Supporting Information

Total Synthesis and Correct Absolute Configuration of Malyngamide U

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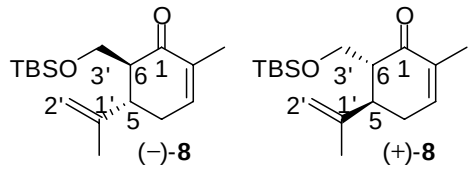
General Procedures. All anhydrous reactions were carried avoiding moisture by standard procedures under argon atmosphere. Commercially available reagents were used as received. PMBBr,[1] (+)-**18** or (−)-**18**[2] are prepared according references. The solvents were dried by distillation over the appropriate drying agents. Petroleum ether used has a b.p. range 60–90 °C. Reactions were monitored by TLC inspection on silica gel GF254 plates. Column chromatography was generally performed on silica gel (200–300 mesh). The optical rotations were measured with a TE 341 polarimeter. IR spectra were recorded on a Nicolet NEXUS 670 FT–IR spectrophotometer and reported in wave number (cm^{-1}). Melting point was measured on a Reichert Microscope apparatus and was uncorrected. ^{1}H, ^{13}C NMR spectra, DEPT 135 and nOe experiments were recorded on a Bruker AM 400 MHz or a Mercury Plus–300 spectrometer. The chemical shifts (δ) are reported in ppm and coupling constants (*J*) in Hz and relative to TMS (δ 0.00) for ^{1}H NMR and chloroform [δ 77.0 except **1**, **2** and **23** (δ 77.4)[3]] for ^{13}C NMR. High resolution mass spectra (HRMS) and mass spectra (MS) were obtained on a Bruker Daltonics APEX II 47e and a Finnegan LCQ mass spectrometer, respectively.

(5*S*,6*S*)/(5*R*,6*R*), 6-(1,1-Dimethylethyl)dimethylsilyoxymethyl-2-methyl-5-(1-methylethenyl)-2-cyclo-hexen-1-one [(−)-8 and (+)-8]



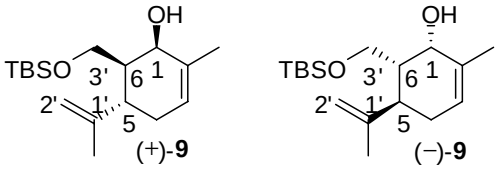
To a stirred solution of (+)-**7** (14.28 g, 79.23 mmol) in dry DMF (40 mL) was added imidazole (11.89 g, 174.65 mmol) and TBSCl (13.16 g, 87.31 mmol), the stirring was continued at rt for 10 h. Then the solution was poured into water (80 mL) and extracted with petroleum ether (5 × 80 mL). The organic extracts were dried ($MgSO_4$), filtered and concentrated in *vacuo*. Flash chromatography of the residue over silica gel (petroleum ether/EtOAc = 100 : 1) afforded compound (−)-**8** as a pale yellow oil (21.93 g, 94% yield).

$[\alpha]^{25}_{D}$ = –19 (*c* 1.0, $CHCl_3$); IR (neat): 2929, 1674, 1253, 1129, 837 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 0.01 (s, 6H, 2 × CH_3), 0.83 (s, 9H, 3 × CH_3), 1.71 (s, 3H, CH_3), 1.76 (s, 3H, CH_3), 2.25–2.37 (m, 3H, H-4 and 5), 2.96–3.05 (m, 1H, H-6), 3.58 (dd, *J* = 9.3 and 3.0, 1H, H-3′a), 4.17 (dd, *J* = 9.3 and 3.0, 1H, H-3′b), 4.82 (d, *J* = 4.5, 2H, H-2′), 6.67–6.68 (m, 1H, H-3); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –5.7 (2 ×CH_3), 16.1 (CH_3), 18.2 (C), 19.5 (CH_3), 25.8 (3 × CH_3), 30.1 (CH_2,

C-4), 43.4 (CH, C-5), 51.6 (CH, C-6), 59.4 (CH_2, C-3′), 112.9 (CH_2, C-2′), 135.6 (C, C-2), 143.7 (CH, C-3), 145.6 (C, C-1′), 198.9 (C, C-1); HRMS (ESI): *m*/*z* $[M + Na]^+$ calcd for $C_{17}H_{30}NaO_2Si$: 317.1907; found: 317.1901.

According to the above procedure, (−)-**7** (16.75 g, 92.99 mmol) afforded (+)-**8** as a pale yellow oil (21.93 g, 80%). $[\alpha]^{20}_D$ = +17 (*c* 1.0, $CHCl_3$); ^1H, ^{13}C NMR data of (+)-**8** are identical with (−)-**8**; LRMS (ESI): *m*/*z* $[M + H]^+$ found: 295.0.

(1*R*,5*S*,6*S*)/(1*S*,5*R*,6*R*), 6-(1,1-Dimethylethyl)dimethylsilyoxymethyl-2-methyl-5-(1-methyl ethenyl)-2-cyclohexen-1-ol [(+)-9 and (−)-9]

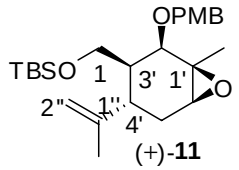


To a stirred solution of (−)-**8** (21.88 g, 74.30 mmol) in MeOH (200 mL) was added $CeCl_3·7H_2O$ (33.28 g, 89.32 mmol) and followed by adding $NaBH_4$ (6.79 g, 178.54 mmol) in five portions carefully at 0 °C. The solution was allowed to rise to rt in 0.5 h. The stirring was continued for 2 h and the reaction was quenched by sat. NH_4Cl solution. The reaction mixture was extracted with EtOAc (3 × 100 mL) after adding brine (50 mL). The organic extracts were dried ($MgSO_4$), filtered and concentrated *in vacuo*. Flash chromatography of the residue over silica gel (petroleum ether/EtOAc = 50 : 1) afforded cyclohexenyl alcohol (+)-**9** as a pale yellow oil (19.61 g, 89% yield). $[\alpha]^{25}_D$ = +48 (*c* 1.0, $CHCl_3$); IR (neat): 3469, 2929, 1254, 1078, 840 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.05 (s, 3H, CH_3), 0.07 (s, 3H, CH_3), 0.90 (s, 9H, 3 × CH_3), 1.67 (s, 3H, CH_3), 1.69–1.76 (m, 1H), 1.83 (s, 3H, CH_3), 2.02–2.04 (m, 2H), 2.46–2.56 (m, 1H), 3.03 (br s, 1H, OH), 3.67–3.75 (m, 2H, H-1 and 3′a), 4.19 (d, *J* = 3.6, 1H, H-3′b), 4.78–4.79 (m, 2H, H-2′), 5.55–5.56 (m, 1H, H-3); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –5.7 (2 × CH_3), 18.0 (C), 18.5 (CH_3), 21.1 (CH_3), 25.8 (3 × CH_3), 31.4 (CH_2, C-4), 38.3 (CH), 42.2 (CH), 63.3 (CH_2, C-3′), 69.7 (CH, C-1), 112.6 (CH_2, C-2′), 124.1 (CH, C-3), 134.5 (C, C-2), 146.0 (C, C-1′); HRMS (ESI): *m*/*z* $[M + Na]^+$ calcd for $C_{17}H_{32}NaO_2Si$: 319.2064; found: 319.2060.

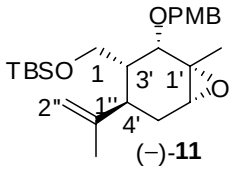
According to the above procedure, (+)-**8** (21.83 g, 74.20 mmol) afforded (−)-**9** as a pale yellow oil (19.91 g, 91%). $[\alpha]^{20}_D$ = –44 (*c* 1.0, $CHCl_3$); ^1H, ^{13}C NMR data of (−)-**9** are identical with (+)-**9**; LRMS (ESI): *m*/*z* $[M + H]^+$ found: 297.1.

{(1*S*,2*R*,3*S*,4*S*,6*S*)/(1*R*,2*S*,3*R*,4*R*,6*R*), 2-(4-Methoxybenzyloxy)-1-methyl-4-(1-methylethenyl)

-7-oxa-bicyclo-[4.1.0]-heptan-3-yl}-methoxy-(1,1-dimethylethyl)-dimethylsilane [(+)-11 and (−)-11]



(+)-**11**



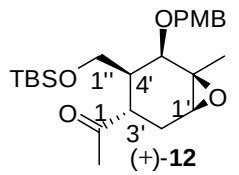
(−)-**11**

To a stirred solution of (+)-**10** (14.67 g, 46.94 mmol) in dry DMF (50 mL) was added *p*-methoxybenzyl bromide (28.35 g, 141.00 mmol) and NaH (50%) (6.77 g, 141.04 mmol) at 0 °C. The stirring was continued at rt for 10 h and the reaction was quenched by sat. NH_4Cl solution. Then the mixture was poured into water (80 mL) and extracted with petroleum ether (5 × 80 mL). The organic extracts were dried ($MgSO_4$), filtered and concentrated in *vacuo*. Flash chromatography of the residue over silica gel (petroleum ether/EtOAc = 20 : 1) afforded compound (+)-**11** (actually the crude product went into the next reaction without careful purification).

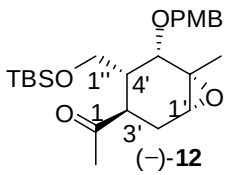
$[\alpha]^{22}_D$ = +48 (*c* 1.0, $CHCl_3$); IR (neat): 2930, 1514, 1249, 1087, 838 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.04 (s, 6H, 2 × CH_3), 0.91 (s, 9H, 3 × CH_3), 1.30 (s, 3H, CH_3), 1.56–1.62 (m, 1H), 1.63 (s, 3H, CH_3), 1.72–1.85 (m, 1H), 2.02–2.03 (m, 1H), 2.34–2.35 (m, 1H), 3.02 (d, *J* = 1.2, 1H, H-2′), 3.48 (dd, *J* = 10.5 and 5.1, 1H, H-1a), 3.65 (t, *J* = 9.9, 1H, H-6′), 3.80 (s, 3H, OCH_3), 3.96 (d, *J* = 5.1, 1H, H-1b), 4.62 (d, *J* = 10.8, 1H, ArCH-a), 4.71 (d, *J* = 10.8, 1H, ArCH-b), 4.73 (s, 2H, H-2′′), 6.87 (d, *J* = 9.0, 2H, 2 × ArH), 7.33 (d, *J* = 9.0, 2H, 2 × ArH); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –5.3 (2 × CH_3), 18.2 (C), 18.5 (CH_3), 23.5 (CH_3), 25.9 (3 × CH_3), 30.2 (CH_2, C-5′), 35.2 (CH), 43.4 (CH), 55.1 (OCH_3), 58.0 (C, C-1′), 59.7 (CH), 60.7 (CH_2, C-1), 72.6 ($ArCH_2$), 74.3 (CH), 112.5 (CH_2, C-2′′), 113.5 (2 × CH), 129.4 (2 × CH), 131.2 (C), 145.6 (C, C-1′′), 159.0 (C); HRMS (ESI): *m*/*z* $[M + Na]^+$ calcd for $C_{25}H_{40}NaO_4Si$: 455.2588; found: 455.2579.

According to the above procedure, (−)-**10** (16.23 g, 51.98 mmol) afforded (−)-**11** as a crude product, it was used for the next step without careful purification.

{(1*S*,3*S*,4*S*,5*R*,6*S*)/(1*R*,3*R*,4*R*,5*S*,6*R*), 4-(1,1-Dimethylethyl)dimethylsilyoxymethyl-5-(4-methoxybenzyloxy)-6-methyl-7-oxa-bicyclo-[4.1.0]-heptan-3-yl}-ethan-1-one [(+)-12 and (−)-12]



(+)-**12**



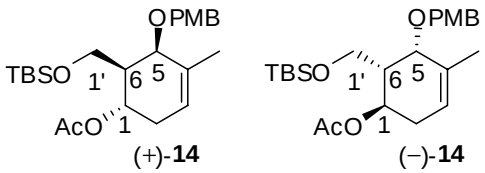
(−)-**12**

To a stirred solution of crude (+)-**11** in THF and H_2O (80 mL, THF/H_2O = 3 : 1), 4-methylmorpholine *N*-oxide (NMO) (6.63 g, 56.42 mmol) and OsO_4 (5 mL, 2% in H_2O) were added. The solution was stirred at rt for 16 h. The reaction mixture was quenched with sat. Na_2SO_3 solution and extracted with EtOAc (5 × 80 mL). The combined organic layer was concentrated in *vacuo* to give the diol. The crude diol was dissolved in THF and H_2O (100 mL, THF : H_2O = 1 : 1), then $NaIO_4$ (30.17 g, 141.07 mmol) was added. The reaction mixture was stirred at rt for 15 min, then poured into water (50 mL) and extracted with EtOAc (3 × 80 mL). The organic layer was successively washed with sat. $Na_2S_2O_3$ solution (100 ml), dried ($MgSO_4$), filtered, and concentrated in *vacuo*. Flash chromatography of the residue over silica gel (petroleum ether/EtOAc = 20 : 1) afforded ketone (+)-**12** as a pale yellow oil (17.02 g, 83% yield for two steps).

$[\alpha]^{22}_D$ = +63 (*c* 1.0, $CHCl_3$); IR (neat): 2930, 1709, 1512, 1248, 1077, 835 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.05 (s, 6H, 2 × CH_3), 0.90 (s, 9H, 3 × CH_3), 1.30 (s, 3H, CH_3), 1.92–2.07 (m, 3H, H-2′ and 4′), 2.09 (s, 3H, H-2), 2.84–2.91 (m, 1H, H-3′), 3.07 (d, *J* = 2.4, 1H, H-5′), 3.65–3.78 (m, 3H, H-1′ and 1′′), 3.80 (s, 3H, OCH_3), 4.58 (d, *J* = 11.7, 1H, ArCH-a), 4.63 (d, *J* = 11.7, 1H, ArCH-b), 6.88 (d, *J* = 8.4, 2H, 2 × ArH), 7.30 (d, *J* = 8.4, 2H, 2 × ArH); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –5.5 (2 × CH_3), 18.0 (C), 21.9 (CH_3), 25.1 (CH_2, C-2′), 25.8 (3 × CH_3), 29.4 (CH_3, C-2), 42.5 (CH), 43.1 (CH), 55.0 (OCH_3), 58.1 (C, C-6′), 59.2 (CH), 59.9 (CH_2, C-1′′), 71.9 ($ArCH_2$), 74.5 (CH), 113.5 (2 × CH), 129.5 (2 × CH), 130.2 (C), 159.1 (C), 211.4 (C, C-1); HRMS (ESI): *m*/*z* $[M + Na]^+$ calcd for $C_{24}H_{38}NaO_5Si$: 457.2381; found: 457.2377.

According to the above procedure, the crude product of (−)-**11** afforded (−)-**12** as a pale yellow oil (18.06 g, 80% yield for two steps). $[\alpha]^{20}_D$ = –62 (*c* 1.0, $CHCl_3$); ^1H, ^{13}C NMR data of (−)-**12** are identical with (+)-**12**; LRMS (ESI): *m*/*z* $[M + H]^+$ found: 435.0.

(1*S*,5*R*,6*R*)/(1*R*,5*S*,6*S*), 6-(1,1-Dimethylethyl)dimethylsilyoxymethyl-5-(4-methoxybenzyloxy) -4-methyl-cyclohex-3-en-1-yl acetate [(+)-14 and (−)-14]



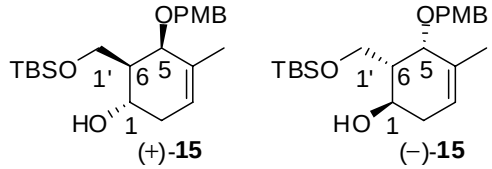
To a stirred suspension of zinc powder (31.87 g, 487.38 mmol), NaOAc (36.57 g, 445.81) and anhydrous NaI (106.99 g, 713.79 mmol) in dry CH_2Cl_2 (700 mL) was added HOAc (92.67 mL, 1.60 mol). After stirring 20 min a solution of (+)-**13** (10.03 g, 22.26 mmol) in CH_2Cl_2 (50 mL) was added.

Then the reaction mixture was refluxed for 2 d and filtered to remove the residue. The filtrate was washed with water (2 × 100 mL), sat. $NaHCO_3$ solution (200 mL), dried ($MgSO_4$), filtered and concentrated in *vacuo*. Flash chromatography of the residue over silica gel (petroleum ether/EtOAc = 20 : 1) afforded compound (+)-**14** as a pale yellow oil (8.32 g, 86% yield).

$[\alpha]^{20}_D$ = +91 (*c* 1.0, $CHCl_3$); IR (neat): 2931, 1740, 1513, 1250, 1033, 838 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.07 (s, 6H, 2 × CH_3), 0.92 (s, 9H, 3 × CH_3), 1.71 (s, 3H, CH_3), 1.92–2.02 (m, 1H), 2.03 (s, 3H, $COCH_3$), 2.18–2.24 (m, 1H), 2.49–2.54 (m, 1H), 3.70 (dd, *J* = 9.9 and 6.3, 1H, H-1′a), 3.80 (s, 3H, OCH_3) 3.86 (d, *J* = 9.9, 1H, H-1′b), 4.07 (d, *J* = 3.6, 1H, H-5), 4.54 (d, *J* = 10.8, 1H, ArCH-a), 4.71 (d, *J* = 10.8, 1H, ArCH-b), 5.10–5.17 (m, 1H, H-1), 5.33–5.34 (m, 1H, H-3), 6.87 (d, *J* = 8.1, 2H, 2 × ArH), 7.28 (d, *J* = 8.1, 2H, 2 × ArH); ^{13}C NMR ($CDCl_3$, 100 MHz) δ = –5.4 (2 × CH_3), 18.2 (C), 20.9 (CH_3), 21.2 (CH_3), 25.9 (3 × CH_3), 30.5 (CH_2, C-2), 45.3 (CH, C-6), 55.2 (OCH_3), 59.8 (CH_2, C-1′), 69.3 (CH), 73.4 ($ArCH_2$), 75.4 (CH), 113.6 (2 × CH), 121.2 (CH, C-3), 129.4 (2 × CH), 131.1 (C), 134.4 (C), 159.1 (C), 170.4 (CO); HRMS (ESI): *m*/*z* $[M + Na]^+$ calcd for $C_{24}H_{38}NaO_5Si$: 457.2381; found: 457.2387.

