UNIVERSIDADE FEDERAL RURAL DO RIO DE JANEIRO

INSTITUTO DE QUÍMICA

CURSO DE PÓS-GRADUAÇÃO EM QUÍMICA

TESE

VOLUME 2

Metabólitos secundários e avaliação de atividades biológicas de *Siolmatra brasiliensis* (Cogn.) Baill. (Cucurbitaceae) e espécies do gênero *Ziziphus* Mill. (Rhamnaceae).

Carlos Henrique Corrêa dos Santos

2018

UNIVERSIDADE FEDERAL RURAL DO RIO DE JANEIRO
INSTITUTO DE QUÍMICA
PROGRAMA DE PÓS-GRADUAÇÃO EM QUÍMICA

Volume 2

Metabólitos secundários e avaliação de atividades biológicas de *Siolmatra brasiliensis* (Cogn.) Baill. (Cucurbitaceae) e espécies do gênero *Ziziphus* Mill. (Rhamnaceae).

(Espectros)

Carlos Henrique Corrêa dos Santos

Sob orientação do

Prof. Dr. Mário Geraldo de Carvalho

E coorientação do

Prof. Dr. Ludger A. Wessjohann

Tese submetida como requisito parcial para a obtenção do grau de **Doutor em Química**, no curso de Pós-Graduação em Química, área de concentração em Química.

Seropédica, RJ

Outubro de 2018

Índice de figuras

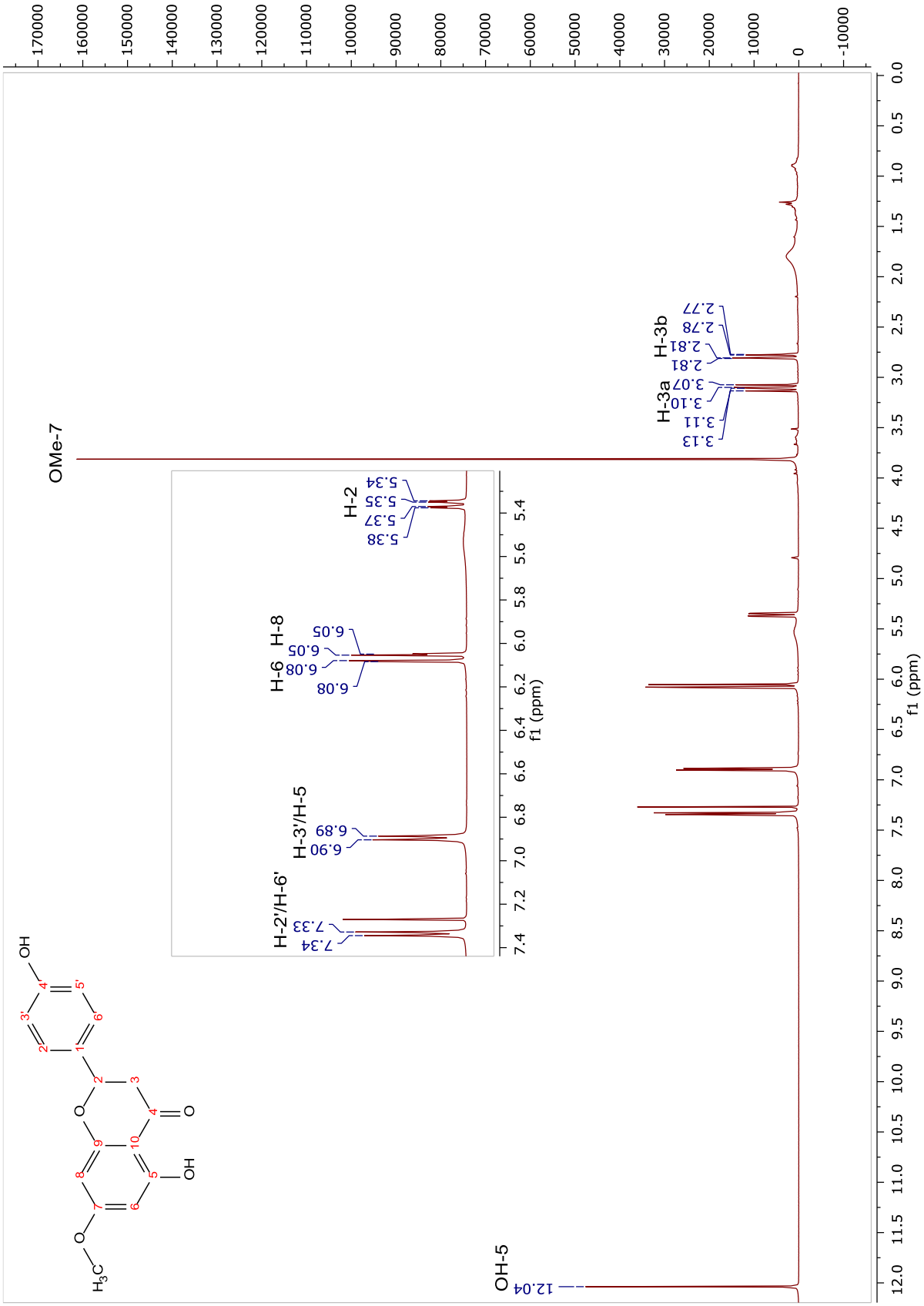


Figura 1. Espectro de RMN ^{1}H de **Sb1** (500 MHz, $CDCl_3$).

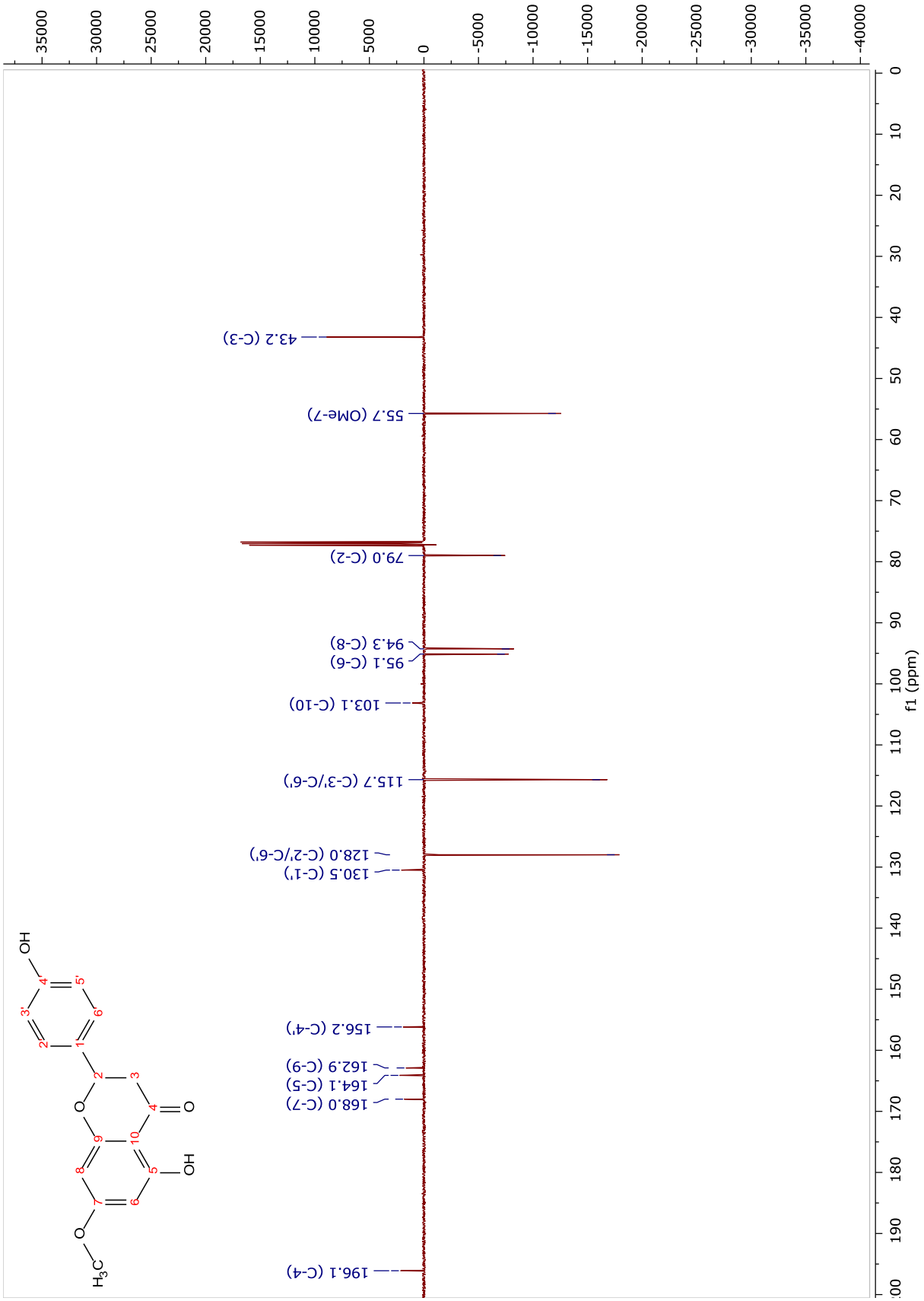


Figura 2. Espectro de DEPTQ de **Sb1** (125 MHz, $CDCl_3$).

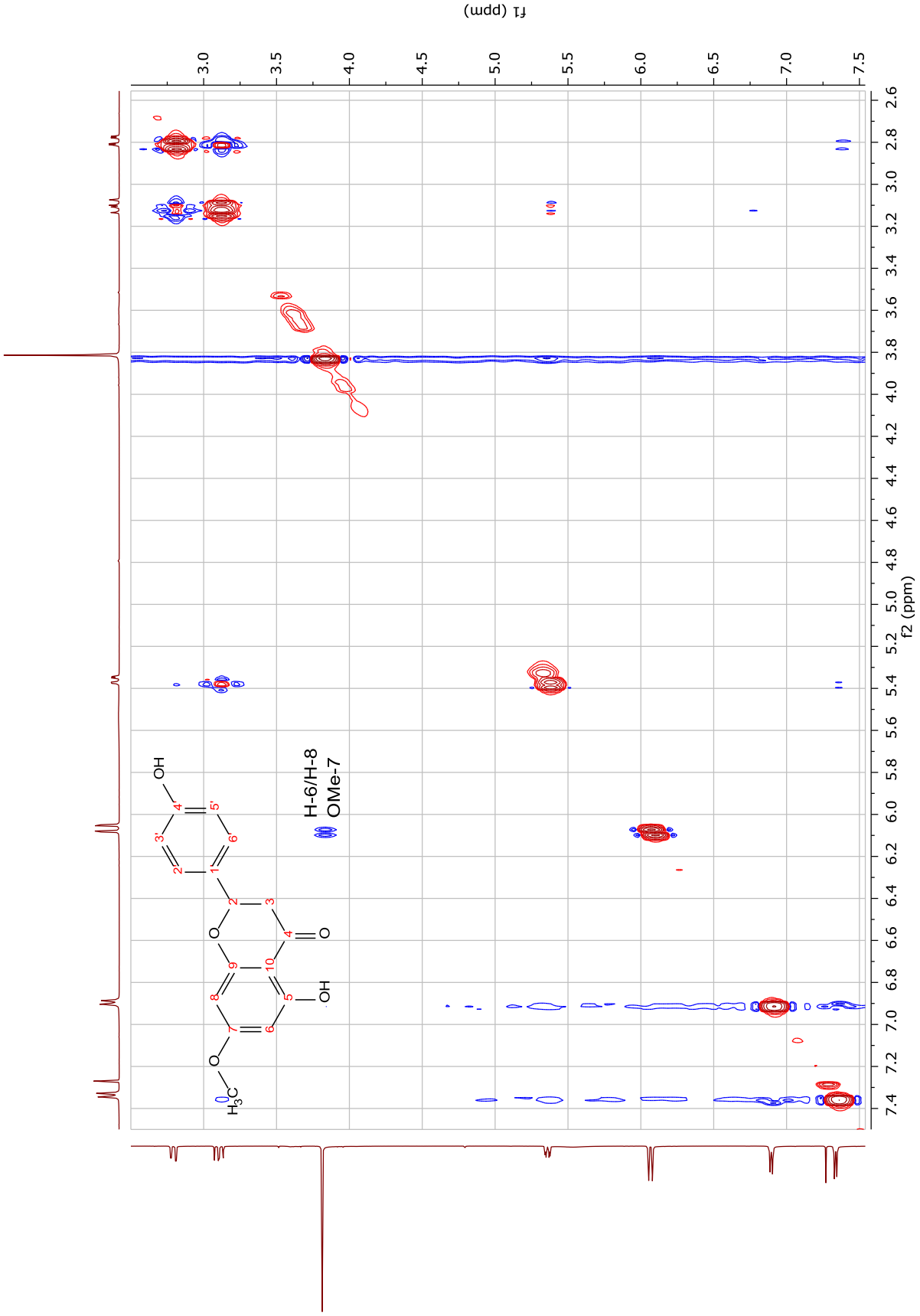


Figura 3. Espectro de NOESY de **Sb1** (500 MHz, $CDCl_3$).

