A stereochemical journey around spirocyclic glutamic acid analogs

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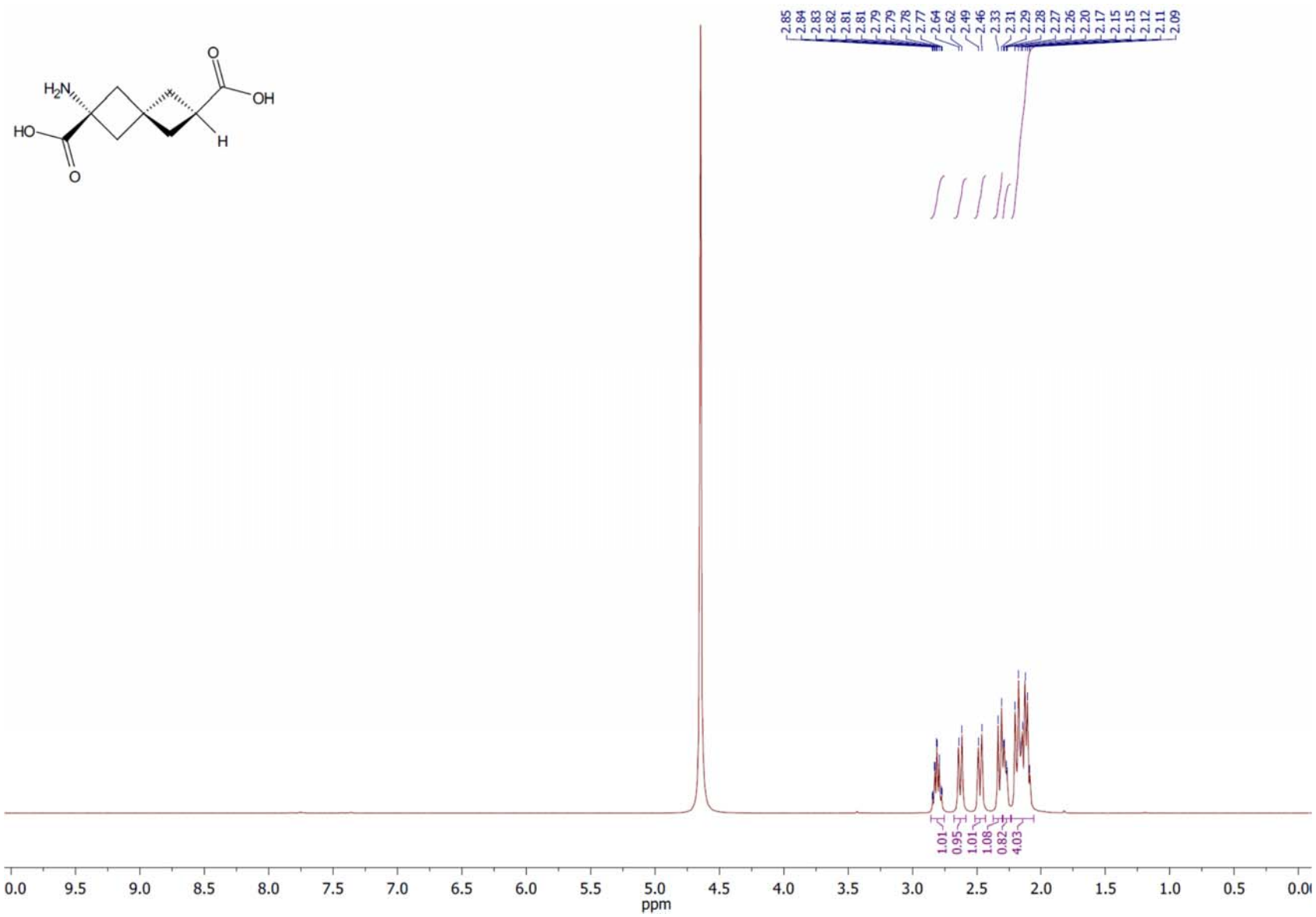
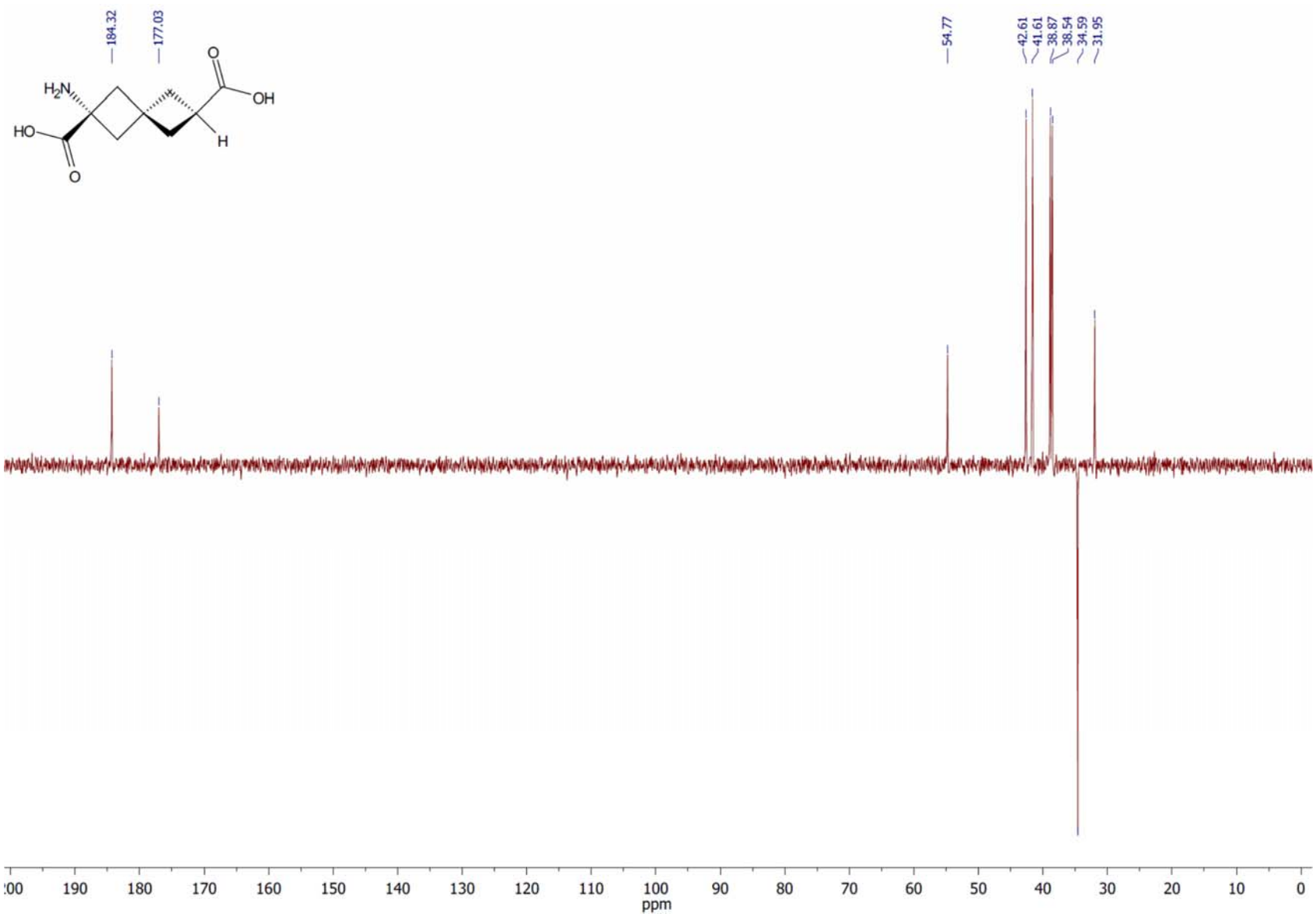
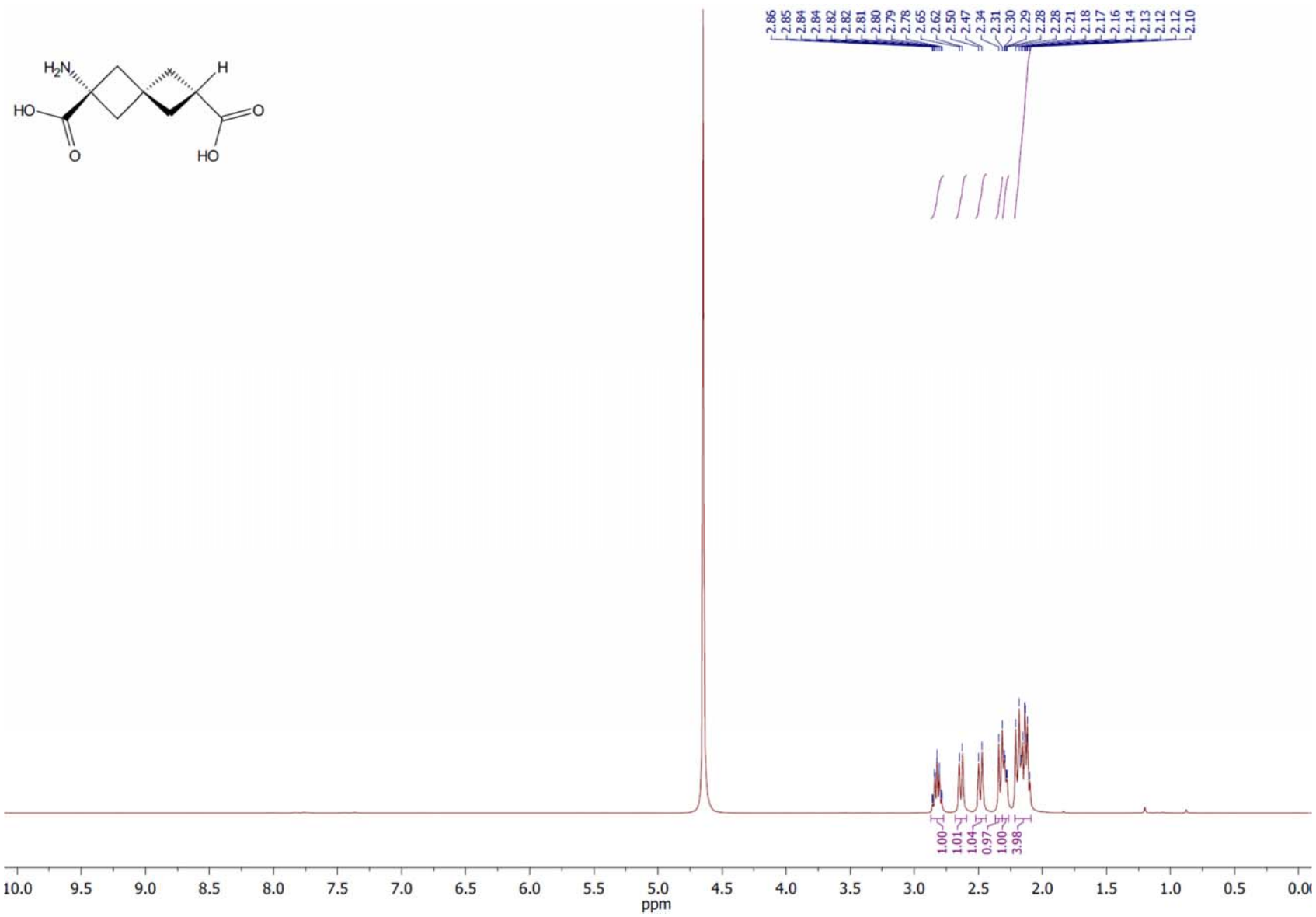
^{1}H NMR spectrum of compound **14a**



APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **14a**



^{1}H NMR spectrum of compound **14b**



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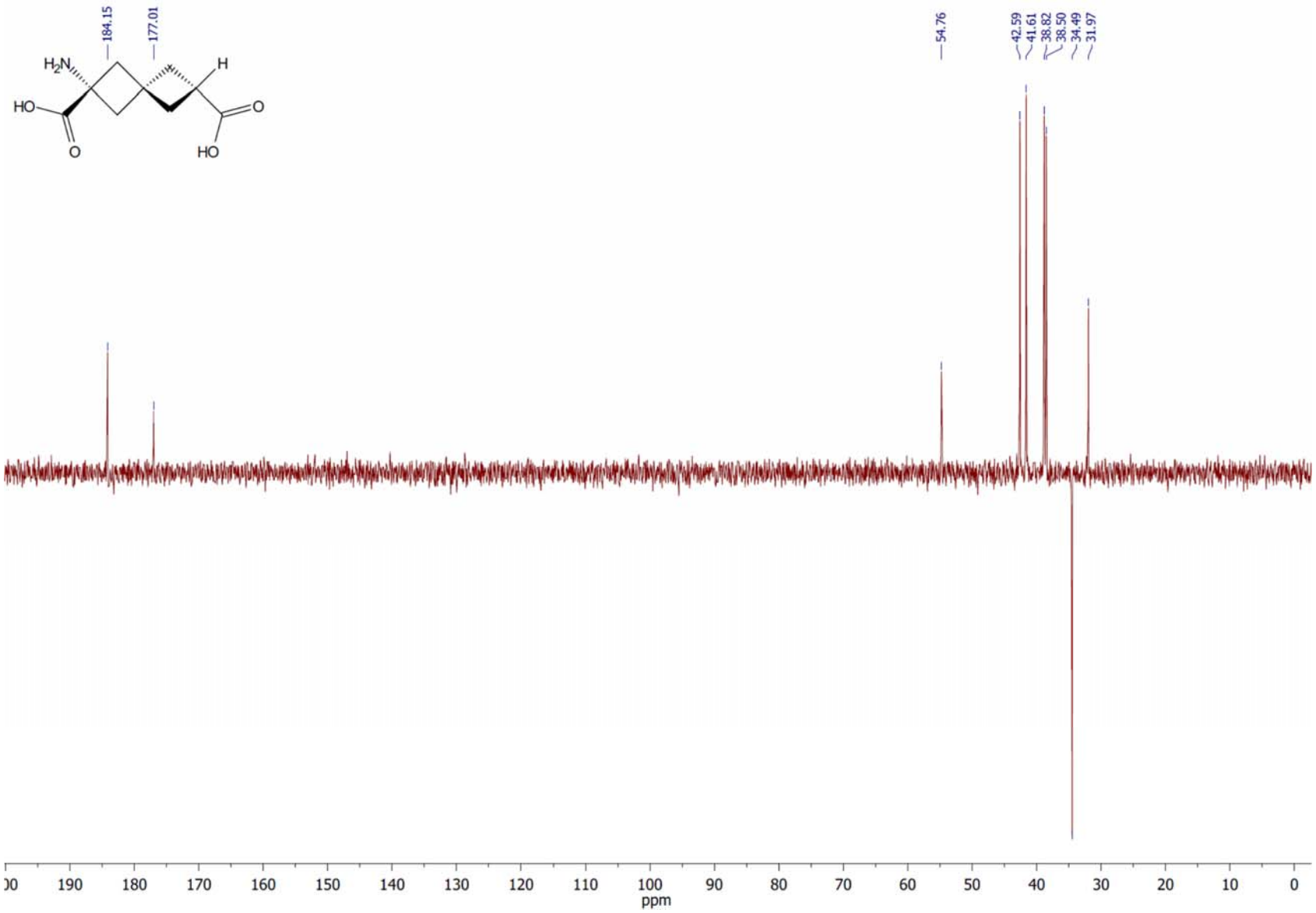

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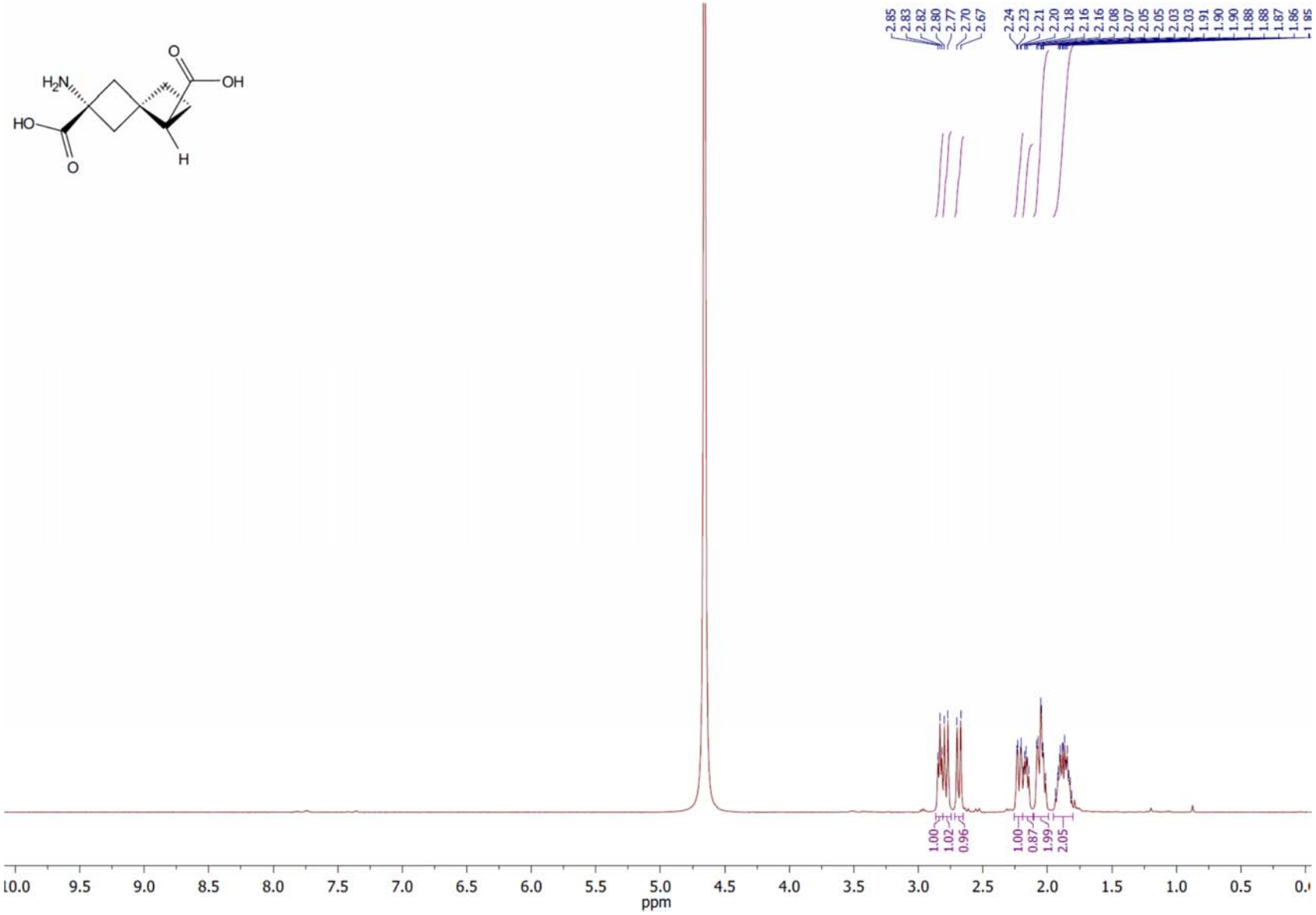
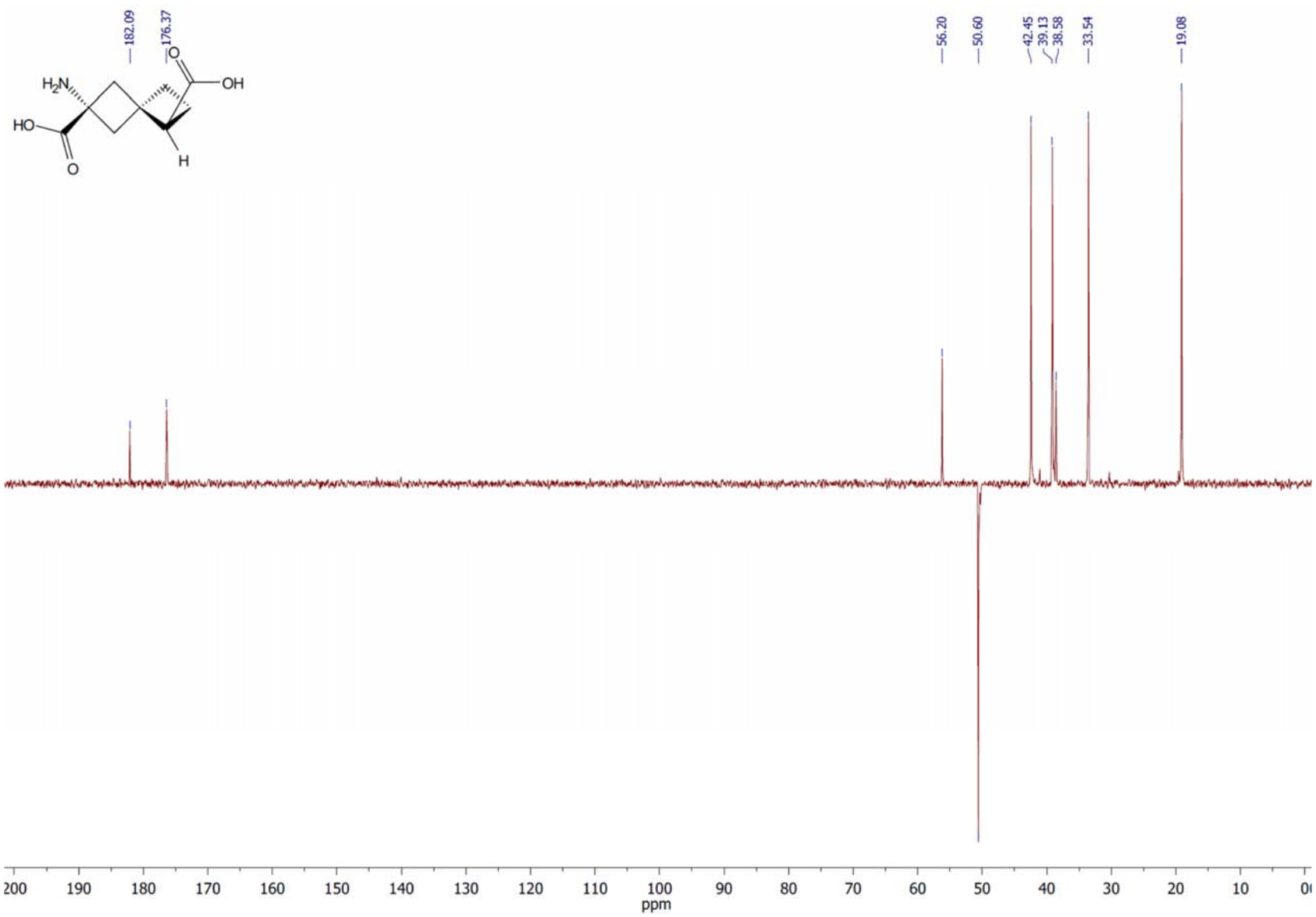


APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **17a**



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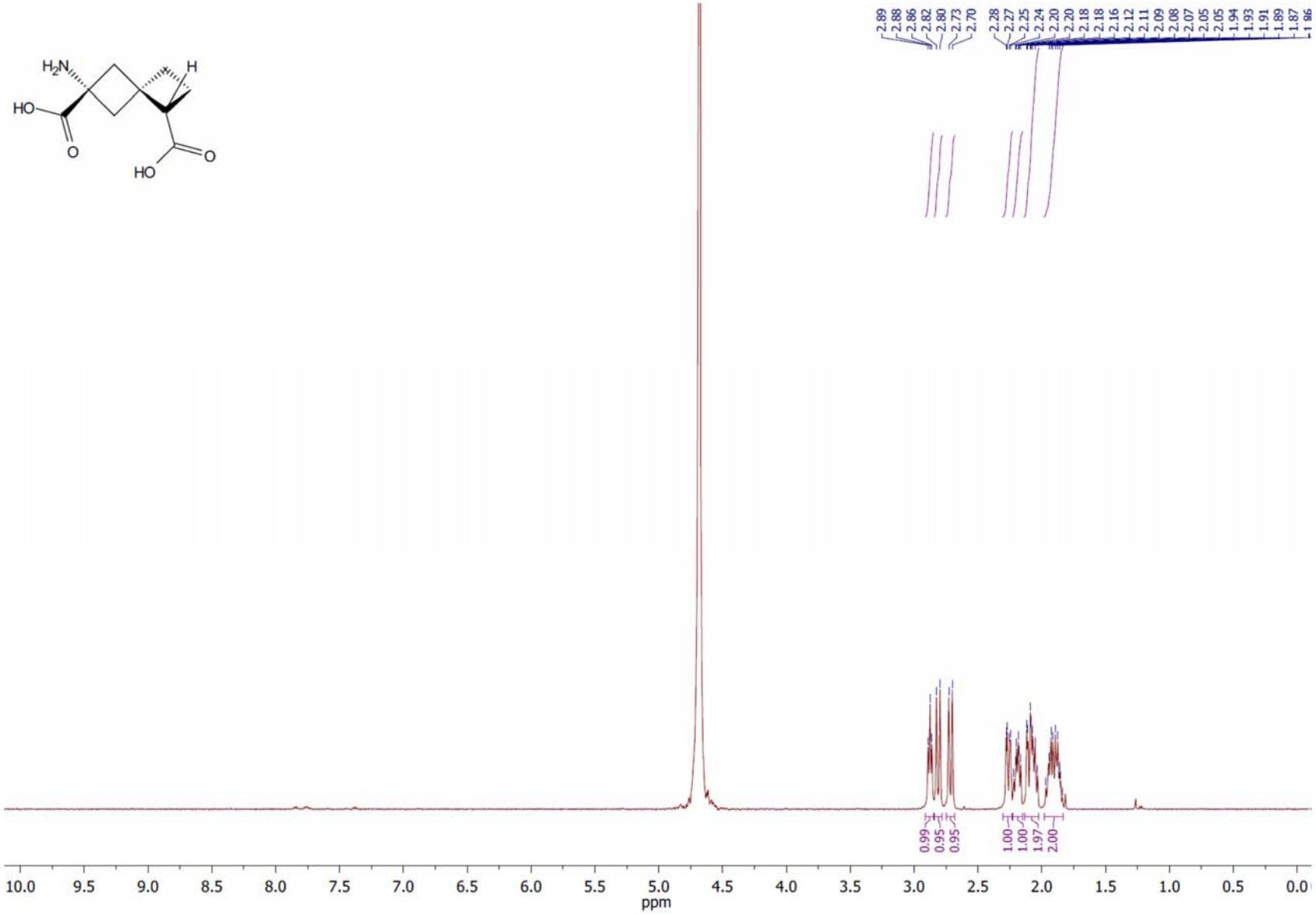

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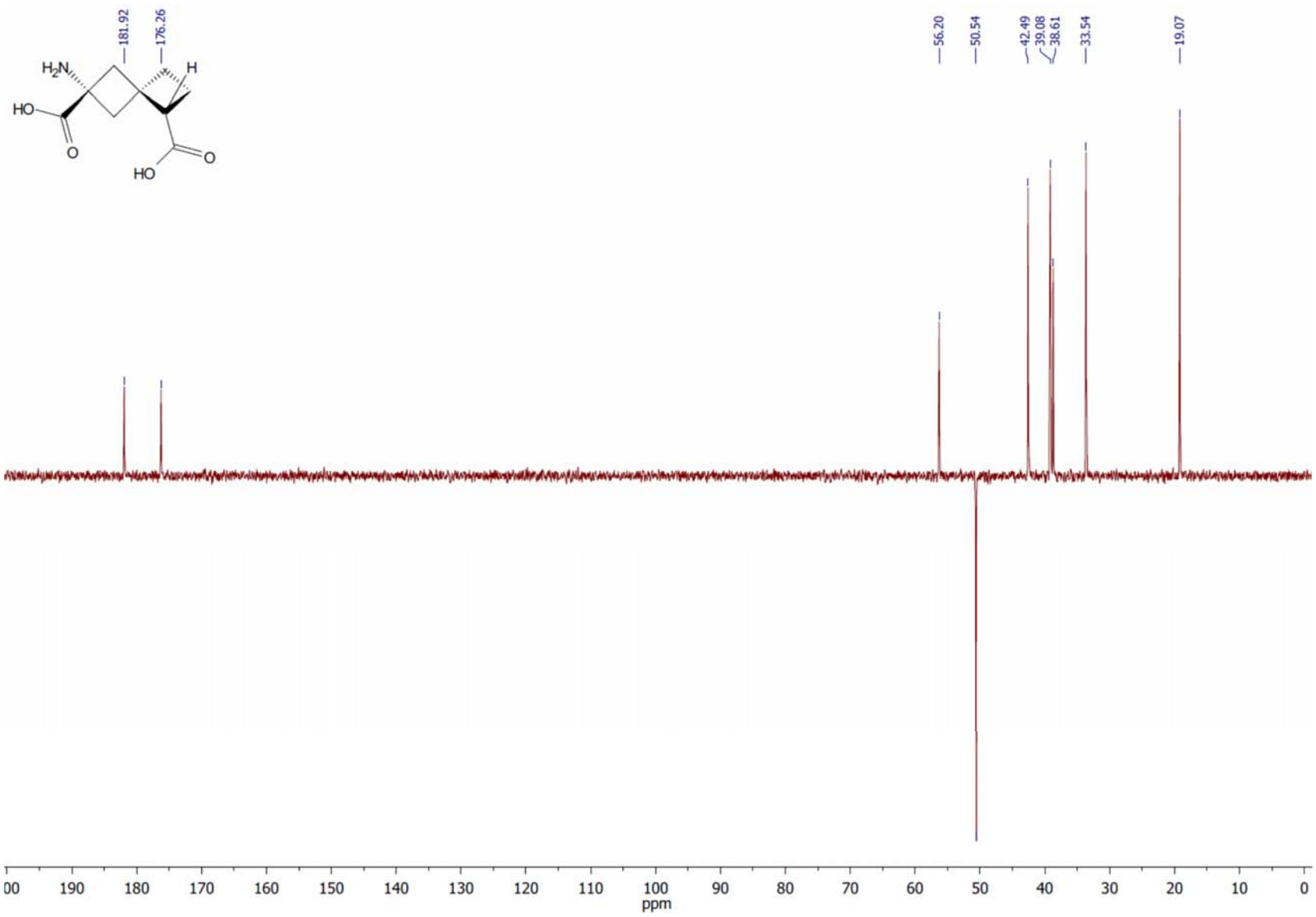

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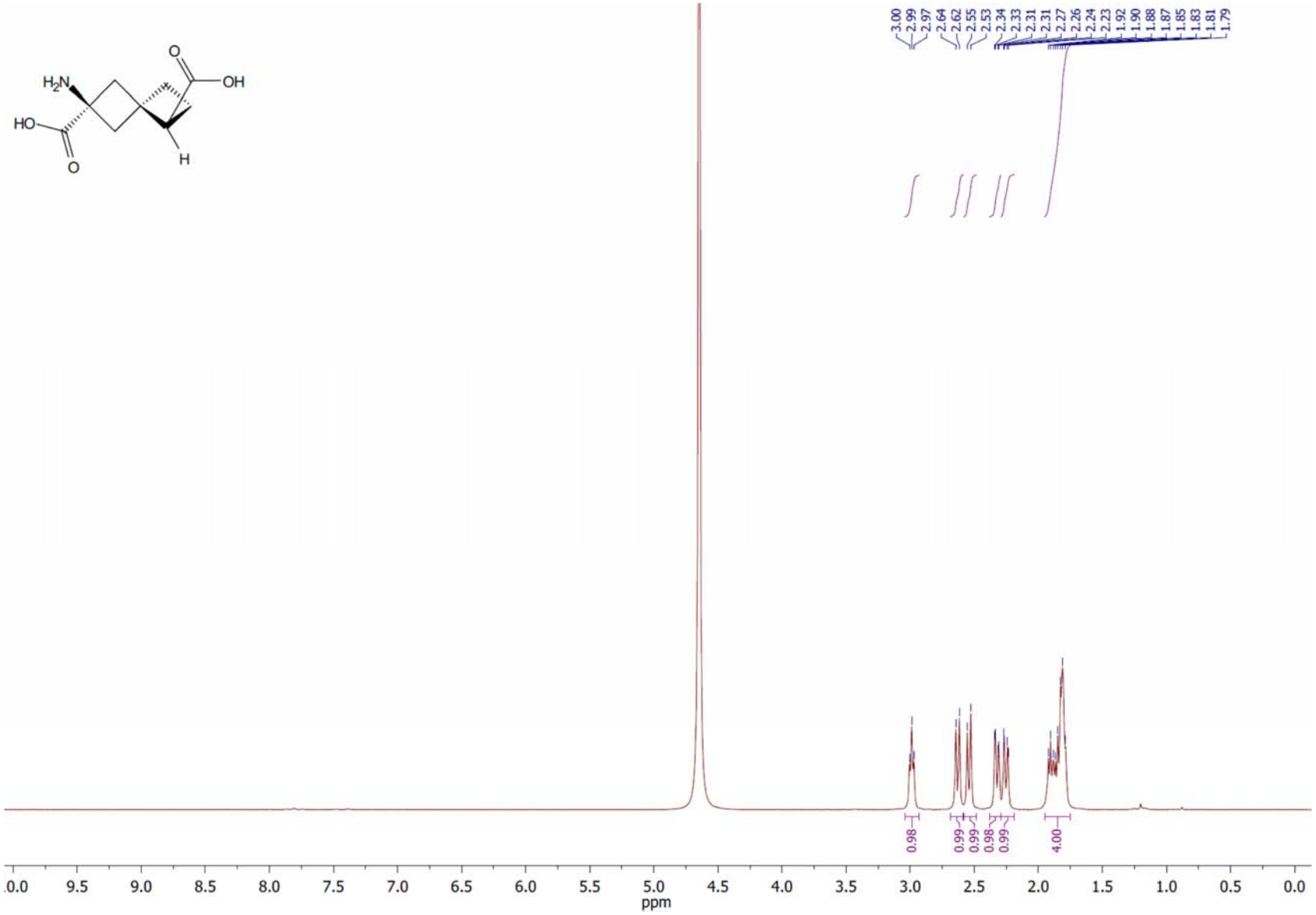

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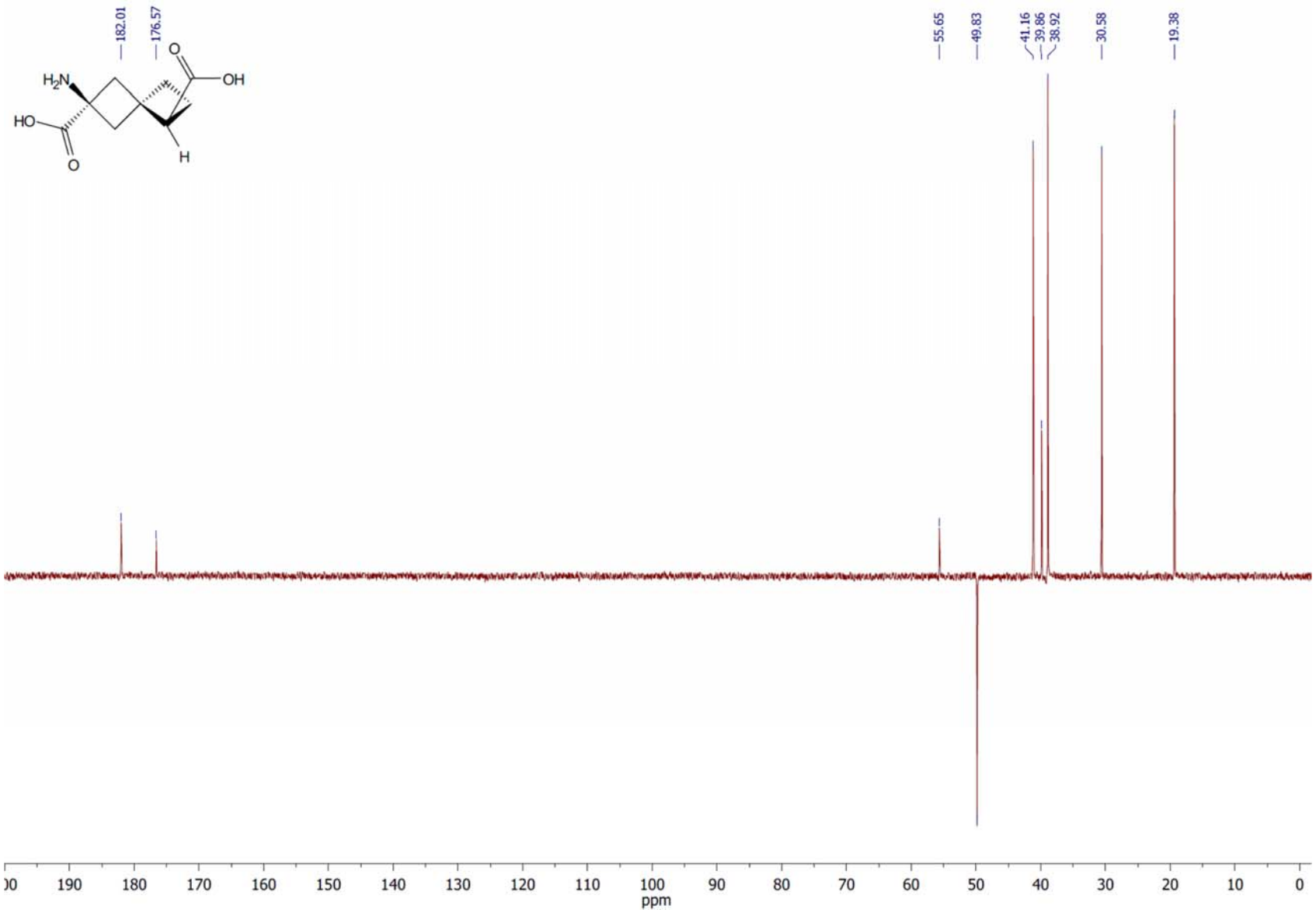

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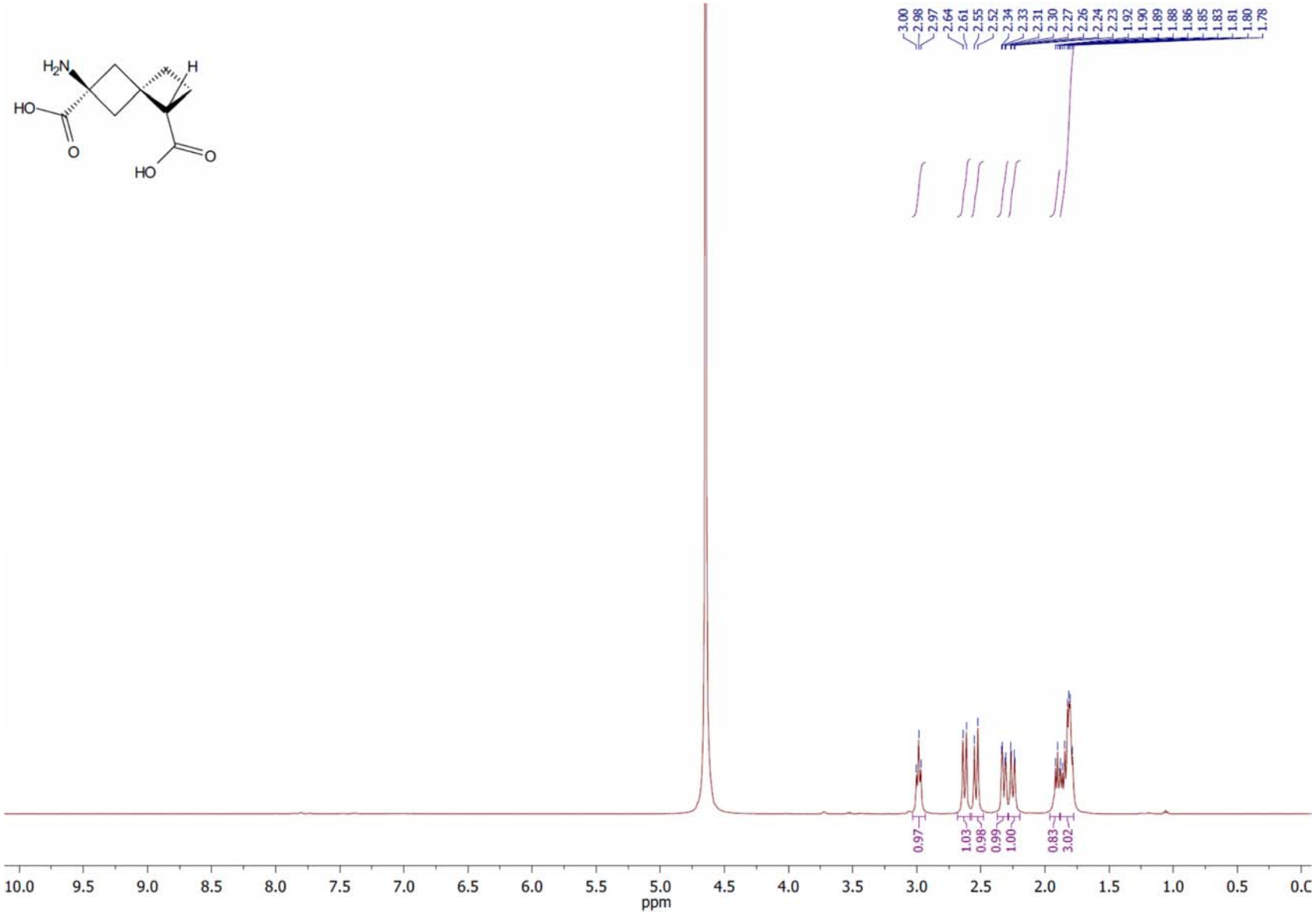

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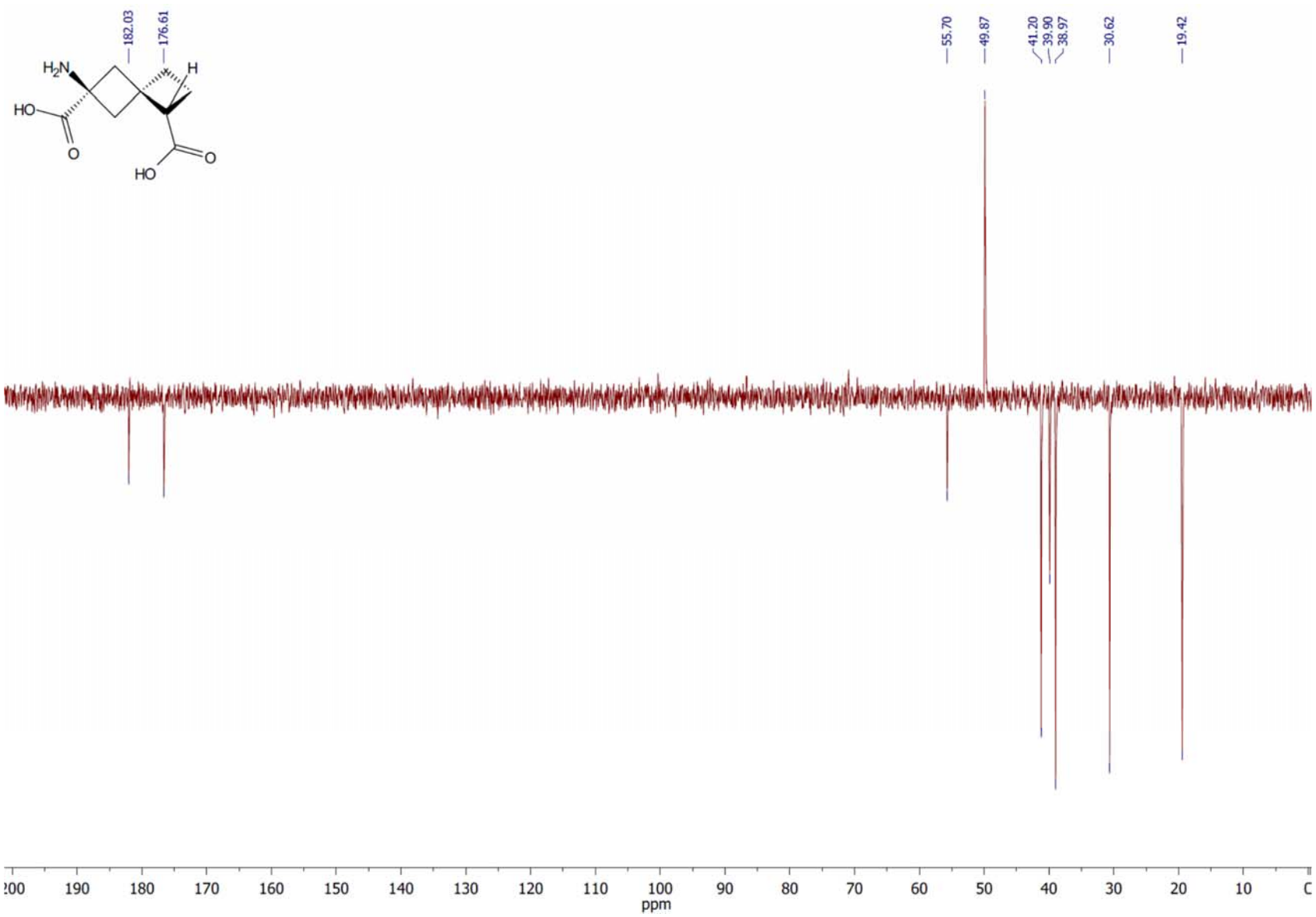

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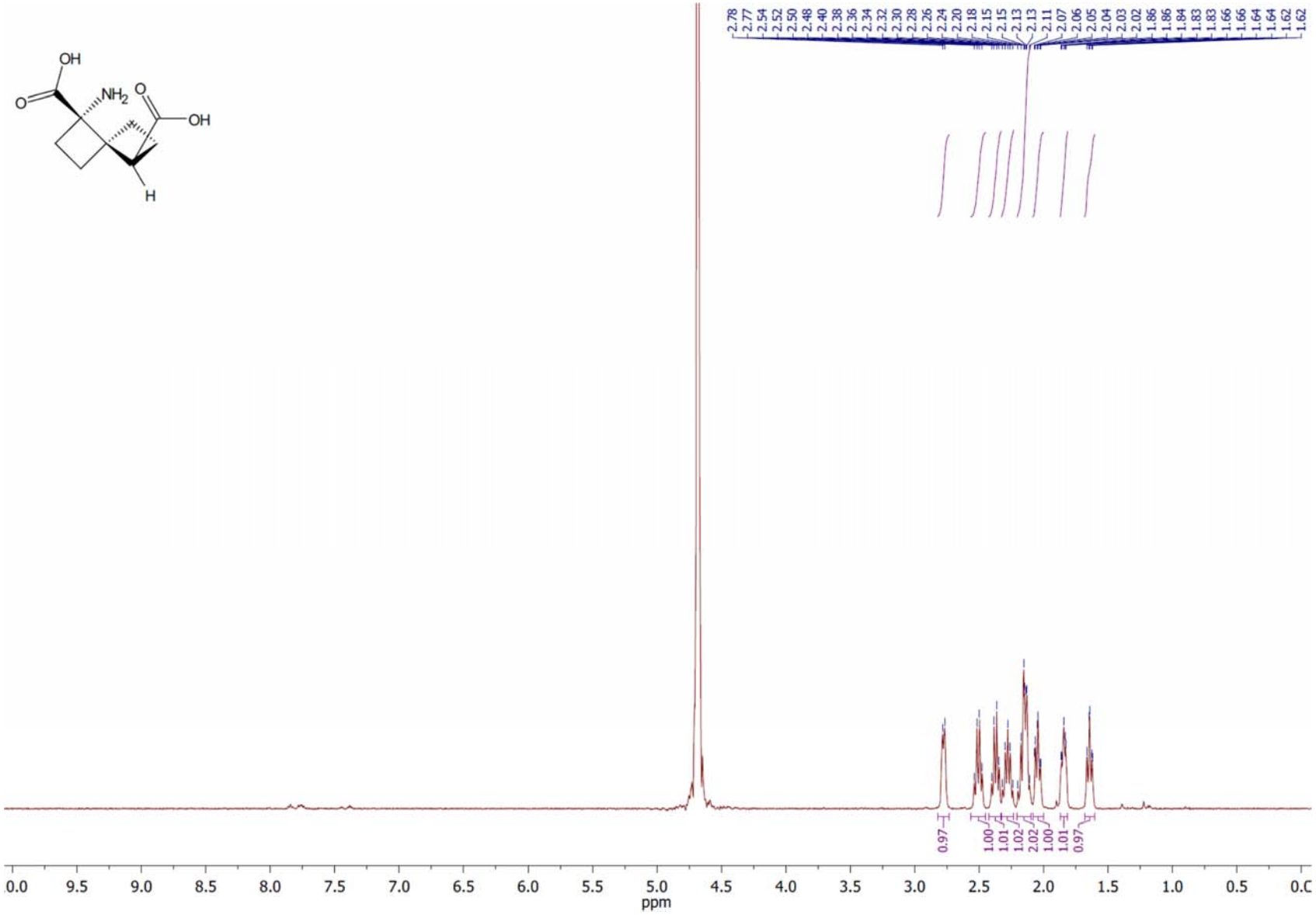

