Studies Towards the Total Synthesis of Angelmicin B (Hibarimicin B): Synthesis of a Model D'–CD Arylnaphthoquinone System

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SUPPORTING INFORMATION

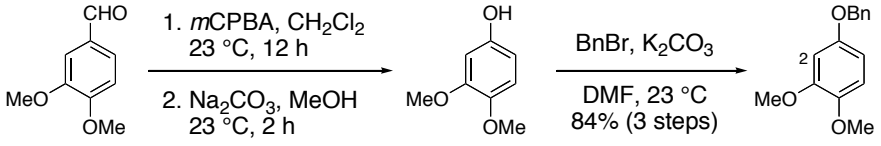
Experimental details and spectroscopic data for compounds **11**, **14**, **15**, **17**–**19**, **21**, and **22**
(21 pages)

General

All reactions were carried out in flame-dried glassware under an atmosphere of dry nitrogen or argon. 4 Å molecular sieves were flame dried under vacuum prior to use. Solvents were purified as follows: THF and Et_2O were either distilled from sodium benzophenone ketyl or used as is from a solvent purification system (Anhydrous Engineering). CH_2Cl_2 was either distilled from CaH_2 or used as is from a solvent purification system. DMF was stored over 4Å M.S., and used without further purification, unless otherwise mentioned.

^{1}H NMR spectra were measured at 500 or 400 MHz on a Varian I-500 or a Varian XL-400 instrument respectively. Chemical shifts are reported relative to residual solvent (δ 7.26, 2.5 and 4.8 ppm for $CDCl_3$, DMSO and MeOH respectively). ^{13}C NMR spectra were measured at 125 or 100 MHz on a Varian I-500 or a Varian XL-400 instrument respectively. Chemical shifts are reported relative to the central line of $CDCl_3$ (δ 77.0 ppm). Infrared spectra were recorded using a Perkin Elmer Spectrum 1000 FT-IR. High resolution mass spectra were measured on a VG 70-250-S Micromass Inc. mass spectrometer at the University of Michigan Mass Spectrometry Laboratory. Elemental analyses were performed at the Elemental Analysis Laboratory at the University of Michigan.

Analytical thin layer chromatography (TLC) was performed using Whatman glass plates coated with a 0.25 mm thickness of silica gel containing PF254 indicator, and compounds were visualized with UV light, potassium iodide – iodine stain, *p*-anisaldehyde stain, ceric ammonium molybdate stain, or phosphomolybdic acid in EtOH. Chromatographic purifications were performed using Kieselgel 60, 230-400 mesh silica gel. All compounds purified by chromatography were sufficiently pure for use in further experiments, unless indicated otherwise.



13 **14**

1-Benzyloxy-3,4-dimethoxybenzene (14)

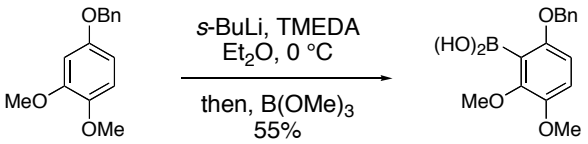
Water-free *m*CPBA[#] (6.85 g, 39.7 mmol) was added in small portions to a solution of

[#] CAUTION: *m*CPBA is known to be explosive in its very pure states and therefore should be handled with extreme care. Although we have never encountered any difficulties, removal of the solvent in the following procedure should always be carried out behind a blast shield. A commercial sample of 80-85% *m*CPBA (10g) was dissolved in 200mL of CH_2Cl_2, and the water layer separated. The solution was dried over anhydrous sodium sulfate, filtered and concentrated under reduced pressure. This sample of *m*CPBA was stored in a –20°C freezer for up to 3 months without deterioration of quality.

veratraldehyde (5.5 g, 33.1 mmol) in 30 mL of CH_2Cl_2 and the solution stirred at ambient temperature. *Caution: Exothermic reaction*. When *m*CPBA is added, the reaction flask should be left open. After 30 min, a white precipitate formed and the heterogeneous mixture stopped stirring. Another 30 mL of CH_2Cl_2 was added and the mixture stirred at ambient temperature for 8 h. After this time, the mixture was filtered, and the residue washed with CH_2Cl_2. The combined filtrates were washed with sat. $NaHCO_3$ (3x), dried (anhydrous Na_2SO_4) and concentrated to obtain the formate as a yellow oil. This material was directly subjected to the methanolysis conditions.

The crude formate from the previous step was dissolved in 15 mL of MeOH and Na_2CO_3 (5.26g, 49.7 mmol) added. The dark green solution was stirred at ambient temperature for 2 h, after which time TLC analysis indicated complete consumption of the starting formate. Most of the methanol was removed under reduced pressure and the oily slurry partitioned between water and EtOAc. The layers were separated, and the aqueous layer further extracted with EtOAc (2x). The combined organic extracts were washed with brine, dried (Na_2SO_4), filtered and concentrated under reduced pressure. The crude phenol was obtained as a reddish brown solid.

To a solution of the phenol in DMF (15 mL) was added K_2CO_3 (6.87 g, 49.7 mmol) and benzyl bromide (5.91 mL, 49.7 mmol). This mixture was stirred at ambient temperature for 12 h. When TLC indicated completion of the reaction, 100 mL water was added and the aqueous solution was extracted three times with Et_2O•hexanes (8 : 2). The combined extracts were washed with brine, dried (anhydrous Na_2SO_4), filtered and concentrated. Purification of the crude material by flash column chromatography (15% EtOAc in hexanes) afforded a sample of pure **14** (6.83 g, 84%) as a clear oil. The spectroscopic data for this sample of **14** matched previously reported data for this compound.[1]

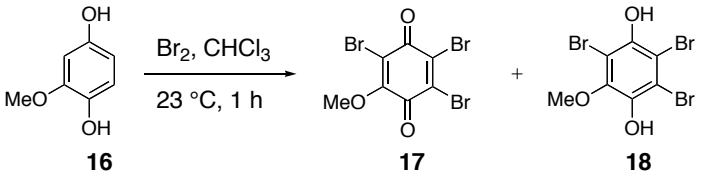


14 **15**

(6-Benzyloxy-2,3-dimethoxyphenyl) boronic acid (15)

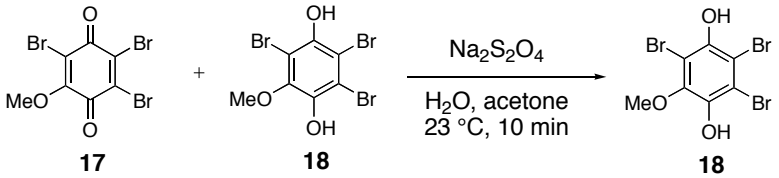
s-BuLi (3.57 mL of a 1.49 M solution in cyclohexane, 5.32 mmol) was added dropwise, to a solution of arene **14** (520 mg, 2.13 mmol), TMEDA (803 μL, 5.32 mmol) in Et_2O (8 mL) at 0 °C. The orange red solution was stirred at 0 °C for 1.75 h, after which trimethyl borate (1.19 mL, 10.7 mmol) was added in one portion. The mixture was then allowed to attain ambient temperature. TLC analysis at this time indicated a small amount of starting material present. The reaction mixture was added to a 1 M HCl solution and the aqueous solution extracted with Et_2O

(3x). theombined extracts were dried (Na_2SO_4) and concentrated. The curde product was purified by flash column chromatography (40% EtOAc in hexanes) to obtain **15** as a pale brown solid (337 mg, 55%). Data for **14**: mp 117–120 °C; ^{1}H NMR (500 MHz, CD_3OD) 7.27 – 7.15 (m, 5H), 6.76 and 6.54 (AB system, J_{AB} = 8.8 Hz, 2H), 4.86 (s, 2H), 3.67 (s, 3H), 3.64 (s, 3H); ^{13}C NMR (125 MHz, CD_3OD) 155.6, 152.1, 147.9, 139.0, 129.4, 128.7, 128.6, 128.1, 115.1, 115.0, 108.2, 108.1, 108.0, 71.4, 60.9, 60.7, 56.7, 56.6; IR (Thin film) cm^{-1}; HRMS (ES) calcd. for $C_{15}H_{17}O_5$ (M+Na$^+$): 311.1067, found 311.1069.