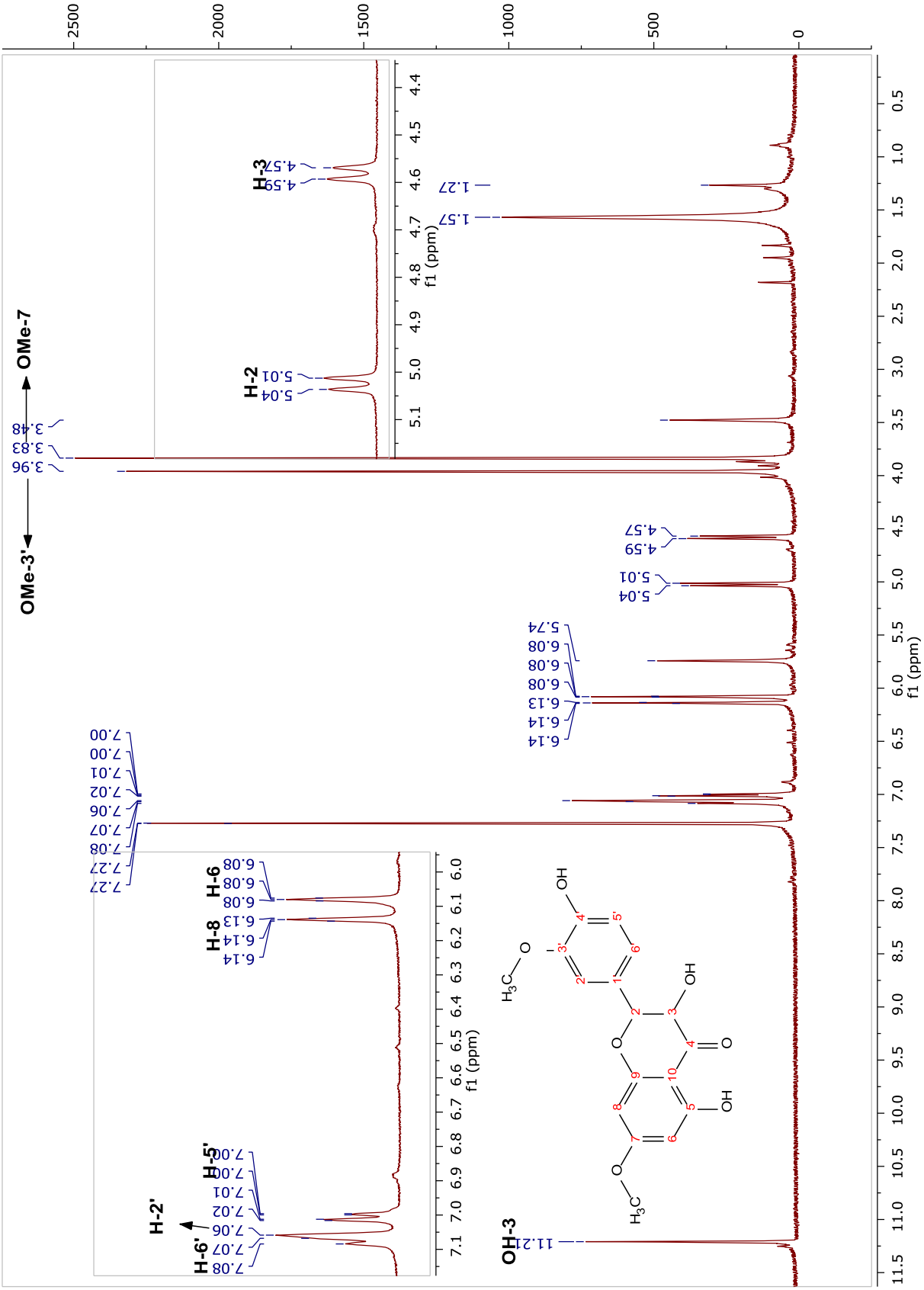


Figura 4. Espectro de RMN ^{1}H de **Sb2** (500 MHz, $CDCl_3$).

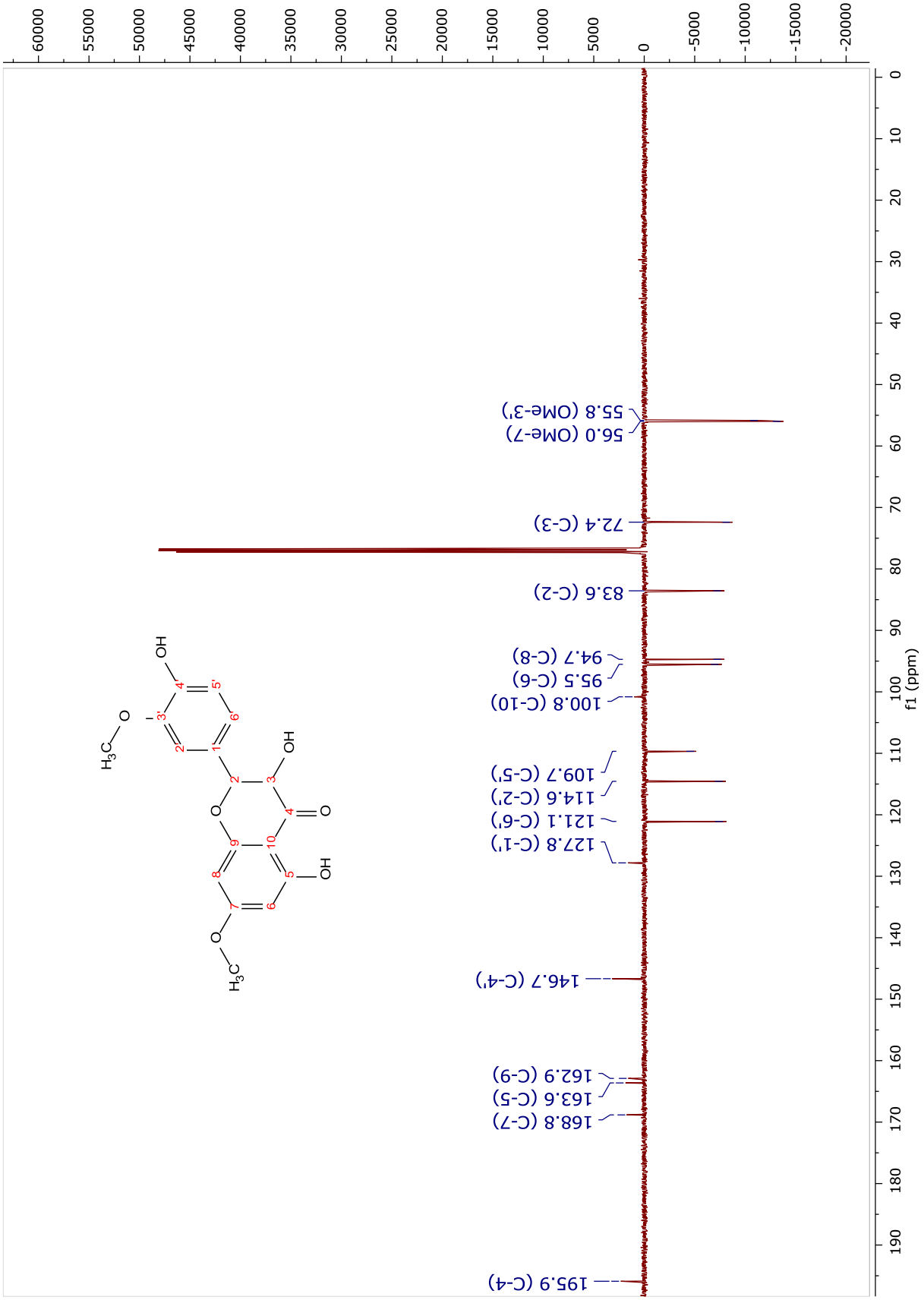


Figura 5. Espectro de DEPTQ de **Sb2** (125 MHz, $CDCl_3$).

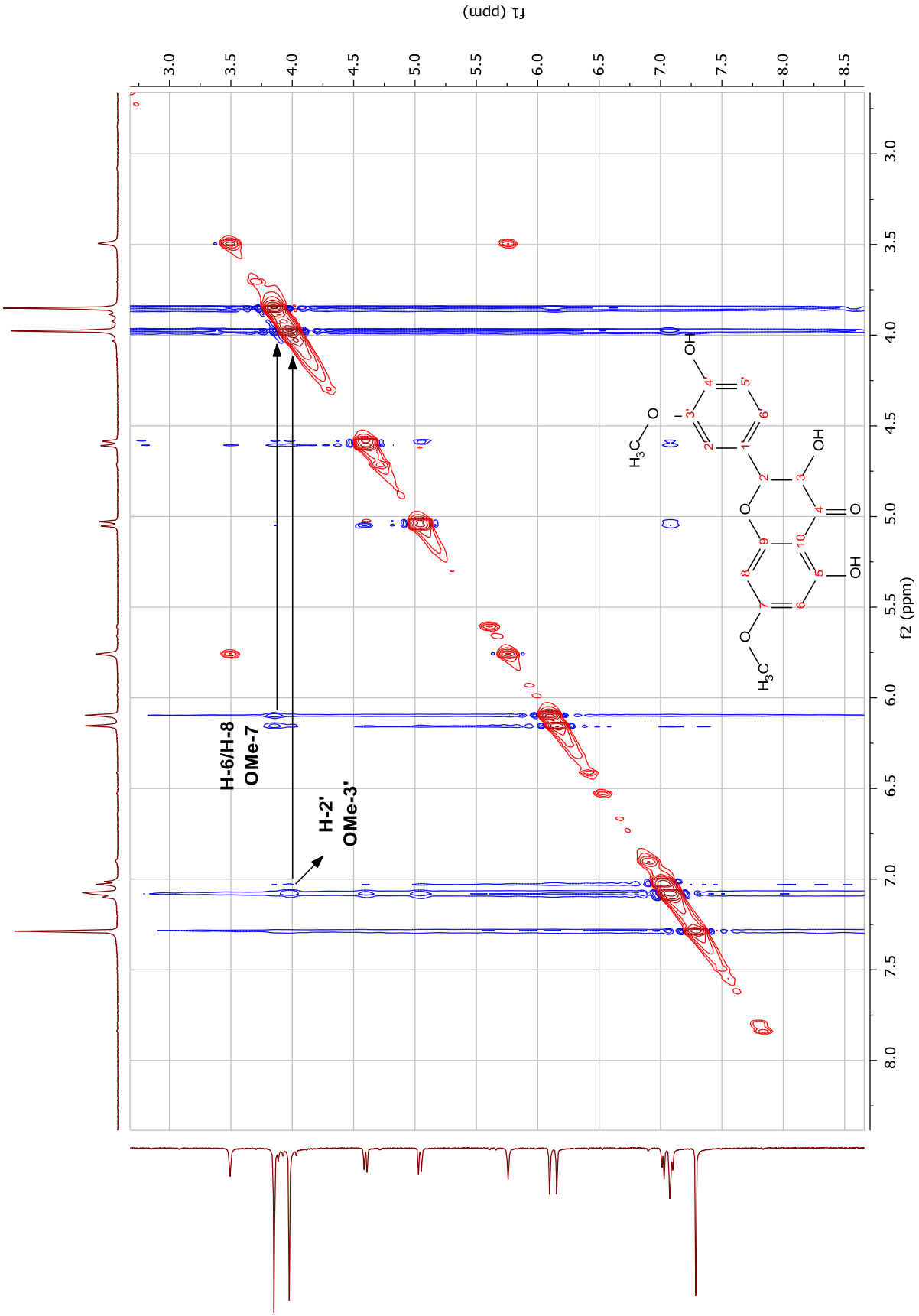


Figura 6. Espectro de NOESY de **Sb2** (500 MHz, $CDCl_3$).

