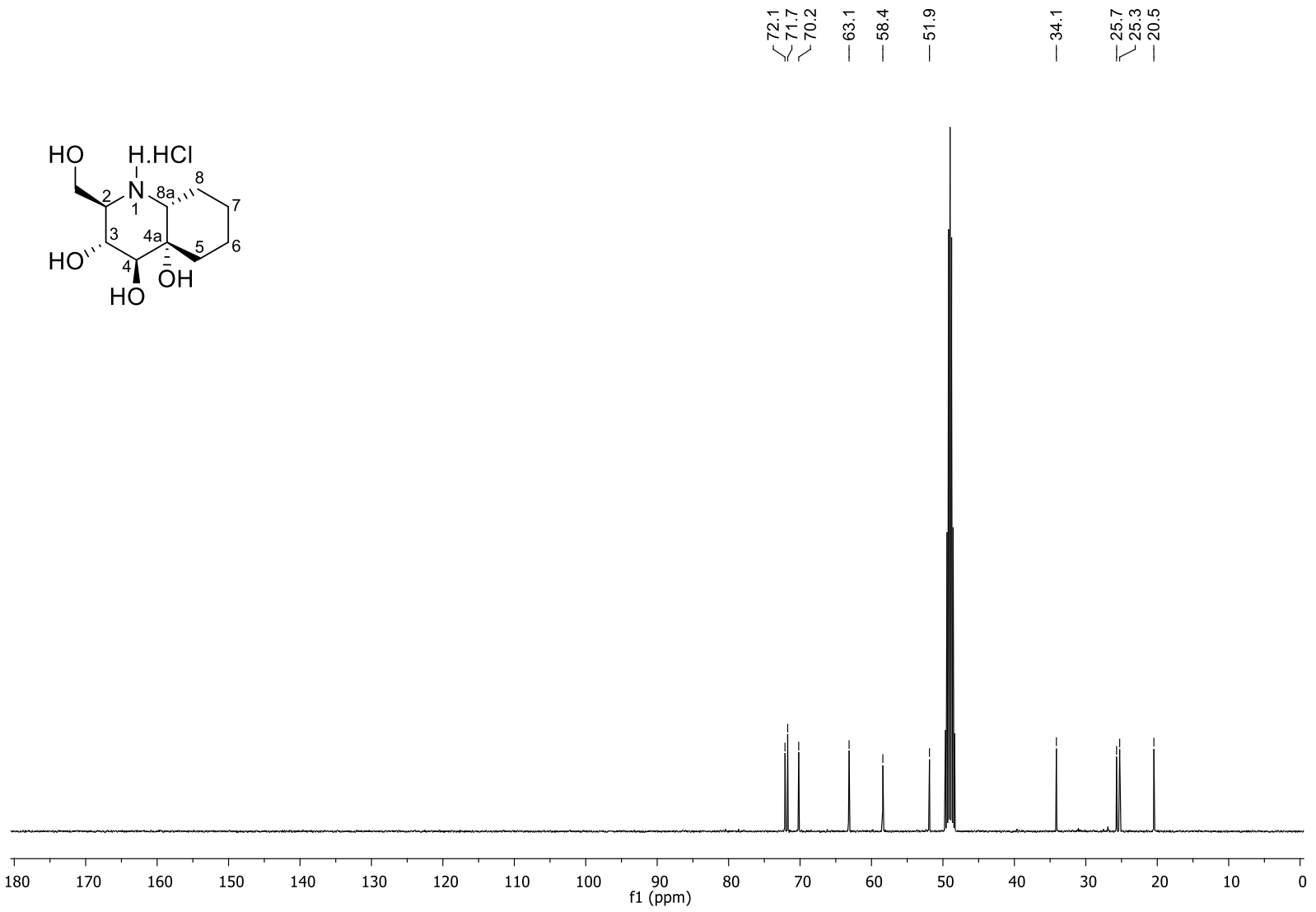
^{13}C NMR spectrum (Methanol-d4, 400 MHz) of compound **10a**.



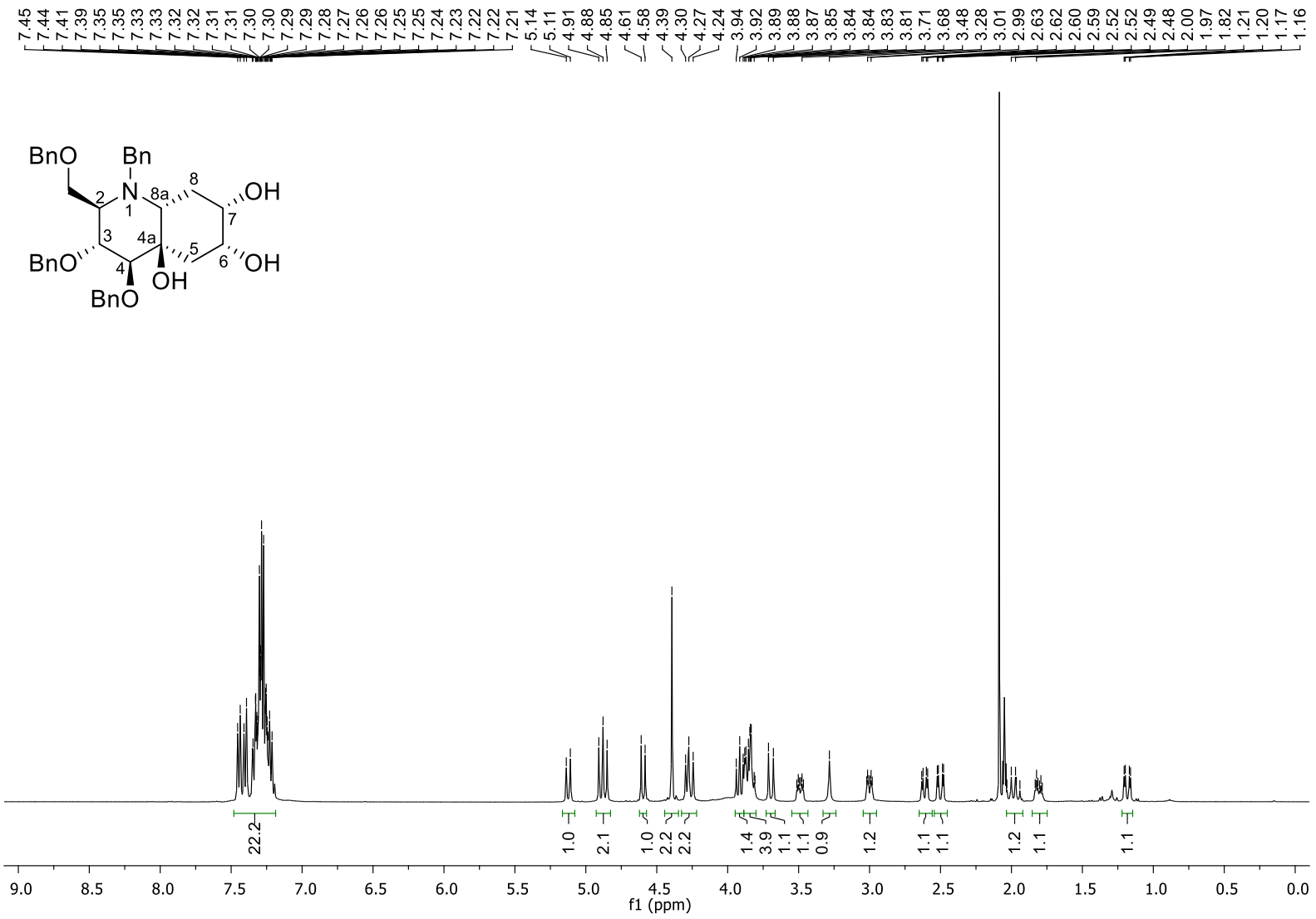
^{1}H NMR spectrum (Methanol-d4, 400 MHz) of compound **10b**.



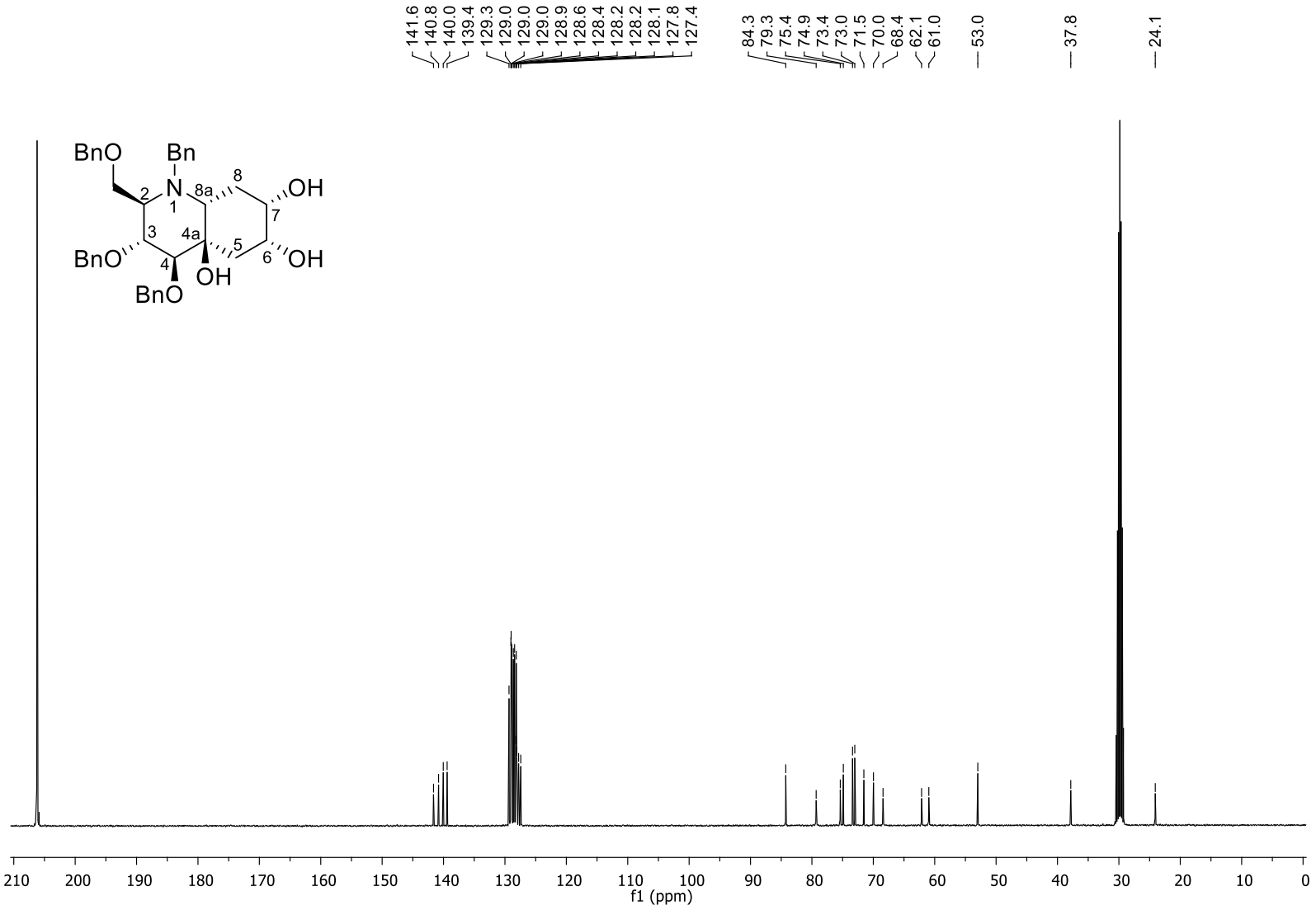
^{13}C NMR spectrum (Methanol-d4, 400 MHz) of compound **10b**.



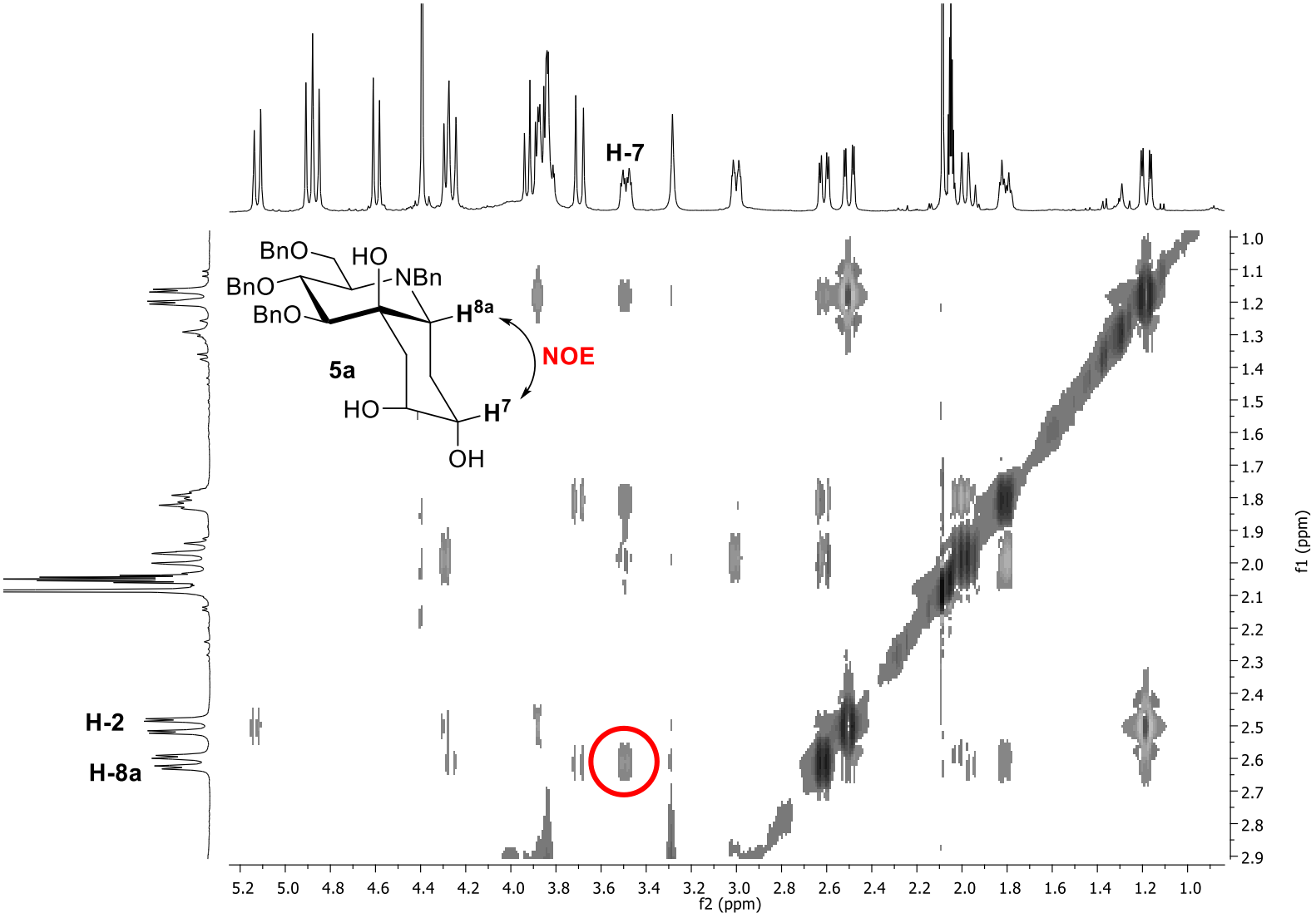
^{1}H NMR spectrum (Acetone-d6, 400 MHz) of compound **11a**.



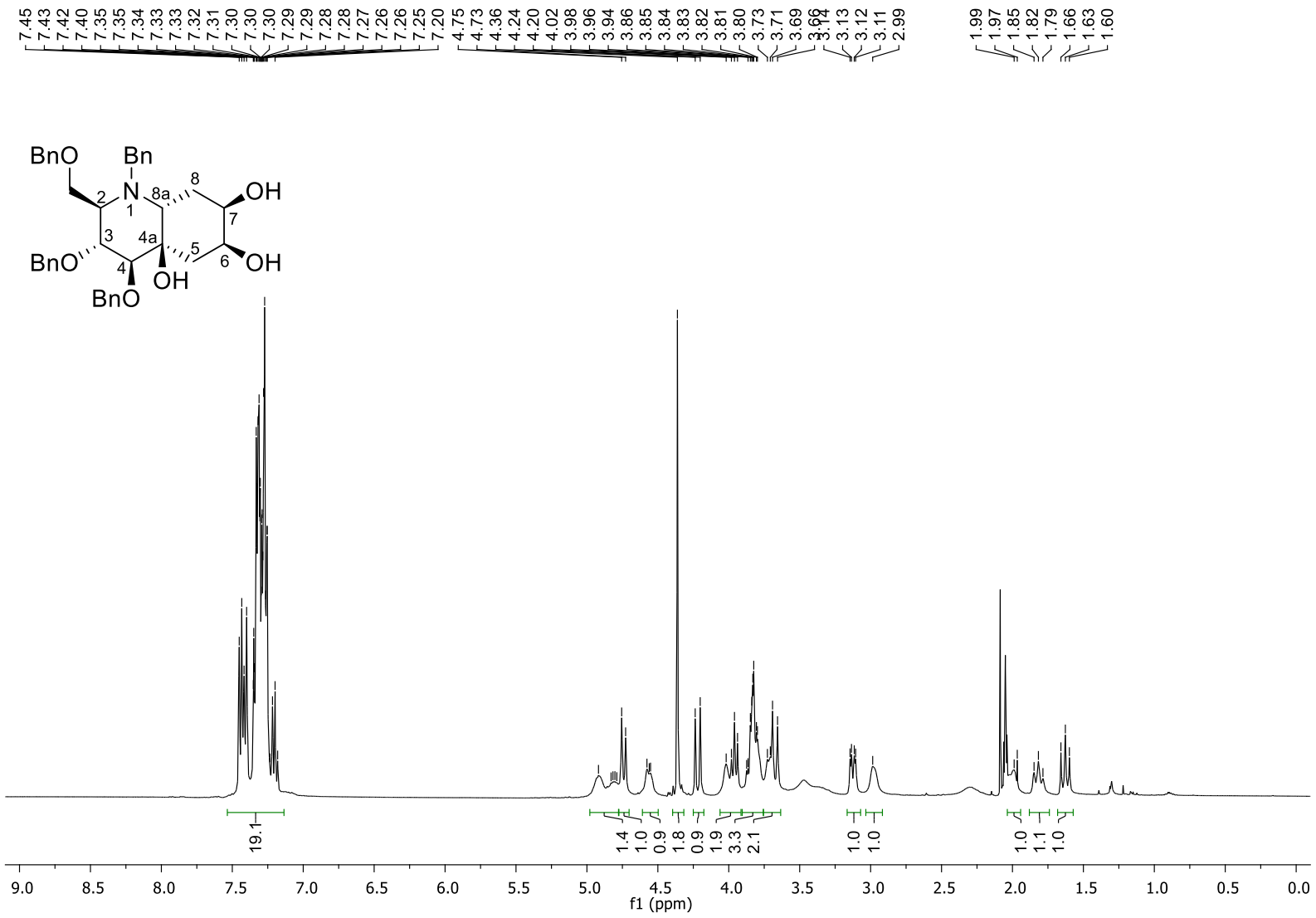
^{13}C NMR spectrum (Acetone-d6, 100 MHz) of compound **11a**.