According to the above procedure, (−)-**13** (13.49 g, 29.96 mmol) afforded (−)-**14** as a pale yellow oil (11.45 g, 88%). $[\alpha]^{20}_D$ = –98 (*c* 1.0, $CHCl_3$); ^1H, ^{13}C NMR data of (−)-**14** are identical with (+)-**14**; LRMS (ESI): *m*/*z* $[M + H]^+$ found: 435.0.

(1*S*,5*R*,6*R*)/(1*R*,5*S*,6*S*), 6-[(1,1-Dimethylethyl)dimethylsilyoxymethyl]-5-(4-methoxybenzyloxy)-4-methyl-cyclohex-3-en-1-ol [(+)-15 and (−)-15]



(+)-**15** (−)-**15**

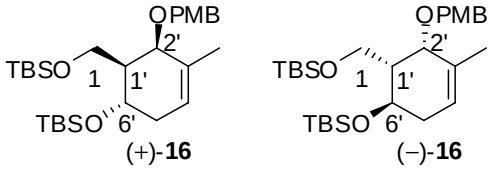
To a stirred solution of (+)-**14** (7.81 g, 17.97 mmol) in MeOH (80 mL) was added K_2CO_3 (12.42 g, 89.86 mmol) in three portions. The stirring was continued at rt for 2 h. Then the reaction mixture was worked up and purified through a silica gel (petroleum ether/EtOAc = 10 : 1) to afford alcohol (+)-**15** as a pale yellow oil (6.84 g, 97%).

$[\alpha]^{20}_D$ = +117 (*c* 1.0, $CHCl_3$); IR (neat): 3400, 2929, 1513, 1249, 1037, 837 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.08 (s, 3H, CH_3), 0.09 (s, 3H, CH_3), 0.91 (s, 9H, 3 × CH_3), 1.76 (s, 3H, CH_3), 1.85–1.99 (m, 2H, H-2a and 6), 2.47 (dt, *J* = 17.7 and 5.4, 1H, H-2b) 3.36 (br s, 1H, OH), 3.80 (s, 3H, OCH_3), 3.82–3.90 (m, 2H), 4.02–4.15 (m, 2H), 4.51 (d, *J* = 10.8, 1H, ArCH-a), 4.55 (d, *J* = 10.8, 1H,

ArCH-b), 5.43–5.44 (m, 1H, H-3), 6.88 (d, J = 8.4, 2H, 2 × ArH), 7.25 (d, 2H, J = 8.4, 2 × ArH); ^{13}C NMR ($CDCl_3$, 100 MHz) δ = –5.6 (CH_3), –5.5 (CH_3), 18.1 (C), 21.4 (CH_3), 25.8 (3 × CH_3), 35.1 (CH_2, C-2), 47.8 (CH, C-6), 55.2 (OCH_3), 64.3 (CH_2, C-1′), 67.7 (CH), 73.8 ($ArCH_2$), 77.4 (CH), 113.7 (2 × CH), 123.2 (CH, C-3), 129.5 (2 × CH), 130.8 (C), 133.5 (C), 159.2 (C); HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{22}H_{36}NaO_4Si$: 415.2275; found: 415.2276.

According to the above procedure, (−)-**14** (11.35 g, 26.14 mmol) afforded (−)-**15** as a pale yellow oil (9.23 g, 90%): $[\alpha]^{20}_D$ = –126 (*c* 1.0, $CHCl_3$); ^{1}H, ^{13}C NMR data of (−)-**15** are identical with (+)-**15**; LRMS (ESI): m/z $[M + H]^+$ found: 393.1.

[(1*S*,2*R*,6*S*)/(1*R*,2*S*,6*R*), 6-(1,1-Dimethylethylsilyoxy)-2-(4-methoxybenzyloxy) -3-methyl-cyclohex-3-en-1-yl]-methoxy-(1,1-dimethylethyl)-dimethylsilane [(+)-16 and (−)-16]



(+)-**16** (−)-**16**

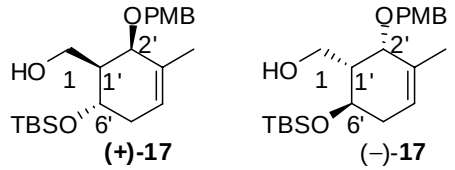
To a stirred solution of (+)-**15** (6.22 g, 15.84 mmol) in dry DMF (5 mL) was added imidazole (2.81 g, 41.27 mmol) and TBSCl (3.11 g, 20.63 mmol) and the stirring was continued at rt for 4 d. Then the solution was poured into water (30 mL) and extracted with petroleum ether (5 × 30 mL). The organic extracts were dried ($MgSO_4$), filtered and concentrated in *vacuo*. Flash chromatography of the residue over silica gel (petroleum ether/EtOAc = 20 : 1) afforded compound (+)-**16** as a pale yellow oil (7.07 g, 88% yield).

$[\alpha]^{16}_D$ = +107 (*c* 1.0, $CHCl_3$); IR (neat): 2930, 1514, 1466, 1251, 1083, 838 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 0.02 (s, 3H, CH_3), 0.03 (s, 3H, CH_3), 0.09 (s, 6H, 2 × CH_3), 0.89 (s, 9H, 3 × CH_3), 0.93 (s, 9H, 3 × CH_3), 1.64 (s, 3H, CH_3), 1.88–1.98 (m, 2H, H-1′ and 5′a), 2.29 (dt, J = 16.8 and 4.8, 1H, H-5′b), 3.81 (s, 3H, OCH_3), 3.75–3.93 (m, 2H), 3.99–4.04 (m, 2H), 4.57 (d, J = 10.5, 1H, ArCH-a), 4.79 (d, J = 10.5, 1H, ArCH-b), 5.31–5.32 (m, 1H, H-4′), 6.87 (d, J = 8.4, 2H, 2 × ArH), 7.30 (d, J = 8.4, 2H, 2 × ArH); ^{13}C NMR ($CDCl_3$, 100 MHz) δ = –5.3 (2 × CH_3), –5.0 (CH_3), –4.2 (CH_3), 18.0 (C), 18.3 (C), 21.0 (CH_3), 25.8 (3 × CH_3), 26.0 (3 × CH_3), 35.6 (CH_2, C-5′), 49.3 (CH, C-1′), 55.2 (OCH_3), 60.6 (CH_2, C-1), 66.2 (CH), 74.1 ($ArCH_2$), 75.9 (CH), 113.6 (2 × CH), 122.3 (CH, C-4′), 129.7 (2 × CH), 131.5 (C), 134.3 (C), 159.1 (C); HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{28}H_{50}NaO_4Si_2$: 529.3140; found: 529.3140.

According to the above procedure, (−)-**15** (9.13 g, 23.28 mmol) afforded (−)-**16** as a pale yellow oil

(9.79 g, 83%). $[\alpha]^{20}_{D}$ = –116 (*c* 1.0, $CHCl_3$); ^1H, ^{13}C NMR data of (−)-**16** are identical with (+)-**16**; LRMS (ESI): *m*/*z* $[M + H]^+$ found: 506.8.

[(1*S*,2*R*,6*S*)/(1*R*,2*S*,6*R*), 6-(1,1-Dimethylethyl)dimethylsilyoxy-2-(4-methoxybenzyloxy)-3-methyl-cyclohex-3-en-1-yl]-methanol [(+)-17 and (−)-17]



(+)-17 (−)-**17**

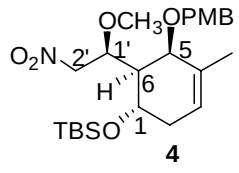
To a stirred solution of (+)-**16** (6.08 g, 12.00 mmol) in MeOH (200 mL) was added *n*-Bu_4NHSO_4 (895 mg, 2.64 mmol) and *p*-TsOH·H_2O (183 mg, 0.96 mmol) at –20 °C. The stirring was continued at this temperature for 24 h. The reaction was quenched by sat. $NaHCO_3$ solution. The reaction mixture was extracted with EtOAc (3 × 100 mL) after adding brine (50 mL). The organic extracts were dried ($MgSO_4$), filtered and concentrated *in vacuo*. Flash chromatography of the residue over silica gel (petroleum ether/EtOAc = 10 : 1) afforded alcohol (+)-**17** as a pale yellow oil (1.67 g, 71% yield on the basis of 50% conversion). The by product was treated with TBSCl in the presence of imidazole to afford compound (+)-**16** which can be reacted again in the conditions as above.

$[\alpha]^{16}_{D}$ = +132 (*c* 1.0, $CHCl_3$); IR (neat): 3422, 2928, 1514, 1250, 1080, 836 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.07 (s, 3H, CH_3), 0.10 (s, 3H, CH_3), 0.90 (s, 9H, 3 × CH_3), 1.76 (s, 3H, CH_3), 1.89–2.01 (m, 2H, H-1′ and 5′a), 2.30 (dt, *J* = 17.4 and 5.1, 1H, H-5′b), 2.76 (br s, 1H, OH), 3.80 (s, 3H, OCH_3), 3.78–3.94 (m, 1H, H-1a), 3.91 (dd, *J* = 11.1 and 6.0, 1H, H-1b) 4.01 (d, *J* = 3.3, 1H, H-2′), 4.04–4.12 (m, 1H, H-6′), 4.59 (s, 2H, $ArCH_2$), 5.37–5.39 (m, 1H, H-4′), 6.88 (d, *J* = 8.7, 2H, 2 × ArH), 7.28 (d, 2H, *J* = 8.7, 2 × ArH); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –5.0 (CH_3), –4.3 (CH_3), 17.9 (C), 21.2 (CH_3), 25.8 (3 × CH_3), 35.6 (CH_2, C-5′), 48.5 (CH, C-1′), 55.2 (OCH_3), 63.1 (CH_2, C-1), 68.3 (CH), 74.3 ($ArCH_2$), 79.0 (CH), 113.8 (2 × CH), 123.0 (CH, C-4′), 129.7 (2 × CH), 130.4 (C), 133.8 (C), 159.3 (C); HRMS (ESI): *m*/*z* $[M + Na]^+$ calcd for $C_{22}H_{36}NaO_4Si$: 415.2275; found: 415.2269.

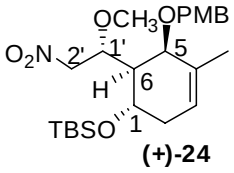
According to the above procedure, (−)-**16** (9.69 g, 19.14 mmol) afforded (−)-**17** as a pale yellow oil (2.17 g, 29%): $[\alpha]^{20}_{D}$ = –144 (*c* 1.0, $CHCl_3$); ^1H, ^{13}C NMR data of (−)-**17** are identical with (+)-**17**; LRMS (ESI): *m*/*z* $[M + H]^+$ found: 393.0.

{(1*S*,5*R*,6*R*)-6-[(1*S*)-Methoxy-2-nitroethyl]-5-(4-methoxybenzyloxyl)-4-methyl-cyclohex-3-enyl-1-oxy}-(1,1-dimethylethyl)-dimethylsilane, {(1*S*,5*R*,6*R*)-6-[(1*R*)-methoxy-2-nitroethyl]-5-

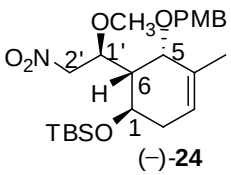
(4-methoxybenzyloxyl)-4-methyl-cyclohex-3-enyl-1-oxy}-(1,1-dimethylethyl)-dimethylsilane and {(1*R*,5*S*,6*S*)-6-[(1*S*)-methoxy-2-nitroethyl]-5-(4-methoxybenzyloxyl)-4-methyl–cyclohex-3-enyl-1-oxy}-(1,1-dimethylethyl)-dimethylsilane [4, (+)-24 and (−)-24]



4



(+)-24



(−)-**24**

To a stirred solution of **19a** (120 mg, 0.27 mmol) in CH_2Cl_2 (5 mL) was added 2,6-di-*tert*-butyl-4-methylpyridine (1.66 g, 8.08 mmol) and MeOTf (0.46 mL, 4.06 mmol). The reaction mixture was refluxed for 3 d and was concentrated *in vacuo* and flash chromatography of the residue over silica gel (petroleum ether/EtOAc = 50 : 1) afforded compound **4** (83 mg, 67% yield) as a pale yellow oil. 2,6-Di-*tert*-butyl-4-methylpyridine can be recovered by flashing chromatography.

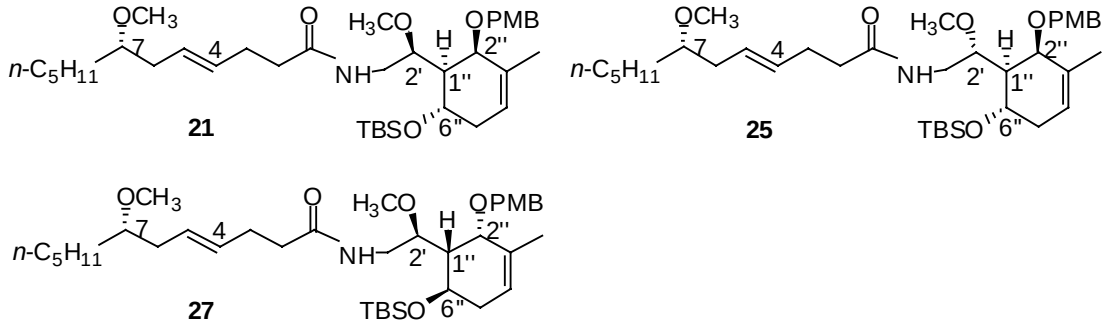
$[\alpha]^{14}_D$ = + 154 (*c* 1.0, $CHCl_3$); IR (neat): 2926, 1555, 1251, 1097, 837 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.02 (s, 3H, CH_3), 0.07 (s, 3H, CH_3), 0.89 (s, 9H, 3 × CH_3), 1.83 (s, 3H, CH_3), 1.93–2.05 (m, 1H, H-2a), 2.28–2.35 (m, 1H, H-6), 2.44 (dt, *J* = 17.1 and 4.5, 1H, H-2b), 3.44 (s, 3H, OCH_3), 3.81 (s, 3H, OCH_3), 3.88–3.96 (m, 1H, H-1′), 4.02 (d, *J* = 3.6, 1H, H-5), 4.43–4.50 (m, 2H, H-2′a and 1), 4.58 (d, *J* = 10.2, 1H, ArCH-a), 4.70 (d, *J* = 10.2, 1H, ArCH-b), 4.88 (dd, *J* = 13.8 and 10.8, 1H, H-2′b), 5.37 (m, 1H, H-3), 6.89 (d, *J* = 8.7, 2H, 2 × ArH), 7.31 (d, *J* = 8.4, 2H, 2 × ArH); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –5.0 (CH_3), –3.2 (CH_3), 17.8 (C), 21.8 (CH_3), 25.7 (3 × CH_3), 36.4 (CH_2, C-2), 46.4 (CH, C-6), 55.2 (OCH_3), 58.3 (OCH_3), 65.6 (CH), 74.0 (CH_2), 76.1 (CH), 77.2 (CH_2), 77.4 (CH), 113.9 (2 × CH), 122.5 (CH, C-3), 130.0 (2 × CH), 130.1 (C), 134.3 (C), 159.3 (C); HRMS (ESI): *m*/*z* $[M + H]^+$ calcd for $C_{24}H_{40}NO_6Si$: 466.2619; found: 466.2620.

As above described procedure, (+)-**19b** (140 mg, 0.31 mmol) afforded compound (+)-**24** (90 mg, 63% yield) as a pale yellow oil. $[\alpha]^{16}_D$ = + 88 (*c* 1.0, $CHCl_3$); IR (neat): 2927, 1554, 1250, 1099, 837 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.08 (s, 3H, CH_3), 0.10 (s, 3H, CH_3), 0.88 (s, 9H, 3 × CH_3), 1.82 (s, 3H, CH_3), 2.02–2.09 (m, 2H, H-2a and 6), 2.30–2.34 (m, 1H, H-2b), 3.36 (s, 3H, OCH_3), 3.80 (s, 3H, OCH_3), 4.12 (d, *J* = 3.6, 1H, H-5), 4.20–4.27 (m, 2H, H-1 and 1′), 4.55–4.68 (m, 3H, $ArCH_2$ and H-2′a), 5.05 (dd, *J* = 12.9 and 3.0, 1H, H-2′b), 5.38–5.42 (m, 1H, H-3), 6.88 (d, *J* = 8.1, 2H, 2 × ArH), 7.26 (d, *J* = 8.1, 2H, 2 × ArH); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –4.7 (CH_3), –4.0 (CH_3), 17.9 (C), 22.0 (CH_3), 25.8 (3 × CH_3), 36.5 (CH_2, C-2), 46.9 (CH, C-6), 55.2 (OCH_3), 58.3 (OCH_3),

66.9 (CH), 72.9 (CH_2), 77.1 (CH), 78.1 (CH), 79.1 (CH_2), 113.7 (2 × CH), 123.3 (CH, C-3), 128.8 (2 × CH), 130.9 (C), 134.4 (C), 159.0 (C); HRMS (ESI): *m*/*z* $[M + NH_4]^+$ calcd for $C_{24}H_{43}N_2O_6Si$: 483.2885; found: 483.2881.

As above described procedure, (−)-**19b** (88 mg, 0.20 mmol) afforded compound (−)-**24** (55 mg, 60% yield) as a pale yellow oil. $[\alpha]^{20}_D$ = –96 (*c* 0.50, $CHCl_3$); ^1H, ^{13}C NMR data of (−)-**24** are identical with (+)-**24**; HRMS (ESI): *m*/*z* $[M + NH_4]^+$ calcd for $C_{24}H_{43}N_2O_6Si$: 483.2885; found: 483.2881.