2,3,5-Tribromo-6-methoxy-[1,4]benzoquinone (17)

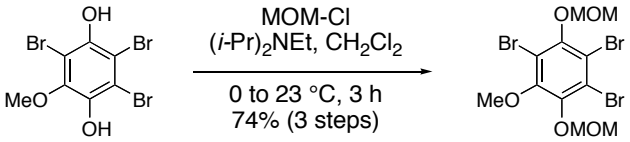
Bromine (5mL, 97.5 mmol) was added to a solution of methoxyhydroquinone (2.8g, 20 mmol) in $CHCl_3$ and the mixture stirred at ambient temperature for 1 h. At this time TLC analysis indicated the formation of quinone **17**, but also a considerable amount of hydroquinone **18**. The volatiles were removed under reduced pressure and the crude residue (red solid) was directly used in the subsequent reaction. An analytical sample was prepared by flash column chromatography (15% EtOAc in hexanes). Data for **17**: ^{1}H NMR (500 MHz, $CDCl_3$) 4.24 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) 172.0, 171.6, 156.7, 138.5, 136.6, 117.4, 62.2; IR (Thin film) 1679, 1656, 1601, 1559, 1452, 1414, 1308, 1193, 1139, 1064, 944, 812, 776, 738, 717, 677 cm^{-1}; HRMS (EI) calcd. for $C_7H_{13}O_3Br_3$ (M$^+$): 371.7632, found 371.7639; *Anal*. calcd for $C_7H_{13}O_3Br_3$: C, 22.42%; H, 0.81%, found C, 22.85%; H, 0.80%.



2,3,5-Tribromo-6-methoxy-benzene-1,4-diol (18)

The mixture of **17** and **18** from the bromination reaction was dissolved in acetone (20 mL) and sodium dithionite (3.48 g, 20 mmol) in 20 mL of water was added. The red color of the solution briefly disappeared when a drop of the dithionite solution was added and then reappeared. Ultimately, the red color of the solution gave way to pale yellow, indicating complete consumption of the quinone. The reaction mixture was partitioned between CH_2Cl_2 and

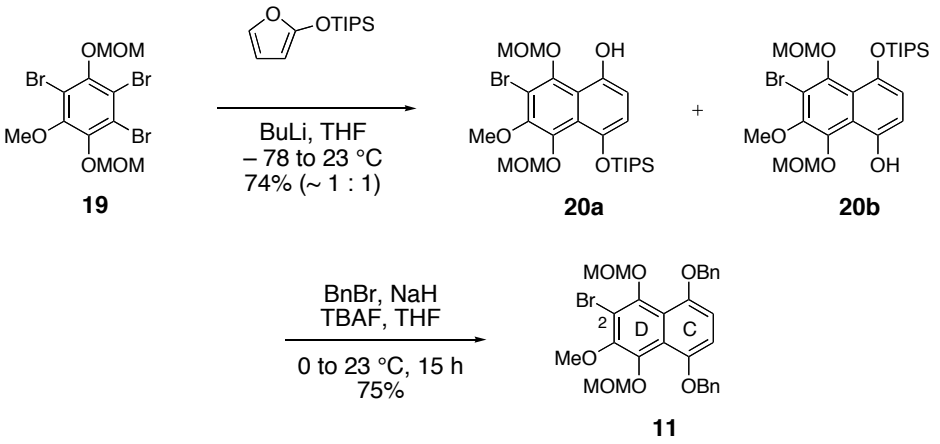
water and the layers separated. The aqueous solution was further extracted with CH_2Cl_2 (2x). The combined extracts were dried (Na_2SO_4) and concentrated under reduced pressure to obtain the crude product as a yellowish white solid (6.2 g) that had a strong sulfurous odor. The crude product was directly utilized in the subsequent reaction. Partial data for **18**: ^{1}H NMR (500 MHz, $CDCl_3$) □ 5.50 (s, 1H), 5.31 (s, 1H), 3.89 (s, 3H); ^{13}C NMR HRMS (EI) calcd. for $C_7H_5O_3Br_3$ (M^+): 373.7789, found 373.7776; *Anal*. calcd for: $C_7H_5O_3Br_3$: C, 22.31%; H, 1.34%, found C, 22.59%; H, 1.13%.



18 **19**

1,2,4-Tribromo-5-methoxy-3,6-bis-methoxymethoxybenzene (19)

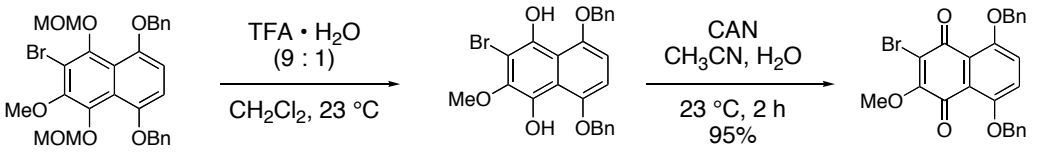
To a solution of hydroquinone **18** (1.02 g, 2.71 mmol) in CH_2Cl_2 (5 mL) at 0□C, was added MOM-Cl (0.514 mL, 6.77 mmol). After the mixture was stirred at 0 °C for 2 min, Hünig's base (1.18 mL, 6.77 mmol) was added, and the mixture stirred at 0 °C for 2 h, at which time TLC analysis indicated complete conversion to **19**. The reaction mixture was diluted with CH_2Cl_2 (10 mL) and the CH_2Cl_2 solution was washed successively with NH_4Cl solution (1 : 1, sat. solution + water), water, and sat $NaHCO_3$ solution. The CH_2Cl_2 layer was dried (Na_2SO_4) and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (15% EtOAc in hexanes) gave **19** as a white solid (1.13 g, 74% over three steps). Data for **19**: mp 169–170 °C; ^{1}H NMR (500 MHz, $CDCl_3$) □ 5.14 (s, 2H), 5.11 (s, 2H), 3.84 (s, 3H), 3.69 (s, 3H), 3.63 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) □ 150.9, 149.4, 146.1, 121.0, 117.2, 114.1, 99.6, 99.3, 60.7, 58.5, 58.2; IR (Thin film) 1599, 1469, 1448, 1427, 1382, 1245, 1161, 1098, 1083, 1049, 945, 925, 864, 800, 765, 704, 670 cm^{-1}; HRMS (EI) calcd. for $C_{11}H_{13}O_5Br_3$ (M^+): 461.8313, found 461.8324; *Anal*. calcd for: $C_{11}H_{13}O_3Br_3$: C, 28.42%; H, 2.82%, found C, 28.50%; H, 2.97%.