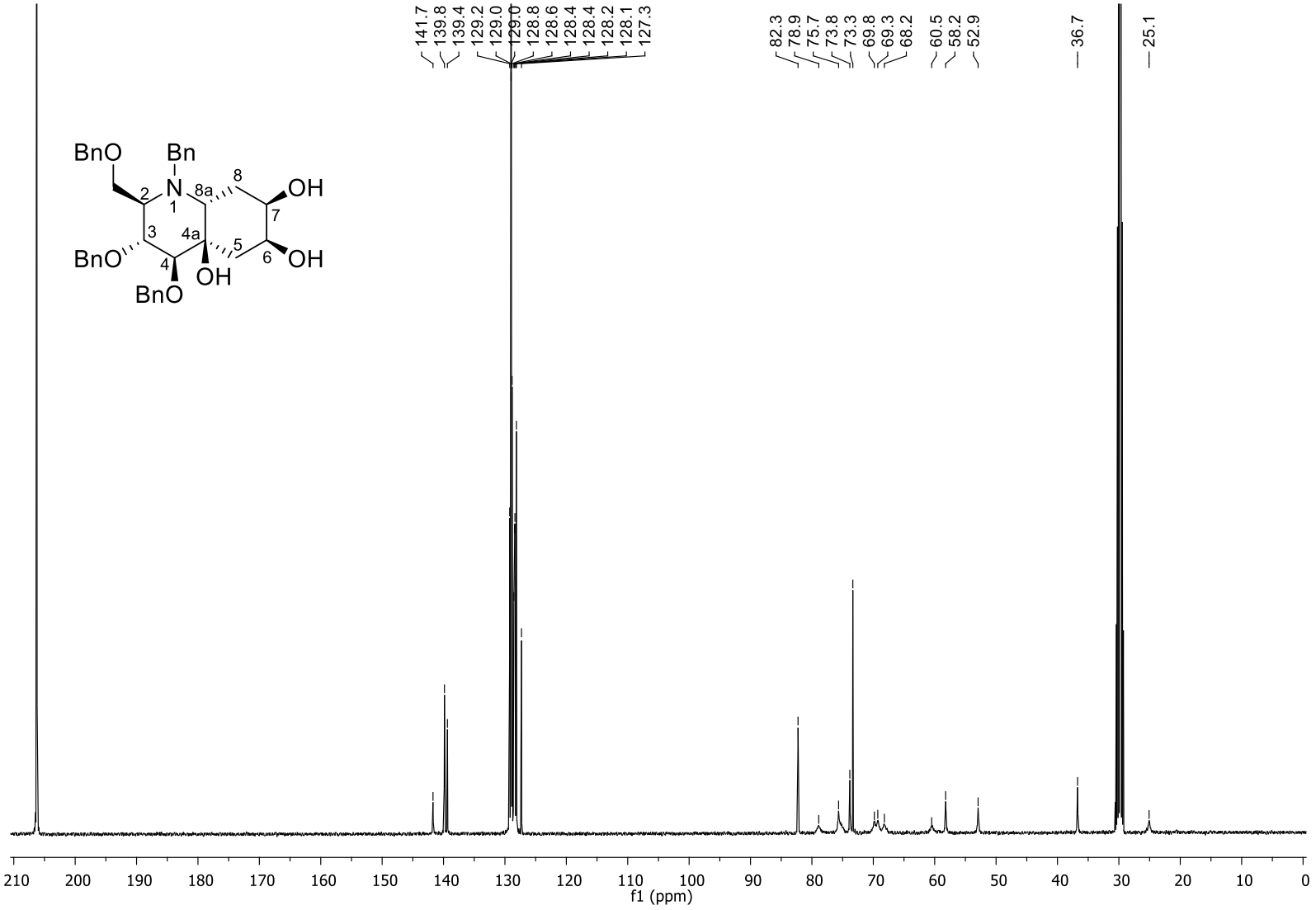
2D NOESY ^{1}H NMR spectrum (Acetone-d6, 100 MHz) of compound **11a**.



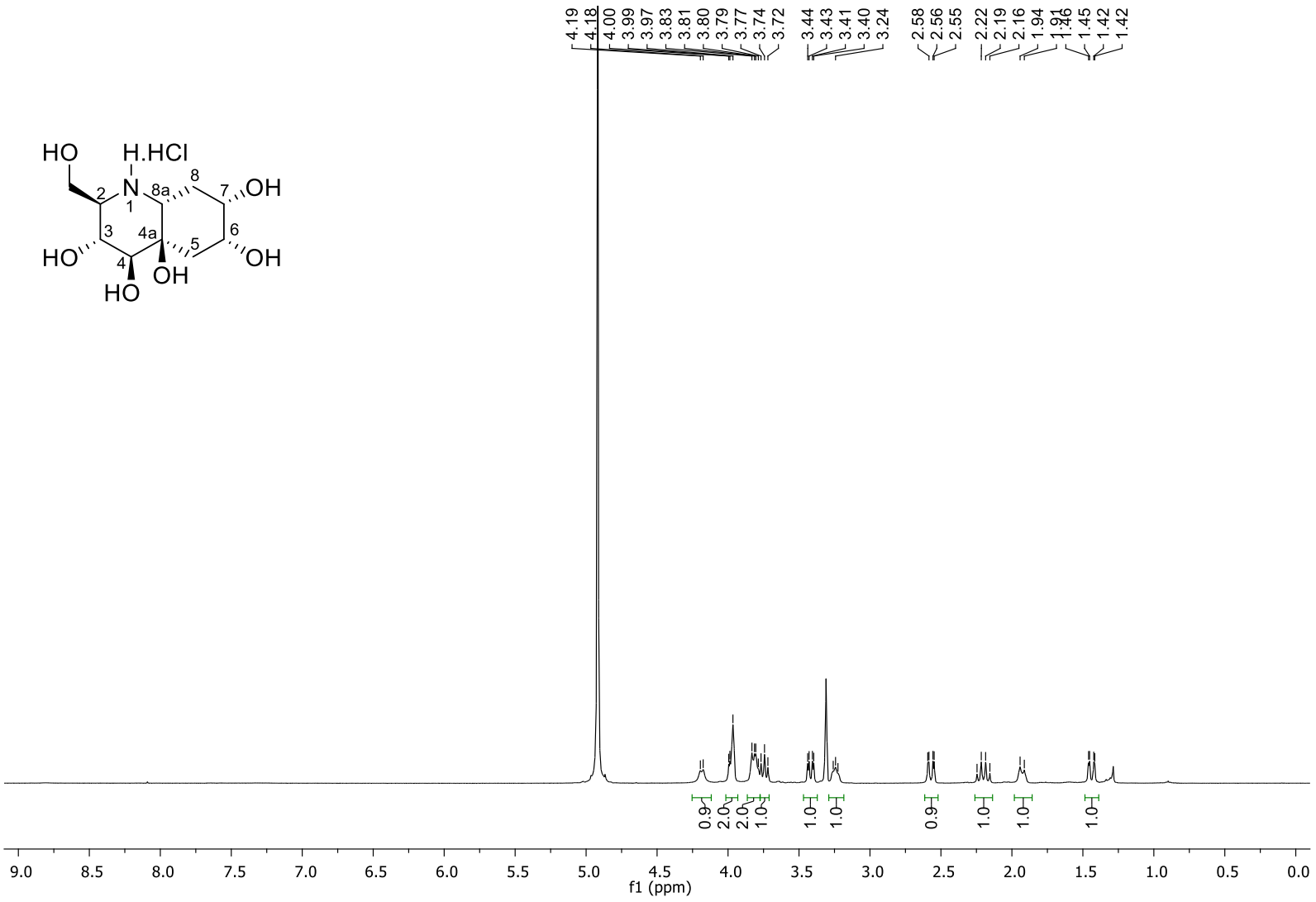
^{1}H NMR spectrum (Acetone-d6, 400 MHz) of compound **11a'**.



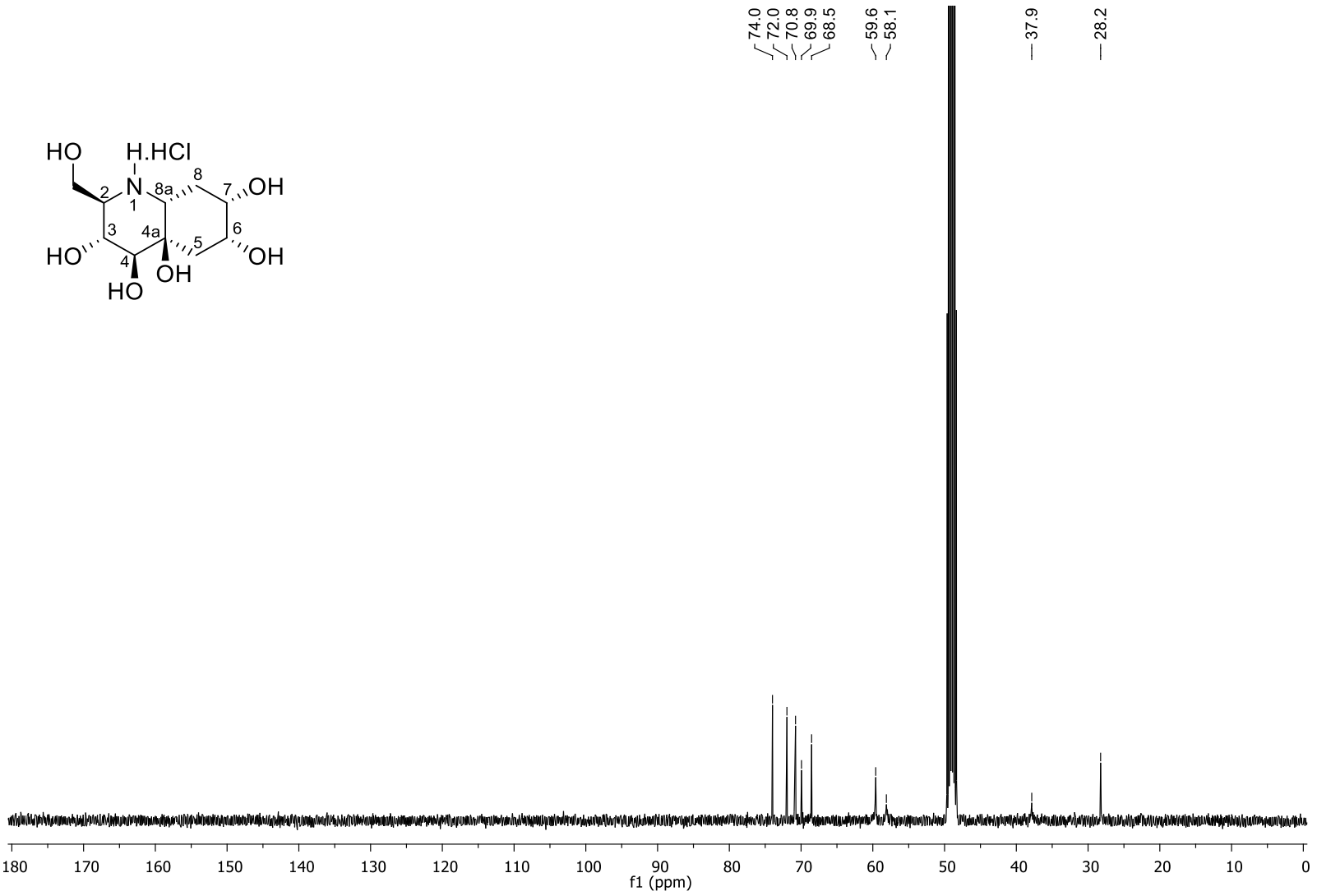
^{13}C NMR spectrum (Acetone-d6, 100 MHz) of compound **11a'**.



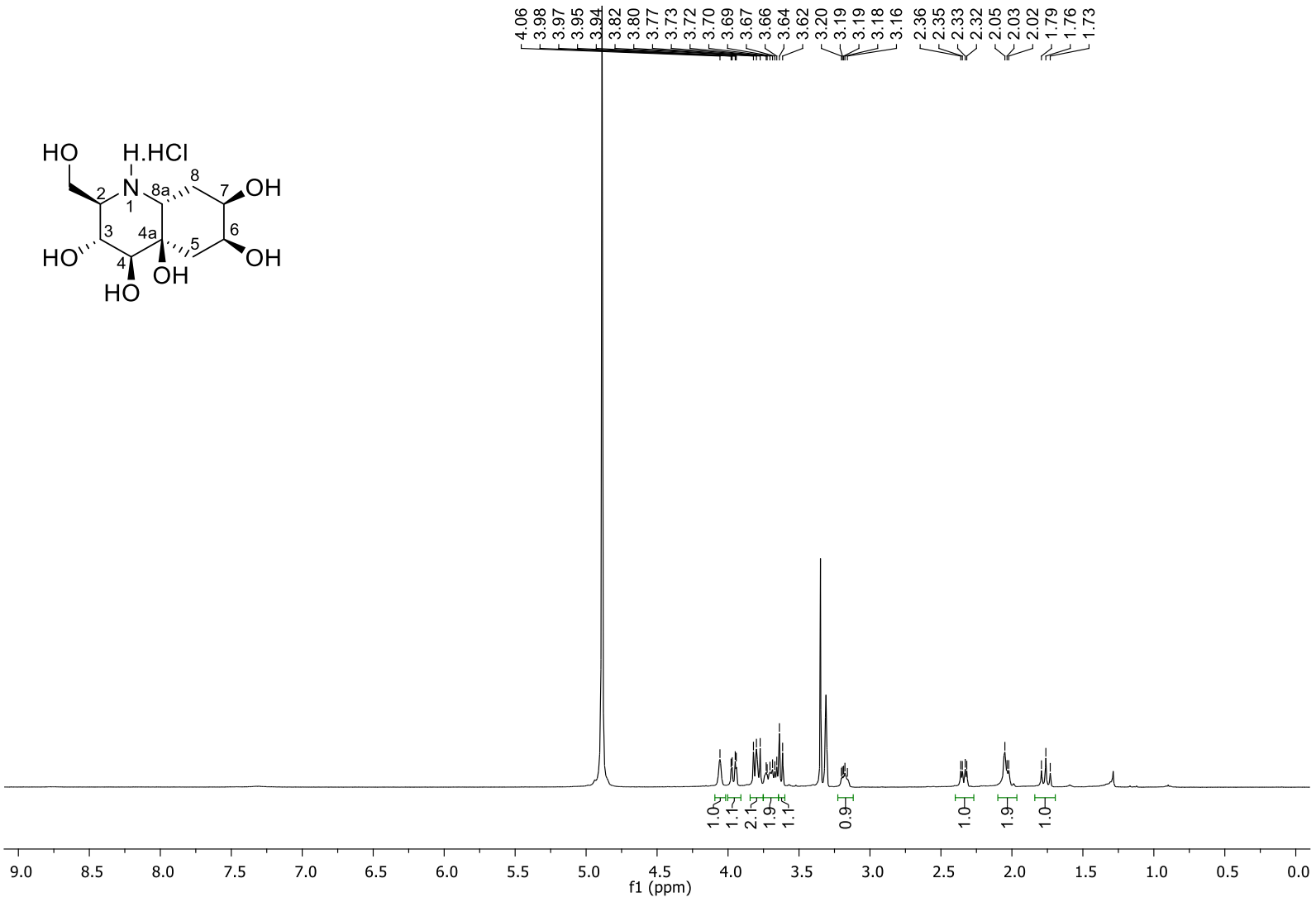
[1]H NMR spectrum (Methanol-d4, 400 MHz) of compound **12a**.



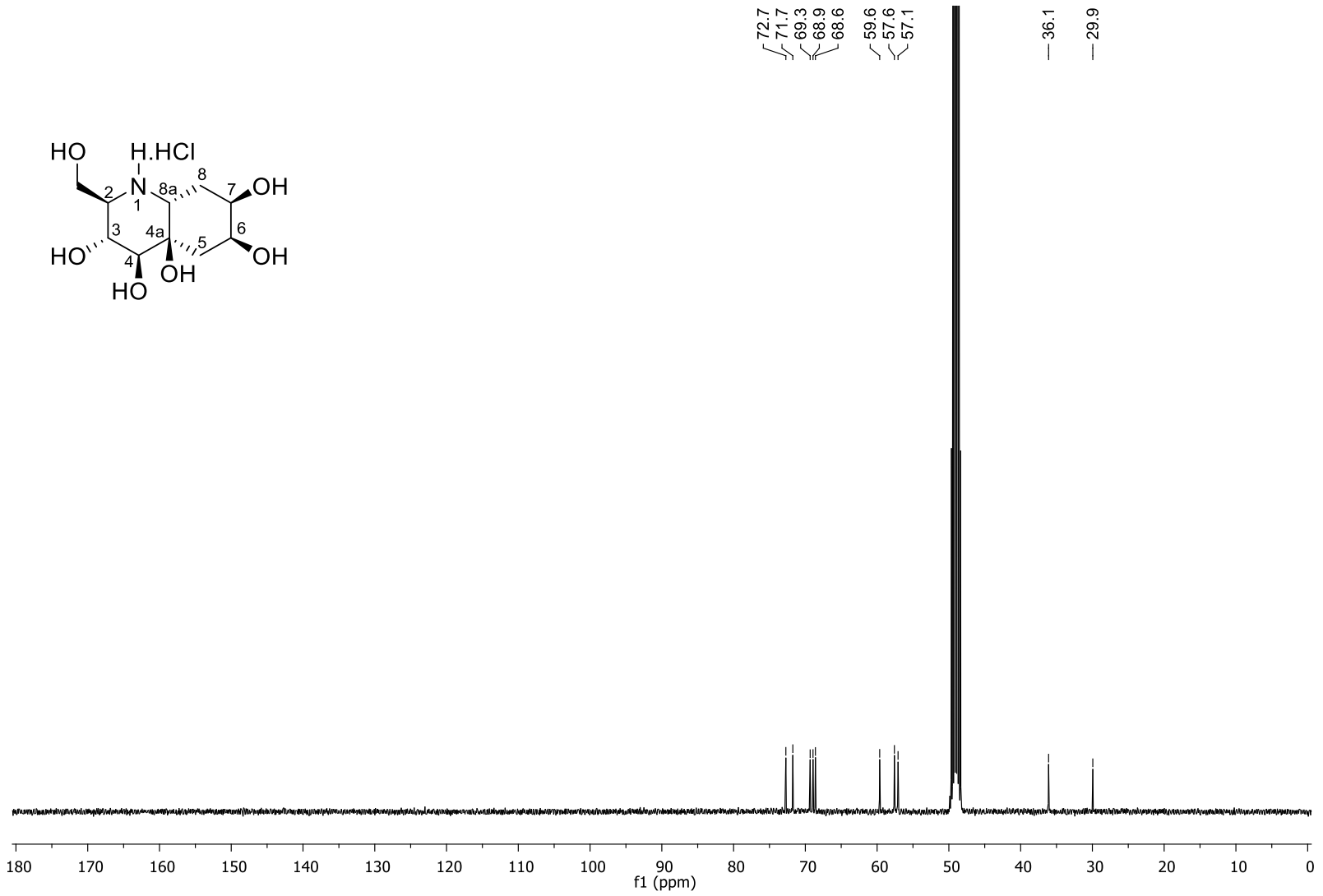
^{13}C NMR spectrum (Methanol-d4, 400 MHz) of compound **12a**.