(4*E*,7*S*)-*N*-{(2*S*)-[(1*R*,2*R*,6*S*)-6-(1,1-Dimethylethyl)dimethylsilyoxy-2-(4-methoxybenzyloxyl)-3-methyl-cyclohex-3-en-1-yl]-2-methoxyethyl}-7-methoxydodec-4-enamide, (4*E*,7*S*)-*N*-{(2*R*)-[(1*R*,2*R*,6*S*)-6-(1,1-dimethylethyl)dimethylsilyoxy-2-(4-methoxybenzyloxyl)-3-methyl-cyclohex-3-en-1-yl]-2-methoxyethyl}-7-methoxydodec-4-enamide and (4*E*,7*S*)-*N*-{(2*S*)-[(1*S*,2*S*,6*R*)-6-(1,1-dimethylethyl)dimethylsilyoxy-2-(4-methoxybenzyloxyl)-3-methyl-cyclohex-3-en-1-yl]-2-methoxyethyl}-7-methoxydodec-4-enamide (21, 25 and 27)



To a stirred solution of $NiCl_2 \cdot 6H_2O$ (31 mg, 0.13 mmol) in MeOH (2 mL) was added $NaBH_4$ (15 mg, 0.39 mmol) and the stirring was continued for 0.5 h, then a solution of **4** (25 mg, 0.05 mmol) in MeOH (2 mL) was added and followed by adding $NaBH_4$ (33 mg, 0.88 mmol) carefully. The stirring was continued for another 0.5 h and flash chromatography of the reaction mixture over a short basic silica gel (CH_2Cl_2/MeOH = 1 : 1) afforded the corresponding amine. The amine was concentrated and placed in CH_2Cl_2 (6 mL), insoluble substance was filtrated and washed with CH_2Cl_2. (4 mL). To the filtrate was added a solution of acid **3** (11 mg, 0.05 mmol) in CH_2Cl_2 (3 mL), DCC (10 mg, 0.05 mmol), 1-hydroxybenzotriazole (HOBt) (8 mg, 0.06 mmol) and 4-methylmorpholine (NMM) (5 mg, 0.05 mmol) and the stirring was continued for 8 h. Then the reaction mixture was concentrated *in vacuo* and flash chromatography of the residue over silica gel (petroleum ether/EtOAc = 10 : 1) afforded amide **21** (29 mg, 83% yield) as a pale yellow oil.

$[\alpha]^{15}_D$ = + 34 (*c* 1.0, $CHCl_3$); IR (neat): 3306, 2929, 1646, 1514, 1250, 1094, 836 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.06 (s, 3H, CH_3), 0.08 (s, 3H, CH_3), 0.87–0.91 (m, 12H, 4 × CH_3),

1.25–1.42 (m, 8H, H-8, 9, 10 and 11), 1.76 (s, 3H, CH_3), 1.88–1.94 (m, 1H), 2.05–2.37 (m, 8H), 3.12–3.16 (m, 1H), 3.32 (s, 3H, OCH_3), 3.36–3.47 (m, 2H), 3.37 (s, 3H, OCH_3), 3.56–3.62 (m, 1H), 3.80 (s, 3H, OCH_3), 4.21–4.25 (m, 2H), 4.48 (d, *J* = 10.5, 1H, ArCH-a), 4.60 (d, *J* = 10.5, 1H, ArCH-b), 5.28–5.32 (m, 1H, H-4′′), 5.42–5.44 (m, 2H, H-4 and 5), 6.17 (br s, 1H, NH), 6.87 (d, *J* = 9.0, 2H, 2 × ArH), 7.29 (d, *J* = 9.0, 2H, 2 × ArH); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –4.8 (CH_3), –4.2 (CH_3), 14.1 (CH_3), 18.0 (C), 20.6 (CH_3), 22.6 (CH_2), 24.9 (CH_2), 25.9 (3 × CH_3), 28.7 (CH_2), 32.0 (CH_2), 33.3 (CH_2), 33.9 (CH_2), 36.4 (CH_2), 36.6 (CH_2), 40.2 (CH_2), 46.2 (CH, C-1′′), 55.2 (OCH_3), 56.5 (OCH_3), 57.3 (OCH_3), 66.9 (CH), 72.8 ($ArCH_2$), 76.3 (CH), 79.6 (CH), 80.7 (CH), 113.8 (2 × CH), 121.3 (CH, C-4′′), 127.1 (CH, C-5), 129.7 (2 × CH), 130.3 (C), 131.0 (CH, C-4), 134.3 (C), 159.2 (C), 172.0 (C, C-1); HRMS (ESI): *m*/*z* $[M + H]^+$ calcd for $C_{37}H_{64}NO_6Si$: 646.4497; found: 646.4502.

As above described procedure, (+)-**24** (20 mg, 0.04 mmol) and **3** (9 mg, 0.04 mmol) afforded amide **25** (20 mg, 72% yield) as a pale yellow oil.

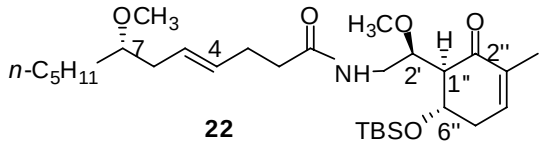
$[\alpha]^{16}_D$ = + 62 (*c* 1.0, $CHCl_3$); IR (neat): 3310, 2927, 1649, 1514, 1249, 1096, 836 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 0.09 (s, 6H, 2 × CH_3), 0.86–0.90 (m, 12H, 4 × CH_3), 1.25–1.41 (m, 8H, H-8, 9, 10 and 11), 1.76 (s, 3H, CH_3), 1.83–2.00 (m, 2H), 2.13–2.44 (m, 7H), 3.09–3.17 (m, 1H), 3.30–3.40 (m, 1H), 3.32 (s, 3H, OCH_3), 3.34 (s, 3H, OCH_3), 3.67–3.73 (m, 1H), 3.80 (s, 3H, OCH_3), 3.95–4.03 (m, 1H), 4.18–4.26 (m, 2H), 4.47 (d, *J* = 10.5, 1H, ArCH-a), 4.58 (d, *J* = 10.5, 1H, ArCH-b), 5.42–5.49 (m, 3H, H-4, H-5 and 4′′), 6.42 (br s, 1H, NH), 6.87 (d, *J* = 8.4, 2H, 2 × ArH), 7.26 (d, *J* = 8.4, 2H, 2 × ArH); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –4.6 (CH_3), –4.1 (CH_3), 14.1 (CH_3), 18.0 (C), 21.3 (CH_3), 22.6 (CH_2), 24.9 (CH_2), 26.0 (3 × CH_3), 28.7 (CH_2), 32.0 (CH_2), 33.3 (CH_2), 36.4 (CH_2), 36.6 (2 × CH_2), 39.1 (CH_2), 48.9 (CH, C-1′′), 55.2 (OCH_3), 56.2 (OCH_3), 56.5 (OCH_3), 66.8 (CH), 71.3 ($ArCH_2$), 76.6 (CH), 77.0 (CH), 80.7 (CH), 113.6 (2 × CH), 123.4 (CH, C-4′′), 127.1 (CH, C-5), 129.1 (2 × CH), 131.0 (C), 131.4 (CH, C-4), 133.7 (C), 159.0 (C), 172.6 (C, C-1); HRMS (ESI): *m*/*z* $[M + H]^+$ calcd for $C_{37}H_{64}NO_6Si$: 646.4497; found: 646.4490.

As above described procedure, (−)-**24** (55 mg, 0.09 mmol) and **3** (21 mg, 0.09 mmol) afforded amide **27** (50 mg, 66% yield) as a pale yellow oil.

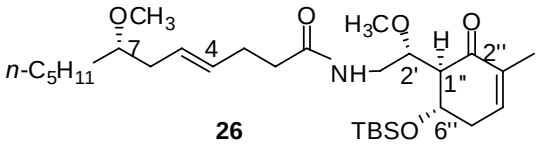
$[\alpha]^{20}_D$ = –93 (*c* 0.5, $CHCl_3$); ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 0.07 (s, 6H, 2 × CH_3), 0.85–0.88 (m, 12H, 4 × CH_3), 1.24–1.41 (m, 8H, H-8, 9, 10 and 11), 1.74 (s, 3H, CH_3), 1.82–1.88 (m, 2H), 2.11–2.45 (m, 7H), 3.09–3.17 (m, 1H), 3.30–3.38 (m, 1H), 3.32 (s, 3H, OCH_3), 3.35 (s, 3H, OCH_3),

3.67–3.72 (m, 1H), 3.78 (s, 3H, OCH_3), 3.93–4.02 (m, 1H), 4.18–4.26 (m, 2H), 4.45 (d, *J* = 10.5, 1H, ArCH-a), 4.56 (d, *J* = 10.5, 1H, ArCH-b), 5.40–5.48 (m, 3H, H-4, H-5 and 4′′), 6.41 (br s, 1H, NH), 6.85 (d, *J* = 8.4, 2H, 2 × ArH), 7.24 (d, *J* = 8.4, 2H, 2 × ArH), ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –4.5, –4.1, 14.0, 18.0, 21.3, 22.6, 24.9, 26.0, 28.7, 32.0, 33.3, 36.4, 36.5, 36.7, 39.2, 48.9, 55.2, 56.3, 56.5, 66.9, 71.4, 76.6, 77.1, 80.8, 113.7, 123.3, 127.2, 129.1, 131.0, 131.5, 133.8, 159.0, 172.6; HRMS (ESI): *m*/*z* $[M + H]^+$ calcd for $C_{37}H_{64}NO_6Si$: 646.4497; found: 646.4497.

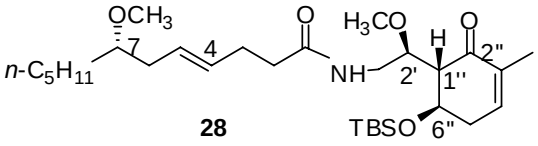
(4*E*,7*S*)-*N*-{(2*S*)-[(1*R*,6*S*)-6-(1,1-Dimethylethyl)dimethylsilyoxy-3-methyl-2-oxocyclohex-3-en-1-yl]-2-methoxyethyl}-7-methoxydodec-4-enamide, (4*E*,7*S*)-*N*-{(2*R*)-[(1*R*,6*S*)-6-(1,1-dimethylethyl)dimethylsilyoxy-3-methyl-2-oxocyclohex-3-en-1-yl]-2-methoxyethyl}-7-methoxydodec-4-enamide and (4*E*,7*S*)-*N*-{(2*S*)-[(1*S*,6*R*)-6-(1,1-dimethylethyl)dimethylsilyoxy-3-methyl-2-oxocyclohex-3-en-1-yl]-2-methoxyethyl}-7-methoxydodec-4-enamide (22, 26 and 28)



22



26



28

To a stirred suspension of **21** (25 mg, 0.04 mmol) in CH_2Cl_2 (1.8 mL) and H_2O (0.1 mL) was added DDQ (23 mg, 0.10 mmol) and the stirring was continued for 10 min. Then the reaction mixture was concentrated *in vacuo* and flash chromatography of the residue over silica gel (petroleum ether/EtOAc = 8 : 1) afforded amide **22** (17 mg, 85% yield) as a pale yellow oil.

$[\alpha]^{16}_D$ = +13 (*c* 1.0, $CHCl_3$); IR (neat): 3387, 2922, 1649, 1449, 1364, 1096 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 0.06 (s, 6H, 2 × CH_3), 0.85–0.91 (m, 12H, 4 × CH_3), 1.22–1.49 (m, 8H, H-8, 9, 10 and 11), 1.78 (d, *J* = 1.2, 3H, CH_3), 2.19–2.41 (m, 7H), 2.54–2.67 (m, 2H), 3.13–3.20 (m, 2H), 3.33 (s, 3H, OCH_3), 3.38 (s, 3H, OCH_3), 3.60–3.68 (m, 2H), 4.35–4.38 (m, 1H, H-6′′), 5.47–5.48 (m, 2H, H-4 and 5), 6.55–6.56 (m, 1H, NH), 6.87–6.89 (m, 1H, H-4′′); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –4.7 (2 × CH_3), 14.1 (CH_3, C-12), 16.0 (CH_3), 17.9 (C), 22.6 (CH_2), 24.9 (CH_2), 25.7 (3 × CH_3), 28.6 (CH_2), 32.0 (CH_2), 33.3 (CH_2), 33.6 (CH_2), 36.3 (CH_2), 36.5 (CH_2), 40.0 (CH_2), 56.5 (OCH_3), 57.7 (OCH_3), 58.0 (CH, C-1′′), 68.6 (CH, C-6′′), 77.3 (CH, C-2′), 80.7 (CH, C-7), 127.4 (CH, C-5), 130.8 (CH, C-4), 135.3 (C, C-3′′), 140.9 (CH, C-4′′), 172.4 (C, C-1), 199.4 (C, C-2′′); HRMS (ESI): *m*/*z* $[M + H]^+$ calcd for $C_{29}H_{54}NO_5Si$: 524.3766; found: 524.3764.

As above described procedure, **25** (19 mg, 0.03 mmol) was treated with DDQ (41 mg, 0.18 mmol) in 24 h to afford amide **26** (12 mg, 80% yield) as a pale yellow oil.

$[\alpha]^{14}_{D}$ = + 17 (*c* 1.0, $CHCl_3$); IR (neat): 3329, 2927, 1654, 1459, 1368, 1096 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.07 (s, 6H, 2 × CH_3), 0.86–0.89 (m, 12H, 4 × CH_3), 1.25–1.42 (m, 8H, H-8, 9, 10 and 11), 1.79 (s, 3H, CH_3), 2.29–2.67 (m, 9H, H-2, 3, 6, 1′′ and 5′′), 3.11–3.18 (m, 1H), 3.32 (s, 3H, OCH_3), 3.33 (s, 3H, OCH_3), 3.39–3.44 (m, 1H), 3.70–3.77 (m, 2H), 4.21–4.22 (m, 1H, H-6′′), 5.48–5.49 (m, 2H, H-4 and 5), 6.57–6.58 (m, 1H, H-4′′), 6.82 (br s, 1H, NH); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –4.9 (CH_3), –4.2 (CH_3), 14.1 (CH_3, C-12), 15.9 (CH_3), 17.9 (C), 22.6 (CH_2), 24.9 (CH_2), 25.7 (3 × CH_3), 28.7 (CH_2), 32.0 (CH_2), 33.3 (CH_2), 34.4 (CH_2), 36.3 (CH_2), 36.6 (CH_2), 40.4 (CH_2), 56.5 (OCH_3), 57.9 (OCH_3), 58.3 (CH, C-1′′), 69.4 (CH, C-6′′), 76.6 (CH, C-2′), 80.7 (CH, C-7), 127.4 (CH, C-5), 130.9 (CH, C-4), 136.2 (C, C-3′′), 140.9 (CH, C-4′′), 172.8 (C, C-1), 198.7 (C, C-2′′); HRMS (ESI): *m*/*z* $[M + H]^+$ calcd for $C_{29}H_{54}NO_5Si$: 524.3766; found: 524.3768.

As above described procedure, **27** (45 mg, 0.07 mmol) was treated with DDQ (95 mg, 0.42 mmol) in 24 h to afford amide **28** (28 mg, 78% yield) as a pale yellow oil.

$[\alpha]^{20}_{D}$ = –25 (*c* 0.15, $CHCl_3$). ^1H NMR ($CDCl_3$, 300 MHz) δ = 0.07 (s, 6H, 2 × CH_3), 0.88–0.90 (m, 12H, 4 × CH_3), 1.25–1.43 (m, 8H, H-8, 9, 10 and 11), 1.79 (s, 3H, CH_3), 2.26–2.66 (m, 9H, H-2, 3, 6, 1′′ and 5′′), 3.10–3.16 (m, 1H), 3.32 (s, 3H, OCH_3), 3.33 (s, 3H, OCH_3), 3.39–3.45 (m, 1H), 3.69–3.77 (m, 2H), 4.21–4.23 (m, 1H, H-6′′), 5.46–5.49 (m, 2H, H-4 and 5), 6.57–6.58 (m, 1H, H-4′′), 6.74 (br s, 1H, NH); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = –4.9, –4.2, 14.0, 15.9, 17.9, 22.6, 24.9, 25.7, 28.7, 32.0, 33.3, 34.4, 36.4, 36.6, 40.4, 56.5, 57.9, 58.2, 69.7, 76.7, 80.8, 127.4, 130.9, 136.2, 140.7, 172.7, 198.7; HRMS (ESI): *m*/*z* $[M + H]^+$ calcd for $C_{29}H_{54}NO_5Si$: 524.3766; found: 524.3764.