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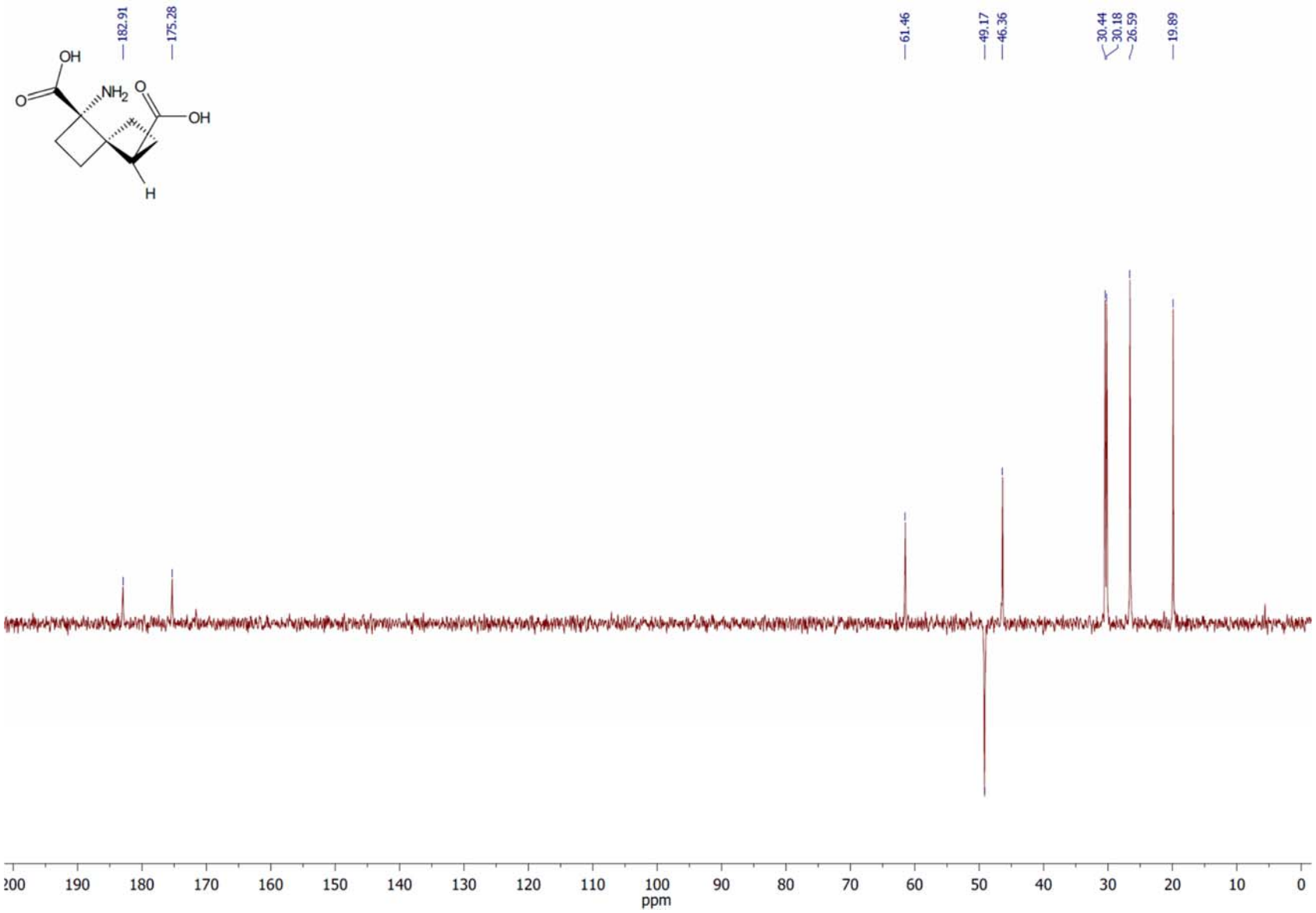

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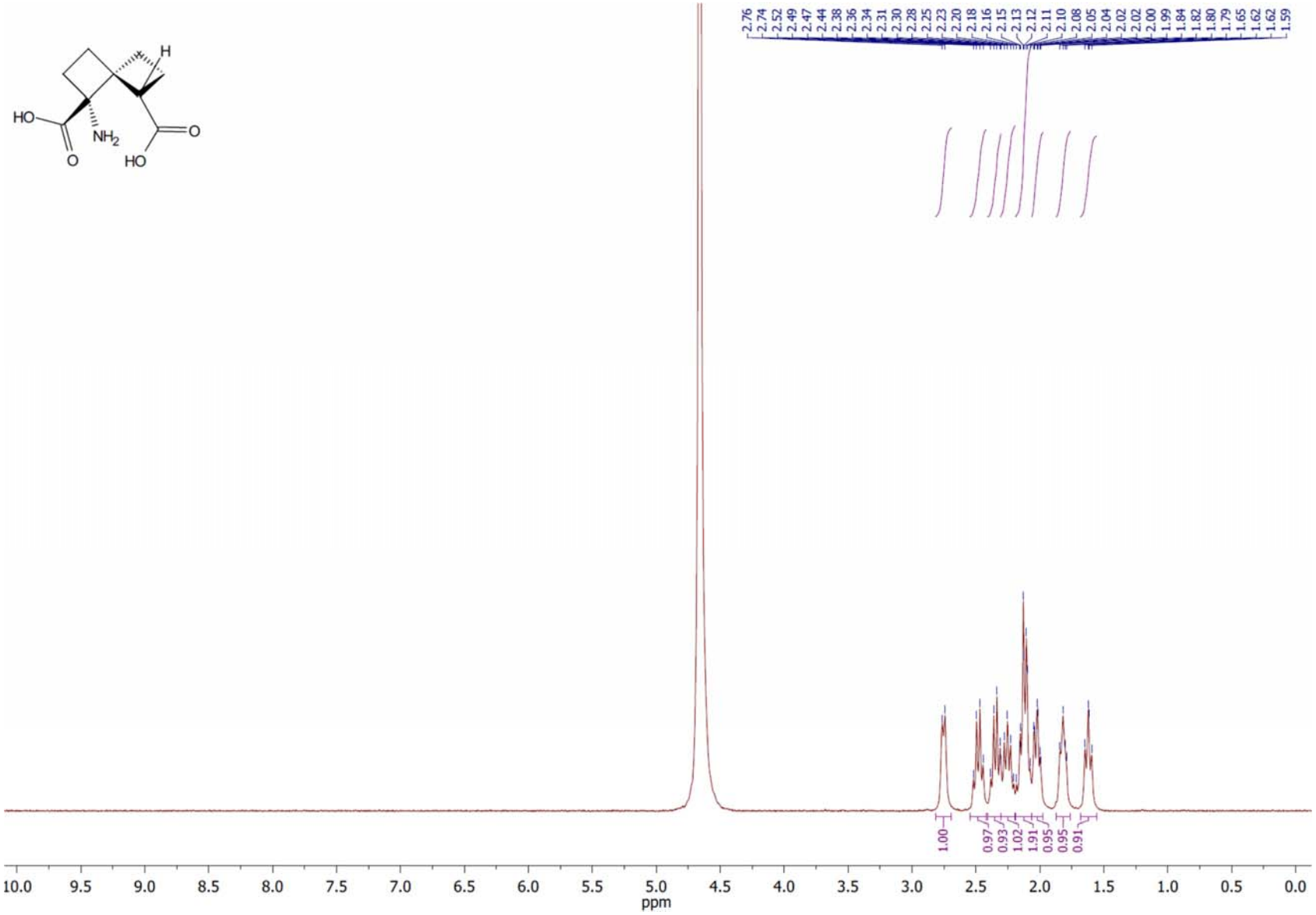

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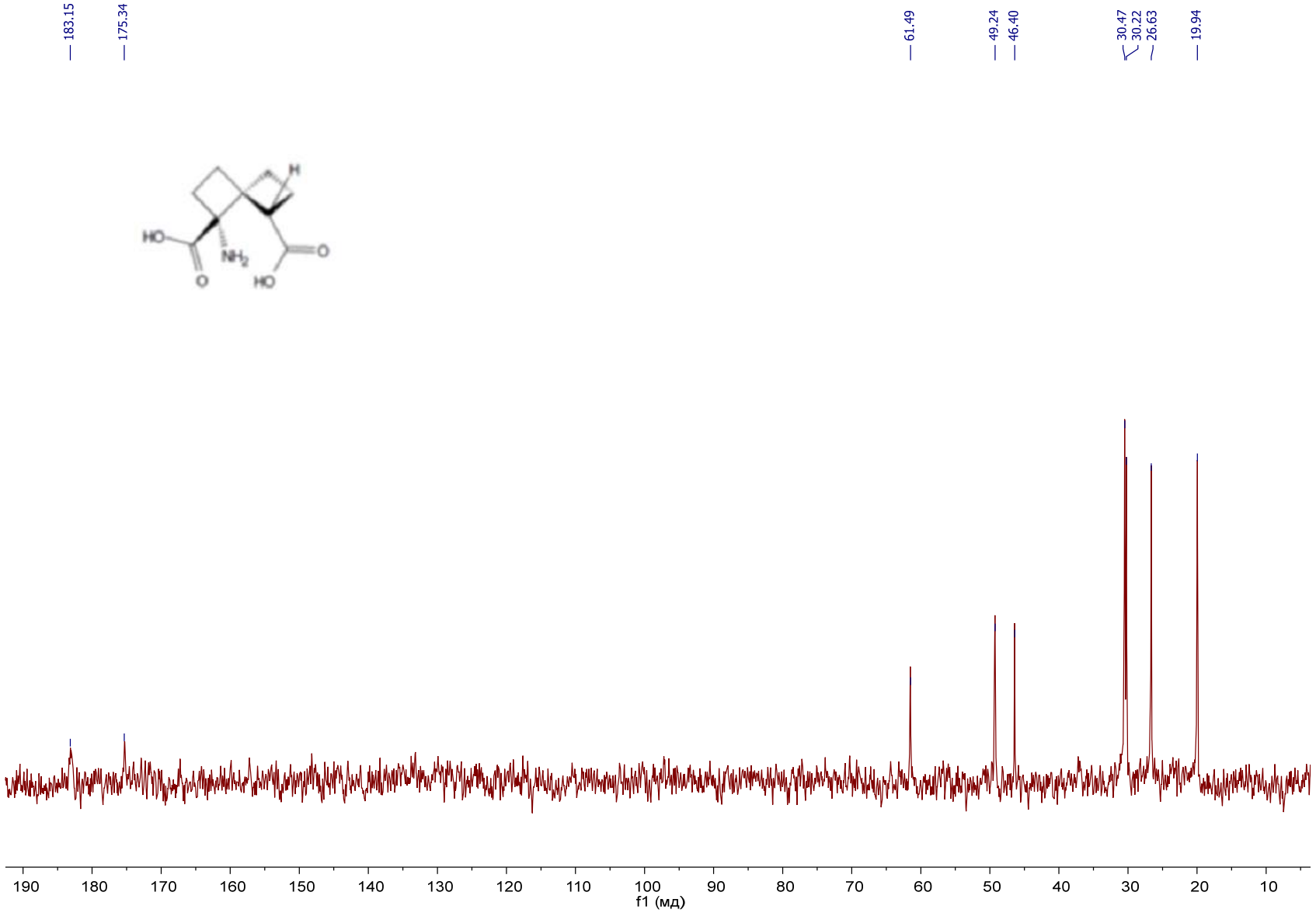

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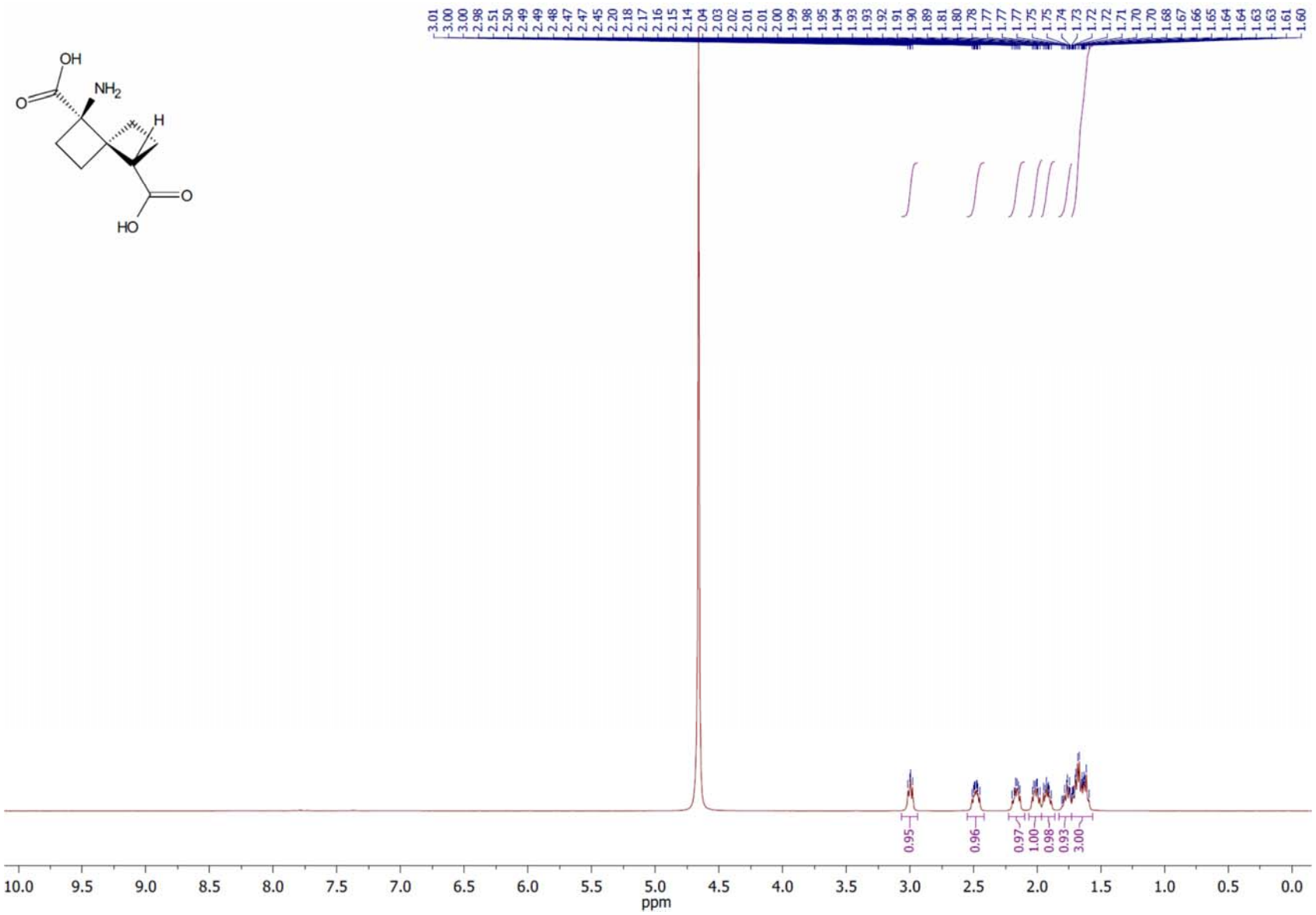

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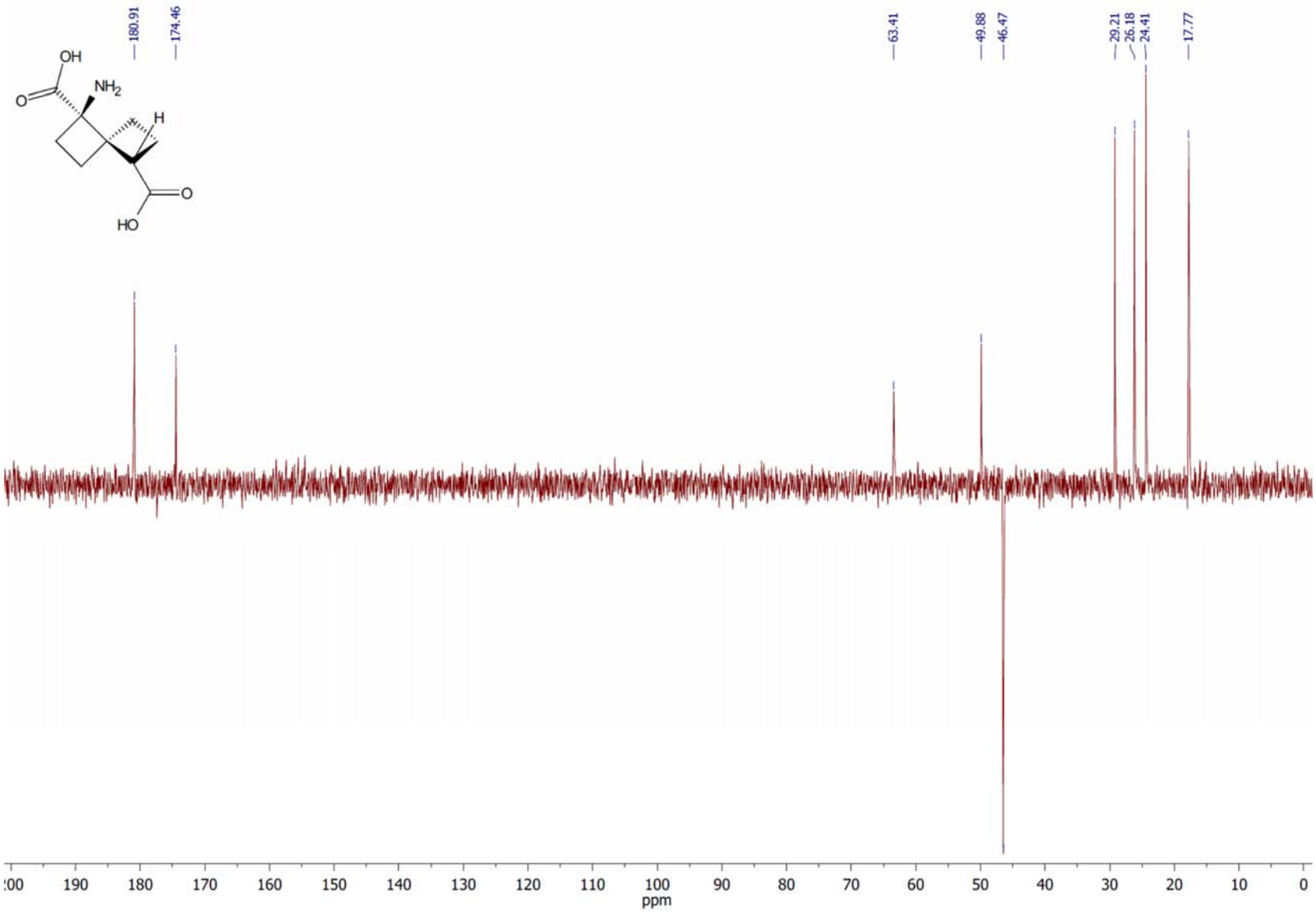

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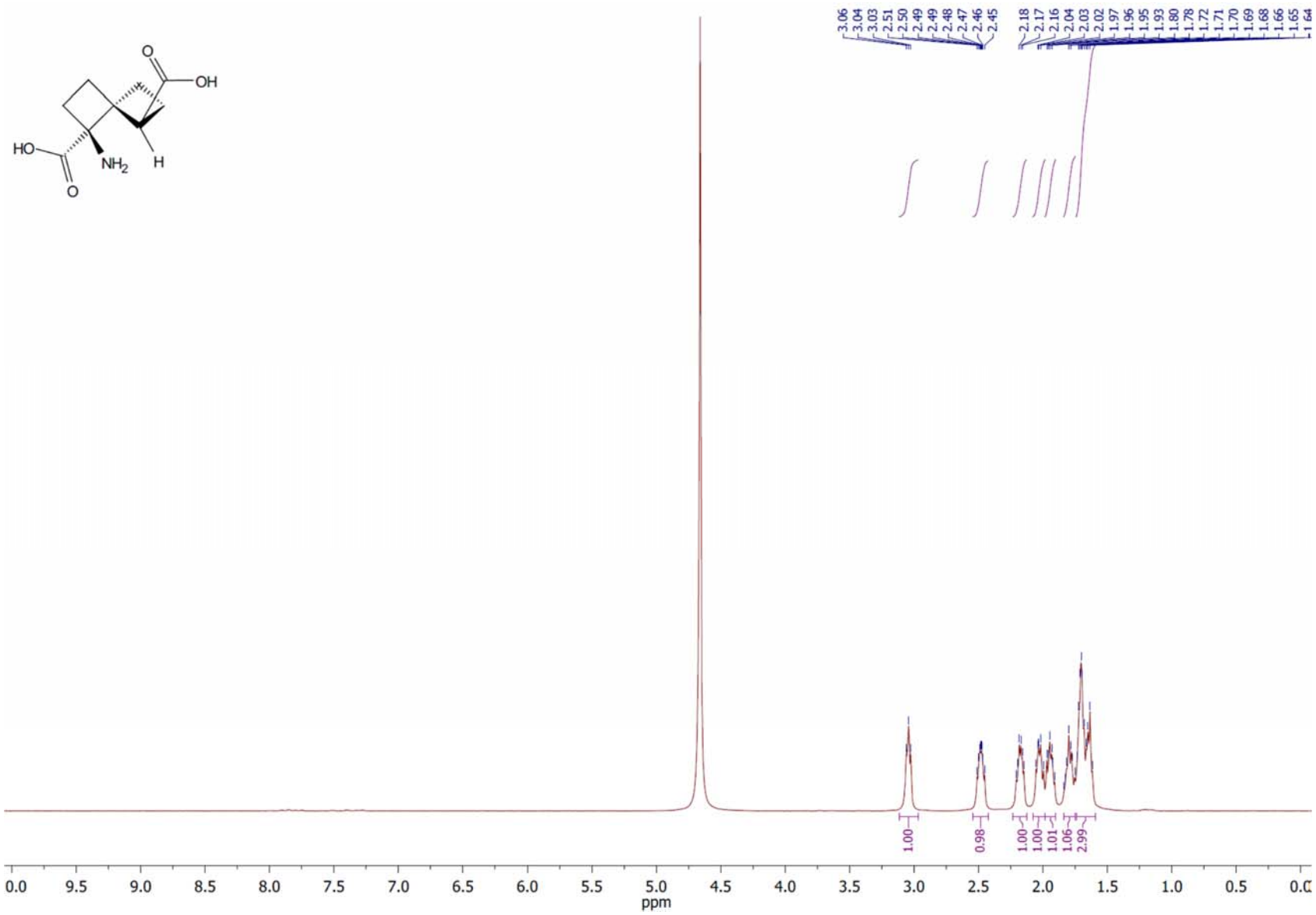

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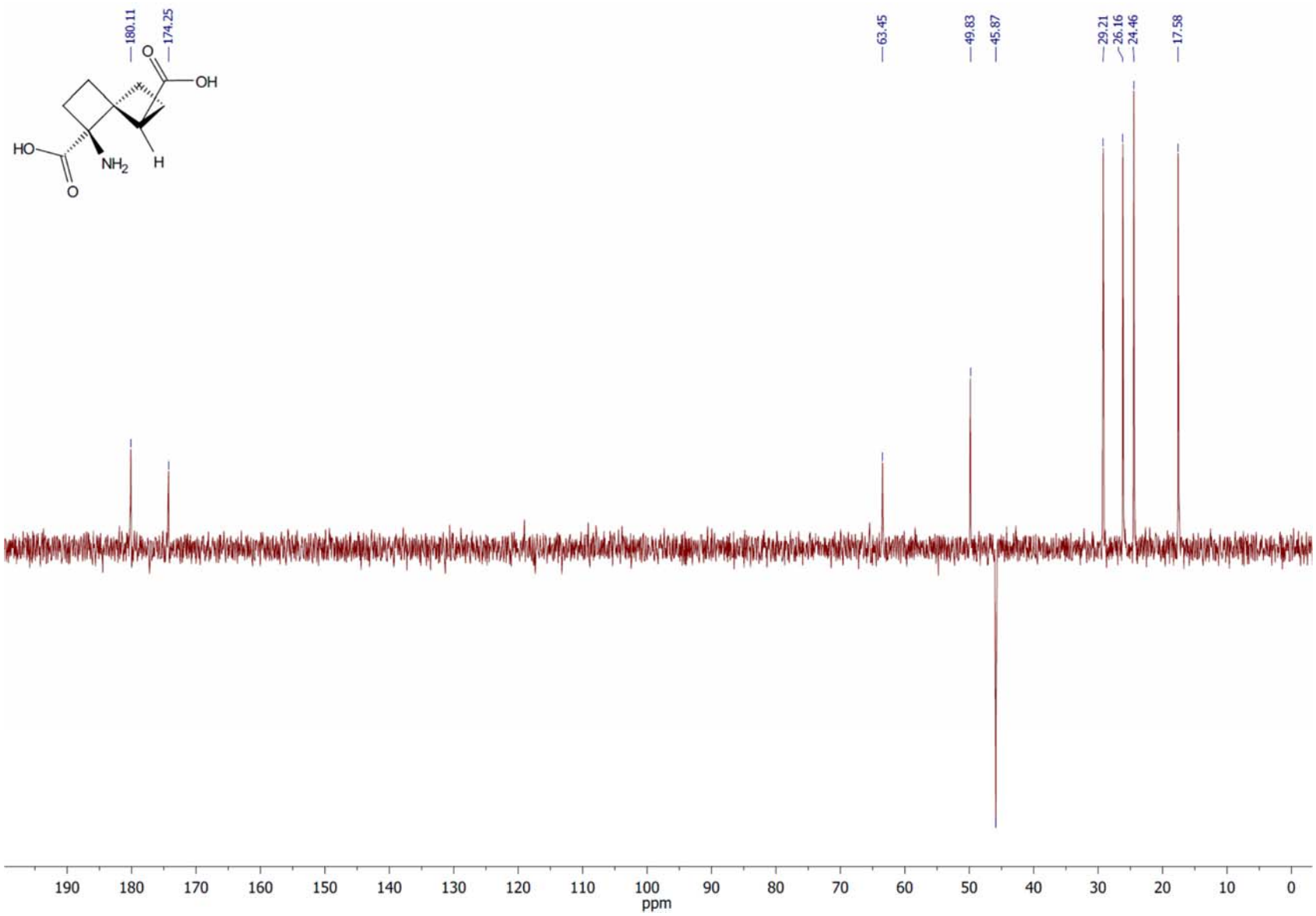

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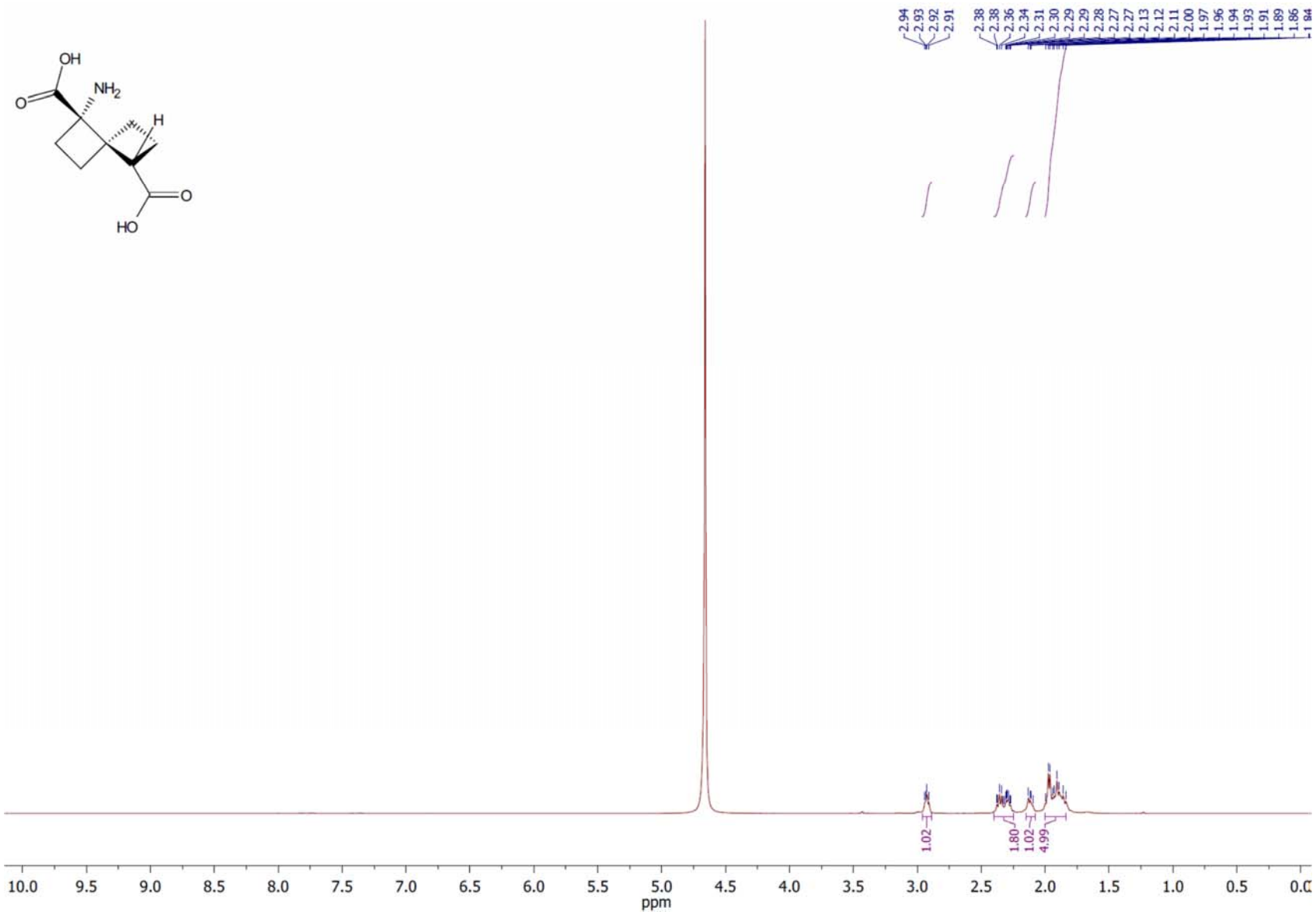
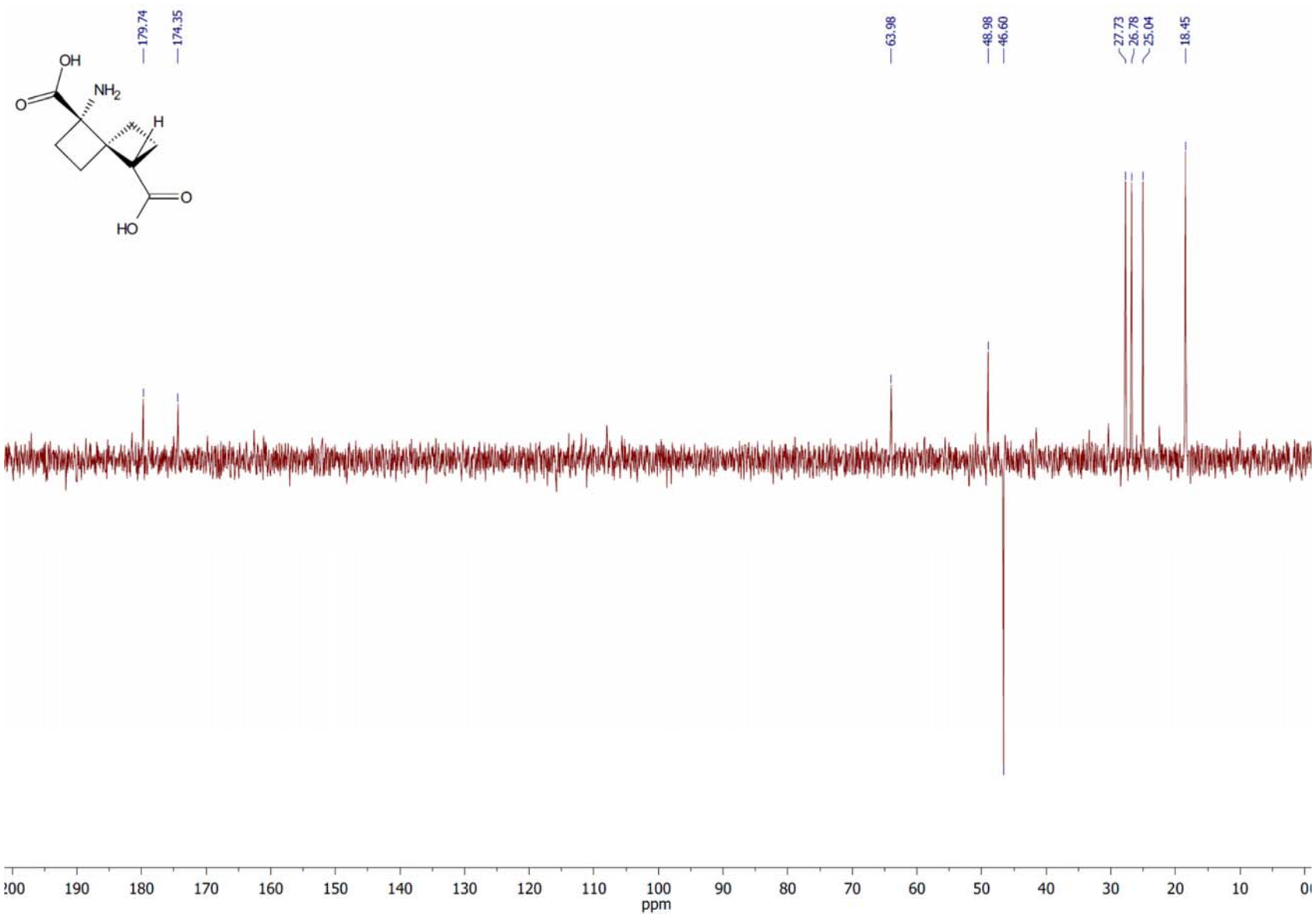


APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **22a**



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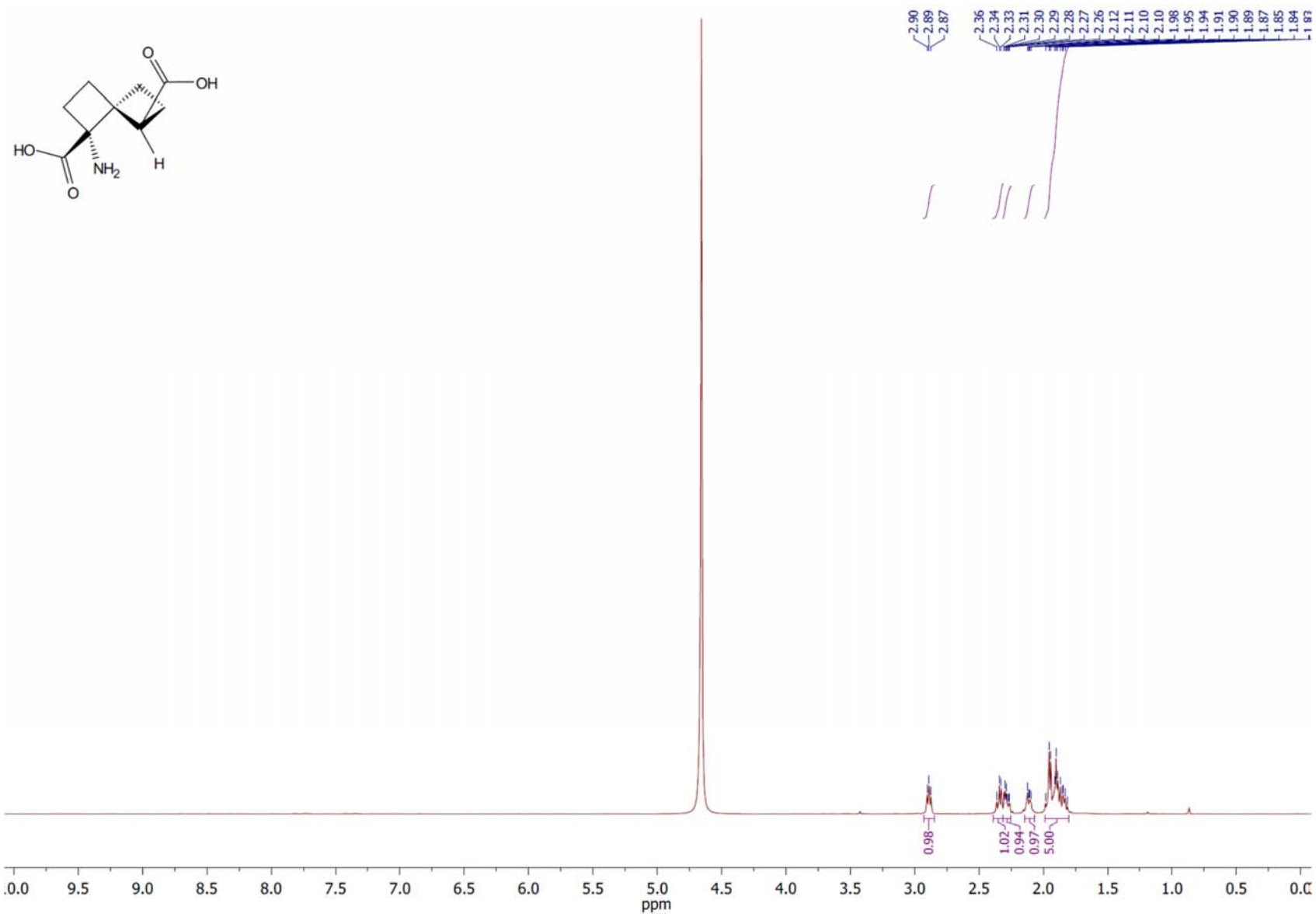

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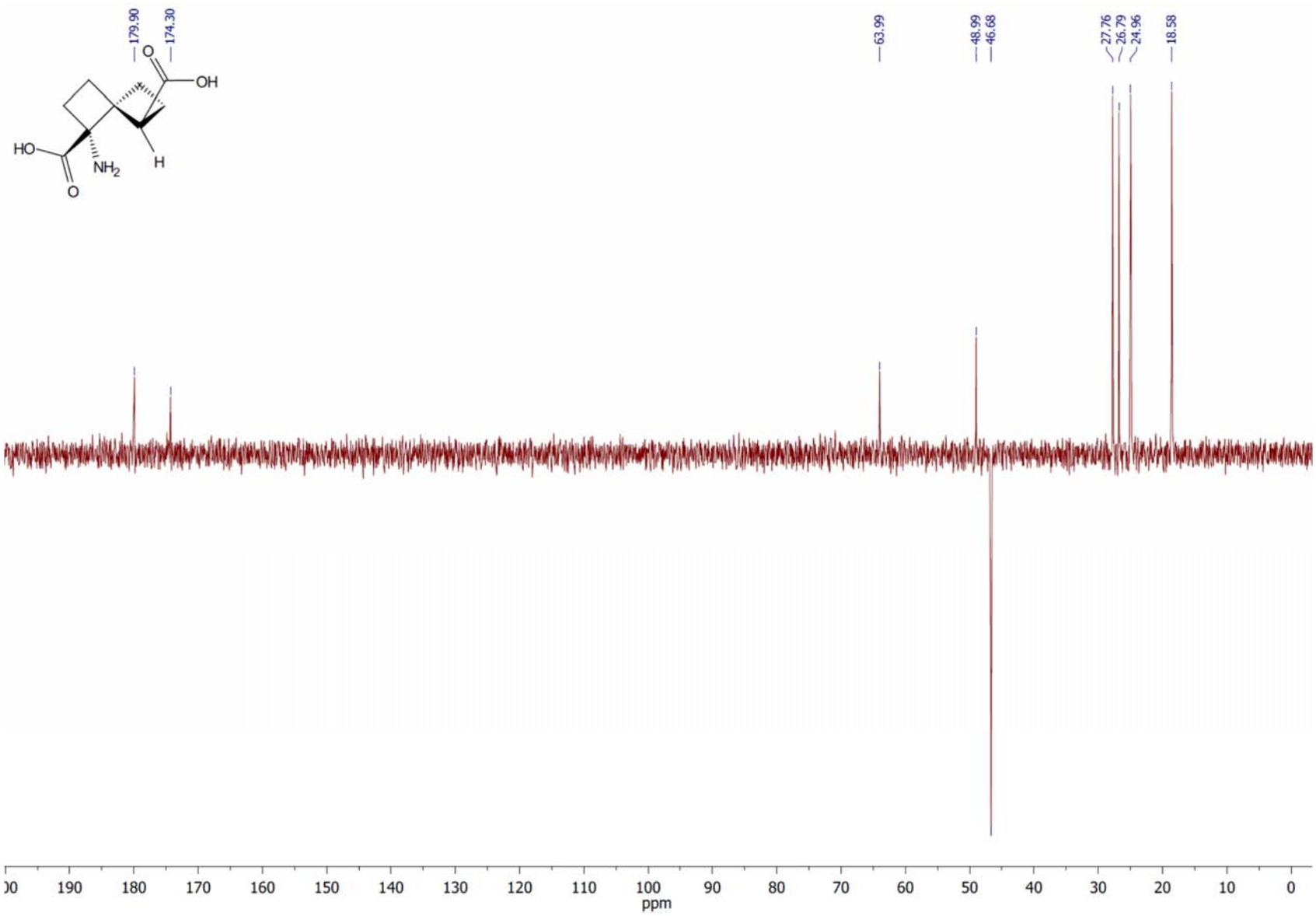

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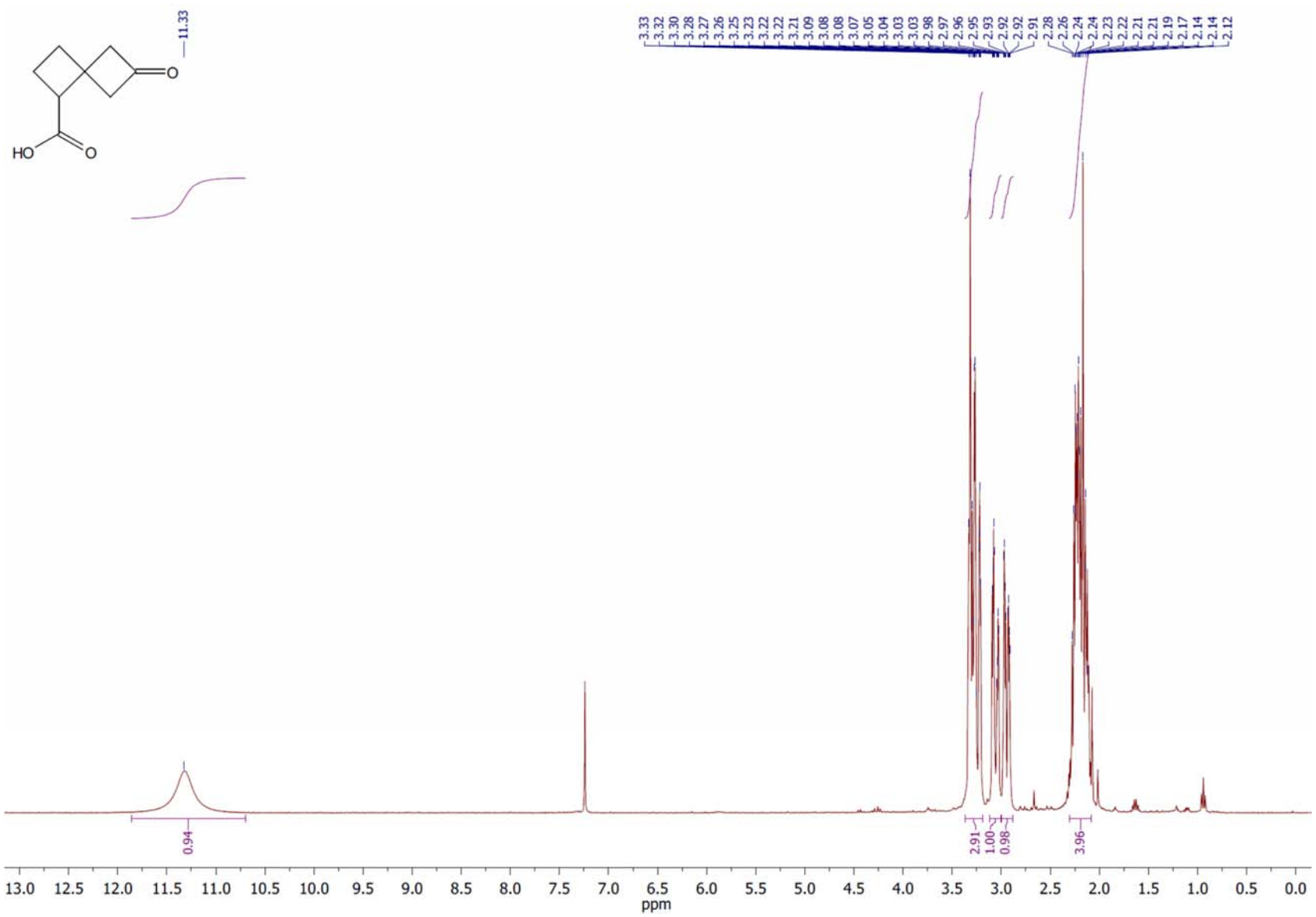
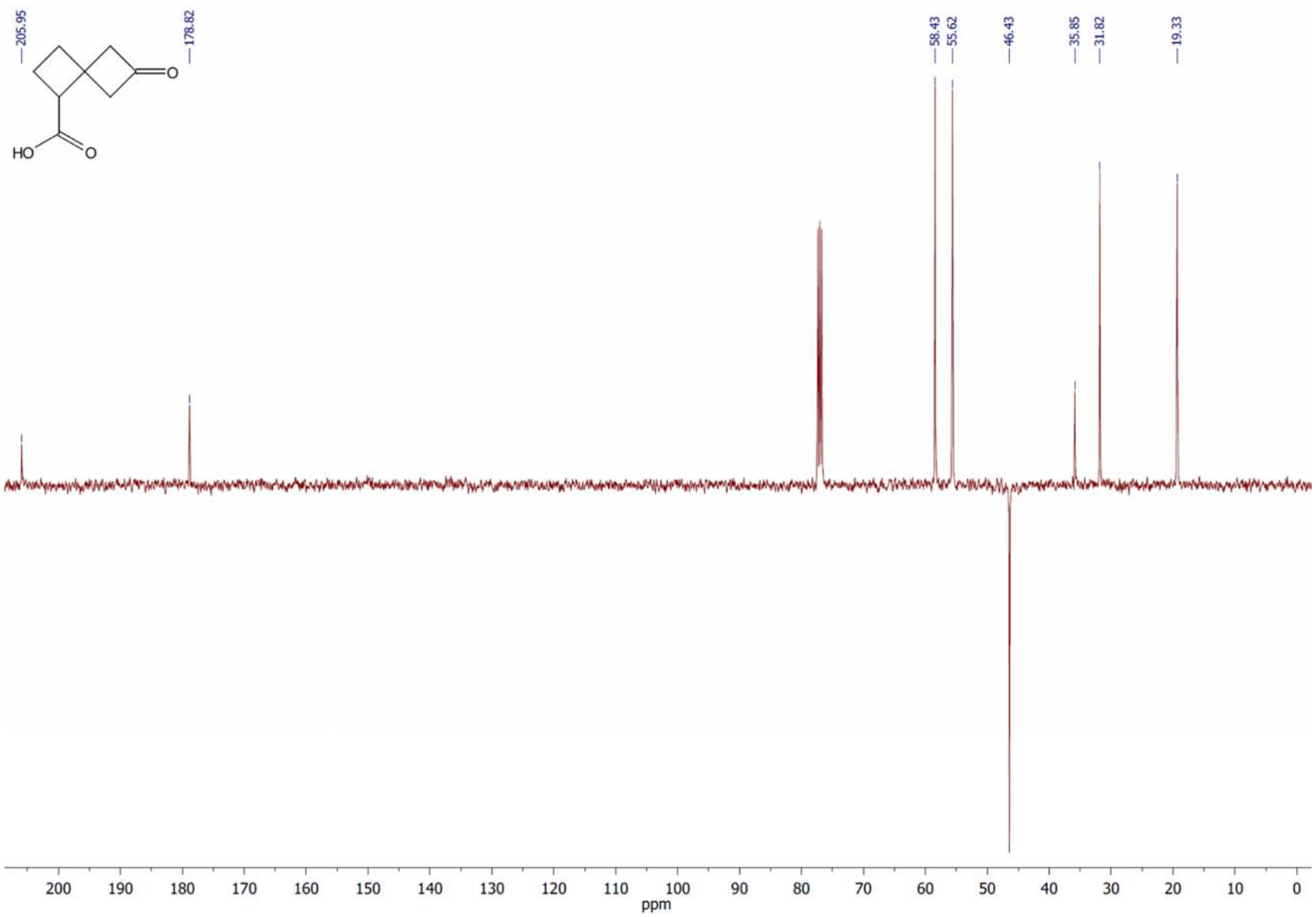


APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **29**



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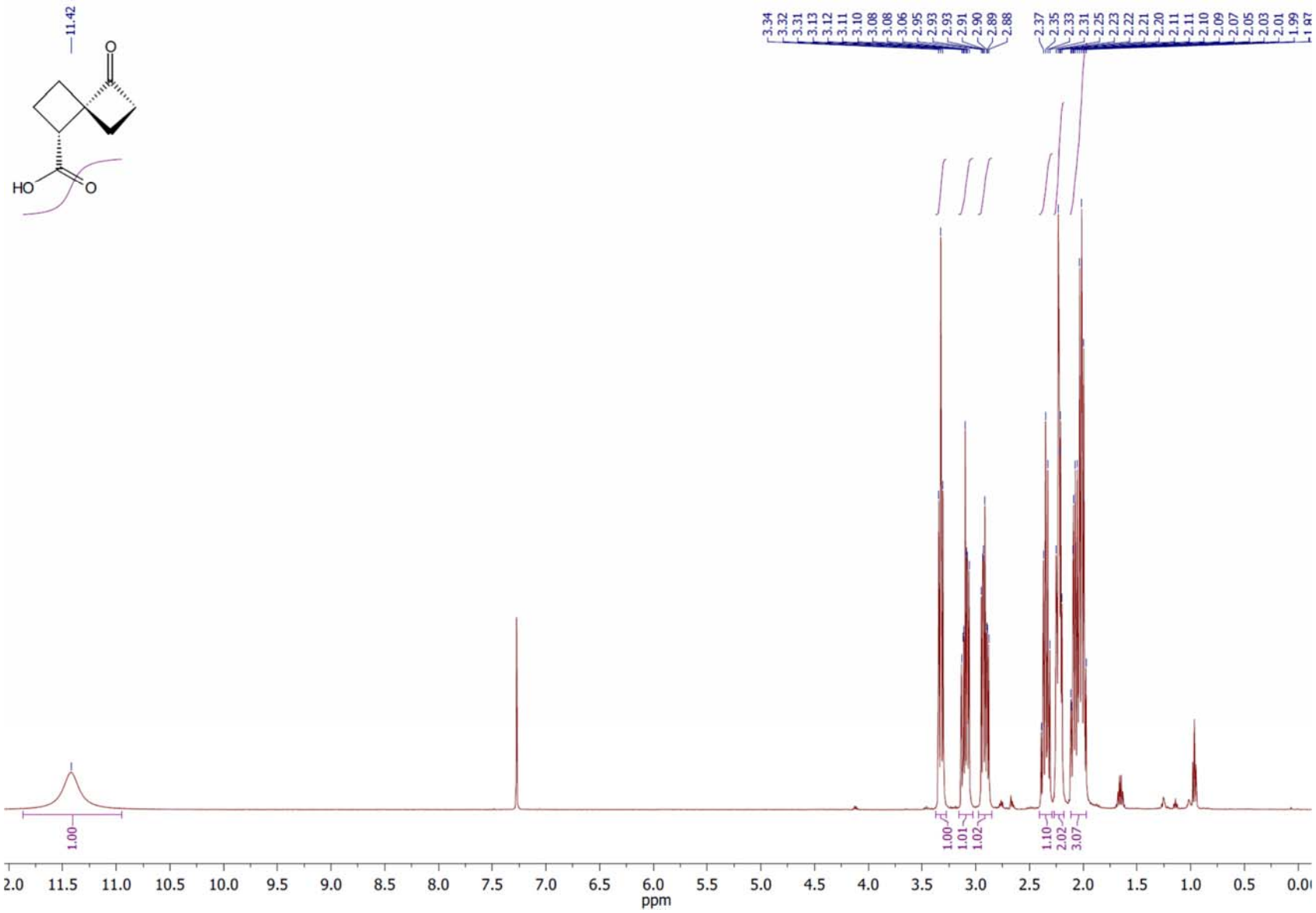

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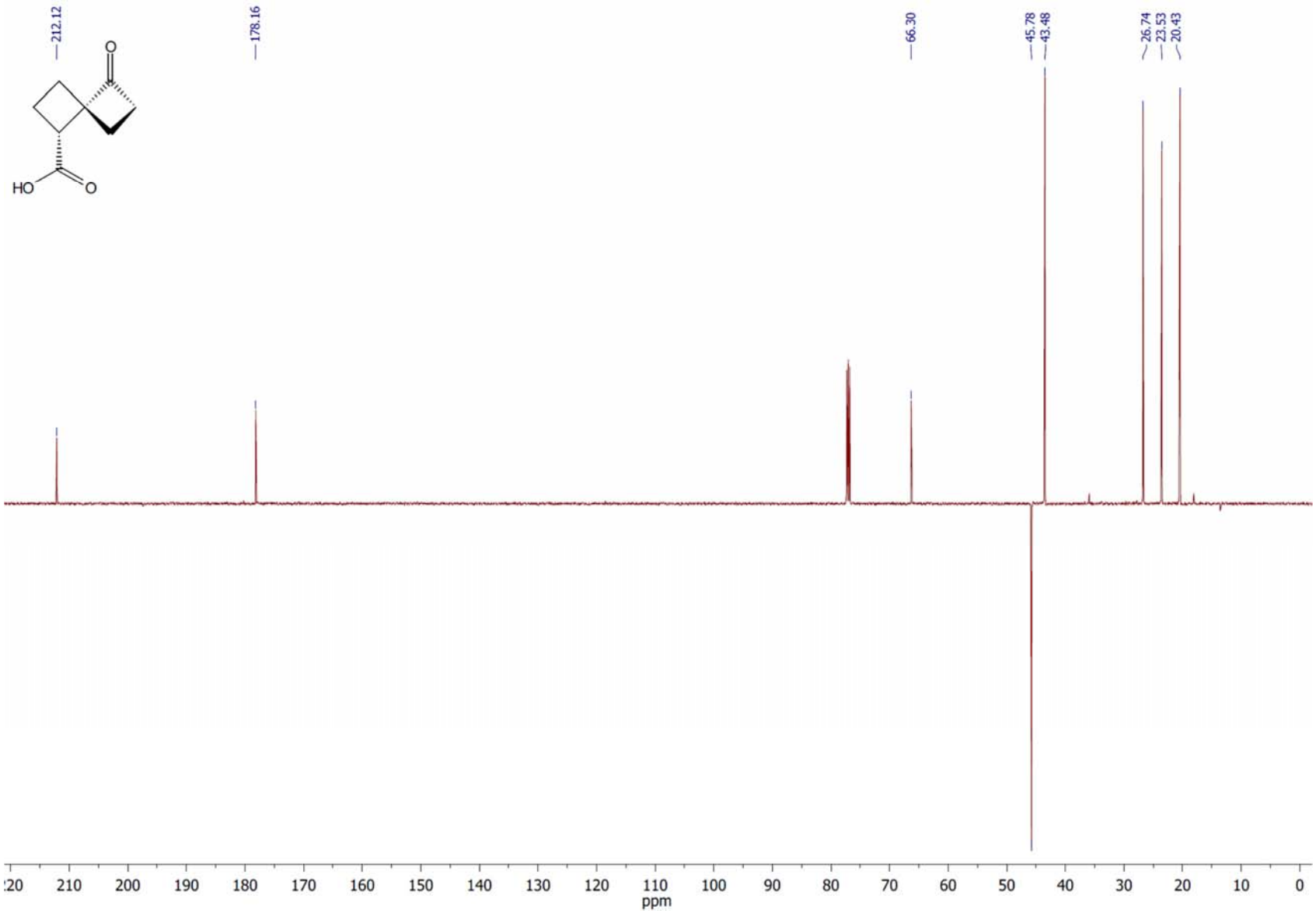
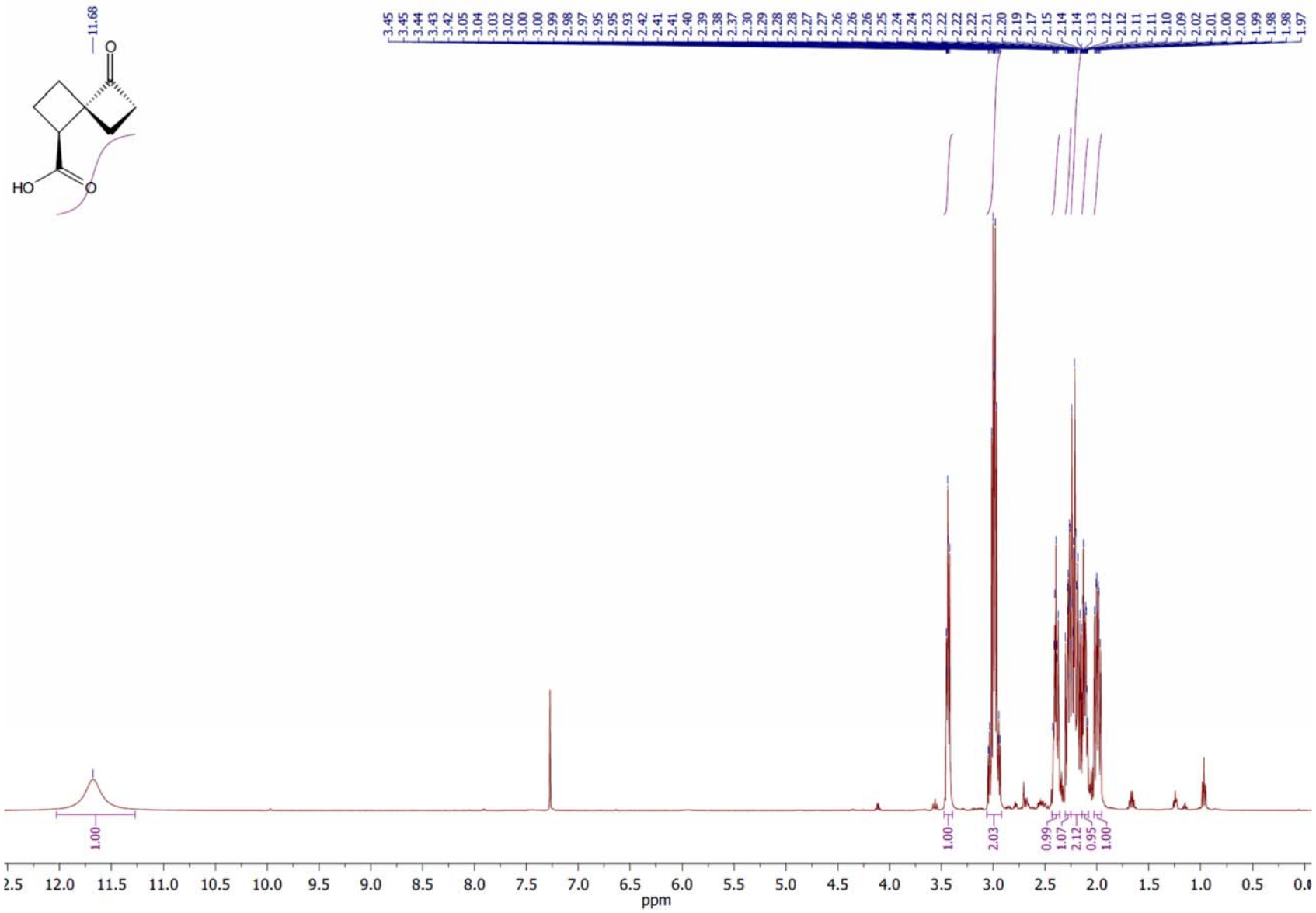
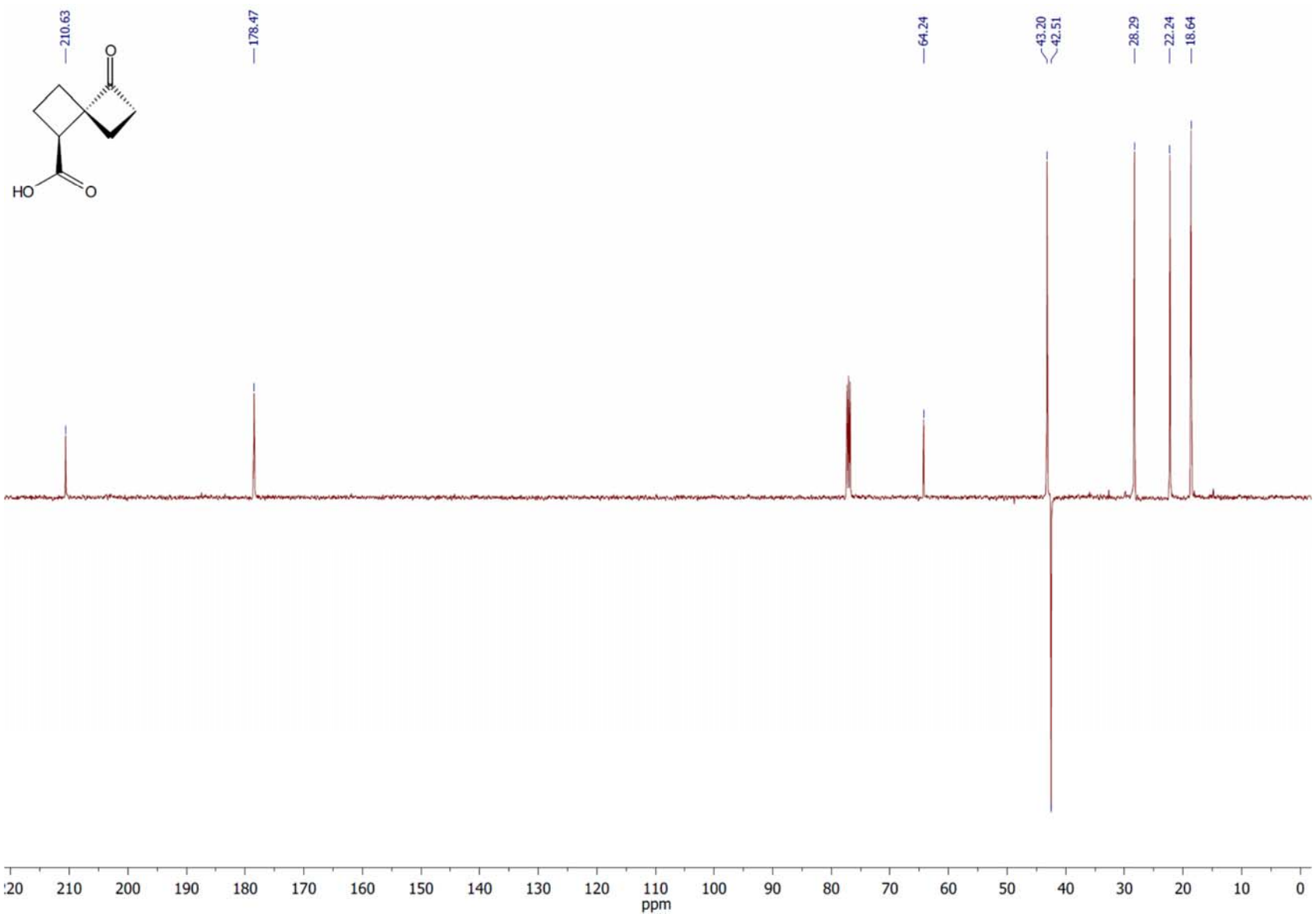


^{1}H NMR spectrum of compound **30b**



APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **30b**



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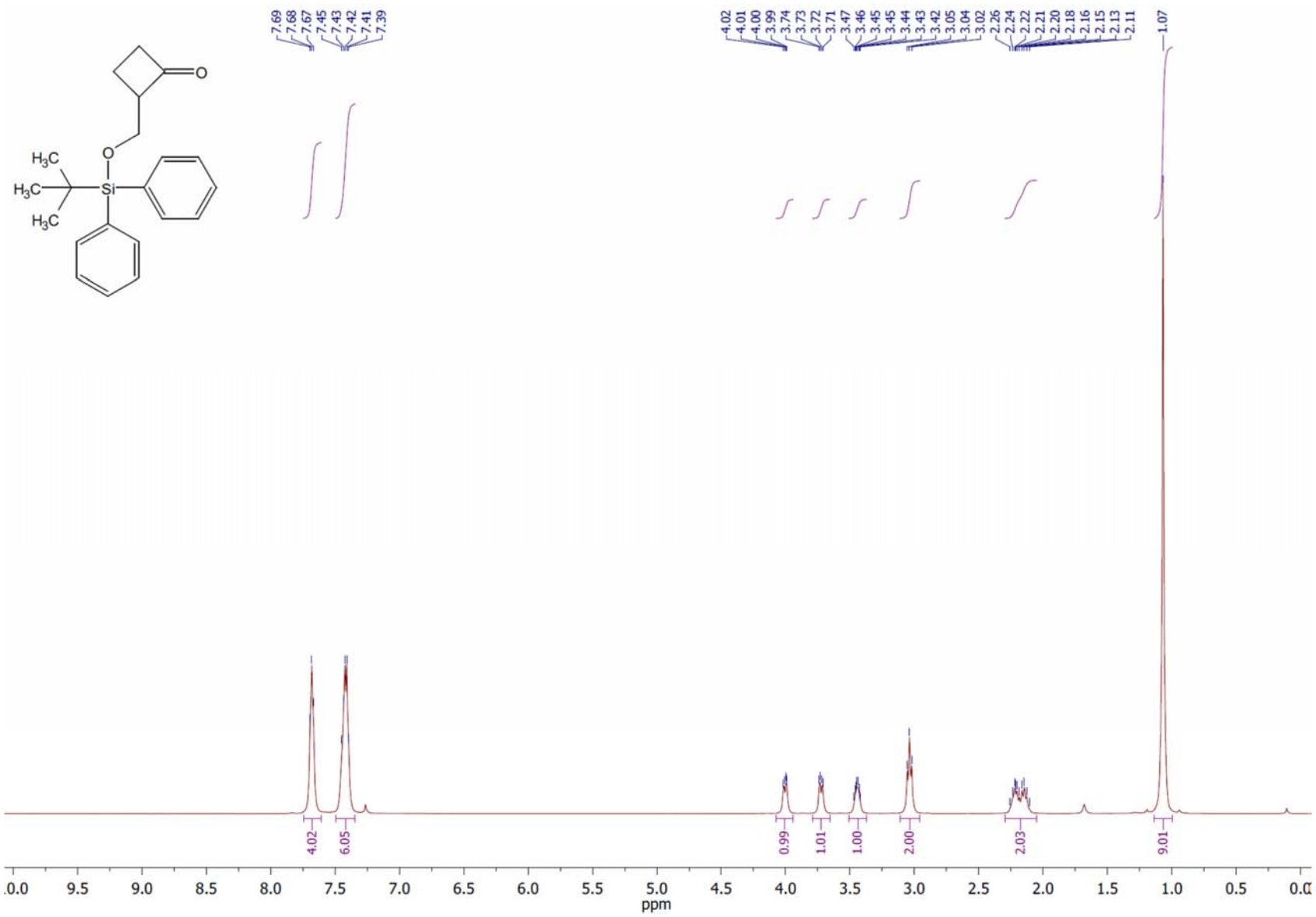
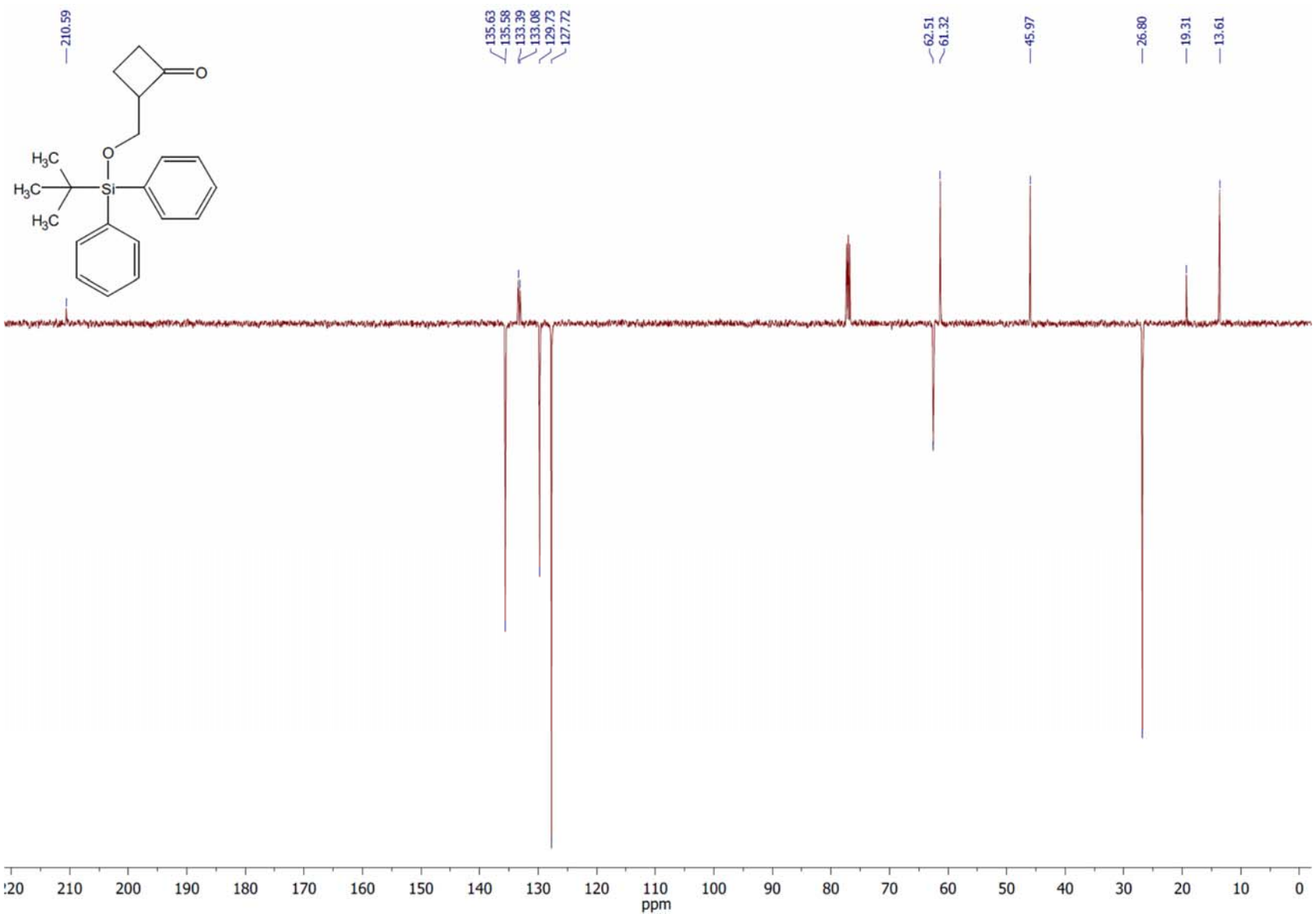


APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **38**



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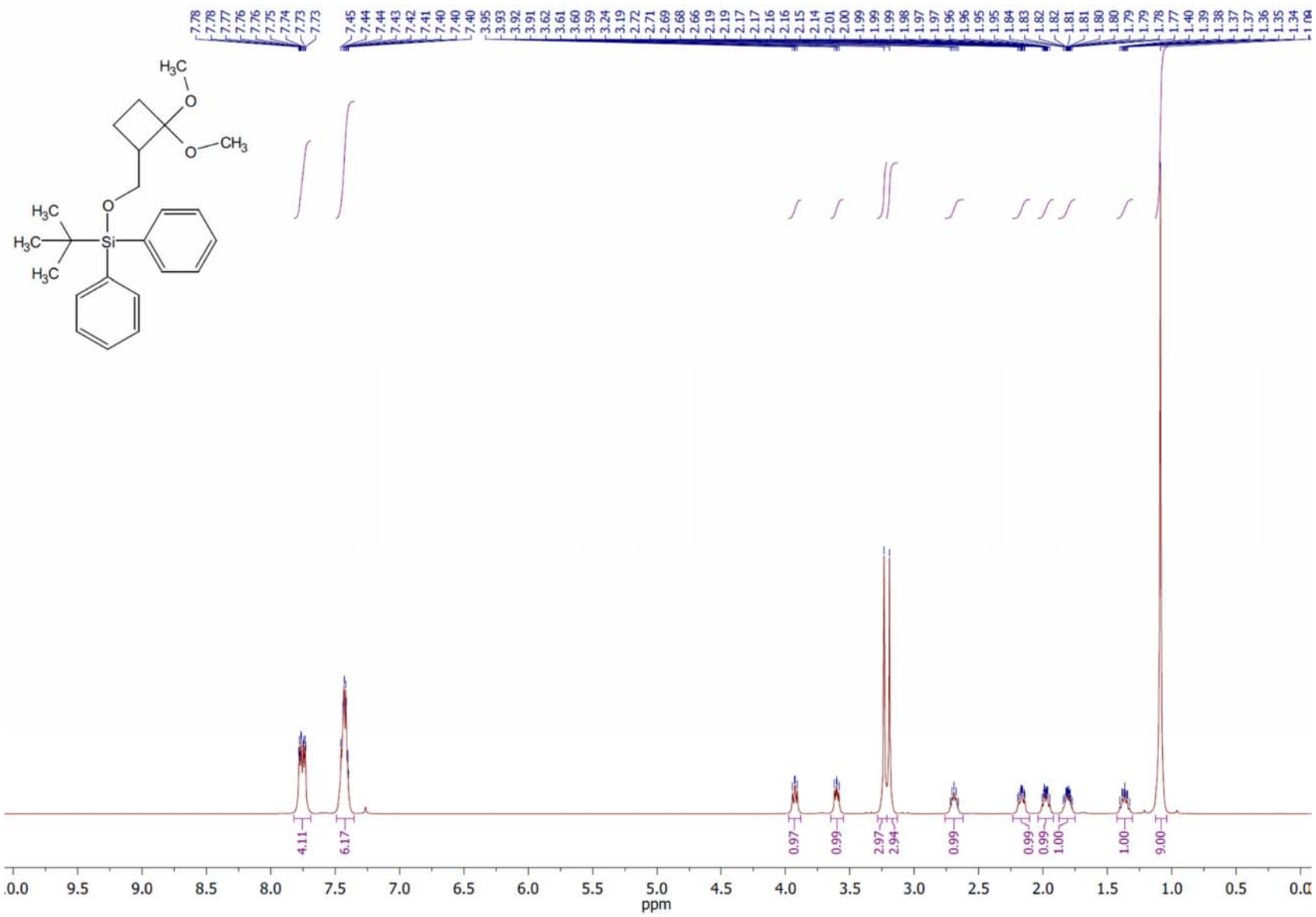

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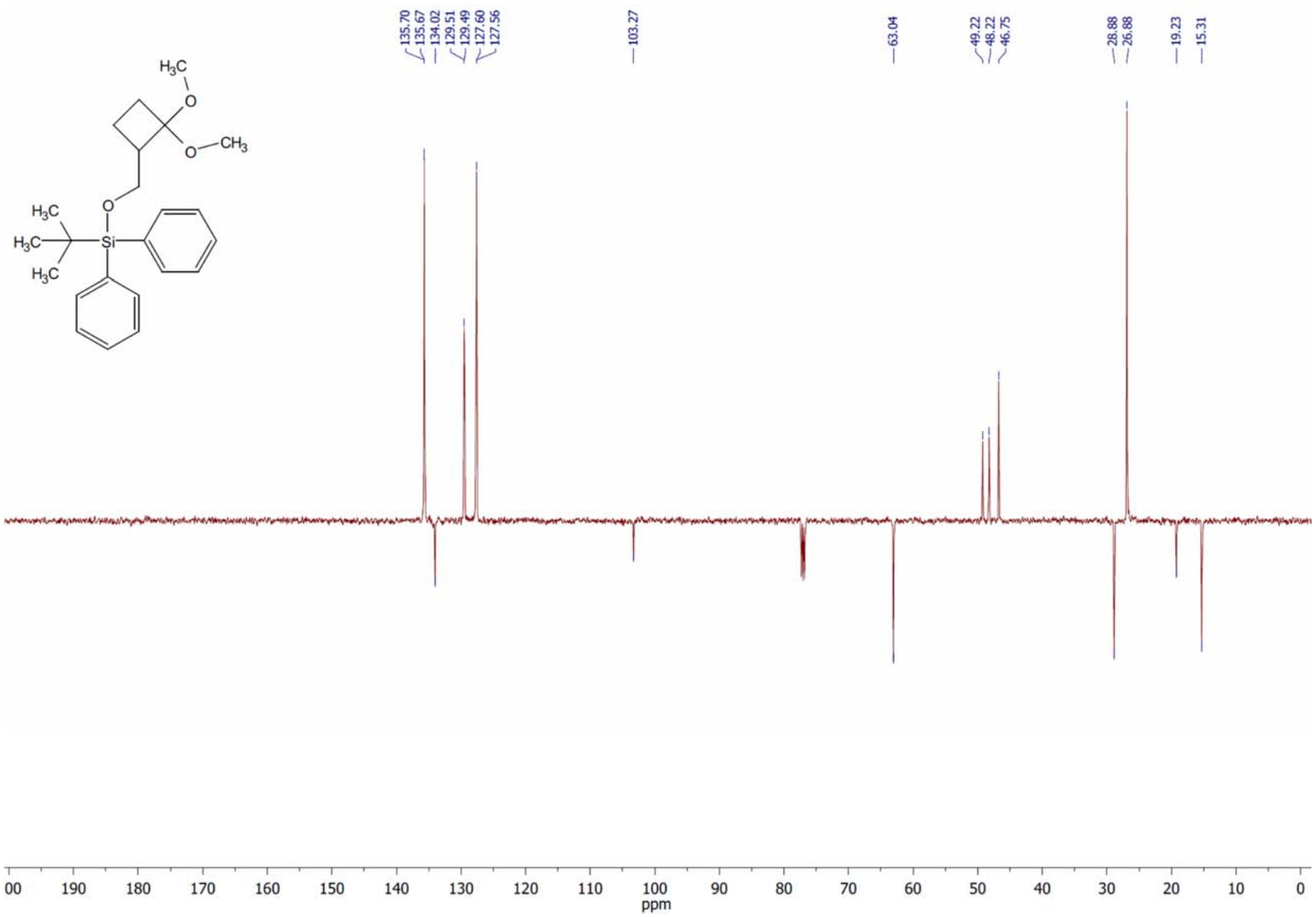

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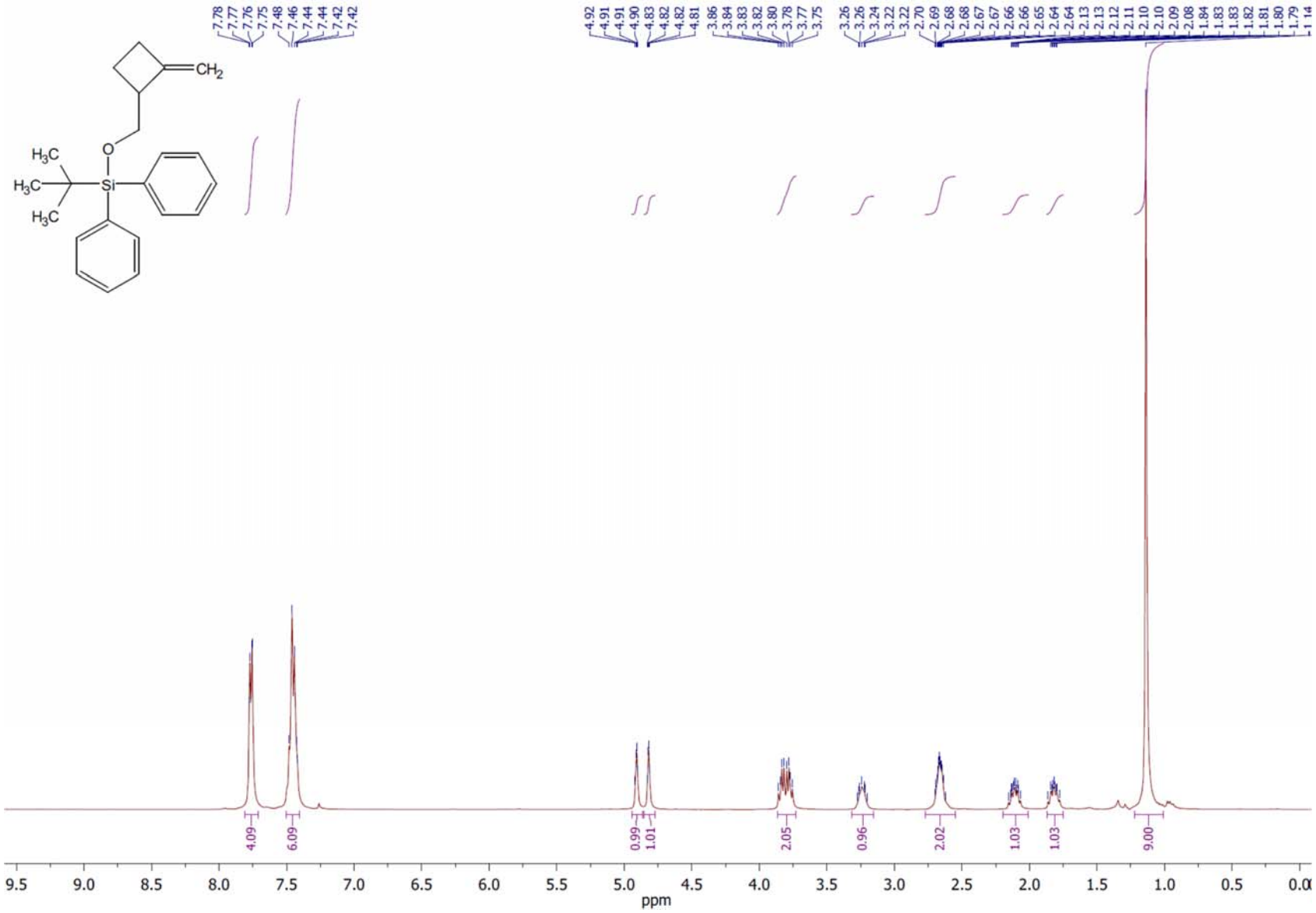

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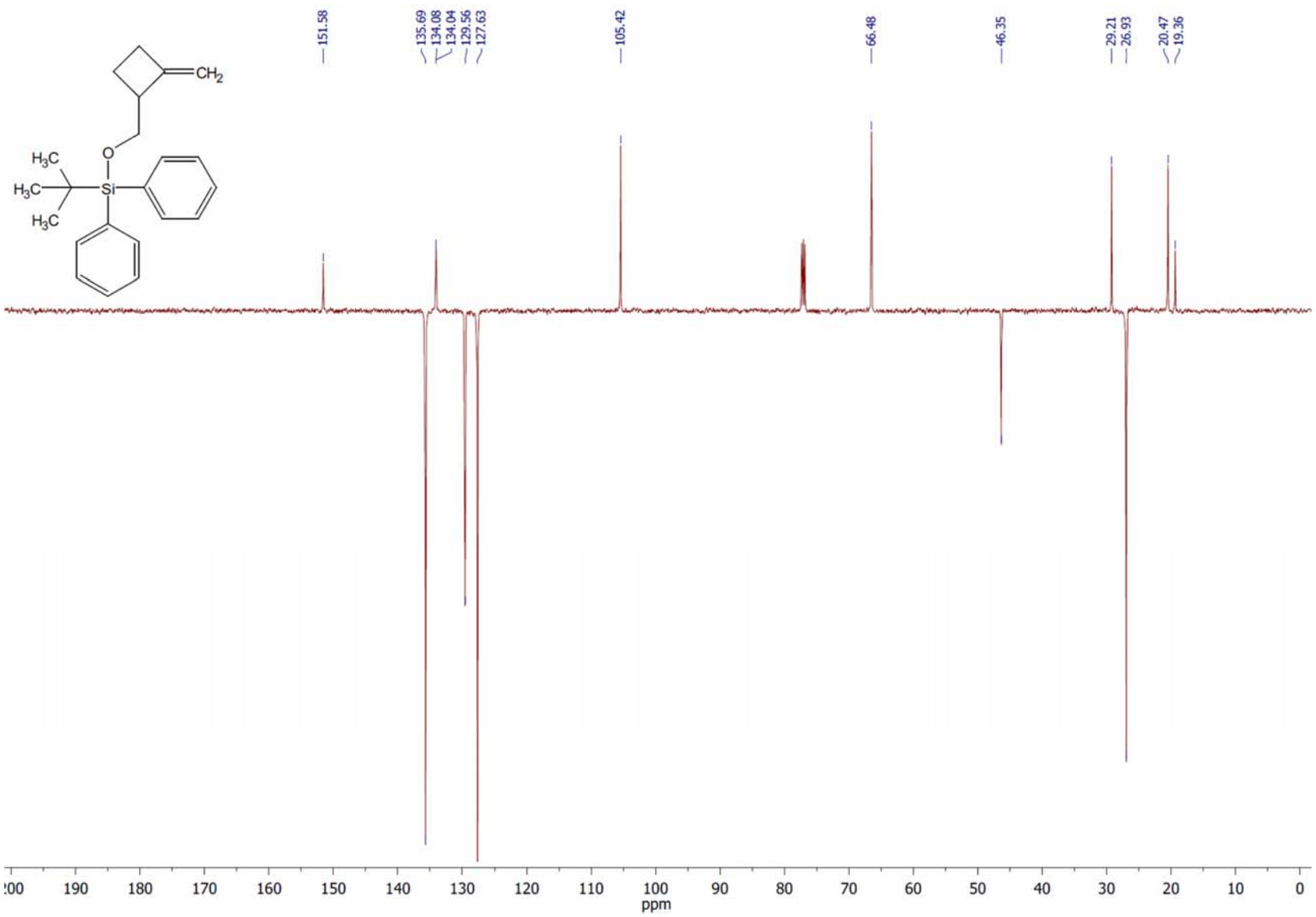

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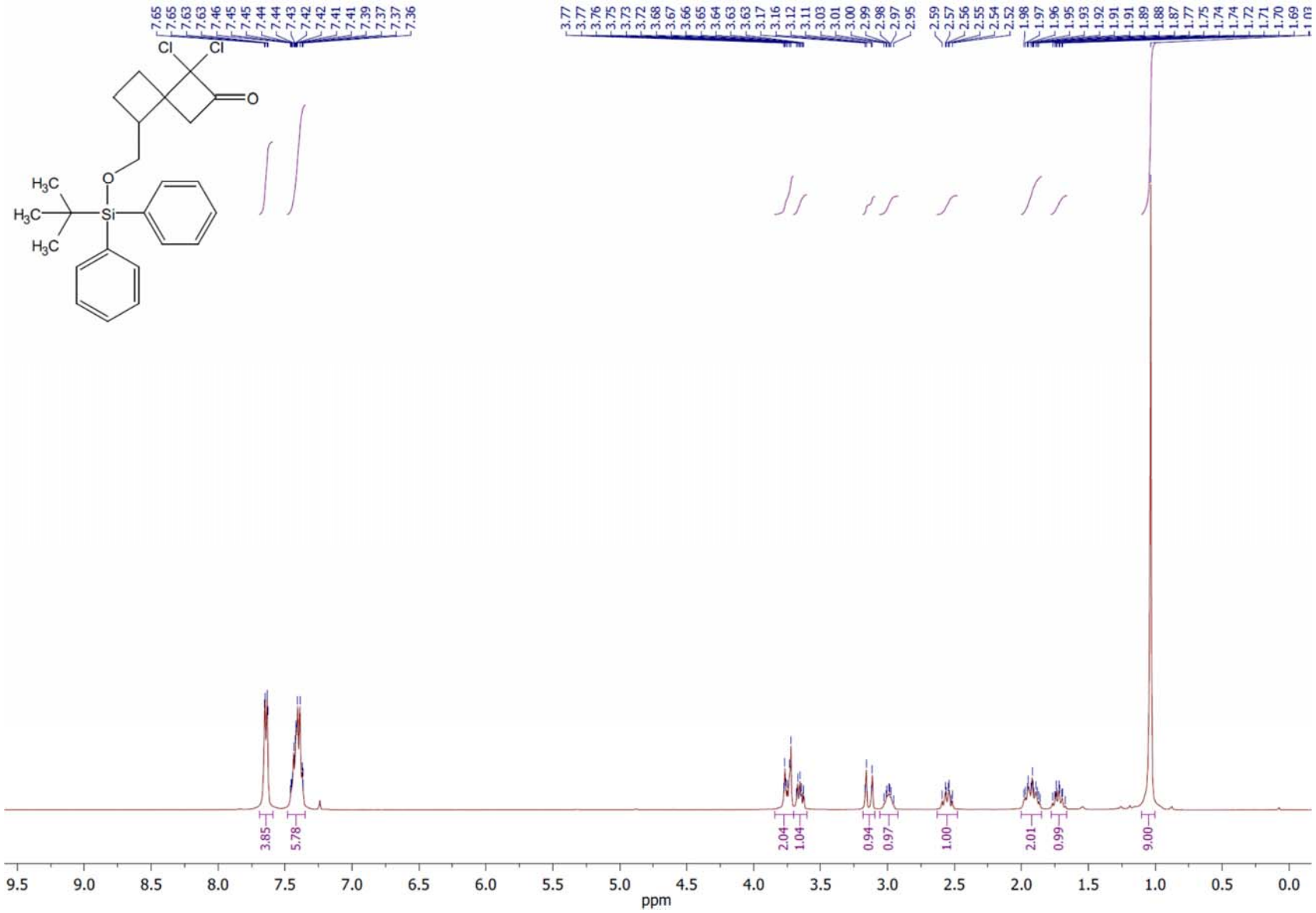

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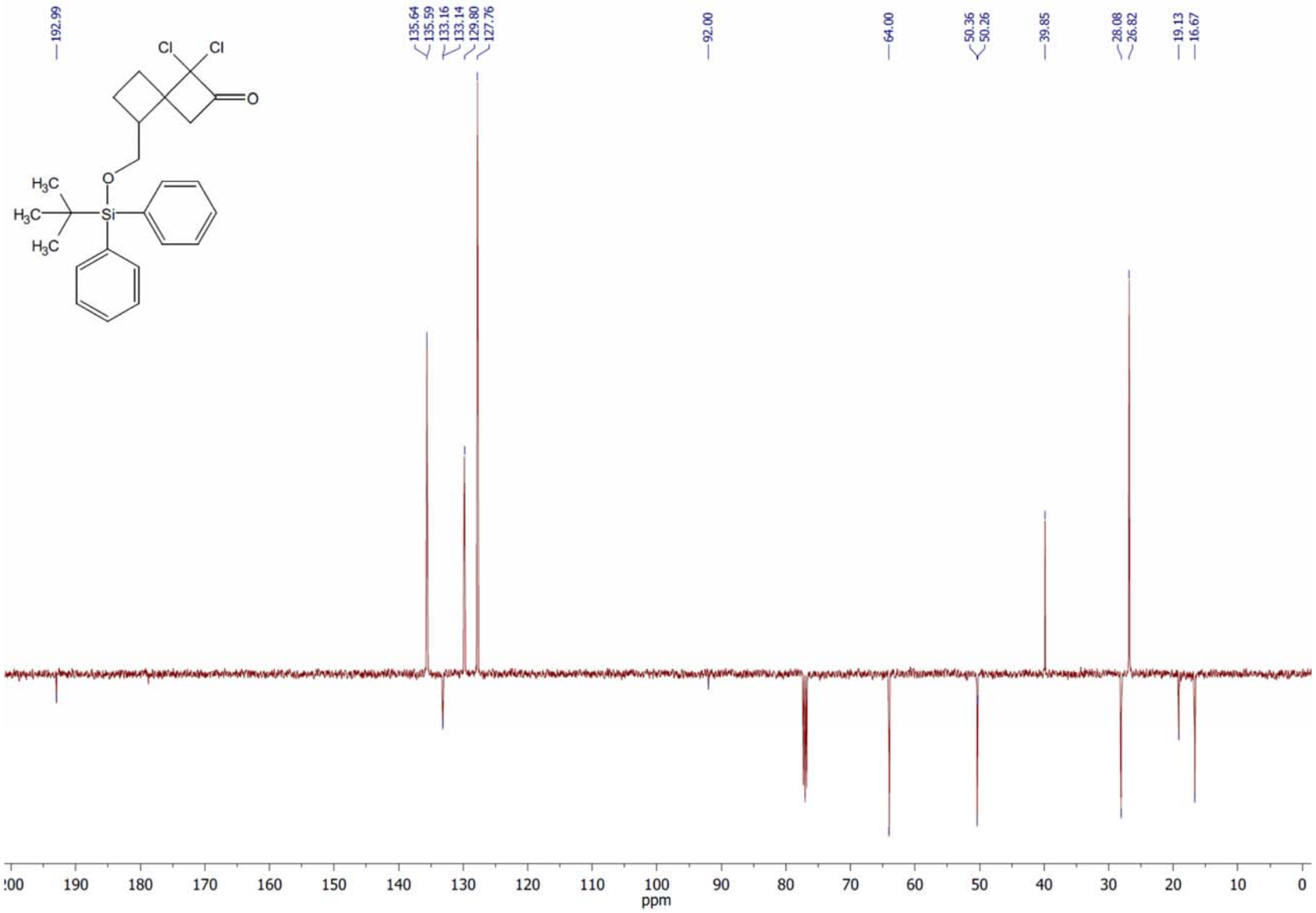

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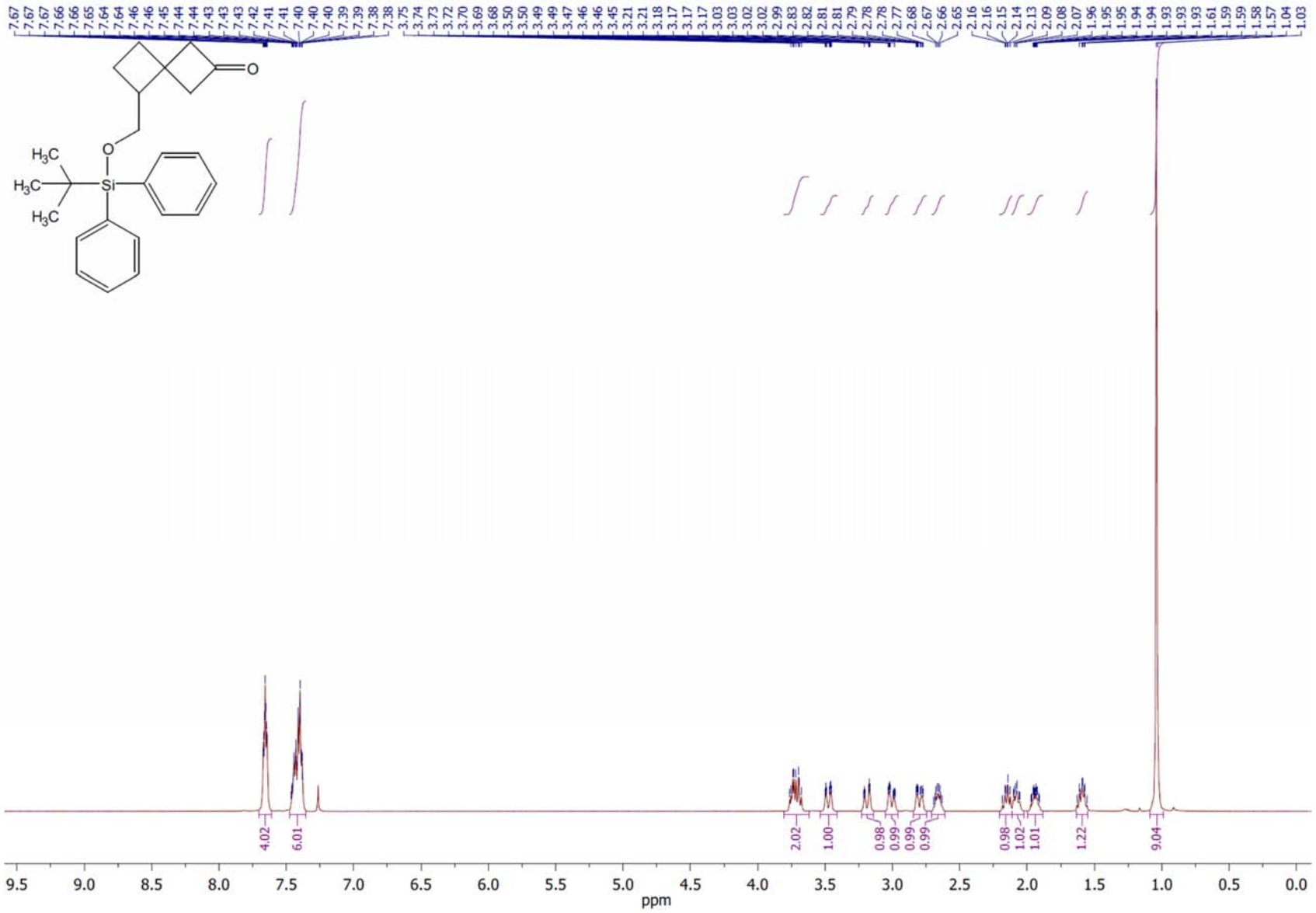
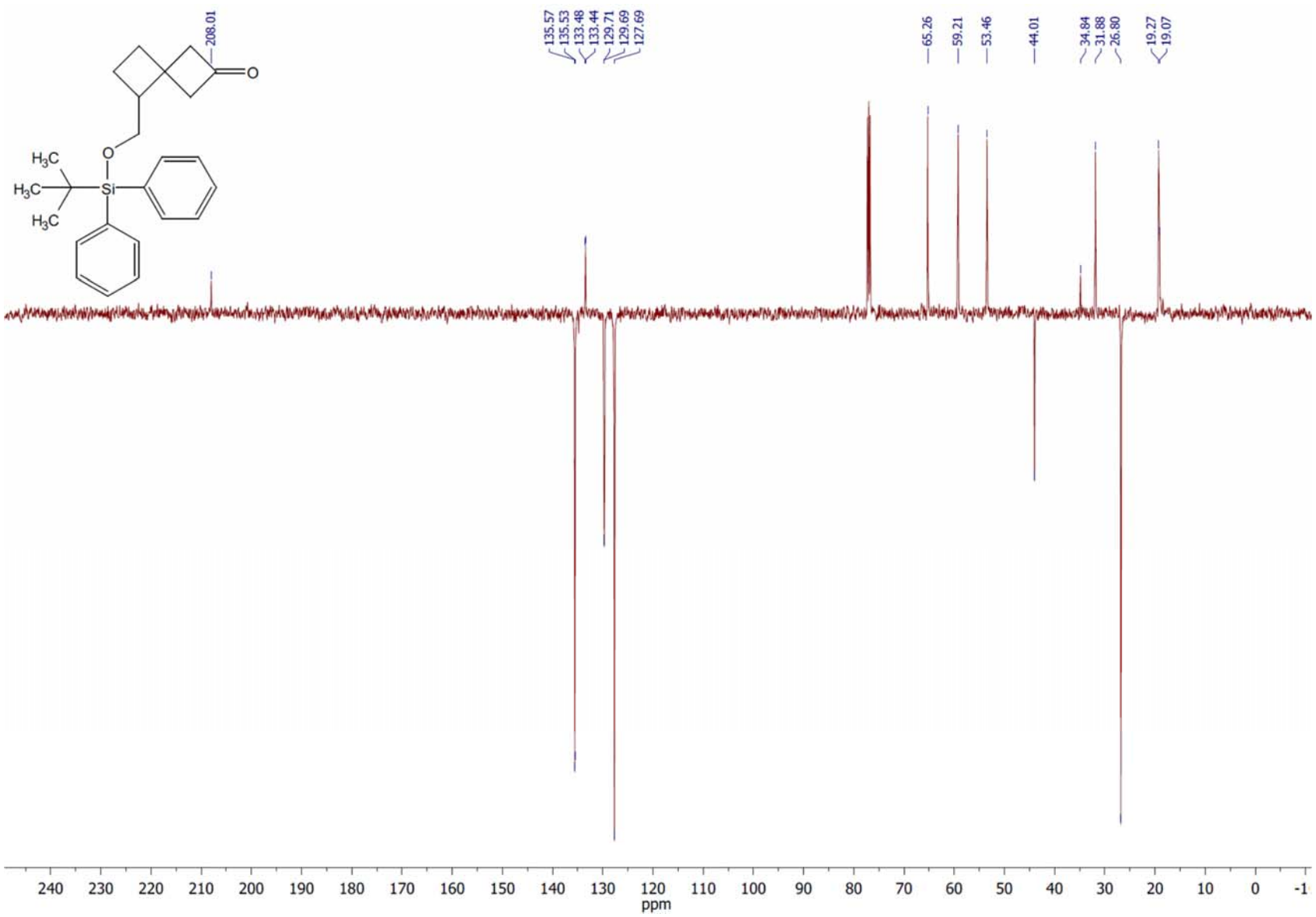


APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **42**



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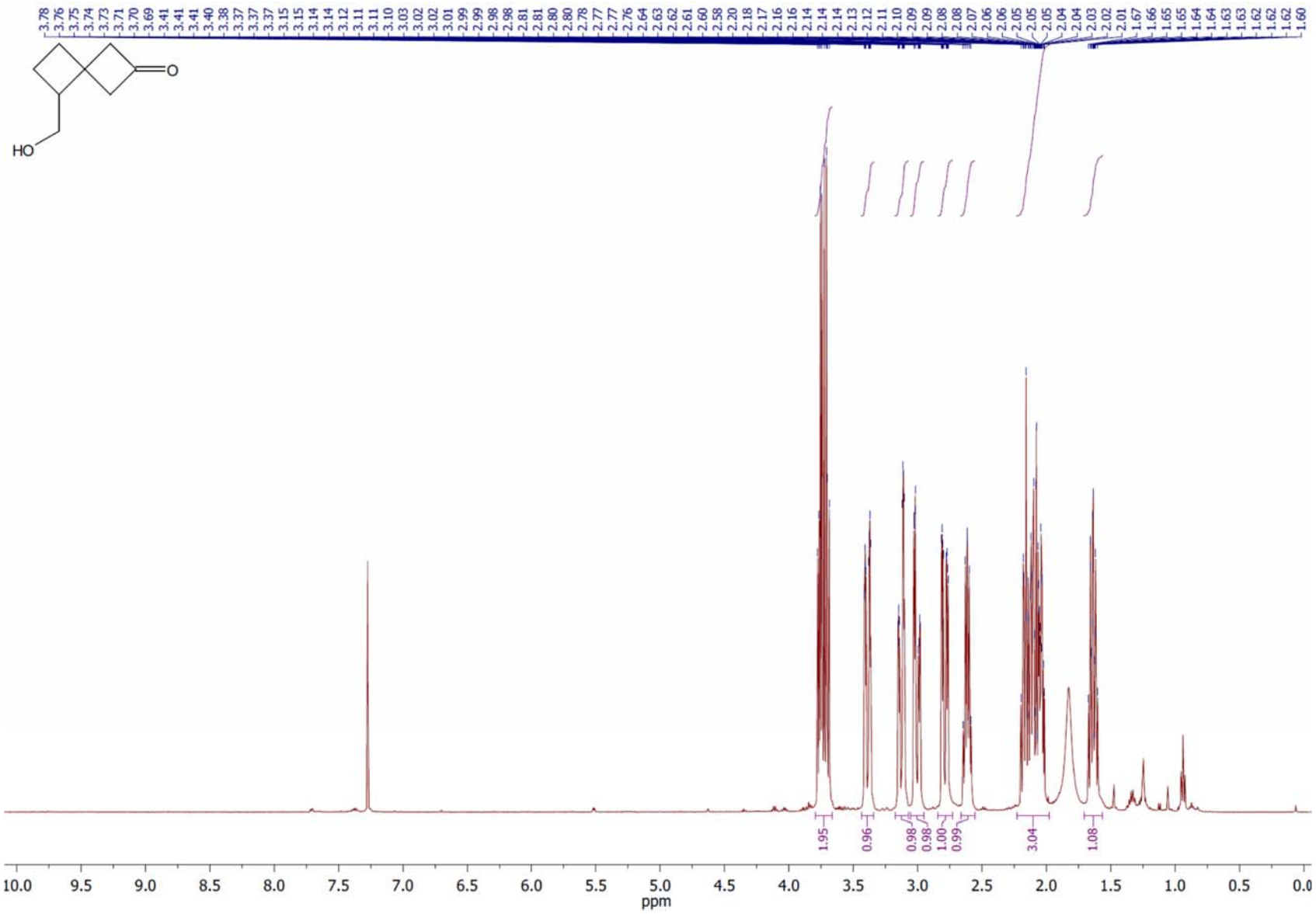

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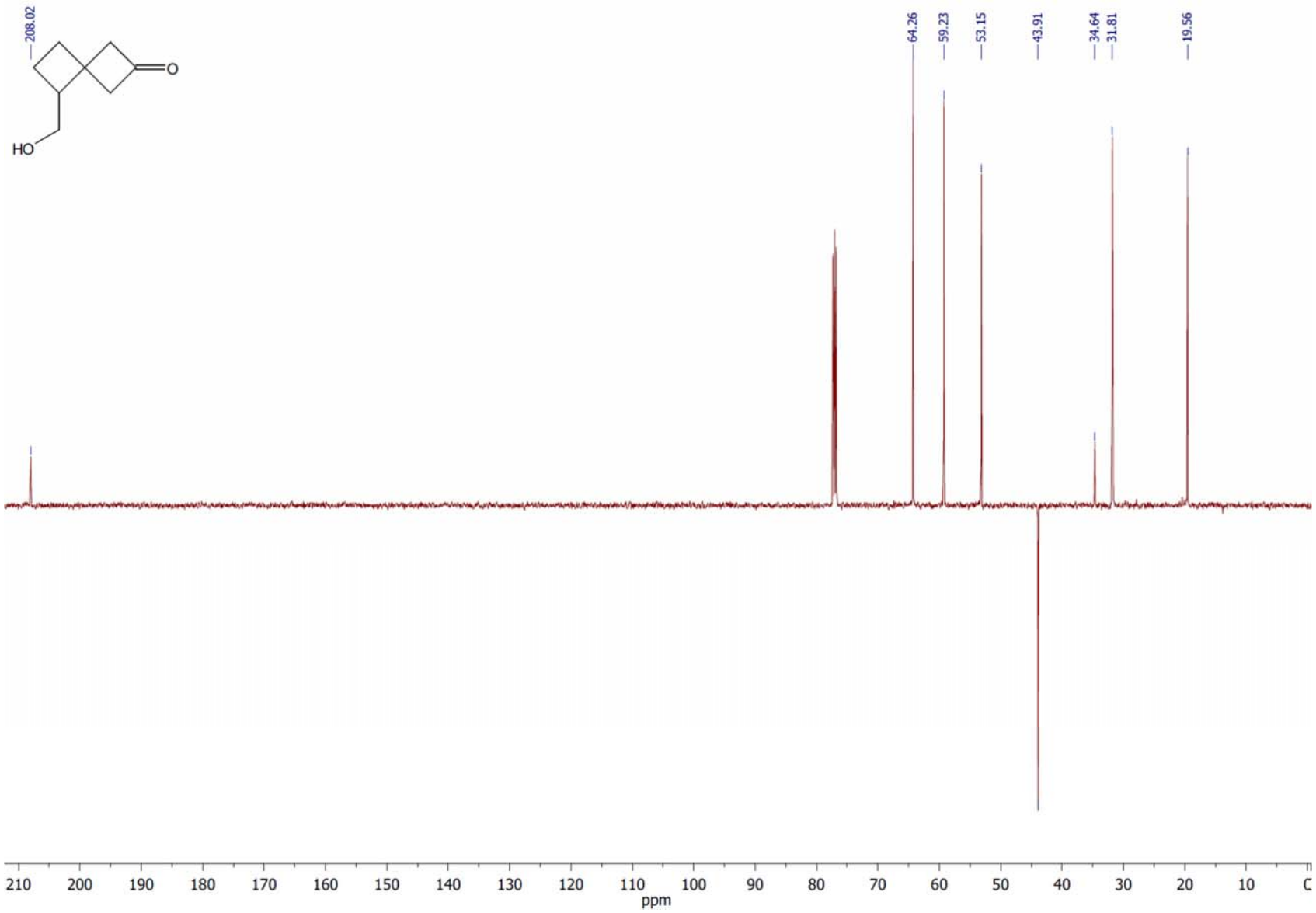

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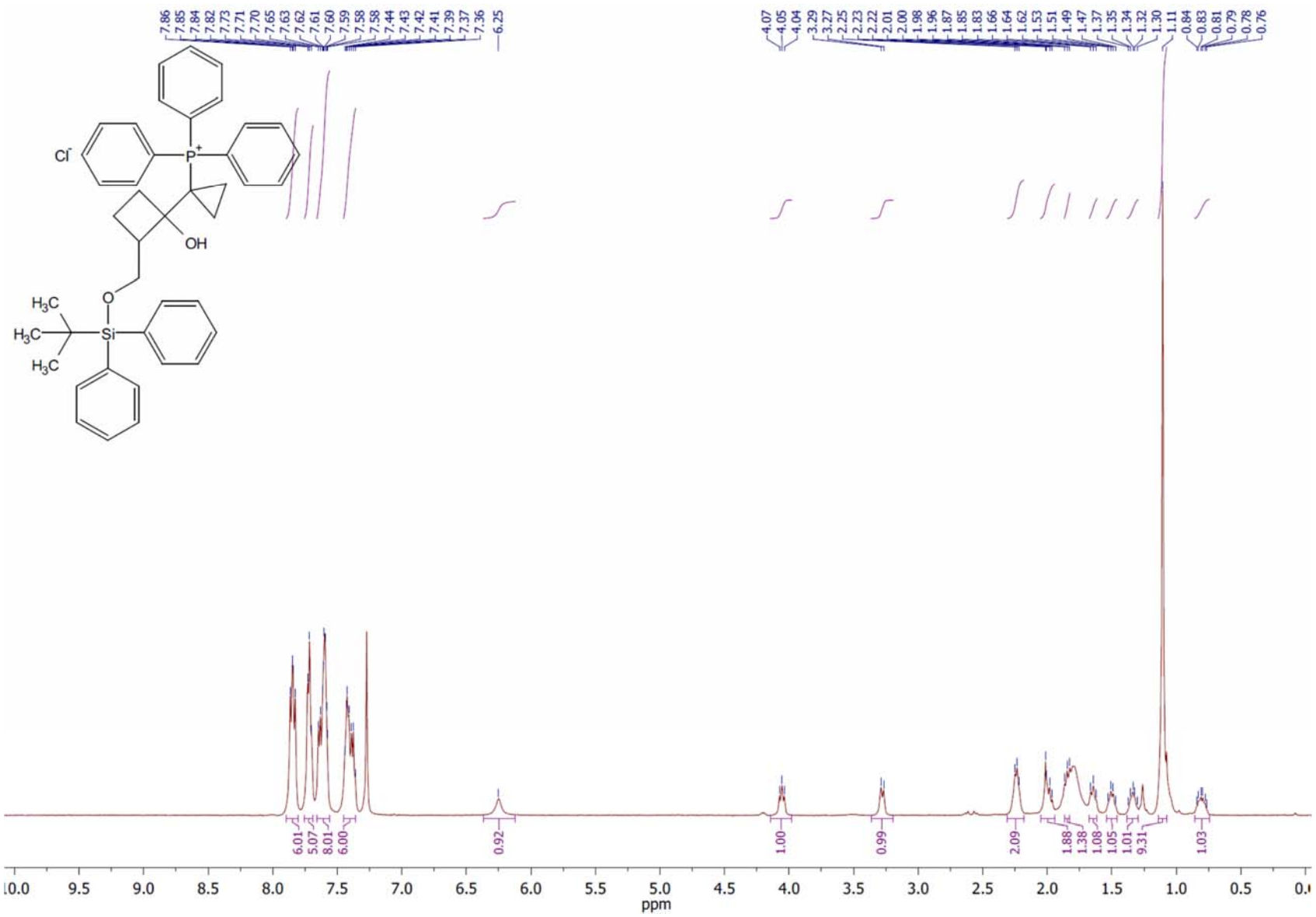
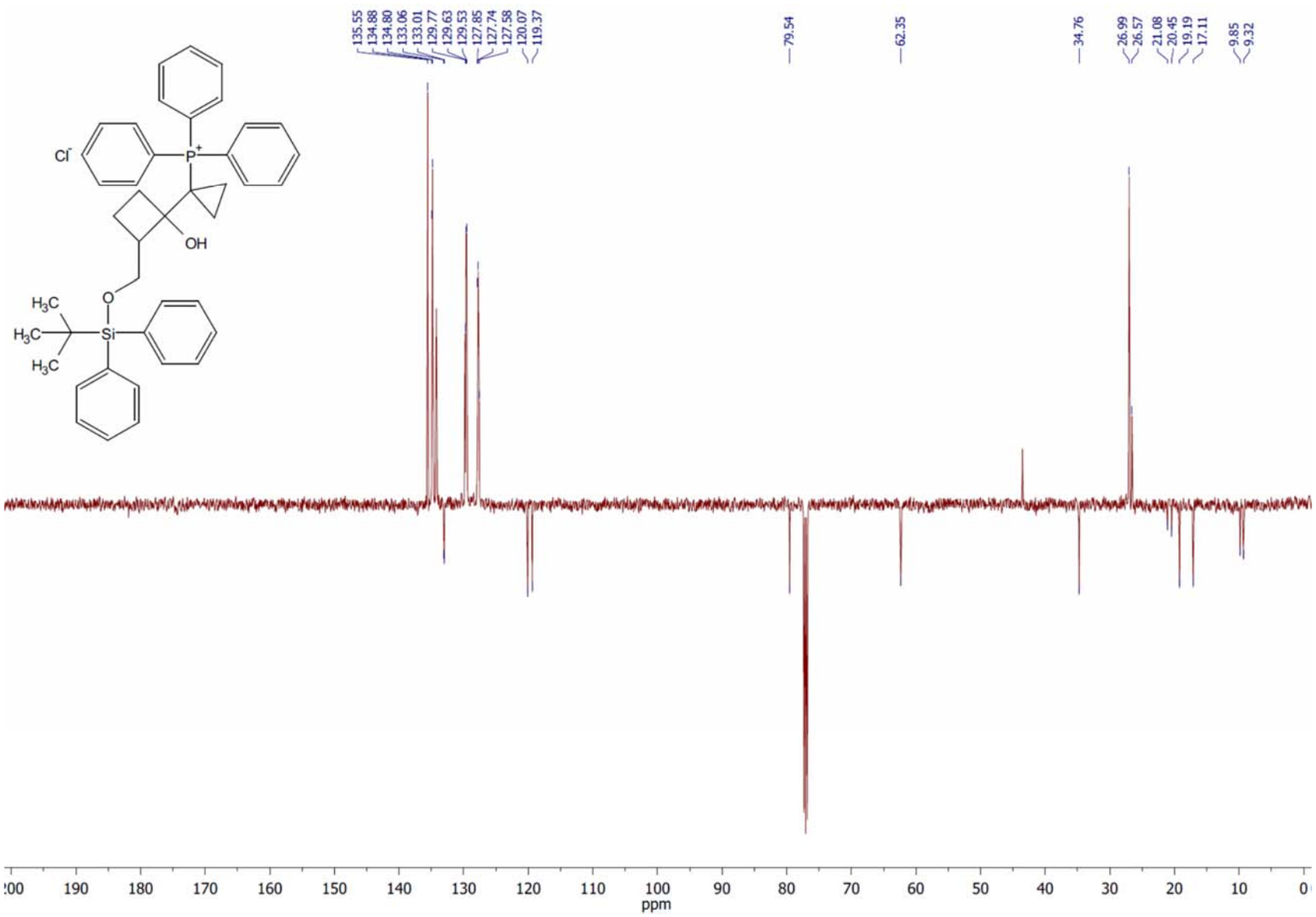


APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **45**



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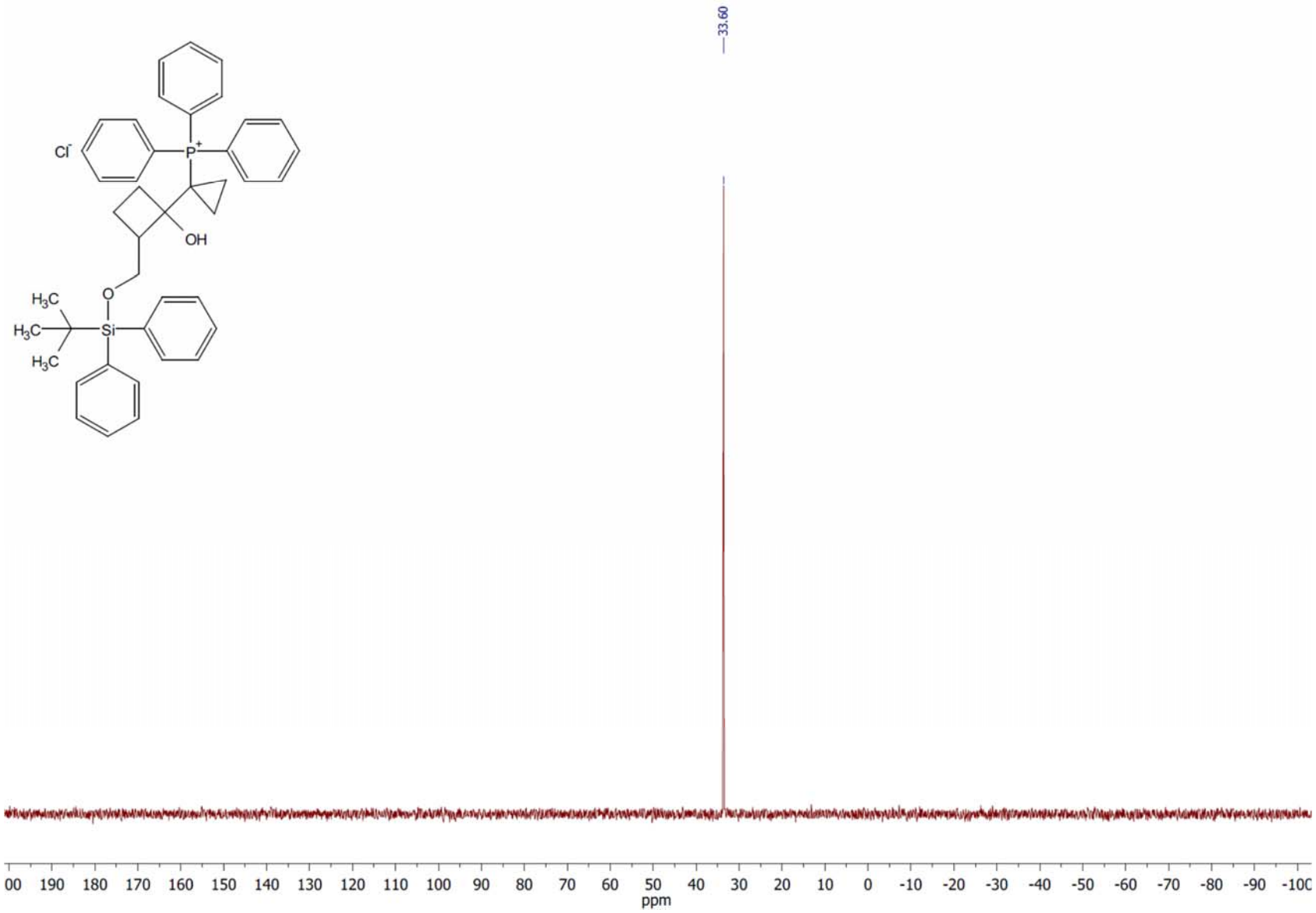
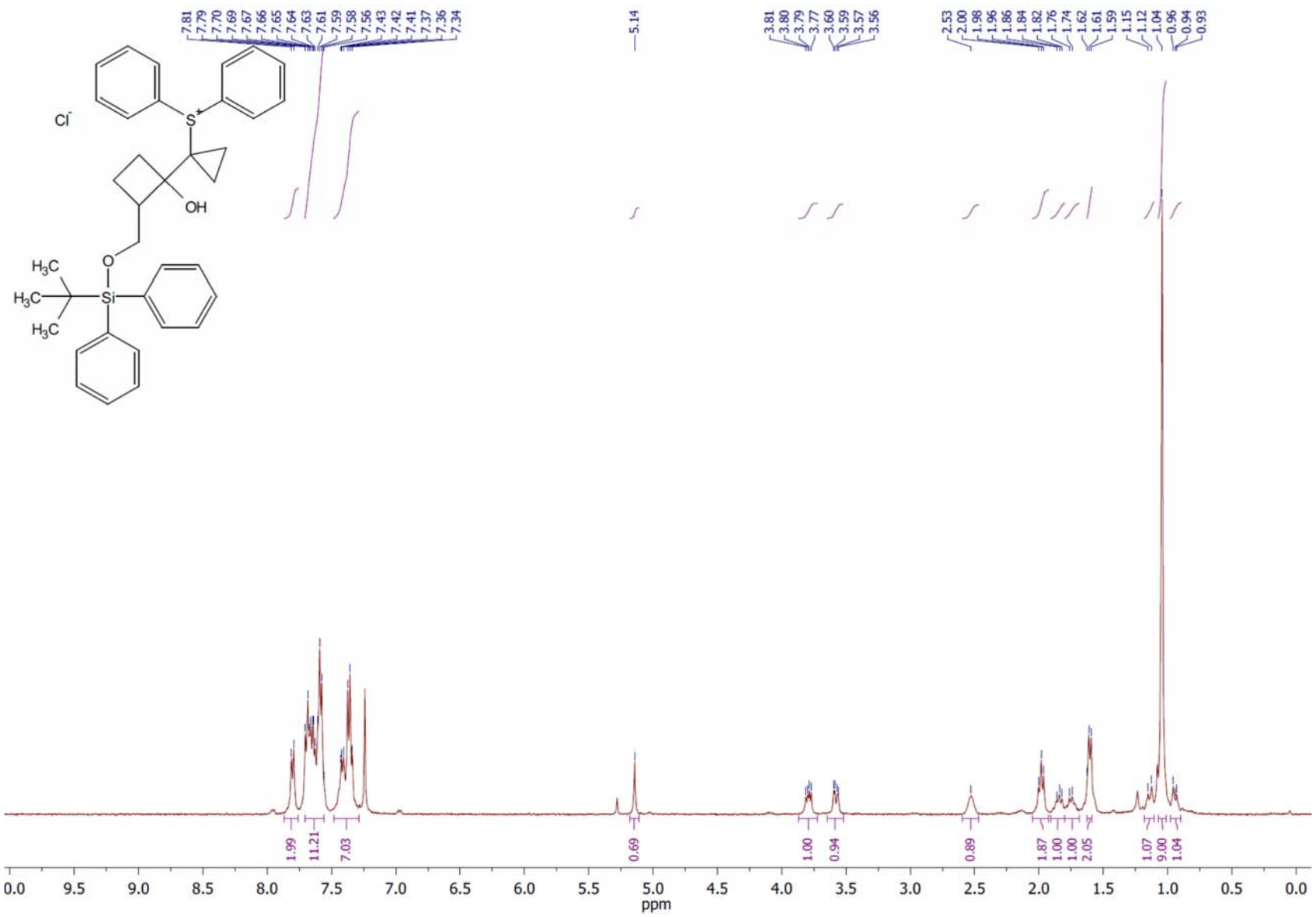
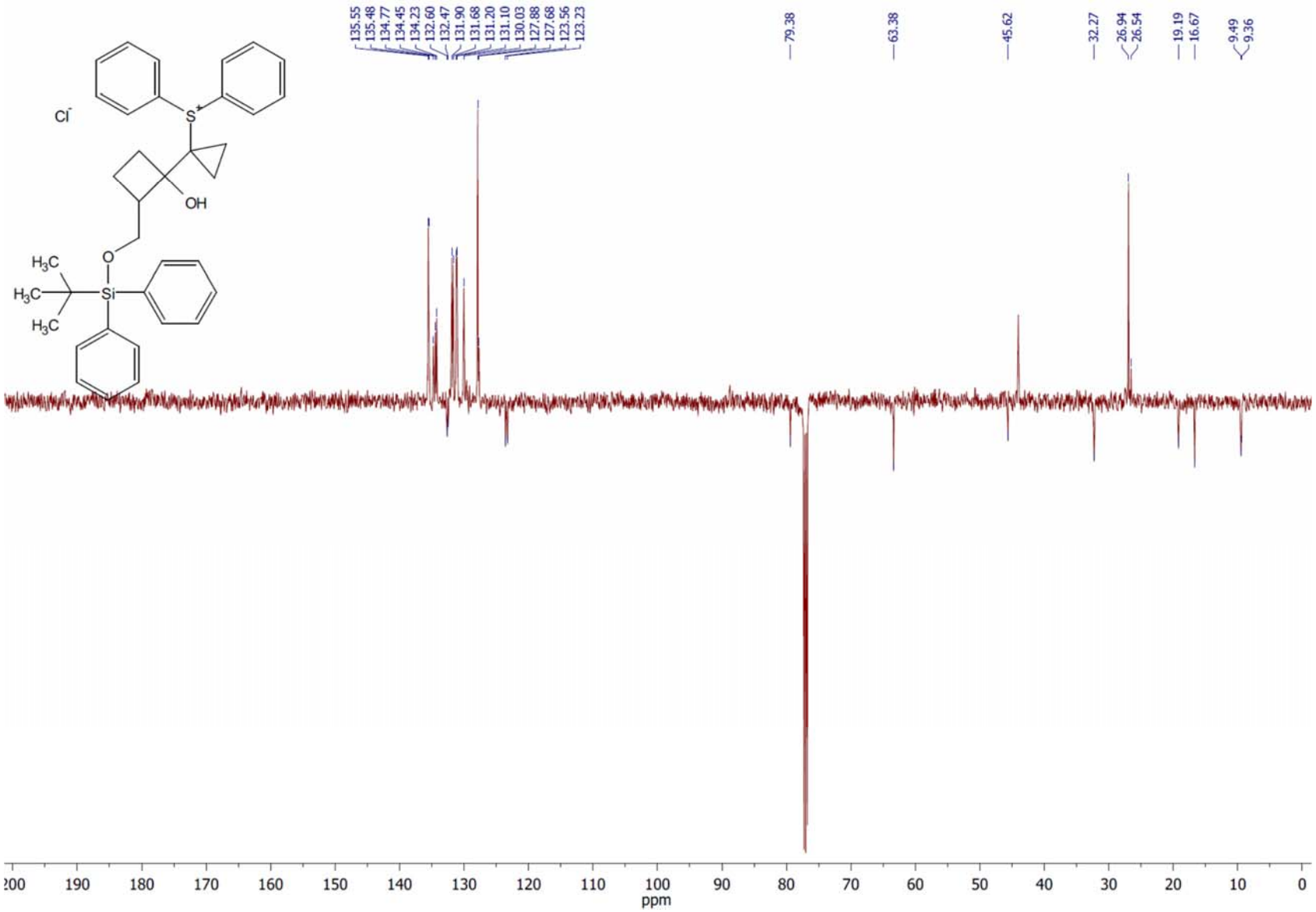


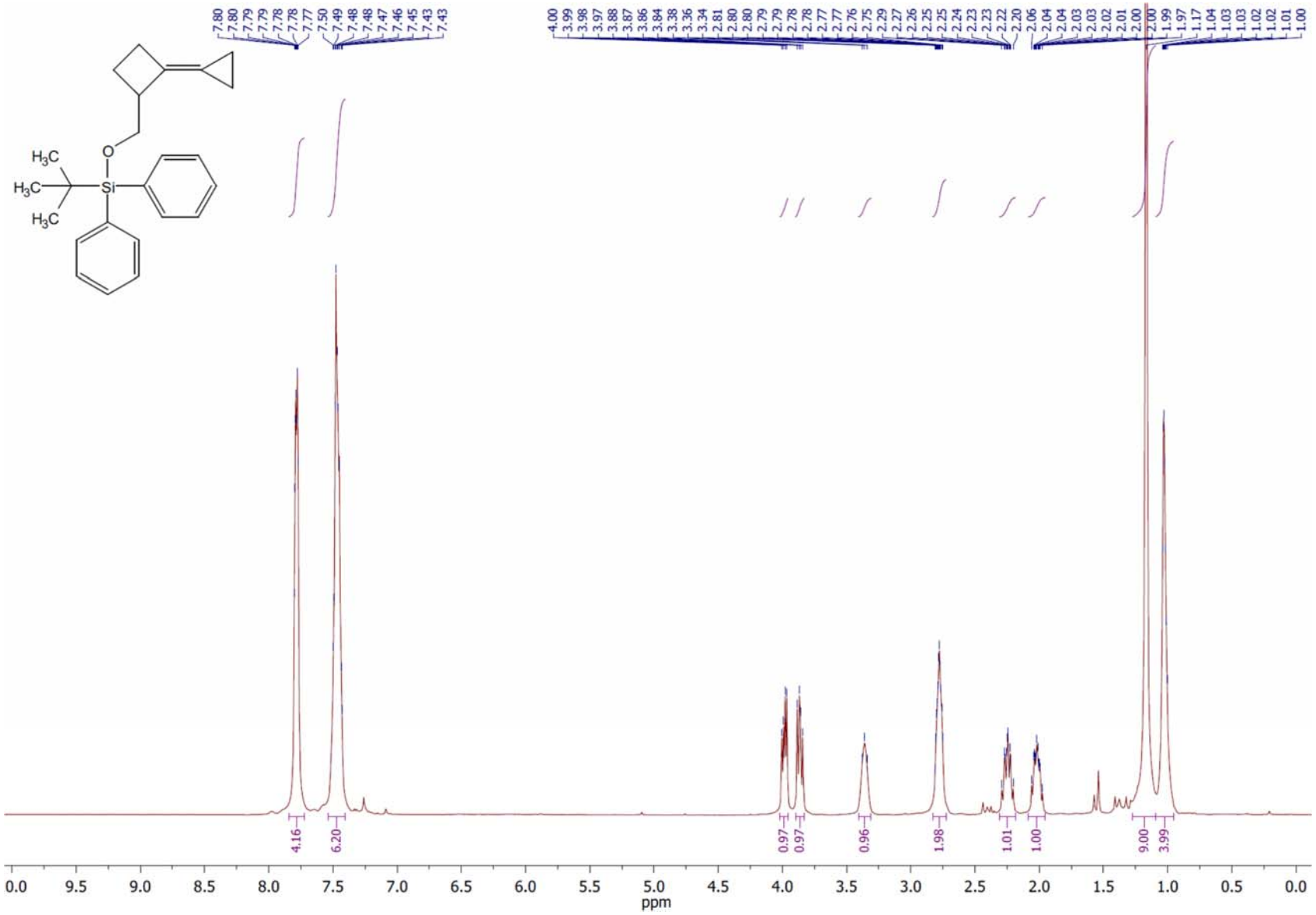
^{1}H NMR spectrum of compound **46**



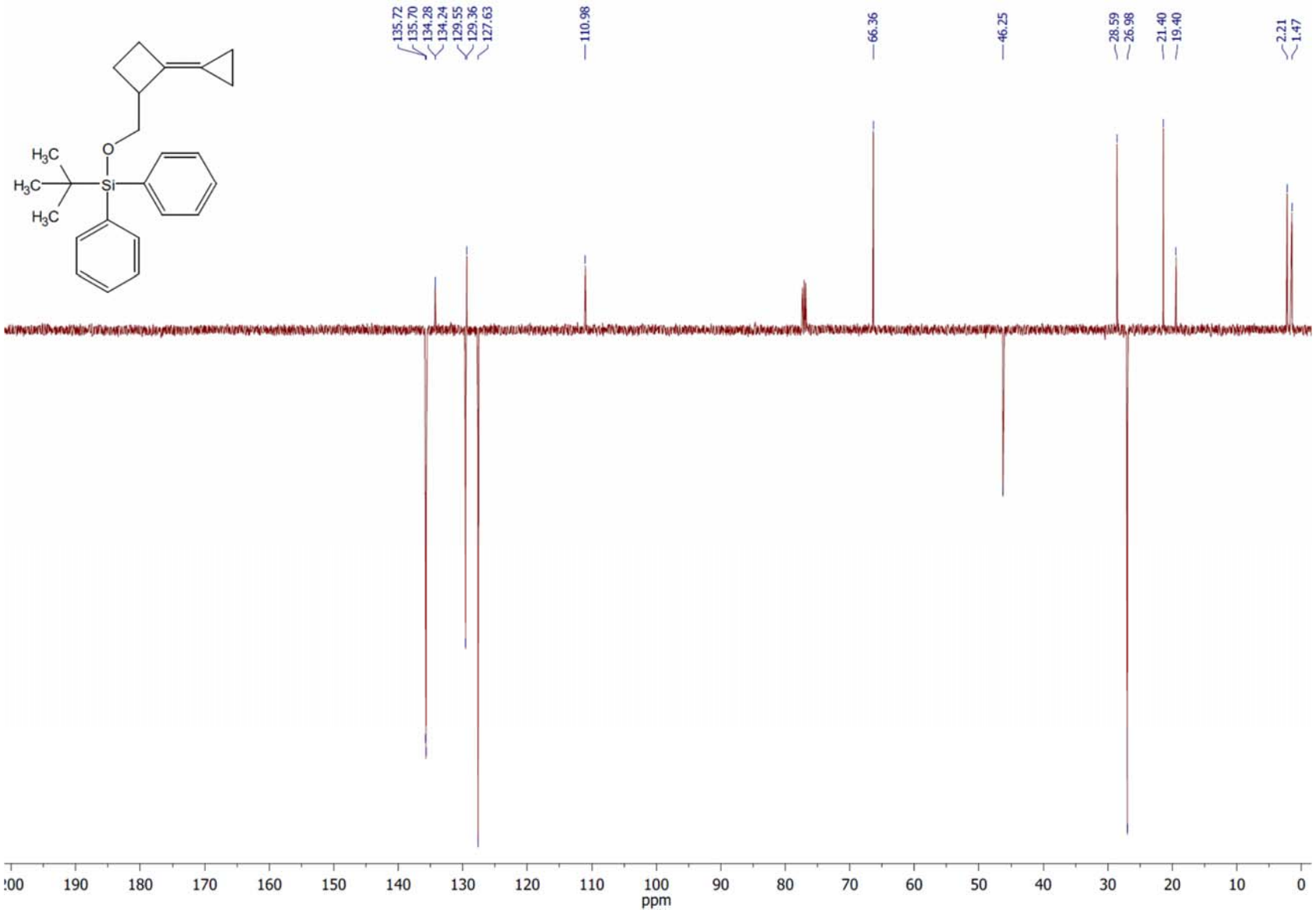
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **46**



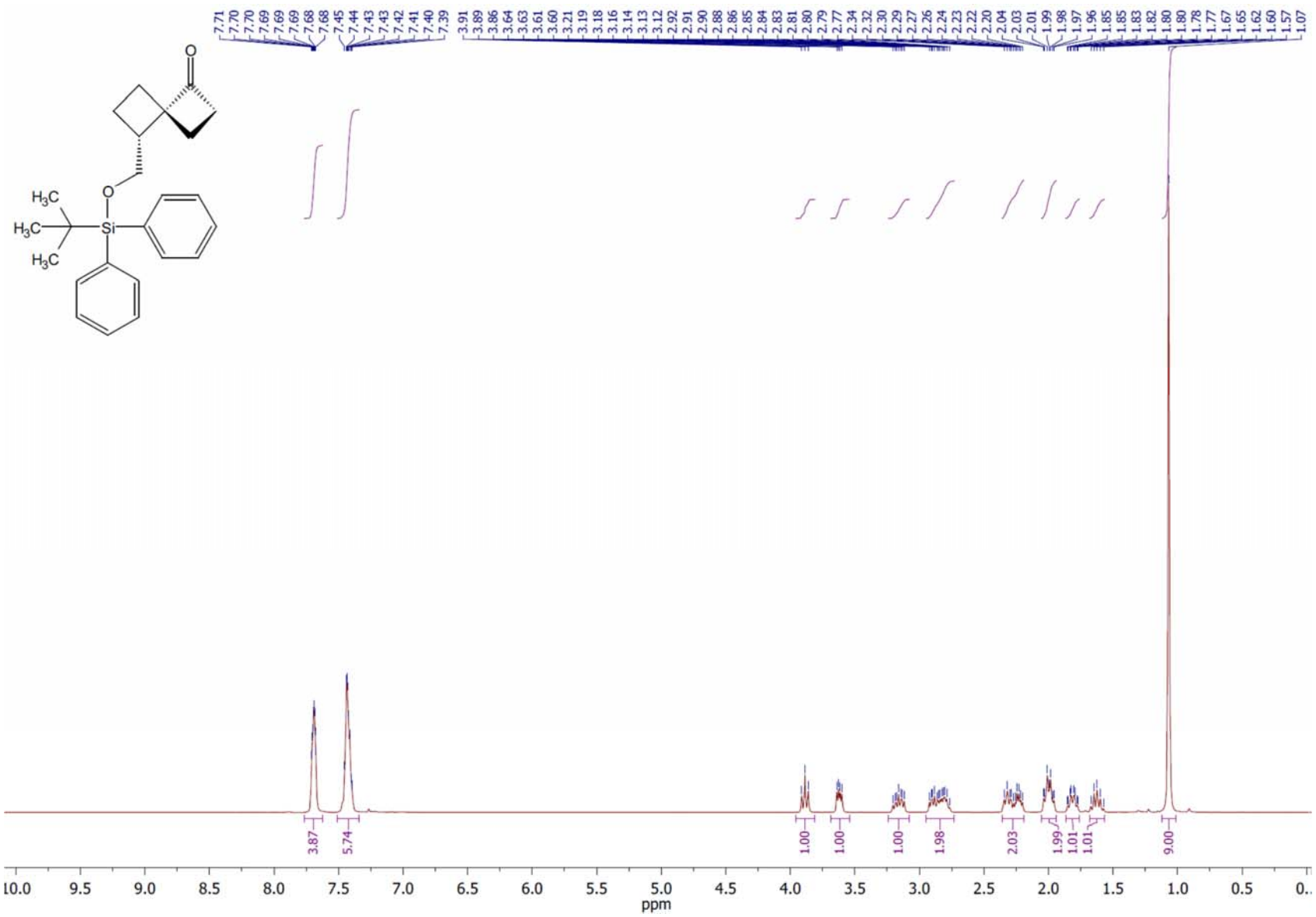
^{1}H NMR spectrum of compound **47**



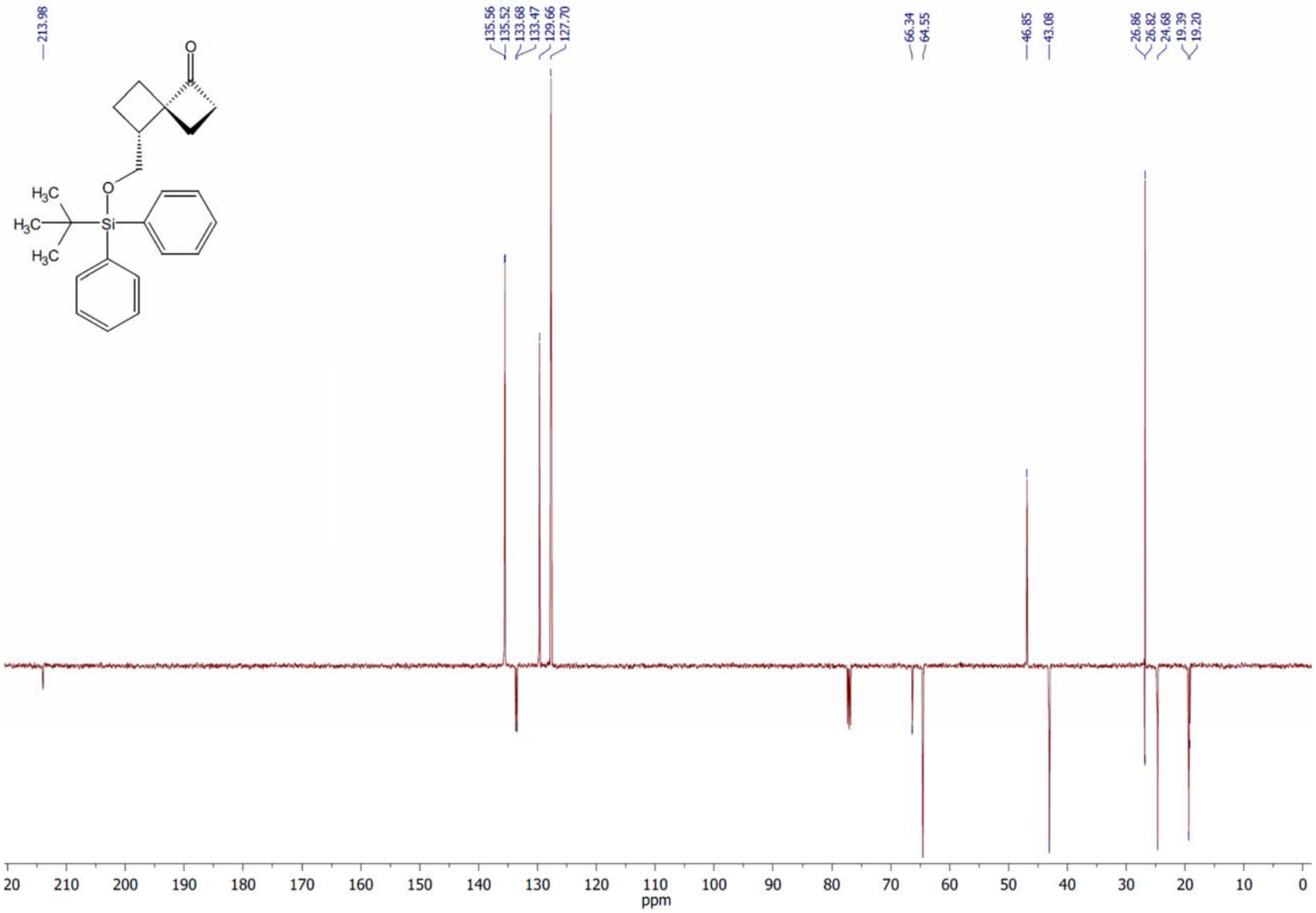
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **47**



^{1}H NMR spectrum of compound **48a**



APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **48a**



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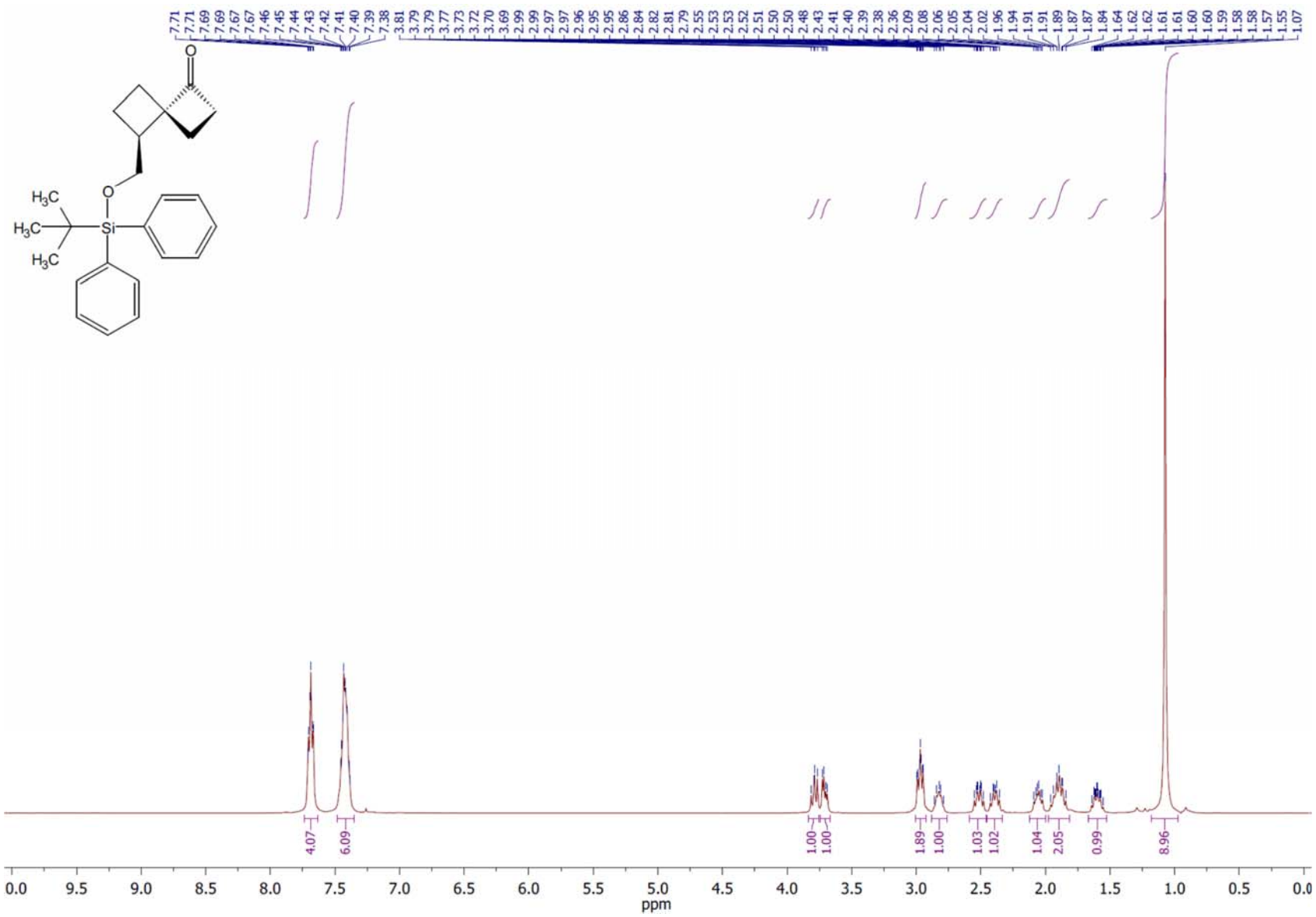
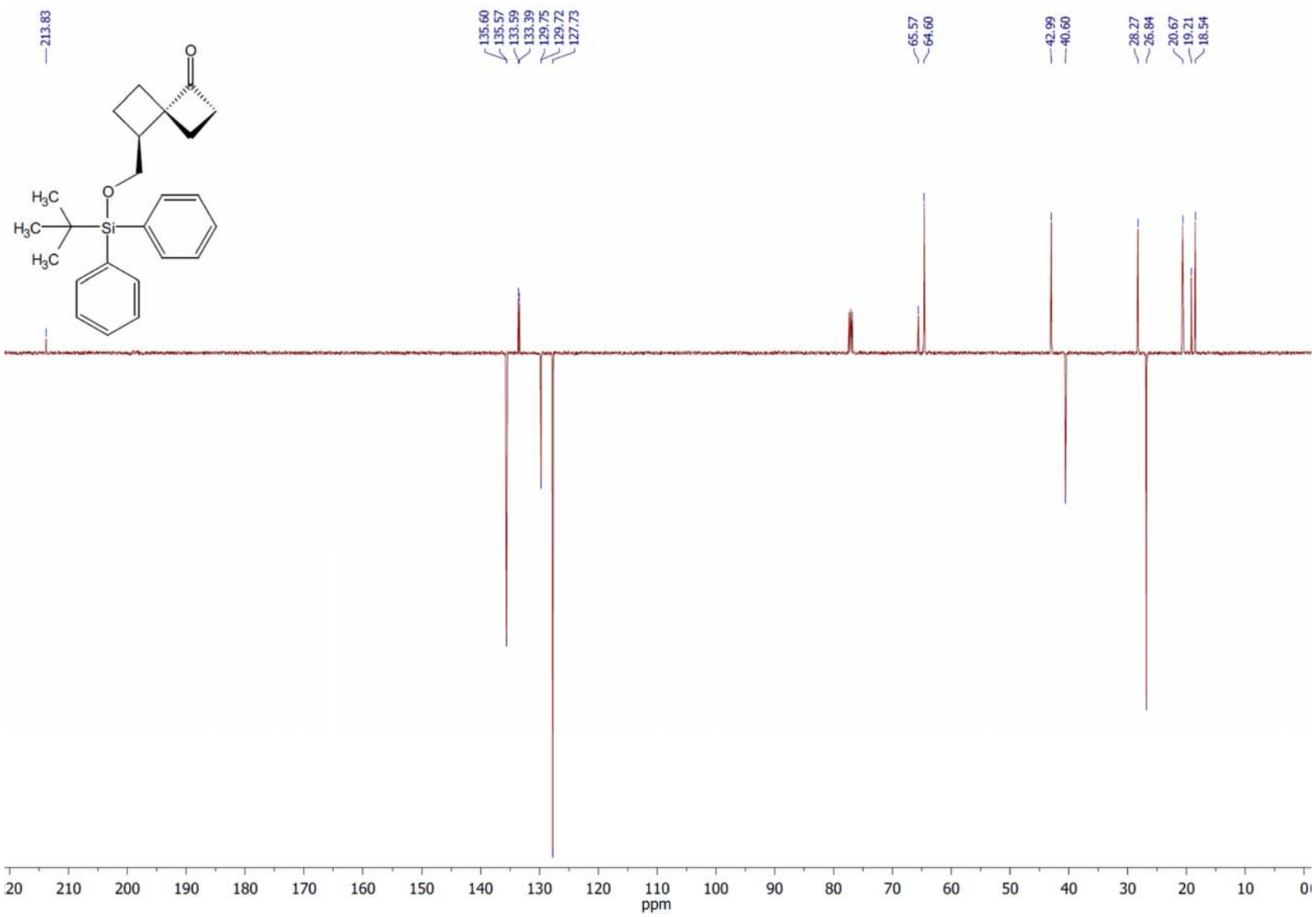
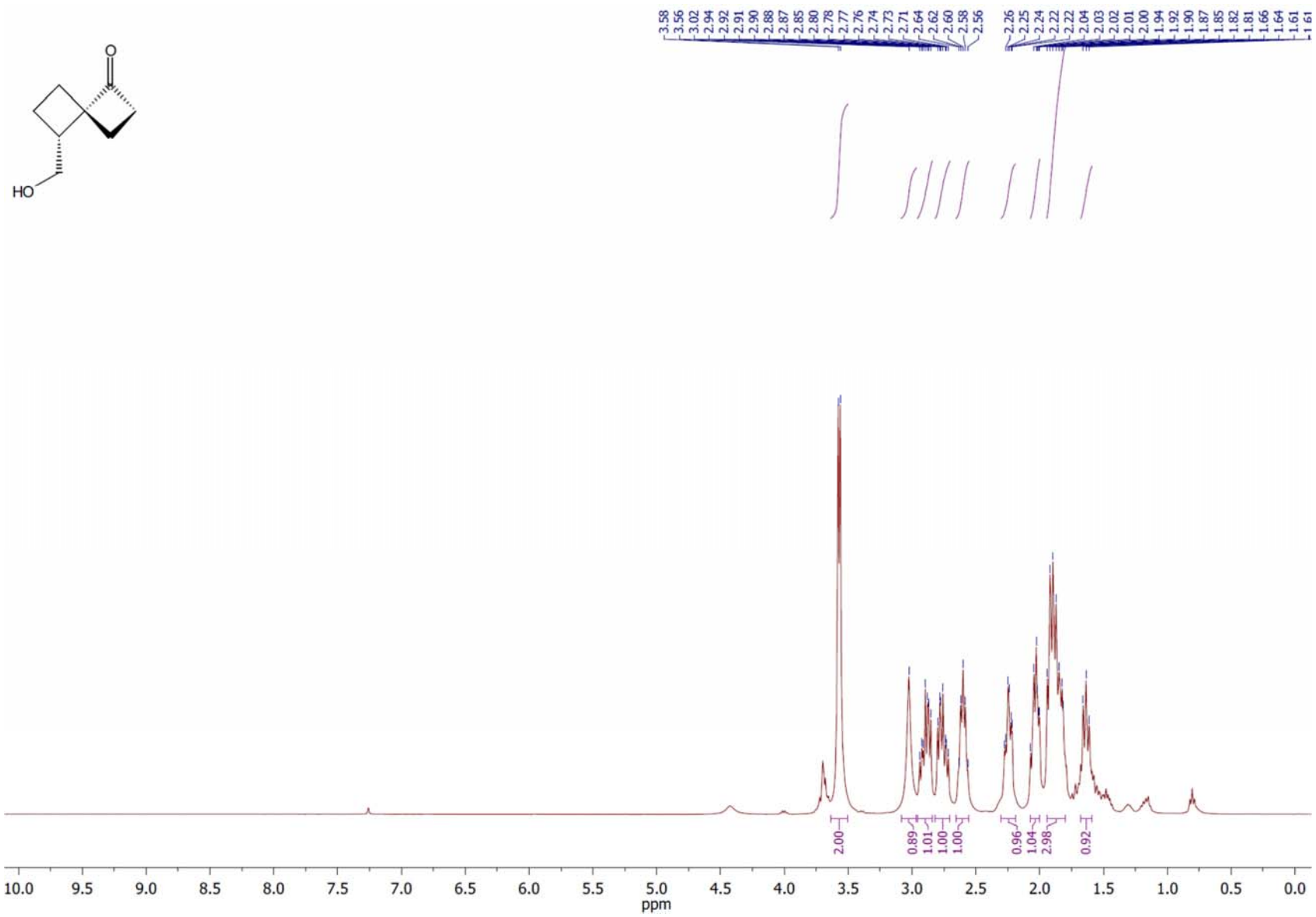