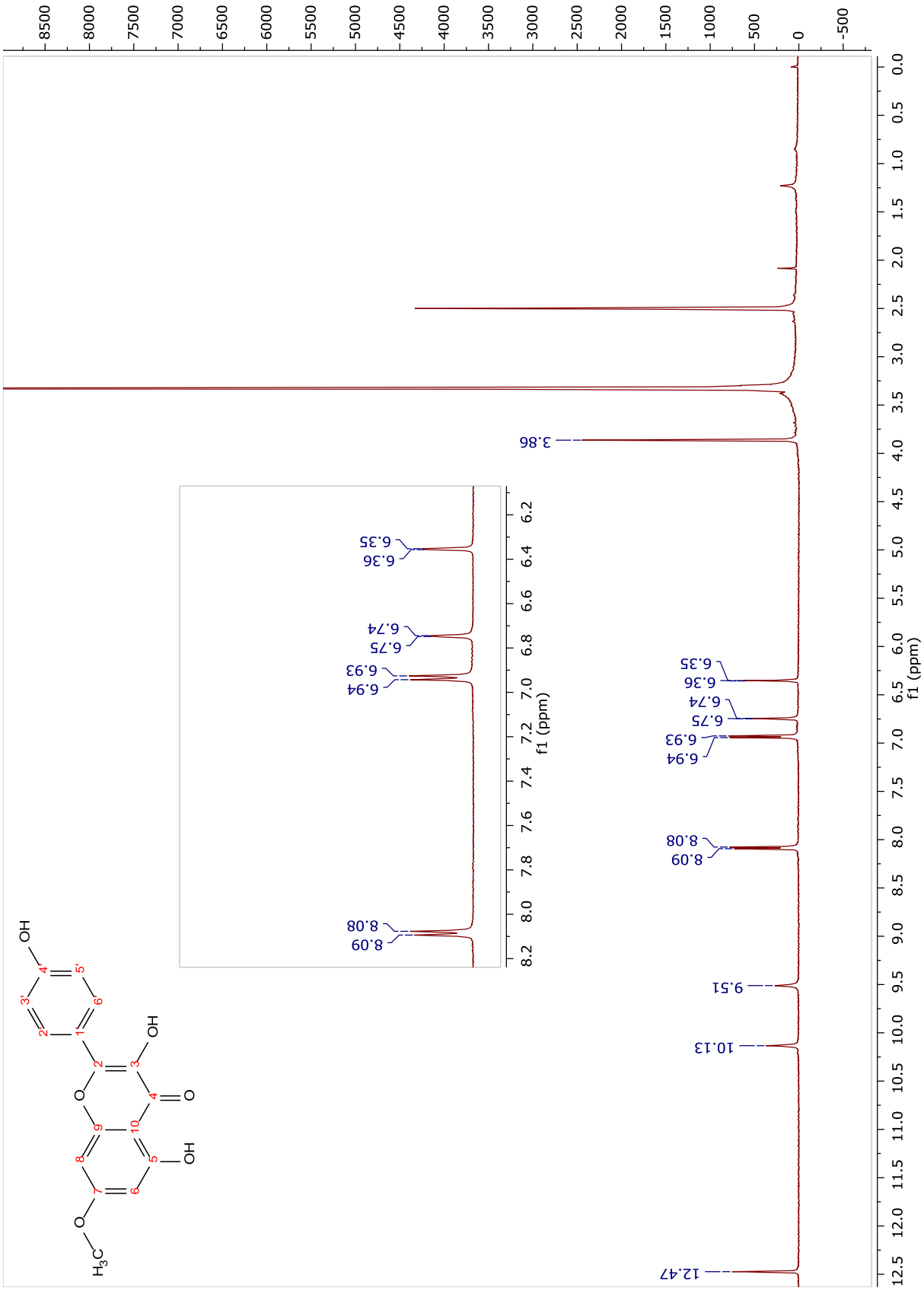


Figura 7. Espectro de RMN ^{1}H de **Sb3** (500 MHz, DMSO-d_6).

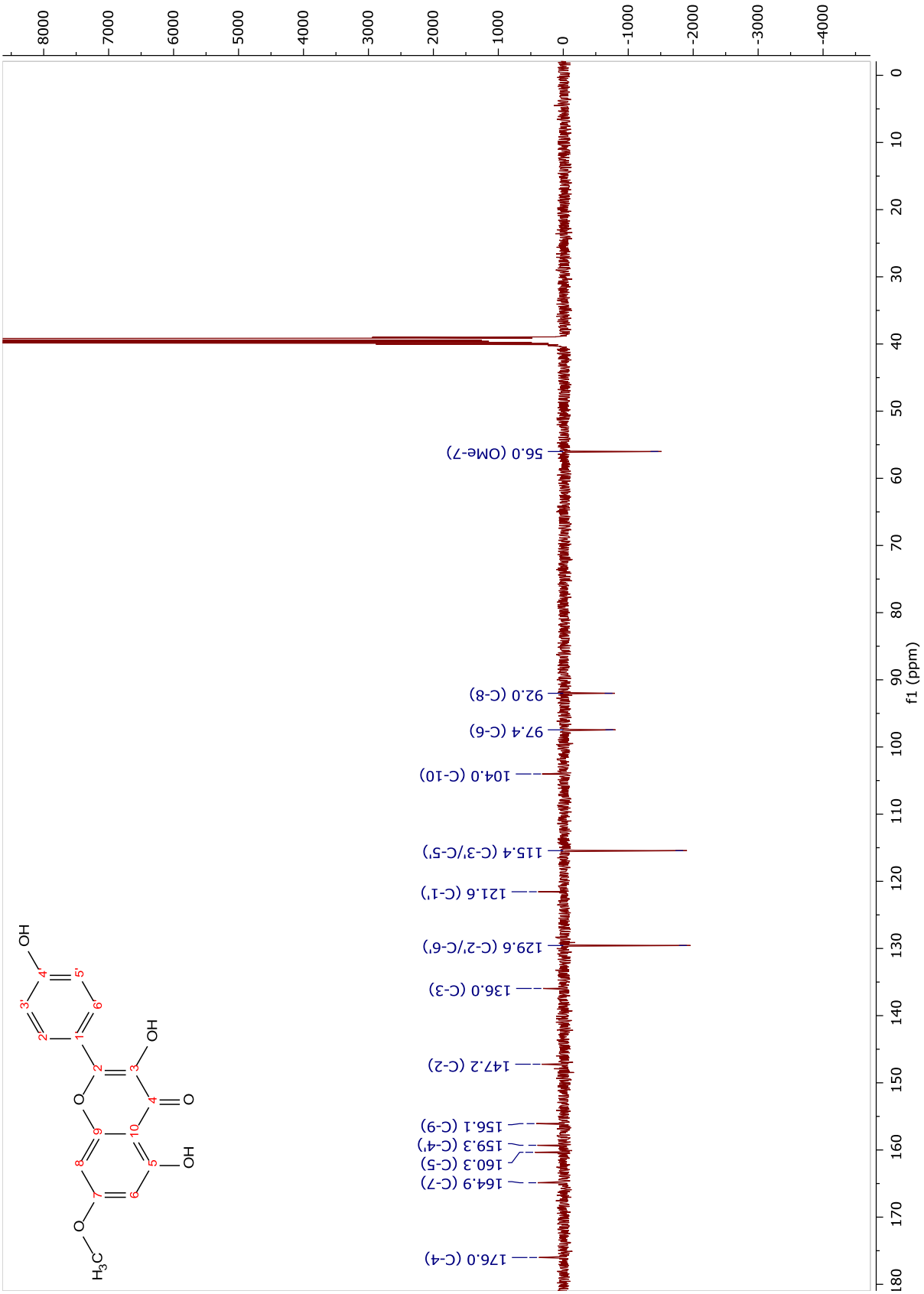


Figura 8. Espectro de DEPTQ de **Sb3** (125 MHz, DMSO-d_6).

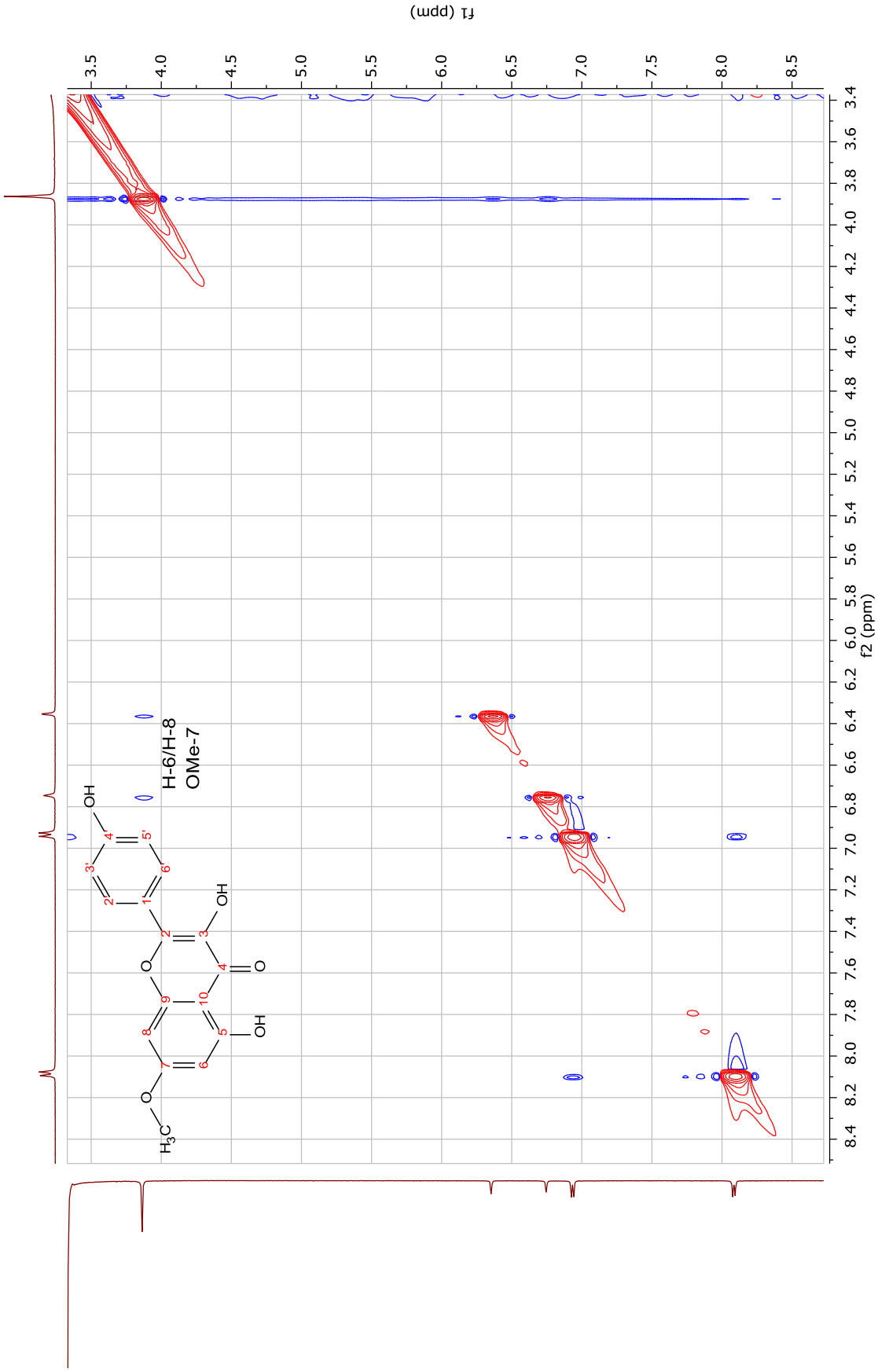


Figura 9. Espectro de NOESY de **Sb3** (500 MHz, DMSO-d_6).