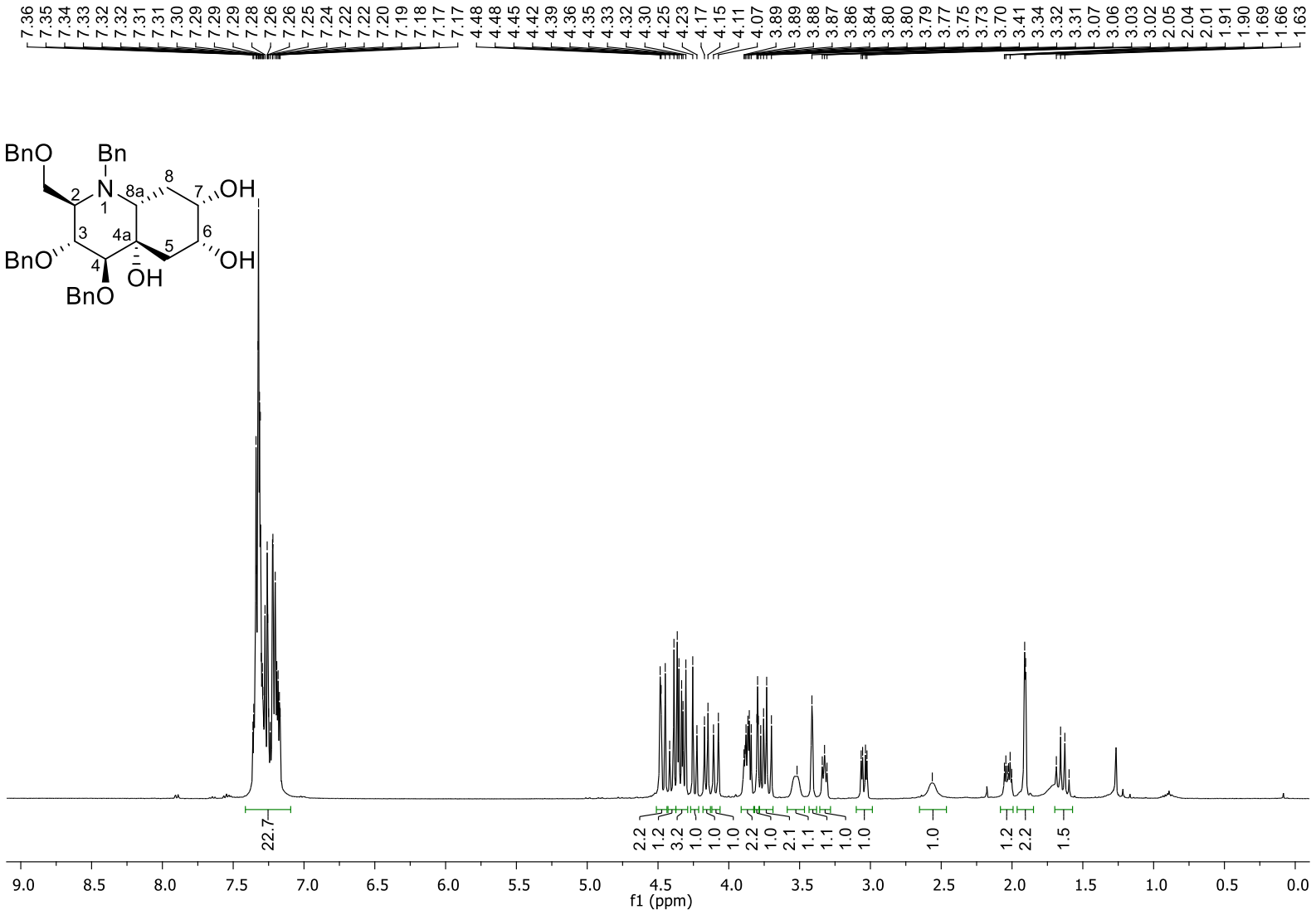
[1]H NMR spectrum (Methanol-d4, 400 MHz) of compound **12a'**.



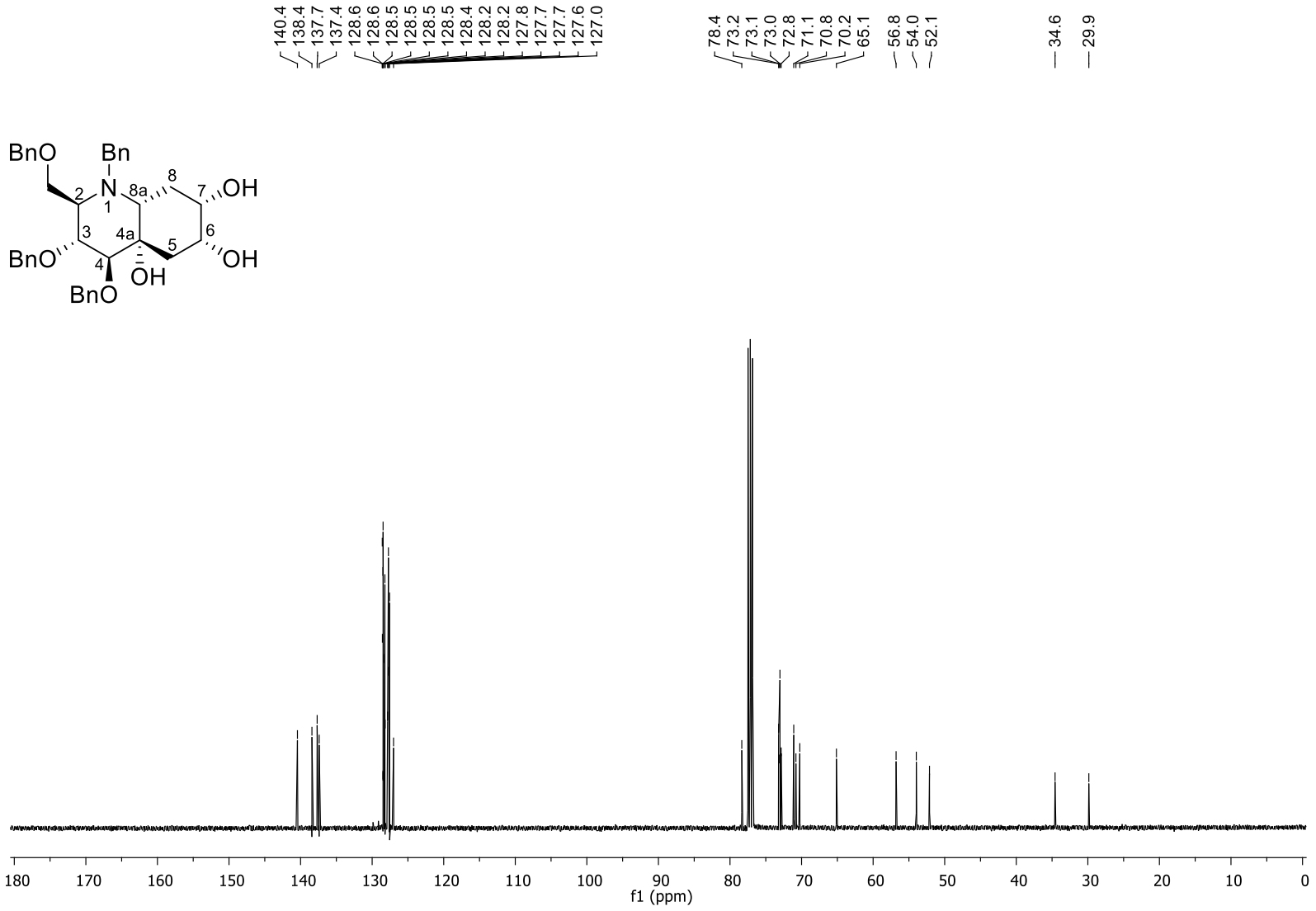
^{13}C NMR spectrum (Methanol-d4, 400 MHz) of compound **12a'**.



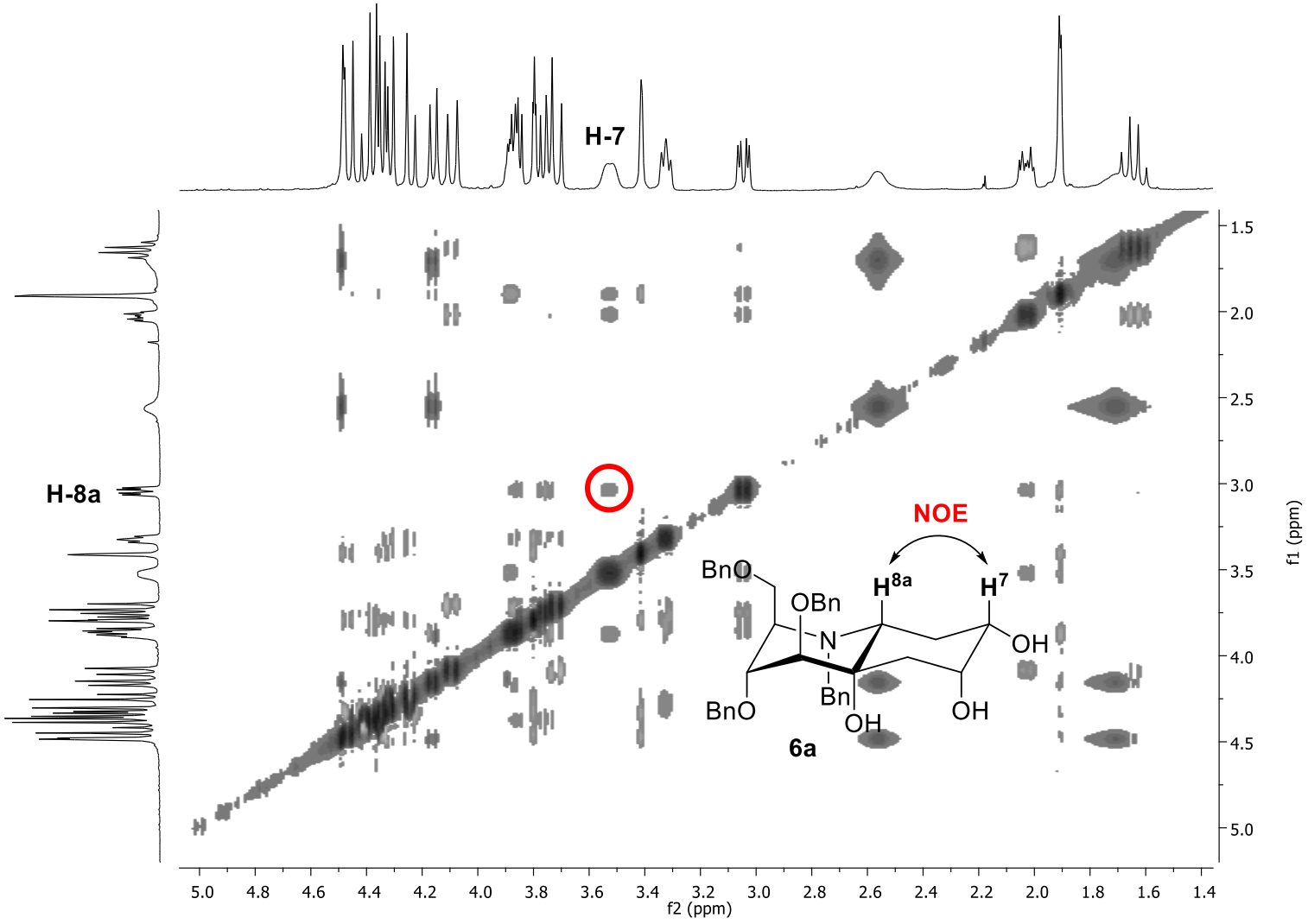
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **11b**.



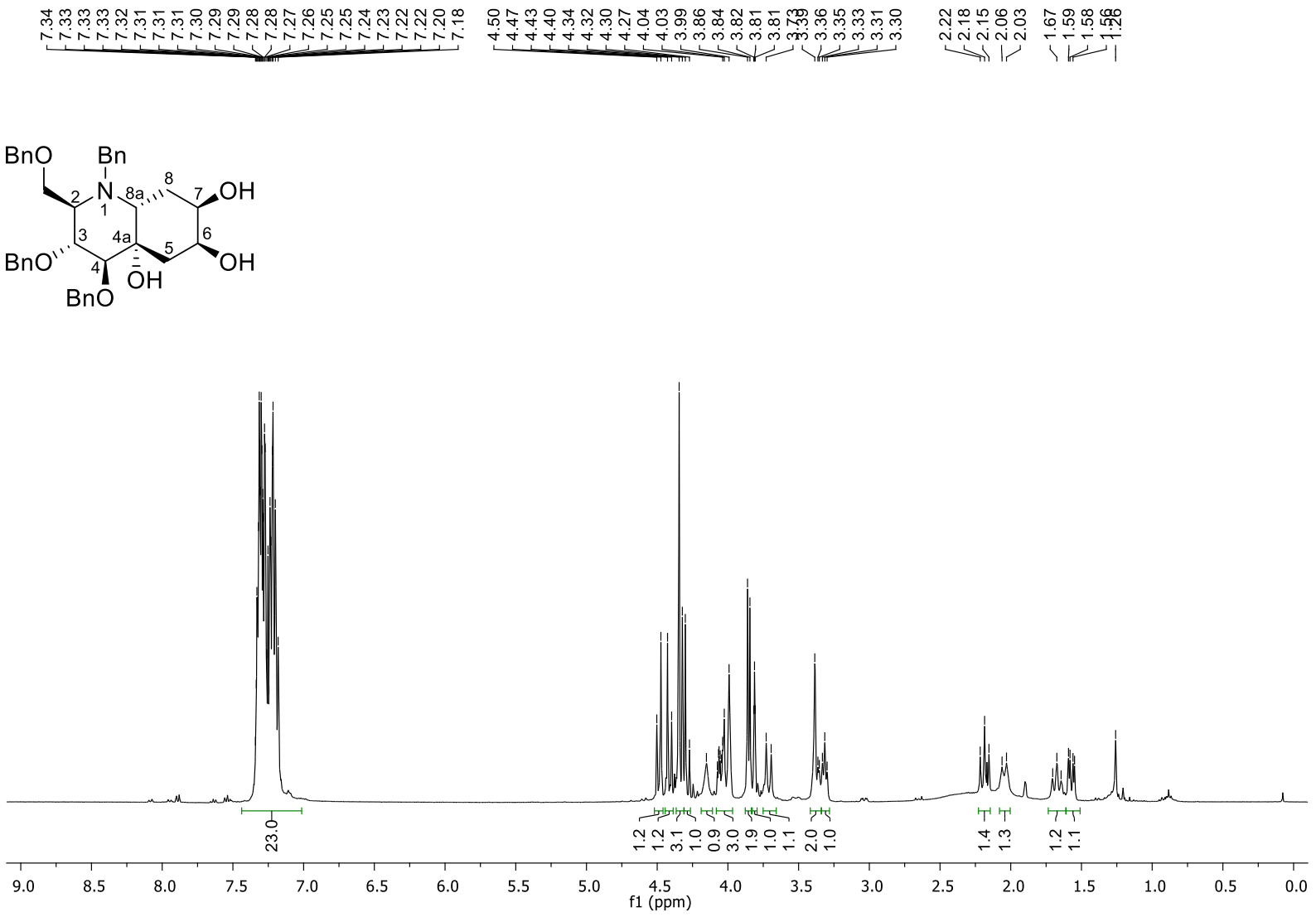
^{13}C NMR spectrum ($CDCl_3$, 400 MHz) of compound **11b**.



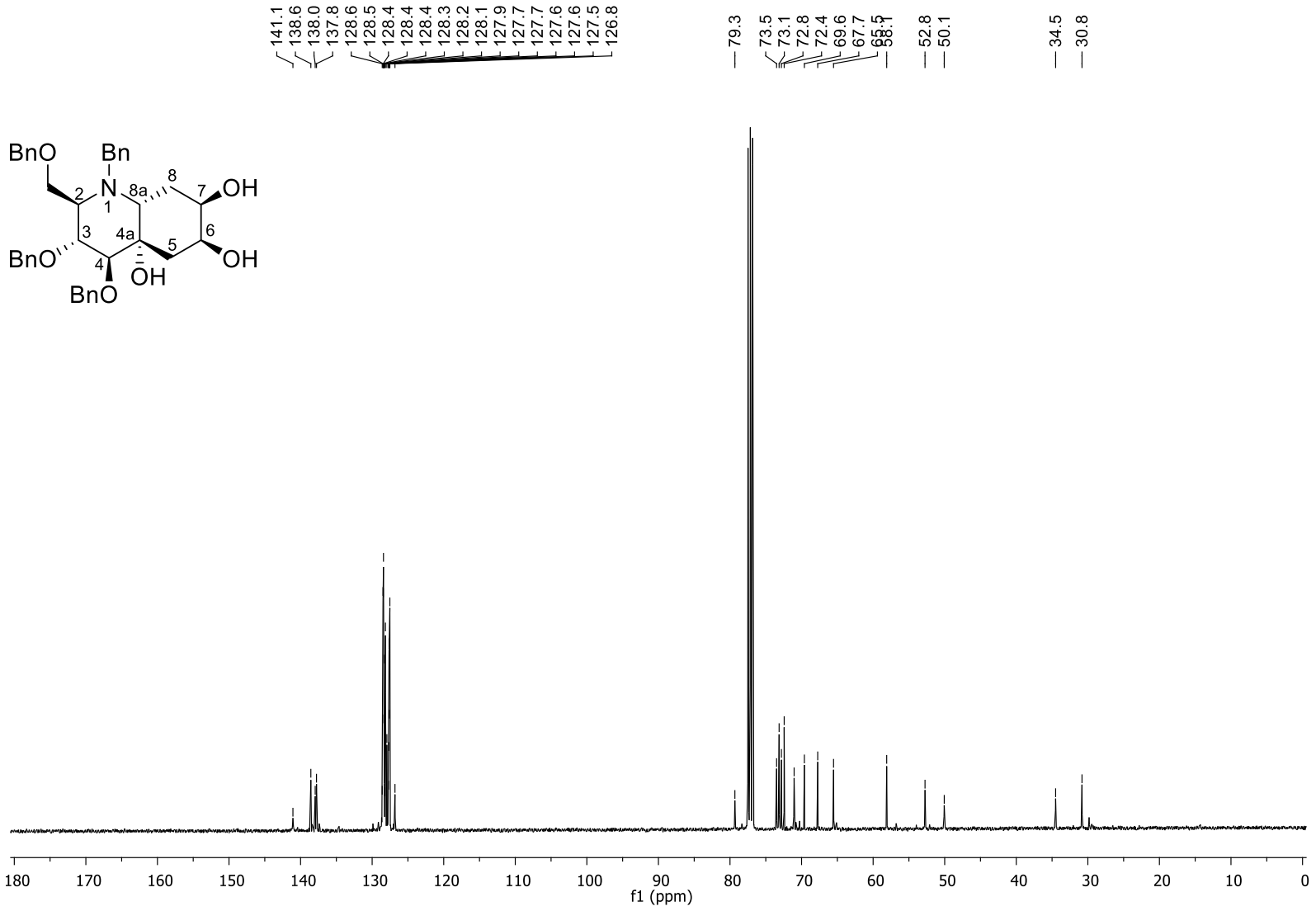
2D NOESY ^{1}H NMR spectrum ($CDCl_3$, 100 MHz) of compound **11b**.