Comparison of ^{1}H NMR data for compounds **23**, **2** (synthetic Malyngamide U) and isolated Malyngamide U

Number	Compound **23**	Compound **2**	Isolated Malyngamide U
1			
2	2.20–2.27 (m, 4H, H-2 and 6)	2.19–2.26 (m, 4H, H-2 and 6)	2.25 (m)
3	2.35–2.41 (m, 3H, H-3 and 5′′)	2.33–2.41 (m, 3H, H-3 and 5′′)	2.35 (m)
4	5.45–5.48 (m, 2H, H-4 and 5)	5.47–5.50 (m, 2H, H-4 and 5)	5.49 (m)
5			5.49 (m)
6	2.20–2.27 (m, 4H, H-6 and 2)	2.19–2.26 (m, 4H, H-2 and 6)	2.20 (m)
7	3.15–3.18 (m, 1H)	3.14–3.17 (m, 1H)	3.16 (p, *J* = 5.8)
8	1.28–1.43 (m, 8H, H-8, 9, 10 and 11)	1.27–1.43 (m, 8H, H-8, 9, 10 and 11)	1.44 (m)
9			1.30 (m)
10			1.28 (m)
11			1.31 (m)
12	0.89 (t, 3H, *J* = 6.4)	0.89 (t, 3H, *J* = 6.4)	0.89 (t, *J* = 6.8)
1′	3.48–3.57 (m, 2H)	3.48–3.56 (m, 2H)	3.48 (m)
			3.57 (m)
2′	4.21–4.29 (m, 2H, H-2′and 6′′)	4.21–4.28 (m, 2H, H-2′and 6′′)	4.23 (m)
1′′	2.82 (dd, *J* = 10.8 and 3.2, 1H)	2.81 (dd, *J* = 11.0 and 3.4, 1H)	2.82 (dd, *J* = 10.9 and 3.4)
2′′			
3′′			
4′′	6.67-6.69 (m, 1H)	6.67-6.68 (m, 1H)	6.68 (dm, *J* = 5.2 and 1.3)
5′′	2.73 (dt, 1H, *J* = 18.0 and 5.2)	2.73 (dt, 1H, *J* = 18.0 and 5.2)	2.73 (dt, *J* = 18.2 and 5.6)
	2.35-2.41 (m, H-5′′ and 3)	2.33-2.41 (m, H-5′′ and 3)	2.38 (m)
6′′	4.21-4.29 (m, H-6′′ and 2′)	4.21-4.28 (m, H-6′′ and 2′)	4.27 (m)
7-OCH_3	3.33 (s, 3H)	3.33 (s, 3H)	3.33 (s)

2′-OCH	3.46 (s, 3H)	3.47 (s, 3H)	3.47 (s)
3			
3′′-CH_3	1.76 (s, 3H)	1.76 (s, 3H)	1.77 (d, *J* = 1.2)
OH			
NH	5.91 (br s, 1H)	5.91 (br s, 1H)	5.90 (br s)

Comparison of ^{13}C NMR data for compounds **1**, **23**, **2** (synthetic Malyngamide U) and isolated Malyngamide U

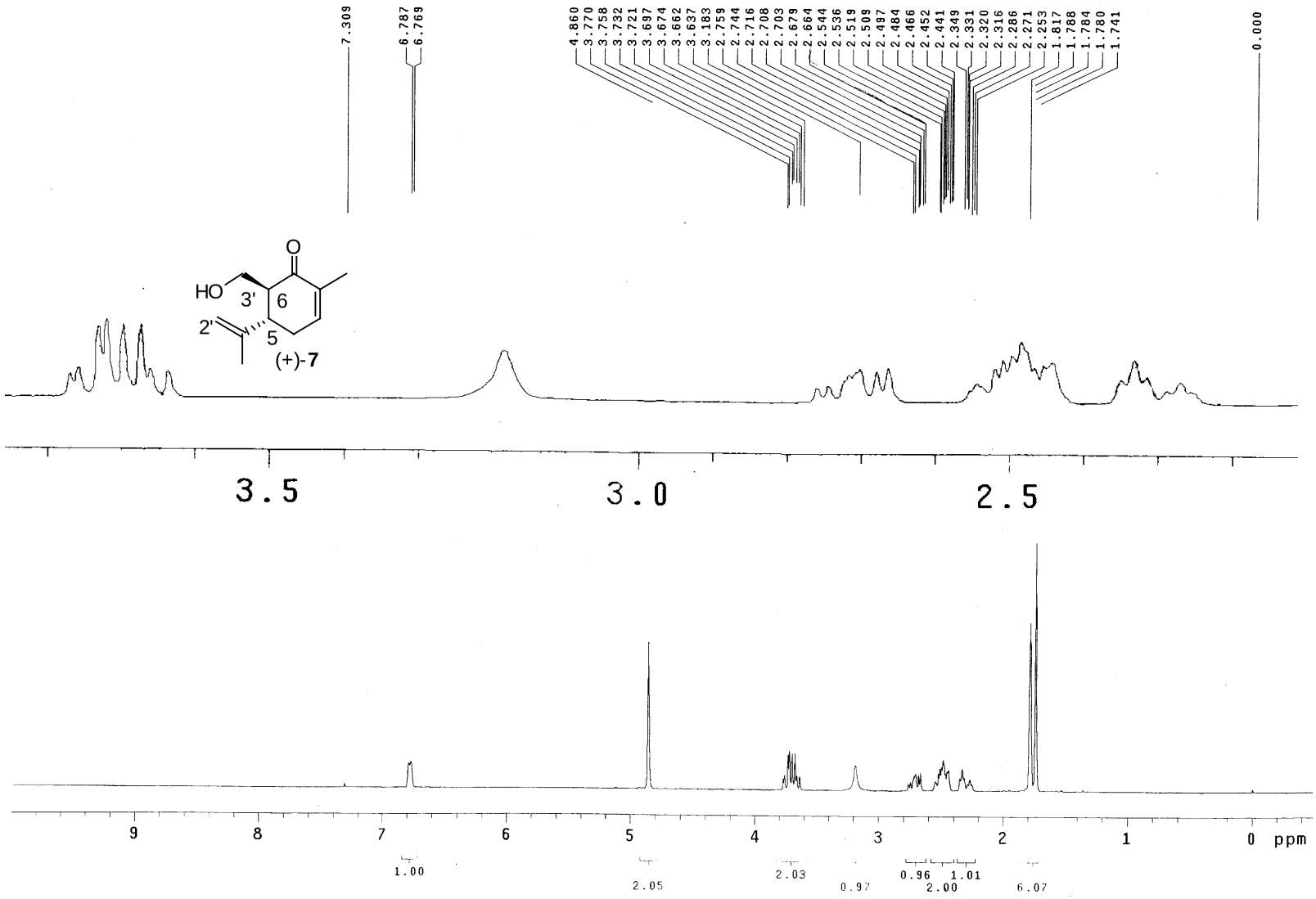
Number	Compound **1**	Compound **23**	Compound **2**	Isolated malyngamide U
1	173.7	172.8	172.8	172.8
2	37.0	36.9	36.9	36.9
3	29.0	28.9	28.9	28.9
4	131.1	131.2	131.2	131.2
5	128.2	127.8	127.8	127.9
6	36.8	36.8	36.8	36.6
7	81.1	81.2	81.2	81.1
8	33.7	33.7	33.7	33.7
9	25.4	25.4	25.4	25.4
10	32.4	32.4	32.4	32.4
11	23.0	23.0	23.0	23.0
12	14.4	14.4	14.4	14.4
1′	41.8	40.0	40.0	40.0
2′	78.4	80.3	80.3	80.3
1′′	54.0	54.8	54.8	54.7
2′′	199.0	198.0	198.0	198.0
3′′	136.1	136.5	136.5	136.5
4′′	142.4	142.6	142.6	142.6
5′′	35.1	34.7	34.7	34.7
6′′	68.5	68.9	68.9	68.9
7-OCH_3	56.9	56.9	56.9	56.9
2′-OCH_3	58.9	58.6	58.6	58.6
3′′-CH3	16.3	16.1	16.1	16.1