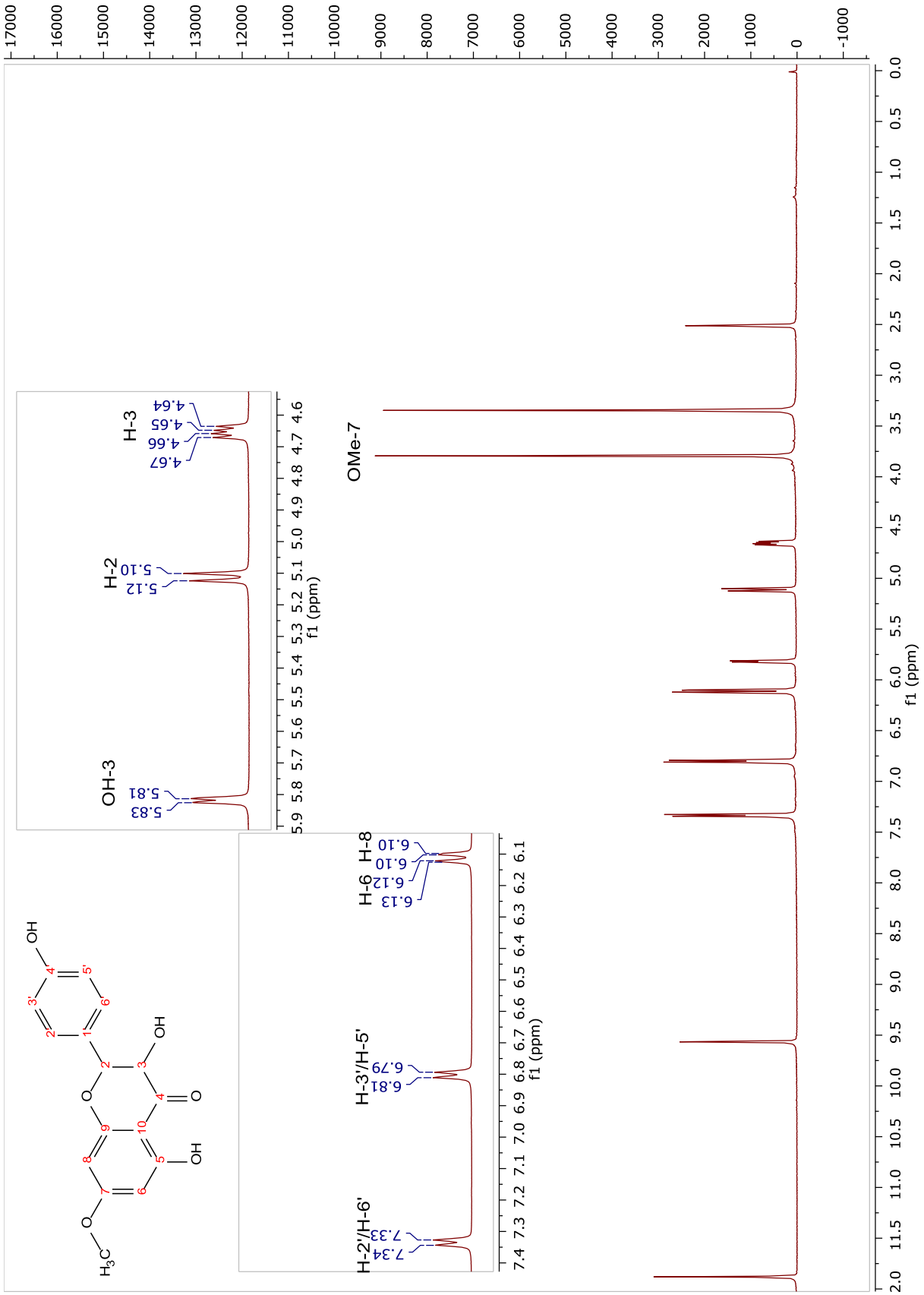


Figura 10. Espectro de RMN ^{1}H de **Sb4** (500 MHz, DMSO-d_6).

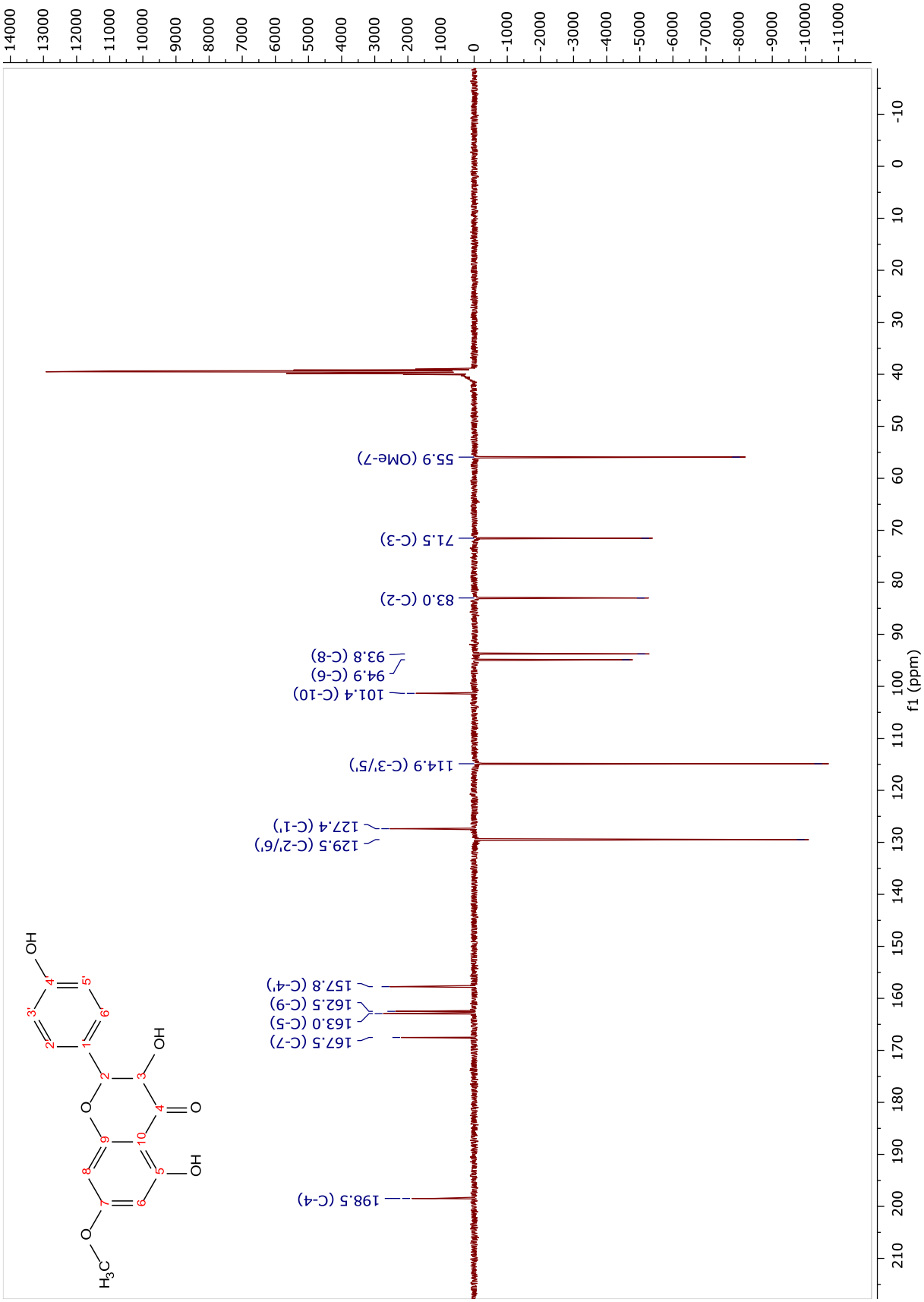


Figura 11. Espectro de DEPTQ de **Sb4** (125 MHz, DMSO-d_6).

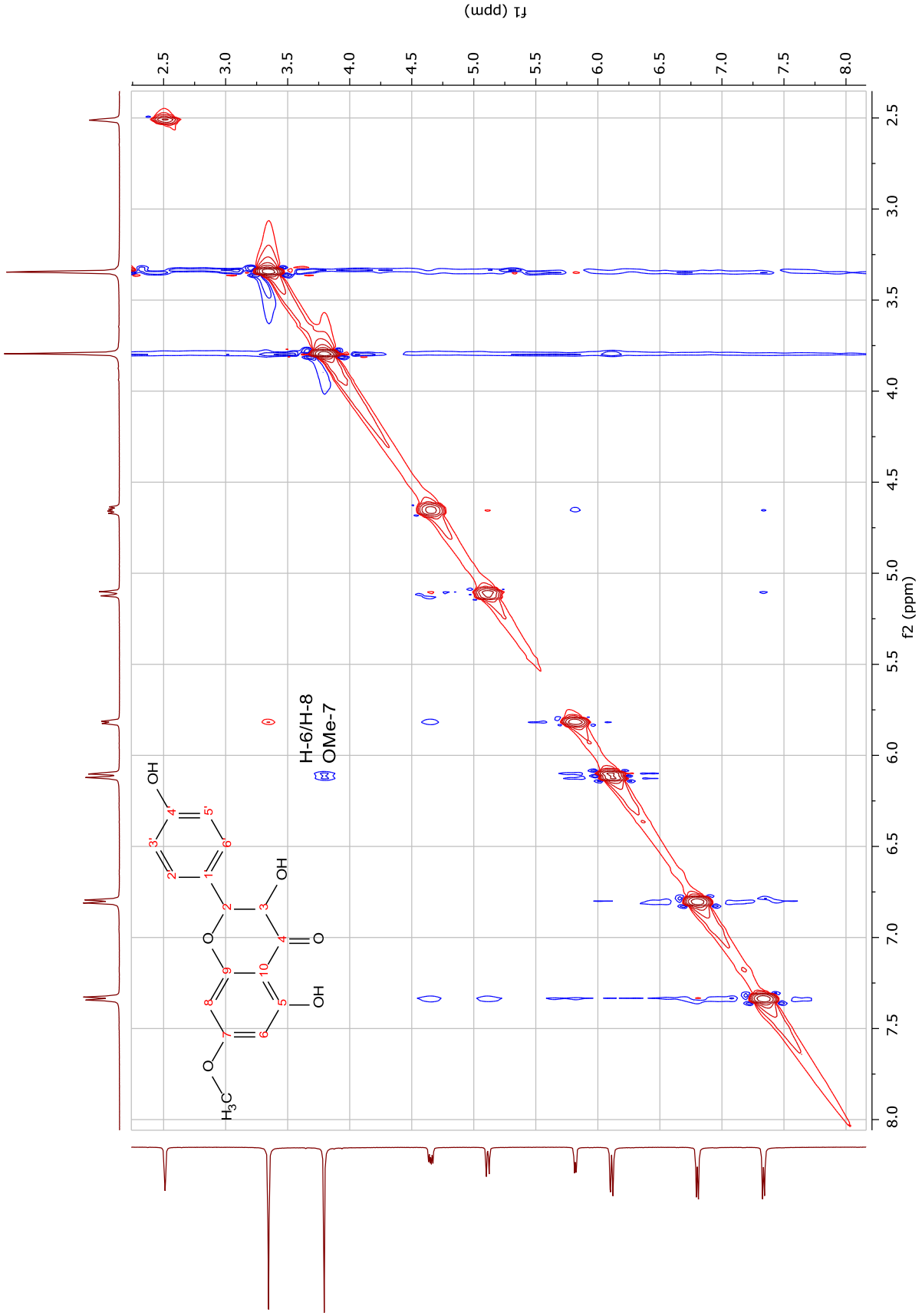


Figura 12. Espectro de NOESY **Sb4** (500 MHz, DMSO-d_6).