5,8-Dibenzyloxy-2-bromo-3-methoxy-1,4-dimethoxymethoxy-naphthalene (11)

To a solution of dibromide **19** (1.03 g, 2.22 mmol) and 2-triisopropylsilyloxyfuran (0.586 g, 2.44 mmol) in 20 mL of THF, was added BuLi (1.03 mL of a 2.15 M solution in hexanes, 2.22 mmol) dropwise over 20 min. After being stirred at – 78 °C for 2 h, the reaction mixture was slowly allowed to attain ambient temperature. Saturated NH_4Cl and water (1 : 1) were added to the reaction mixture and the aqueous solution extracted four times with Et_2O (containing ~ 20% hexanes). The combined Et_2O extracts were washed with brine, dried (Na_2SO_4) and concentrated to obtain a red oil. Purification of the crude product by silica gel chromatography (10 to 25% EtOAc in hexanes) afforded naphthols **20a**,**b** (896 mg, 74%) in a nearly 1 : 1 regioisomeric ratio. The naphthols **20a,b** readily underwent air oxidation to unidentified quinonoid products. Therefore, they were immediately used in the subsequent step.

NaH (24 mg, 1.01 mmol) was added to a solution of naphthols **20a,b** (220 mg, 0.403 mmol) and benzyl bromide (0.24 mL, 2.02 mmol) in THF (5 mL) at 0 °C. The reaction mixture was stirred at 0 °C for 1 h, then was allowed to attain ambient temperature and stirred for another 4 h. TBAF (1.01 mL of a 1 M solution in THF, 1 .01 mmol) was then added, and the mixture stirred for 10 h. The reaction mixture was partitioned between sat $NaHCO_3$ and Et_2O, and the layers separated, and the aqueous solution further extracted with Et_2O (3x). The combined Et_2O extracts were washed with brine, dried ($MgSO_4$) and concentrated. The crude product was purified by flash column chromatography (15 to 25% EtOAc in hexanes) to obtain **11** (172 mg, 75%) as a white solid. Data for **11**: mp 110–111 °C; ^{1}H NMR (500 MHz, $CDCl_3$) □ 7.51 – 7.33 (m, 10H), 6.64 and 6.79 (AB system, J_{AB} = 8.5 Hz, 2H), 5.11 (s, 2H), 5.08 (s, 2H), 4.98 (s, 4H), 3.99 (s, 3H), 3.57 (s, 3H), 3.54 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) □ 149.6, 148.8, 148.6, 147.6, 142.7, 136.9, 128.5, 128.0, 127.9, 127.8, 123.1, 120.6, 114.5, 110.4, 110.0, 101.4, 101.0, 72.6, 61.3, 58.3, 57.3, 30.9, 29.7; IR (Thin film) 2921, 2850, 1735, 1664, 1605, 1566, 1497, 1454, 1372, 1345, 1310, 1260, 1212, 1157, 1080, 1023, 961, 931, 797, 736, 697 cm^{-1}; HRMS (ES) calcd. for $C_{29}H_{29}BrO_7$ (M+Na$^+$): 591.0994, found 591.1003.

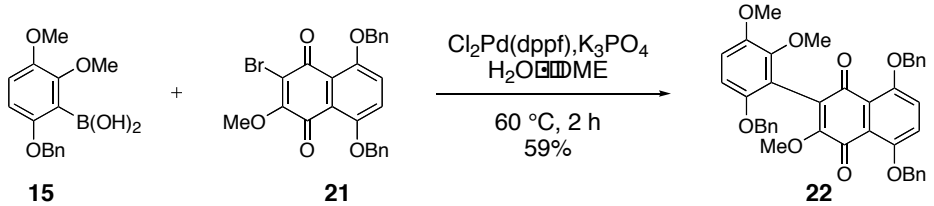


11 **21**

5,8-dibenzyloxy-2-bromo-3-methoxy-[1,4]naphthoquinone (21)

To a solution of **11** (85 mg, 0.149 mmol) in CH_2Cl_2 (3 mL), was added TFA•H_2O (9 : 1) and the mixture stirred at ambient temperature for 2 h. At this time, reaction mixture was partitioned between CH_2Cl_2 and sat $NaHCO_3$ solution. The layers were separated and the aqueous solution further extracted with CH_2Cl_2 (2x). Combined extracts were dried (Na_2SO_4) and concentrated to obtain the hydroquinone as an orange-yellow solid. Partial data for intermediate hydroquinone: ^{1}H NMR (500 MHz, $CDCl_3$) □ 9.94 (s, 1H), 9.32 (s, 1H), 7.49 – 7.40 (m, 10H), 6.74 and 6.70 (AB system, J_{AB} = 8.5 Hz, 2H), 5.20 (s, 2H), 5.19 (s, 2H), 3.92 (s, 3H).

The crude hydroquinone was dissolved in CH_3CN (5 mL) and CAN (2 mL of a 0.1 M solution in H_2O, 0.2 mmol) was added. The mixture was vigorously stirred at ambient temperature for 2 h. At this time, most of the CH_3CN was removed under reduced pressure, and the residue diluted with water and sat. $NaHCO_3$ solution. The resulting aqueous solution was extracted with CH_2Cl_2 (3x) and the combined extracts dried (Na_2SO_4) and concentrated. Purification of the crude product by flash column chromatography (25% EtOAc in hexanes) afforded quinone **21** as a red solid (68 mg, 95%). Data for **21**: mp 138–140 °C; ^{1}H NMR (400 MHz, $CDCl_3$) □ 7.55 – 7.23 (m, 12 H), 5.22 (s, 2H), 5.19 (s, 2H), 4.23 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) □ 177.9, 177.5, 158.8, 153.2, 136.2, 136.1, 128.7, 128.6, 127.9, 127.0, 126.8, 123.0, 122.0, 121.0, 120.7, 94.4, 71.8, 71.7, 61.3, 29.7; IR (Thin film): 1672, 1654, 1604, 1584, 1562, 1498, 1477, 1449, 1412, 1381, 1330, 1294, 1268, 1201, 1158, 1100, 1080, 1050, 1030, 1011, 948, 917, 807, 774, 732, 693; HRMS (ES) calcd for $C_{25}H_{19}BrO_5$ (M+Na$^+$) 501.0314, found 501.0313.



15 **21** **22**

5,8-Dibenzyloxy-2-(6-benzyloxy-2,3-dimethoxyphenyl)-3-methoxy-[1,4]naphthoquinone (22)

Dimethoxyethane (DME) was degassed by sparging argon through it for 15 min. A solution of arylboronic acid **15** (8.4 mg, 29. 2 □mol), bromonaphthoquinone **21** (9.5 mg, 19.8 □mol), $Cl_2Pd(dppf)•CH_2Cl_2$ (3.2 mg, 3.96 □mol) and K_3PO_4 (89 □L of a 1 M solution in H_2O, 89

mol) in DME (0.75 mL) was heated at 60 °C for 2 h. TLC analysis at this point indicated complete consumption of both starting materials. The reaction mixture was cooled to ambient temperature, added to water and extracted with Et_2O (4x). The combined extracts were washed with brine, dried (Na_2SO_4) and concentrated. Purification of the crude product by flash column chromatography (30 to 40% EtOAc in hexanes) afforded **22** (7.5 mg, 59%) as a red film. Data for **22**: ^{1}H NMR (400 MHz, DMSO) 7.64 – 7.19 (m, 17H), 7.02 and 6.78 (AB system, J_{AB} = 9.2 Hz, 2H), 5.29 (s, 2H), 5.20 (s, 2H), 5.02 and 4.95 (AB system, J_{AB} = 12.6 Hz, 2H), 3.79 (s, 3H), 3.73 (s, 3H), 3.60 (s, 3H); ^{13}C NMR (125 MHz, DMSO) 183.0, 180.0, 157.3, 152.1, 151.7, 150.0, 147.1, 146.7, 137.4, 137.0, 136.9, 128.5, 128.4, 128.3, 127.8, 127.6, 127.5, 127.2, 127.0, 124.2, 123.1, 121.8, 121.0, 120.6, 116.3, 113.2, 107.5, 70.6, 69.8, 60.0, 59.6, 56.0; IR (Thin film) 2923, 2852, 1742, 1661, 1567, 1482, 1453, 1420, 1379, 1274, 1208, 1078, 1028, 964, 796, 737, 696, 665; HRMS (ES) calcd. for $C_{40}H_{34}O_8$ ($M+Na^+$): 665.2151, found 665.2155.