References

1 Burke, S. D.; Hong, J.; Lennox, J. R.; Mongin, A. P. *J. Org. Chem.* **1998**, *63*, 6952.

2 Kurosu, M.; Porter, J. R.; Foley, M. A. *Tetrahedron Lett.* **2004**, *45*,145.

3 McPhail, K. L.; Gerwick, W. H. *J. Nat. Prod.* **2003**, *66*, 132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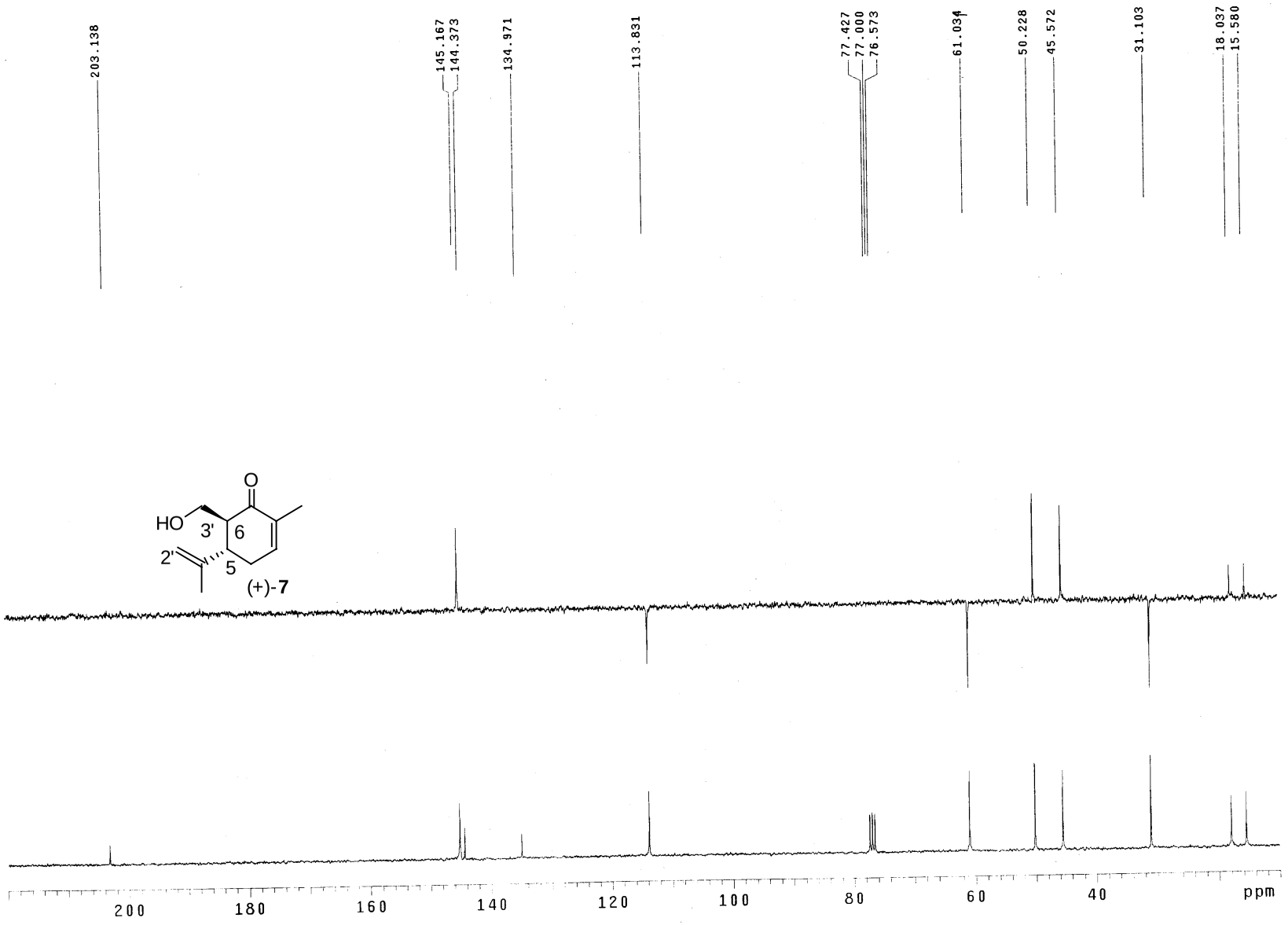
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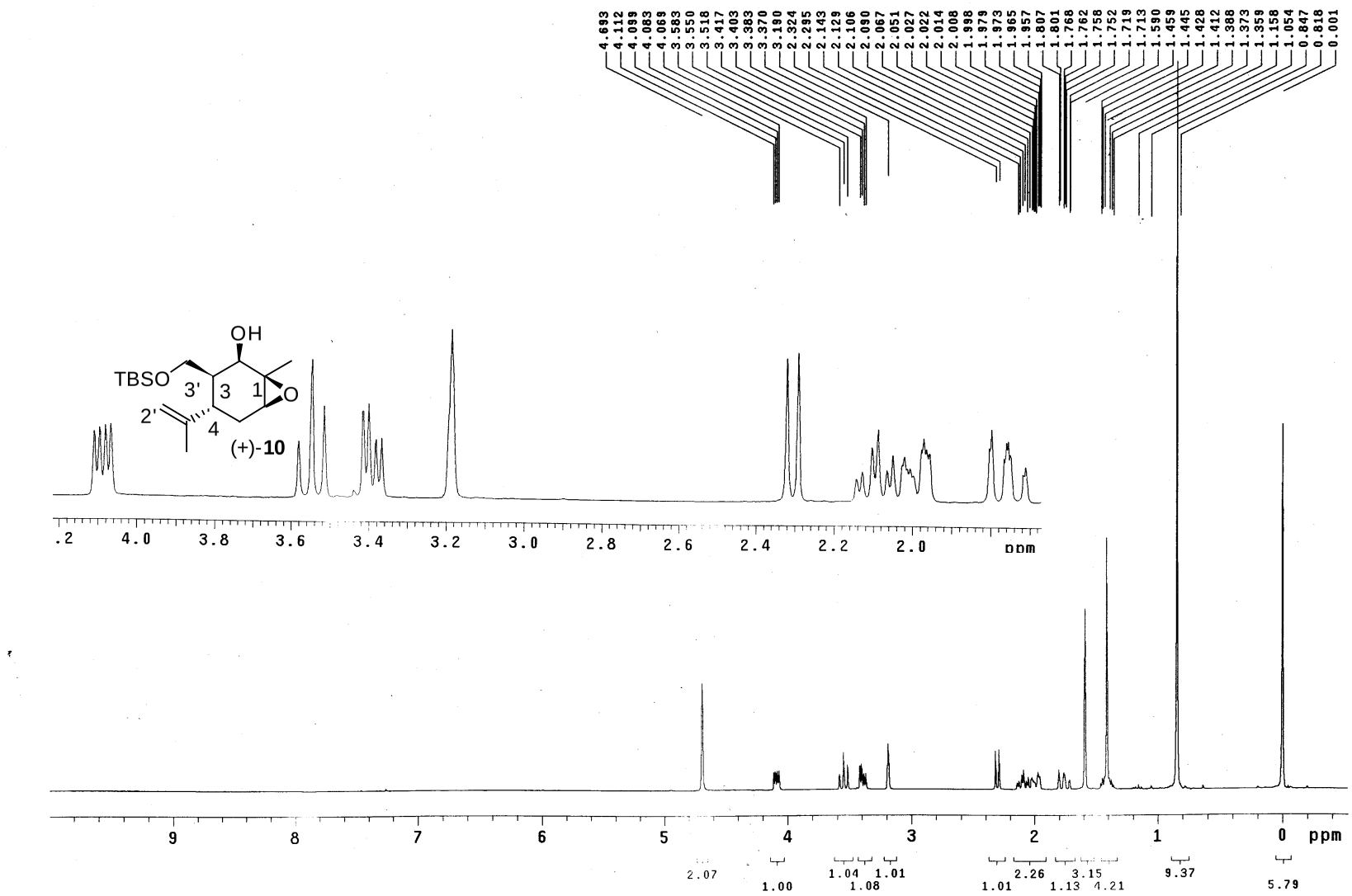
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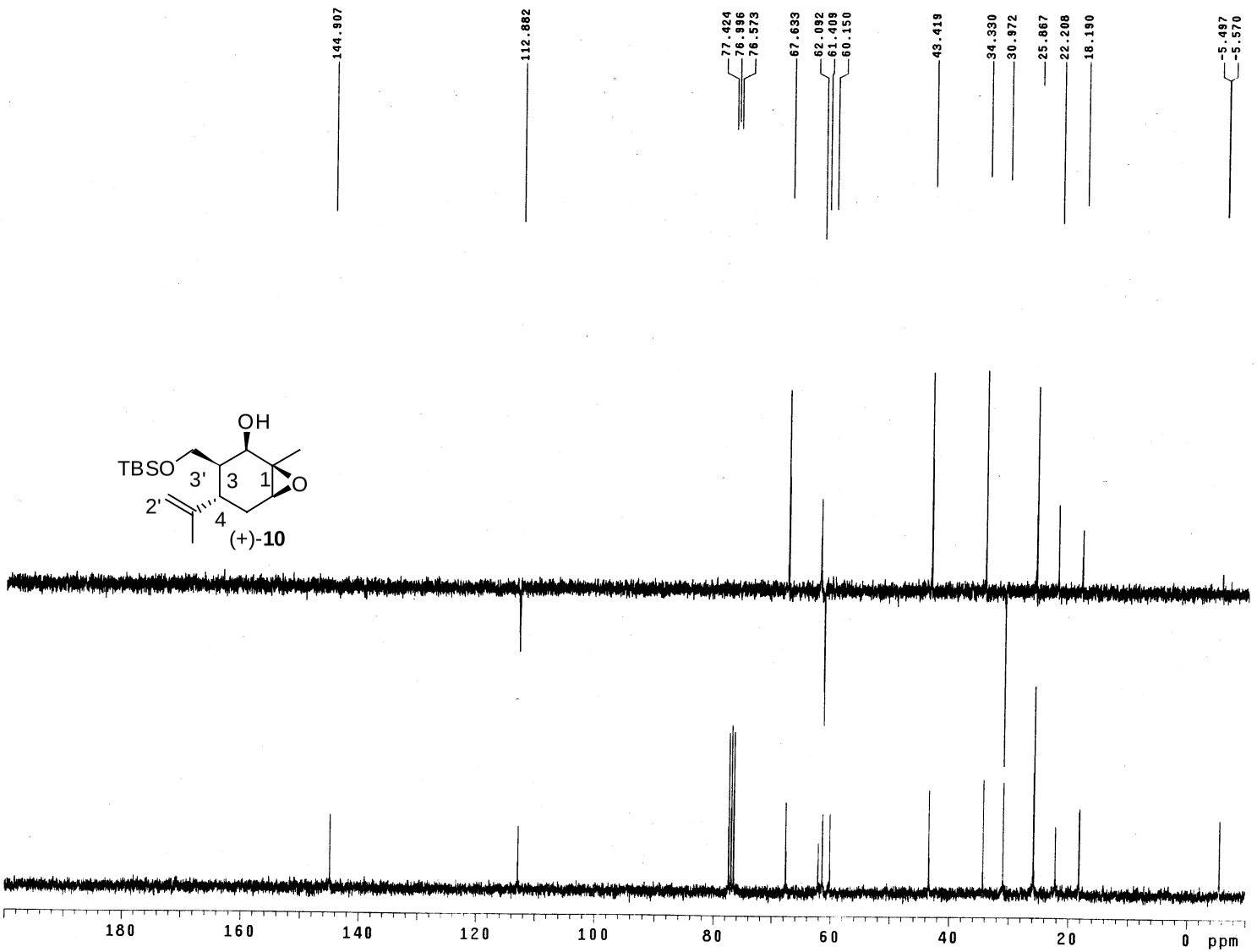
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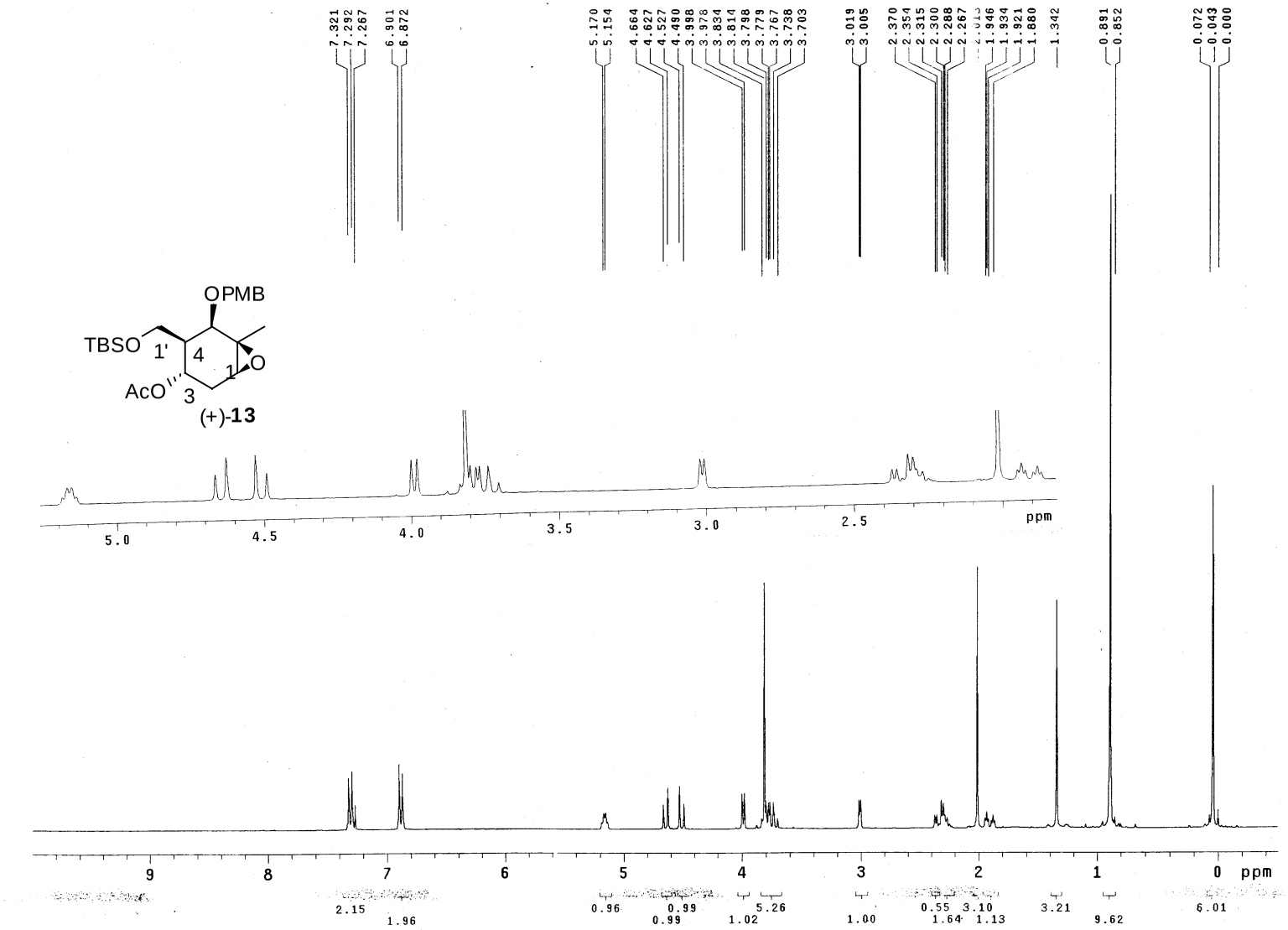
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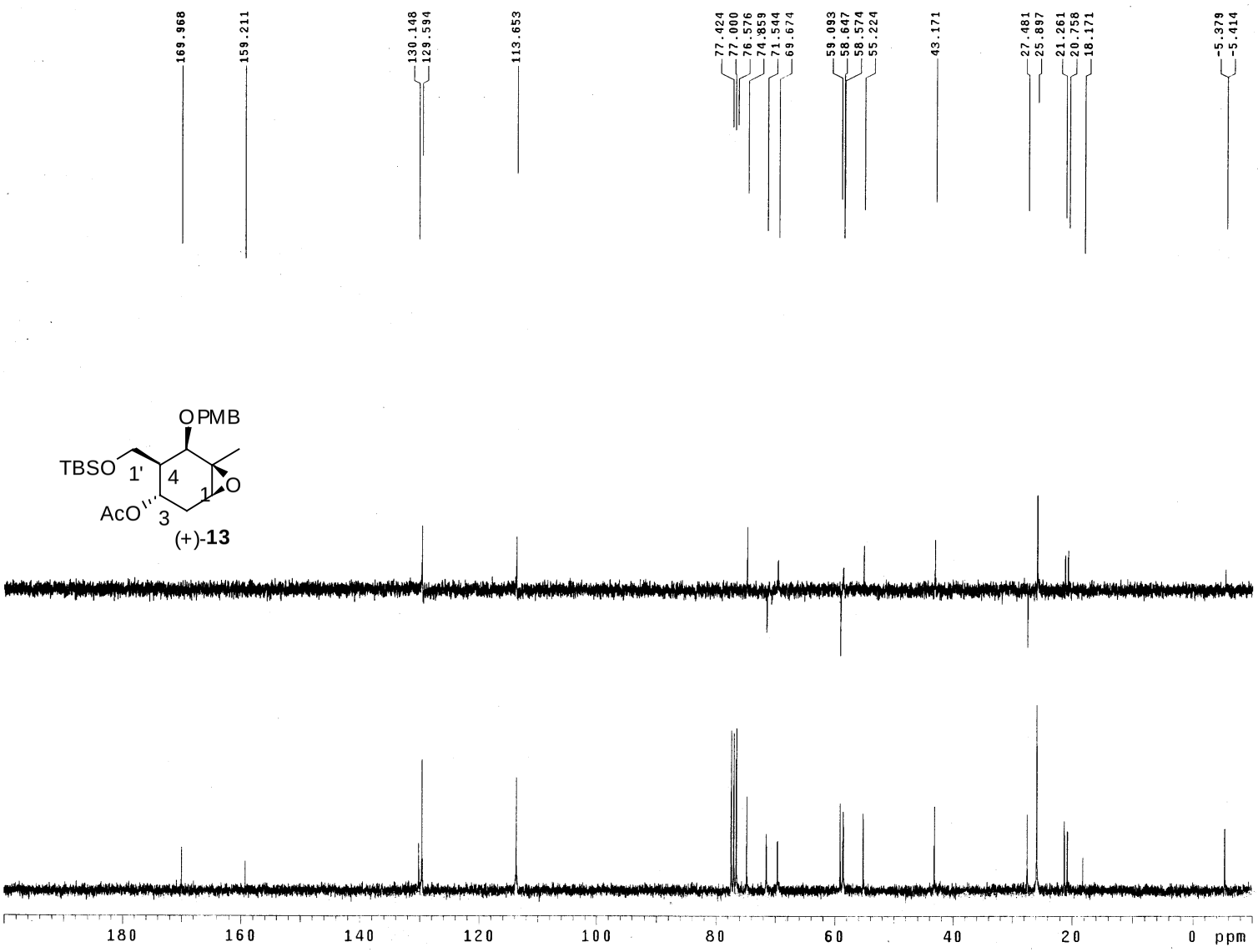
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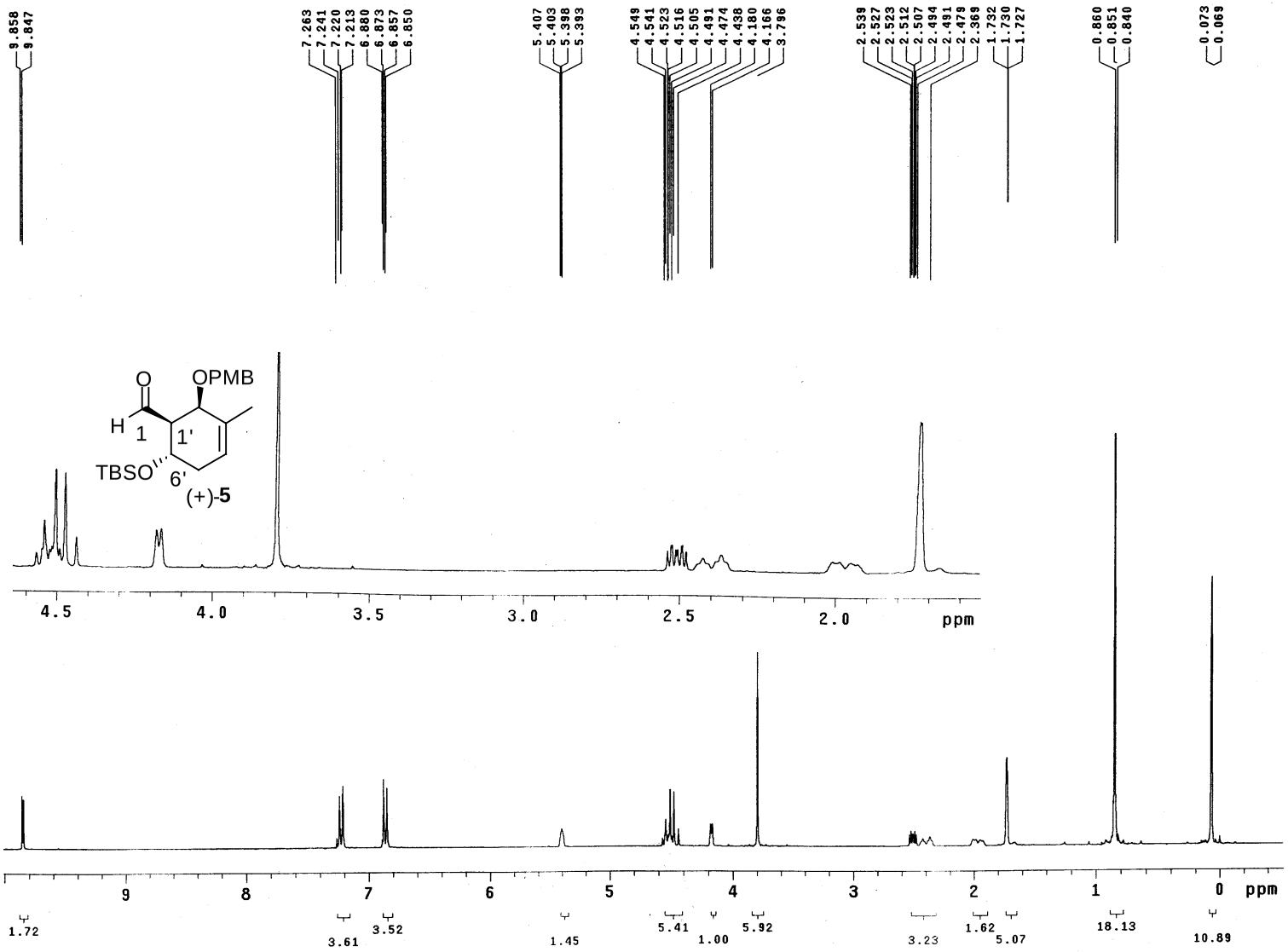
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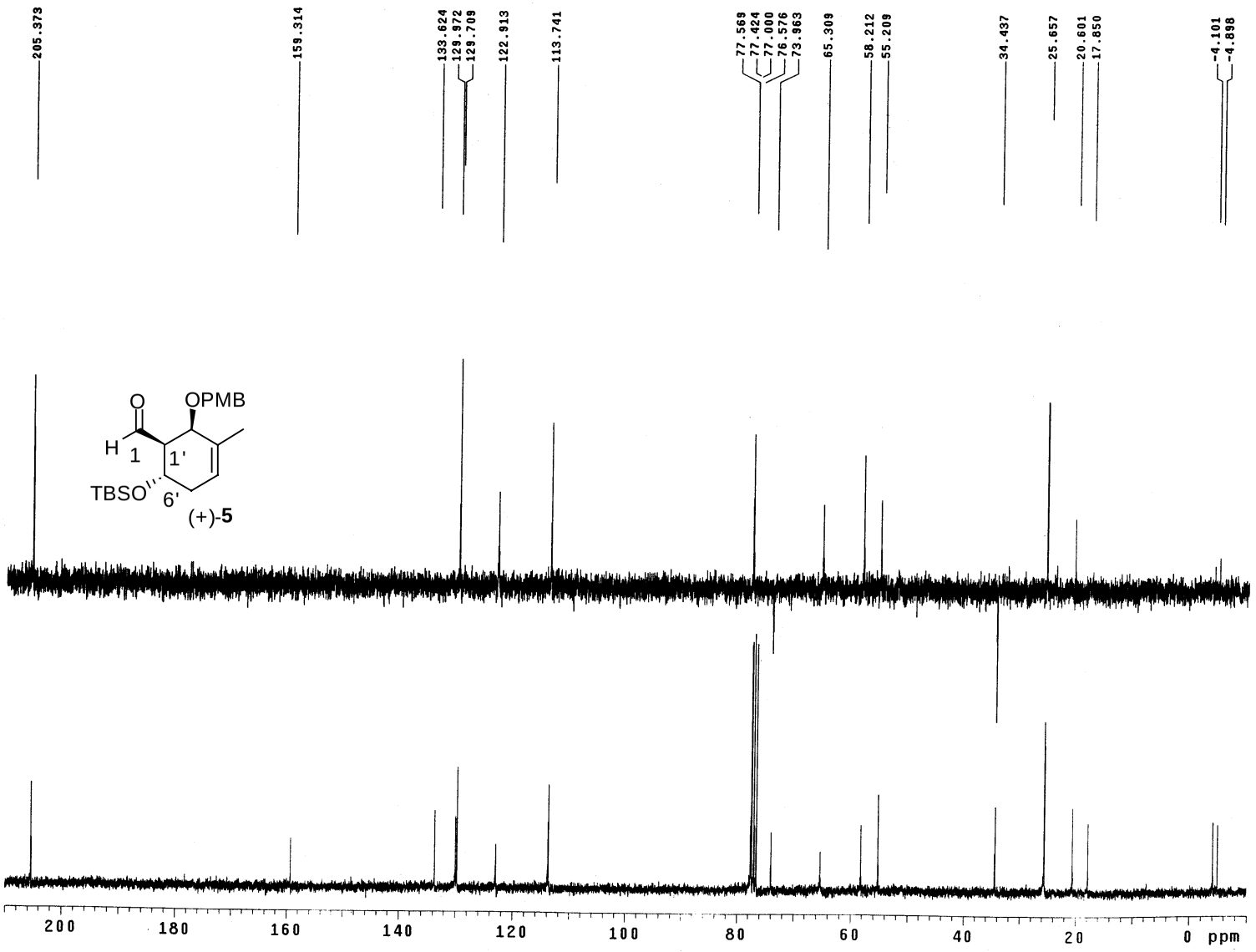
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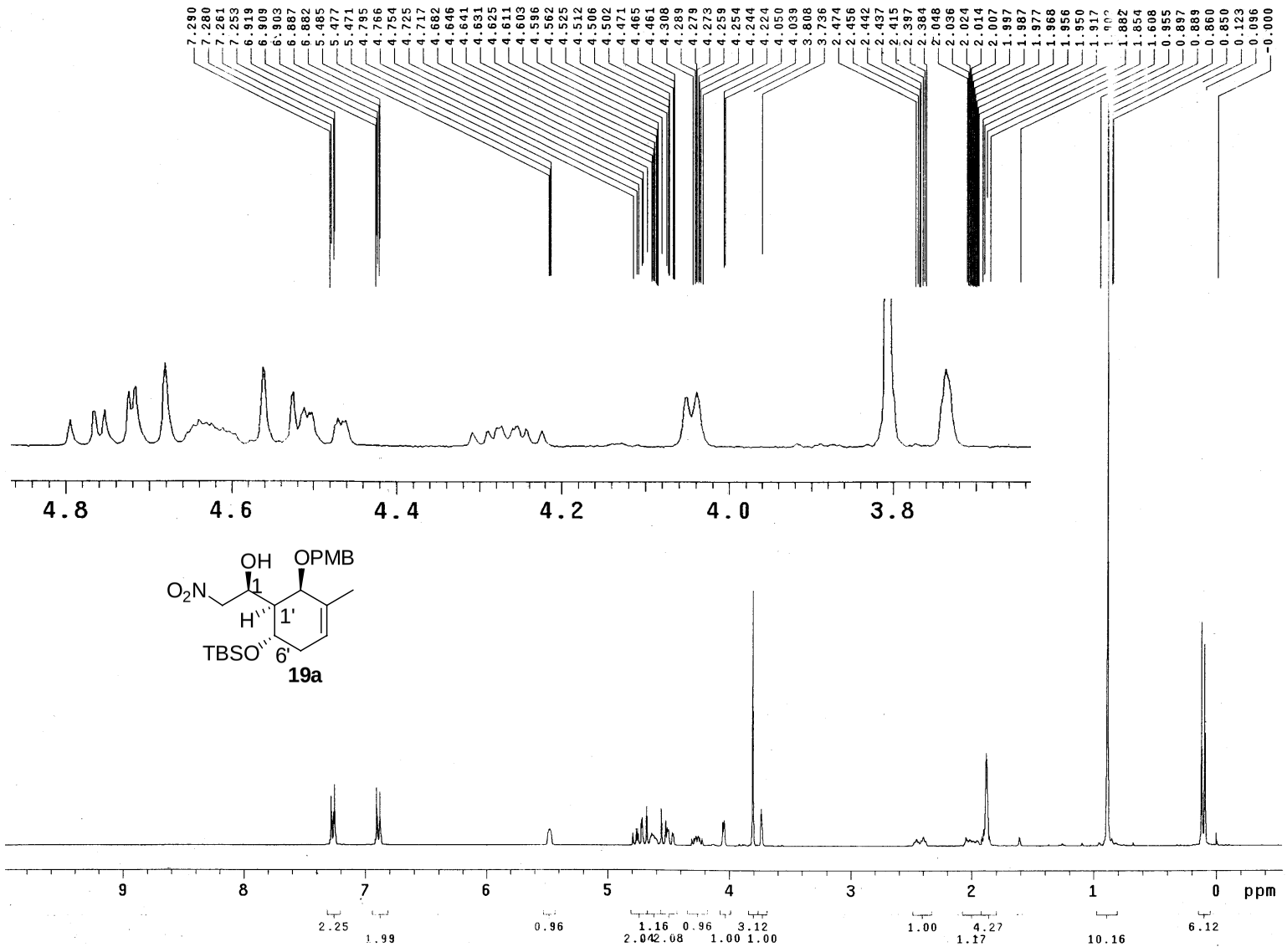
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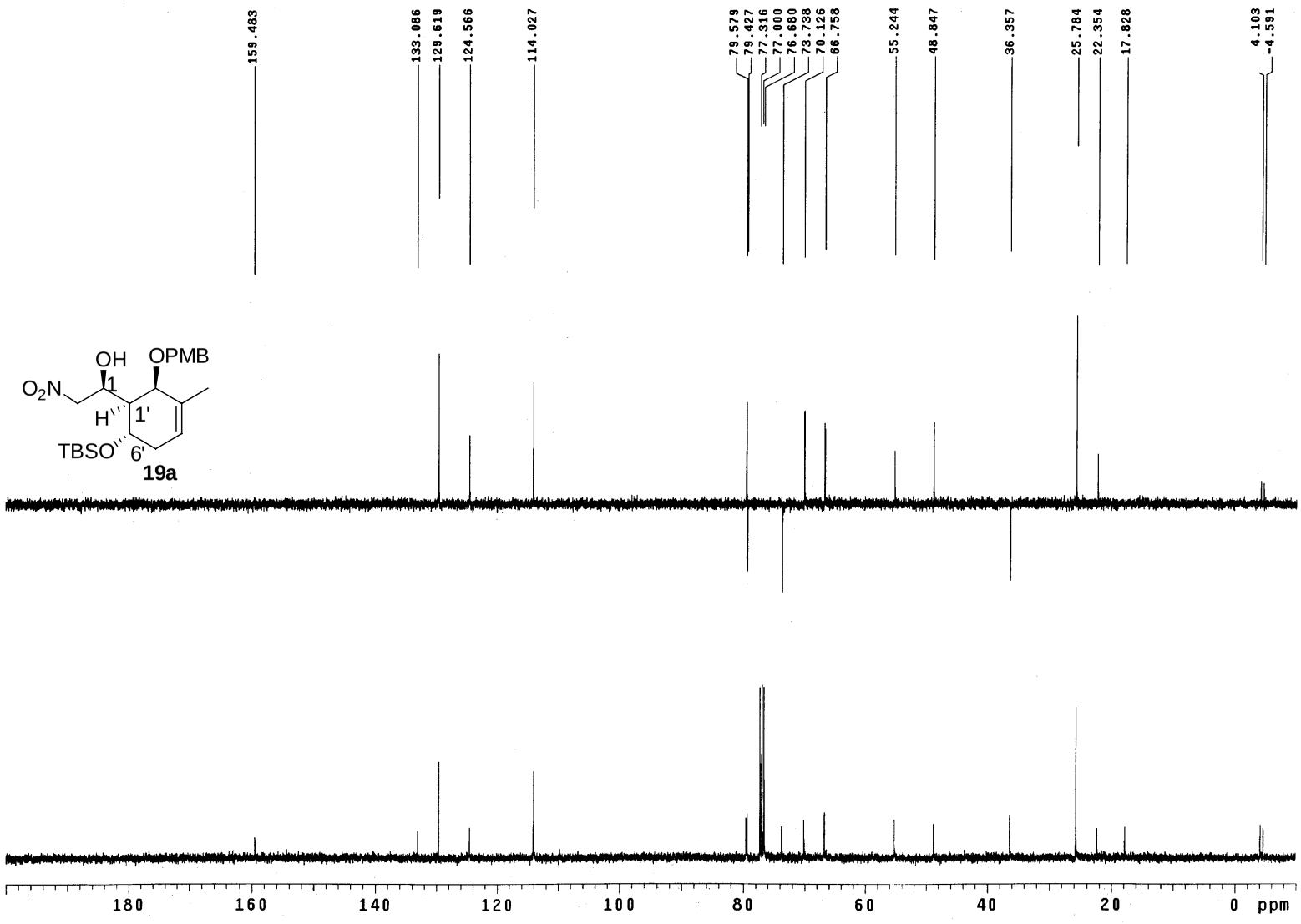
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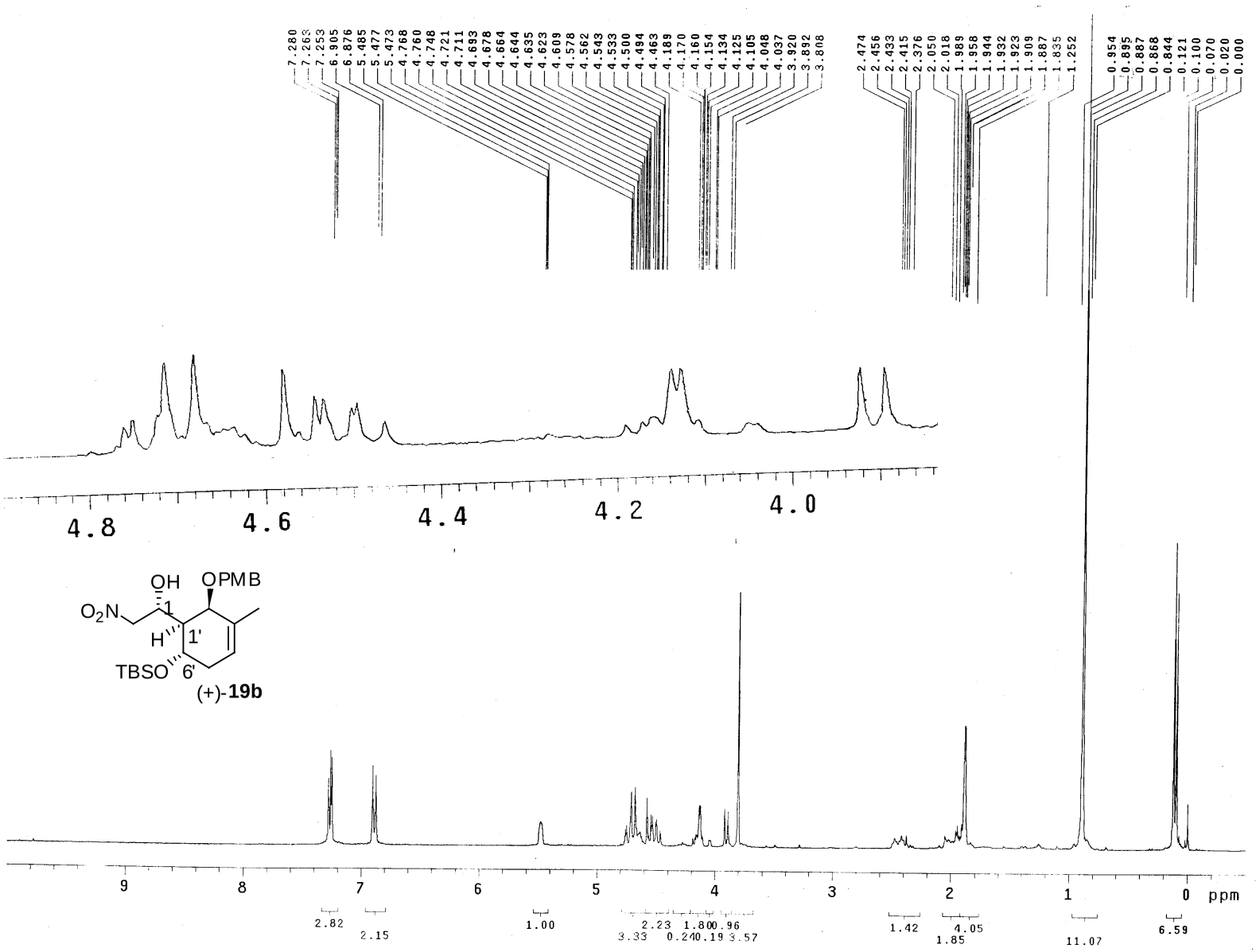
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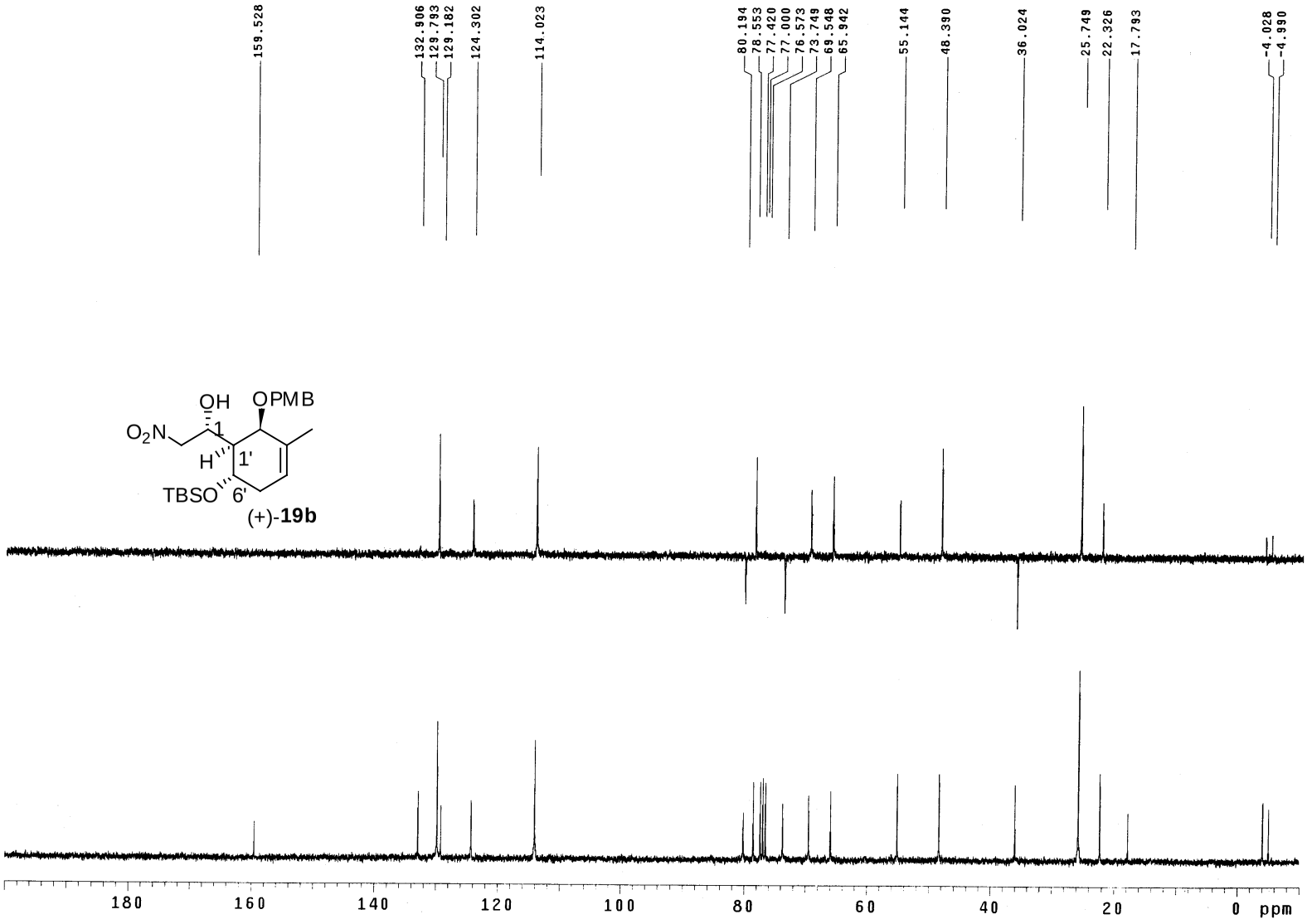
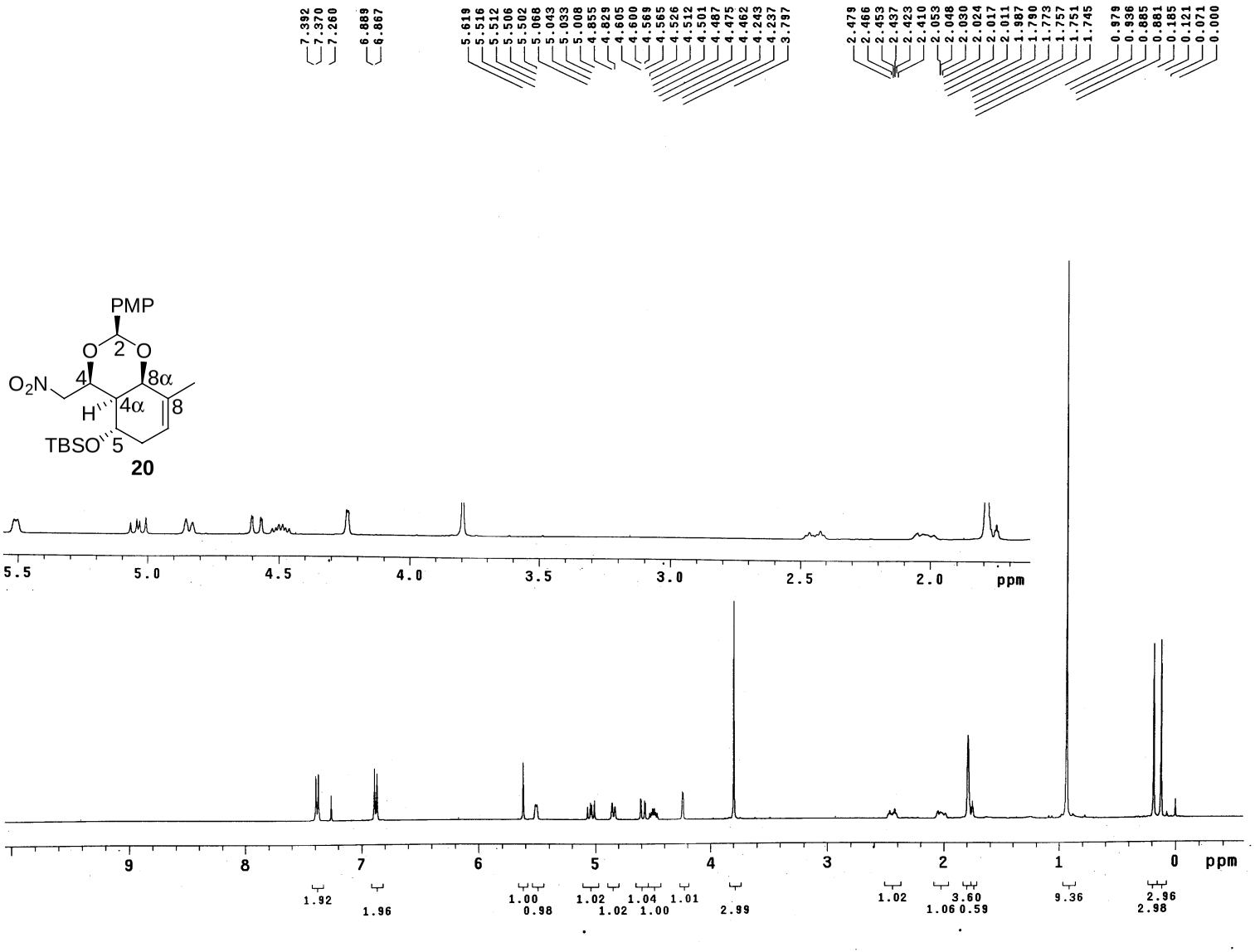
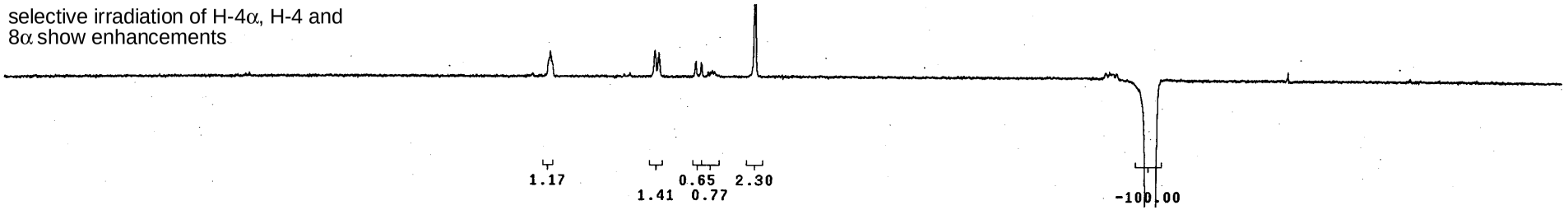
TBSO
6'
(+)-19b
9
8
7
6
5
4
3
2
1
0
ppm
2.82
2.15
1.00
2.23
1.80
0.96
3.33
0.24
0.19
3.57
1.42
4.05
1.85
11.07
6.59