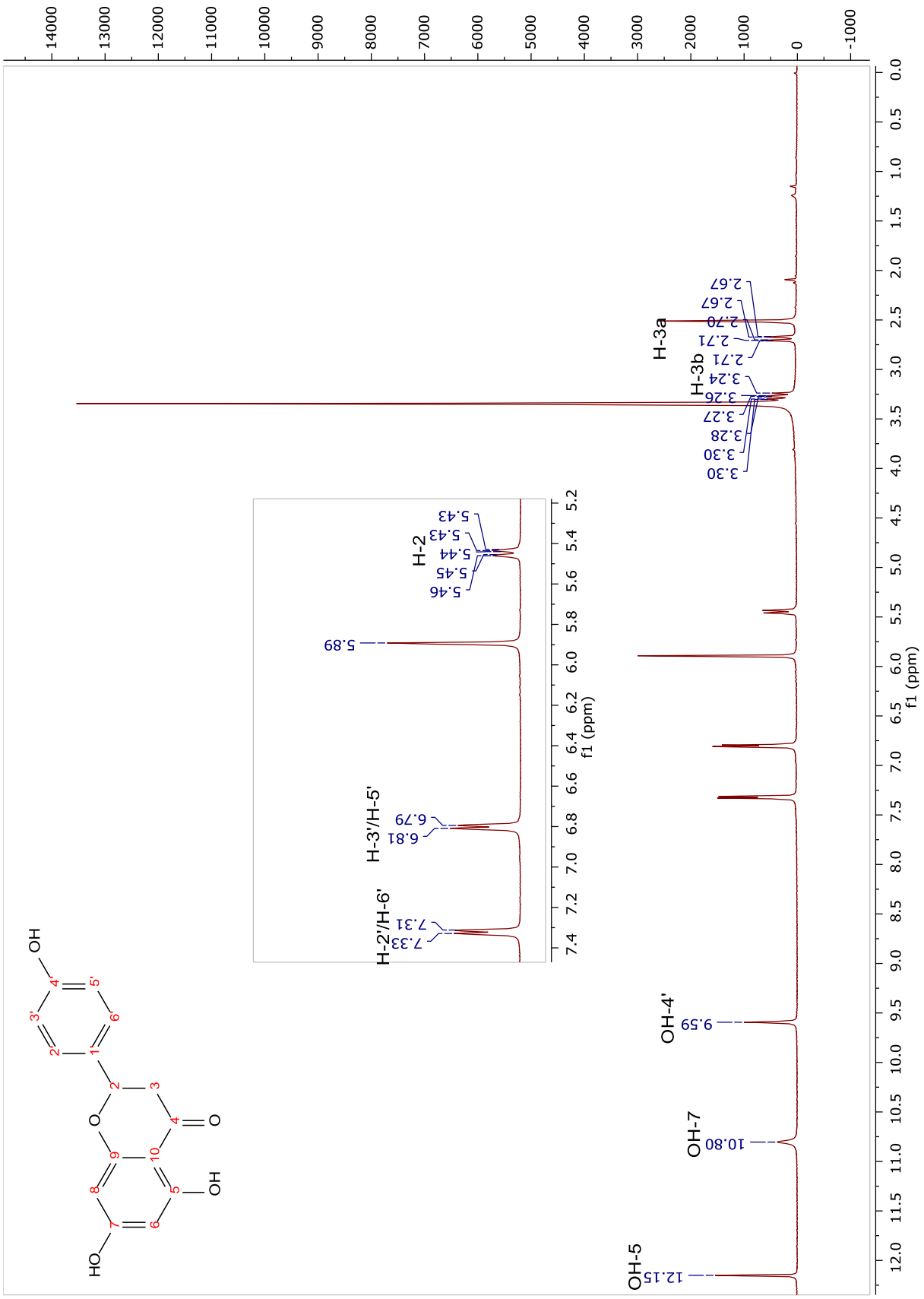


Figura 13. Espectro de RMN ^{1}H de **Sb5** (500 MHz, DMSO-d_6).

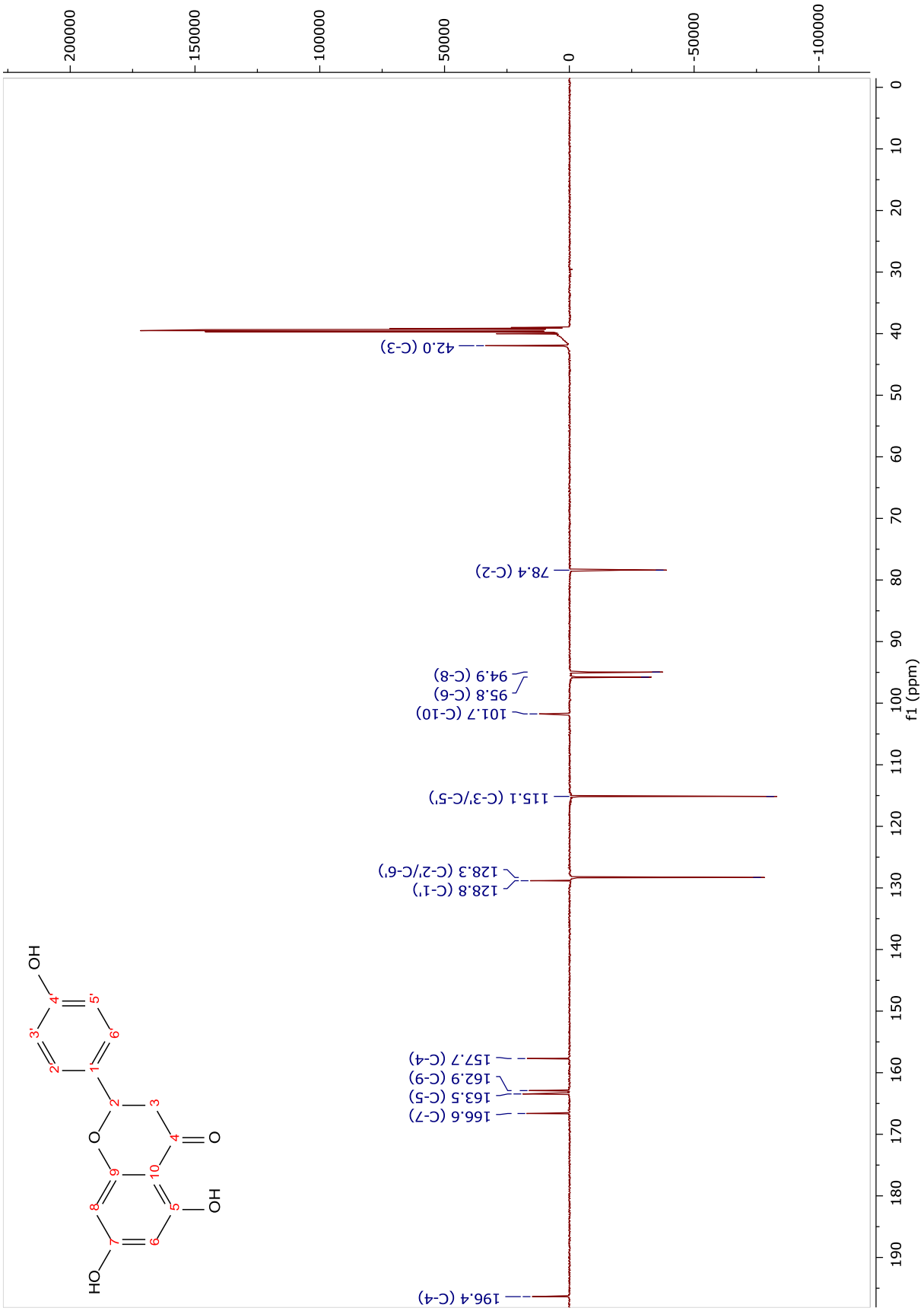


Figura 14. Espectro de DEPTQ de **Sb5** (125 MHz, DMSO-d_6).

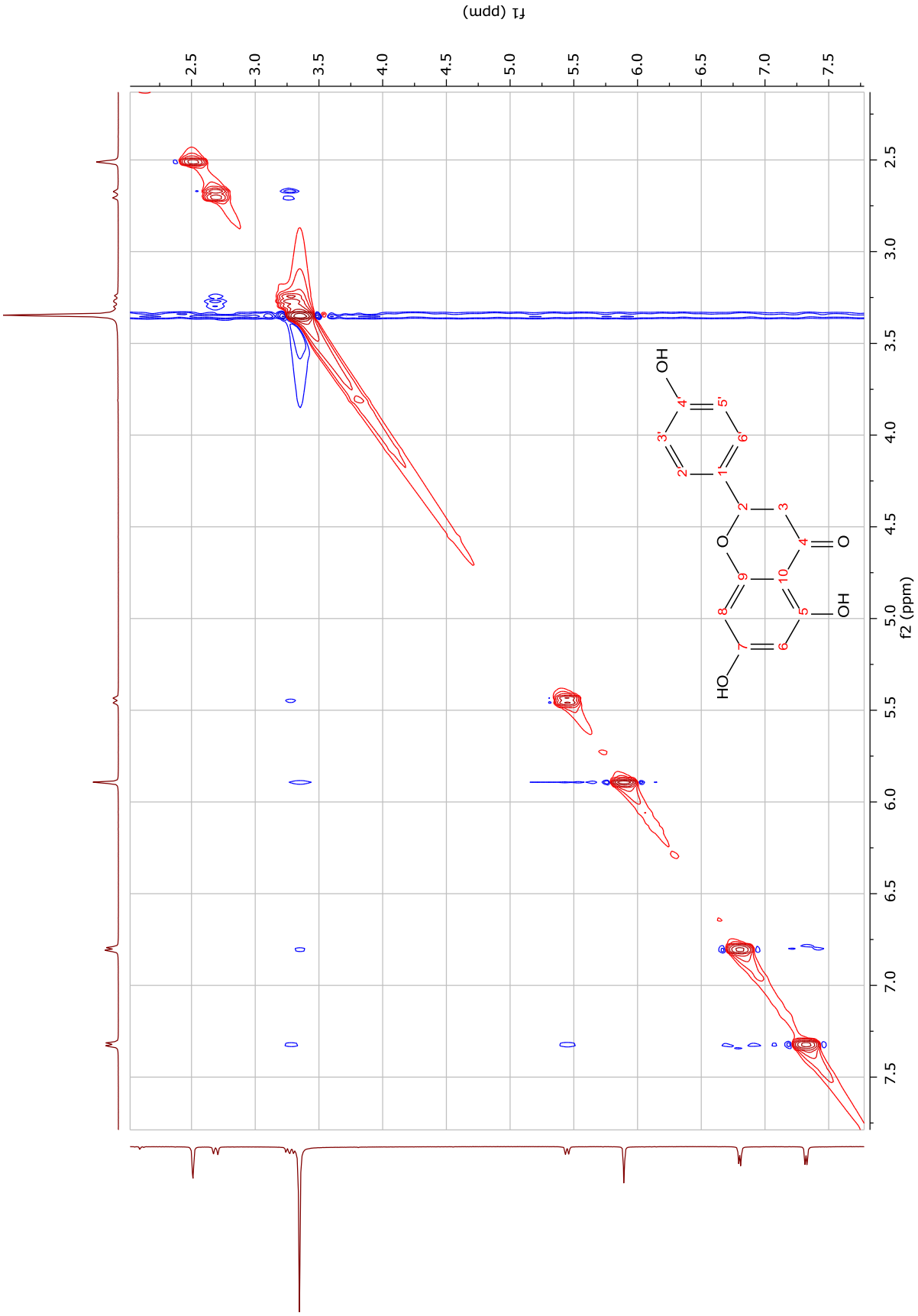


Figura 15. Espectro de NOESY de **Sb5** (500 MHz, DMSO-d_6).

