**Stereocontrol in the EtAlCl₂-Induced Cyclization of Chiral γ,δ -Unsaturated
Methyl Ketones to Cyclopentanones**

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Supporting Material

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(R)-3,7-Dimethyl-2-methyleneoctanal. (R)-3,7-Dimethyloctanal (**8**)⁵ (1.04 g, 6.67 mmol), formaldehyde (37% aqueous solution, 0.55 mL, 7.34 mmol), piperidine (33 μ L, 0.33 mmol) and 6 M HCl (28 μ L, 0.17 mmol) were stirred at reflux for 13 h. The reaction mixture was acidified with 6 M HCl and diluted with CH₂Cl₂ (3 mL). The phases were separated and the aqueous phase was extracted with CH₂Cl₂ (2 $\times$ 3 mL). The organic phases were combined, dried (MgSO₄) and concentrated under reduced pressure to give the known aldehyde⁷ (1.09 g, 98%) that was >95% pure by ¹H NMR analysis: ¹H NMR (CDCl₃) 9.53 (s, 1), 6.23 (s, 1), 5.98 (s, 1), 2.73-2.65 (m, 1), 1.55-1.41 (m, 2), 1.36-1.10 (m, 5), 1.06 (d, 3, *J* = 6.7), 0.85 (d, 6, *J* = 6.7); ¹³C NMR 194.8, 155.7, 133.1, 38.9, 35.8, 31.1, 27.8, 24.9, 22.59, 22.56, 19.5; IR (CH₂Cl₂) 1698, 1623 cm⁻¹; [α]_D²⁰ -10.6 (*c* 0.57, CHCl₃).

(5R)-5,9-Dimethyl-4-methylene-1-phenyldecan-3-ol (9c). Phenethylmagnesium bromide (8.28 mL of a 1.0 M solution in THF, 8.28 mmol) was added dropwise to a solution of the above aldehyde (0.91 g, 5.42 mmol) in dry THF (29 mL). The reaction mixture was stirred at 25 °C for 2 h and quenched with saturated NH₄Cl, and the phases separated. The aqueous phase was extracted with Et₂O, and the combined extracts were washed with brine, dried (MgSO₄) and concentrated under reduced pressure to yield 1.424 g (96%) of crude alcohol **9c** as a mixture of diastereomers: ¹H NMR (CDCl₃) 7.30-7.26 (m, 2), 7.24-7.16 (m, 3), 5.10 (s, 1 $\times$ 0.46), 5.09 (s, 1 $\times$ 0.54), 4.90 (s, 1), 4.10-4.04 (m, 1), 2.83-2.76 (m, 1), 2.70-2.63 (m, 1), 2.14-2.01 (m, 1), 1.95-1.75 (m, 2), 1.58-1.36 (m, 2), 1.34-1.21 (m, 3), 1.17-1.10 (m, 3), 1.06 (d, 3 $\times$ 0.46, *J* = 6.7), 1.02 (d, 3 $\times$ 0.54, *J* = 6.7), 0.85 (d, 6, *J* = 6.7).

Ethyl (R)-5,9-Dimethyl-4-(3-phenylpropylidene)decanoate (10c). Allylic alcohol **9c** (735 mg, 2.68 mmol), triethyl orthoacetate (2.83 mL, 15.41 mmol), and propionic acid (9 μ L, 0.119 mmol) were stirred at 155 °C for 1 h, cooled, and treated with dilute H₂SO₄ at 25 °C for 20 min. The reaction mixture was diluted with Et₂O, the layers were separated, and the aqueous phase was extracted with Et₂O. The organic extracts were