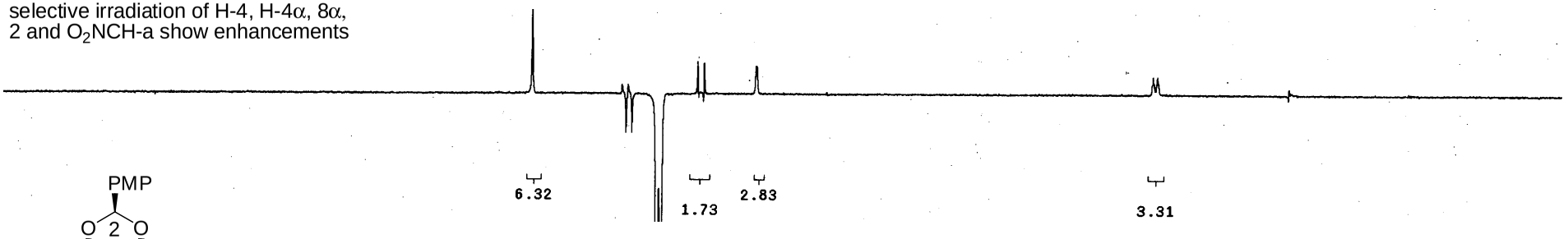

159.528
132.906
129.793
129.182
124.302
114.023
80.194
78.553
77.420
77.000
76.573
73.749
69.548
65.942
55.144
48.390
36.024
25.749
22.326
17.793
-4.028
-4.990
OH
OPMB
O2N
1
H
1'
TBSO
6'
(+)-19b
180
160
140
120
100
80
60
40
20
0
ppm

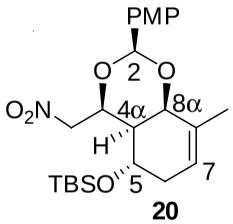

7.392
7.370
7.260
6.889
6.867
5.619
5.516
5.512
5.506
5.502
5.068
5.043
5.033
5.008
4.855
4.829
4.605
4.600
4.569
4.565
4.526
4.512
4.501
4.487
4.475
4.462
4.243
4.237
3.797
2.479
2.466
2.453
2.437
2.423
2.410
2.053
2.048
2.030
2.024
2.017
2.011
1.987
1.790
1.773
1.757
1.751
1.745
0.979
0.936
0.885
0.881
0.185
0.121
0.071
0.000
PMP
O
2
O
O2N
4
8α
H
4α
8
TBSO
5
20
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
ppm
9
8
7
6
5
4
3
2
1
0
ppm
1.92
1.96
1.00
0.98
1.02
1.02
1.04
1.00
1.01
2.99
1.02
3.60
1.06
0.59
9.36
2.96
2.98

selective irradiation of H-4α, H-4 and 8α show enhancements



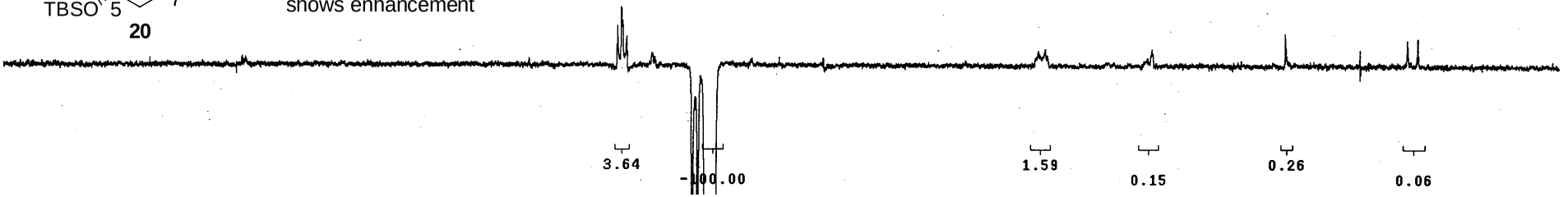
selective irradiation of H-4, H-4α, 8α, 2 and O_2NCH-a show enhancements