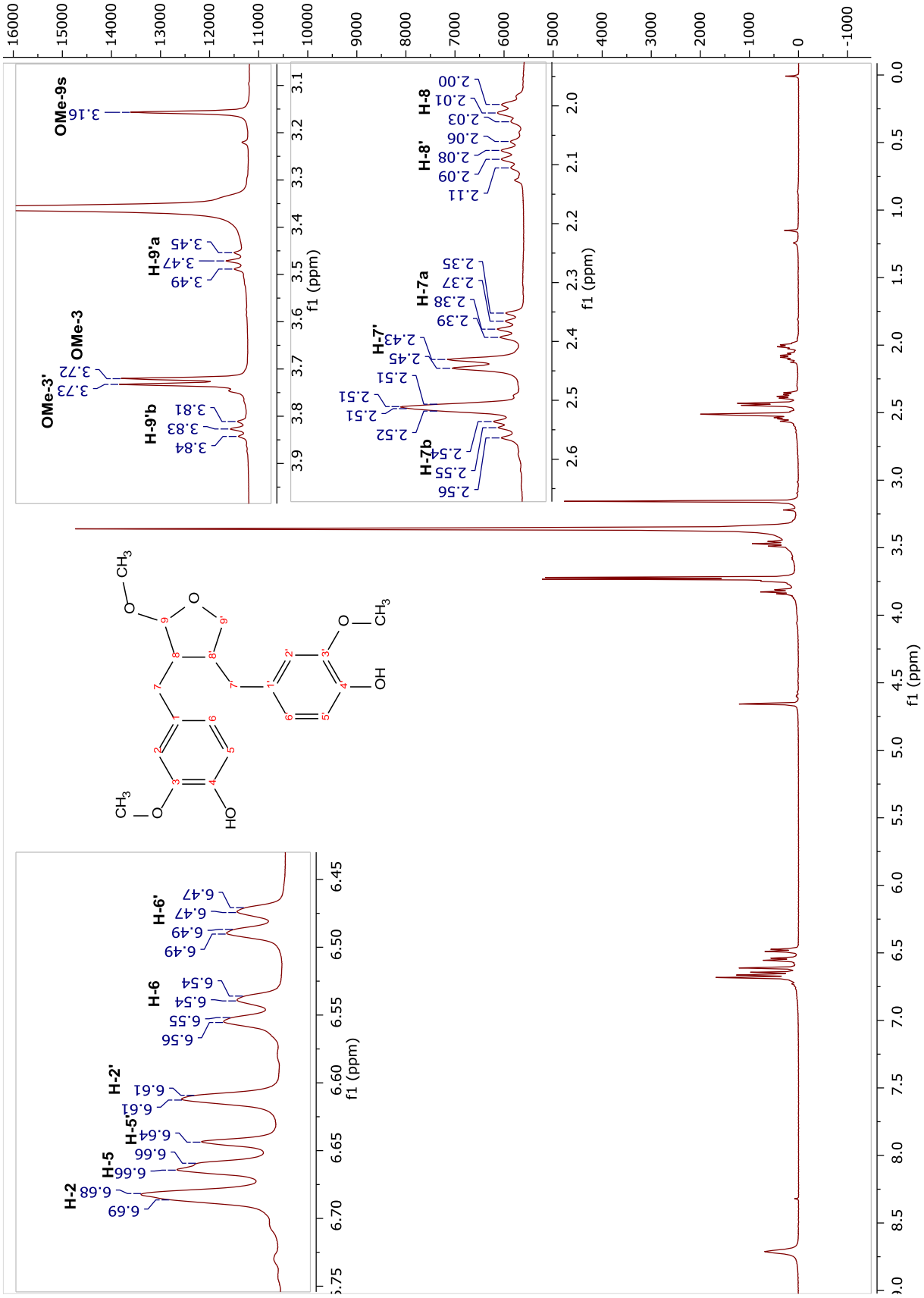


Figura 16. Espectro de RMN ^{1}H de **Sb6** (500 MHz, DMSO-d_6).

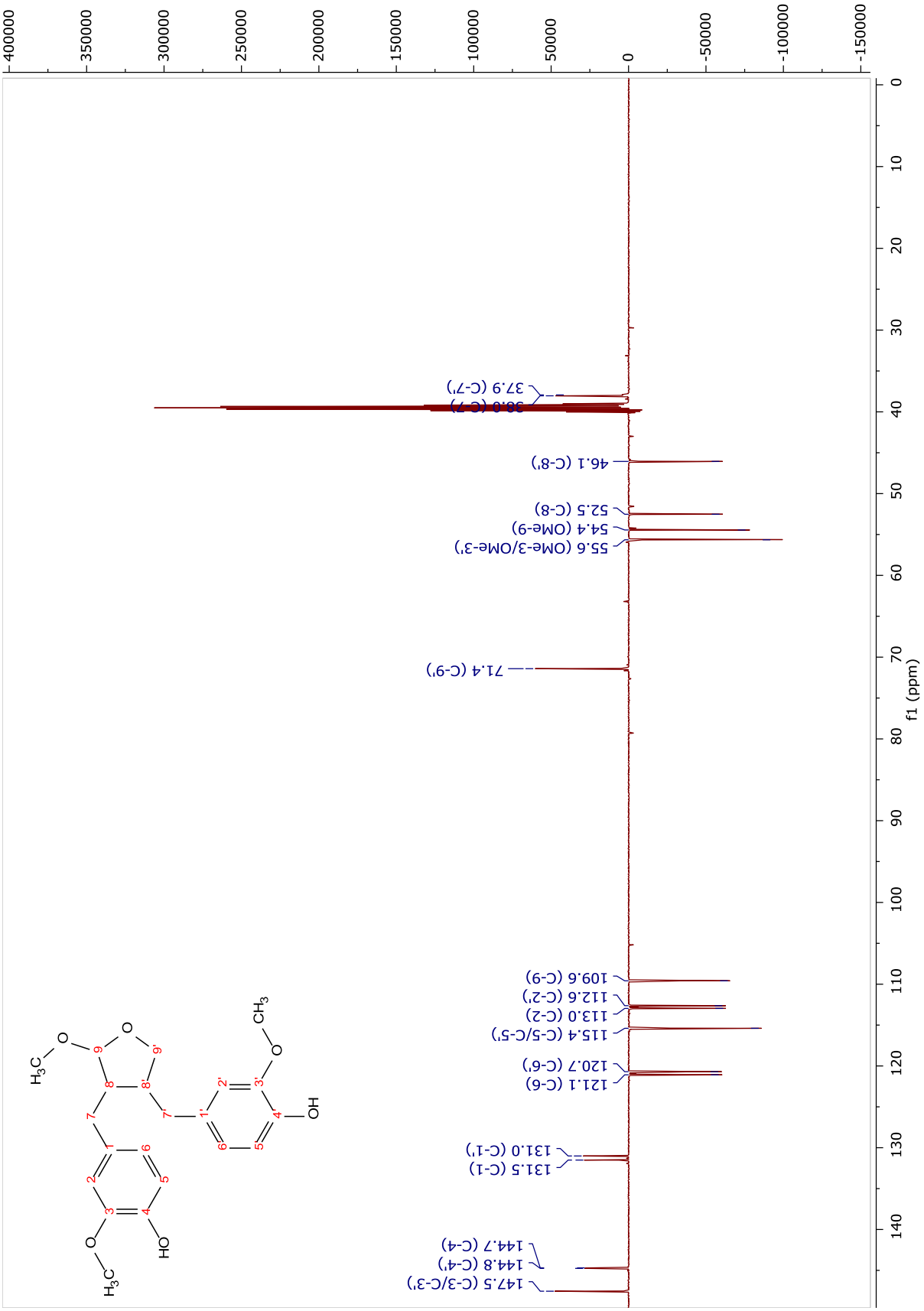


Figura 17. Espectro de DEPTQ de **Sb6** (125 MHz, DMSO-d_6).

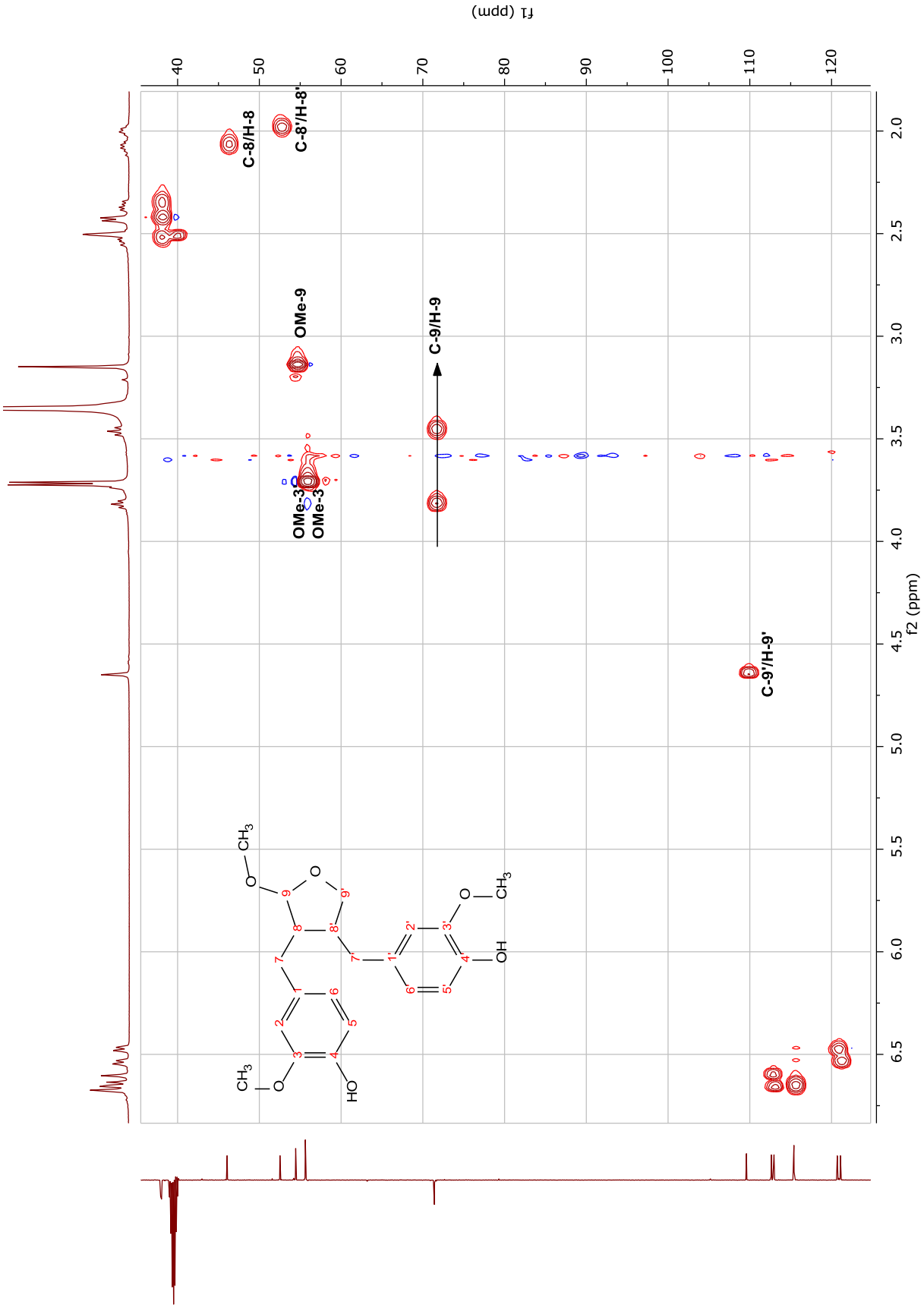


Figura 18. Espectro de HSQC de **Sb6** (500 MHz, DMSO-*d*$_6$).