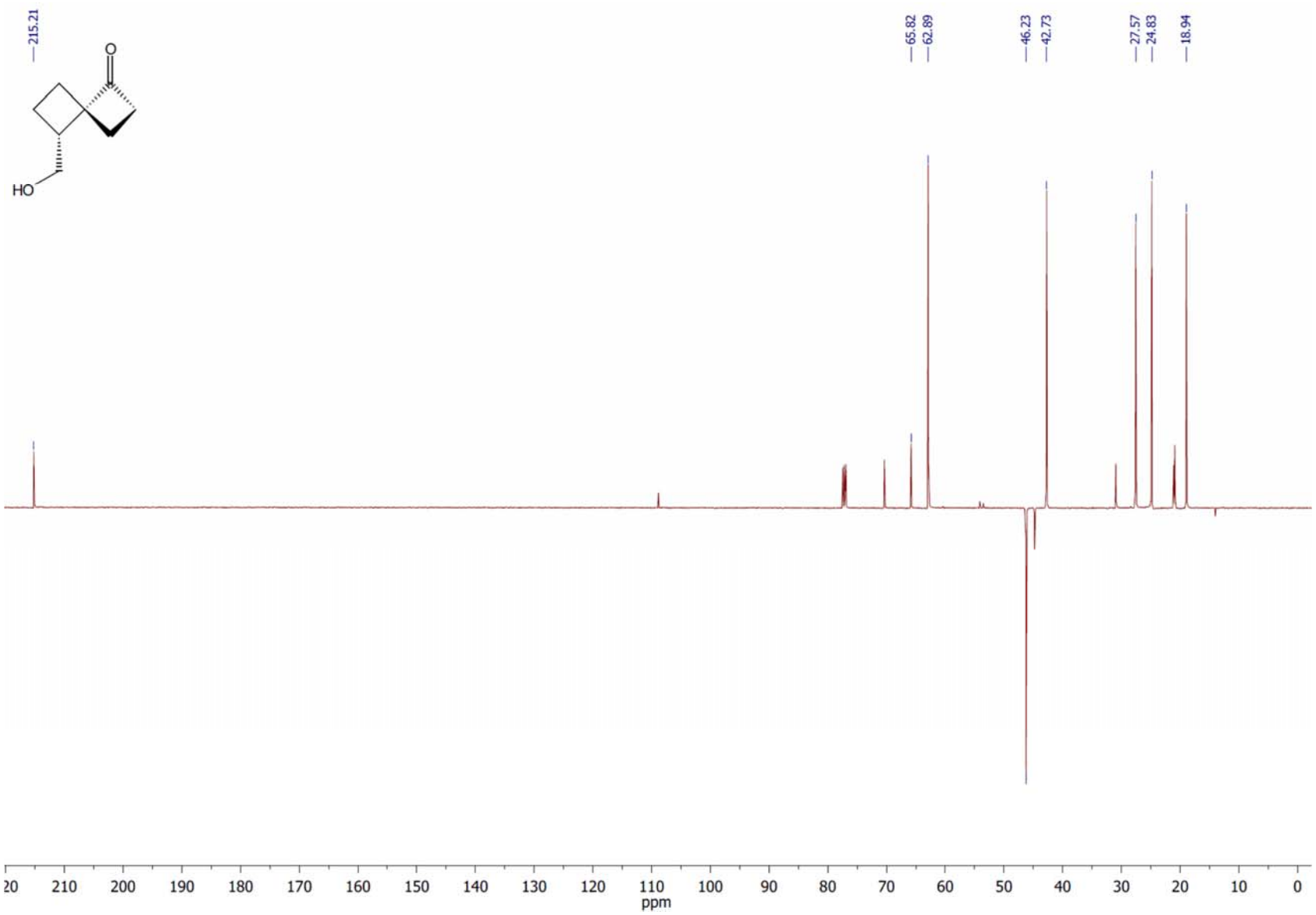
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **48b**



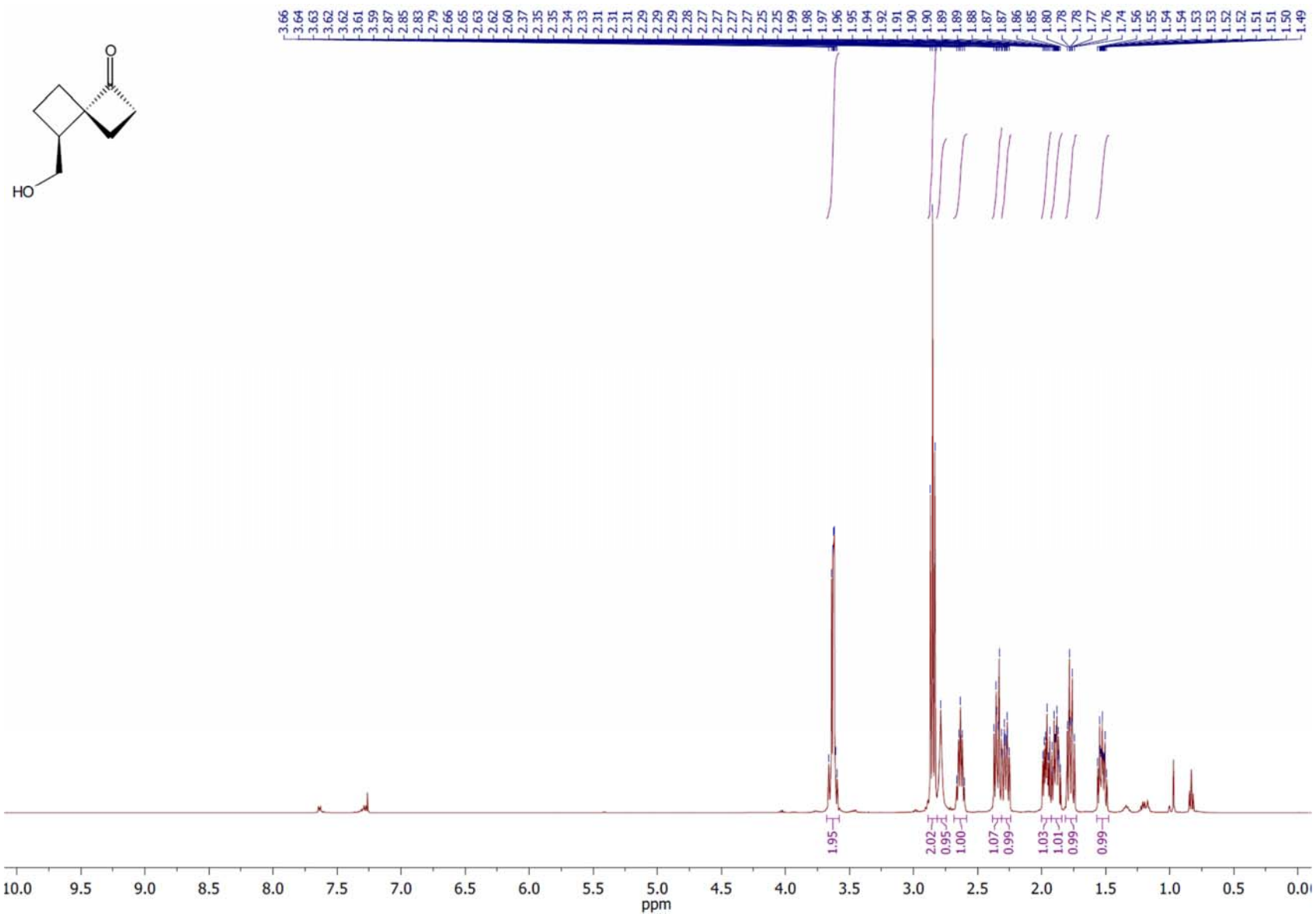
^{1}H NMR spectrum of compound **49a**



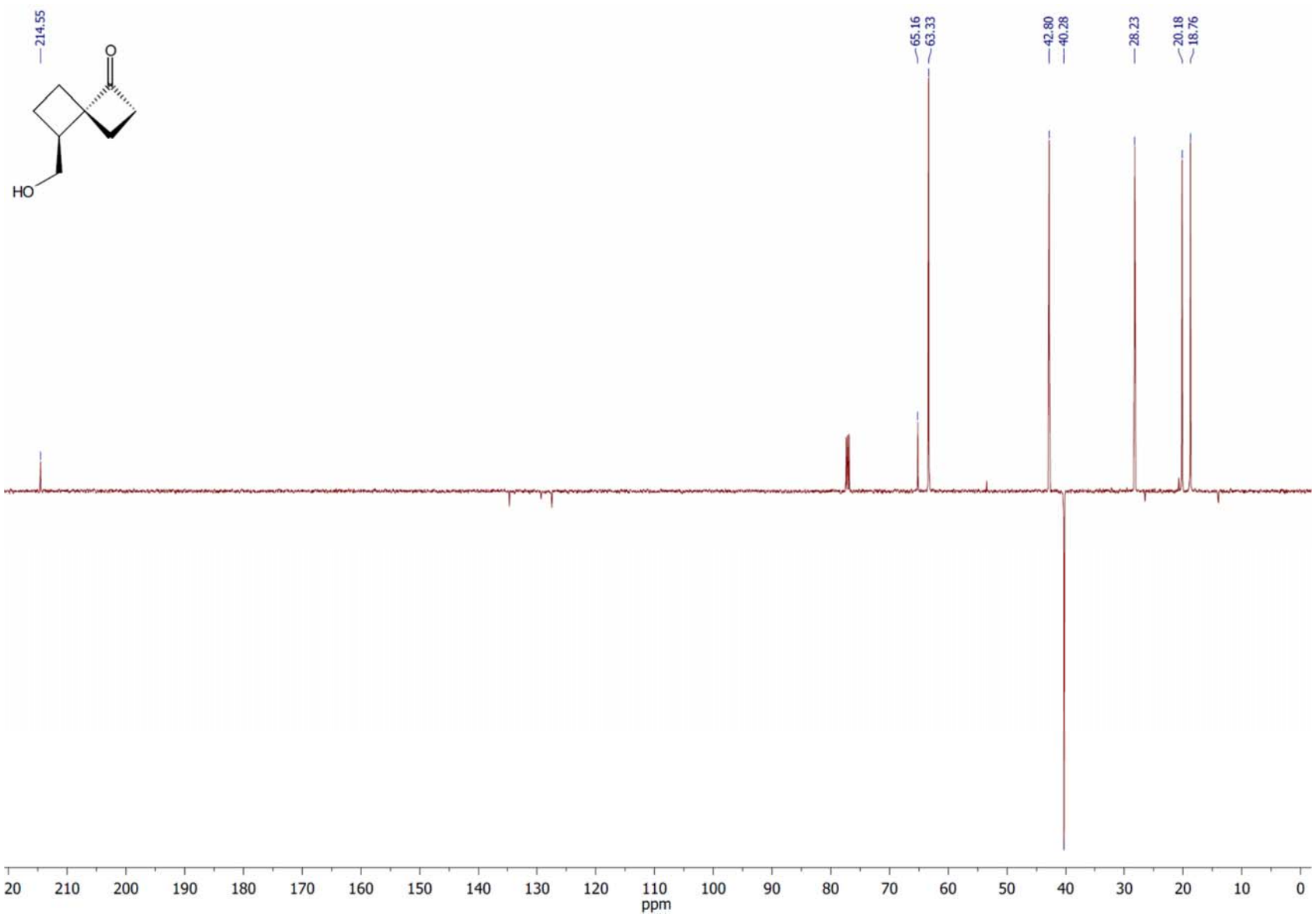
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **49a**



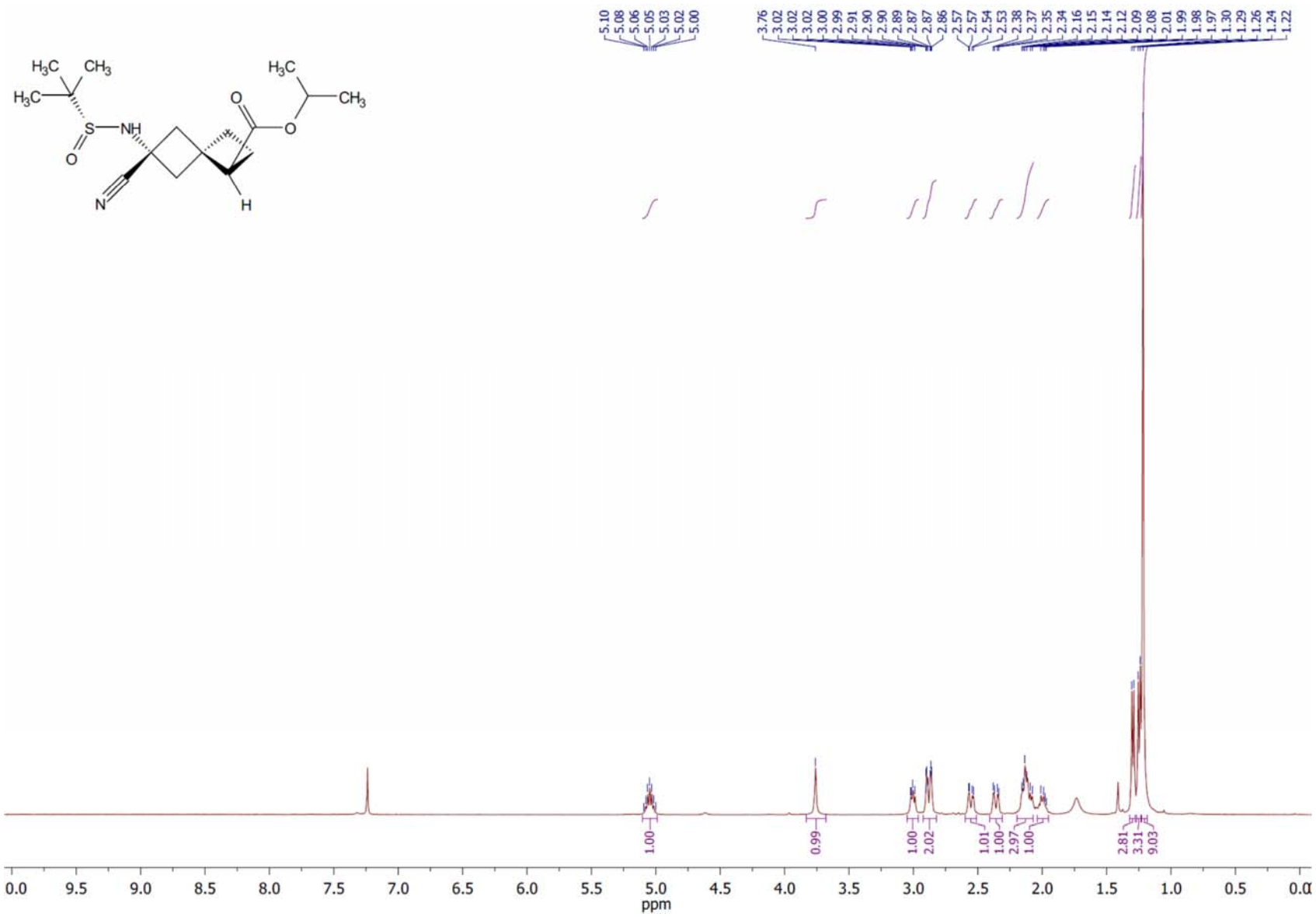
^{1}H NMR spectrum of compound **49b**



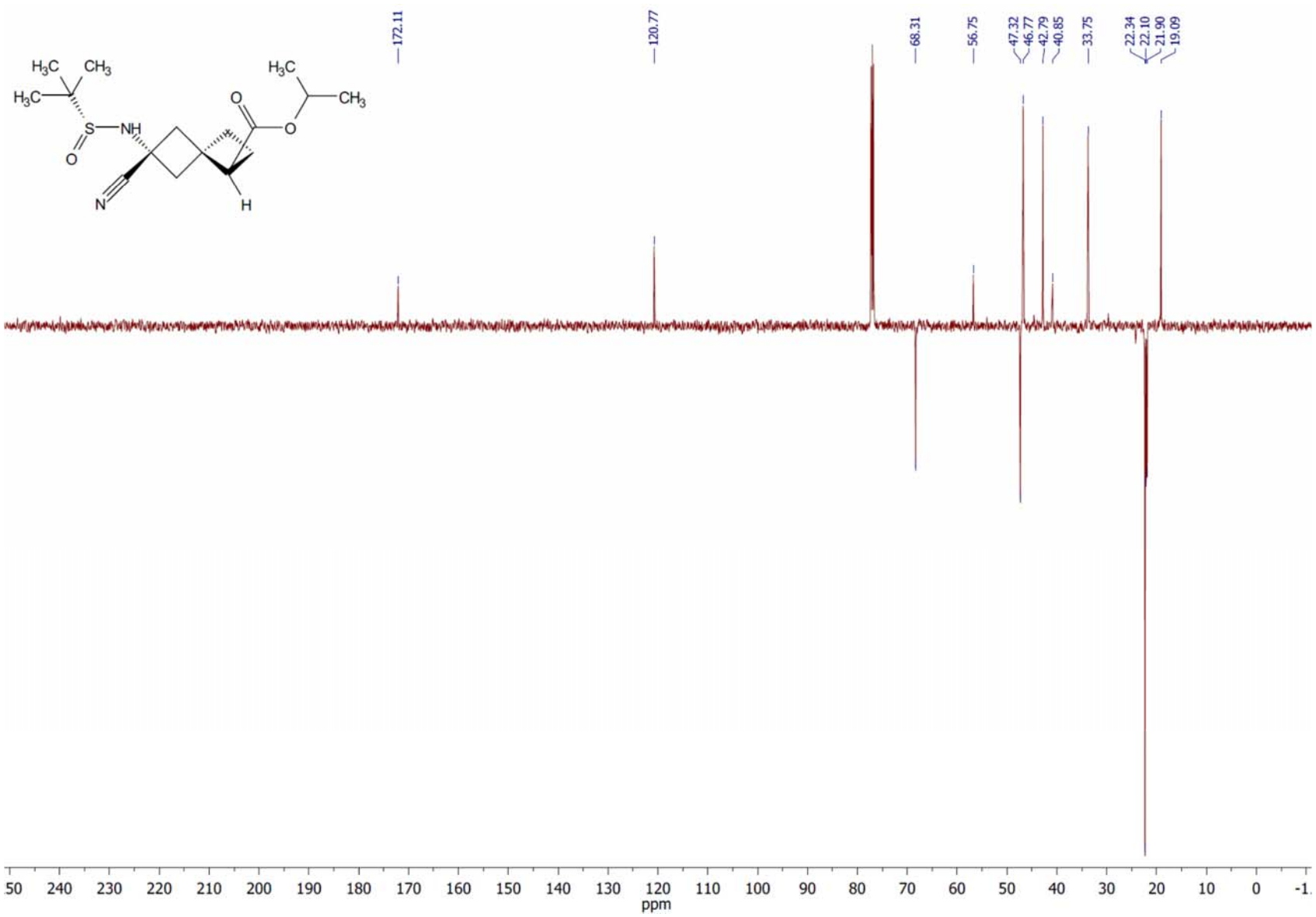
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **49b**



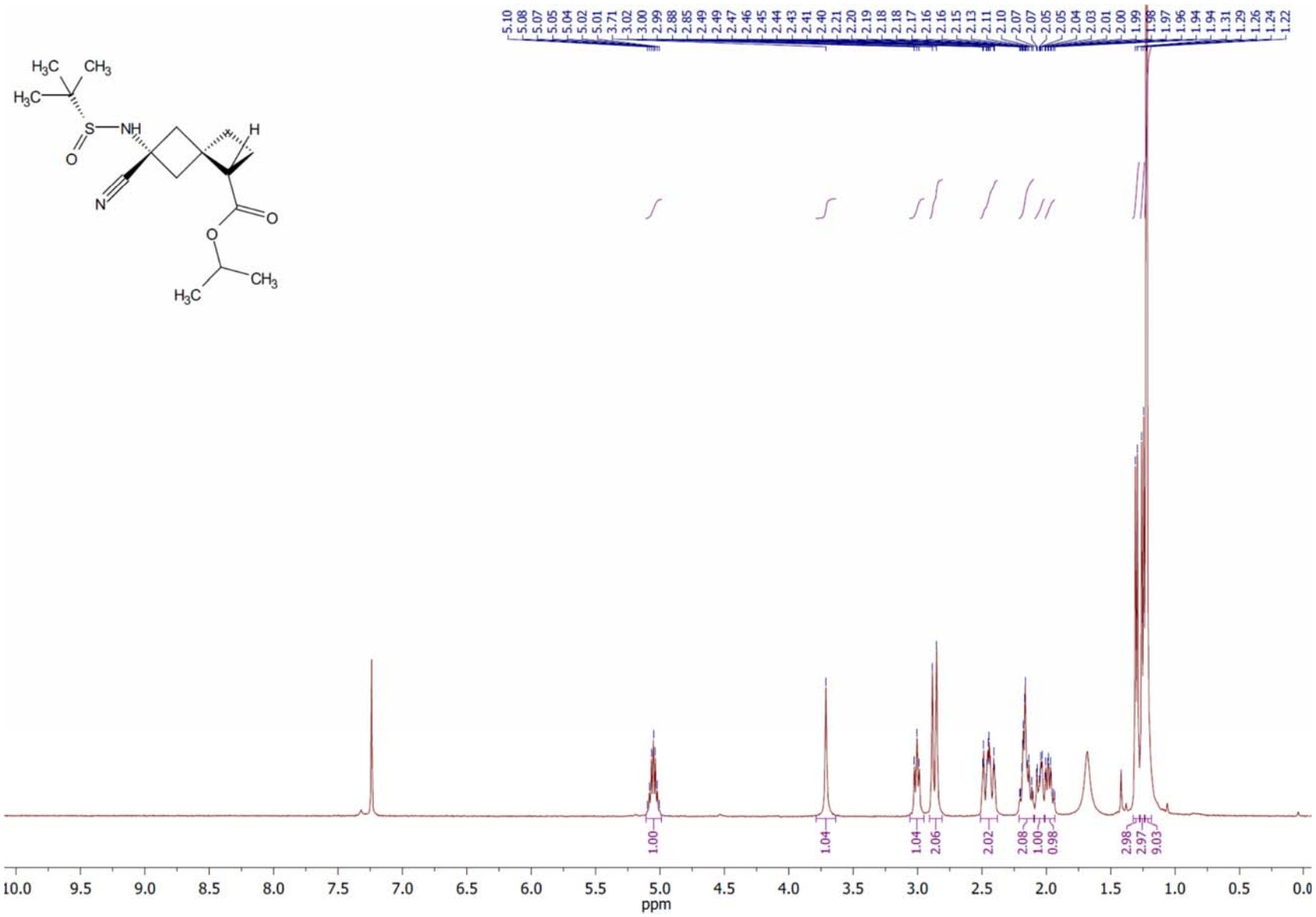
^{1}H NMR spectrum of compound **50a**



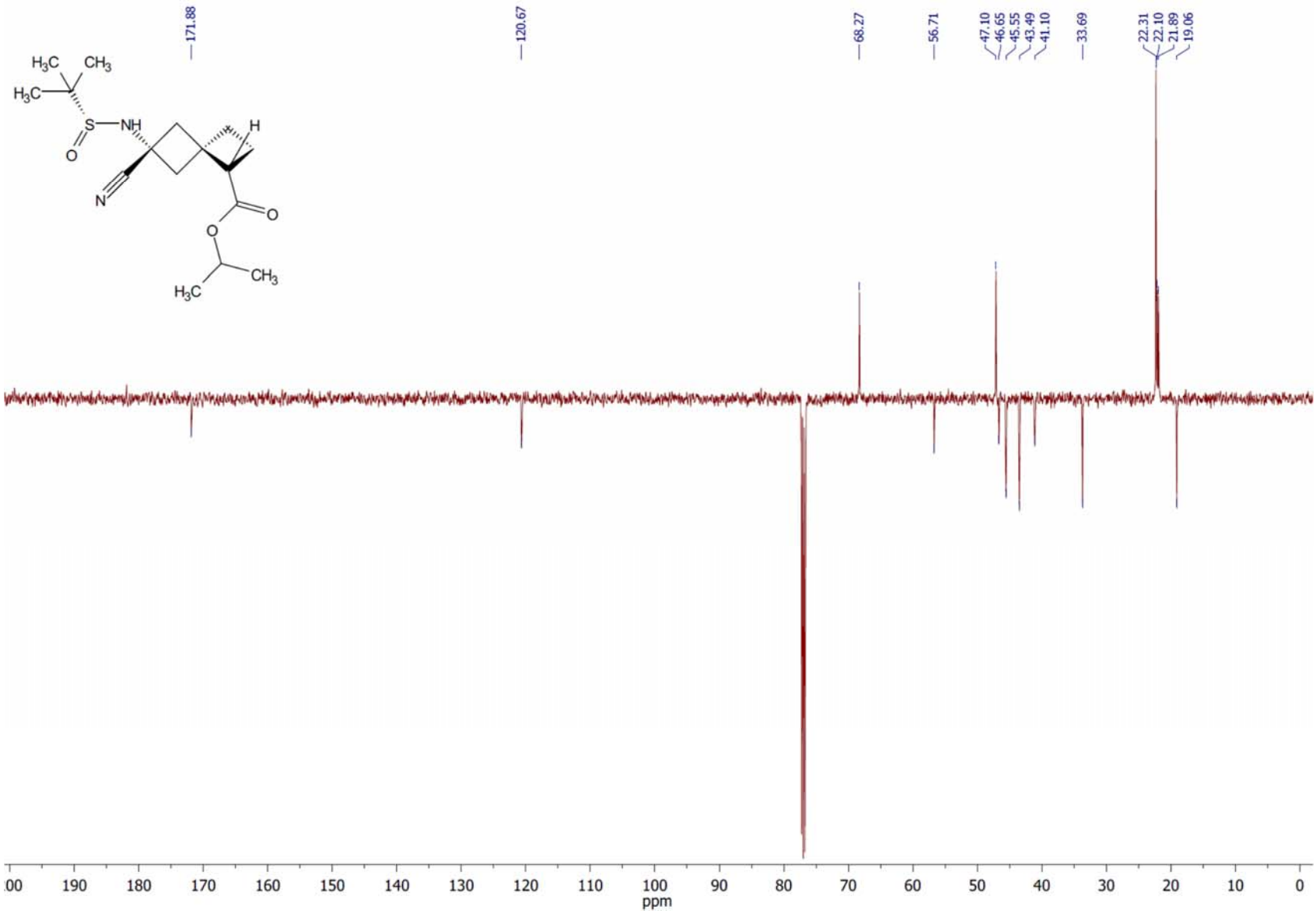
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **50a**



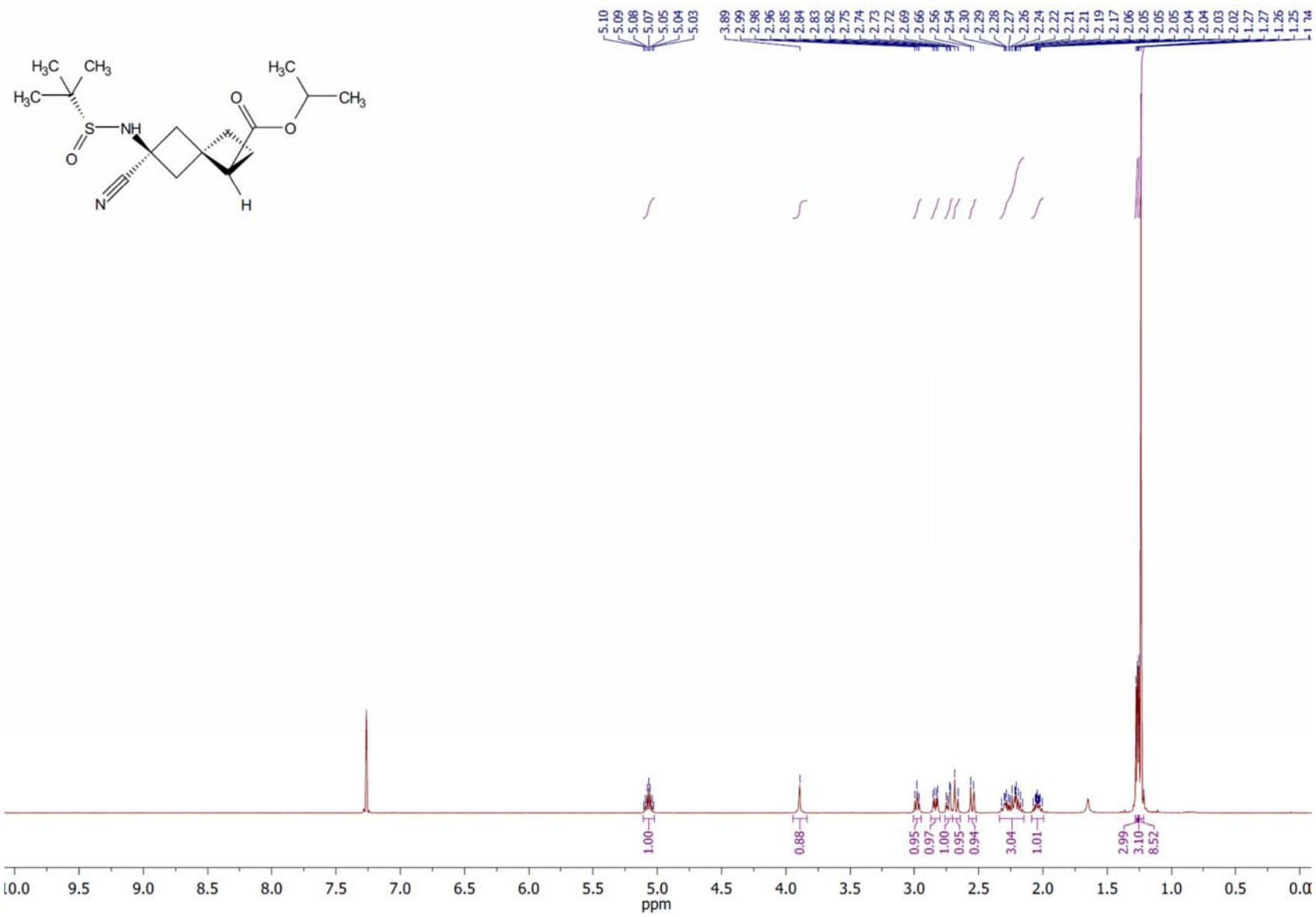
^{1}H NMR spectrum of compound **50b**



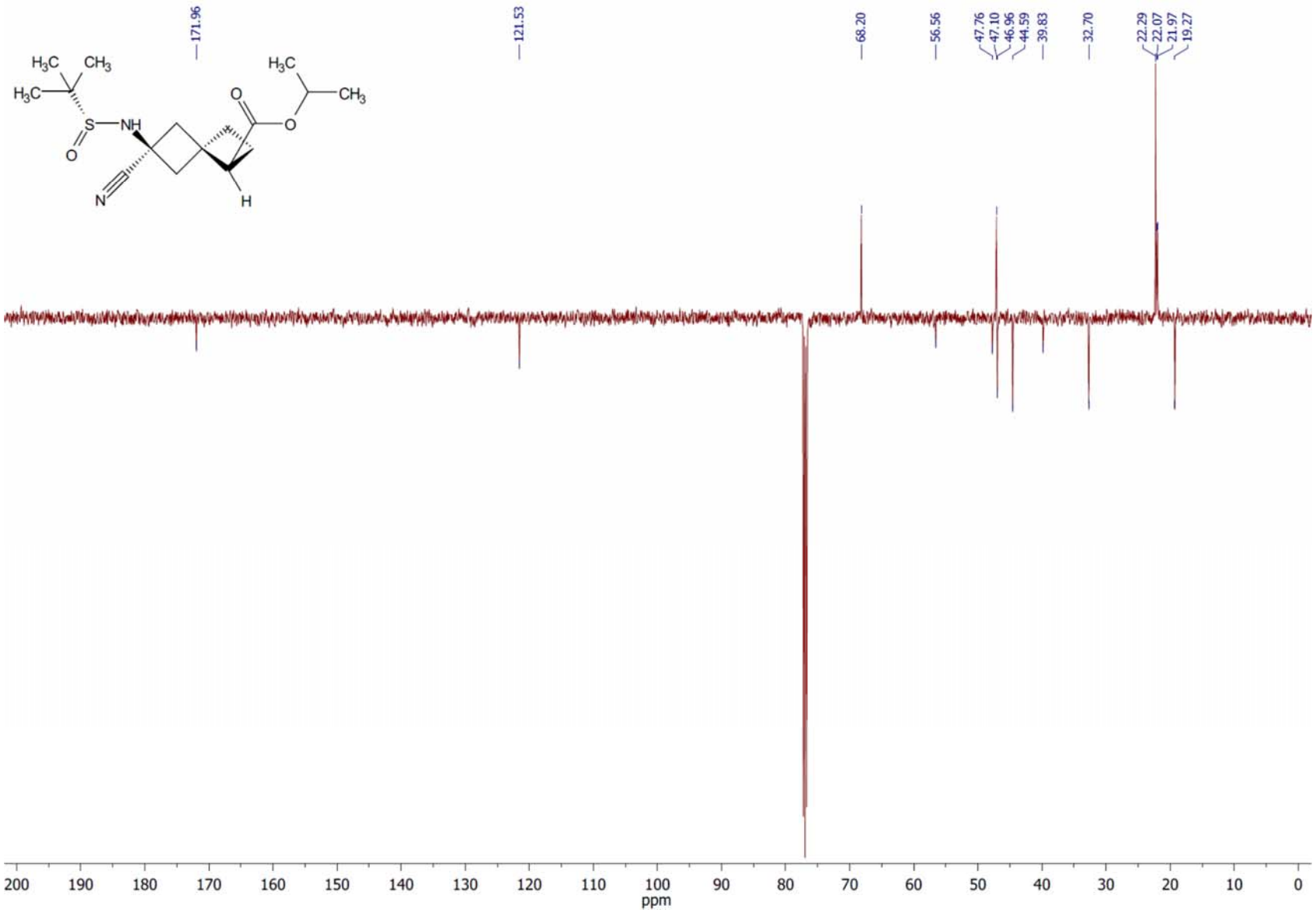
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **50b**



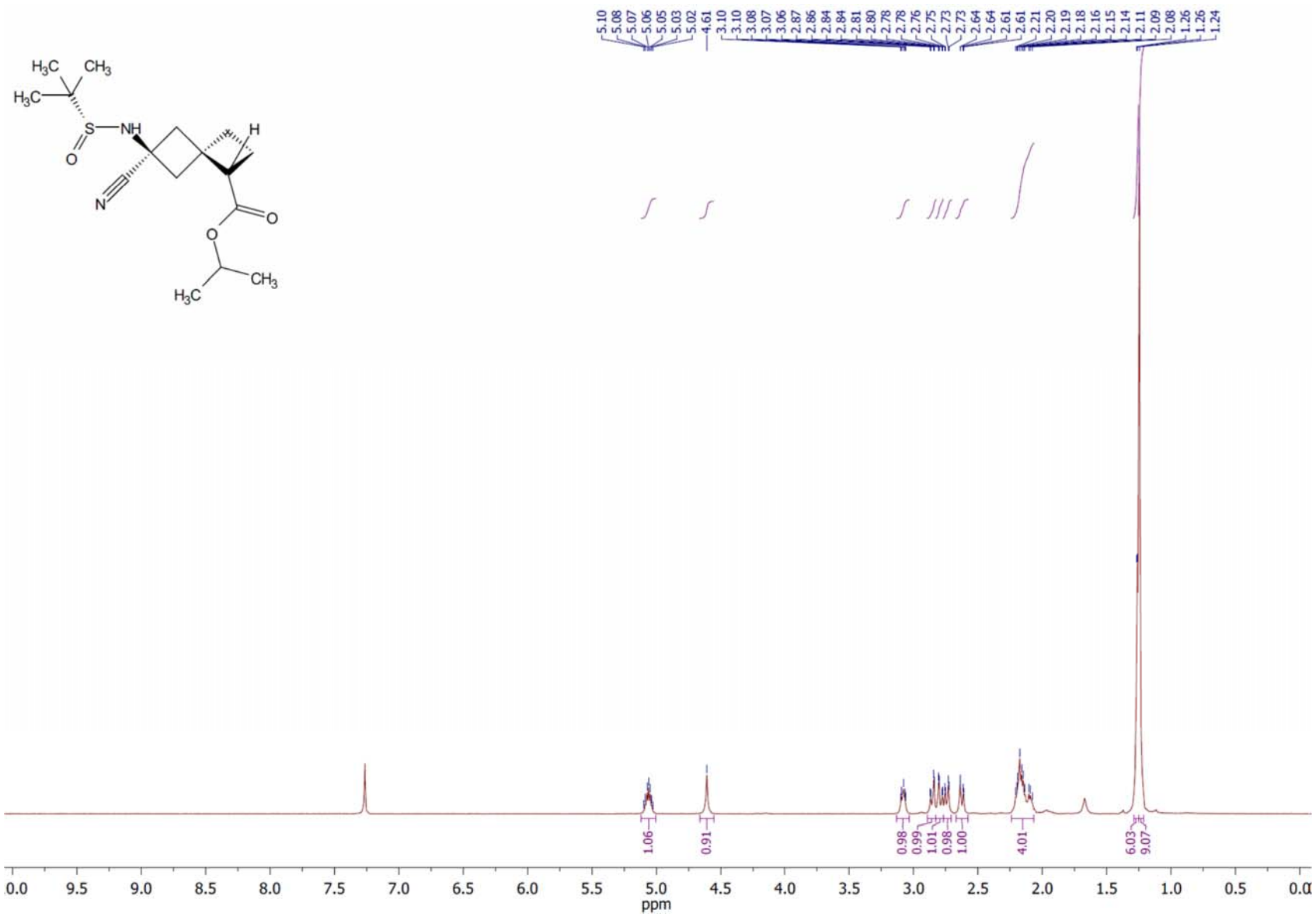
^{1}H NMR spectrum of compound **51a**



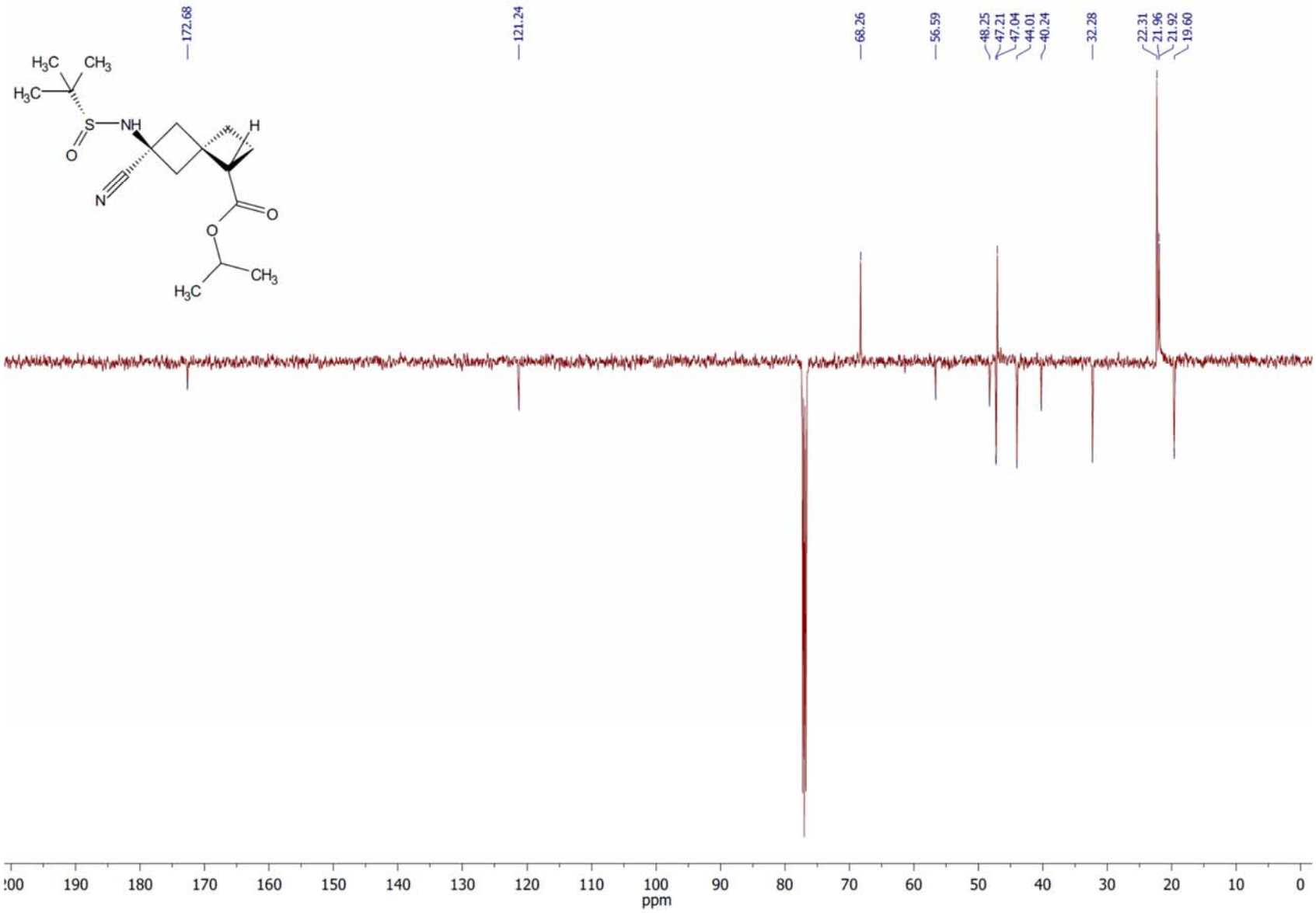
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **51a**