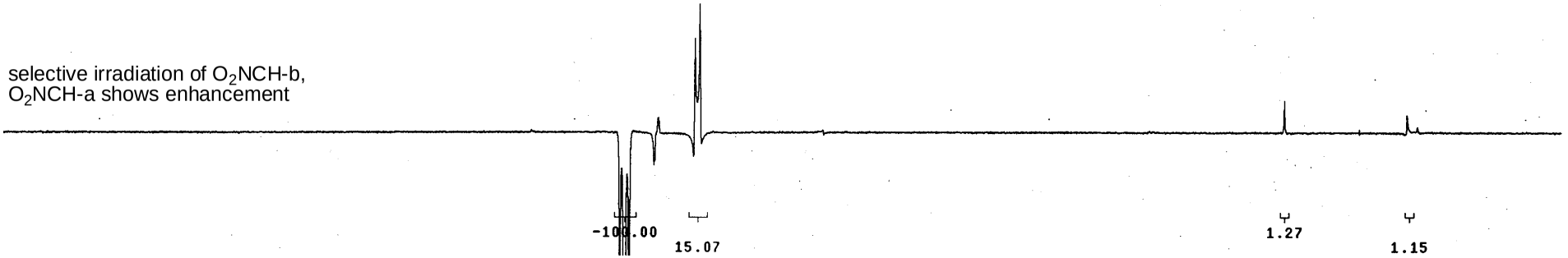


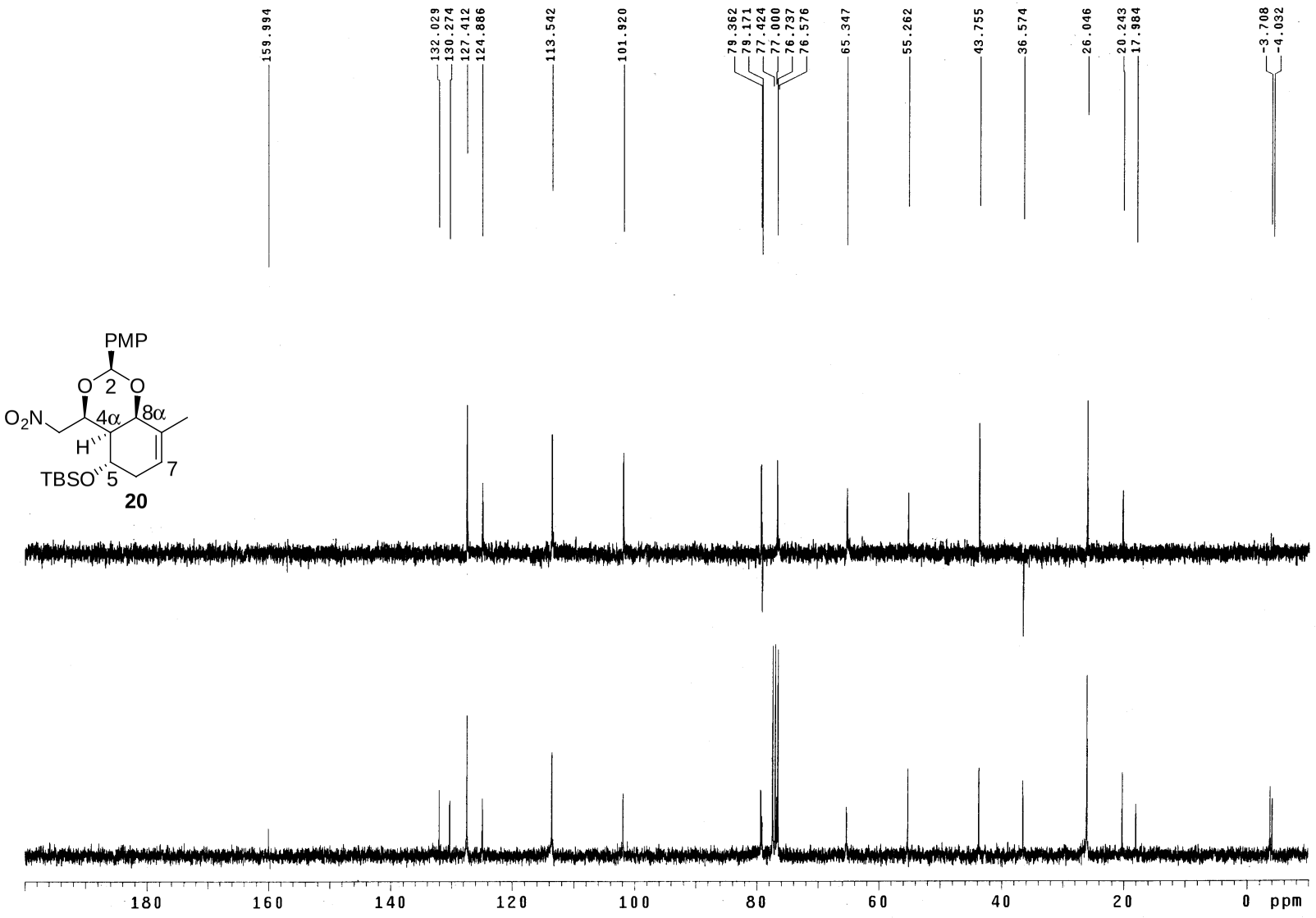
20

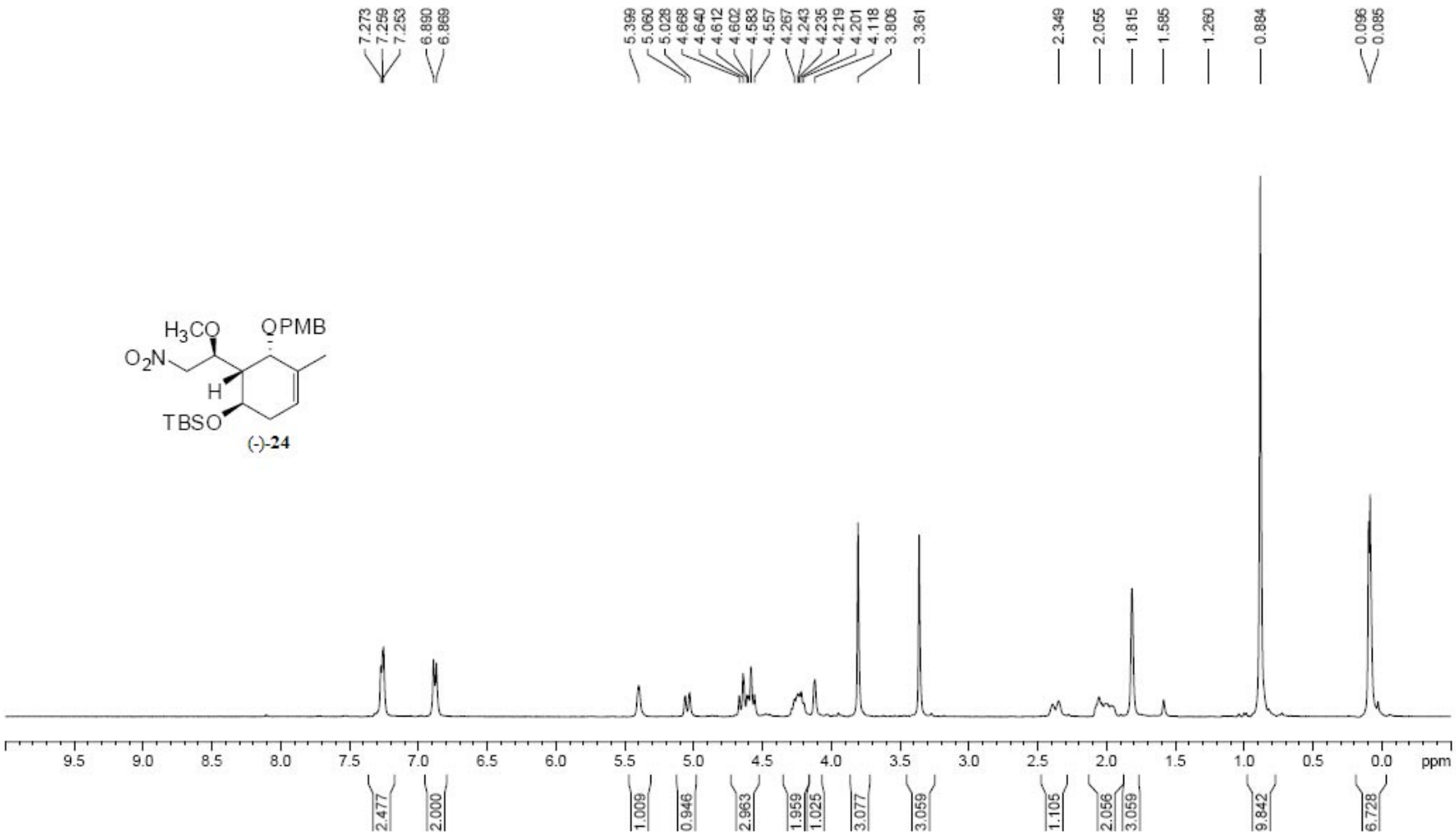
selective irradiation of H-5, H-6a shows enhancement

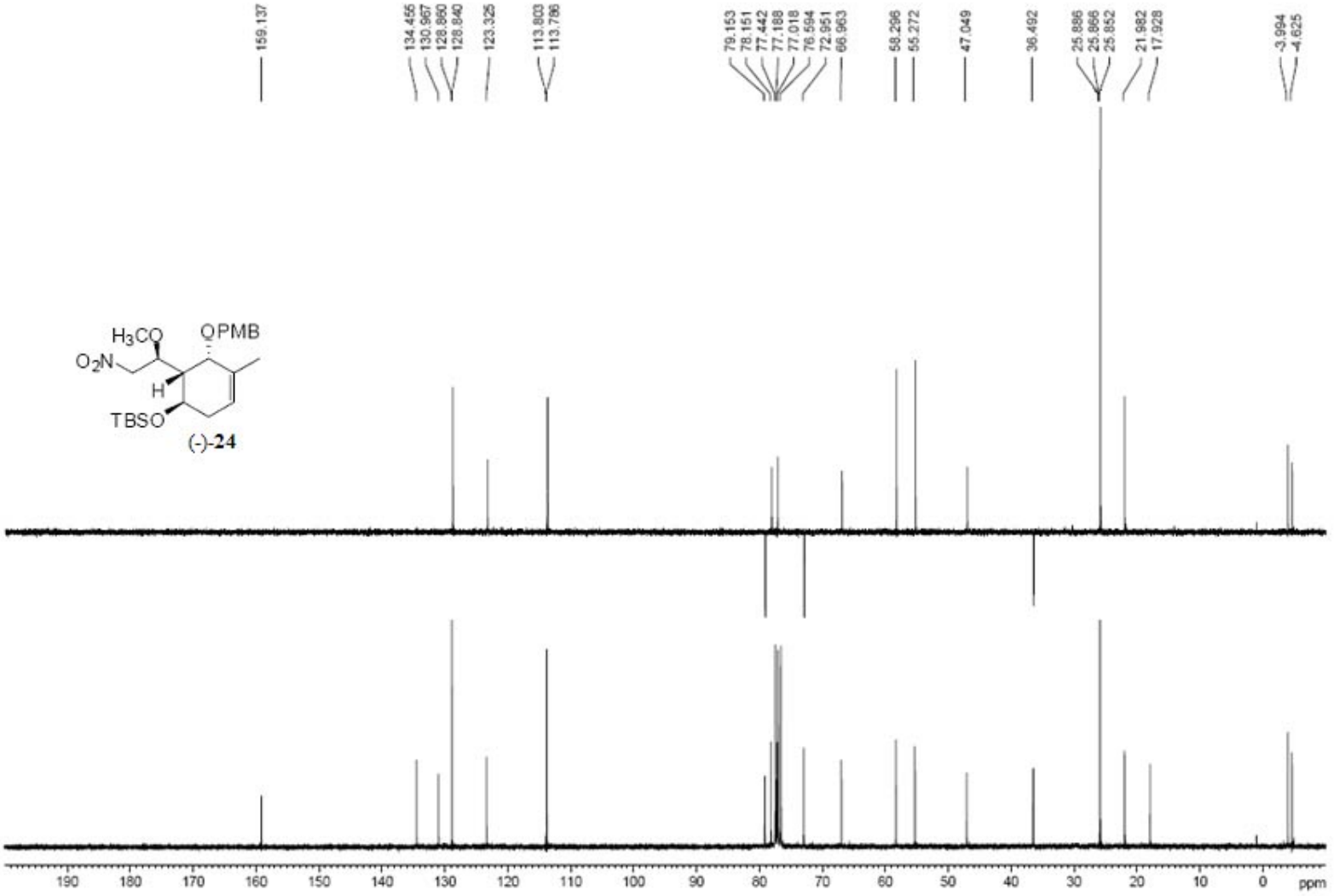


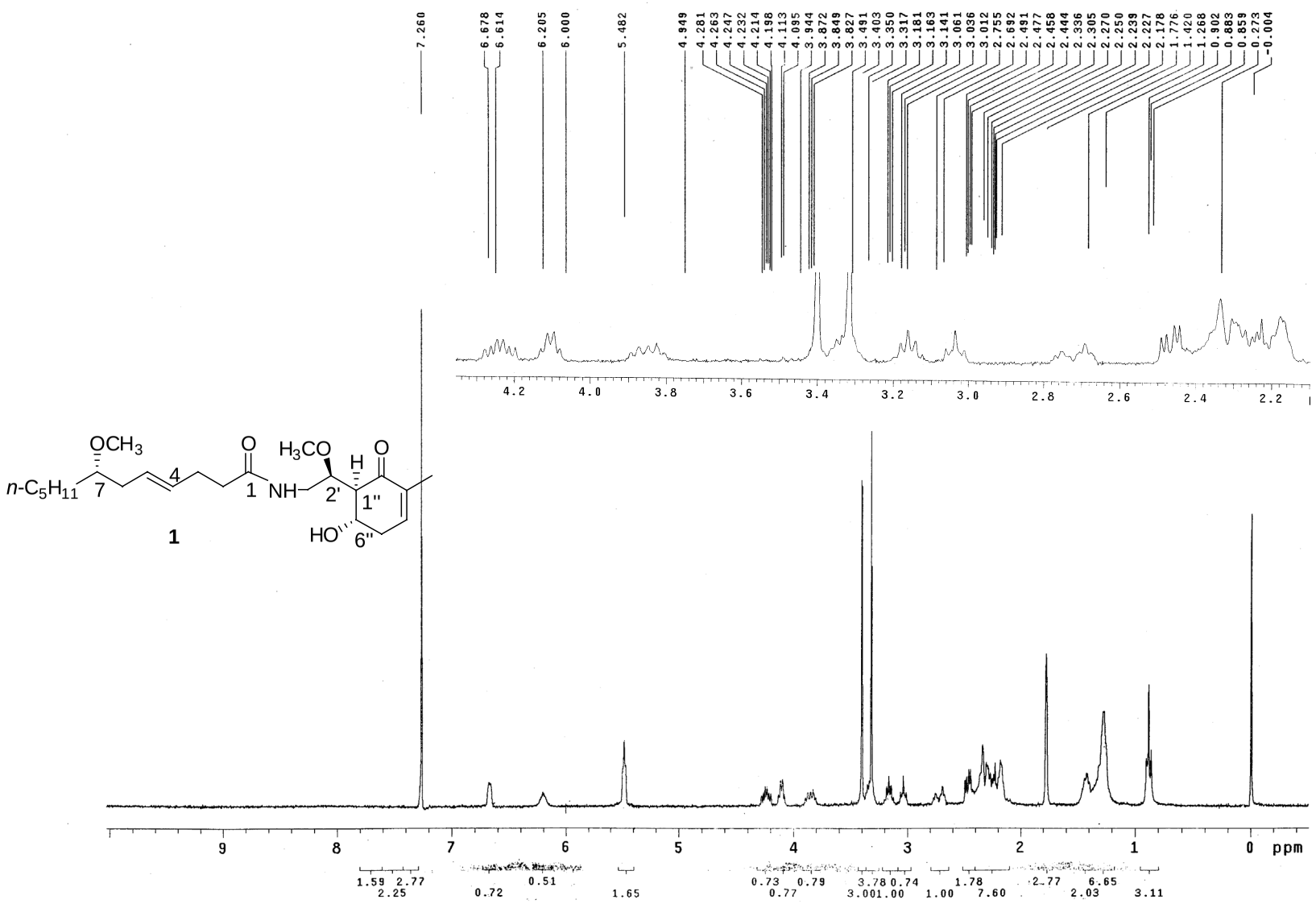
selective irradiation of O_2NCH-b, O_2NCH-a shows enhancement