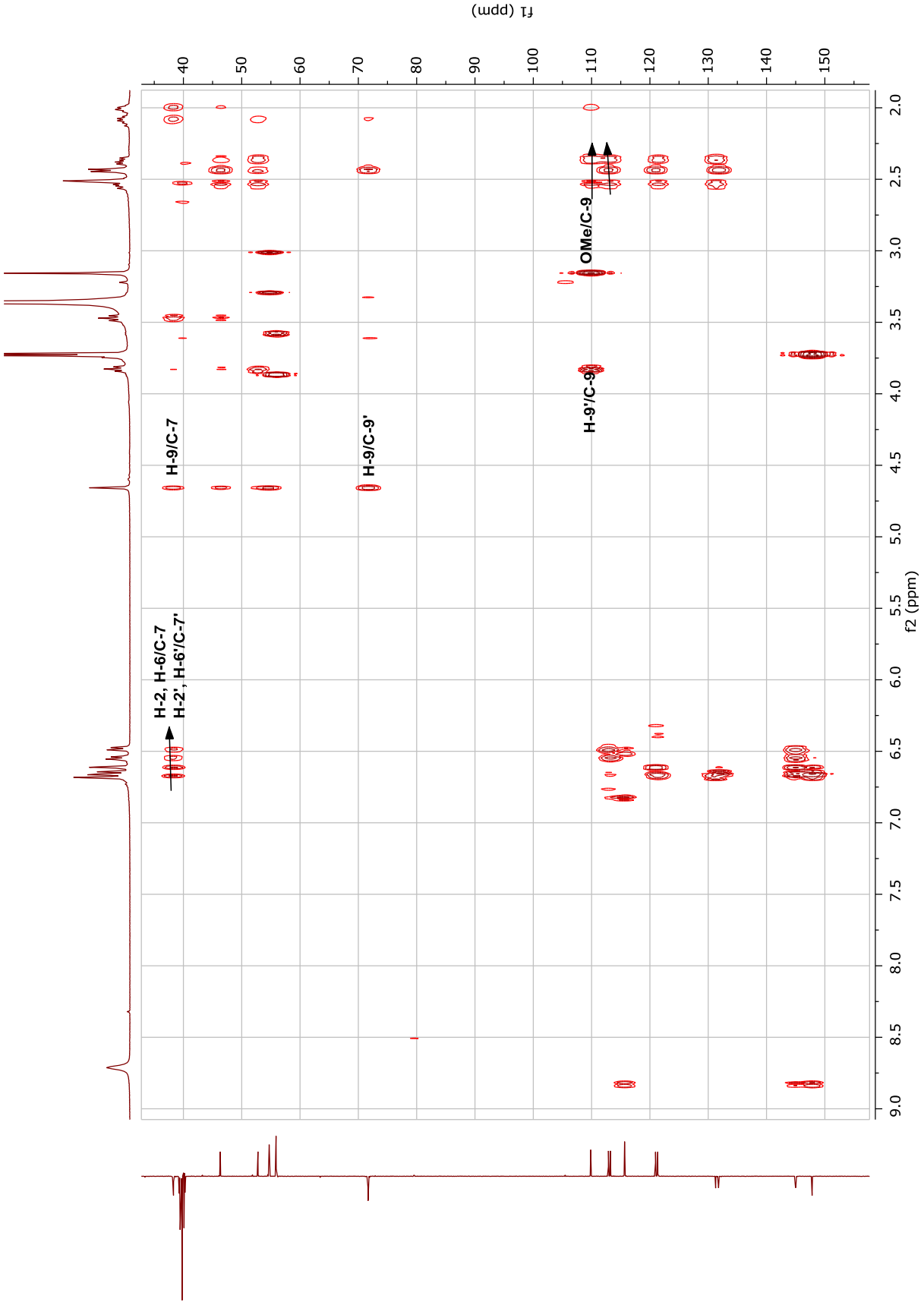


Figura 19. Espectro de HMBC de **Sb6** (500 MHz, DMSO-d_6).

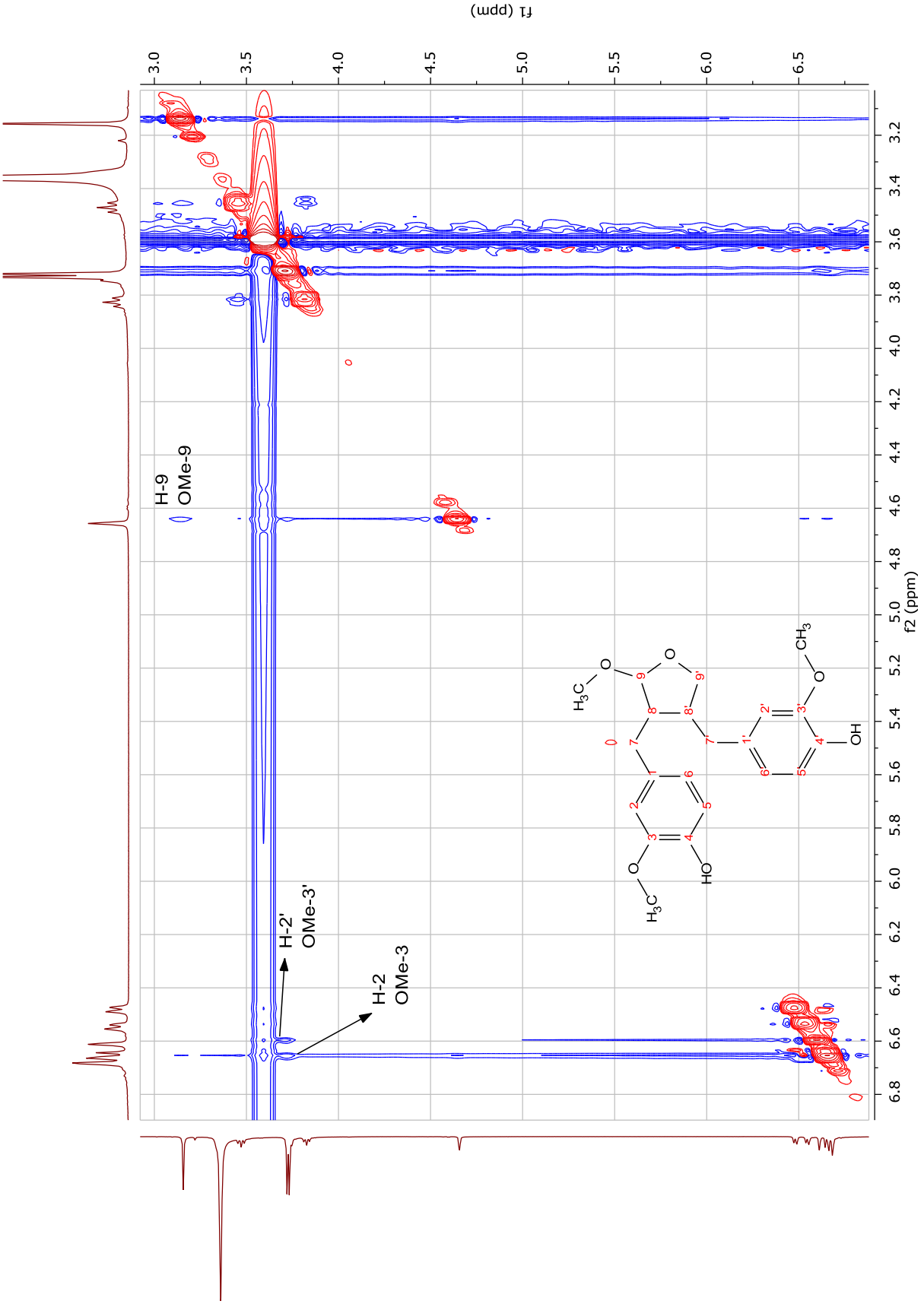


Figura 20. Espectro de NOESY de **Sb6** (500 MHz, DMSO-d_6).

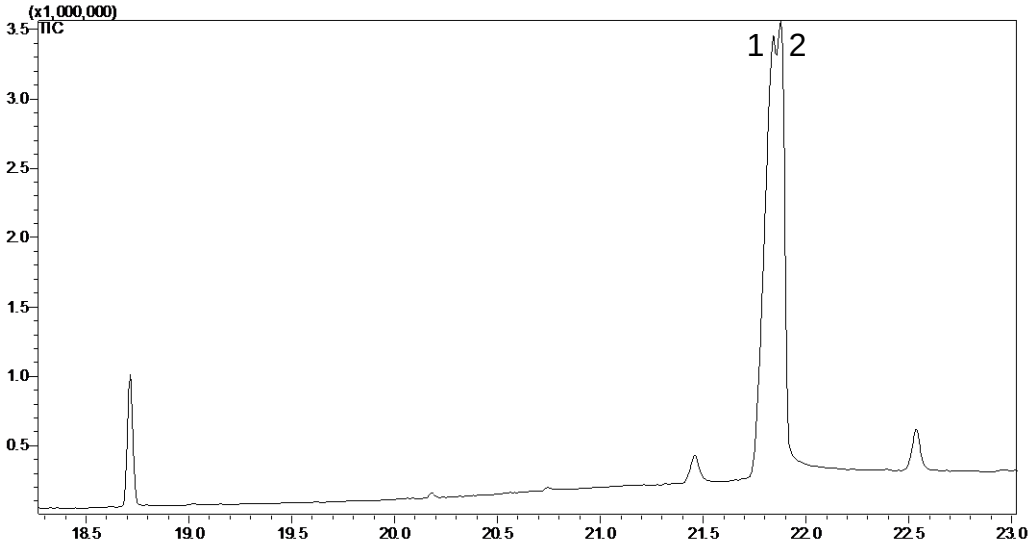


Figura 21. Cromatograma de CG-EM de **Sb6**.

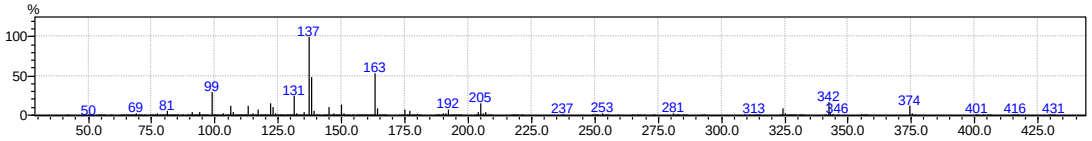


Figura 22. Espectro de massas do pico 1 de **Sb6** (i.e. 70 eV).

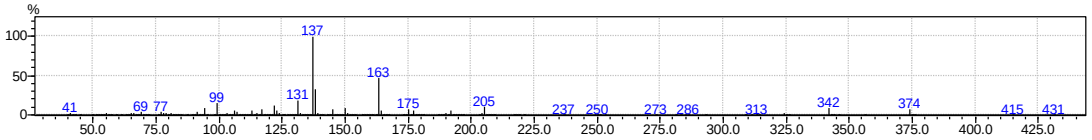


Figura 23. Espectro de massas do pico 2 de **Sb6** (i.e. 70 eV).

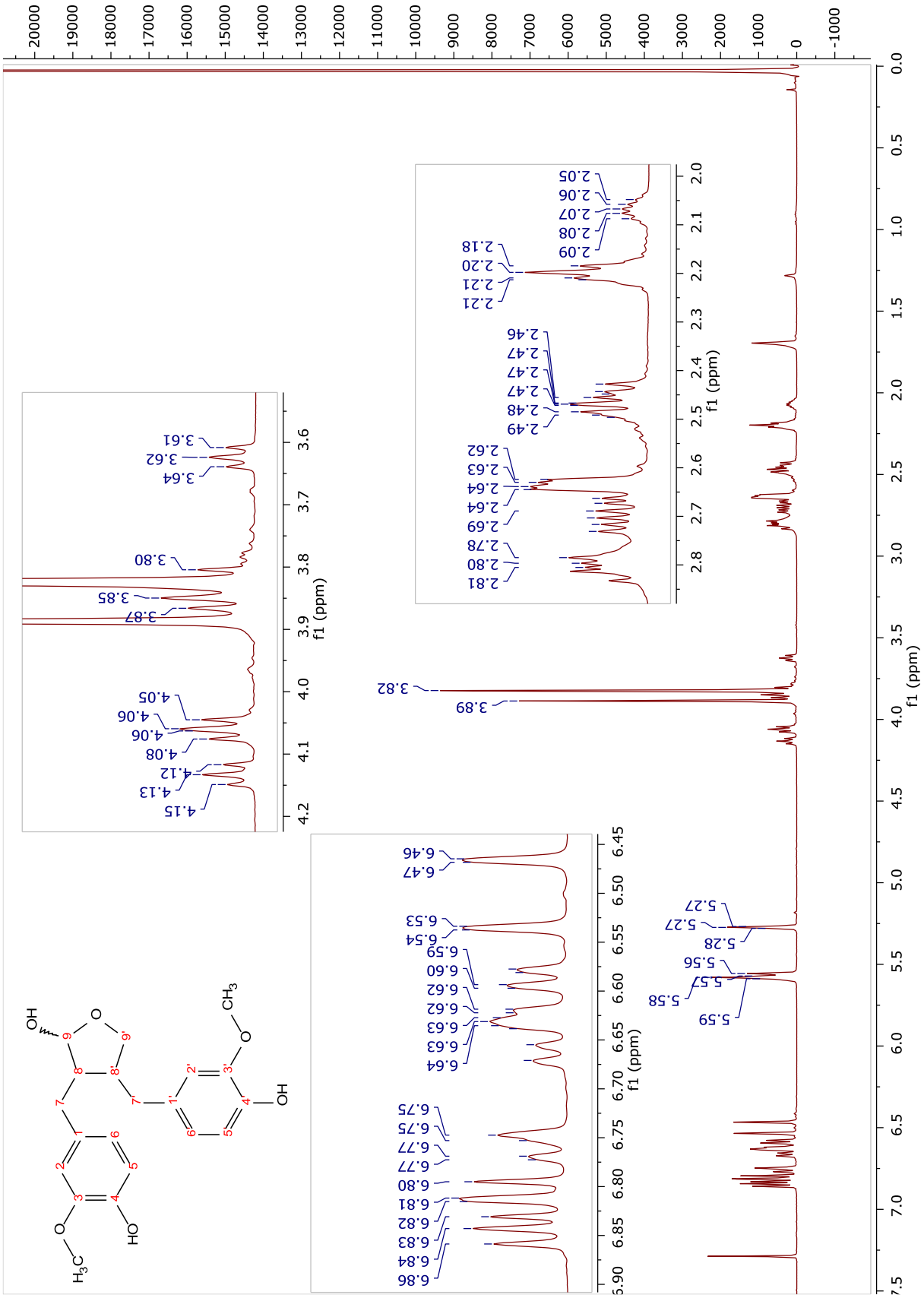


Figura 24. Espectro de RMN ^{1}H de **Sb7** (500 MHz, $CDCl_3$).