References

1. Kupchan, S. M.; Liepa, A. J.; Kameswar.V; Sempuku, K. *J. Am. Chem. Soc.* **1973**, *95*, 2995.

sn-tc-iii-159-a

Pulse Sequence: s2pul

Date: Thu Jan 2 21:50:13 EST 2003
Solvent: CD3OD

Spectrometer: I-500
Nucleus: H1

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5	3613.466	7.228	11.4
6	3608.339	7.218	30.7
7	3606.630	7.215	17.3
8	3601.991	7.205	11.1
9	3600.527	7.202	15.4
10	3581.971	7.165	11.1
11	3574.891	7.151	13.2
12	3385.920	6.773	22.4
13	3377.131	6.756	25.8
14	3272.147	6.546	25.2
15	3263.358	6.528	22.2
16	2428.372	4.858	59.6
17	2389.552	4.780	54.7
18	1844.858	3.690	29.0
19	1841.928	3.685	8.7
20	1840.707	3.682	9.7
21	1834.115	3.669	167.2
22	1832.406	3.665	14.1
23	1831.185	3.663	10.6
24	1830.453	3.662	10.2
25	1829.721	3.660	10.1
26	1829.232	3.659	10.6
27	1828.500	3.658	10.3
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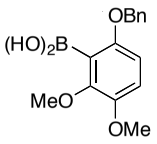

15

sn-tc-iii-159-a

Pulse Sequence: s2pul

Date: Fri Jan 3 04:11:06 EST 2003
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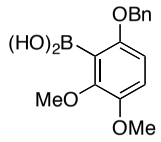
7	16178.647	128.707	24.4
8	16175.870	128.685	31.2
9	16163.968	128.590	5.7
10	16102.873	128.104	136.4
11	14472.334	115.133	23.0
12	14456.862	115.010	25.2
13	14454.879	114.994	25.6
14	13605.888	108.240	20.9
15	13597.557	108.174	5.0
16	13587.242	108.091	24.2
17	13585.655	108.079	27.4
18	9001.105	71.607	9.1
19	8982.062	71.456	7.4
20	8974.524	71.396	48.0
21	8948.737	71.190	12.3
22	7652.638	60.880	16.5
23	7649.464	60.854	5.1
24	7637.562	60.760	26.8
25	7622.090	60.637	6.3
26	7147.211	56.859	4.8
27	7130.945	56.729	21.0
28	7119.043	56.635	7.2
29	7115.473	56.606	34.5
30	7099.604	56.480	6.3
31	6223.636	49.511	22.9
32	6202.212	49.341	66.0
33	6180.789	49.170	130.8
34	6159.366	49.000	155.4
35	6137.943	48.830	132.9
36	6116.520	48.659	66.6
37	6095.097	48.489	22.9



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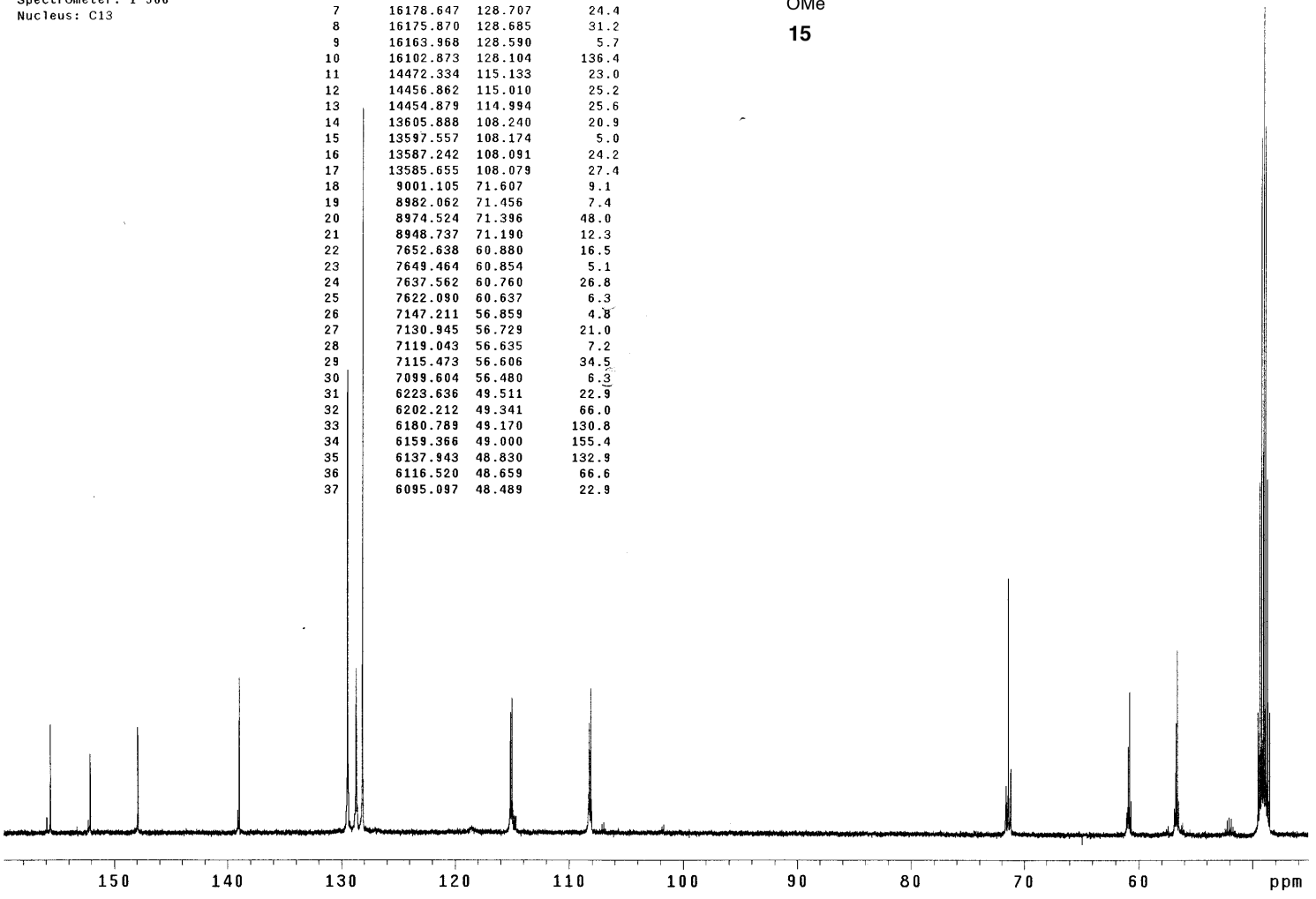