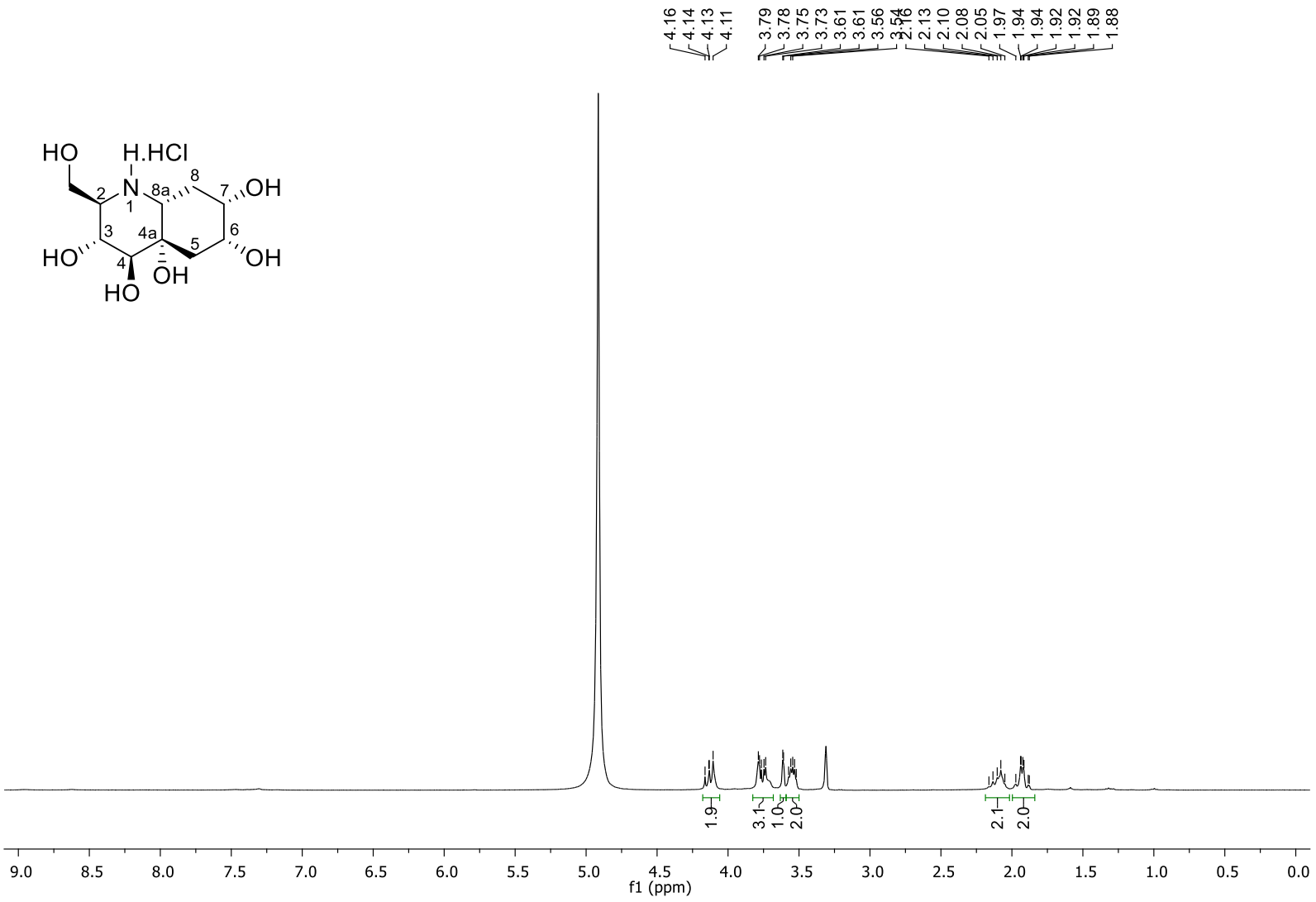
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **11b'**.



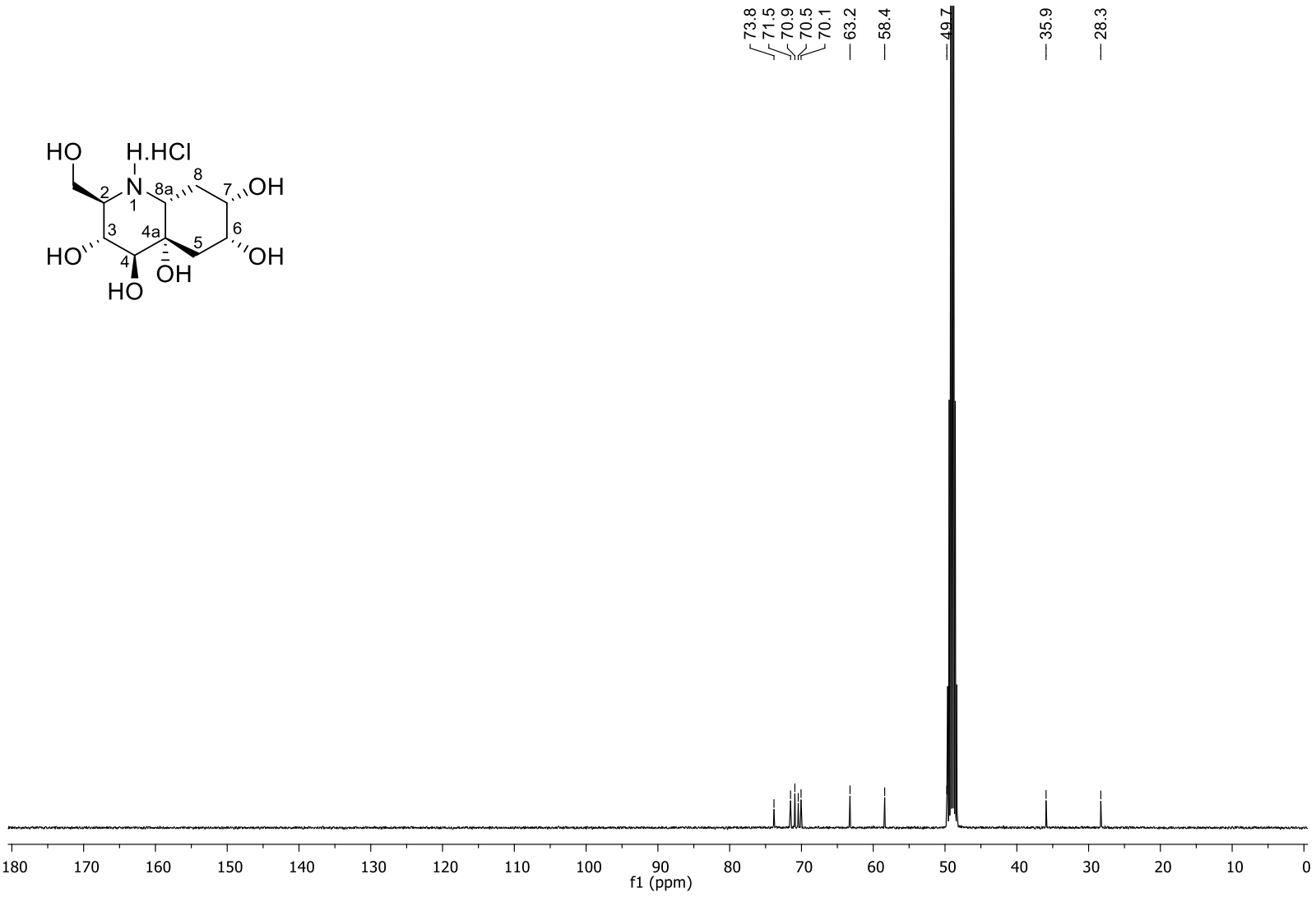
^{13}C NMR spectrum ($CDCl_3$, 400 MHz) of compound **11b'**.



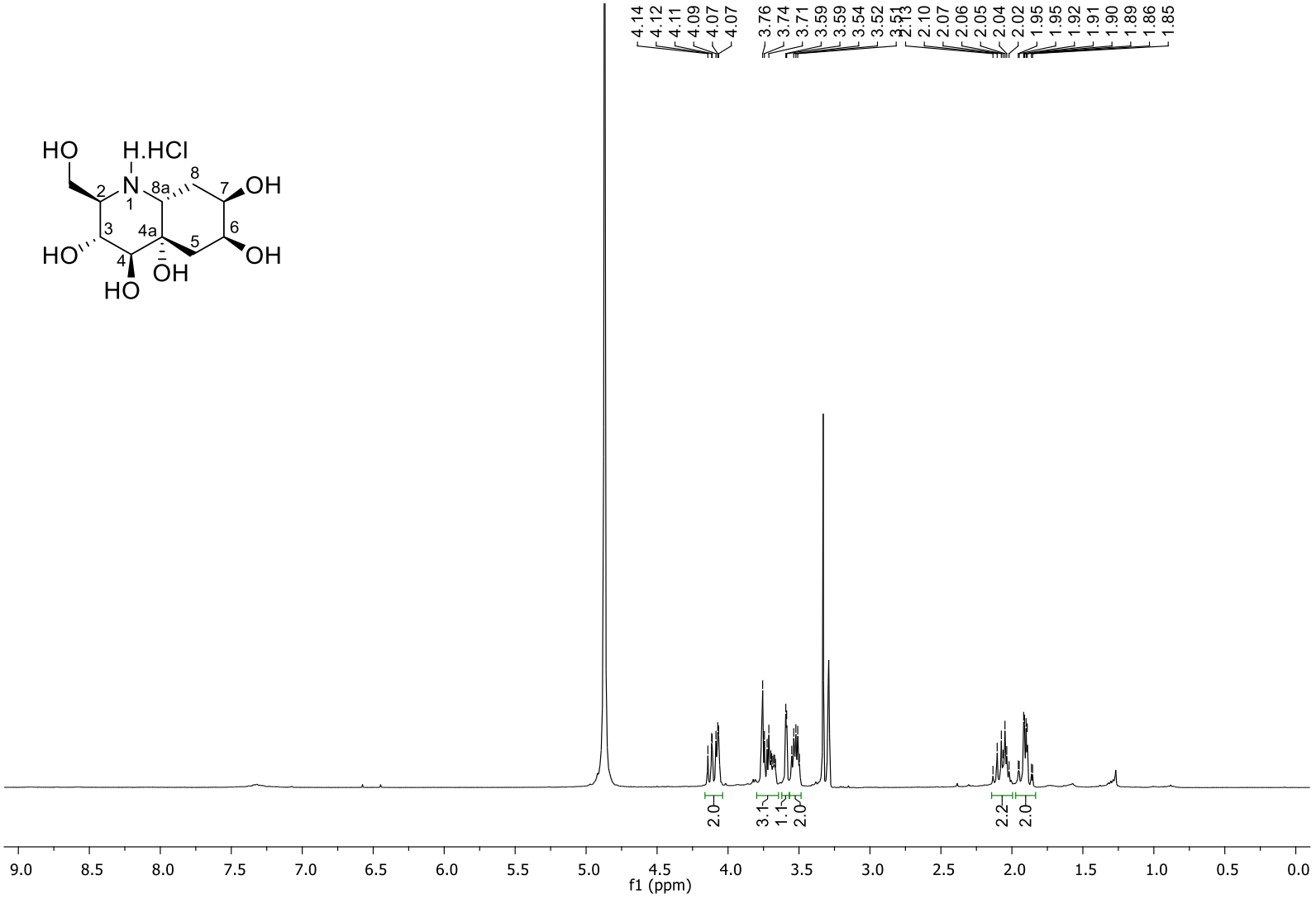
^{1}H NMR spectrum (Methanol-d4, 400 MHz) of compound **12b**.



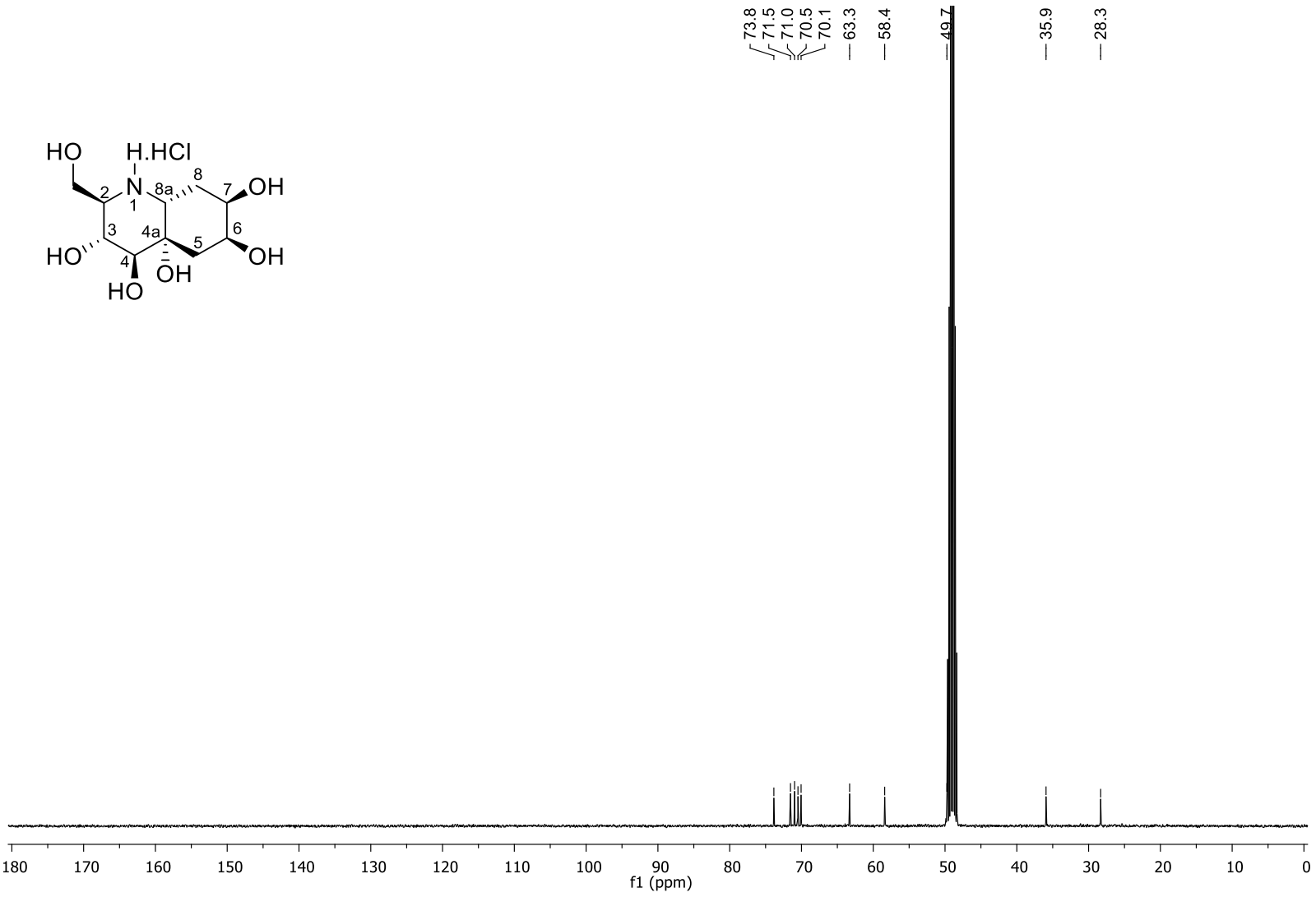
^{13}C NMR spectrum (Methanol-d4, 400 MHz) of compound **12b**.



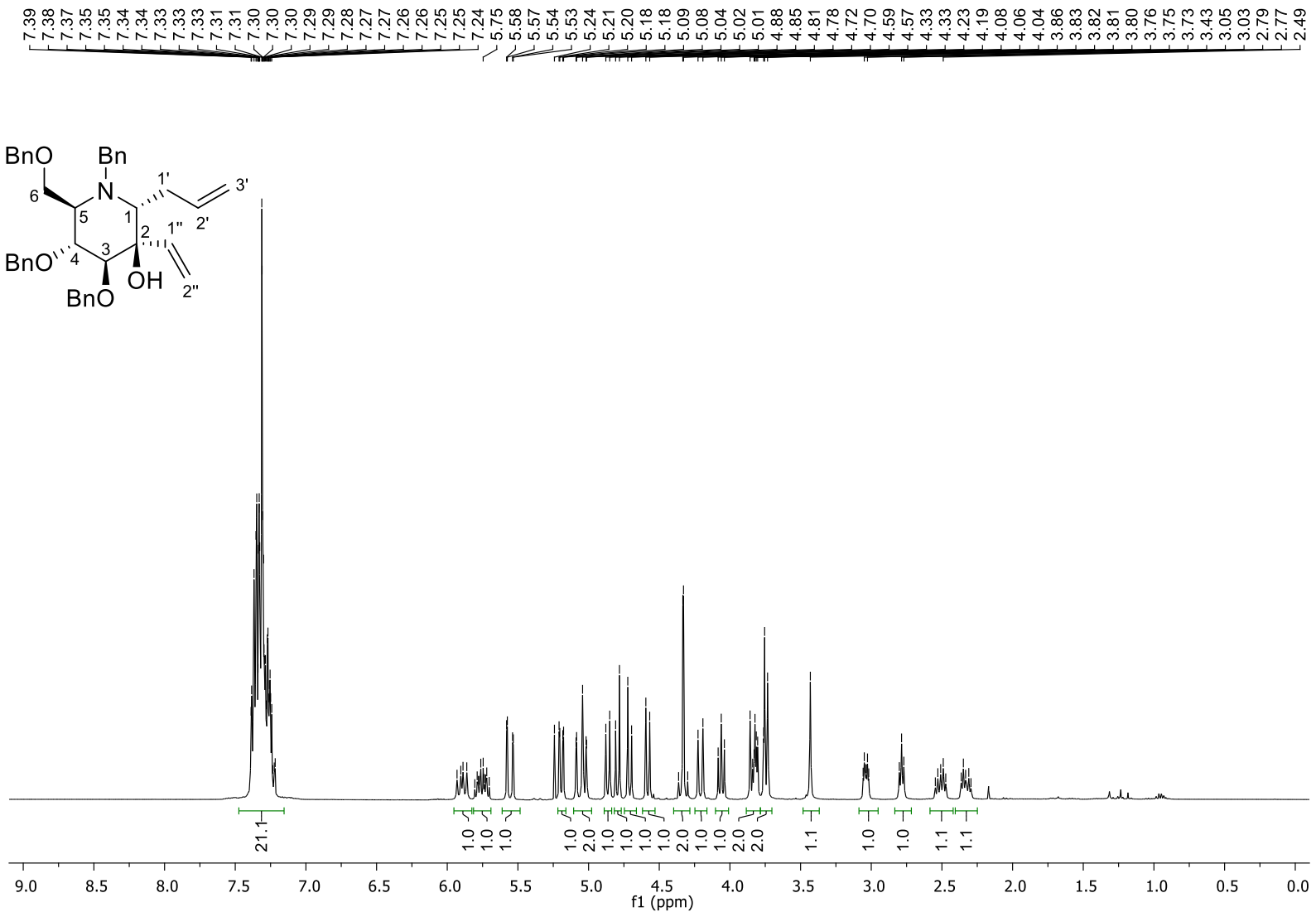
^{1}H NMR spectrum (Methanol-d4, 400 MHz) of compound **12b'**.