combined, washed with brine, dried (MgSO₄) and concentrated under reduced pressure to yield 900 mg (98%) of crude ester **10c** as an 87:13 *Z/E* mixture that was used without purification: ¹H NMR (CDCl₃) 7.29-7.25 (m, 2), 7.19-7.15 (m, 3), 5.19 (t, 1 × 0.13, *J* = 7.3), 5.12 (t, 1 × 0.87, *J* = 7.3), 4.12 (q, 2 × 0.87, *J* = 7.3), 4.11 (q, 2 × 0.13, *J* = 7.3), 2.64-2.58 (m, 3), 2.41-2.31 (m, 4), 2.26-2.18 (m, 2), 1.54-1.45 (m, 1), 1.26 (t, 3, *J* = 7.3), 1.26-1.23 (m, 2), 1.20-1.09 (m, 4), 0.96 (d, 3 × 0.13, *J* = 6.7), 0.91 (d, 3 × 0.87, *J* = 6.7), 0.85 (d, 3, *J* = 6.7), 0.84 (d, 3, *J* = 6.7); ¹³C NMR 173.7, 142.25, 142.15, 128.4 (2 C), 128.2 (2 C) 125.7, 123.1, 60.2, 39.1, 36.4, 35.1, 34.4, 33.6, 29.4, 27.9, 25.6, 25.4, 22.6 (2 C), 19.3, 14.0; IR (CH₂Cl₂) 1738 cm⁻¹; [α]_D²⁰ +4.0 (*c* 0.52, CHCl₃); HRMS(DEL) calcd for C₂₃H₃₆O₂ (M⁺) 344.2715, found 344.2719.

(R)-5,9-Dimethyl-4-(3-phenylpropylidene)decanoic Acid. A solution of ester **10c** (900 mg, 2.62 mmol) and KOH (206 mg, 3.67 mmol) in MeOH (0.8 mL) and H₂O (0.31 mL) was stirred at reflux for 1 h. The reaction mixture was cooled and extracted with Et₂O. The aqueous layer was acidified with conc HCl and extracted with Et₂O. The combined extracts were washed with brine, dried (MgSO₄) and concentrated under reduced pressure to yield 704 mg (85%) of crude acid as an 87:13 *Z/E* mixture: ¹H NMR (CDCl₃) 7.29-7.26 (m, 2), 7.19-7.16 (m, 3), 5.21 (t, 1 × 0.13, *J* = 7.3), 5.13 (t, 1 × 0.87, *J* = 7.3), 2.67-2.56 (m, 3), 2.47 (t, 2, *J* = 7.9), 2.39-2.32 (m, 2), 2.29-2.17 (m, 2), 1.54-1.43 (m, 1), 1.26-1.22 (m, 2), 1.19-1.08 (m, 4), 0.96 (d, 3 × 0.13, *J* = 6.7), 0.89 (d, 3 × 0.87, *J* = 6.7), 0.85 (3, d, *J* = 6.7), 0.84 (d, 3, *J* = 6.7).

(R)-6,10-Dimethyl-5-(3-phenylpropylidene)undecan-2-one (11c). MeLi (2.75 mL of a 1.6 M solution in ether, 4.40 mmol) was added dropwise to a solution of the above acid (550 mg, 1.74 mmol) in dry THF (14 mL) at 0 °C. The reaction mixture was allowed to warm up to 25 °C over the period of 1 h and quenched by transferring it into an ice-1 N HCl mixture by cannula. The reaction mixture was extracted with Et₂O. The combined extracts were washed with brine, dried (MgSO₄) and concentrated under reduced pressure to yield 500 mg of a crude mixture of methyl ketone **11c** and the

corresponding tertiary alcohol. Flash chromatography (9/1 hexanes/EtOAc) gave 416 mg (76%) of ketone **11c** as an 87:13 *Z/E* mixture: ¹H NMR (CDCl₃) 7.29-7.26 (m, 2), 7.20-7.16 (m, 3), 5.17 (t, 1 × 0.13, *J* = 7.3), 5.07 (t, 1 × 0.87, *J* = 7.3), 2.67-2.56 (m, 3), 2.53 (t, 2, *J* = 7.9), 2.37-2.28 (m, 2), 2.23-2.09 (m, 2), 2.14 (s, 3), 1.54-1.44 (m, 1), 1.26-1.22 (m, 2), 1.19-1.08 (m, 4), 0.95 (d, 3 × 0.13, *J* = 6.7), 0.90 (d, 3 × 0.87, *J* = 6.7), 0.850 (d, 3, *J* = 6.7), 0.846 (d, 3, *J* = 6.7); ¹³C NMR 209.0, 142.5, 142.1, 128.4 (2 C), 128.2 (2 C), 125.7, 123.0, 43.0, 39.1, 36.4, 35.1, 34.5, 29.9, 29.4, 27.4, 25.6, 24.2, 22.6 (2 C), 19.4; IR (CH₂Cl₂) 1718 cm⁻¹; [α]_D²⁰ +8.5 (*c* 0.38, CHCl₃); HRMS(ESI) calcd for C₂₂H₃₄O (M⁺) 314.2610, found 314.2613.