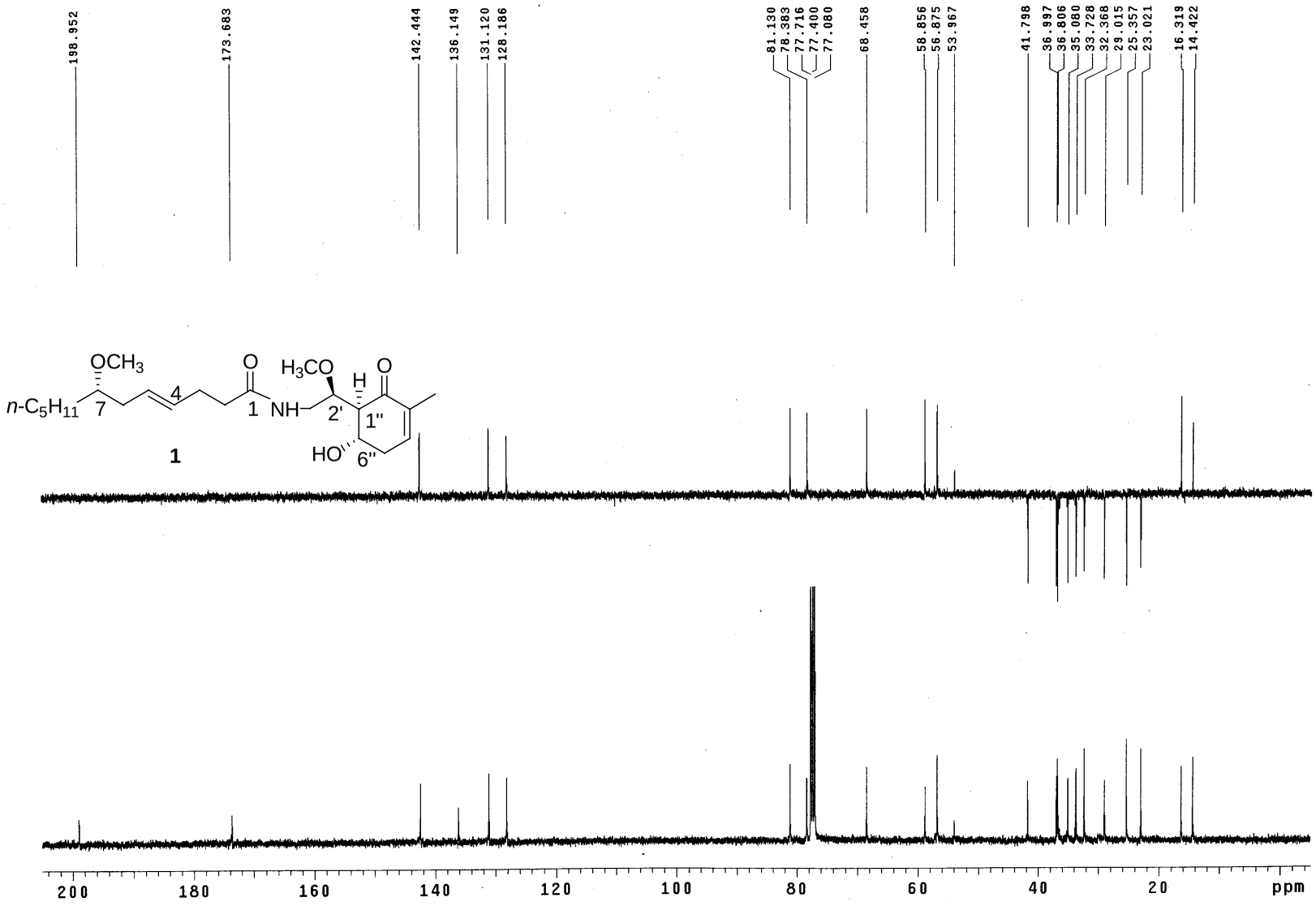


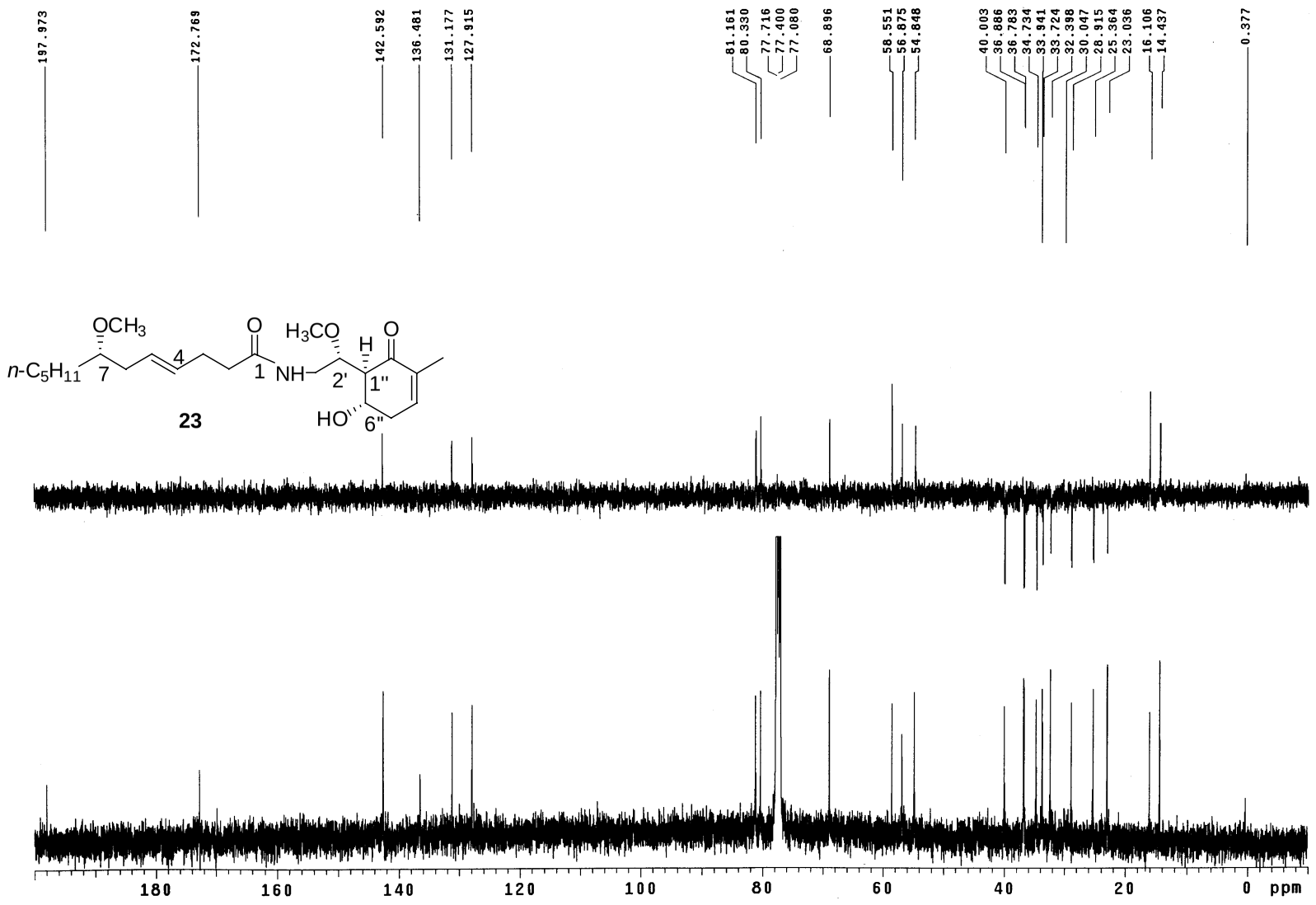

159.994
132.029
130.274
127.412
124.886
113.542
101.920
79.362
79.171
77.424
77.000
76.737
76.576
65.347
55.262
43.755
36.574
26.046
20.243
17.984
-3.708
-4.032
PMP
O
2
O
O2N
4α
8α
H
TBSO
5
7
20
180
160
140
120
100
80
60
40
20
0
ppm

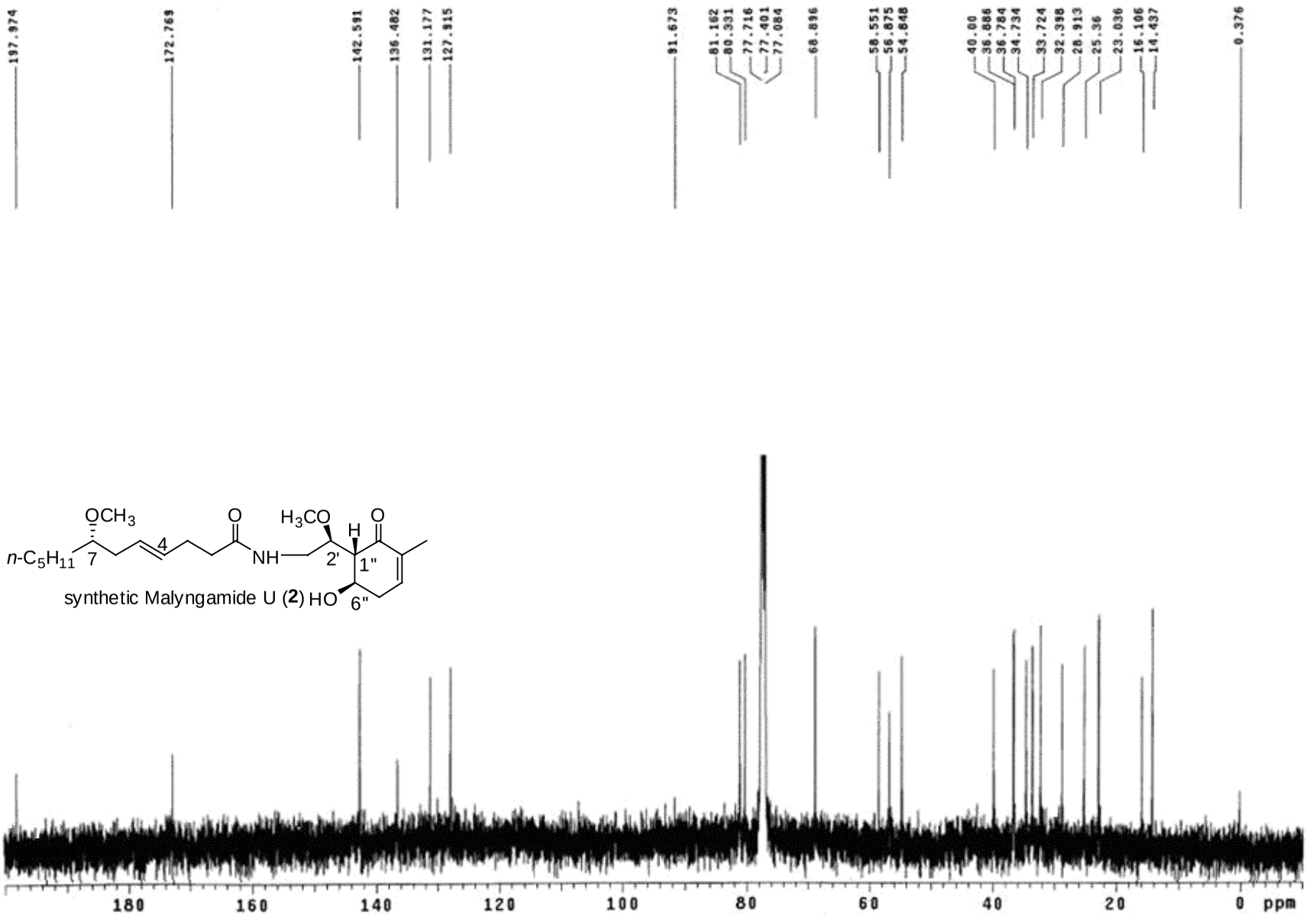

7.273
7.259
7.253
6.890
6.869
5.399
5.060
5.028
4.668
4.640
4.612
4.602
4.583
4.557
4.267
4.243
4.235
4.219
4.201
4.118
3.806
3.361
2.349
2.055
1.815
1.585
1.260
0.884
0.096
0.085
H3CO
QPMB
O2N
H
TBSO
(-)-24
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.477
2.000
1.009
0.946
2.963
1.959
1.025
3.077
3.059
1.105
2.056
3.059
9.842
6.728


159.137
134.456
130.967
128.860
128.840
123.325
113.803
113.786
79.153
78.151
77.442
77.188
77.018
76.594
72.951
66.963
58.296
55.272
47.049
36.492
25.886
25.866
25.852
21.982
17.928
-3.994
-4.625
H3CO
OPMB
O2N
H
TBSO
(-)-24
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

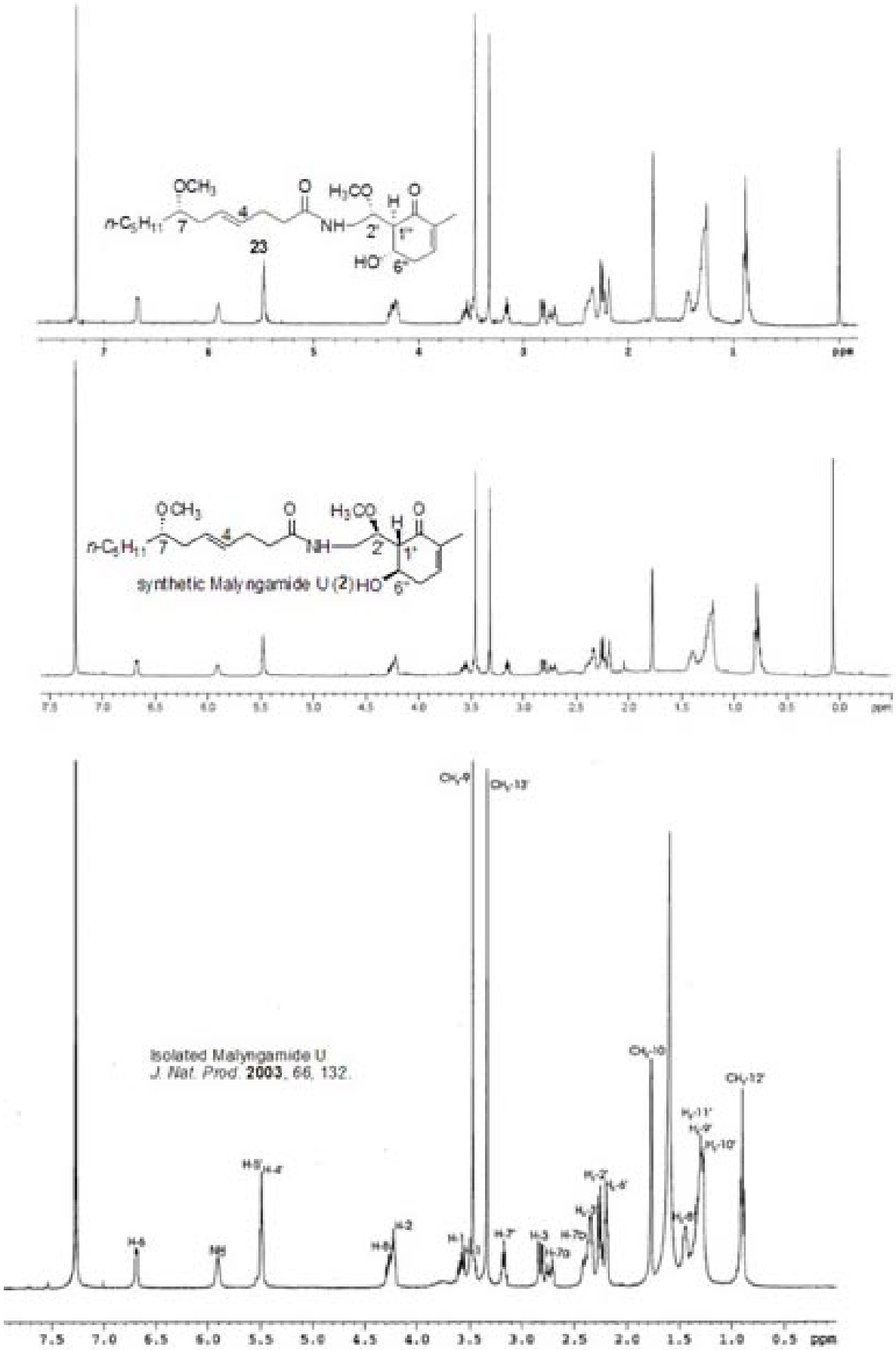

7.260
6.678
6.614
6.205
6.000
5.482
4.949
4.281
4.263
4.247
4.232
4.214
4.198
4.113
4.095
3.944
3.872
3.849
3.827
3.491
3.403
3.350
3.317
3.181
3.163
3.141
3.061
3.036
3.012
2.755
2.692
2.491
2.477
2.458
2.444
2.336
2.305
2.270
2.250
2.239
2.227
2.178
1.776
1.420
1.268
0.902
0.883
0.859
0.273
-0.004
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
OCH3
O
H3CO
H
O
n-C5H11
7
4
1
NH
2'
1"
HO
6"
1
9
8
7
6
5
4
3
2
1
0
ppm
1.59 2.77
2.25
0.72
0.51
1.65
0.73 0.79
0.77
3.78 0.74
3.00 1.00
1.78
1.00
7.60
2.77
6.65
2.03
3.11


198.952
173.683
142.444
136.149
131.120
128.186
81.130
78.383
77.716
77.400
77.080
68.458
58.856
56.875
53.967
41.798
36.997
36.806
35.080
33.728
32.368
29.015
25.357
23.021
16.319
14.422
OCH3
O
H3CO
H
O
n-C5H11
7
4
1
NH
2'
1"
HO
6"
1
200
180
160
140
120
100
80
60
40
20
ppm


197.973
172.769
142.592
136.481
131.177
127.915
81.161
80.330
77.716
77.400
77.080
68.896
58.551
56.875
54.848
40.003
36.886
36.783
34.734
33.941
33.724
32.398
30.047
28.915
25.364
23.036
16.106
14.437
0.377
OCH3
O
H3CO
H
O
n-C5H11
7
4
1
NH
2'
1"
HO
6"
23
180
160
140
120
100
80
60
40
20
0
ppm


197.974
172.769
142.591
136.482
131.177
127.915
91.673
81.162
80.331
77.716
77.401
77.084
68.836
58.551
56.875
54.848
40.00
36.886
36.784
34.734
33.724
32.398
28.913
25.36
23.036
16.106
14.437
0.376
OCH3
O
H3CO
H
O
n-C5H11
7
4
NH
2'
1"
HO
6"
synthetic Malyngamide U (2)
180
160
140
120
100
80
60
40
20
0
ppm

Comparison of ^{1}H NMR spectra for compound **23**, **2** (synthetic Malyngamide U), and isolated Malyngamide U



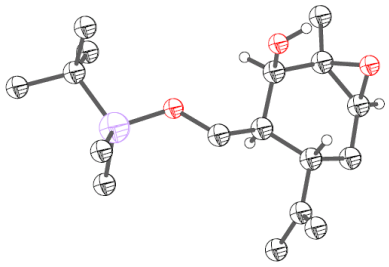


Figure 1 X-ray structure of epoxide (+)-**10**, partial hydrogen atoms are omitted for clarity