sn-tc-iv-22-a

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Solvent: CDCl3

Spectrometer: I-500

Nucleus: H1

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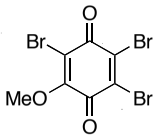
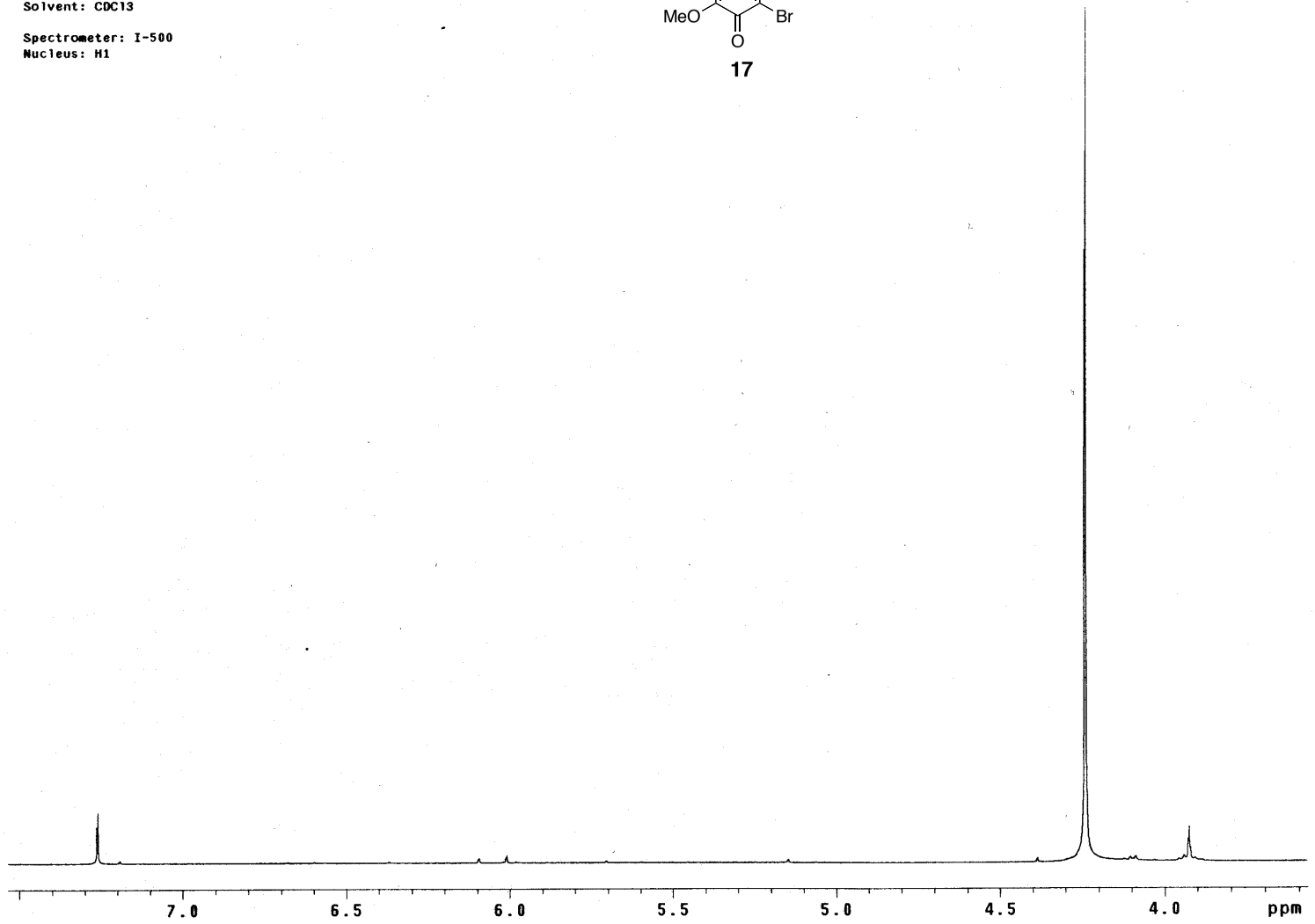
2	2120.470	4.242	116.1
3	2118.517	4.238	162.0



17



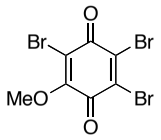
sn-tc-iv-22-a

Pulse Sequence: s2pul

Date: Fri Jan 10 20:14:40 EST 2003
Solvent: CDCl3

Spectrometer: I-500
Nucleus: C13

INDEX	FREQUENCY	PPM	HEIGHT
1	21617.977	171.979	15.6
2	21564.424	171.553	14.4
3	19699.700	156.719	16.0
4	17409.759	138.501	22.6
5	17172.206	136.611	23.1
6	14756.395	117.393	19.4
7	9710.562	77.251	77.2
8	9678.522	76.996	81.0
9	9646.482	76.741	78.7
10	7816.086	62.180	46.9



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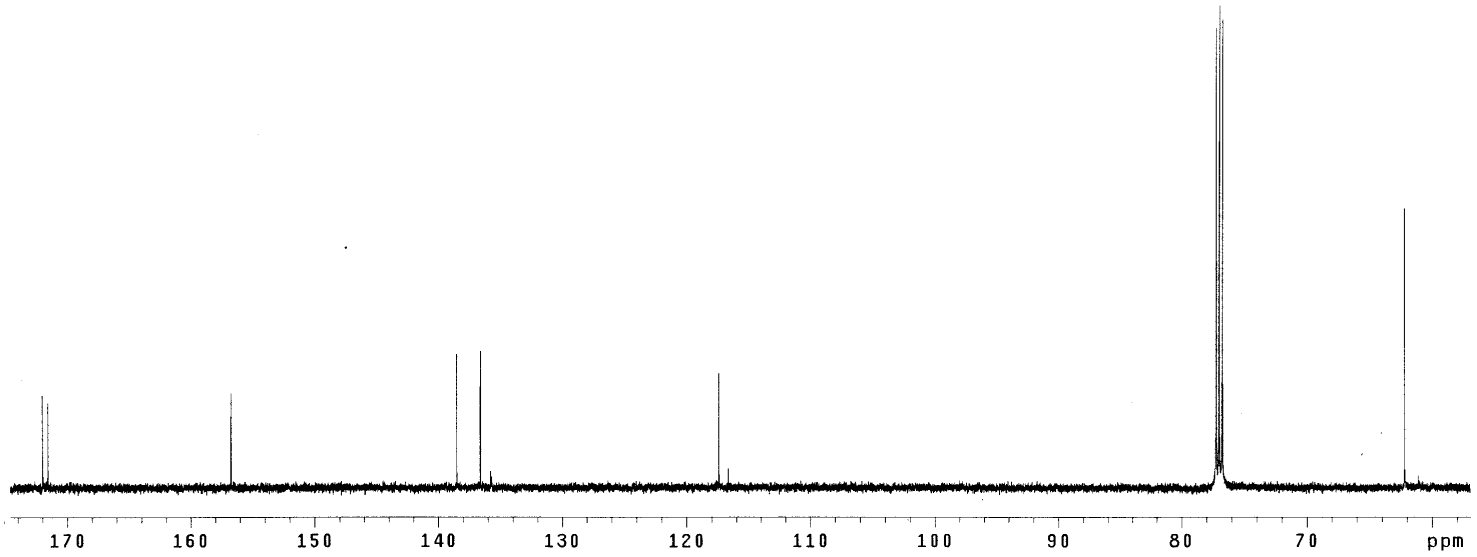