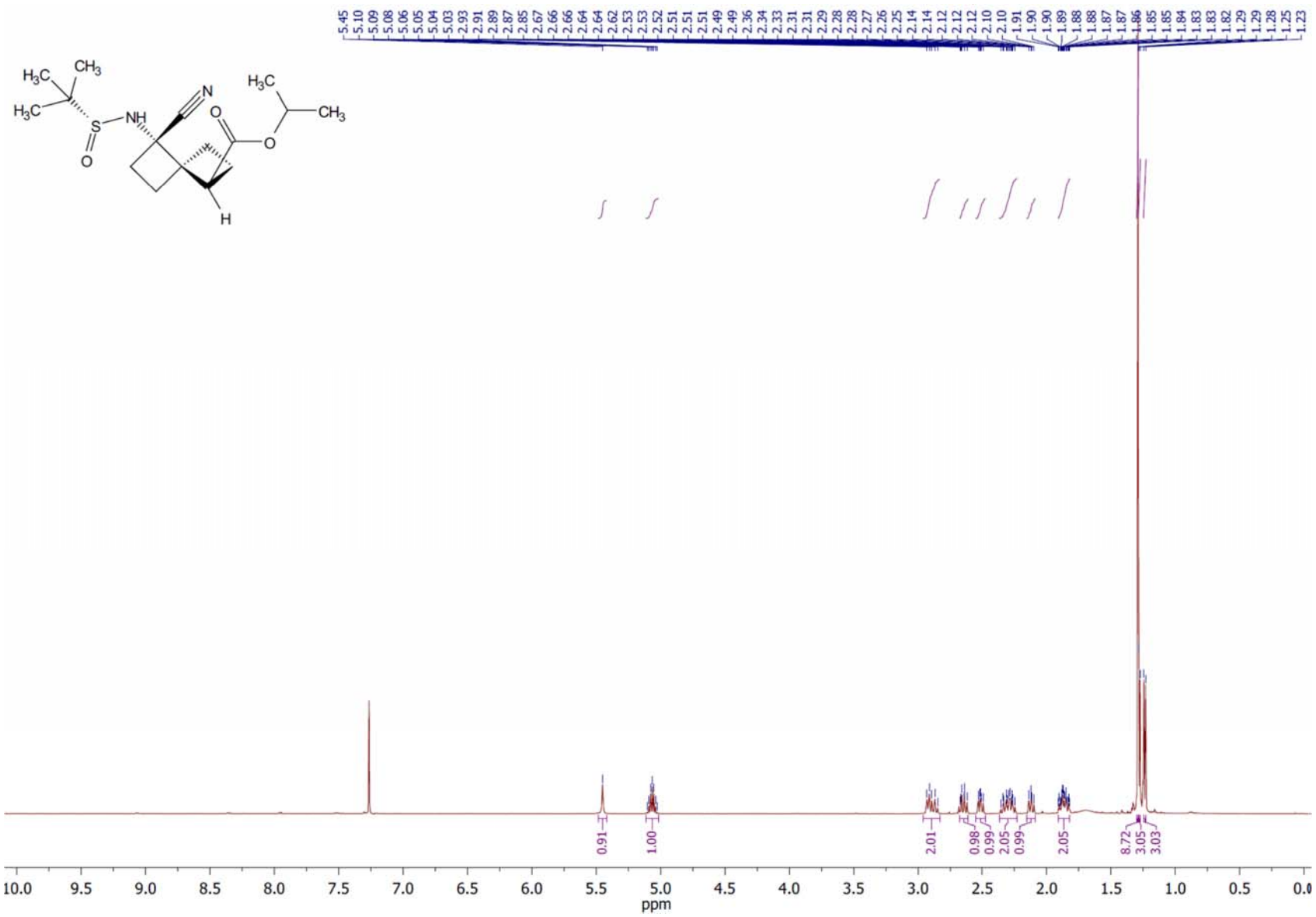
^{1}H NMR spectrum of compound **51b**



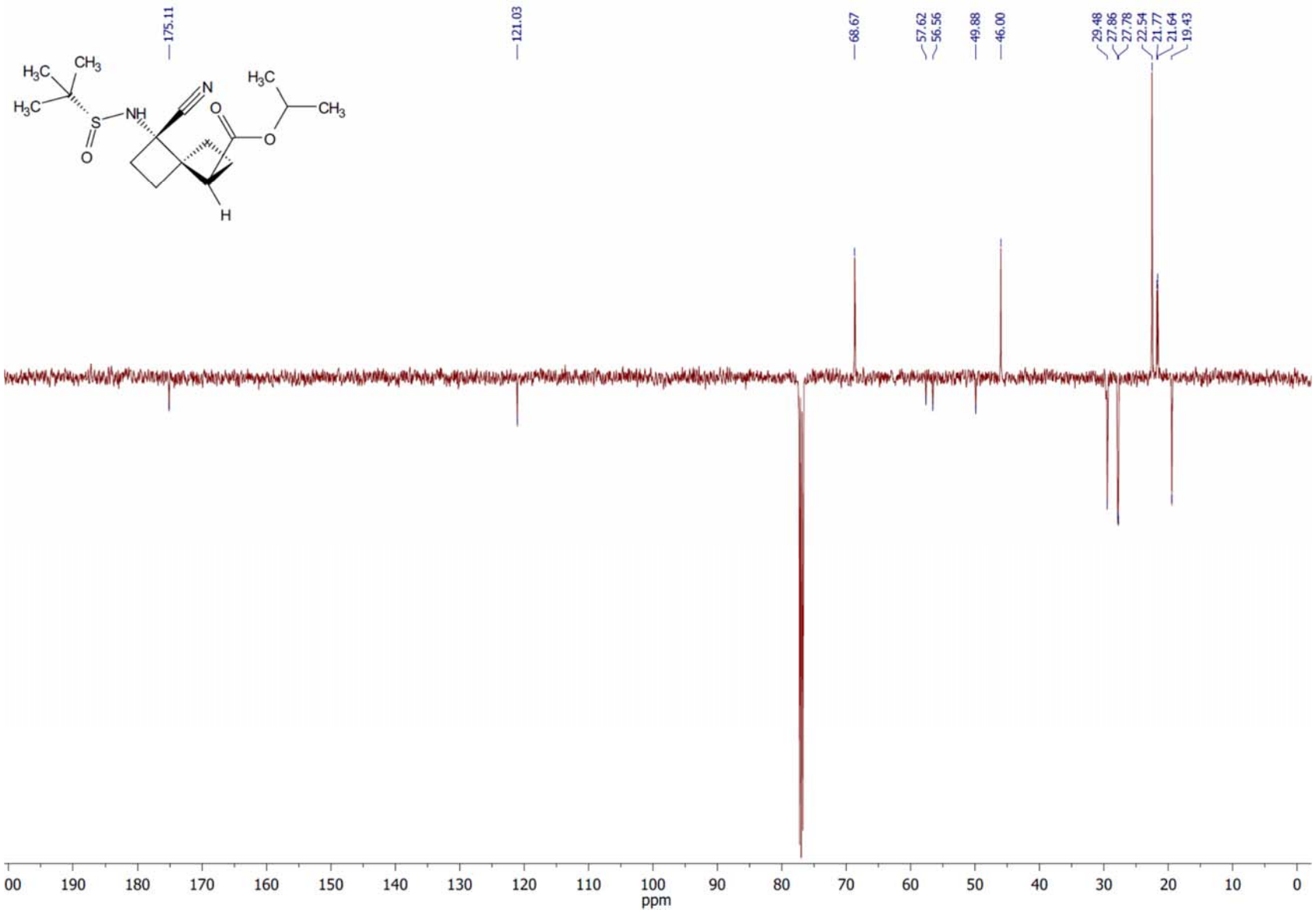
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **51b**



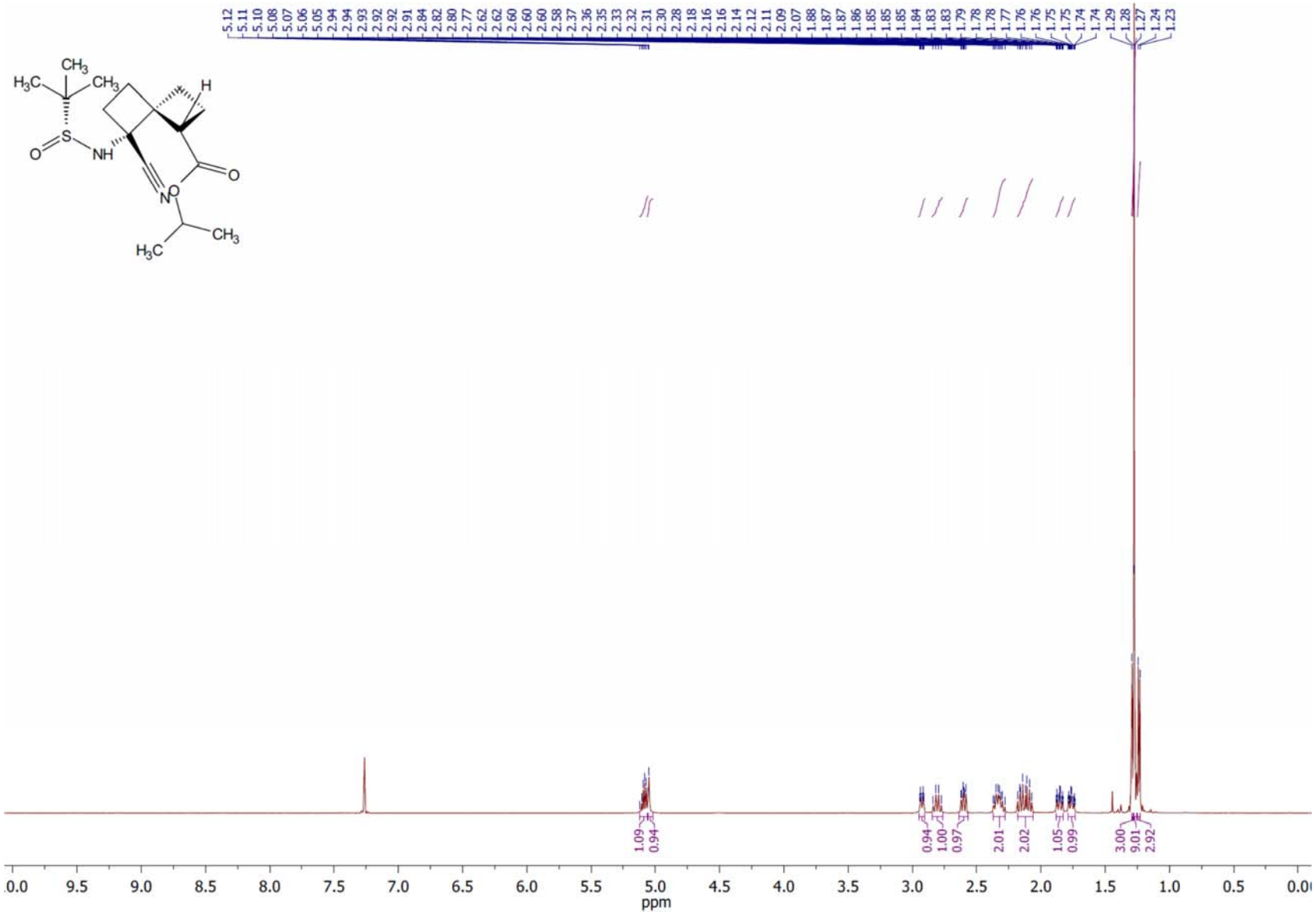
^{1}H NMR spectrum of compound **52a**



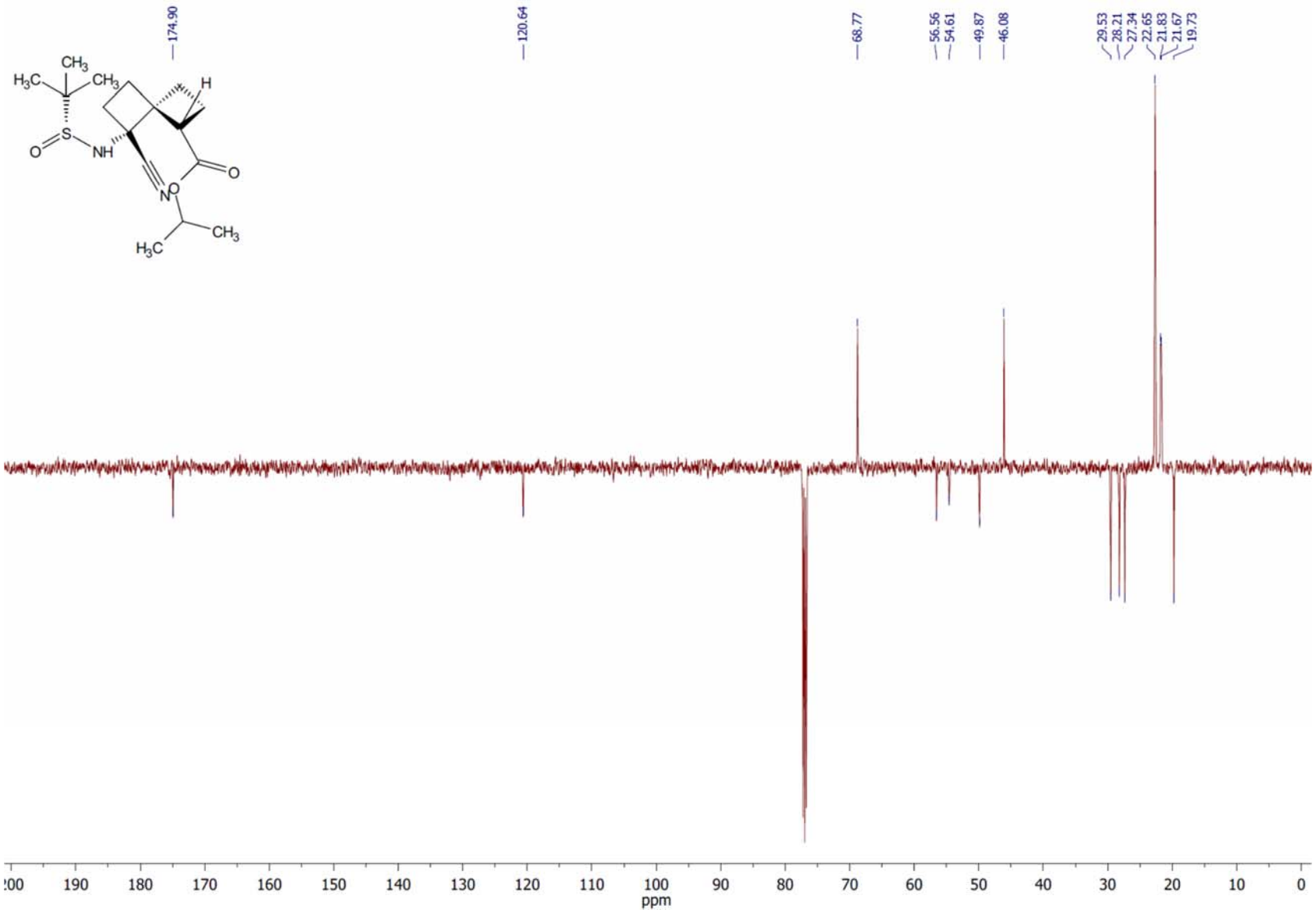
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **52a**



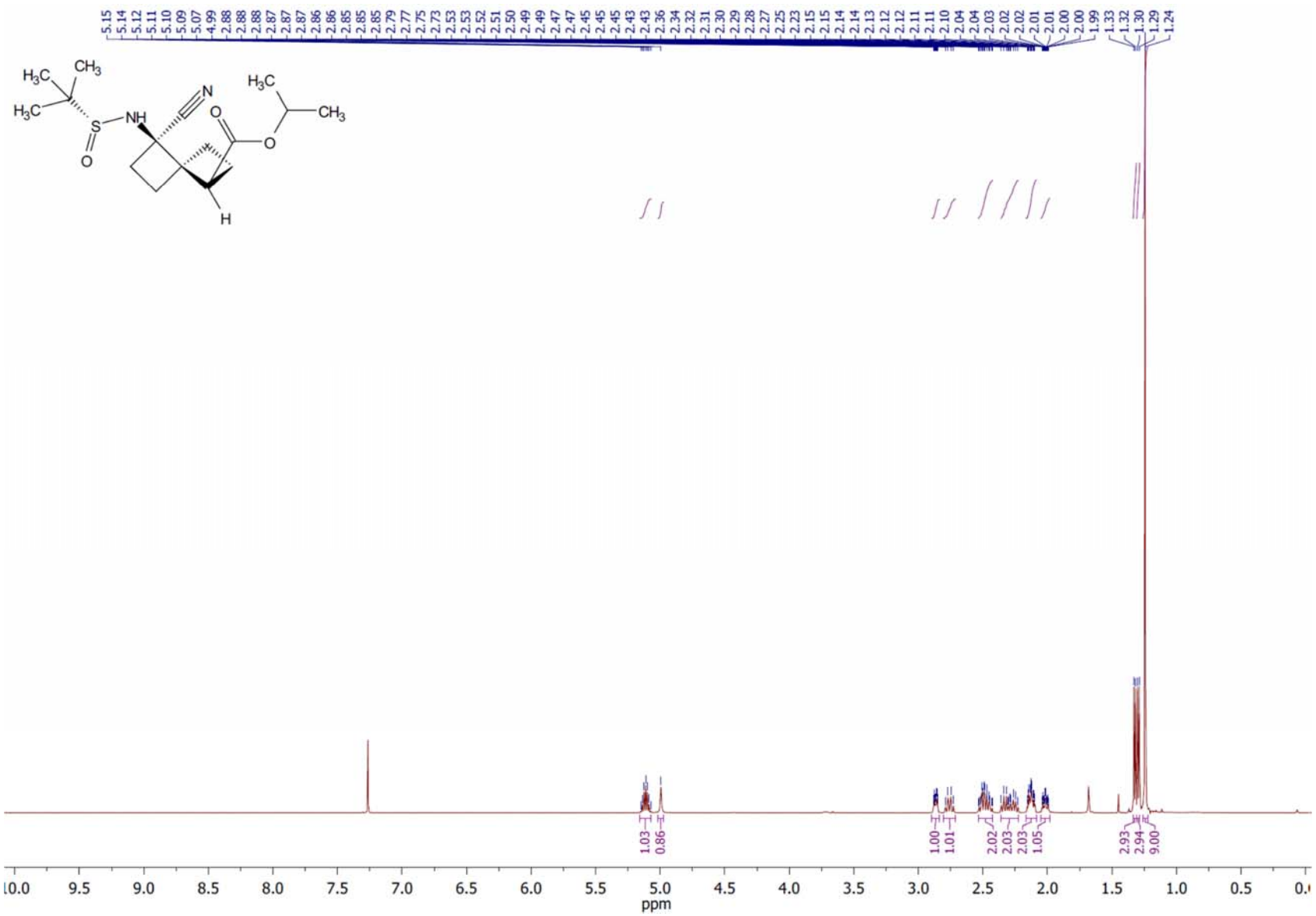
^{1}H NMR spectrum of compound **52b**



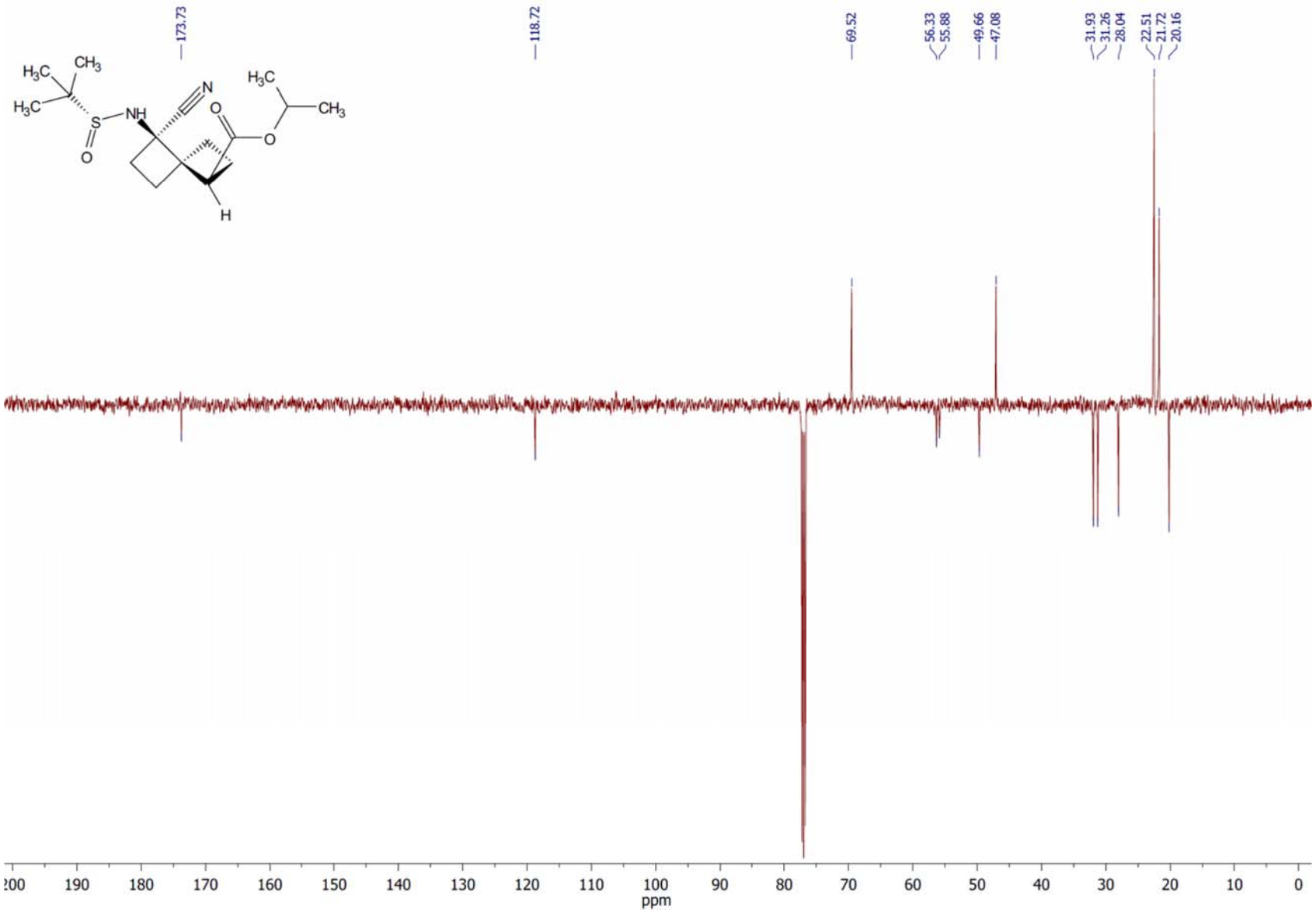
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **52b**



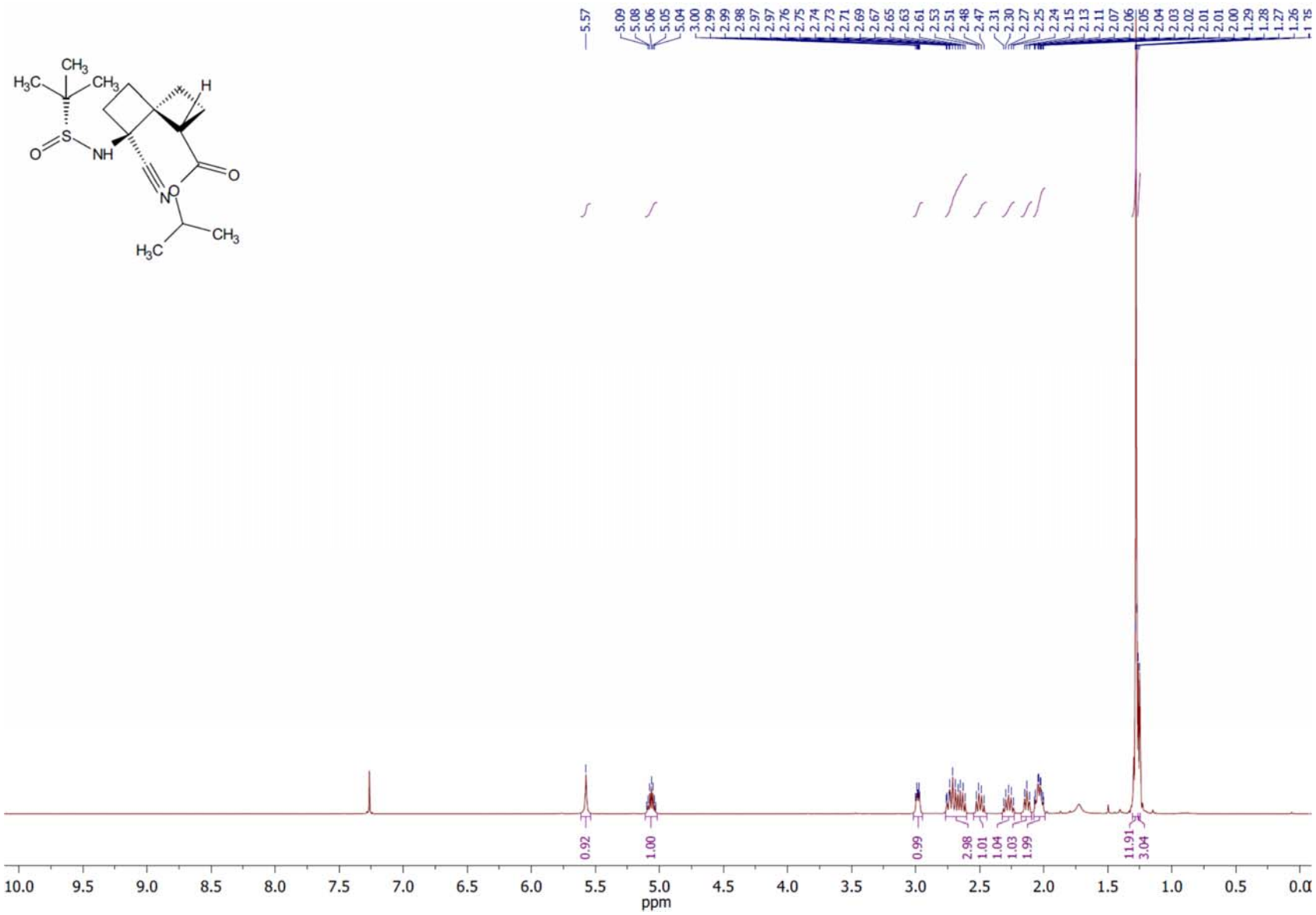
^{1}H NMR spectrum of compound **53a**



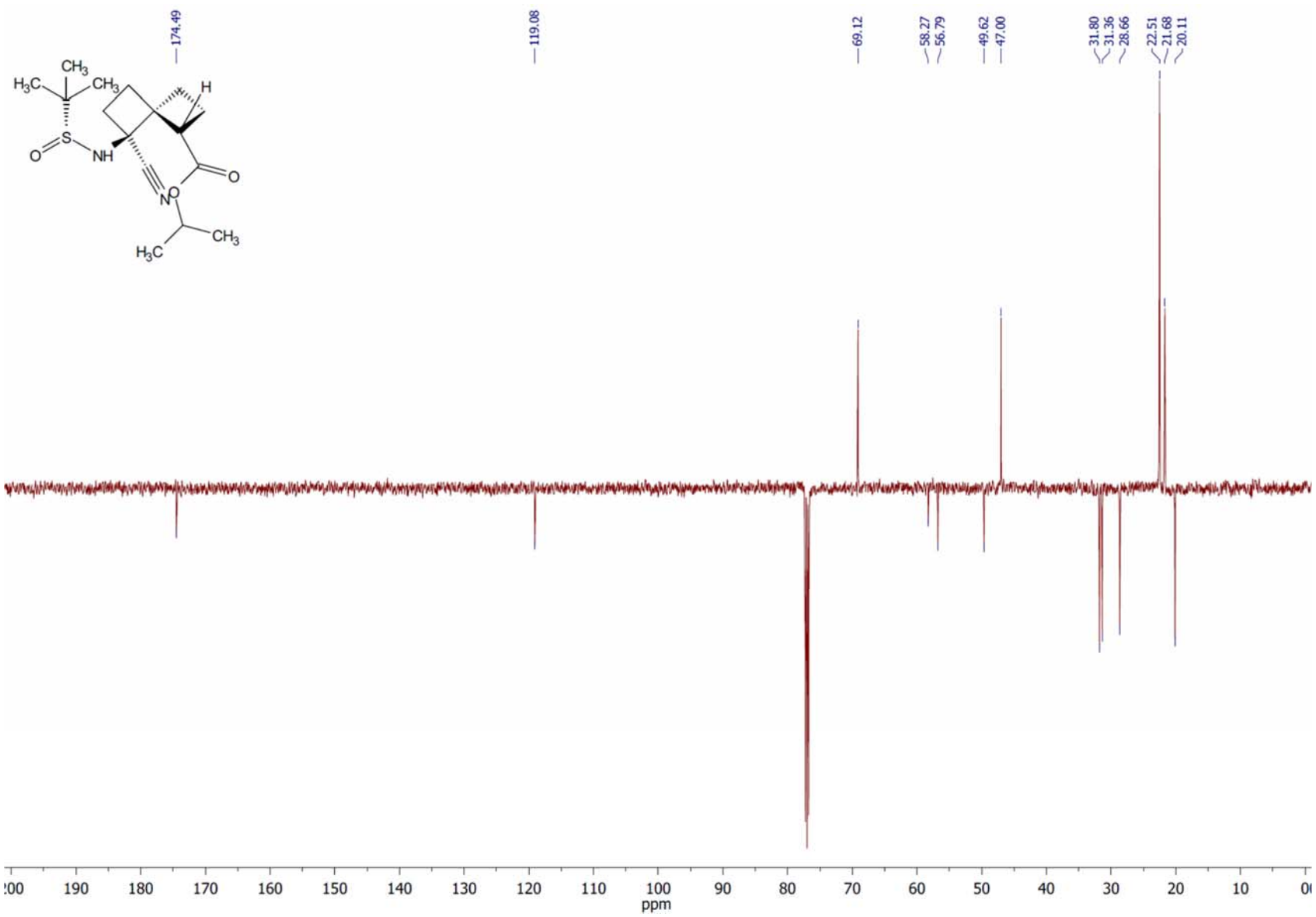
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **53a**



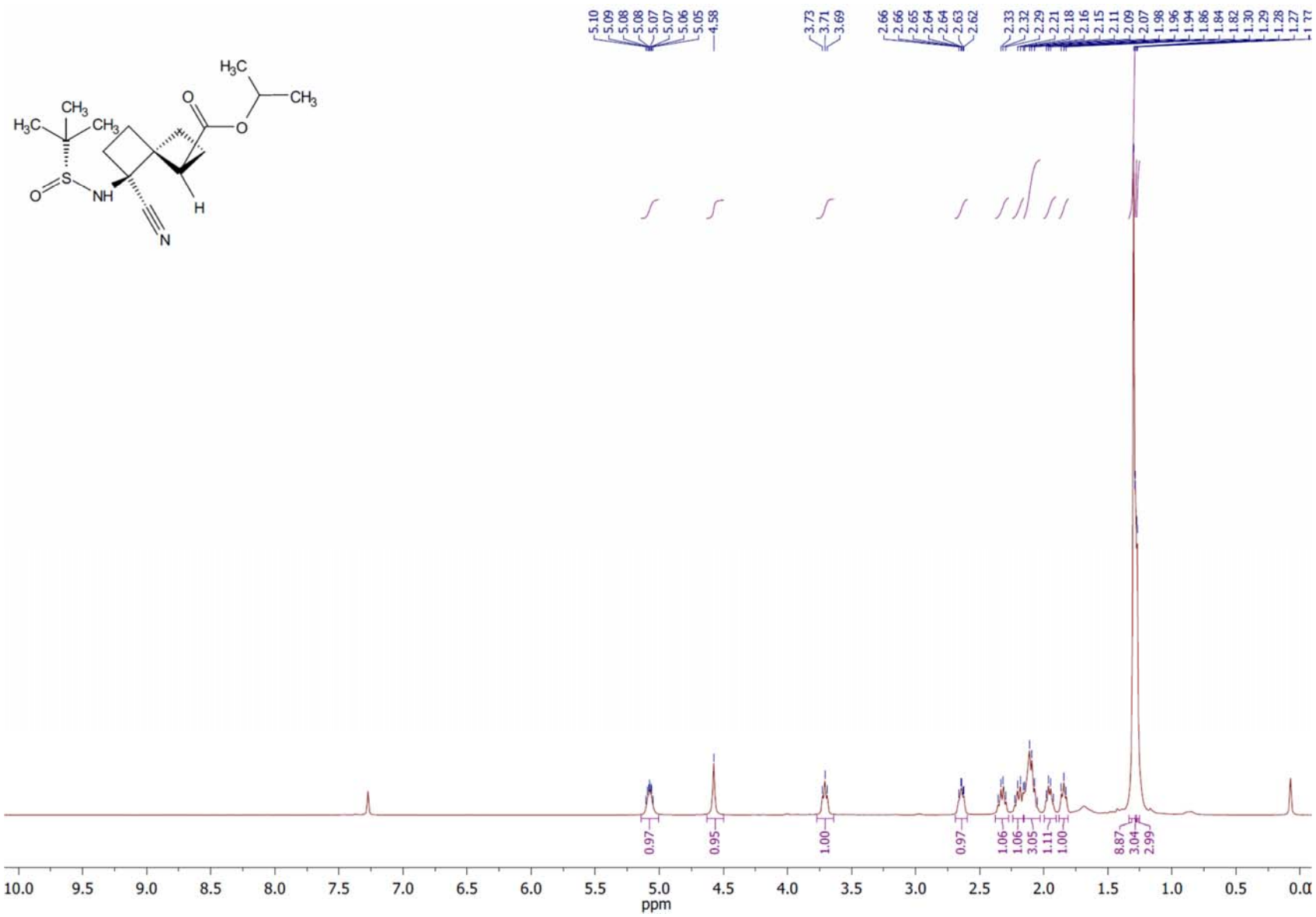
^{1}H NMR spectrum of compound **53b**



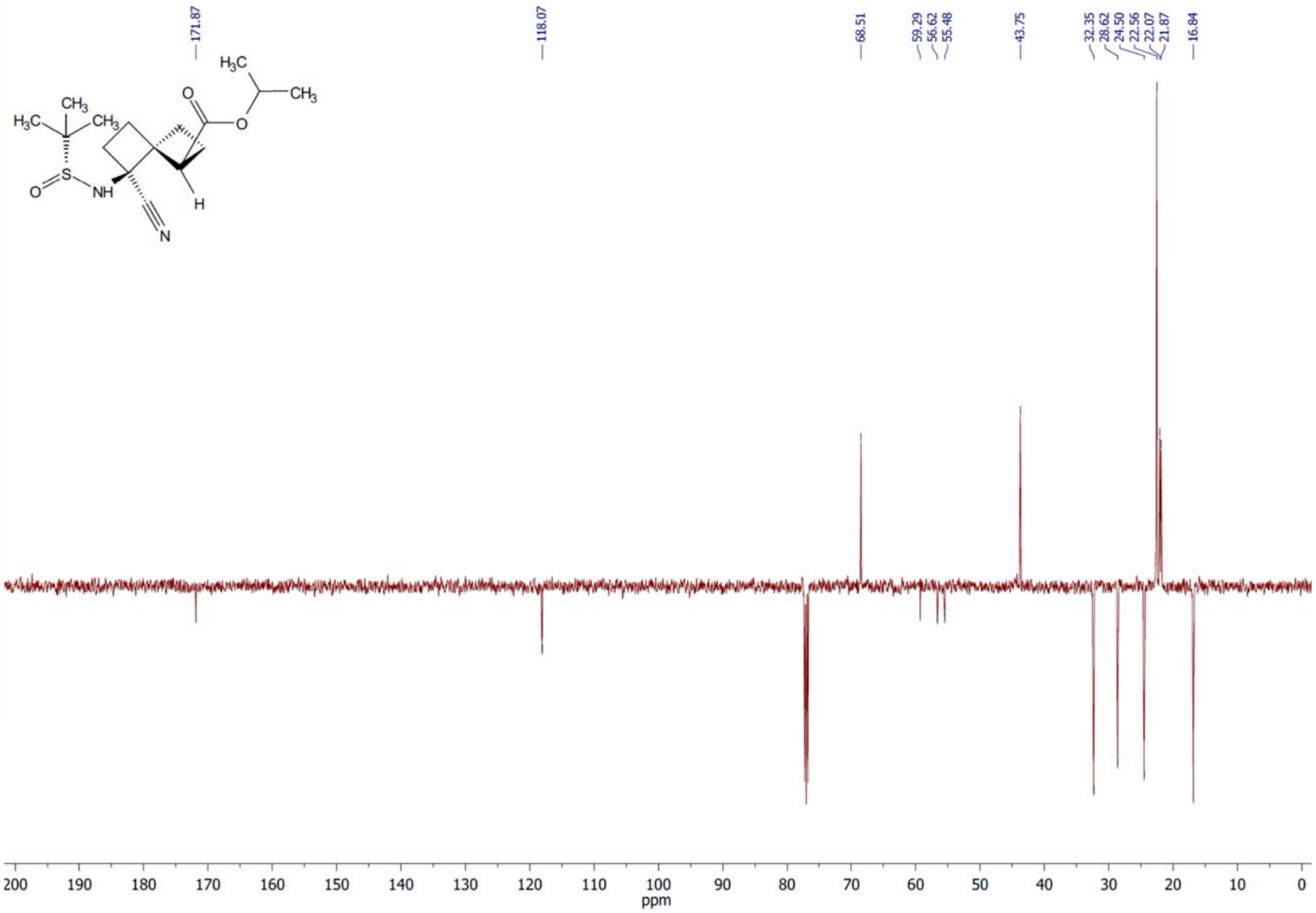
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **53b**



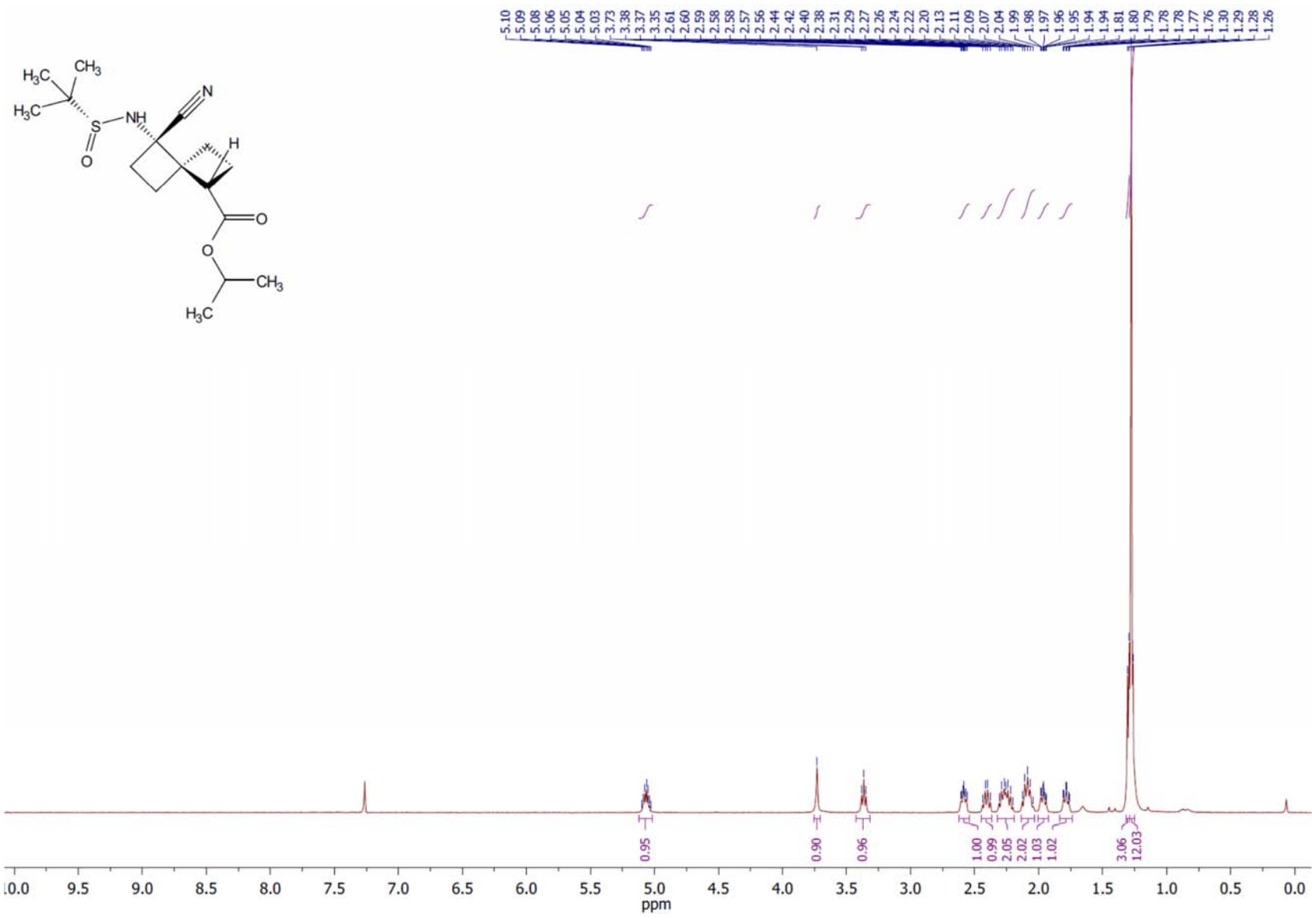
^{1}H NMR spectrum of compound **54b**



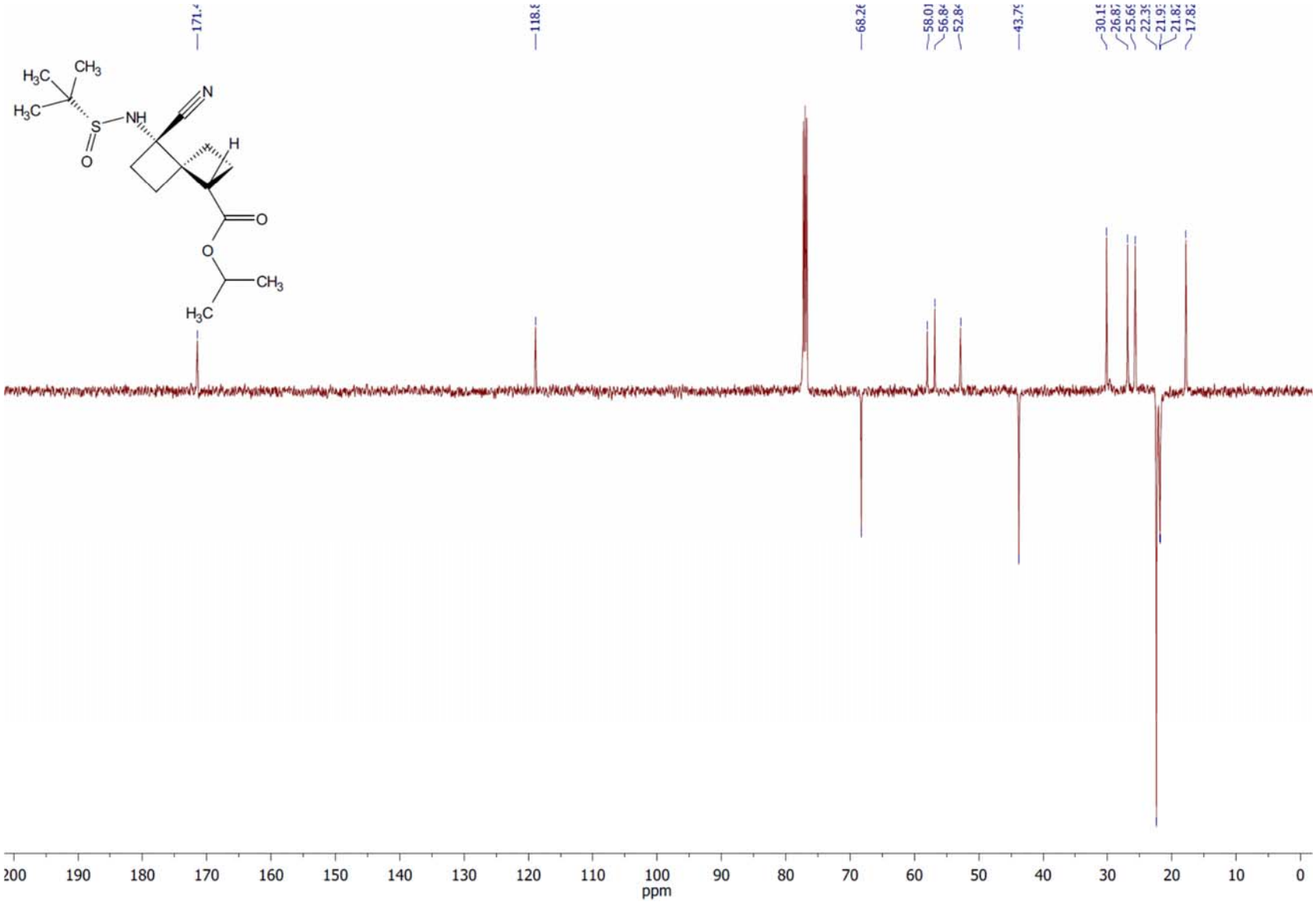
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **54b**



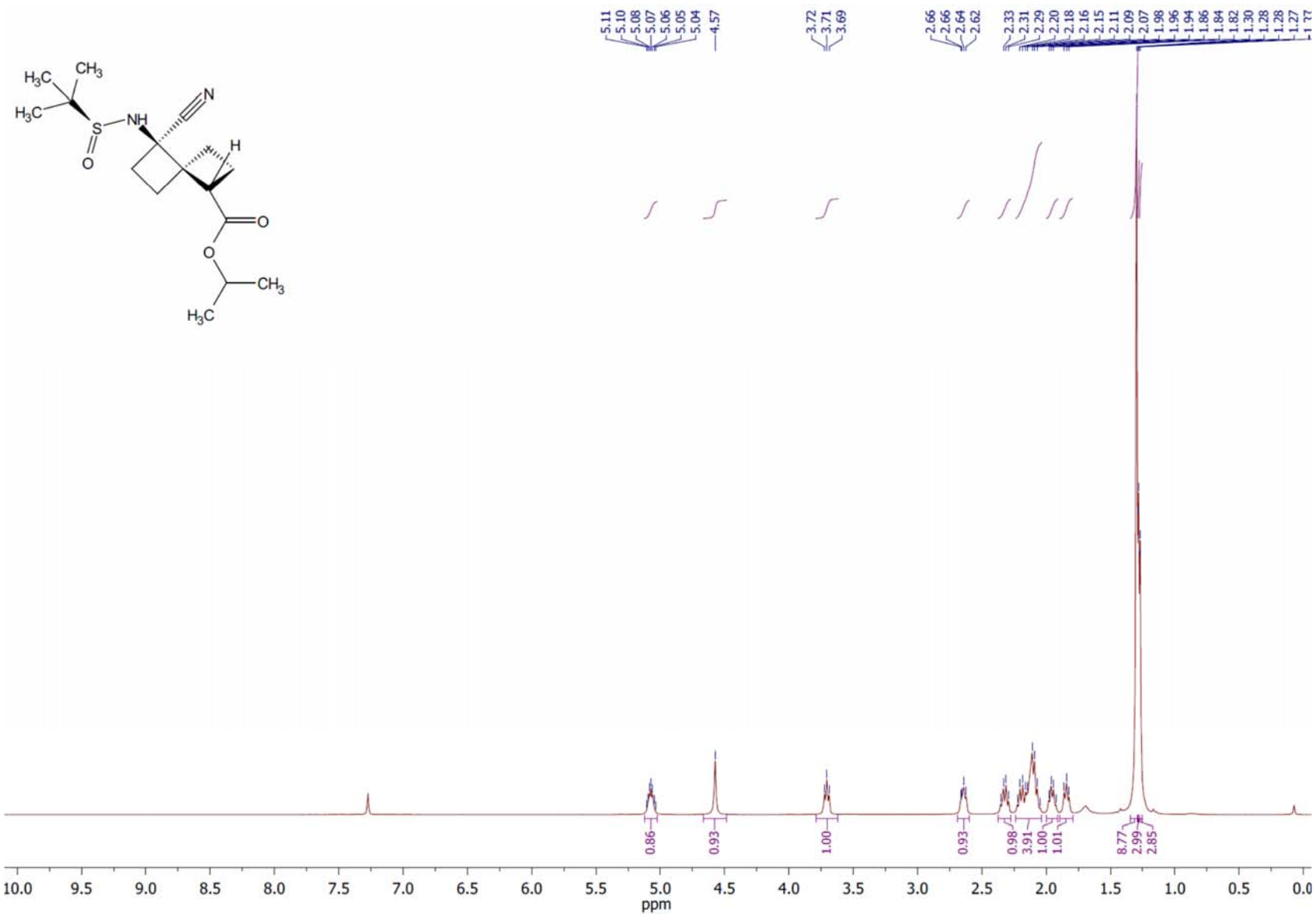
^{1}H NMR spectrum of compound **55a**



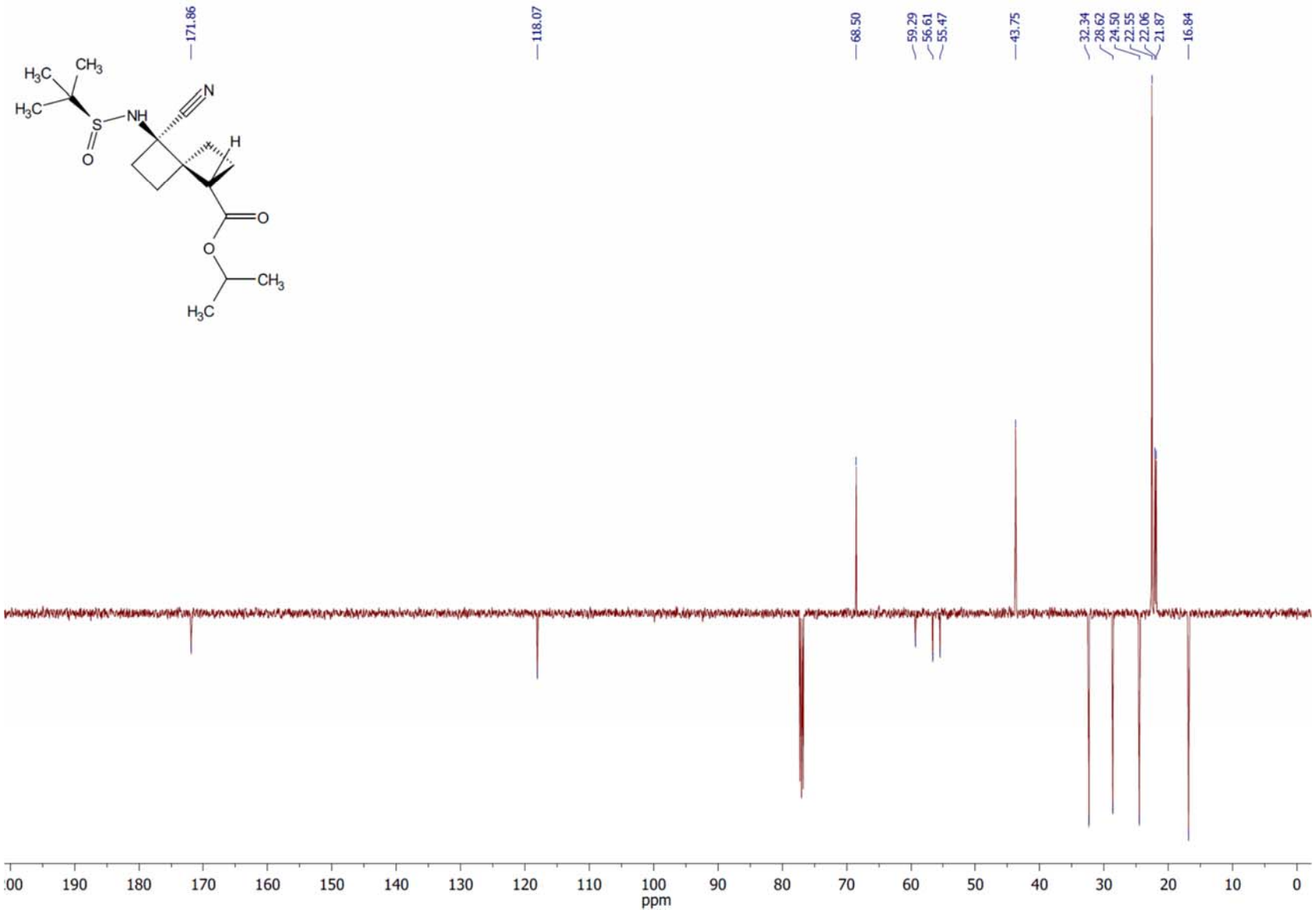
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **55a**