The isomers could not be fully separated; a fraction containing a 93:7 *Z/E* mixture was used for the cyclization to give **12**.

3-Methylene-2-phenyloctan-4-ol (15a). *n*-BuLi (1.7 mL of 2.79 M solution in THF, 4.74 mmol) was added to a solution of 2-methylene-3-phenylbutyraldehyde¹⁴ (0.50 g, 3.16 mmol) in dry THF (15 mL) at 0 °C. The reaction was stirred for 2 h at 25 °C and worked up as described above for the preparation of **9c** to yield 590 mg (87%) of crude **15a** as a mixture of diastereomers: ¹H NMR 7.30-7.23 (m, 2), 7.23-7.17 (m, 3), 5.31 (s, 1 × 0.61), 5.21 (s, 1 × 0.39), 5.14 (s, 1 × 0.61), 5.07 (s, 1 × 0.39), 4.02-3.97 (m, 1 × 0.39), 3.92-3.88 (m, 1 × 0.61), 3.60 (q, 1 × 0.39, *J* = 7.3), 3.43 (q, 1 × 0.61, *J* = 7.3), 1.55-1.50 (m, 2), 1.41-1.22 (m, 4), 1.40 (d, 3 × 0.39, *J* = 7.3), 1.39 (d, 3 × 0.61, *J* = 7.3), 0.85 (t, 3, *J* = 6.7).

Ethyl 4-(1-Phenylethyl)-4*Z*-nonenoate (16a). Allylic alcohol **15a** (826 mg, 3.79 mmol), triethyl orthoacetate (4 mL, 21.0 mmol), and propionic acid (12 μL, 0.16 mmol) were stirred at 155 °C for 1 h, cooled, and treated with 1 M H₂SO₄ (12 mL) at 25 °C for 20 min. Work up as described above for the preparation of **10c** gave 0.896 g (82%) of ester **16a** as an 83:17 *Z/E* mixture: ¹H NMR 7.30-7.26 (m, 2), 7.24-7.16 (m, 3), 5.37 (t, 1 × 0.17, *J* = 7.3), 5.19 (t, 1 × 0.83, *J* = 7.3), 4.09 (q, 1, *J* = 7.3), 4.06 (q, 2, *J* = 7.3), 2.32-2.14 (m, 4), 2.14-1.96 (m, 2), 1.40 (d, 3, *J* = 7.3), 1.41-1.22 (m, 4), 1.21 (t,

3, $J = 7.3$), 0.91 (t, 3, $J = 6.7$); ¹³C NMR (Z-isomer) 173.7, 144.2, 140.9, 128.1 (2 C), 127.3 (2 C), 125.8, 125.1, 60.1, 38.7, 33.6, 32.2, 27.4, 26.6, 22.4, 17.4, 14.2, 14.0; IR (neat) 1735 cm⁻¹; HRMS(DEI) calcd for C₁₉H₂₈O₂ (M⁺) 288.2089, found 288.2088.

4-(1-Phenylethyl)-4Z-nonenoic Acid. A solution of ester **16a** (298 mg, 1.03 mmol) and KOH (80.8 mg, 1.44 mmol) in MeOH (0.3 mL) and H₂O (0.1 mL) was stirred at reflux for 1 h. Work up as described above for the hydrolysis of **10c** gave 175 mg (67%) of crude acid as an 83:17 *E/Z* mixture: ¹H NMR 7.30-7.26 (m, 2), 7.23-7.18 (m, 3), 5.20 (t, 1, $J = 7.3$), 4.11 (q, 1, $J = 7.3$), 2.38-2.27 (m, 2), 2.21-2.16 (m, 2), 2.10-1.99 (m, 2), 1.41-1.33 (m, 4), 1.39 (d, 3, $J = 7.3$), 0.92 (t, 3, $J = 6.7$).