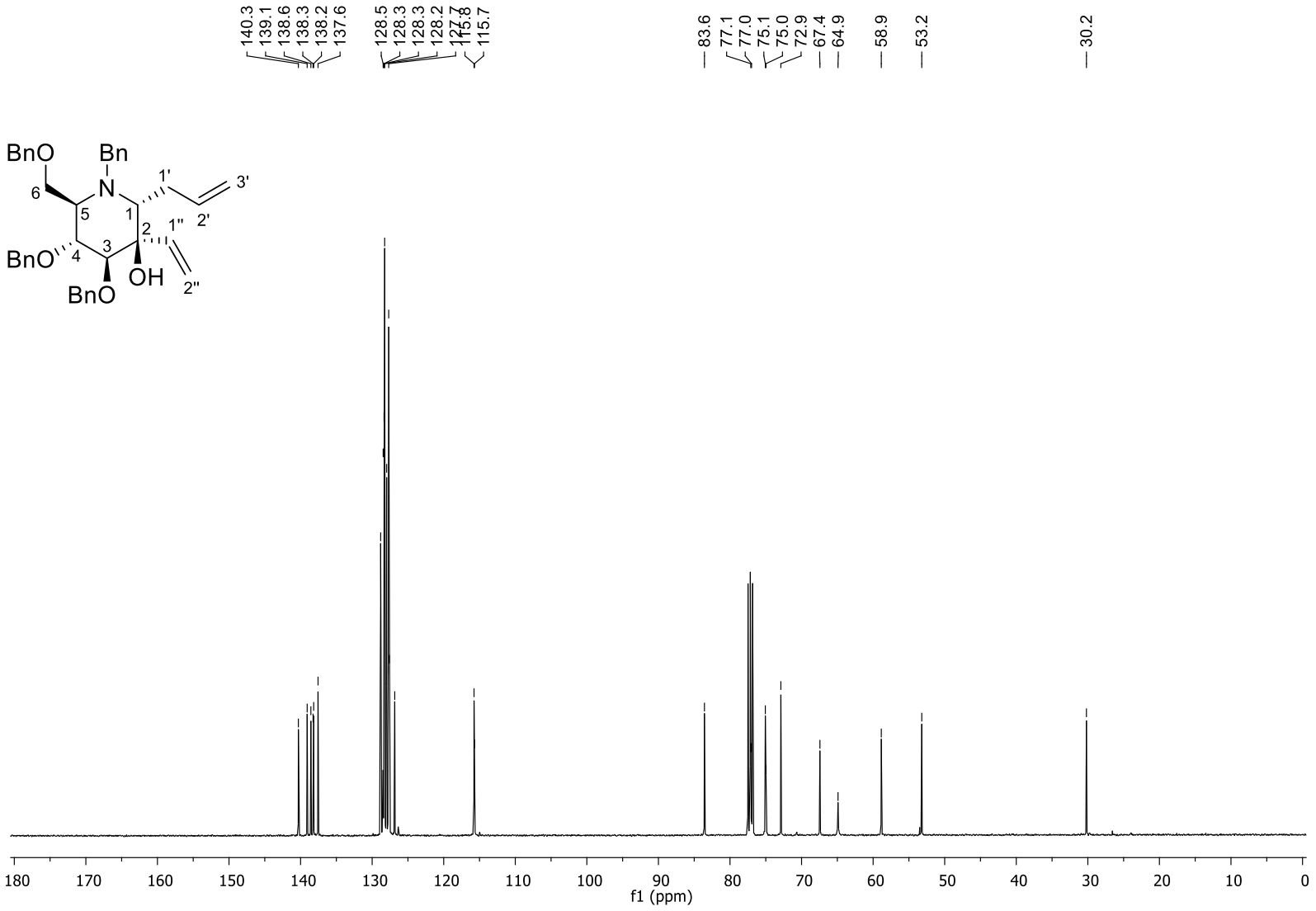
^{13}C NMR spectrum (Methanol-d4, 400 MHz) of compound **12b'**.



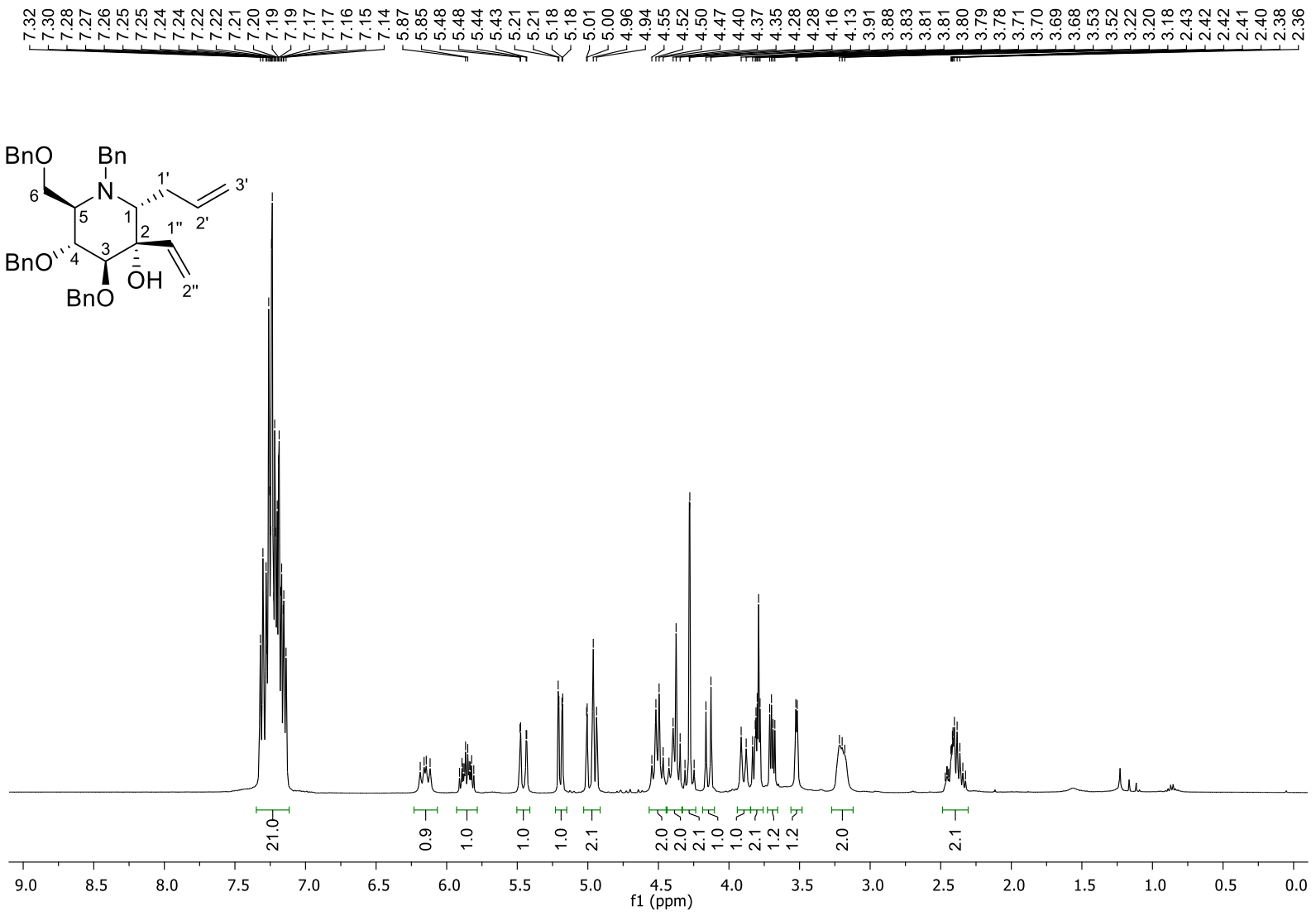
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **13a**.



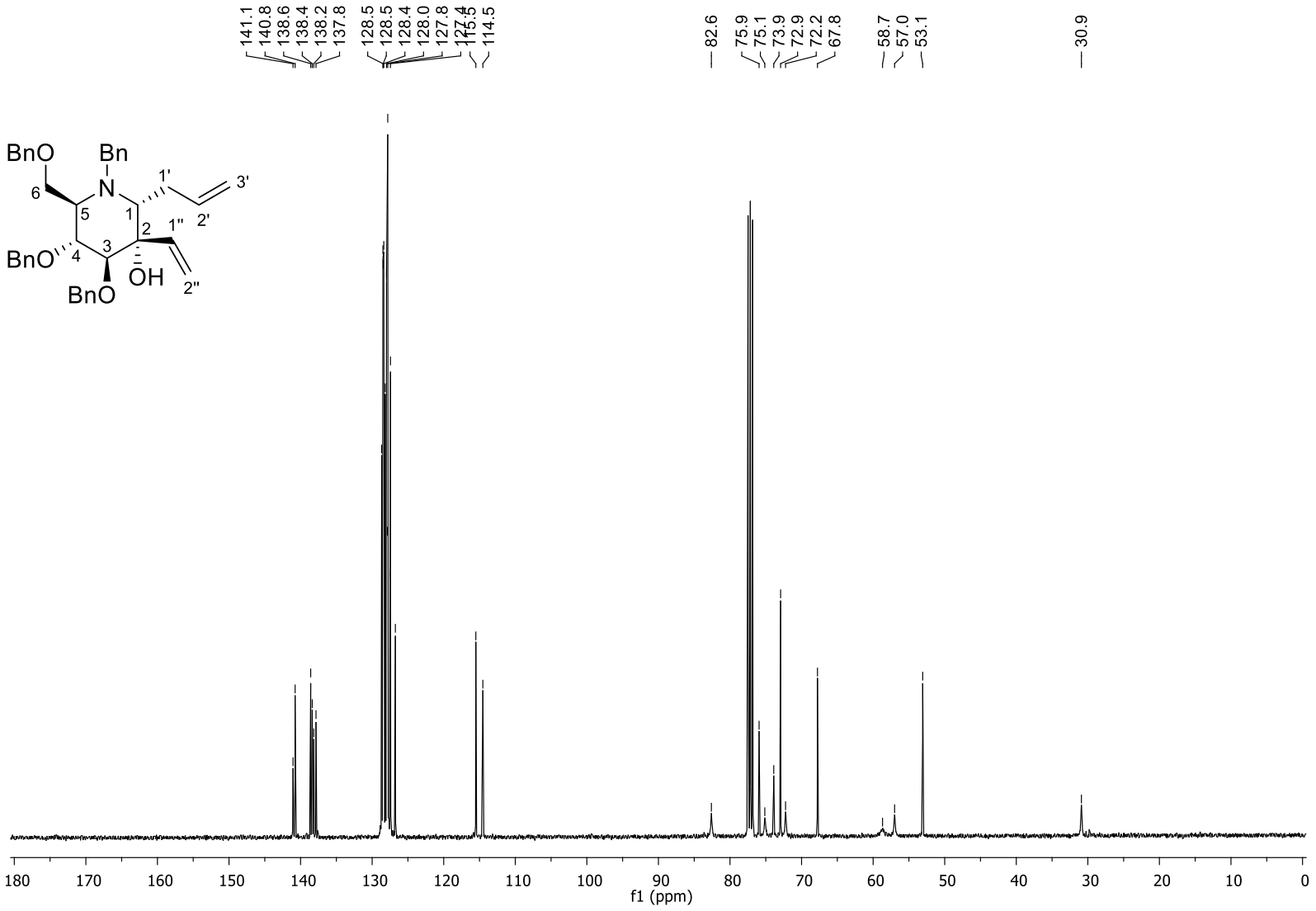
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **13a**.



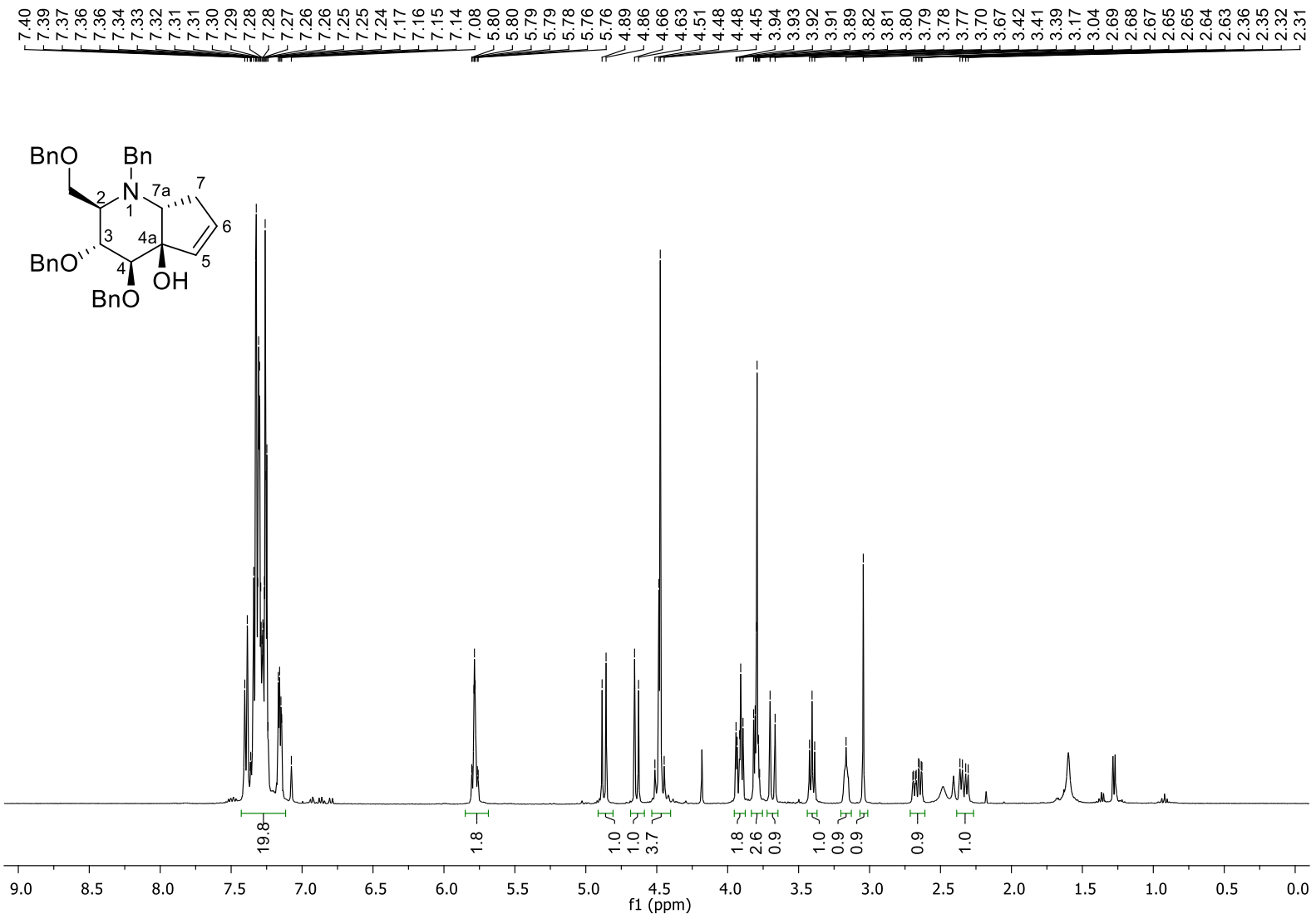
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **13b**.