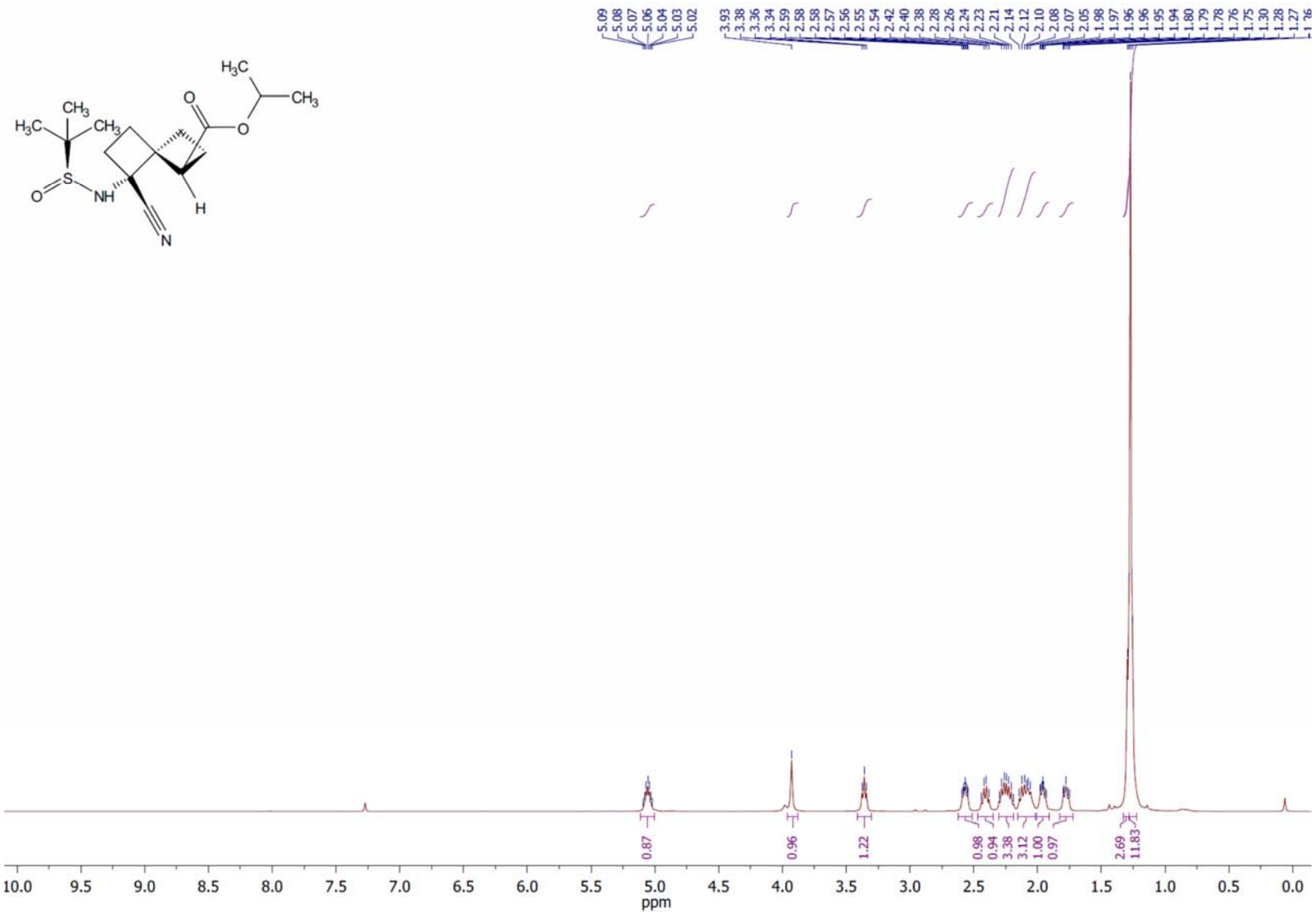
^{1}H NMR spectrum of compound **59**



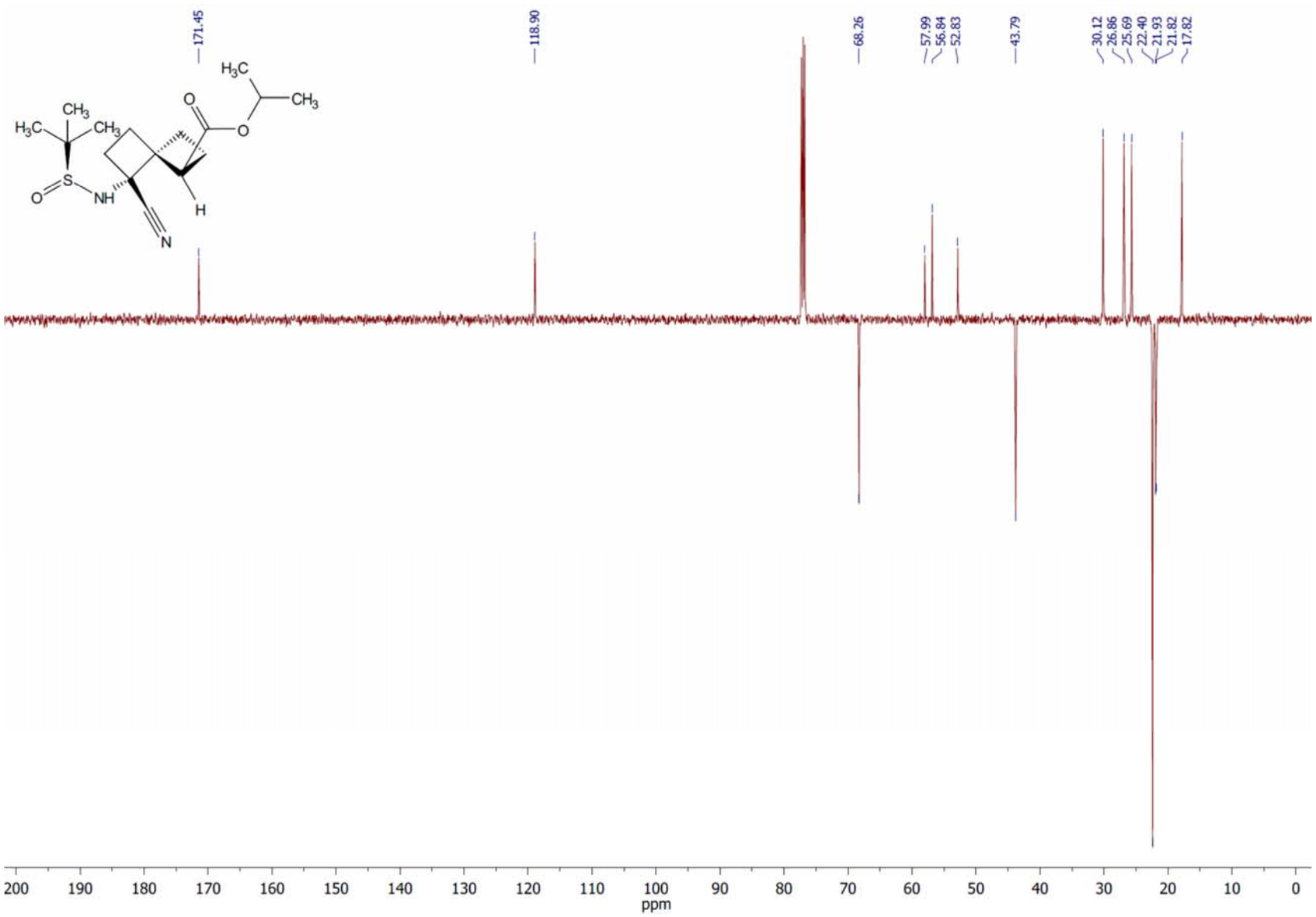
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **59**



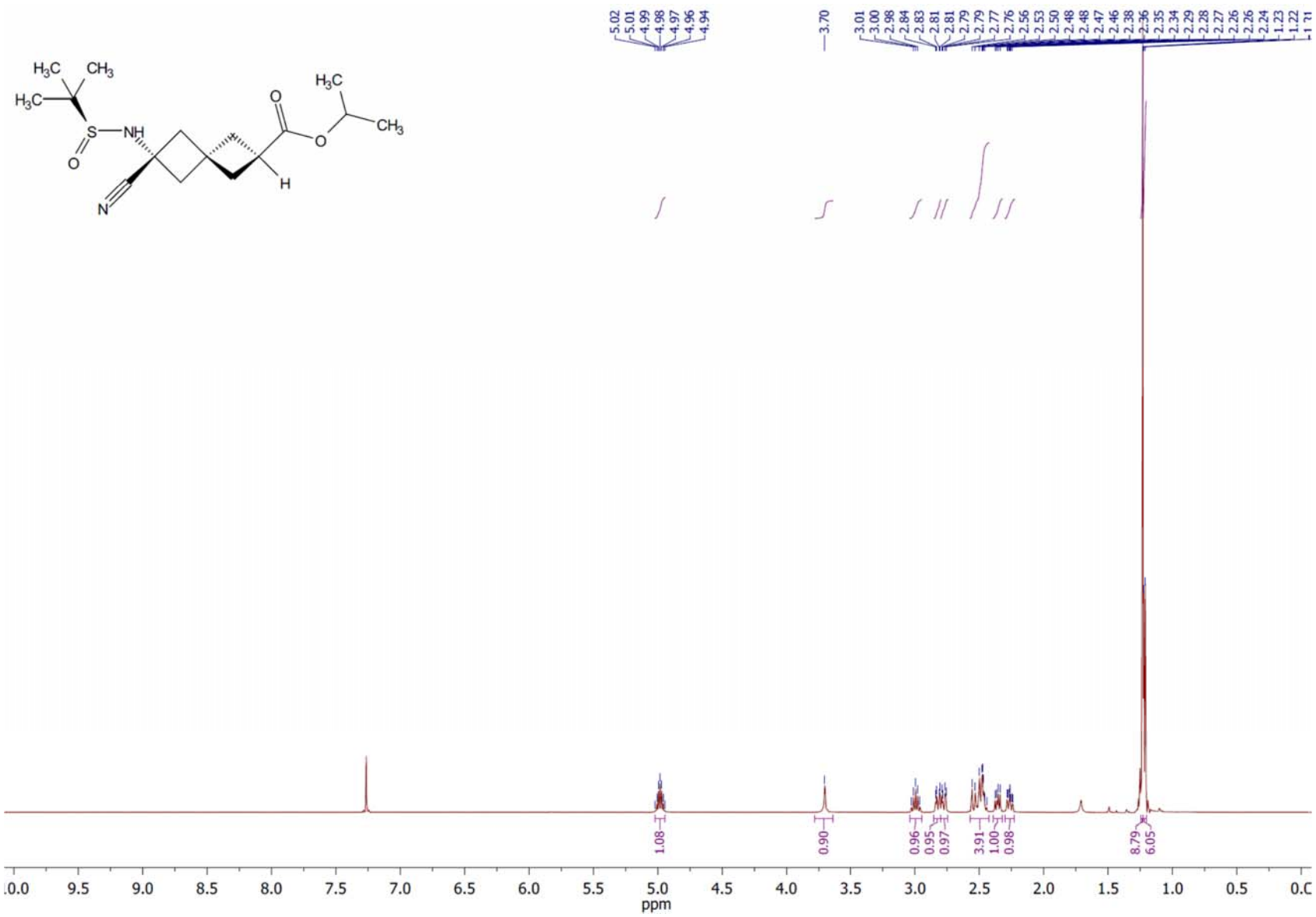
^{1}H NMR spectrum of compound **60**



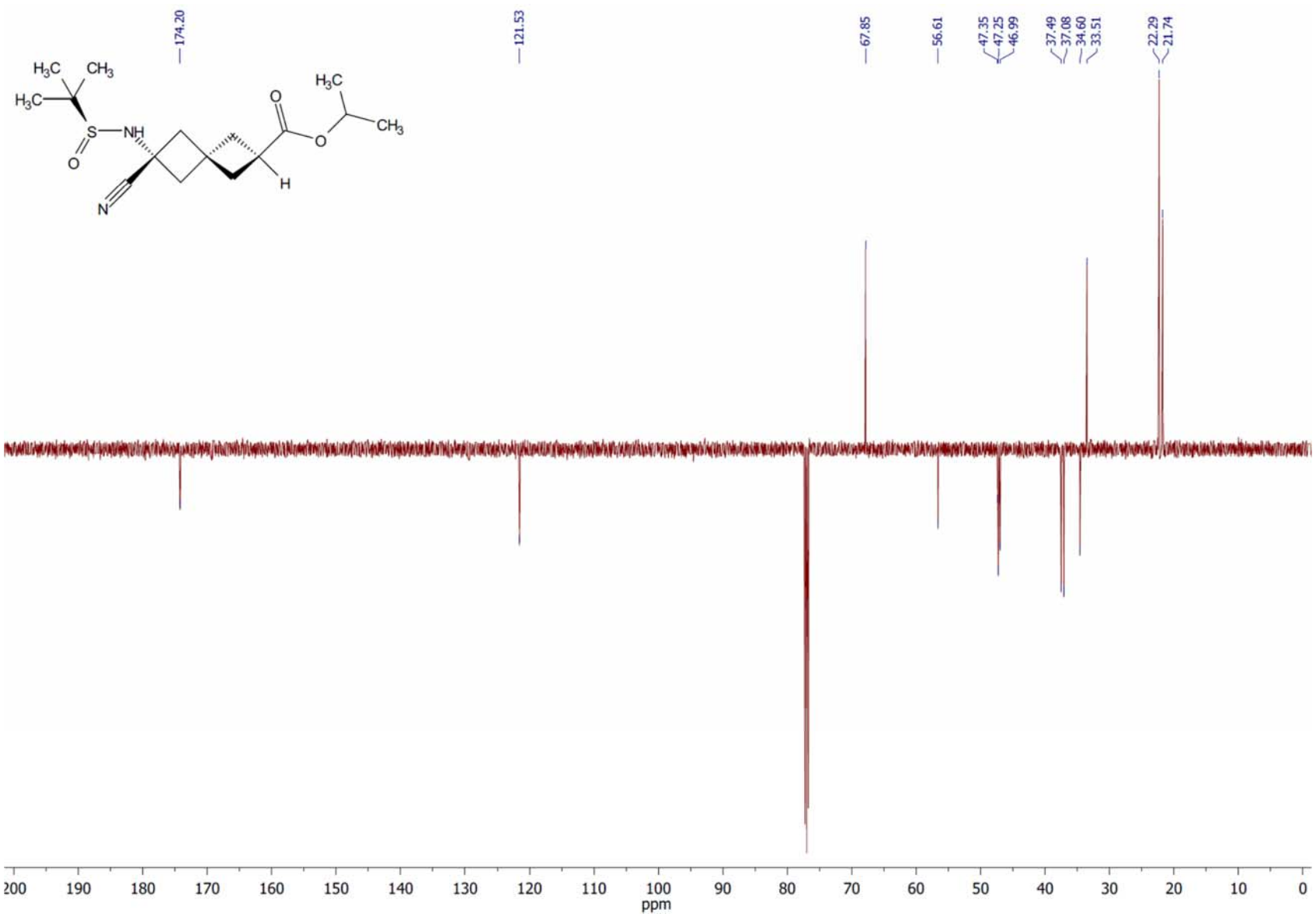
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **60**



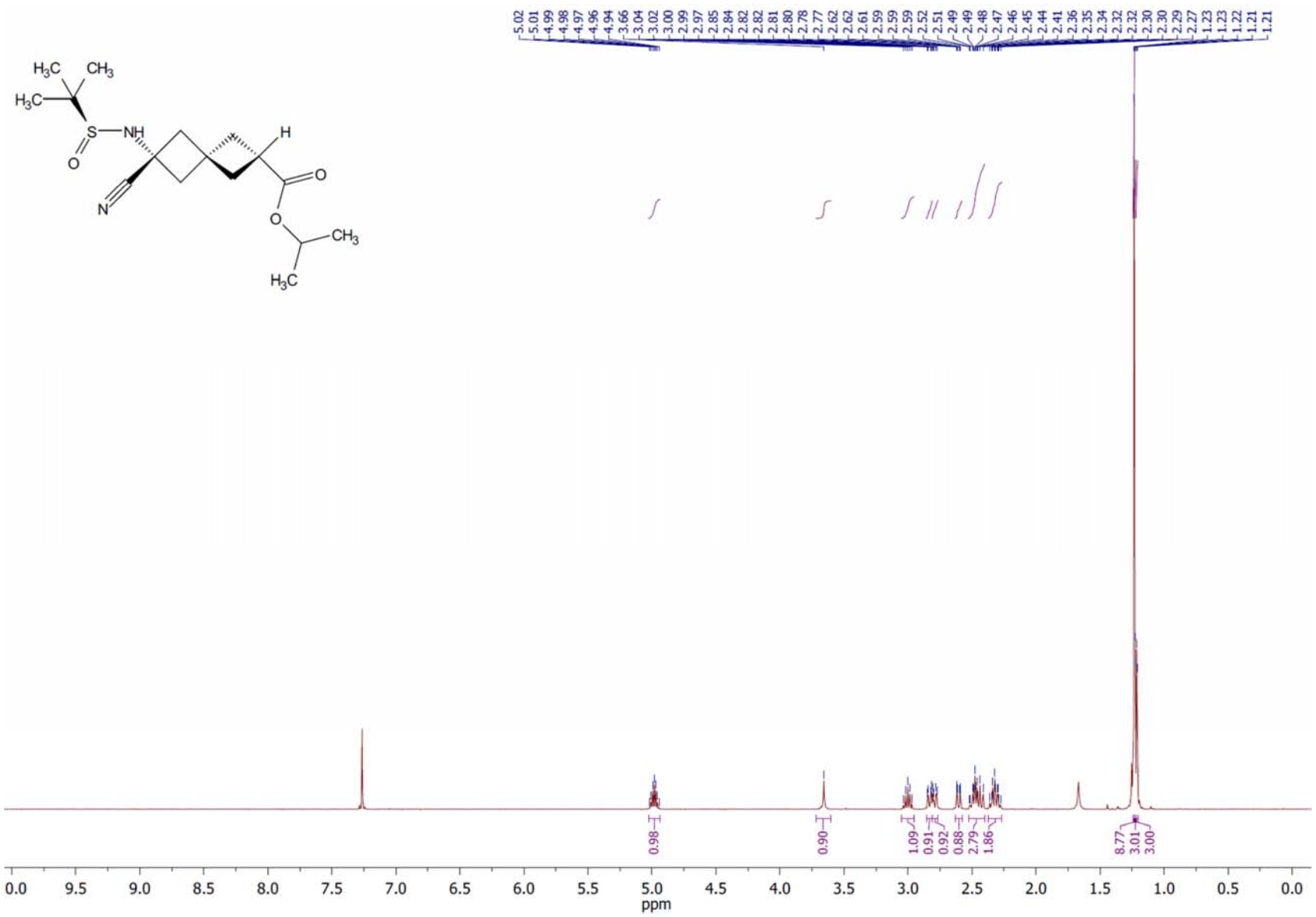
^{1}H NMR spectrum of compound **62a**



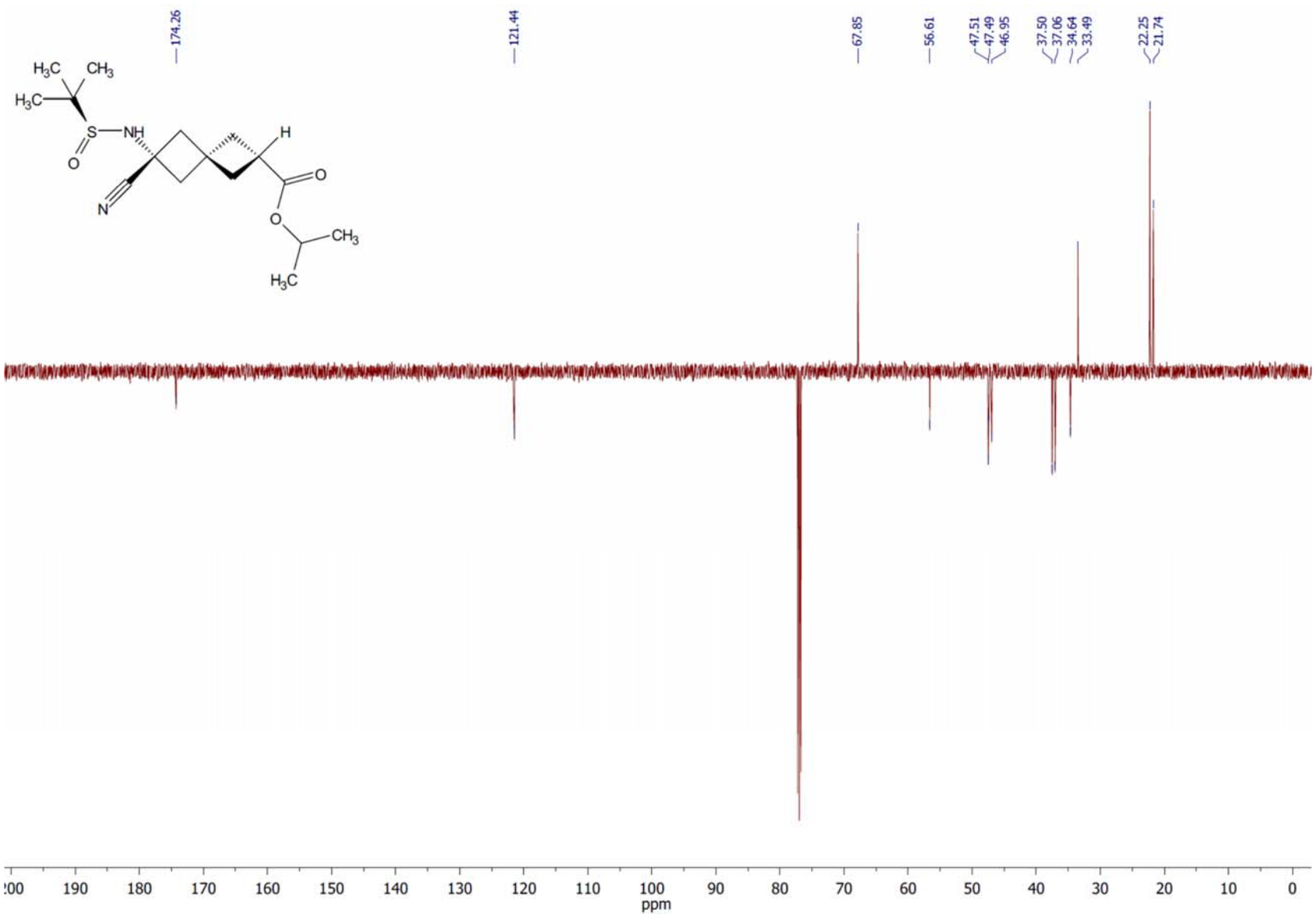
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **62a**



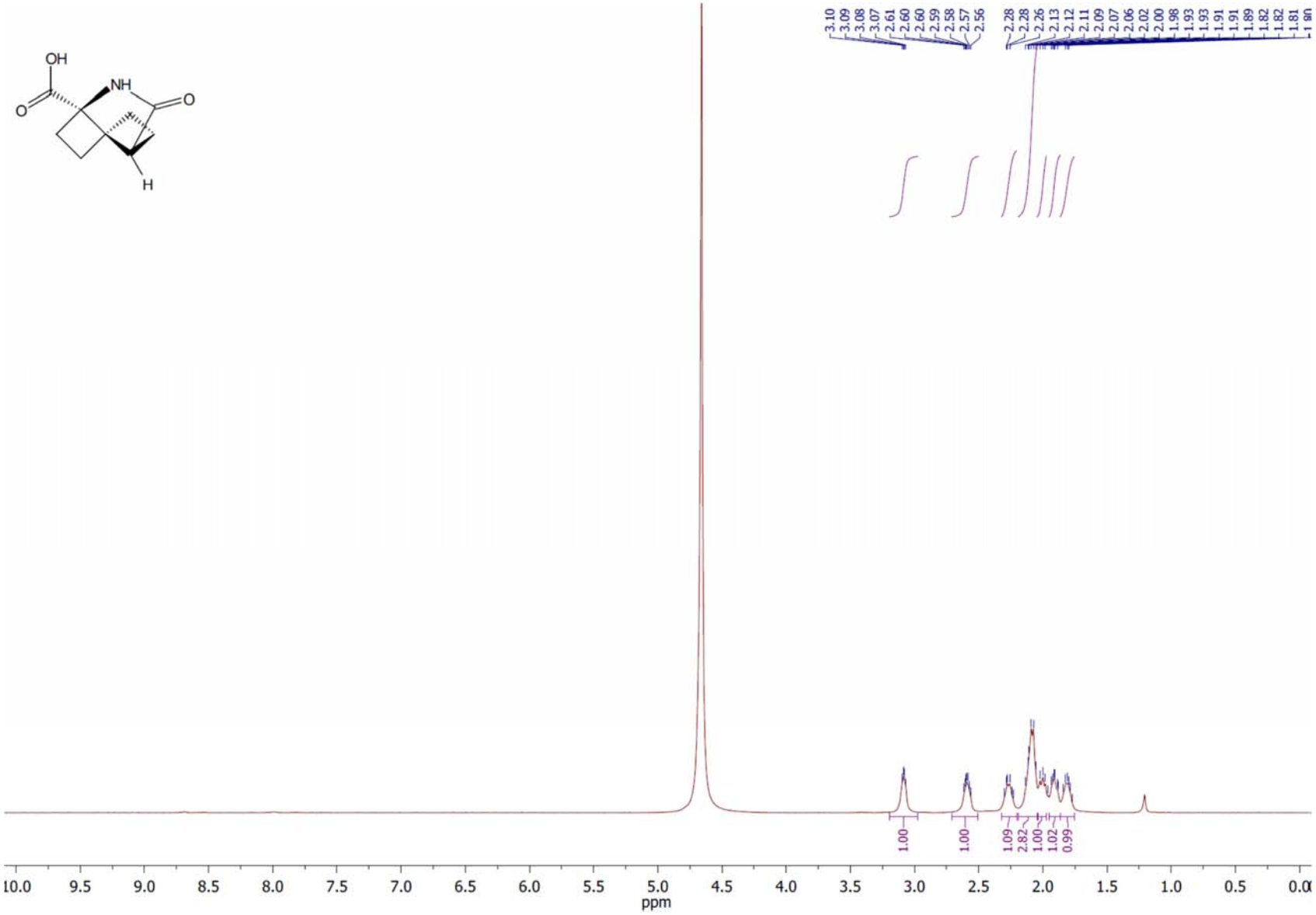
^{1}H NMR spectrum of compound **62b**



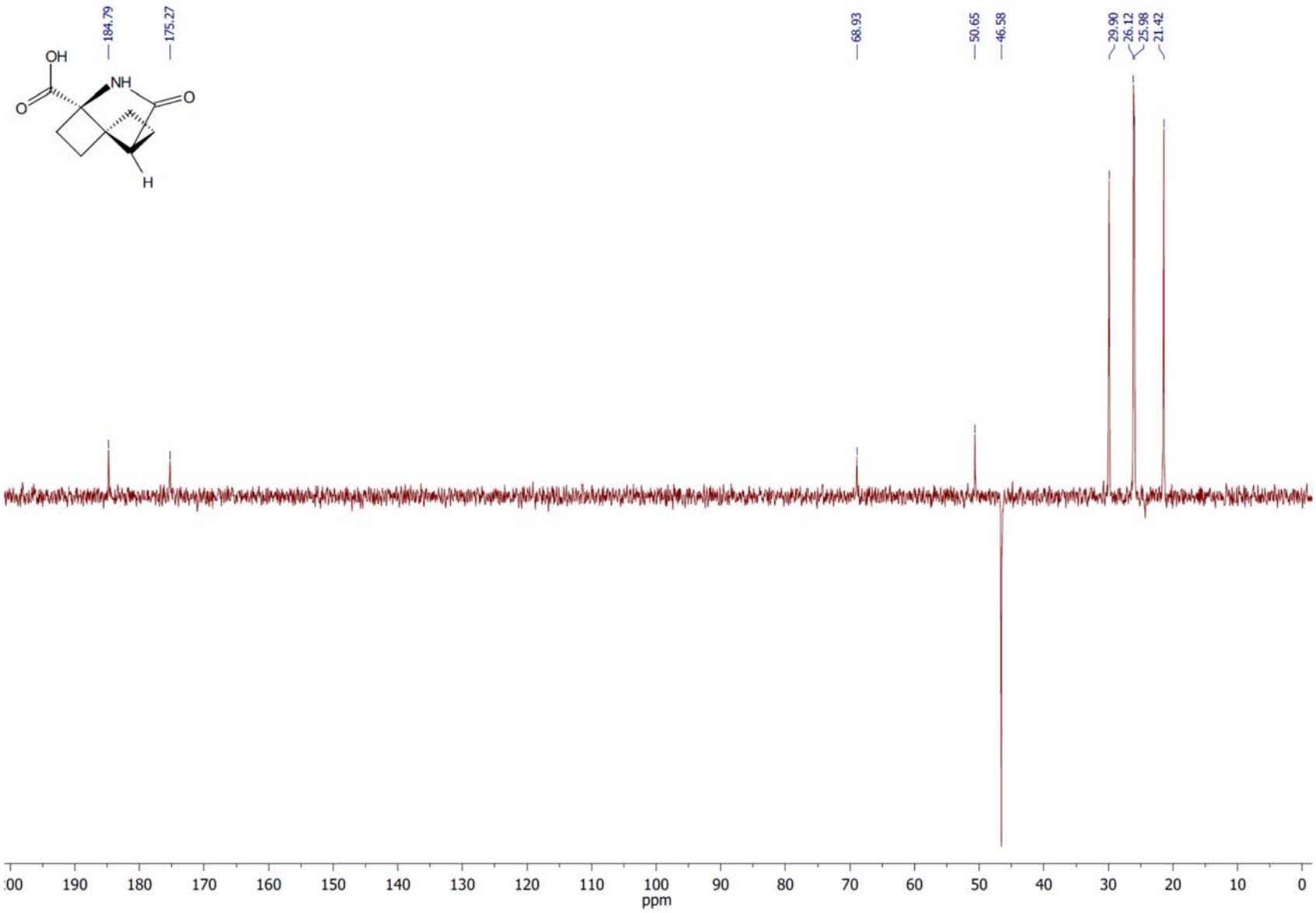
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **62b**



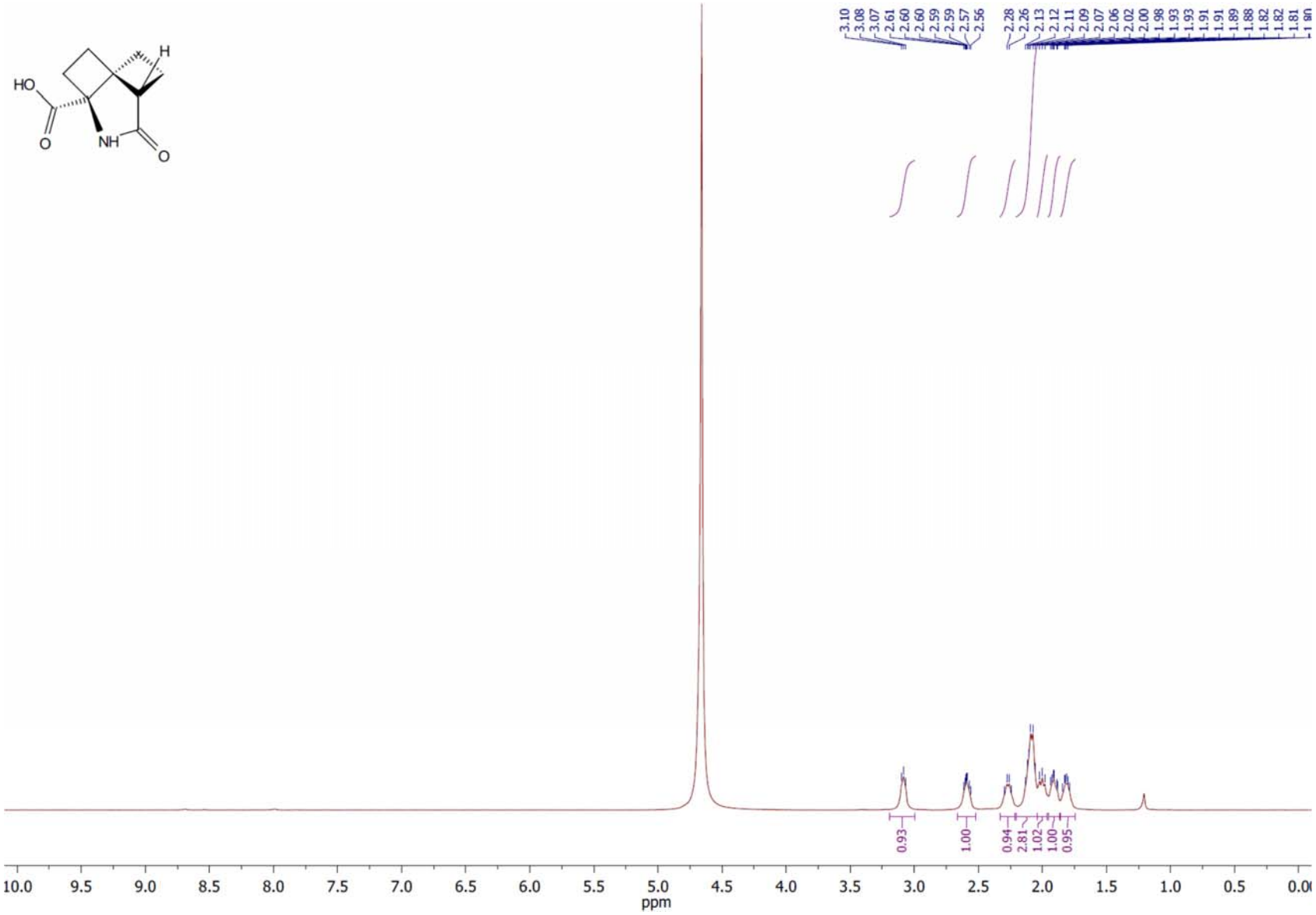
^{1}H NMR spectrum of compound **63a**



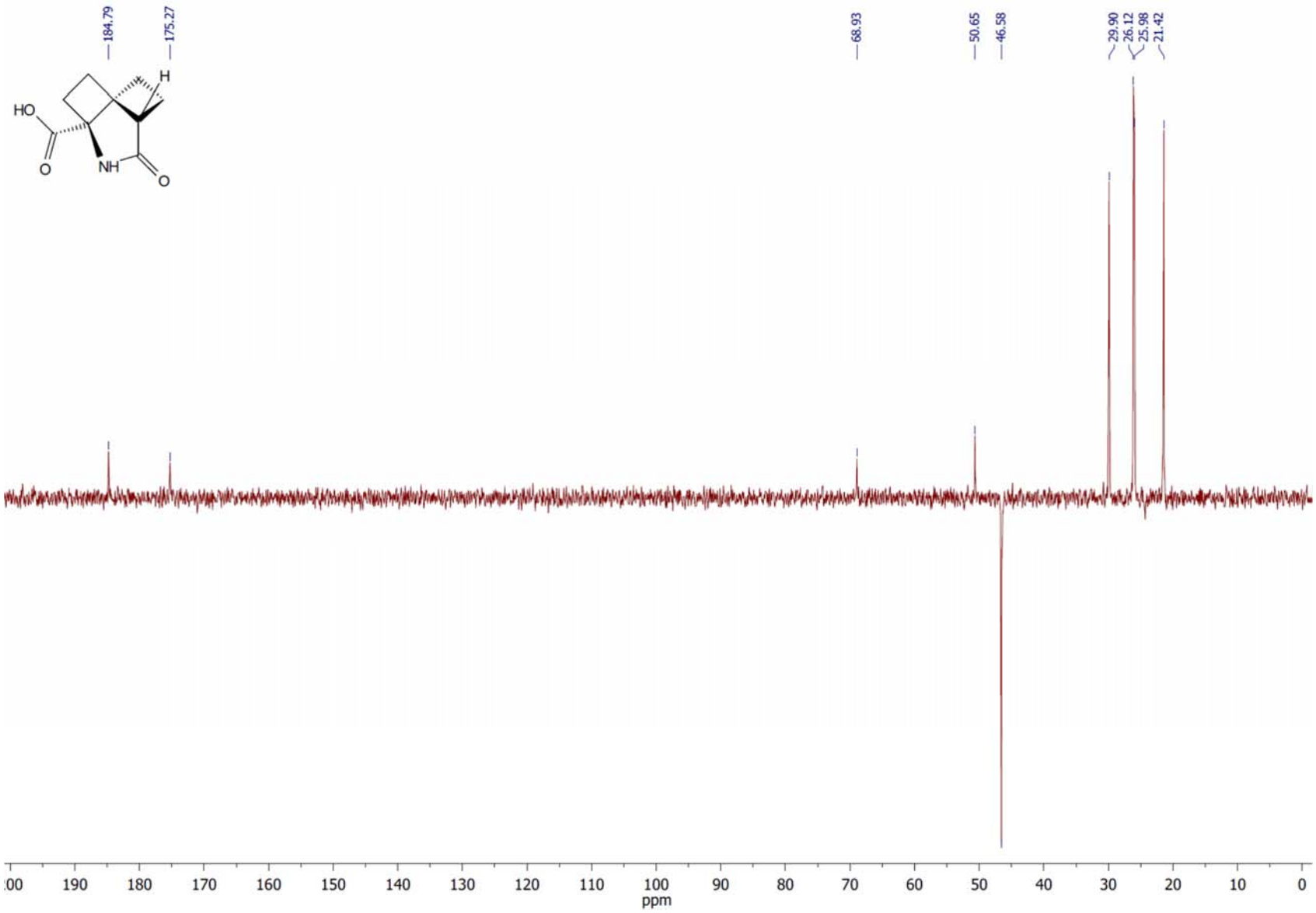
APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **63a**



^{1}H NMR spectrum of compound **63b**



APT $^{13}C\{^{1}H\}$ NMR spectrum of compound **63b**



X-Ray diffraction studies and ORTEP diagrams of compounds 50–62

Crystal data for compound 50a: $C_{16}H_{26}N_2O_3S$, M = 326.45, monoclinic, space group *C2*, *a* = 18.407(3), *b* = 6.1109(8), *c* = 18.265(2)Å, *β* = 118.358(4)º V = 1808.0(4)Å^3, Z = 4, d_c = 1.199 g·cm^{-3}, μ = 0.192 mm^{-1}, F(000) = 704, crystal size ca. 0.07 × 0.13 × 0.52 mm. All crystallographic measurements were performed at 138K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 25.5°$ using Mo-Kα radiation (λ = 0.71073 Å). The intensities of 9459 reflections were collected (3160 unique reflections, R_{merg} = 0.0333). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen was found in DF synthesis of the electron density maps and refined isotropically. The solvate water molecule could not be modeled satisfactorily thus SQUEEZE routine in the PLATON software[2, 3] were applied for correction of the data. Convergence was obtained at R_1 = 0.0332 and wR_2 = 0.0715 for 2877 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0. 0388 and wR_2 = 0.0739, GOF = 1.047 for 3160 independent reflections, 203 parameters, Flack parameter = 0.02(4), the largest and minimal peaks in the final difference map 0.21 and –0.16 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108576. The molecular structure of compound **50a** is shown in Figure S1.

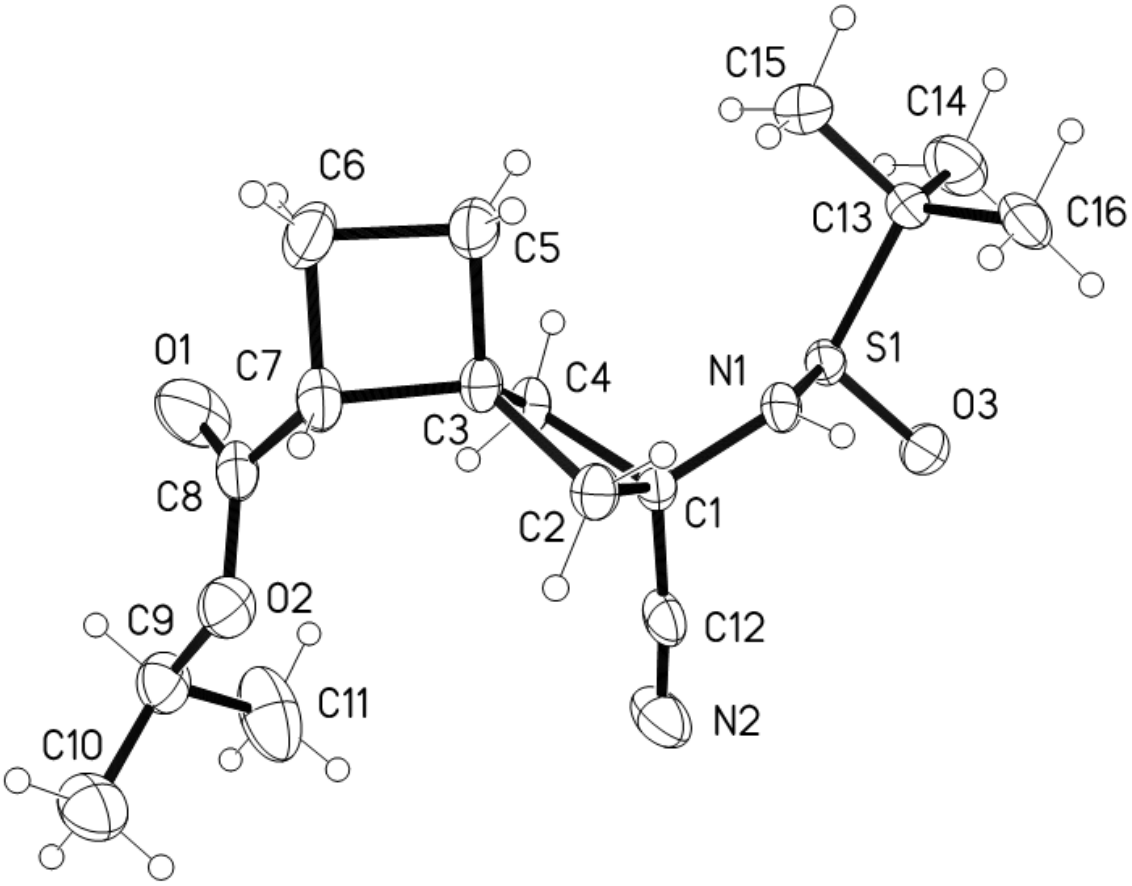


Figure S1. ORTEP diagram of compound **50a** including thermal displacement ellipses with 50% probability.

Crystal data for compound 50b: $C_{16}H_{26}N_2O_3S$, M = 326.45, monoclinic, space group *P2₁*, *a* = 10.091(3), *b* = 6.9401(17), *c* = 13.251(3)Å, *β* = 93.847(10)º, V = 925.9(4)Å^3, Z = 2, d_c = 1.171 g·cm^{-3}, μ = 0.188 mm^{-1}, F(000) = 352, crystal size ca. 0.07 × 0.25 × 0.50 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 26.6°$ using Mo-K_α radiation (λ = 0.71073 Å). The intensities of 14193 reflections were collected (3777 unique reflections, R_{merg} = 0.0511). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0450 and wR_2 = 0.0988 for 3118 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0. 0591 and wR_2 = 0.1064, GOF = 1.055 for 3777 independent reflections, 197 parameters, Flack parameter = 0.01(6), the largest and minimal peaks in the final difference map 0.26 and –0.25e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108577. The molecular structure of compound **50b** is shown in Figure S2.

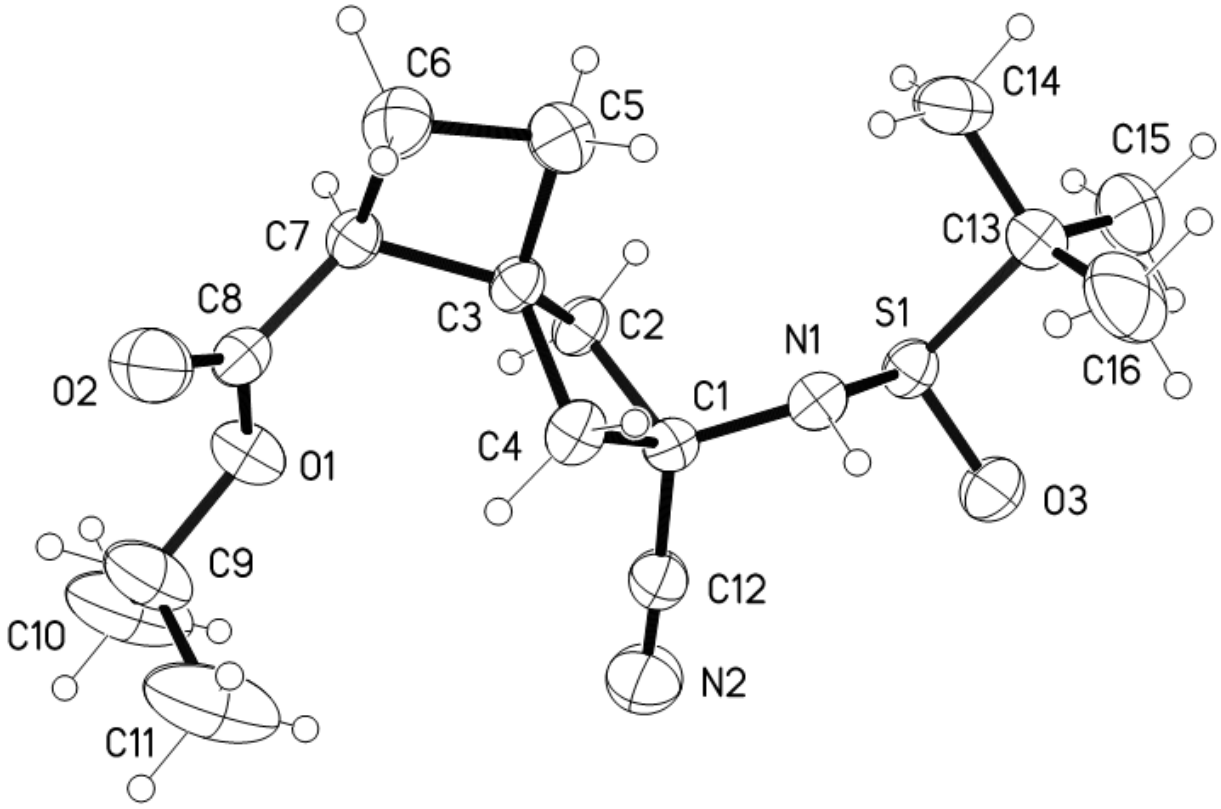


Figure S2. ORTEP diagram of compound **50b** including thermal displacement ellipses with 50% probability

Crystal data for compound 51a: $C_{16}H_{26}N_2O_3S$, M = 326.45, monoclinic, space group *P2₁*, *a* = 9.675(2), *b* = 8.970(2), *c* = 11.079(3)Å, *β* = 112.311(9)º, V = 889.5(4)Å^3, Z = 2, d_c = 1.219 g·cm^{-3}, μ = 0.195 mm^{-1}, F(000) = 352, crystal size ca. 0.38 × 0.43 × 0.48 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 25.05°$ using Mo-K$_\alpha$ radiation (λ = 0.71073 Å). The intensities of 8575 reflections were collected (3026 unique reflections, $R_{me}R_g$ = 0.0261). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0310 and wR_2 = 0.0784 for 2903 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0.0331 and wR_2 = 0.0799, GOF = 1.002 for 3026 independent reflections, 203 parameters, Flack parameter = 0.03(3), the largest and minimal peaks in the final difference map 0.21 and –0.18 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108578. The molecular structure of compound **51a** is shown in Figure S3.