5-(1-Phenylethyl)-5Z-decen-2-one (17a). MeLi (3.5 mL of 1.6 M solution in ether, 5.61 mmol) was added dropwise to a solution of the above acid (579 mg, 2.22 mmol) in dry THF (15 mL) at 0 °C. Work up as described above for the preparation of **11c** gave 489 mg of a mixture of methyl ketone **17a** and the corresponding tertiary alcohol. Flash chromatography (40:1 hexanes/EtOAc) gave the *E*-isomer of **17a**, followed by 261 mg (52%) of ketone **17a**, and then pure tertiary alcohol: ¹H NMR 7.30-7.27 (m, 2), 7.23-7.16 (m, 3), 5.15 (t, 1, $J = 7.3$), 4.10 (q, 1, $J = 7.3$), 2.42-2.33 (m, 1), 2.25-2.12 (m, 4), 2.05-1.93 (m, 1), 1.99 (s, 3), 1.39 (d, 3, $J = 7.3$), 1.40-1.34 (m, 4), 0.92 (t, 3); ¹³C NMR 208.8, 144.2, 141.2, 128.1 (2 C), 127.3 (2 C), 125.9, 125.2, 43.0, 38.7, 32.3, 29.6, 27.4, 25.5, 22.4, 17.4, 14.0; HRMS(DEI) calcd for C₁₈H₂₆O (M⁺) 258.1984, found 258.1985.

3-Phenylbutanol. 3-Phenylbutanal (5.0 g, 33.7 mmol), and NaBH₄ (0.6 g, 48 mmol) in EtOH (100 mL) were stirred at 25 °C for 3 h. The reaction mixture was concentrated, diluted with H₂O and extracted with Et₂O. The combined extracts were washed with brine, dried with MgSO₄ and concentrated to yield 4.70 g (93%) of 3-phenylbutanol: ¹H NMR 7.32-7.26 (m, 2), 7.22-7.18 (m, 3), 3.60-3.53 (m, 2), 2.92-2.86 (m, 1), 1.89-1.83 (m, 2), 1.28 (d, 3, $J = 7.3$).

3-Cyclohexylbutanol. 3-Phenylbutanol (5.06 g, 33.7 mmol), 5% Rh/Al₂O₃ (5.05 g, 48 mmol), and acetic acid (5.06 mL) in EtOH (100 mL) were shaken under H₂ (60 psi)

for 21 h. The reaction mixture was filtered through Celite and concentrated to give 4.41 g (86%) of 3-cyclohexylbutanol: ¹H NMR 3.74-3.61 (m, 2), 1.75-1.59 (m, 6), 1.45-1.34 (m, 2), 1.26-0.96 (m, 6), 0.85 (d, 3, *J* = 6.7).

3-Cyclohexylbutanal (14b). A solution of 3-cyclohexylbutanol (4.41 g, 28.4 mmol) in CH₂Cl₂ (20 mL) was added dropwise to a solution of PCC (6.51 g, 30.2 mmol) and NaOAc (0.496 g, 6.04 mmol) in CH₂Cl₂ (100 mL). The reaction mixture was stirred for 4 h, filtered through Florisil, and concentrated to give 3.59 g (83%) of **14b** with ¹H NMR spectral data identical to those previously reported.¹⁵

3-Cyclohexyl-2-methylenebutanal. Aldehyde **14b** (3.824 g, 25.0 mmol), formaldehyde (37% aqueous solution, 2.66 mL, 27.4 mmol), piperidine (126 μL, 1.27 mmol) and 6 M HCl (106 μL, 0.635 mmol) were stirred at reflux for 2.5 h. Work up as described above for the methylenation of **8** gave 3.79 g (92%) of the enal: ¹H NMR 9.50 (s, 1), 6.18 (s, 1), 6.00 (s, 1), 2.58-2.51 (m, 1), 1.70-1.51 (m, 4), 1.36-1.24 (m, 1), 1.20-1.04 (m, 4), 1.00 (d, 3, *J* = 7.3), 0.95-0.78 (m, 2); ¹³C NMR 194.8, 154.7, 134.0, 41.5, 36.6, 31.3, 29.4, 26.49, 26.48, 26.40, 16.1; IR (neat) 1686.1, 1618.5 cm⁻¹.