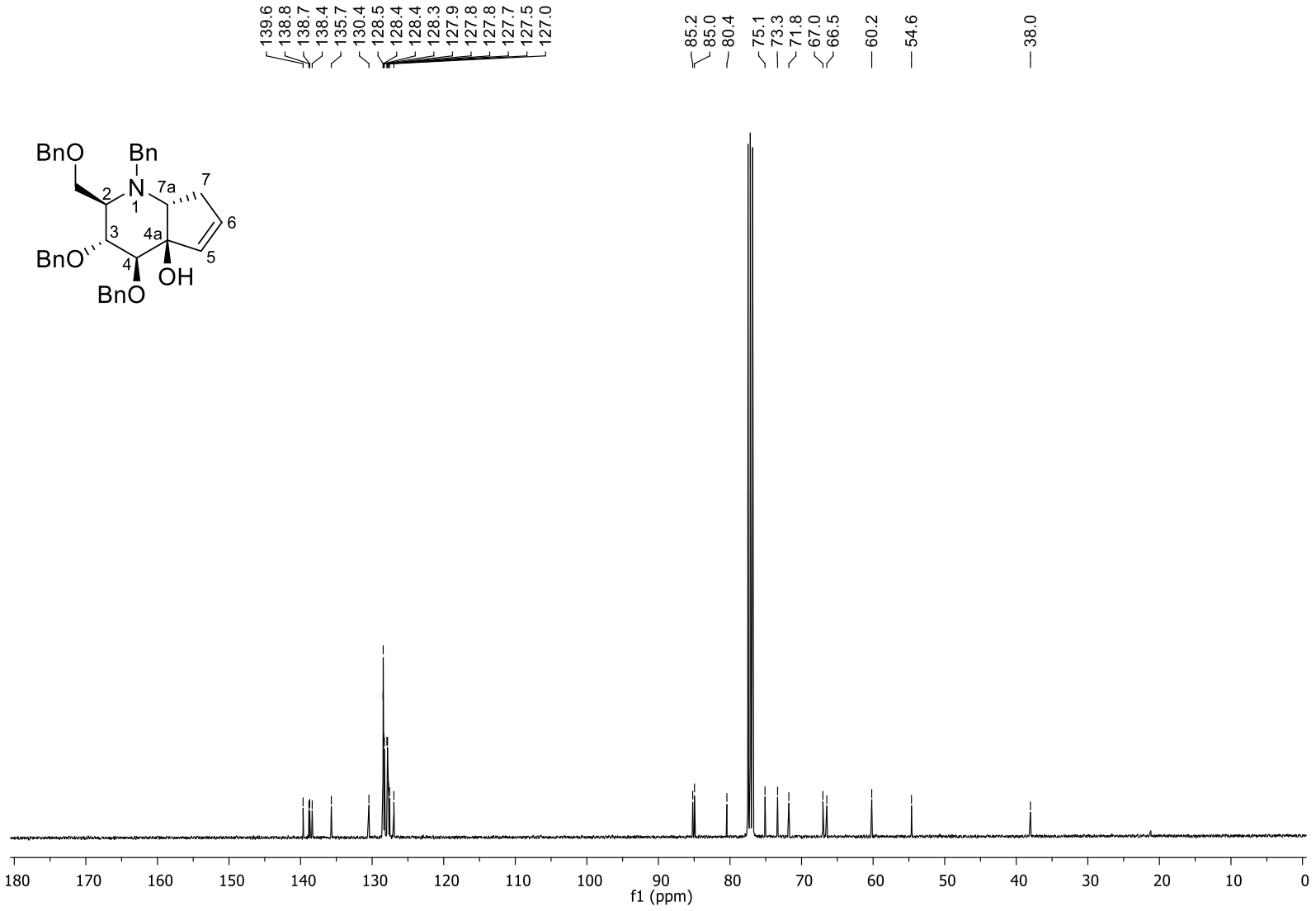
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **13b**.



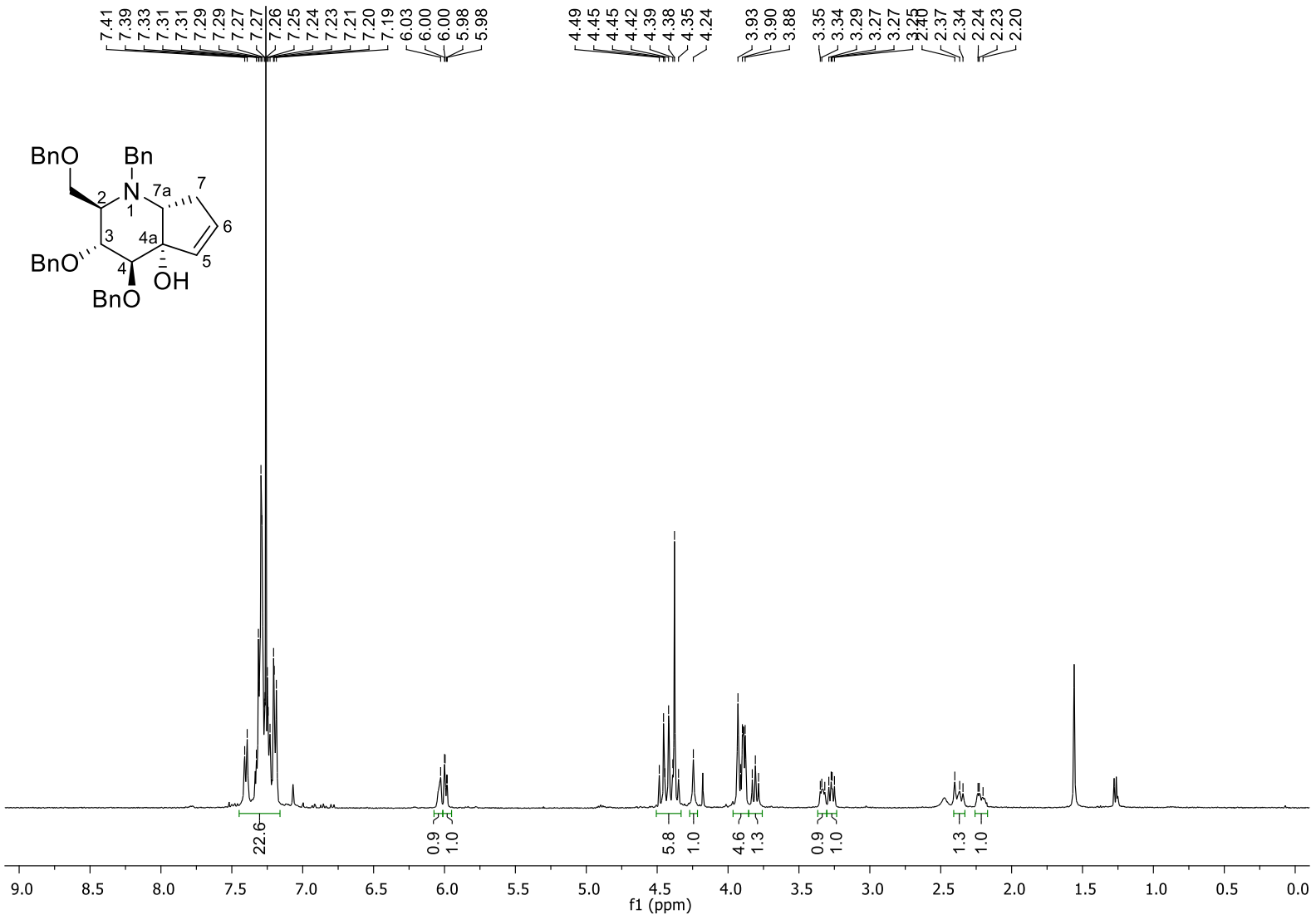
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **14a**.



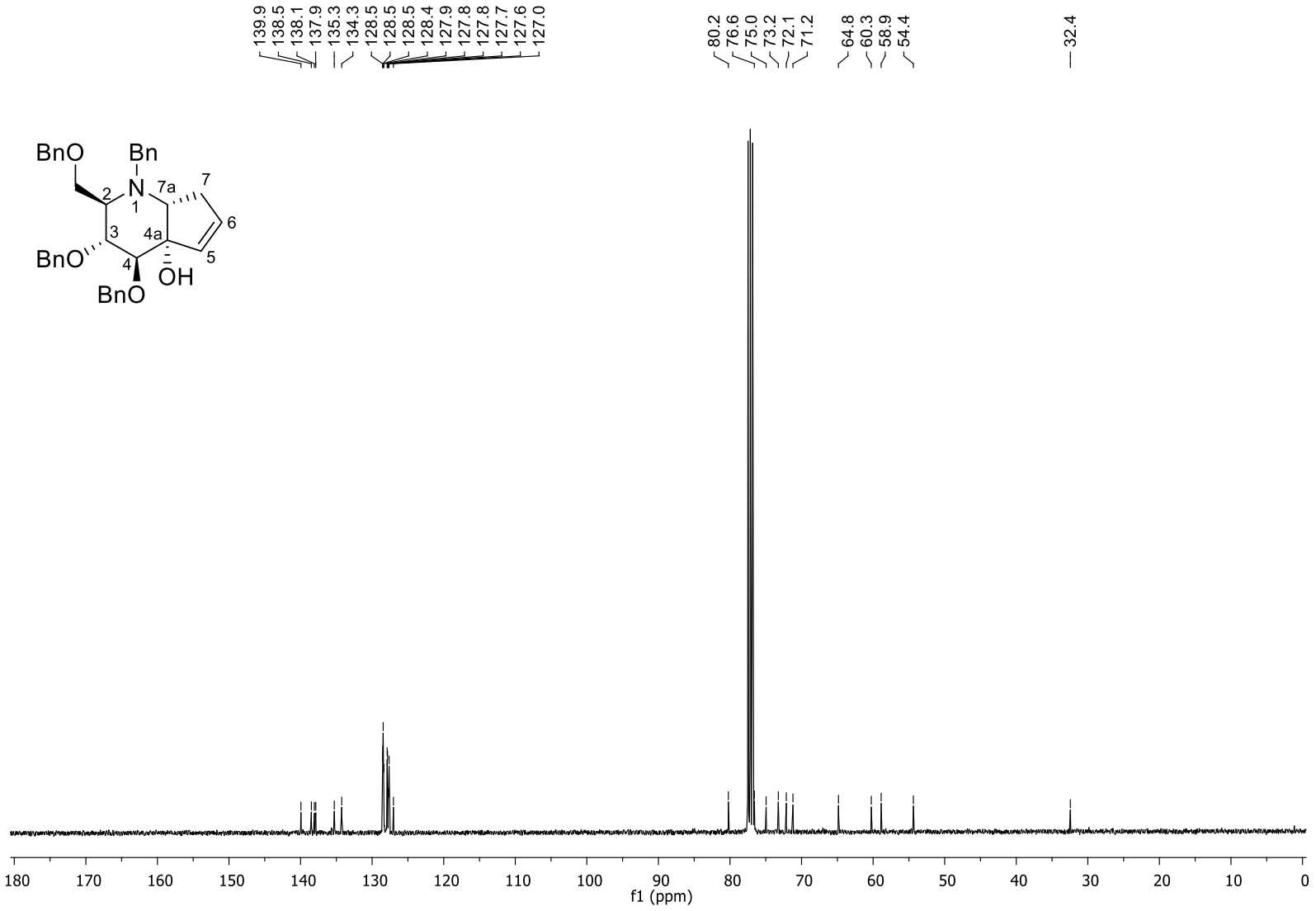
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **14a**.



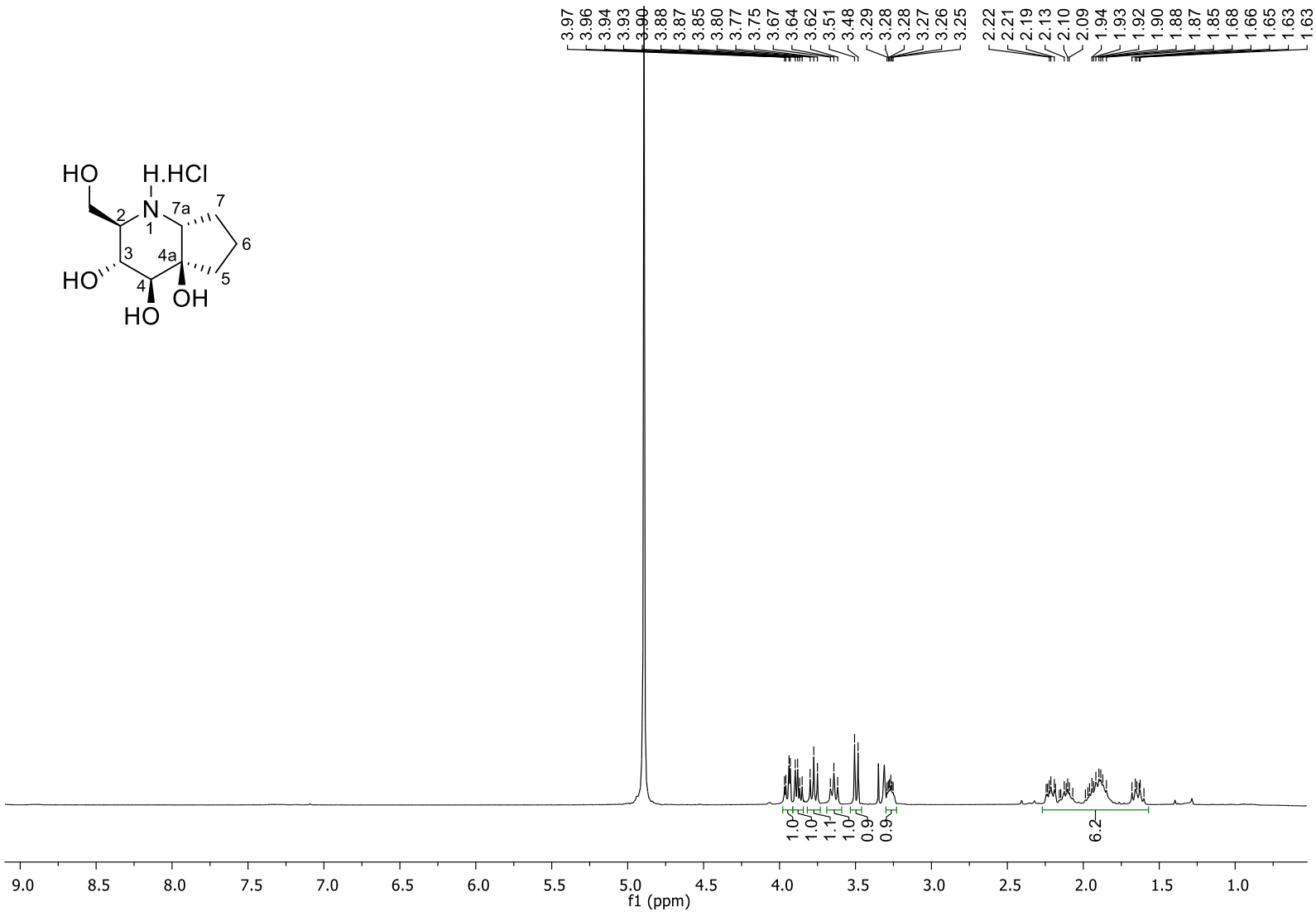
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **14b**.



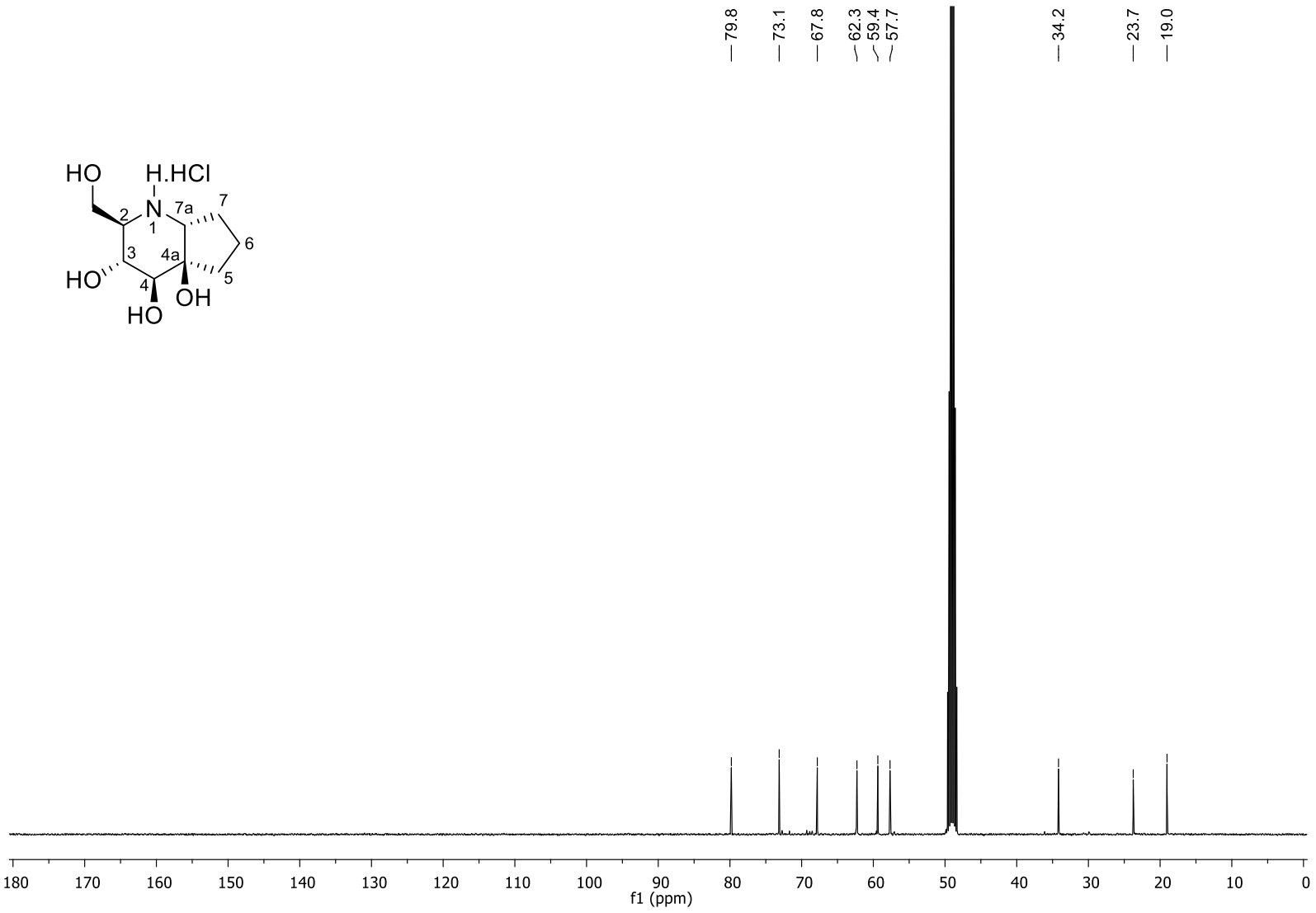
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **14b**.