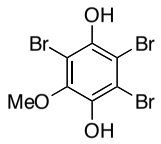
sn-tc-iv-40-a

Pulse Sequence: s2pul

Date: Fri Jan 10 20:44:28 EST 2003
Solvent: CDCl3

Spectrometer: I-500
Nucleus: H1

INDEX	FREQUENCY	PPM	HEIGHT
1	3629.305	7.260	16.3
2	3628.817	7.259	16.1
3	3569.977	7.141	46.5
4	3569.489	7.140	45.9
5	2844.369	5.690	16.2
6	2825.814	5.653	16.9
7	2751.348	5.504	39.0
8	2656.619	5.314	41.9
9	1962.750	3.926	81.5
10	1956.646	3.914	7.0
11	1951.519	3.904	7.7
12	1950.787	3.902	8.4
13	1950.299	3.901	8.8
14	1949.566	3.900	9.1
15	1949.078	3.899	9.9
16	1946.392	3.894	178.2
17	1945.904	3.893	168.5
18	1941.265	3.883	8.0



18

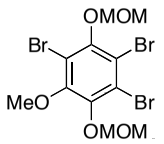
sn-tc-iv-90-a

Pulse Sequence: s2pul

Date: Fri Jan 10 20:26:14 EST 2003
Solvent: CDCl3

Spectrometer: I-500
Nucleus: H1

INDEX	FREQUENCY	PPM	HEIGHT
1	2570.191	5.141	99.6
2	2554.321	5.110	99.5
3	1920.024	3.841	145.3
4	1846.292	3.693	150.6
5	1816.017	3.633	149.6



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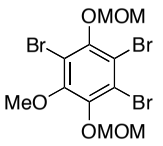
sn-tc-iv-90-a_c13

Pulse Sequence: s2pul

Date: Fri Jan 10 20:30:04 EST 2003
Solvent: CDCl3

Spectrometer: I-500
Nucleus: C13

INDEX	FREQUENCY	PPM	HEIGHT
1	18966.901	150.889	25.2
2	18781.985	149.418	31.1
3	18367.754	146.123	27.6
4	15212.278	121.020	33.6
5	14733.510	117.211	31.0
6	14344.911	114.119	33.9
7	12525.958	99.649	143.0
8	12487.052	99.339	138.2
9	9711.020	77.255	22.4
10	9678.980	77.000	24.6
11	9646.940	76.745	22.2
12	7633.917	60.731	113.3
13	7351.050	58.480	112.1
14	7319.010	58.226	108.6



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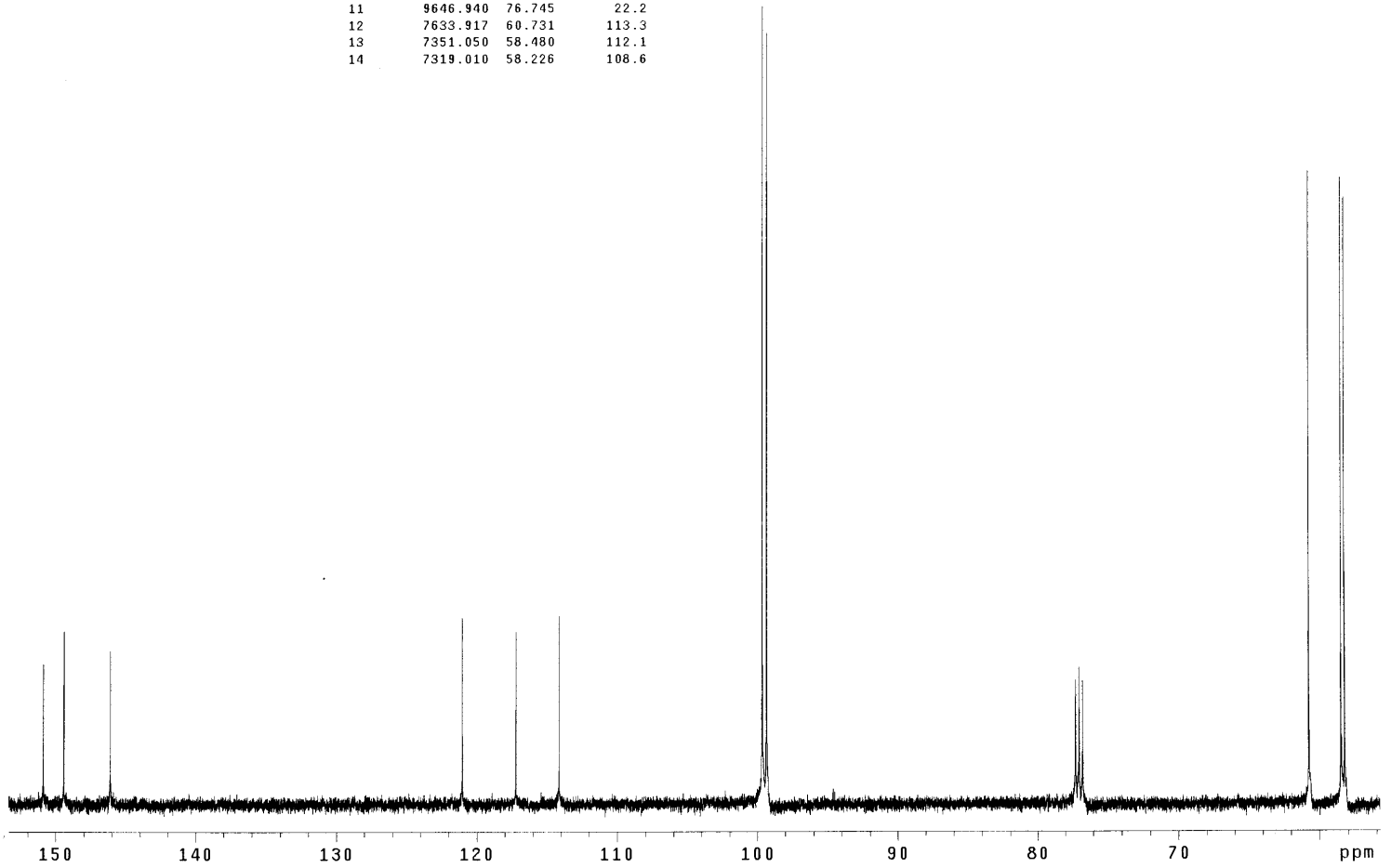


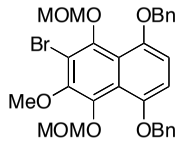
sn-tc-iv-64-a

Pulse Sequence: s2pul

Date: Sat Jan 11 13:36:07 EST 2003
Solvent: CDCl3

Spectrometer: I-500
Nucleus: H1

INDEX	FREQUENCY	PPM	HEIGHT
1	3756.018	7.513	31.4
2	3750.647	7.503	44.5
3	3748.937	7.499	46.8
4	3743.810	7.489	39.3
5	3708.897	7.419	28.0
6	3707.188	7.416	30.3
7	3702.061	7.406	48.7
8	3700.108	7.402	53.6
9	3694.248	7.390	35.4
10	3692.539	7.386	33.0
11	3678.867	7.359	25.7
12	3677.646	7.357	26.5
13	3671.787	7.345	26.8
14	3670.322	7.342	26.6
15	3664.462	7.330	14.5
16	3629.305	7.260	31.7
17	3421.291	6.844	17.8
18	3412.746	6.827	35.7
19	3400.050	6.801	35.7
20	3391.505	6.784	18.1
21	2551.879	5.105	77.9
22	2537.475	5.076	78.5
23	2490.354	4.982	116.9
24	2488.889	4.979	123.9
25	1995.466	3.992	151.8
26	1786.231	3.573	159.6
27	1768.897	3.538	162.0
28	1086.747	2.174	113.8
29	792.060	1.584	11.1
30	627.748	1.255	31.1