2-Cyclohexyl-3-methylene-4-octanol (15b). *n*-BuLi (11.4 mL of a 2.79 M solution in THF, 31.7 mmol) was added dropwise to a solution of the above aldehyde (3.49 g, 21.1 mmol) in dry THF (120 mL) at 0 °C. The reaction mixture was stirred at 25 °C for 2 h and worked up as described above for the preparation of **9c** yielding 4.55 g (97%) of crude **15b** as a mixture of diastereomers: ¹H NMR 5.13 (s, 1 × 0.34), 5.07 (s, 1 × 0.66), 4.84 (s, 1), 4.01-3.97 (m, 1), 1.93-1.54 (m, 6), 1.52-1.09 (m, 10), 1.01 (d, 3 × 0.34, *J* = 7.3), 0.99 (d, 3 × 0.66, *J* = 7.3), 0.91 (t, 3, *J* = 6.7), 0.93-0.83 (m, 2).

Ethyl 4-(1-Cyclohexylethyl)-4Z-nonenoate (16b). Allylic alcohol **15b** (4.25 g, 19 mmol), triethyl orthoacetate (20 mL, 109 mmol), and propionic acid (63 μL, 0.844 mmol) were stirred at 155 °C for 1 h, cooled, and treated with 1 M H₂SO₄ (50 mL) at 25 °C for 20 min. Work up as described above for the preparation of **10c** yielded

5.16 g (93%) of crude ester **16b** as an 85:15 *Z/E* mixture: ¹H NMR 5.08 (t, 1 × 0.15, *J* = 6.7), 5.04 (t, 1 × 0.85, *J* = 6.7), 4.11 (q, 2, *J* = 7.3), 2.44-2.39 (m, 2), 2.36-2.10 (m, 4), 2.05-1.86 (m, 4), 1.73-1.51 (m, 4), 1.30-1.10 (m, 8), 1.24 (t, 3, *J* = 7.3), 0.94 (d, 3, *J* = 6.7), 0.86 (t, 3, *J* = 6.7); ¹³C NMR 173.9, 141.0, 124.4, 60.2, 40.5, 40.3, 33.5, 32.3, 32.1, 31.8, 31.1, 27.2, 26.60, 26.56, 26.53, 25.8, 17.0, 14.2, 14.0; IR (neat) 1736.0 cm⁻¹; HRMS(DEI) calcd for C₁₉H₃₄O₂ (M⁺) 294.2559, found 294.2567.

4-(1-Cyclohexylethyl)-4*Z*-nonenoic acid. A solution of ester **16b** (4.856 g, 16.5 mmol) and KOH (1.29 g, 23.1 mmol) in MeOH (4.53 mL) and H₂O (1.51 mL) was stirred at reflux for 1 h. Work up as described above for the hydrolysis of **10c** gave 3.063 g (70%) of the crude acid as an 85:15 *Z/E* mixture: ¹H NMR 5.12 (t, 1 × 0.15, *J* = 7.3), 5.08 (t, 1 × 0.85, *J* = 7.3), 2.51-2.47 (m, 2), 2.41-2.16 (m, 2), 2.10-1.96 (m, 2), 1.91-1.88 (m, 2), 1.79-1.59 (m, 5), 1.34-1.29 (m, 4), 1.23-1.09 (m, 4), 0.964 (d, 3 × 0.72, *J* = 6.7), 0.956 (d, 3 × 0.28, *J* = 7.3), 0.92-0.80 (m, 4).