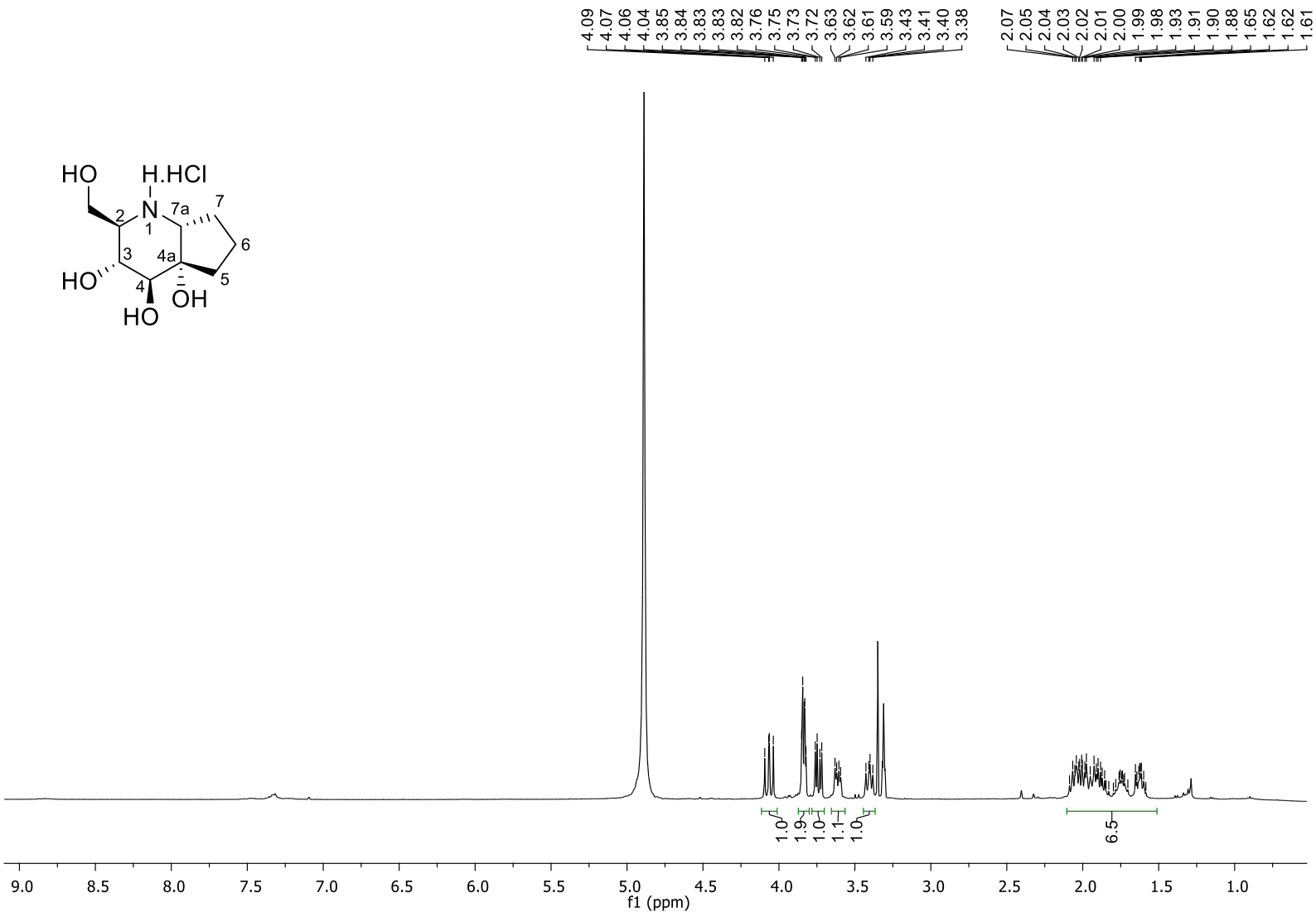
^{1}H NMR spectrum (Methanol-d4, 400 MHz) of compound **15a**.



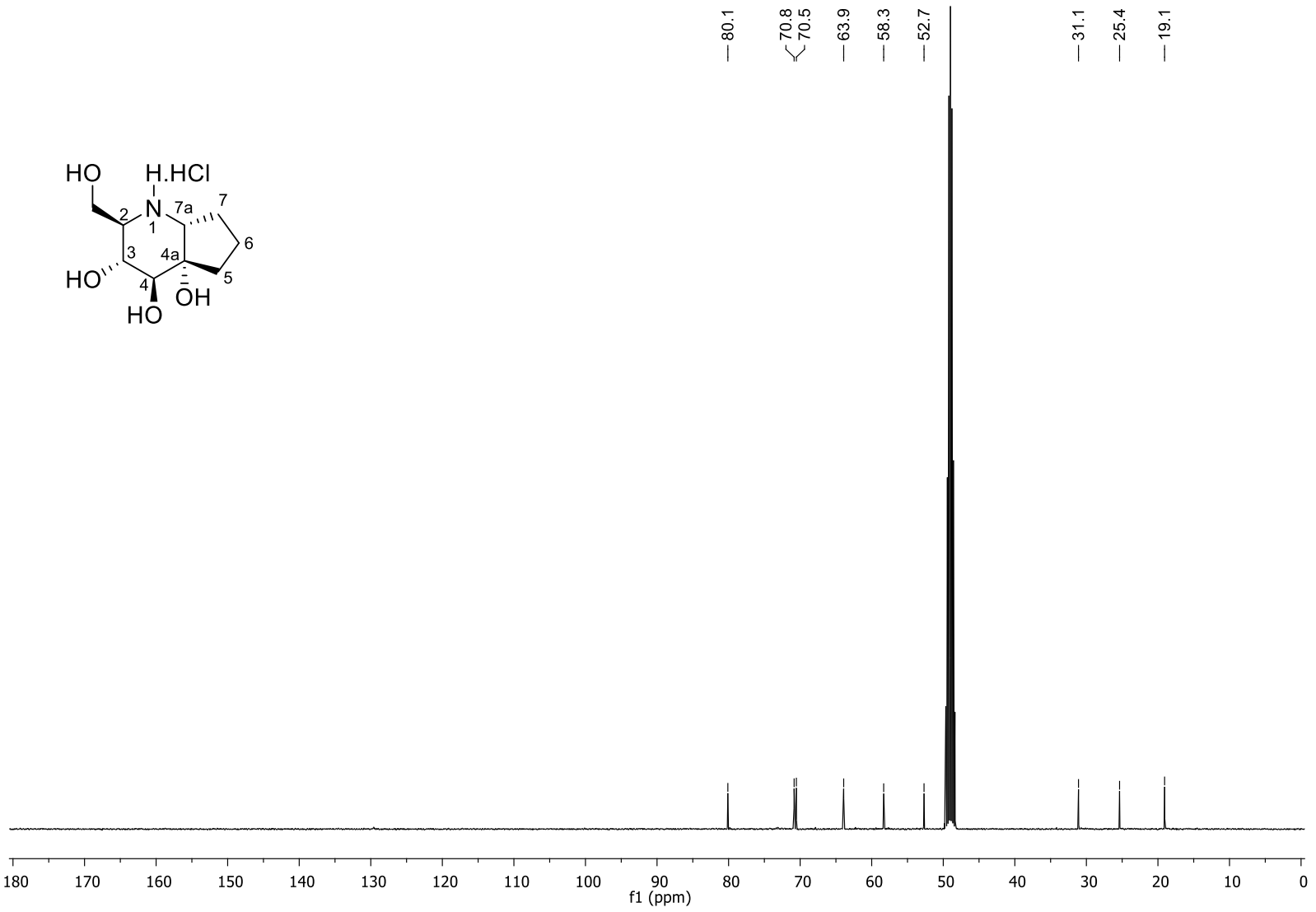
^{13}C NMR spectrum (Methanol-d4, 400 MHz) of compound **15a**.



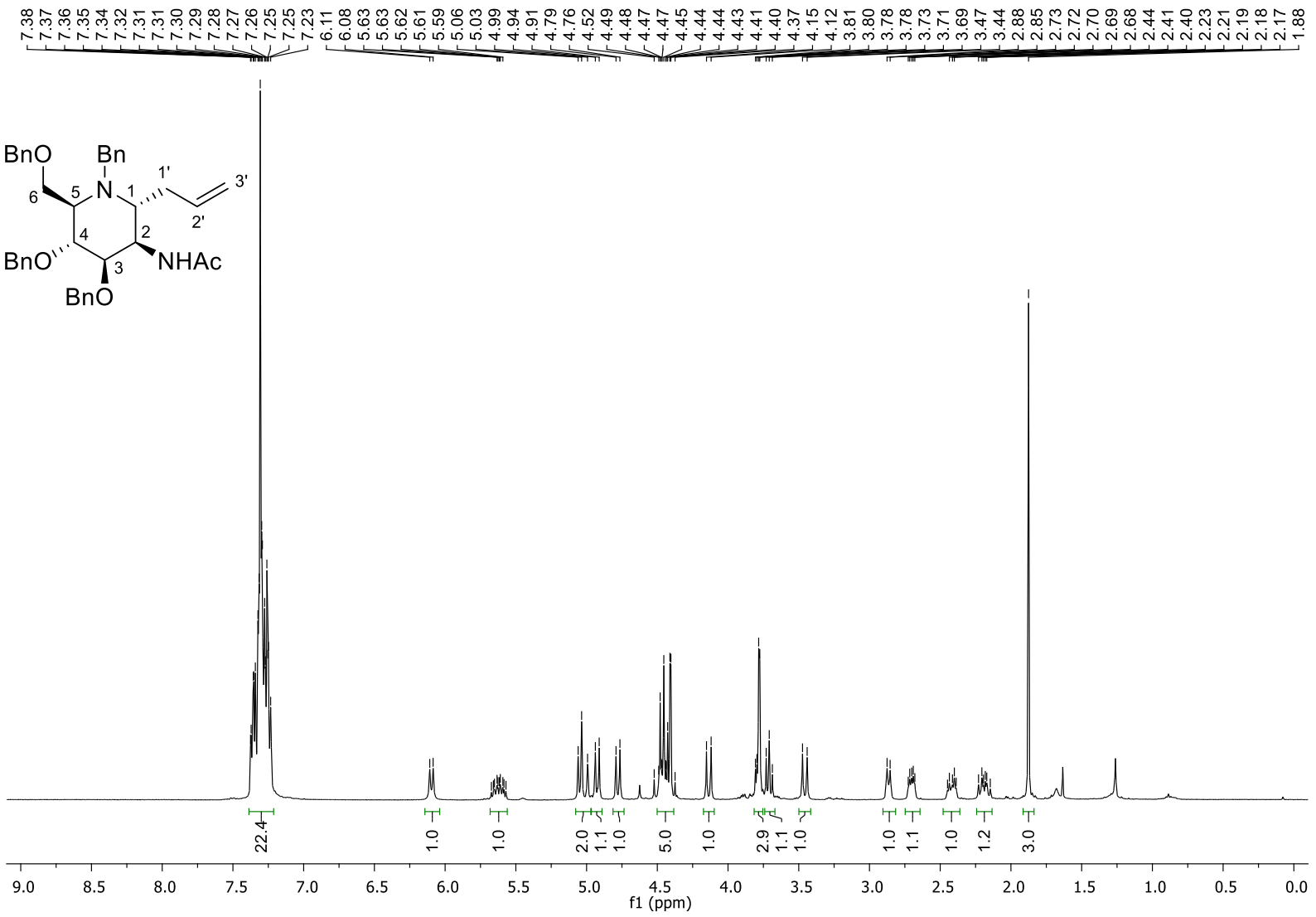
^{1}H NMR spectrum (Methanol-d4, 400 MHz) of compound **15b**.



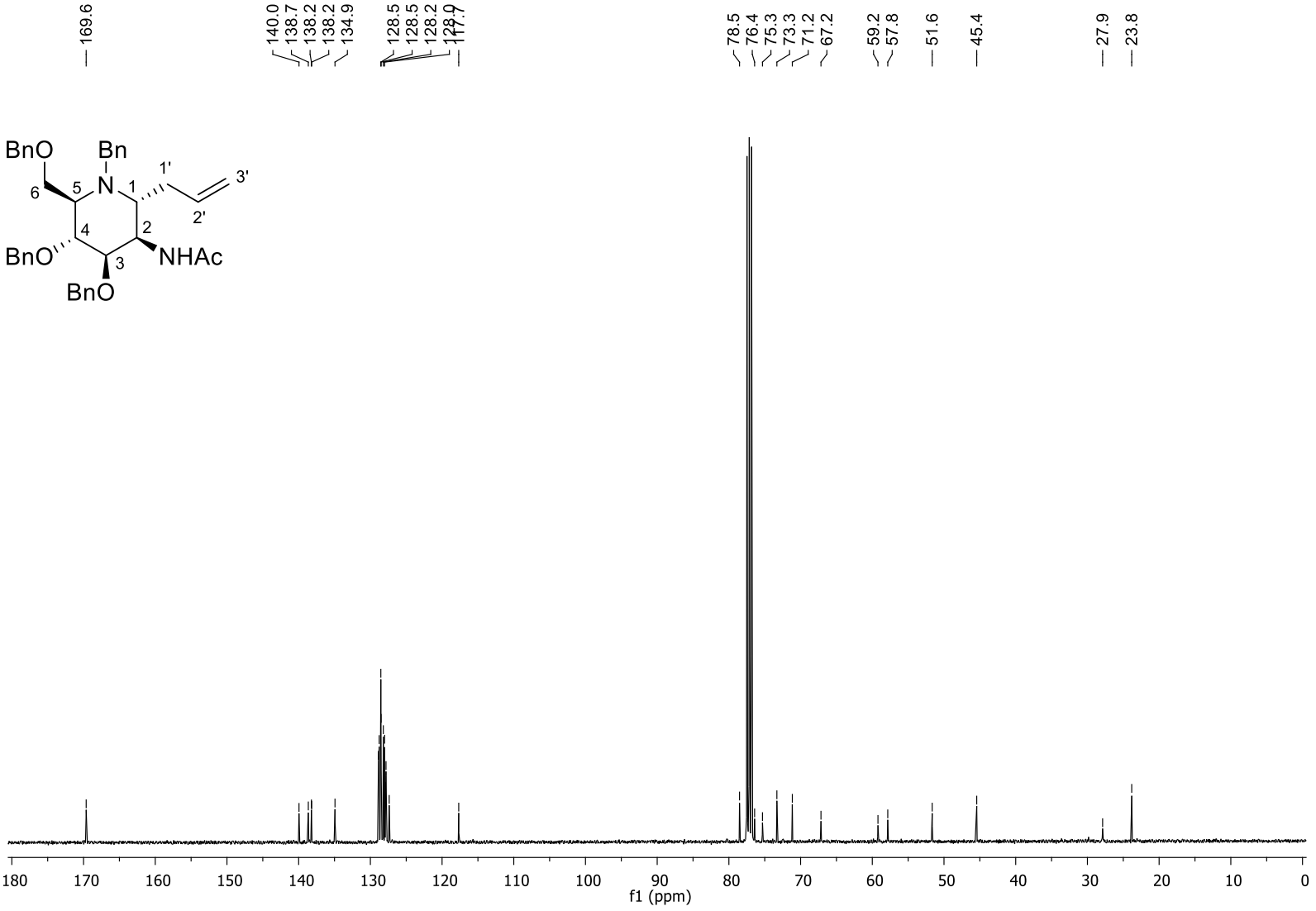
^{13}C NMR spectrum (Methanol-d4, 400 MHz) of compound **15b**.



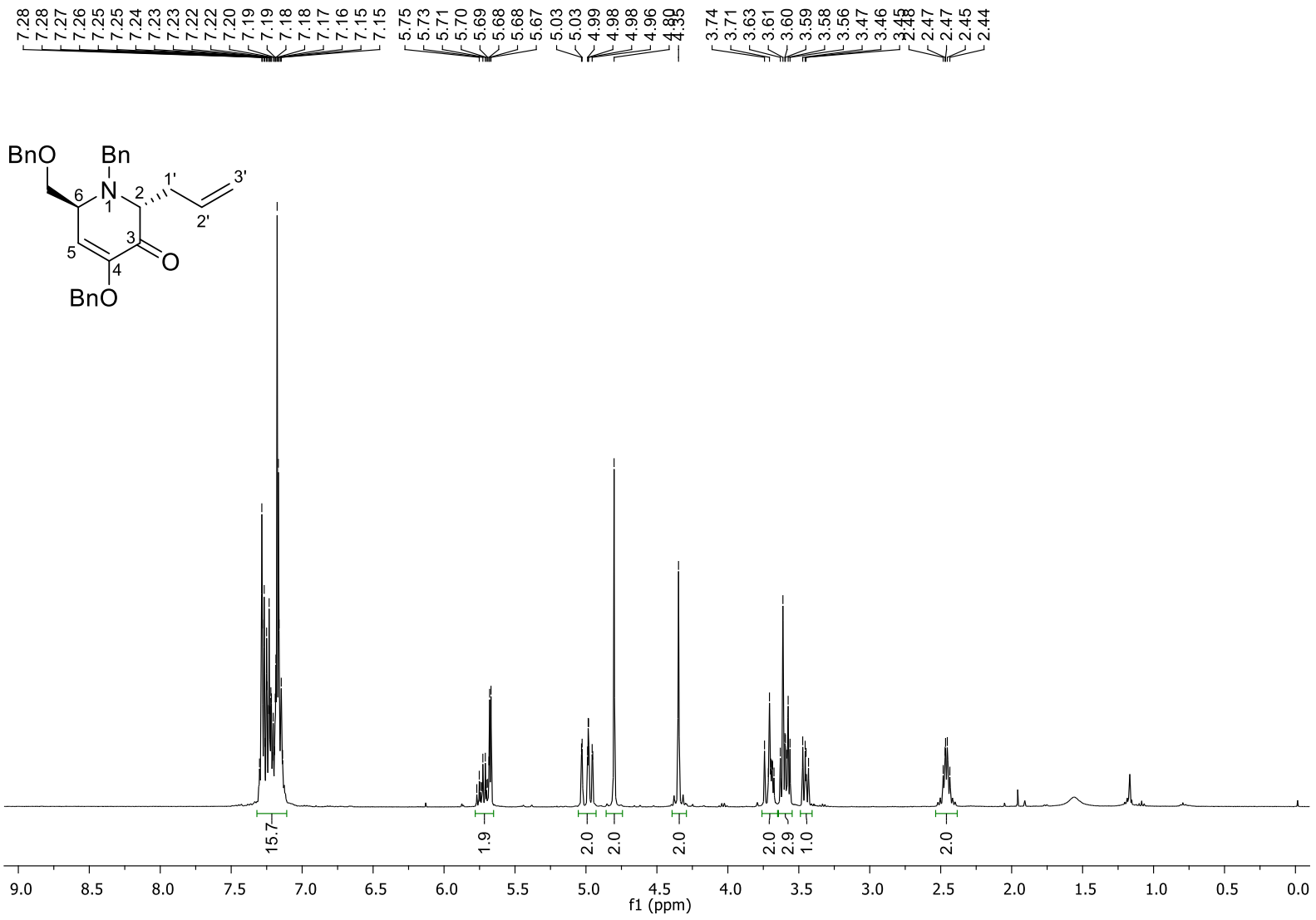
^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **17**.