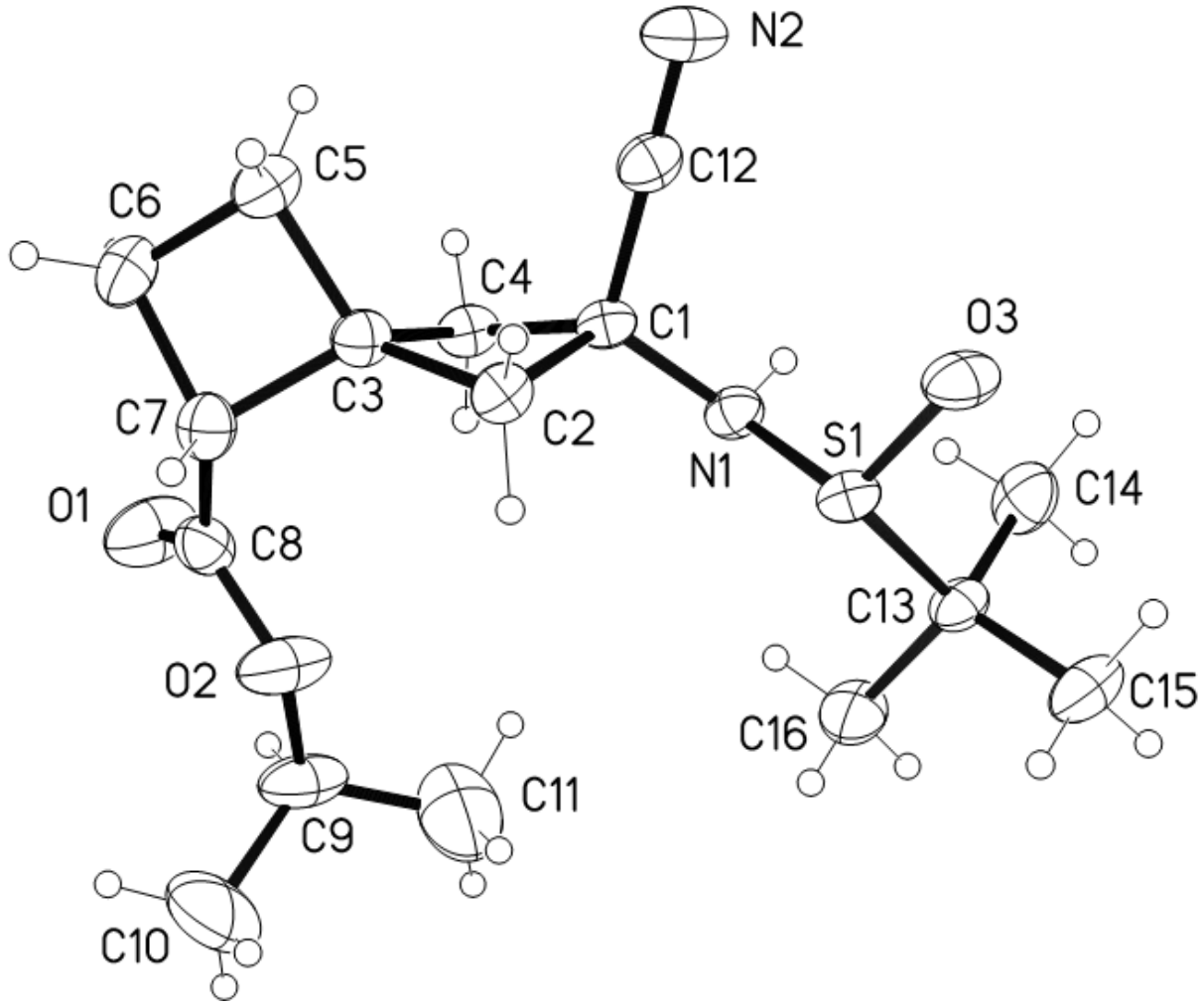


Figure S3. ORTEP diagram of compound **51a** including thermal displacement ellipses with 50% probability.

Crystal data for compound 51b: $C_{16}H_{26}N_2O_3S$, M = 326.45, monoclinic, space group *P2₁*, *a* = 9.705(3), *b* 8.9445(19), *c* = 11.226(2)Å, *β* = 110.390(4)º, V = 913.4(4)Å^3, Z = 2, d_c = 1.187 g·cm^{-3}, μ = 0.190 mm^{-1}, F(000) = 352, crystal size ca. 0.19 × 0.26 × 0.32 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 27.26°$ using Mo-K$_\alpha$ radiation (λ = 0.71073 Å). The intensities of 14266 reflections were collected (4062 unique reflections, $R_{me}R_g$ = 0.0498). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0428 and wR_2 = 0.0913 for 3359 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0. 0579 and wR_2 = 0.0974, GOF = 1.049 for 4062 independent reflections, 203 parameters, Flack parameter = -0.04(4), the largest and minimal peaks in the final difference map 0.22 and –0.22 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108579. The molecular structure of compound **51b** is shown in Figure S4.

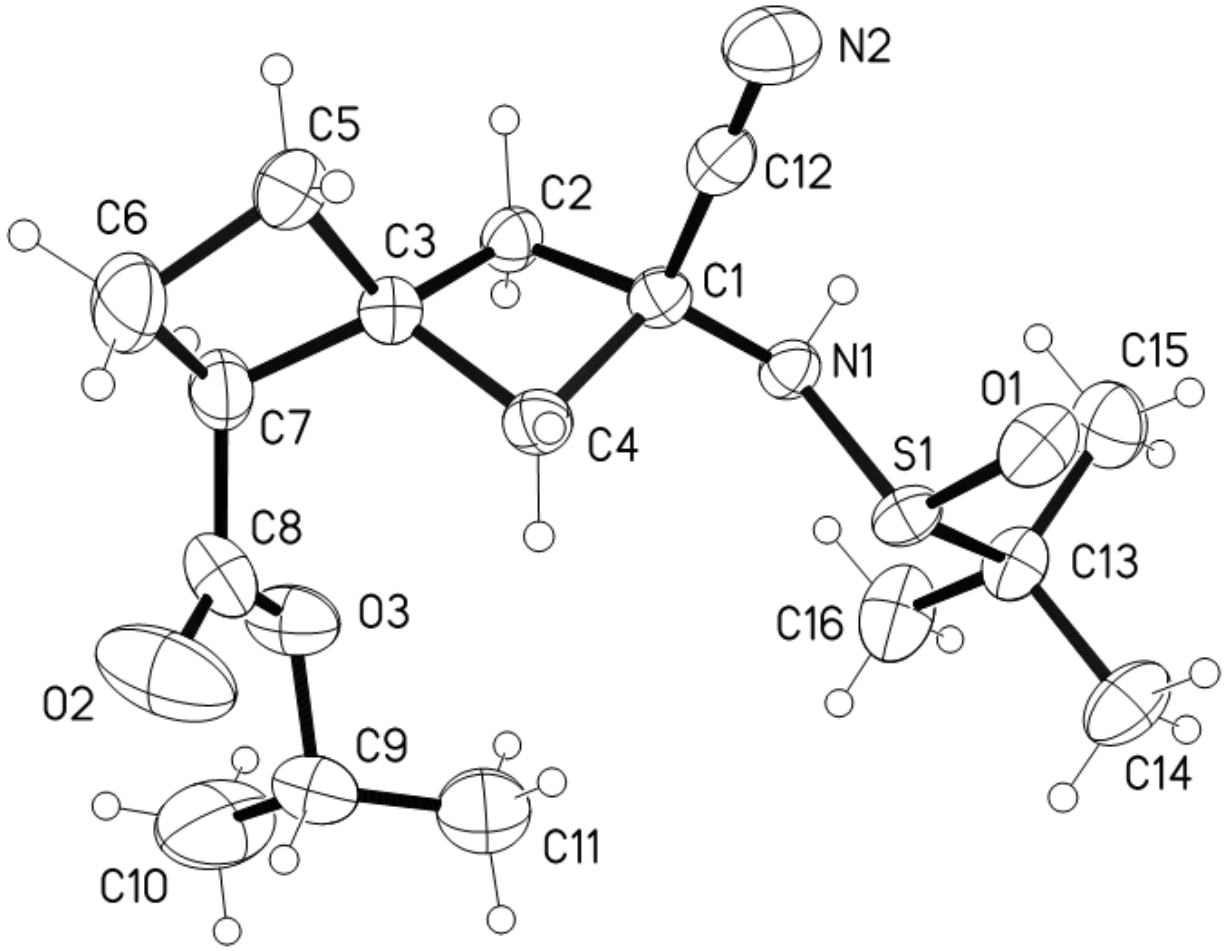


Figure S4. ORTEP diagram of compound **51b** including thermal displacement ellipses with 50% probability.

Crystal data for compound 52a: $C_{16}H_{26}N_2O_3S$, M = 326.45, orthorhombic, space group $P2_12_12_1$, a = 9.5944(16), b = 12.7794(19), c = 14.847(3)Å, V = 1820.4(6)Å^3, Z = 4, d_c = 1.191 g·cm^{-3}, μ = 0.191 mm^{-1}, F(000) = 704, crystal size ca. 0.17 × 0.30 × 0.45 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 26.0°$ using Mo-K_α radiation (λ = 0.71073 Å). The intensities of 17158 reflections were collected (3577 unique reflections, $R_{me}R_g$ = 0.0496). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0384 and wR_2 = 0.0763 for 2998 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0. 0511 and wR_2 = 0.0812, GOF = 1.034 for 3577 independent reflections, 206 parameters, Flack parameter = 0.04(4), the largest and minimal peaks in the final difference map 0.22 and –0.23 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108580. The molecular structure of compound **52a** is shown in Figure S5.

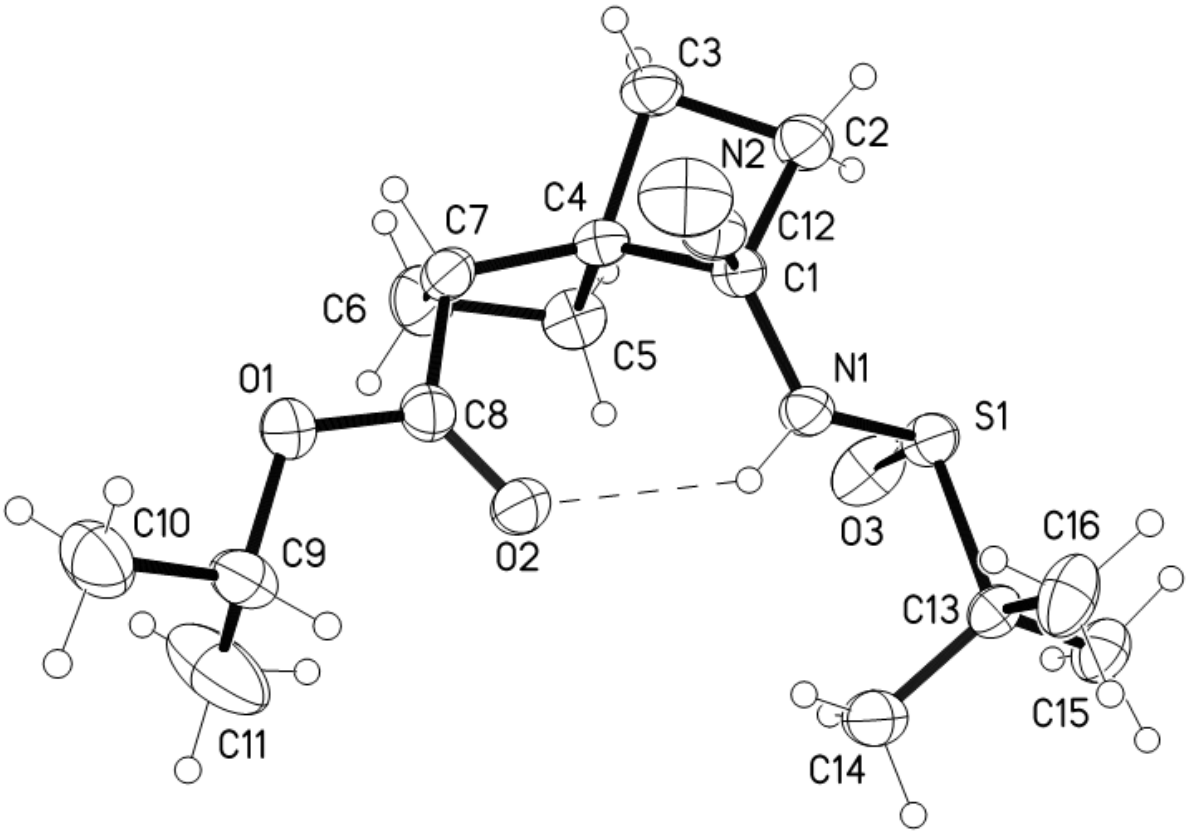


Figure S5. ORTEP diagram of compound **52a** including thermal displacement ellipses with 50% probability.

Crystal data for compound 52b: $C_{16}H_{26}N_2O_3S$, M = 326.45, hexagonal, space group *P6₅*, *a* = 11.311(3), *c* = 25.025(16)Å, V = 2773(2)Å^3, Z = 6, d_c = 1.173 g·cm^{-3}, μ = 0.188 mm^{-1}, F(000) = 1056, crystal size ca. 0.14 × 0.33 × 0.36 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 26.4°$ using Mo-Kα radiation (λ = 0.71073 Å). The intensities of 30833 reflections were collected (3791 unique reflections, $R_{me}R_g$ = 0.0847). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0401 and wR_2 = 0.0701 for 2854 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0. 0697 and wR_2 = 0.0807, GOF = 1.013 for 3791 independent reflections, 208 parameters, Flack parameter = 0.05(5), the largest and minimal peaks in the final difference map 0.18 and –0.23 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108581. The molecular structure of compound **52b** is shown in Figure S6.

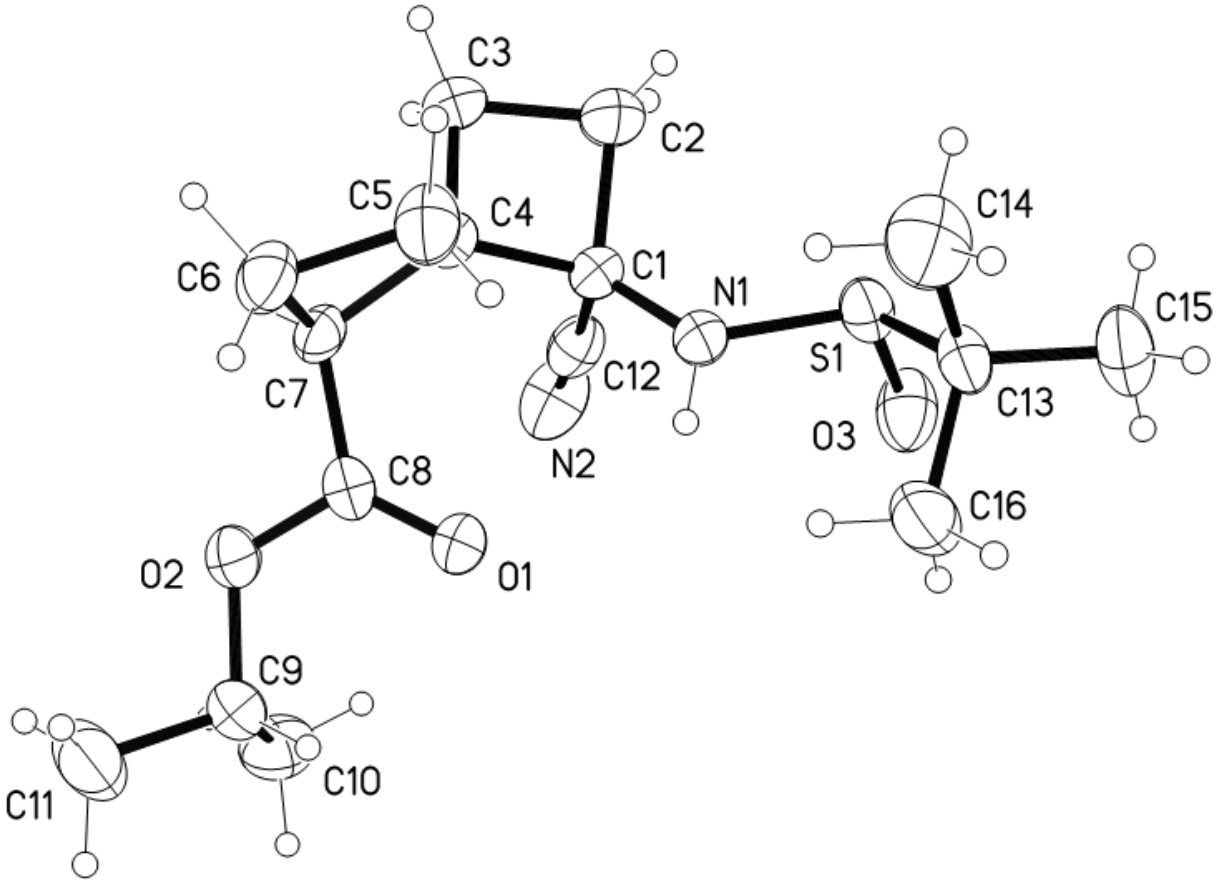


Figure S6. ORTEP diagram of compound **52b** including thermal displacement ellipses with 50% probability.

Crystal data for compound 53a: $C_{16}H_{26}N_2O_3S$, C_9 H_{10} N_2 O, M = 488.64, orthorhombic, space group $P2_12_12_1$, a = 11.3229(14), b = 12.9953(15), c = 17.423(2)Å, V = 2563.7(5)Å^3, Z = 4, d_c = 1.266 g·cm^{-3}, μ = 0.164 mm^{-1}, F(000) = 1048, crystal size ca. 0.22 × 0.26 × 0.37 mm. All crystallographic measurements were performed at 138K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 25.5°$ using Mo-Kα radiation (λ = 0.71073 Å). The intensities of 26501 reflections were collected (4768 unique reflections, $R_{me}R_g$ = 0.0734). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0401 and wR_2 = 0.0767 for 3834 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0. 0605 and wR_2 = 0.0838, GOF = 1.028 for 4768 independent reflections, 318 parameters, Flack parameter = -0.04(5), the largest and minimal peaks in the final difference map 0.18 and –0.20 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108582. The molecular structure of compound **53a** is shown in Figure S7.

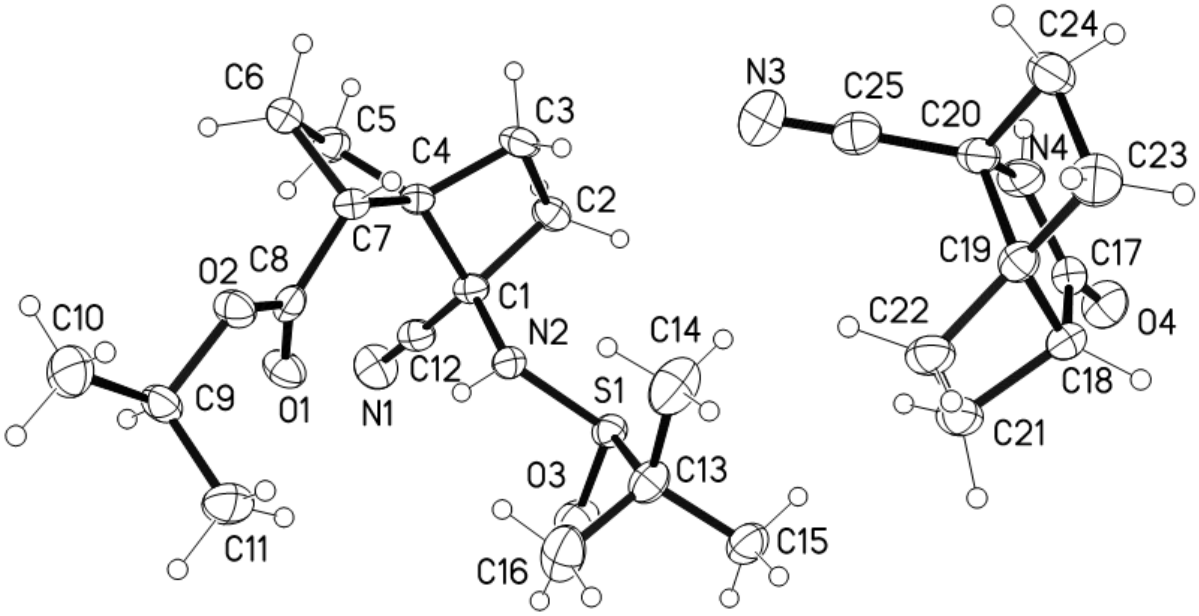


Figure S7. ORTEP diagram of compound **53a** including thermal displacement ellipses with 50% probability.

Crystal data for compound 54b: $C_{16}H_{26}N_2O_3S$, M = 326.45, trigonal, space group *P3₁*, *a* = 9.7014(14), *c* = 16.297(3)Å, V = 1328.3(4)Å^3, Z = 3, d_c = 1.224 g·cm^{-3}, μ = 0.196 mm^{-1}, F(000) = 528, crystal size ca. 0.10 × 0.12 × 0.46 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 25.5°$ using Mo-K_α radiation (λ = 0.71073 Å). The intensities of 8230 reflections were collected (2879 unique reflections, $R_{me}R_g$ = 0.0634). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0394 and wR_2 = 0.0656 for 2074 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0.0599 and wR_2 = 0.0708, GOF = 0.728 for 2879 independent reflections, 203 parameters, Flack parameter = 0.11(7), the largest and minimal peaks in the final difference map 0.15 and –0.17 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108583. The molecular structure of compound **54b** is shown in Figure S8.

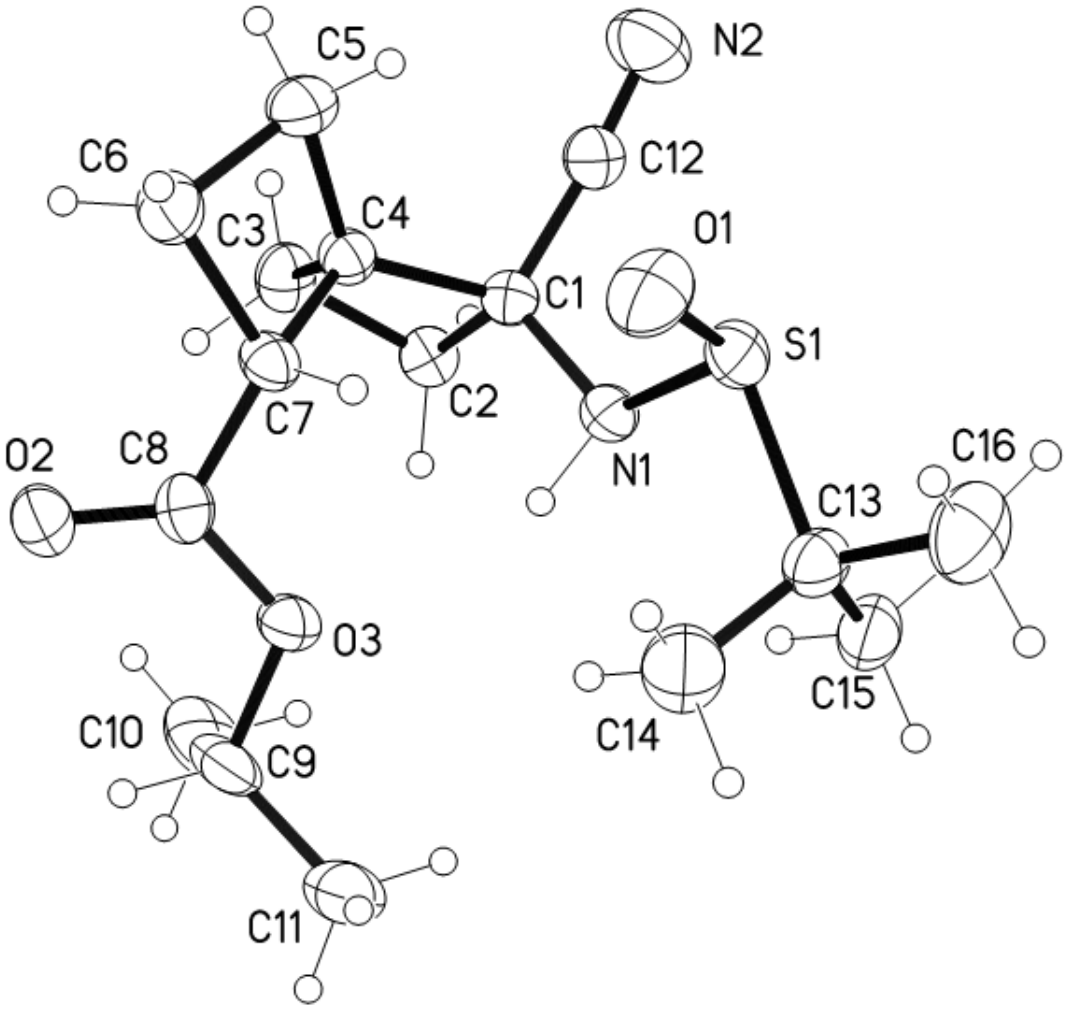


Figure S8. ORTEP diagram of compound **54b** including thermal displacement ellipses with 50% probability.

Crystal data for compound 55a: $C_{16}H_{26}N_2O_3S$, M = 326.45, trigonal, space group *P3₁*, *a* = 10.673(3), *c* = 13.675(8)Å, V = 1349.0(12)Å^3, Z = 3, d_c = 1.206 g·cm^{-3}, μ = 0.193 mm^{-1}, F(000) = 528, crystal size ca. 0.13 × 0.13 × 0.50 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 26.4°$ using Mo-K_α radiation (λ = 0.71073 Å). The intensities of 4749 reflections were collected (3326 unique reflections, $R_{me}R_g$ = 0.0673). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0679 and wR_2 = 0.1142 for 1947 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0.1236 and wR_2 = 0.1409, GOF = 0.944 for 3326 independent reflections, 203 parameters, Flack parameter = –0.14(16), the largest and minimal peaks in the final difference map 0.28 and –0.40 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108584. The molecular structure of compound **55a** is shown in Figure S9.

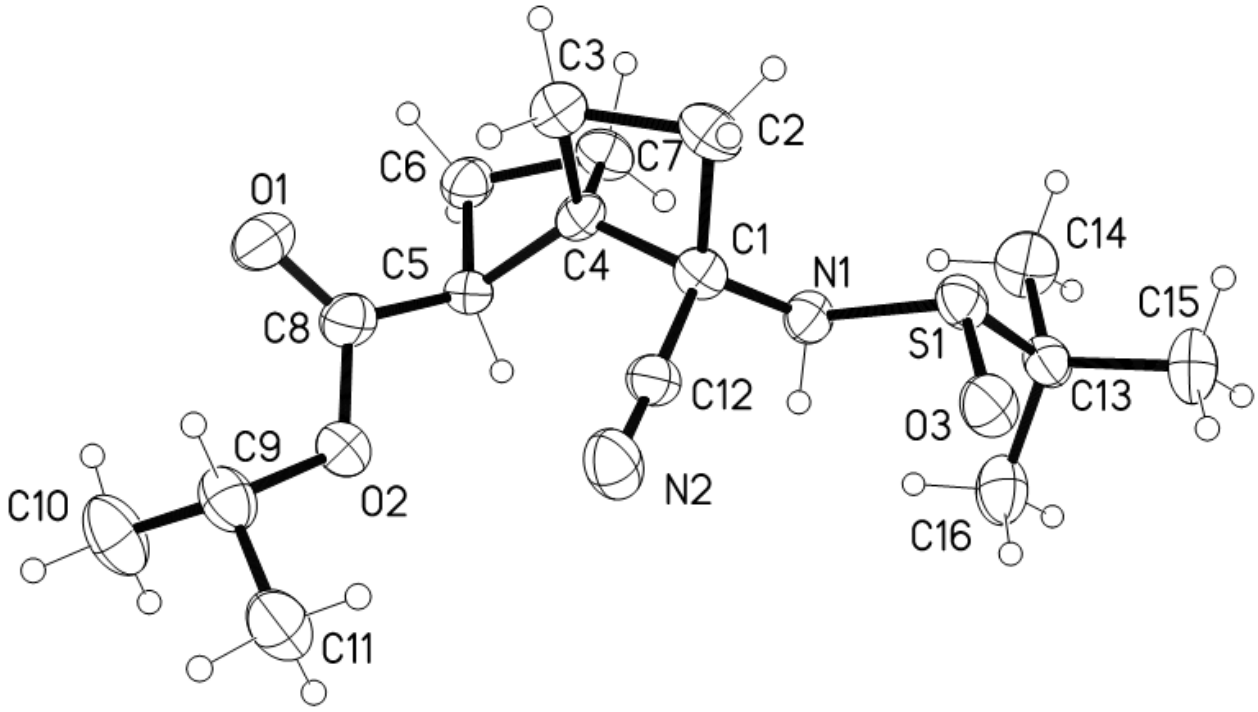


Figure S9. ORTEP diagram of compound **55a** including thermal displacement ellipses with 50% probability.

Crystal data for compound 59: $C_{16}H_{26}N_2O_3S$, M = 326.45, trigonal, space group *P3₂*, *a* = 9.6924(9), *c* = 16.293(4)Å, V = 1325.5(4)Å^3, Z = 3, d_c = 1.227 g·cm^{-3}, μ = 0.197 mm^{-1}, F(000) = 528, crystal size ca. 0.07 × 0.36 × 0.50 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 25.5°$ using Mo-K_α radiation (λ = 0.71073 Å). The intensities of 7786 reflections were collected (2911 unique reflections, $R_{me}R_g$ = 0.0529). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0815 and wR_2 = 0.3003 for 2449 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0. 0923 and wR_2 = 0.3115, GOF = 1.143 for 2911 independent reflections, 206 parameters, Flack parameter = 0.06(5), the largest and minimal peaks in the final difference map 0.55 and –0.45 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108585. The molecular structure of compound[**59** is shown in Figure S10.

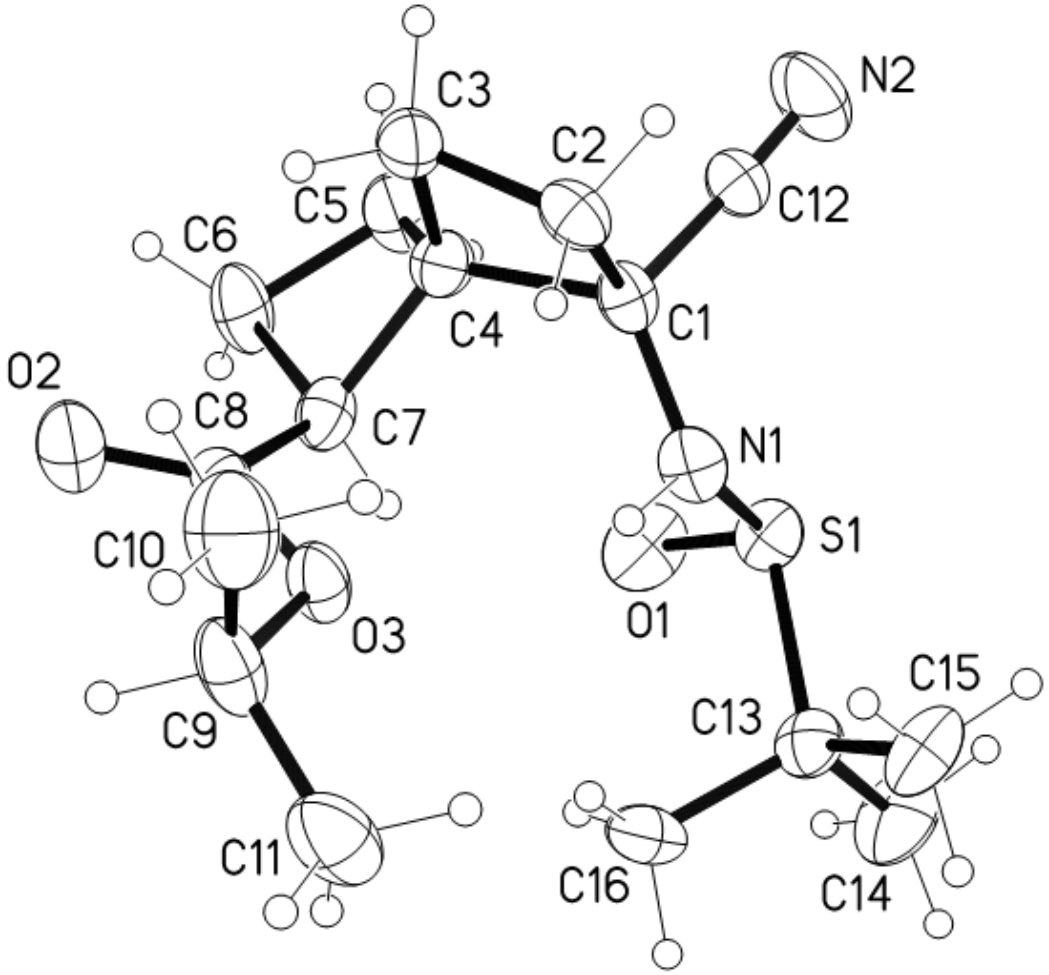


Figure S10. ORTEP diagram of compound **59** including thermal displacement ellipses with 50% probability.

Crystal data for compound 60: $C_{16}H_{26}N_2O_3S$, M = 326.45, trigonal, space group *P3₂*, *a* = 10.6671(8), *c* = 13.665(2)Å, V = 1346.5(3)Å^3, Z = 3, d_c = 1.208 g·cm^{-3}, μ = 0.194 mm^{-1}, F(000) = 528, crystal size ca. 0.14 × 0.13 × 0.50 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 26.0°$ using Mo-K_α radiation (λ = 0.71073 Å). The intensities of 10864 reflections were collected (3414 unique reflections, $R_{me}R_g$ = 0.0537). The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0391 and wR_2 = 0.0708 for 2876 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0. 0505 and wR_2 = 0.0735, GOF = 0.955 for 3414 independent reflections, 206 parameters, Flack parameter = -0.01(4), the largest and minimal peaks in the final difference map 0.18 and –0.26 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108586. The molecular structure of compound **60** is shown in Figure S11.

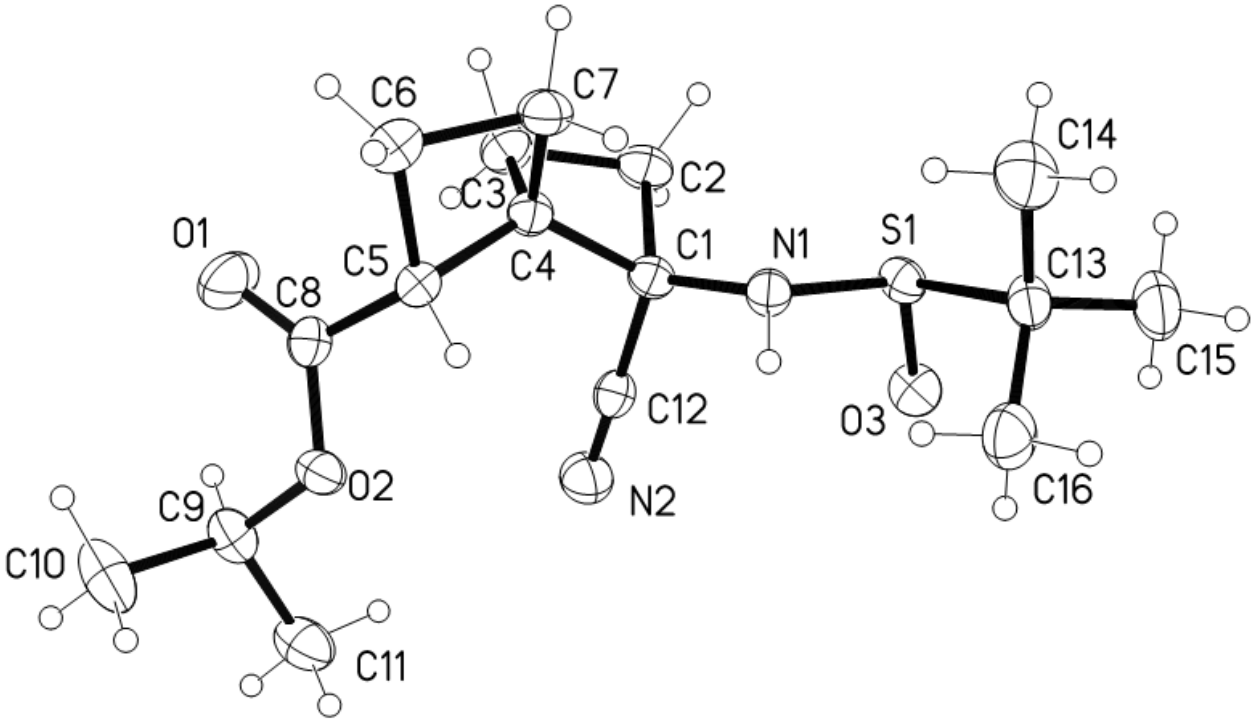


Figure S11. ORTEP diagram of compound **60** including thermal displacement ellipses with 50% probability.

Crystal data for compound 62a: $C_{16}H_{26}N_2O_3S$, M = 326.45, monoclinic, space group *P2₁*, *a* = 6.1605(12), *b* = 9.3672(16), *c* = 32.178(7)Å, *β* = 94.850(8)º, V = 1850.2(6)Å^3, Z = 4, d_c = 1.172 g·cm^{-3}, μ = 0.188 mm^{-1}, F(000) = 704, crystal size ca. 0.08 × 0.16 × 0.50 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 25.5°$ using Mo-Kα radiation (λ = 0.71073 Å). The intensities of 17702 reflections were collected (6575 unique reflections, $R_{me}R_g$ = 0.0510. The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0512 and wR_2 = 0.0985 for 5257 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0. 0692 and wR_2 = 0.1060, GOF = 1.010 for 6575 independent reflections, 479 parameters, Flack parameter = 0.03(5), the largest and minimal peaks in the final difference map 0.26and –0.23 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108587. The molecular structure of compound **62a** is shown in Figure S12.

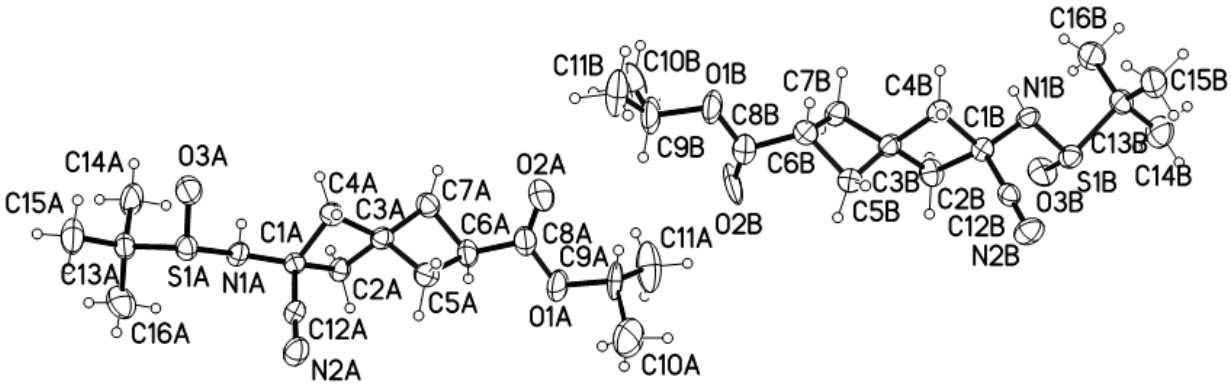


Figure S12. ORTEP diagram of compound **62a** including thermal displacement ellipses with 50% probability (two independent molecules are shown).

Crystal data for compound 62b: $C_{16}H_{26}N_2O_3S$, M = 326.45, orthorhombic, space group $P2_12_12_1$, a = 7.0729(19), b = 9.1807(18), c = 28.272(6)Å, V = 1835.8(7)Å^3, Z = 4, d_c = 1.181 g·cm^{-3}, μ = 0.189 mm^{-1}, F(000) = 704, crystal size ca. 0.03 × 0.12 × 0.56 mm. All crystallographic measurements were performed at 173 K on a Bruker Smart Apex II diffractometer operating in the ω scans mode. The intensity data were collected within the $\theta_{max} \leq 26.4°$ using Mo-Kα radiation (λ = 0.71073 Å). The intensities of 19832 reflections were collected (3753 unique reflections, $R_{me}R_g$ = 0.0726. The structure was solved by direct methods and refined by the full-matrix least-squares technique in the anisotropic approximation for non-hydrogen atoms using the Bruker SHELXTL program package.[1] All CH hydrogen atoms were placed at calculated positions and refined as 'riding' model, and NH hydrogen atom was found in DF synthesis of the electron density maps and refined isotropically. Convergence was obtained at R_1 = 0.0492 and wR_2 = 0.1010 for 2940 observed reflections with $I \geq 2\sigma(I)$, R_1 = 0. 0707 and wR_2 = 0.1110, GOF = 1.026 for 3753 independent reflections, 206 parameters, Flack parameter = 0.04(6), the largest and minimal peaks in the final difference map 0.27and –0.25 e/Å^3. Full crystallographic details have been deposited at Cambridge Crystallographic Data Centre (CCDC). Any request to the CCDC for these materials should quote the full literature citation and reference number CCDC 2108588. The molecular structure of compound **62b** is shown in Figure S13.

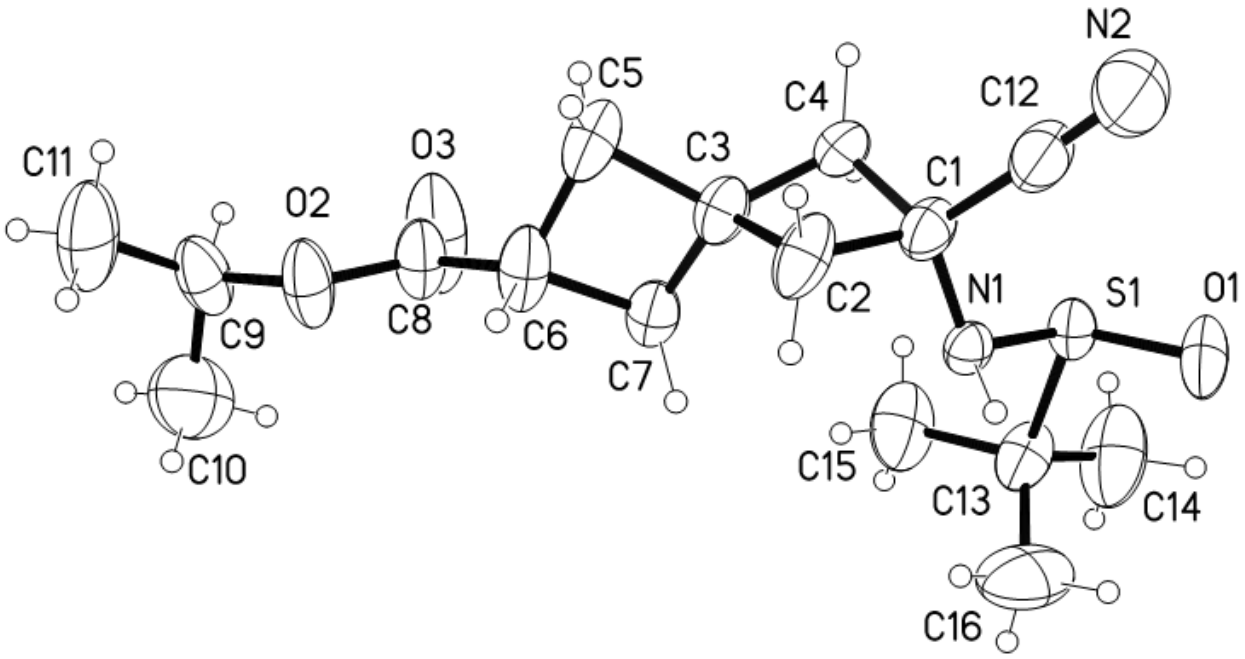
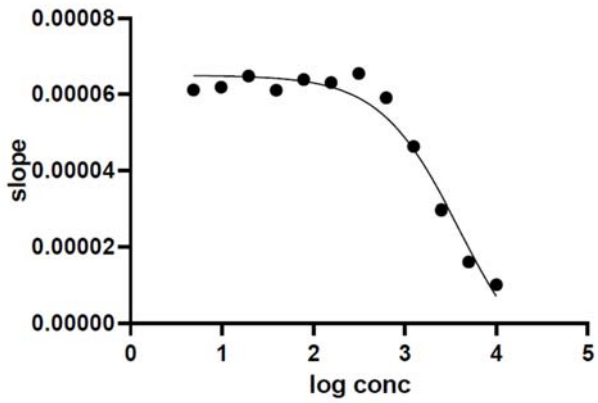
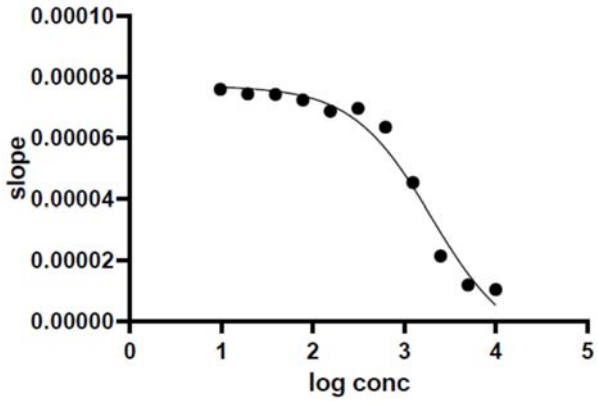


Figure S13. ORTEP diagram of compound **62b** including thermal displacement ellipses with 50% probability.

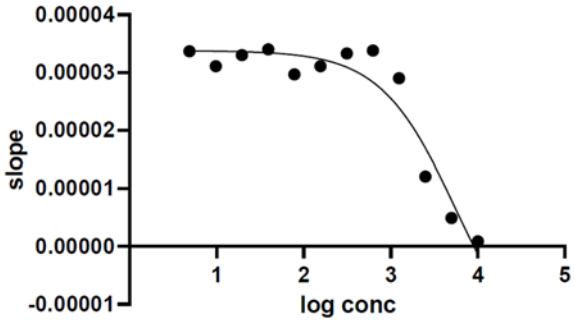
Inhibition of *H. Pylori* glutamate racemase by the spiro[3.3]heptane-derived amino acids (dose – response curves)



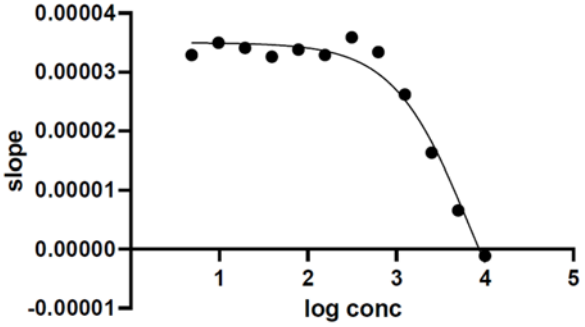
Compound **15a**·HCl, IC_{50} = 4.0 mM, R^2 = 0.97



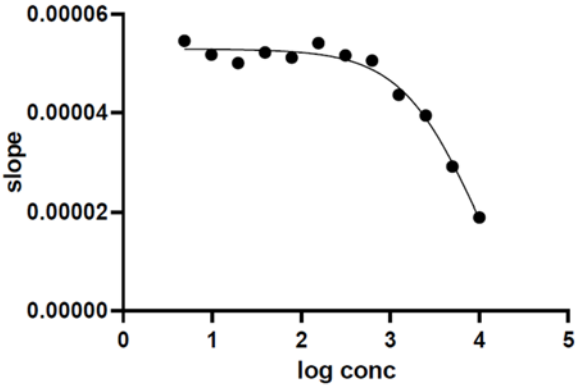
Compound **15b**·HCl, IC_{50} = 2.0 mM, R^2 = 0.97



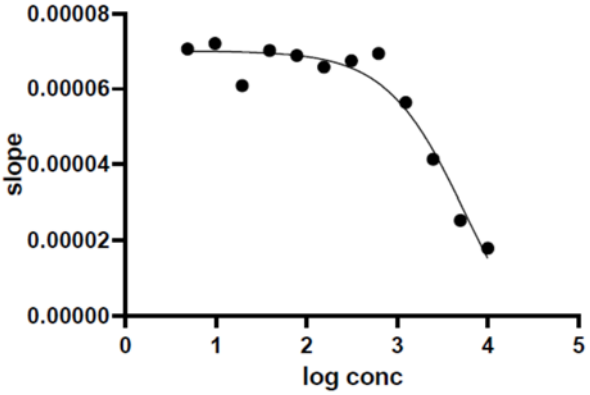
Compound **16a**·HCl, IC_{50} = 5.6 mM, R^2 = 0.93



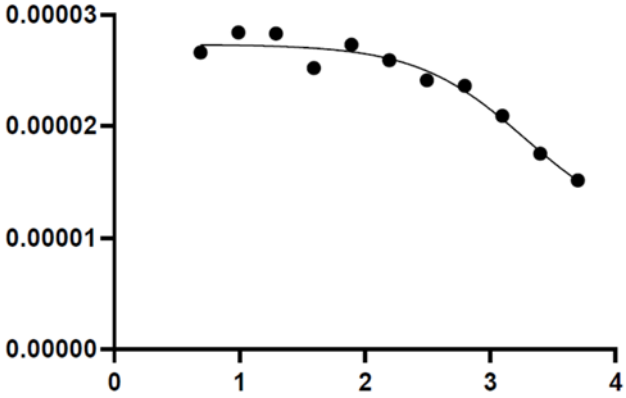
Compound **16b**·HCl, IC_{50} = 6.7 mM, R^2 = 0.97



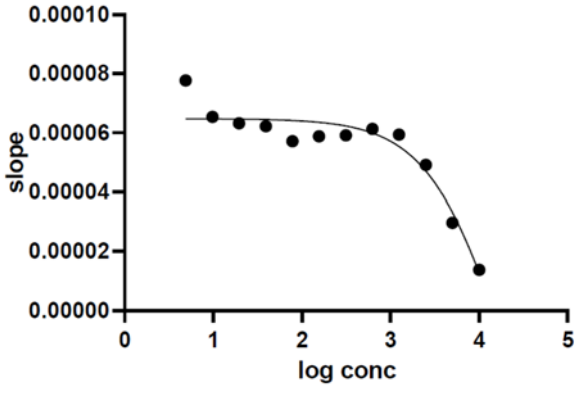
Compound **17a**, IC_{50} = 9.3 mM, R^2 = 0.98



Compound **17b**, IC_{50} = 5.6 mM, R^2 = 0.95



Compound **18b**, IC_{50} = 1.9 mM, R^2 = 0.96



Compound **21b**, IC_{50} = 18 mM, R^2 = 0.91

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2. A. L. Spek, *J. Appl. Cryst.* 2003, **36**, 7–13.

3. P.van der Sluis, A. L. Spek, *Acta Cryst.* 1990, **A46**, 194–201.