5-(1-Cyclohexylethyl)-5*Z*-decen-2-one (17b). MeLi (17.6 mL of a 1.6 M solution in ether, 28.2 mmol) was added dropwise to a solution of the above acid (2.963 g, 11.1 mmol) in dry THF (76 mL) at 0 °C. The reaction mixture was warmed to 25 °C, stirred for 2 h and worked up as described above for the preparation of **11c**, yielding 3.25 g of a crude ketone **17b**. Flash chromatography (99:1 hexanes/EtOAc) gave the *E*-isomer of **17b**, followed by 2.28 g (70%) of ketone **17b** and then pure tertiary alcohol: ¹H NMR 5.02 (t, 1, *J* = 7.3), 2.61-2.40 (m, 2), 2.32-2.26 (m, 1), 2.23-2.10 (m, 2), 2.16 (s, 3), 2.06-1.95 (m, 2), 1.95 (br d, 1, *J* = 13.4), 1.73 (br d, 1, *J* = 12.2), 1.68-1.56 (m, 4), 1.34-1.25 (m, 2), 1.24-1.08 (m, 5), 0.95 (d, 3, *J* = 7.3), 0.89 (t, 3, *J* = 6.7), 0.86-0.66 (m, 2); ¹³C NMR 209.1, 141.2, 124.3, 42.9, 40.44, 40.37, 32.3, 31.9, 31.1, 27.2, 26.65, 26.58, 26.54, 26.51, 24.6, 22.4, 17.0, 14.0; IR (neat) 1718.3 cm⁻¹; HRMS(DEI) calcd for C₁₈H₃₂O (M⁺) 264.2453, found 264.2461.

References and Notes

- (14) Bernhagen, W.; Weber, J.; Springer, H. Gr. Patent. 3,141,301, 1983; *Chem. Abstr.* **1983**, 99, 70381t.
- (15) (a) Tanaka, K.; Fu, G. C. *J. Org. Chem.* **2001**, 66, 8177-8186. (b) Tanaka, K.; Qiao, S.; Tobisu, M.; Lo, M. M.-C.; Fu, G. C. *J. Am. Chem. Soc.* **2000**, 122, 9870-9871. (c) Ollivier, C.; Renaud, P. *Chem. Eur. J.* **1999**, 5, 1468-1473.

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INDEX	FREQUENCY	PPM	HEIGHT
1	14302.390	142.287	6.4
2	12903.922	128.374	31.5
3	12900.931	128.344	43.5
4	12644.566	125.794	18.9
5	7771.934	77.319	425.2
6	7760.397	77.204	20.2
7	7739.889	77.000	442.5
8	7707.843	76.681	437.5
9	5251.872	52.248	10.7
10	4723.762	46.994	10.8
11	4031.150	40.104	6.0
12	4019.187	39.985	13.9
13	3960.650	39.402	15.3
14	3940.568	39.203	6.8
15	3781.622	37.621	15.6
16	3776.068	37.566	8.0
17	3625.240	36.066	6.4
18	3469.285	34.514	16.7
19	3431.685	34.140	15.4
20	3367.594	33.502	7.5
21	3153.957	31.377	16.2
22	3138.148	31.230	6.5
23	2813.847	27.993	9.7
24	2495.100	24.822	7.5
25	2414.773	24.023	14.4
26	2357.946	23.458	14.6
27	2290.864	22.791	13.6
28	2282.318	22.706	6.4
29	2270.781	22.591	6.9
30	2265.654	22.540	13.1
31	2256.254	22.446	6.2
32	1849.062	18.395	13.7
33	1827.698	18.183	14.0
34	1736.689	17.277	7.0
35	-1.461	-0.015	8.8

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INDEX	FREQUENCY	PPM	HEIGHT
1	22546.979	224.308	4.6
2	14720.728	146.449	8.7
3	12907.950	128.414	7.3
4	12893.942	128.275	60.0
5	12880.759	128.144	5.1
6	12864.279	127.980	5.1
7	12817.312	127.513	7.0
8	12788.472	127.226	54.5
9	12774.464	127.086	5.7
10	12692.890	126.275	27.0
11	7771.200	77.312	154.3
12	7759.664	77.197	22.3
13	7739.889	77.000	151.2
14	7707.753	76.680	153.8
15	5262.152	52.350	9.7
16	4717.495	46.932	21.5
17	4148.119	41.267	25.4
18	3890.210	38.702	4.9
19	3802.043	37.824	31.0
20	3566.382	35.480	29.9
21	3157.683	31.414	4.5
22	2983.822	29.684	8.2
23	2664.938	26.512	25.6
24	2449.052	24.364	26.0
25	2301.558	22.897	24.5
26	2175.488	21.643	27.3
27	1936.531	19.266	22.2
28	1391.874	13.847	17.4