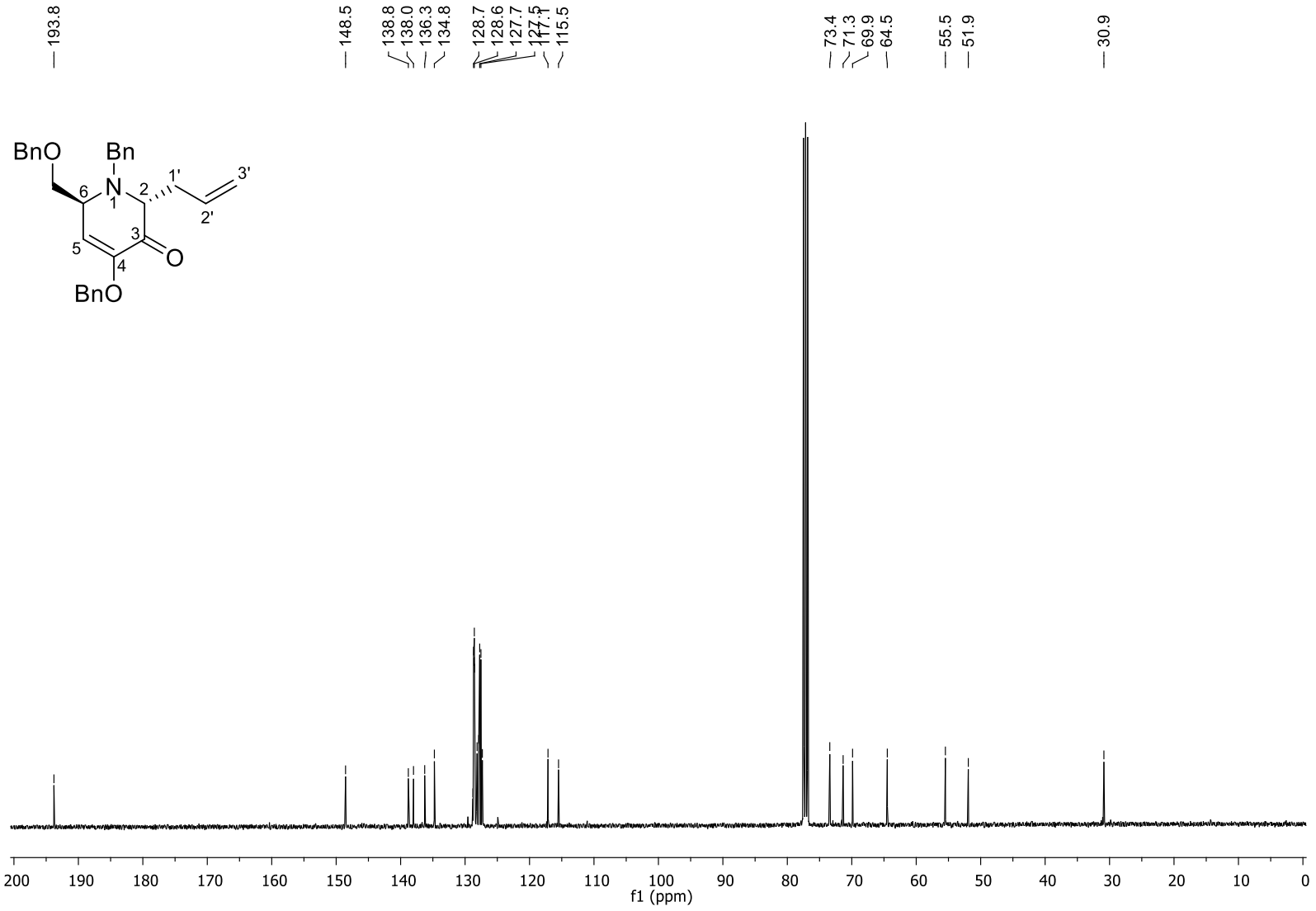
^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **17**.



^{1}H NMR spectrum ($CDCl_3$, 400 MHz) of compound **19**.

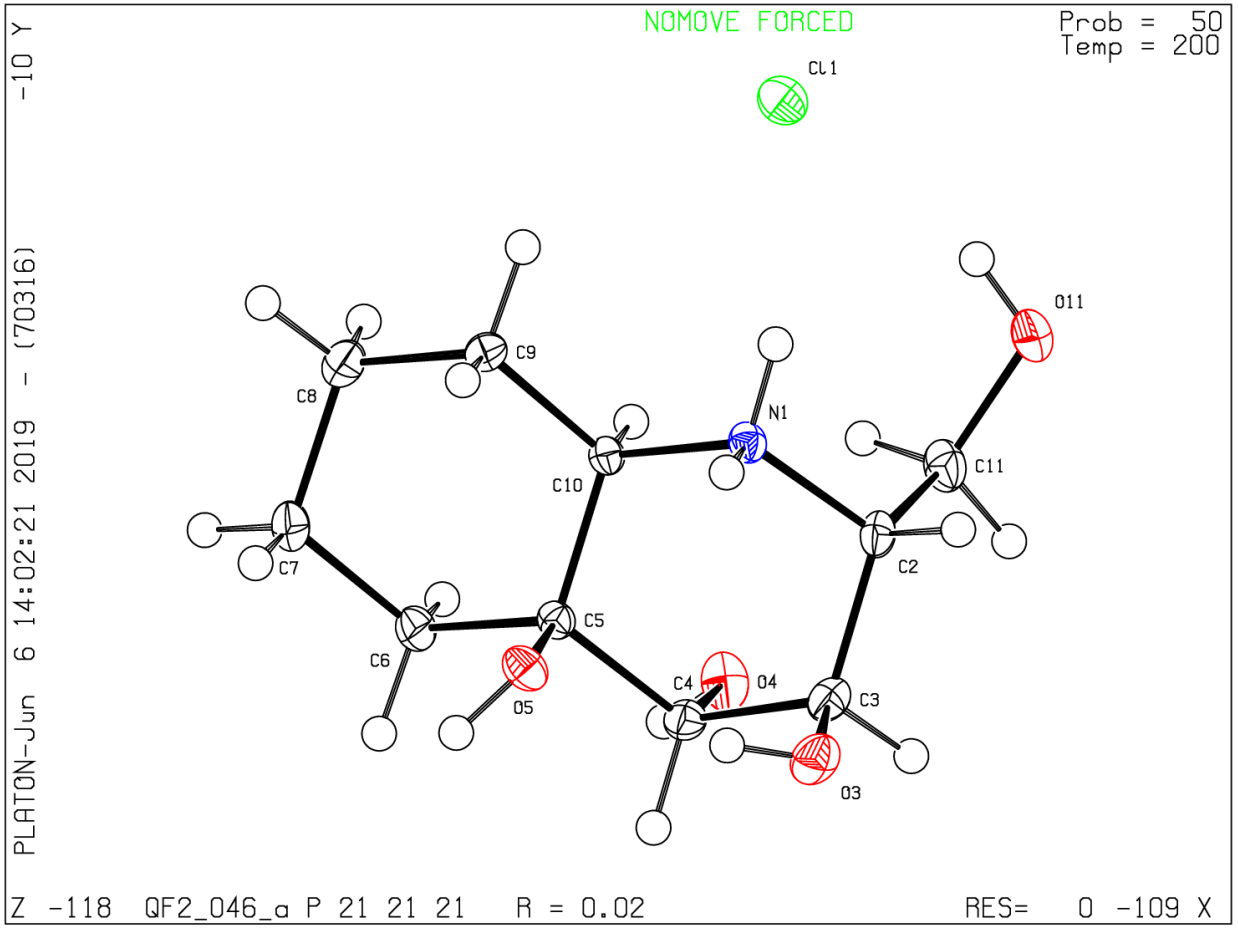


^{13}C NMR spectrum ($CDCl_3$, 100 MHz) of compound **19**.



Cristallographic data for compound 10b

CCDC 1921458



Computing details

Data collection: Bruker *APEX3*; cell refinement: Bruker *SAINT*; data reduction: Bruker *SAINT*; program(s) used to solve structure: *SHELXT* 2014/4 (Sheldrick, 2014); program(s) used to refine structure: *SHELXL2018*/3 (Sheldrick, 2018); molecular graphics: Bruker *SHELXTL*; software used to prepare material for publication: Bruker *SHELXTL*.

Acknowledgements

Funding information

References

Figure 1

(QF2_046_a)

Crystal data

$C_{10}H_{19}ClNO_4$
$M_r = 252.71$
Orthorhombic, $P2_12_12_1$
$a = 7.9383$ (2) Å
$b = 8.9382$ (2) Å
$c = 16.3920$ (5) Å
$V = 1163.08$ (5) Å^3
$Z = 4$
$F(000) = 540$

$D_x = 1.443$ Mg m^{-3}
Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
Cell parameters from 9816 reflections
$\theta = 2.5$–$30.0°$
$\mu = 0.33$ mm^{-1}
$T = 200$ K
Parallelepiped, yellow
0.30 × 0.26 × 0.10 mm

Data collection

Bruker D8 VENTURE diffractometer
Radiation source: microsource
φ and ω scans
Absorption correction: multi-scan *SADABS* (Sheldrick, V2014/5)

48658 measured reflections

3408 independent reflections
3289 reflections with $I > 2\sigma(I)$
$R_{int} = 0.033$
$\theta_{max} = 30.0°$, $\theta_{min} = 2.5°$
$h = -11 \rightarrow 11$
$k = -12 \rightarrow 12$
$l = -23 \rightarrow 23$

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)] = 0.023$
$wR(F^2) = 0.064$
$S = 1.10$
3408 reflections
149 parameters
0 restraints
Hydrogen site location: inferred from neighbouring sites
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.0368P)^2 + 0.165P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max} = 0.001$
$\Delta\rho_{max} = 0.31$ e Å^{-3}
$\Delta\rho_{min} = -0.17$ e Å^{-3}
Absolute structure: Flack x determined using 1374 quotients [(I+)-(I-)]/[(I+)+(I-)] (Parsons, Flack and Wagner, Acta Cryst. B69 (2013) 249-259).
Absolute structure parameter: 0.004 (11)

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å²)

	x	*y*	*z*	U_{iso}*/U_{eq}	Occ. (<1)
Cl1	0.70776 (4)	0.57152 (4)	0.59820 (2)	0.01926 (8)	
N1	0.35720 (14)	0.61732 (12)	0.48111 (7)	0.0128 (2)	
H1A	0.319079	0.692557	0.448576	0.015*	0.5
H1B	0.438186	0.656036	0.514242	0.015*	0.5
C2	0.21304 (17)	0.56170 (14)	0.53323 (8)	0.0144 (2)	
H2	0.160564	0.652185	0.558550	0.017*	
C3	0.07855 (17)	0.49237 (15)	0.47741 (8)	0.0157 (2)	
H3	−0.007991	0.444077	0.513070	0.019*	
O3	−0.00278 (14)	0.60884 (12)	0.43289 (7)	0.0203 (2)	
H3A	0.049210	0.623991	0.389027	0.030*	
C4	0.15102 (17)	0.37108 (15)	0.42125 (8)	0.0146 (2)	
H4	0.061120	0.335806	0.383095	0.018*	
O4	0.19880 (15)	0.25121 (11)	0.47375 (6)	0.0201 (2)	
H4A	0.203343	0.171331	0.446847	0.030*	
C5	0.30219 (16)	0.43022 (15)	0.37129 (7)	0.0120 (2)	
O5	0.24003 (13)	0.54963 (11)	0.32061 (6)	0.0160 (2)	
H5	0.212412	0.515209	0.274838	0.024*	
C6	0.38559 (18)	0.30780 (16)	0.32039 (8)	0.0164 (3)	
H6A	0.302268	0.266573	0.281479	0.020*	
H6B	0.422052	0.225591	0.356806	0.020*	
C7	0.53784 (19)	0.36646 (18)	0.27310 (9)	0.0196 (3)	
H7A	0.499438	0.439883	0.231880	0.024*	
H7B	0.592312	0.282401	0.243929	0.024*	
C8	0.66643 (17)	0.44078 (18)	0.32946 (9)	0.0190 (3)	
H8A	0.717882	0.363868	0.365065	0.023*	
H8B	0.757196	0.485955	0.296159	0.023*	
C9	0.58557 (16)	0.56183 (16)	0.38241 (8)	0.0145 (2)	
H9A	0.669327	0.600510	0.421870	0.017*	
H9B	0.548353	0.646064	0.347578	0.017*	
C10	0.43525 (16)	0.49780 (14)	0.42814 (7)	0.0114 (2)	
H10	0.477277	0.416373	0.464692	0.014*	
C11	0.27482 (19)	0.46377 (15)	0.60355 (8)	0.0188 (3)	

H11A	0.178608	0.407400	0.626618	0.023*
H11B	0.357884	0.390537	0.582704	0.023*
O11	0.35068 (15)	0.55188 (14)	0.66613 (6)	0.0237 (2)
H11	0.454241	0.560664	0.656759	0.036*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Cl1	0.02191 (15)	0.01602 (14)	0.01987 (15)	−0.00071 (12)	−0.00127 (12)	−0.00122 (12)
N1	0.0150 (5)	0.0111 (5)	0.0124 (5)	−0.0011 (4)	0.0010 (4)	−0.0013 (4)
C2	0.0161 (5)	0.0133 (5)	0.0137 (5)	0.0004 (5)	0.0042 (4)	−0.0016 (4)
C3	0.0132 (6)	0.0146 (6)	0.0193 (6)	0.0002 (5)	0.0029 (5)	−0.0005 (5)
O3	0.0157 (4)	0.0215 (5)	0.0238 (5)	0.0059 (4)	0.0009 (4)	0.0010 (4)
C4	0.0144 (6)	0.0129 (5)	0.0166 (6)	−0.0024 (5)	0.0010 (5)	−0.0014 (5)
O4	0.0301 (5)	0.0104 (4)	0.0198 (5)	−0.0015 (4)	0.0047 (4)	0.0008 (4)
C5	0.0132 (5)	0.0115 (5)	0.0114 (5)	−0.0009 (5)	−0.0003 (4)	−0.0002 (4)
O5	0.0194 (5)	0.0158 (4)	0.0128 (4)	0.0017 (4)	−0.0035 (3)	0.0012 (3)
C6	0.0177 (6)	0.0151 (6)	0.0164 (6)	−0.0005 (5)	0.0016 (5)	−0.0051 (5)
C7	0.0199 (7)	0.0229 (7)	0.0160 (6)	−0.0002 (5)	0.0042 (5)	−0.0055 (5)
C8	0.0153 (6)	0.0218 (6)	0.0200 (6)	−0.0002 (5)	0.0036 (5)	−0.0017 (5)
C9	0.0130 (5)	0.0150 (6)	0.0156 (5)	−0.0026 (5)	0.0009 (4)	0.0000 (5)
C10	0.0125 (5)	0.0108 (5)	0.0110 (5)	0.0003 (4)	0.0004 (4)	−0.0006 (4)
C11	0.0241 (7)	0.0186 (6)	0.0138 (5)	−0.0024 (5)	0.0027 (5)	0.0012 (5)
O11	0.0251 (5)	0.0331 (6)	0.0130 (4)	−0.0035 (5)	0.0020 (4)	−0.0031 (4)

Geometric parameters (Å, °)

N1—C10	1.5097 (16)	O5—H5	0.8400
N1—C2	1.5122 (16)	C6—C7	1.529 (2)
N1—H1A	0.9100	C6—H6A	0.9900
N1—H1B	0.9100	C6—H6B	0.9900
C2—C11	1.5282 (18)	C7—C8	1.529 (2)
C2—C3	1.5366 (19)	C7—H7A	0.9900
C2—H2	1.0000	C7—H7B	0.9900
C3—O3	1.4258 (17)	C8—C9	1.528 (2)
C3—C4	1.5342 (19)	C8—H8A	0.9900
C3—H3	1.0000	C8—H8B	0.9900
O3—H3A	0.8400	C9—C10	1.5210 (17)
C4—O4	1.4256 (16)	C9—H9A	0.9900
C4—C5	1.5459 (18)	C9—H9B	0.9900
C4—H4	1.0000	C10—H10	1.0000
O4—H4A	0.8400	C11—O11	1.4265 (17)
C5—O5	1.4398 (15)	C11—H11A	0.9900
C5—C6	1.5270 (18)	C11—H11B	0.9900
C5—C10	1.5326 (17)	O11—H11	0.8400
C10—N1—C2	113.76 (10)	C7—C6—H6A	109.2
C10—N1—H1A	108.8	C5—C6—H6B	109.2
C2—N1—H1A	108.8	C7—C6—H6B	109.2
C10—N1—H1B	108.8	H6A—C6—H6B	107.9
C2—N1—H1B	108.8	C6—C7—C8	111.75 (11)
H1A—N1—H1B	107.7	C6—C7—H7A	109.3

N1—C2—C11	111.82 (11)	C8—C7—H7A	109.3
N1—C2—C3	108.78 (10)	C6—C7—H7B	109.3
C11—C2—C3	116.18 (11)	C8—C7—H7B	109.3
N1—C2—H2	106.5	H7A—C7—H7B	107.9
C11—C2—H2	106.5	C9—C8—C7	111.74 (11)
C3—C2—H2	106.5	C9—C8—H8A	109.3
O3—C3—C4	112.25 (11)	C7—C8—H8A	109.3
O3—C3—C2	108.96 (11)	C9—C8—H8B	109.3
C4—C3—C2	112.44 (11)	C7—C8—H8B	109.3
O3—C3—H3	107.7	H8A—C8—H8B	107.9
C4—C3—H3	107.7	C10—C9—C8	110.06 (11)
C2—C3—H3	107.7	C10—C9—H9A	109.6
C3—O3—H3A	109.5	C8—C9—H9A	109.6
O4—C4—C3	105.59 (10)	C10—C9—H9B	109.6
O4—C4—C5	111.73 (11)	C8—C9—H9B	109.6
C3—C4—C5	111.55 (11)	H9A—C9—H9B	108.2
O4—C4—H4	109.3	N1—C10—C9	109.83 (10)
C3—C4—H4	109.3	N1—C10—C5	110.23 (10)
C5—C4—H4	109.3	C9—C10—C5	112.91 (10)
C4—O4—H4A	109.5	N1—C10—H10	107.9
O5—C5—C6	111.37 (10)	C9—C10—H10	107.9
O5—C5—C10	107.15 (10)	C5—C10—H10	107.9
C6—C5—C10	108.41 (11)	O11—C11—C2	111.20 (11)
O5—C5—C4	107.04 (10)	O11—C11—H11A	109.4
C6—C5—C4	112.40 (11)	C2—C11—H11A	109.4
C10—C5—C4	110.34 (10)	O11—C11—H11B	109.4
C5—O5—H5	109.5	C2—C11—H11B	109.4
C5—C6—C7	111.97 (11)	H11A—C11—H11B	108.0
C5—C6—H6A	109.2	C11—O11—H11	109.5

Hydrogen-bond geometry (Å, °)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
O11—H11···Cl1	0.84	2.23	3.0505 (12)	165
C10—H10···O4^{i}	1.00	2.52	3.4522 (16)	155
C9—H9*A*···O3^{ii}	0.99	2.61	3.3971 (17)	137
C9—H9*A*···Cl1	0.99	2.92	3.6689 (13)	133
O5—H5···O11^{iii}	0.84	1.95	2.7846 (14)	176
O4—H4*A*···Cl1^{iv}	0.84	2.29	3.1173 (10)	167
O3—H3*A*···O5	0.84	2.00	2.7171 (15)	143
C3—H3···Cl1^{v}	1.00	2.89	3.6172 (14)	131
N1—H1*B*···O3^{vi}	0.91	2.32	3.0354 (15)	135
N1—H1*B*···Cl1	0.91	2.65	3.4053 (12)	140
N1—H1*A*···Cl1^{vii}	0.91	2.41	3.2912 (12)	163

Symmetry codes: (i) $x+1/2, -y+1/2, -z+1$; (ii) $x+1, y, z$; (iii) $-x+1/2, -y+1, z-1/2$; (iv) $x-1/2, -y+1/2, -z+1$; (v) $x-1, y, z$; (vi) $x+1/2, -y+3/2, -z+1$; (vii) $x-1/2, -y+3/2, -z+1$.