11

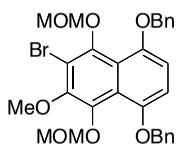
sn-tc-iv-64-1_c13

Pulse Sequence: s2pul

Date: Sat Jan 11 17:22:09 EST 2003
Solvent: CDCl3

Spectrometer: I-500
Nucleus: C13

INDEX	FREQUENCY	PPM	HEIGHT
1	18799.377	149.556	24.7
2	18699.138	148.759	21.5
3	18674.879	148.566	18.0
4	18555.416	147.615	17.6
5	17932.926	142.663	17.4
6	17213.400	136.939	27.0
7	17202.415	136.852	26.9
8	16155.167	128.521	162.0
9	16085.137	127.963	64.9
10	16081.933	127.938	63.4
11	16073.694	127.872	125.5
12	16061.336	127.774	110.8
13	15468.597	123.059	16.9
14	15153.690	120.553	17.3
15	14398.005	114.542	14.5
16	13873.923	110.372	47.6
17	13821.744	109.957	50.5
18	12750.236	101.433	52.5
19	12691.191	100.963	55.7
20	9711.019	77.255	150.3
21	9678.979	77.000	156.0
22	9646.939	76.745	153.0
23	9154.897	72.831	57.4
24	9126.977	72.609	57.8
25	7699.826	61.255	51.6
26	7325.874	58.280	48.2
27	7229.755	57.515	53.7
28	3888.447	30.934	14.9
29	3730.993	29.681	14.7



11

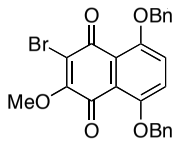
sn-iv-272-b

Pulse Sequence: s2pul

Date: Sat Dec 28 15:38:46 EST 2002
Solvent: CDCl3

Spectrometer: VXR-400
Nucleus: H1

INDEX	FREQUENCY	PPM	HEIGHT
1	3018.022	7.546	22.1
2	3010.330	7.526	40.8
3	3001.540	7.505	29.4
4	2966.378	7.417	17.4
5	2963.448	7.409	19.2
6	2959.419	7.399	35.7
7	2956.488	7.392	37.5
8	2951.727	7.380	24.3
9	2948.797	7.373	23.3
10	2937.442	7.344	13.3
11	2930.483	7.327	21.7
12	2924.257	7.311	17.8
13	2903.746	7.260	17.7
14	2892.025	7.231	57.5
15	2890.926	7.228	59.4
16	2088.062	5.221	70.5
17	2075.976	5.190	72.3
18	1689.927	4.225	162.0



21

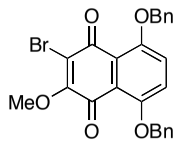
sn-tc-iv-272-A b

Pulse Sequence: s2pul

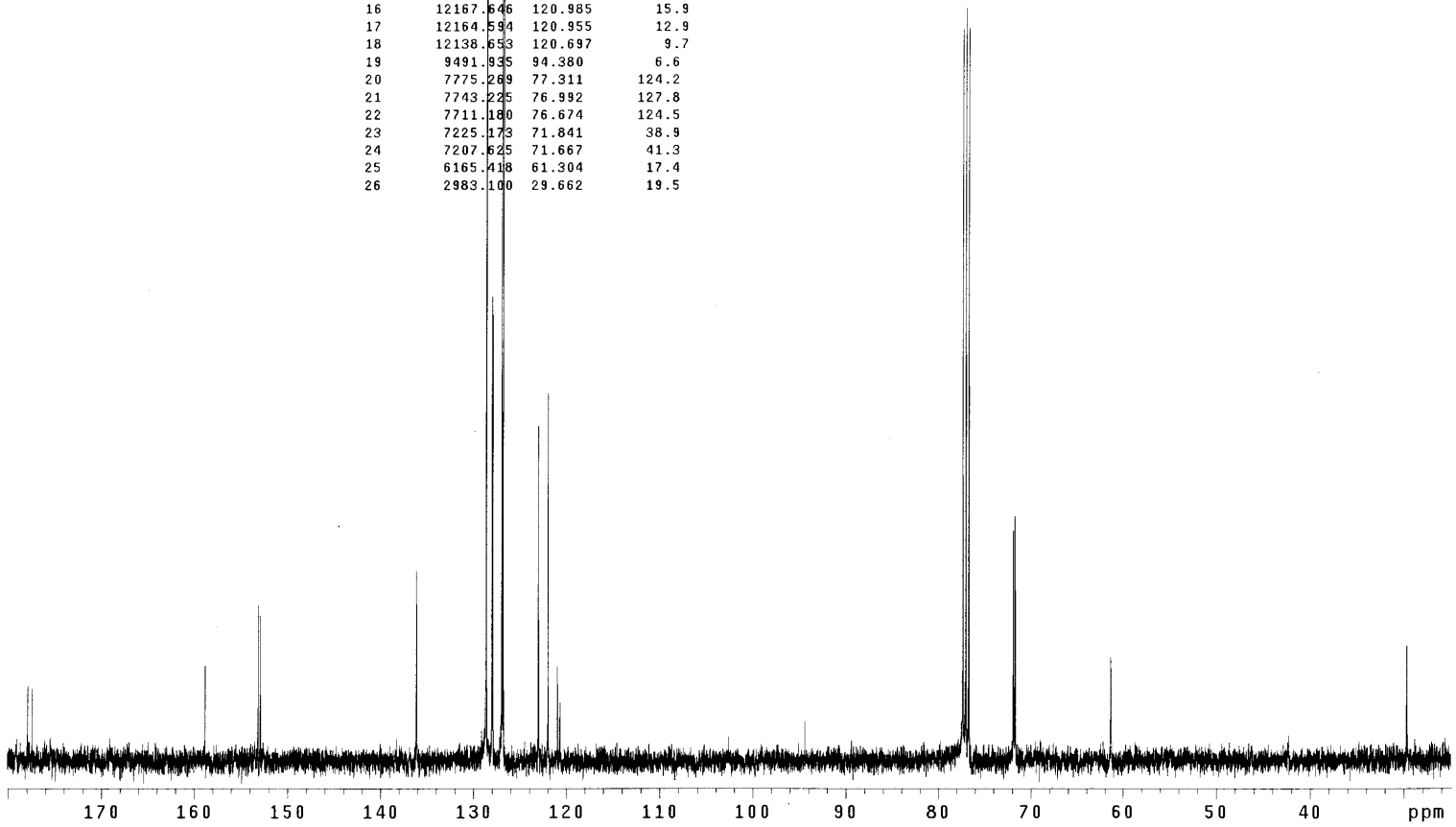
Date: Sat Dec 28 17:22:58 EST 2002
Solvent: CDCl3

Spectrometer: VXR-400
Nucleus: C13

INDEX	FREQUENCY	PPM	HEIGHT
1	17895.970	177.943	12.6
2	17847.140	177.458	12.2
3	15974.830	158.841	16.1
4	15402.608	153.151	26.3
5	15378.193	152.908	24.6
6	13692.808	136.150	32.1
7	13685.942	136.082	26.5
8	12939.001	128.655	162.0
9	12936.712	128.632	161.7
10	12875.675	128.025	78.7
11	12866.520	127.934	75.6
12	12769.623	126.971	145.4
13	12755.850	126.834	150.4
14	12372.883	123.026	56.7
15	12268.357	121.987	62.3
16	12167.646	120.985	15.9
17	12164.594	120.955	12.9
18	12138.653	120.697	9.7
19	9491.935	94.380	6.6
20	7775.269	77.311	124.2
21	7743.225	76.992	127.8
22	7711.180	76.674	124.5
23	7225.173	71.841	38.9
24	7207.625	71.667	41.3
25	6165.418	61.304	17.4
26	2983.100	29.662	19.5