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INDEX	FREQUENCY	PPM	HEIGHT
1	22523.907	224.078	4.5
2	14759.455	146.834	20.3
3	12912.894	128.463	134.0
4	12792.592	127.267	102.0
5	12687.121	126.217	71.8
6	5229.193	52.022	38.1
7	4759.519	47.350	40.8
8	4273.365	42.513	60.0
9	3811.107	37.915	52.4
10	3769.083	37.497	53.3
11	2758.872	27.447	49.4
12	2561.115	25.479	56.3
13	2338.638	23.266	54.0
14	2107.920	20.971	43.2
15	1862.372	18.528	33.7
16	1407.529	14.003

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INDEX	FREQUENCY	PPM	HEIGHT
1	22569.227	224.529	4.8
2	7772.848	77.328	25.6
3	7740.712	77.008	26.1
4	7708.577	76.688	25.3
5	5226.721	51.998	19.1
6	4385.427	43.628	35.8
7	4181.902	41.604	36.8
8	3957.777	39.374	5.4
9	3876.202	38.562	40.0
10	3830.883	38.111	41.6
11	3769.907	37.505	51.3
12	3233.490	32.168	4.3
13	3193.115	31.767	55.4
14	2793.480	27.791	46.3
15	2725.913	27.119	51.1
16	2639.545	26.856	42.8
17	2686.361	26.725	59.5
18	2681.417	26.676	55.9
19	2577.595	25.643	4.3
20	2360.885	23.487	36.8
21	2337.814	23.258	44.1
22	1859.900	18.303	30.8
23	1400.114	13.929	28.4
24	1349.850	13.429	34.6

INDEX	FREQUENCY	PPM	HEIGHT
1	22586.531	224.701	3.9
2	13887.674	138.161	3.5
3	12858.511	127.922	4.2
4	12587.419	125.225	-3.5
5	7771.200	77.312	282.3
6	7759.664	77.197	29.6
7	7739.064	76.992	302.0
8	7706.929	76.672	303.2
9	6339.931	63.073	3.8
10	5225.073	51.981	13.5
11	4393.667	43.710	26.2
12	3959.425	39.390	62.2
13	3855.602	38.357	3.6
14	3820.171	38.005	34.5
15	3785.563	37.661	36.0
16	3235.138	32.185	37.5
17	2982.997	29.676	16.0
18	2748.160	27.340	34.0
19	2730.857	27.168	40.4
20	2706.137	26.922	39.2
21	2694.601	26.807	42.5
22	2579.243	25.660	36.5
23	2434.220	24.217	32.9
24	2332.046	23.200	34.6
25	2279.311	22.676	5.2
26	1859.076	18.495	28.1
27	1401.762	13.945	22.8
28	1306.179	12.994	27.5
29	-3.140	-0.031	7.6

INDEX	FREQUENCY	PPM	HEIGHT
1	17456.982	173.670	9.3
2	14299.079	142.254	17.3
3	14288.397	142.148	14.2
4	12907.436	128.409	64.6
5	12886.835	128.204	61.9
6	12635.820	125.707	43.1
7	12374.888	123.111	30.4
8	7771.170	77.311	33.9
9	7739.126	76.992	34.8
10	7707.082	76.674	35.5
11	6051.452	60.203	26.8
12	3933.468	39.132	37.7
13	3659.564	36.407	46.9
14	3534.438	35.162	41.5
15	3458.142	34.403	40.8
16	3380.320	33.629	35.7
17	2956.112	29.409	42.2
18	2802.757	27.883	24.2
19	2571.579	25.583	45.2
20	2557.083	25.439	26.3
21	2275.550	22.638	43.1
22	1942.898	19.329	31.0
23	1430.187	14.228	26.6

INDEX	FREQUENCY	PPM	HEIGHT
1	2099.527	208.913	5.0
2	1433.564	142.497	7.5
3	1428.133	142.145	11.4
4	1290.599	128.431	35.9
5	1288.175	128.218	42.1
6	1263.506	125.734	21.9
7	1235.766	123.020	17.0
8	7770.376	77.303	64.0
9	7739.064	76.992	69.7
10	7706.929	76.672	69.1
11	6404.202	63.712	4.5
12	4321.156	42.989	19.8
13	3935.529	39.152	19.9
14	3660.317	36.415	26.3
15	3535.895	35.177	24.0
16	3464.207	34.464	22.5
17	3005.245	29.898	7.4
18	2951.686	29.365	21.5
19	2804.192	27.897	14.6
20	2573.475	25.602	23.3
21	2431.749	24.192	13.3
22	2275.190	22.635	38.0
23	1945.595	19.356	19.3

16a

INDEX	FREQUENCY	PPM	HEIGHT
1	21013.096	209.048	4.9
2	14521.808	144.470	8.3
3	14215.859	141.426	7.8
4	12903.563	128.371	52.3
5	12821.164	127.551	46.4
6	12674.675	126.094	29.5
7	12603.720	125.388	20.7
8	7794.765	77.546	56.8
9	7762.721	77.227	56.9
10	7730.676	76.908	57.5
11	4349.226	43.268	25.1
12	3913.574	38.934	26.0
13	3270.396	32.535	24.8
14	3003.359	29.879	7.9
15	2779.048	27.647	25.6
16	2582.967	25.697	18.3
17	2278.545	22.668	21.1
18	1769.649	17.605	26.2
19	1430.893	14.235	15.3

17a

enal from 14b

INDEX	FREQUENCY	PPM	HEIGHT
1	19585.648	194.847	11.4
2	15553.390	154.732	7.3
3	13473.554	134.041	19.1
4	7771.933	77.319	91.1
5	7739.889	77.000	98.8
6	7707.844	76.681	97.1
7	4173.801	41.523	29.2
8	3675.586	36.566	21.3
9	3145.327	31.291	42.6
10	2958.401	29.432	34.0
11	2661.135	26.494	53.9
12	2661.608	26.479	57.6
13	2653.979	26.403	43.6
14	1620.164	16.118	30.8

enal from 14b

INDEX	FREQUENCY	PW	HEIGHT
1	17498.125	174.079	11.9
2	14190.682	141.176	10.6
3	12525.897	124.613	24.2
4	7793.939	77.531	154.3
5	7781.795	77.417	15.3
6	7761.195	77.212	154.8
7	7729.814	76.901	156.3
8	6074.884	60.430	19.4
9	4090.581	40.695	26.4
10	4074.559	40.536	22.6
11	3390.181	33.727	27.5
12	3268.107	32.513	25.8
13	3220.804	32.042	27.9
14	3155.137	31.359	28.9
15	2755.386	27.412	25.5
16	2695.122	26.812	43.3
17	2691.308	26.774	38.6
18	2688.256	26.744	31.5
19	2615.011	26.015	19.7
20	2270.915	22.592	21.4
21	1733.026	17.241	18.0
22	1455.256	14.448	21.0
23	1431.656	14.243	13.0

16b

17b

INDEX	FREQUENCY	PPM	HEIGHT
1	21020.781	209.124	3.8
2	14222.021	141.487	4.2
3	14190.738	141.176	19.1
4	12644.213	125.790	12.4
5	12496.961	124.326	34.6
6	7769.644	77.296	95.3
7	7737.600	76.977	97.6
8	7705.555	76.658	97.1
9	4694.142	46.699	9.5
10	4374.460	43.519	12.5
11	4314.949	42.927	40.8
12	4144.045	41.227	10.0
13	4063.171	40.422	41.9
14	4055.542	40.346	41.0
15	3248.327	32.316	40.4
16	3241.460	32.248	12.2
17	3230.016	32.134	14.3
18	3200.260	31.838	49.3
19	3126.253	31.101	46.0
20	3007.231	29.917	21.5
21	2750.875	27.367	11.4
22	2733.327	27.192	40.8
23	2676.105	26.623	33.6
24	2669.238	26.555	68.8
25	2665.424	26.517	65.1
26	2662.372	26.487	60.7
27	2466.290	24.536	26.2
28	2387.705	23.754	8.8
29	2251.135	22.395	42.9
30	1740.713	17.317	10.4
31	1708.668	16.999	33.6
32	1407.298	14.000	29.2
33	-626.761	-6.235	-3.6