21

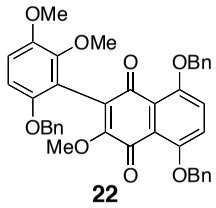


sn-iv-137-a var temp 20deg C

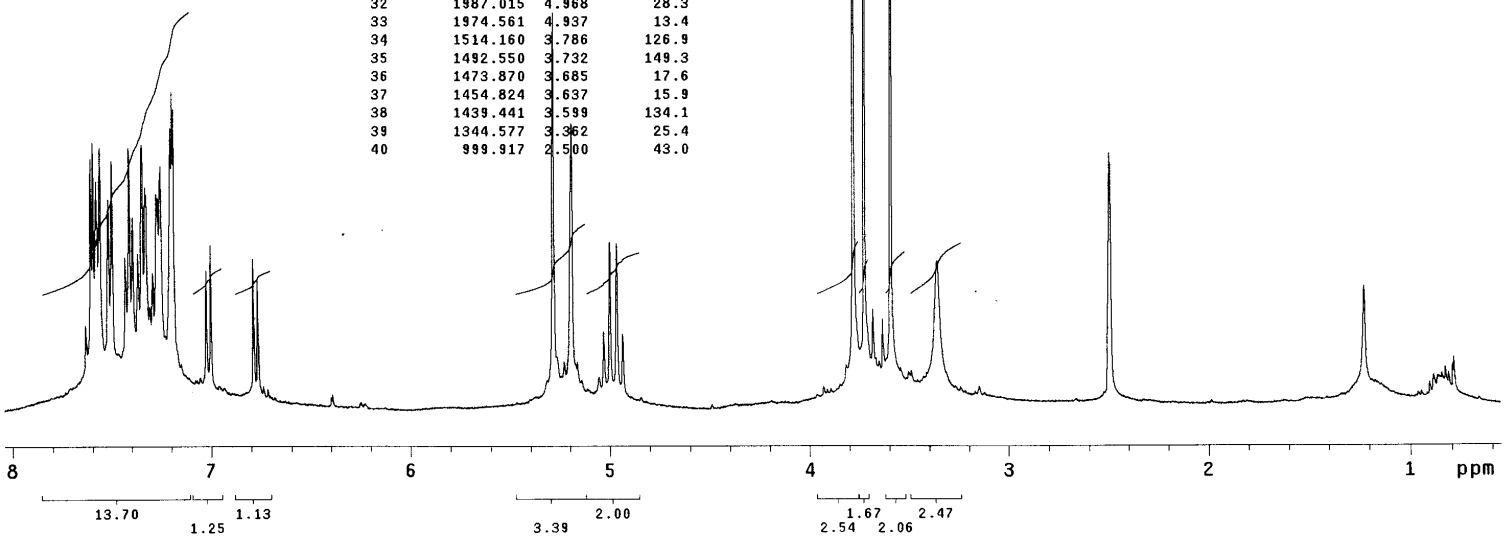
Pulse Sequence: s2pul

Date: Thu Jan 2 16:36:55 EST 2003
Solvent: DMSO
File: sn-iv-137-a_vt-20
Spectrometer: VXR-400
Nucleus: H1

INDEX	FREQUENCY	PPM	HEIGHT	INDEX	FREQUENCY	PPM	HEIGHT
1	3053.593	7.635	14.9	41	998.086	2.495	41.4
2	3044.070	7.611	42.2	42	490.069	1.225	21.2
3	3039.308	7.599	44.8				
4	3032.715	7.582	38.5				
5	3025.023	7.563	44.0				
6	3008.541	7.522	35.6				
7	3000.850	7.503	41.8				
8	2973.746	7.435	26.1				
9	2966.420	7.417	44.0				
10	2958.729	7.397	32.6				
11	2948.107	7.371	26.7				
12	2940.781	7.353	44.5				
13	2933.090	7.333	37.5				
14	2931.625	7.330	36.3				
15	2923.933	7.310	18.0				
16	2918.073	7.296	23.5				
17	2910.747	7.277	36.4				
18	2907.817	7.270	35.8				
19	2903.788	7.260	38.8				
20	2901.957	7.255	41.0				
21	2882.544	7.207	47.2				
22	2879.248	7.199	53.2				
23	2876.684	7.192	50.4				
24	2810.756	7.027	23.8				
25	2801.599	7.005	28.0				
26	2716.624	6.792	25.8				
27	2707.467	6.769	22.4				
28	2115.575	5.289	66.2				
29	2078.216	5.196	48.0				
30	2013.386	5.034	13.8				
31	2000.567	5.002	28.5				
32	1987.015	4.968	28.3				
33	1974.561	4.937	13.4				
34	1514.160	3.786	126.9				
35	1492.550	3.732	149.3				
36	1473.870	3.685	17.6				
37	1454.824	3.637	15.9				
38	1439.441	3.599	134.1				
39	1344.577	3.362	25.4				
40	999.917	2.500	43.0				



22



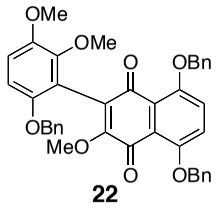
sn-tc-iv-137-a_c13

Pulse Sequence: s2pul

Date: Sat Jan 11 21:29:48 EST 2003
Solvent: DMSO

Spectrometer: I-500
Nucleus: C13

INDEX	FREQUENCY	PPM	HEIGHT	INDEX	FREQUENCY	PPM	HEIGHT
1	23000.041	182.973	25.7	41	4923.564	39.169	850.5
2	22632.039	180.046	26.2	42	4902.967	39.005	275.0
3	19769.042	157.270	27.3				
4	19115.885	152.073	34.5				
5	19062.790	151.651	32.9				
6	18860.938	150.045	34.7				
7	18492.479	147.114	31.9				
8	18434.349	146.652	33.0				
9	17266.265	137.359	38.1				
10	17215.916	136.959	42.2				
11	17213.170	136.937	40.1				
12	16150.359	128.482	136.7				
13	16134.339	128.354	136.2				
14	16120.608	128.245	121.0				
15	16061.105	127.772	50.7				
16	16043.254	127.630	45.9				
17	16032.269	127.542	48.7				
18	15984.209	127.160	142.0				
19	15964.070	127.000	159.1				
20	15962.239	126.985	152.5				
21	15618.039	124.247	26.9				
22	15473.859	123.100	25.8				
23	15315.948	121.844	26.9				
24	15213.420	121.028	31.8				
25	15162.156	120.620	29.3				
26	14623.885	116.338	26.6				
27	14227.963	113.188	25.7				
28	13512.099	107.493	27.1				
29	8875.462	70.607	48.6				
30	8871.343	70.575	46.9				
31	8778.884	69.839	43.8				
32	7545.804	60.029	55.7				
33	7496.829	59.640	65.0				
34	7045.066	56.046	51.6				
35	5763.468	45.850	-8.9				
36	5028.838	40.006	432.8				
37	5007.783	39.839	1026.5				
38	4986.729	39.671	1841.2				
39	4965.674	39.504	2081.7				
40	4944.619	39.336	1719.0				



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