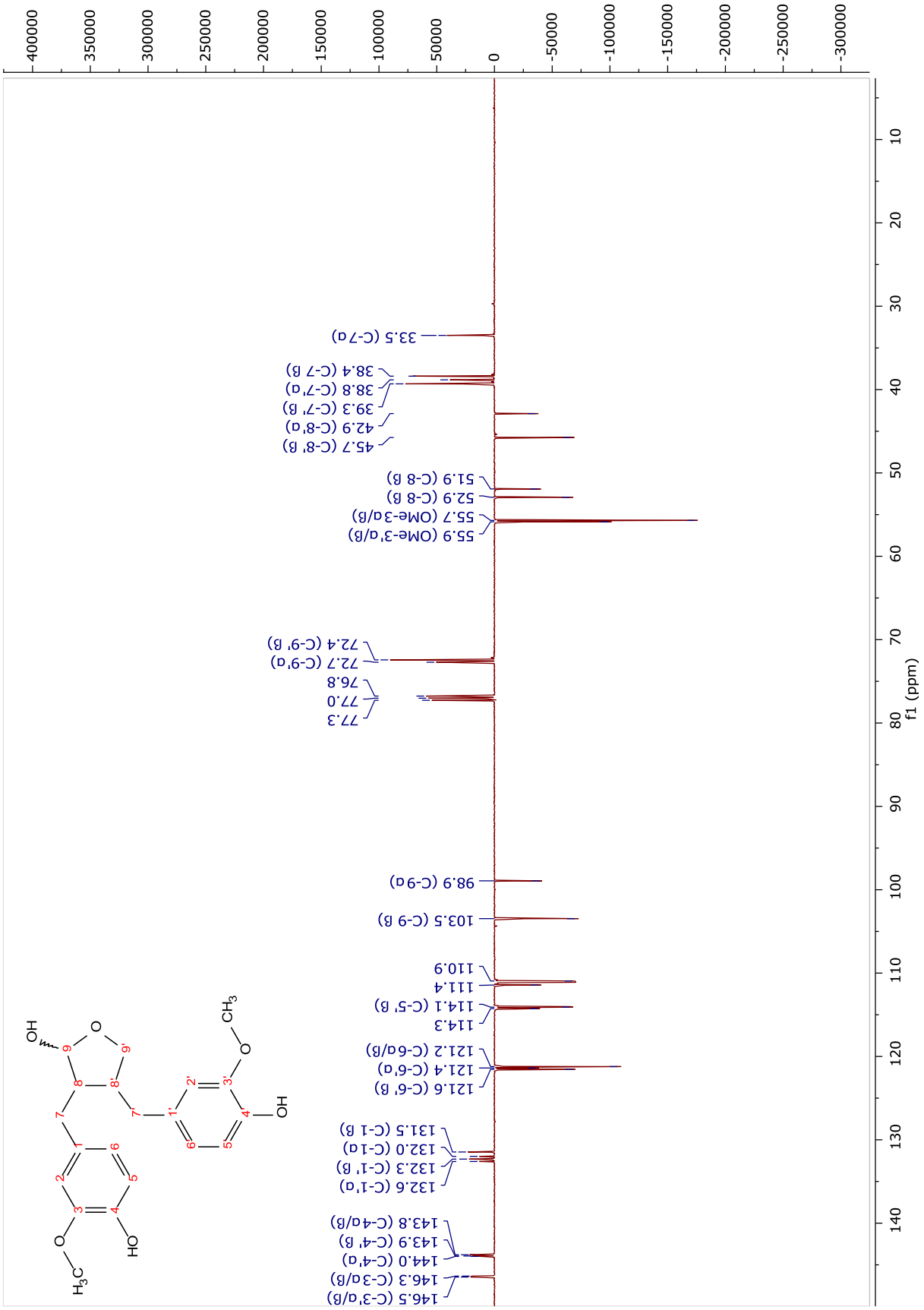


Figura 25. Espectro de DEPTQ de **Sb7** (125 MHz, $CDCl_3$).

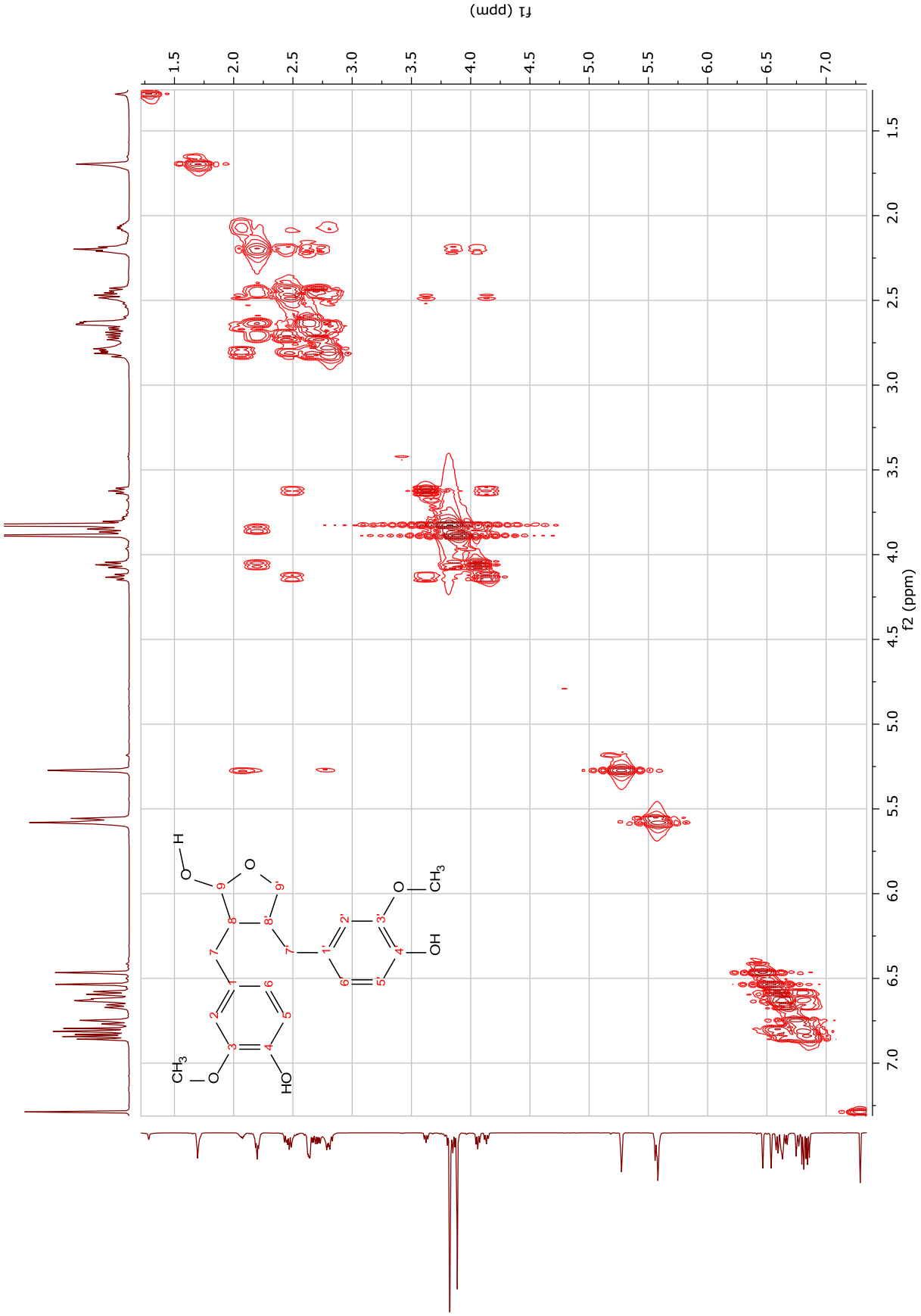


Figura 26. Espectro de COSY de **Sb7** (500 MHz, $CDCl_3$).

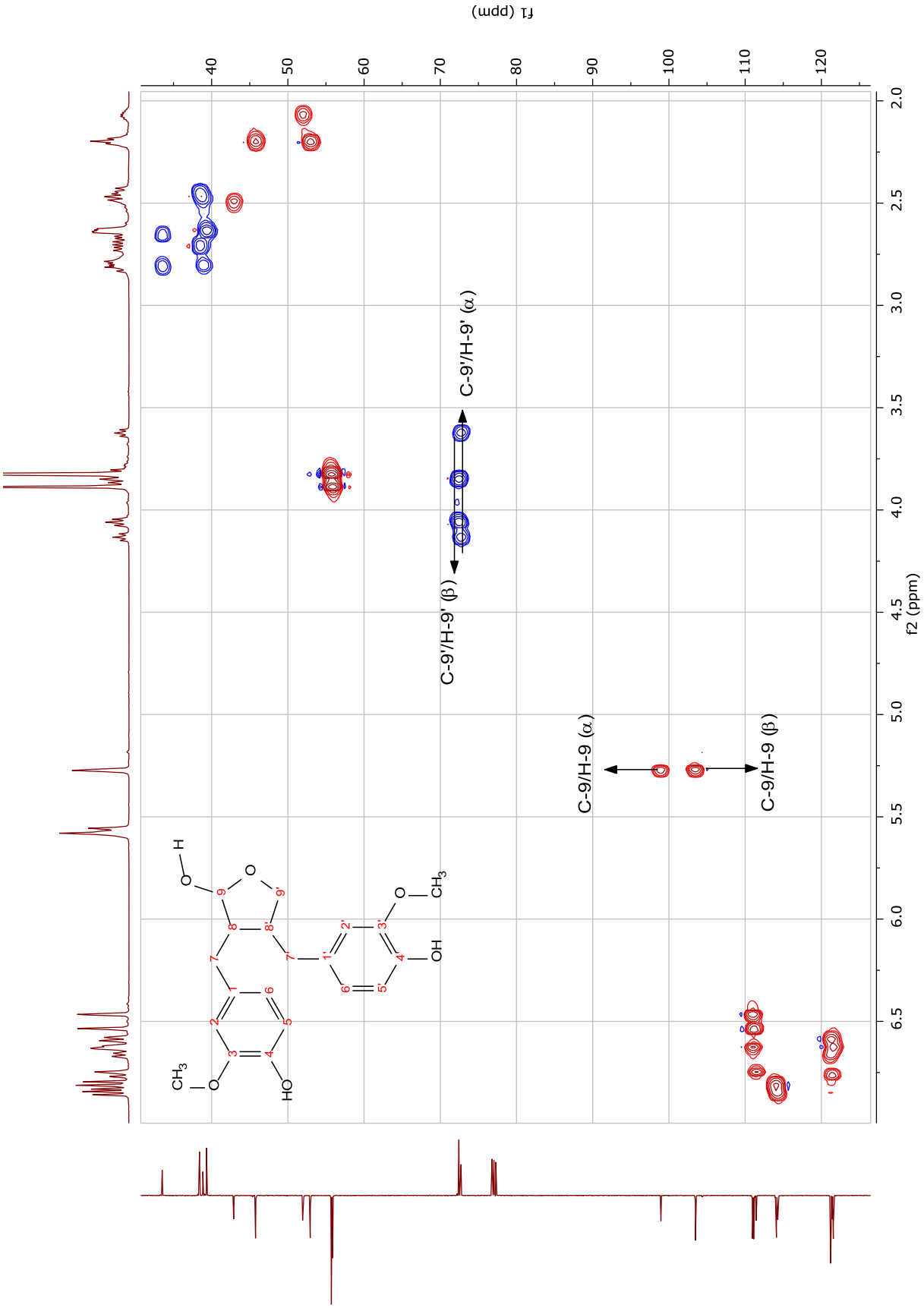


Figura 27. Espectro de HSQC de **Sb7** (500 MHz, $CDCl_3$).

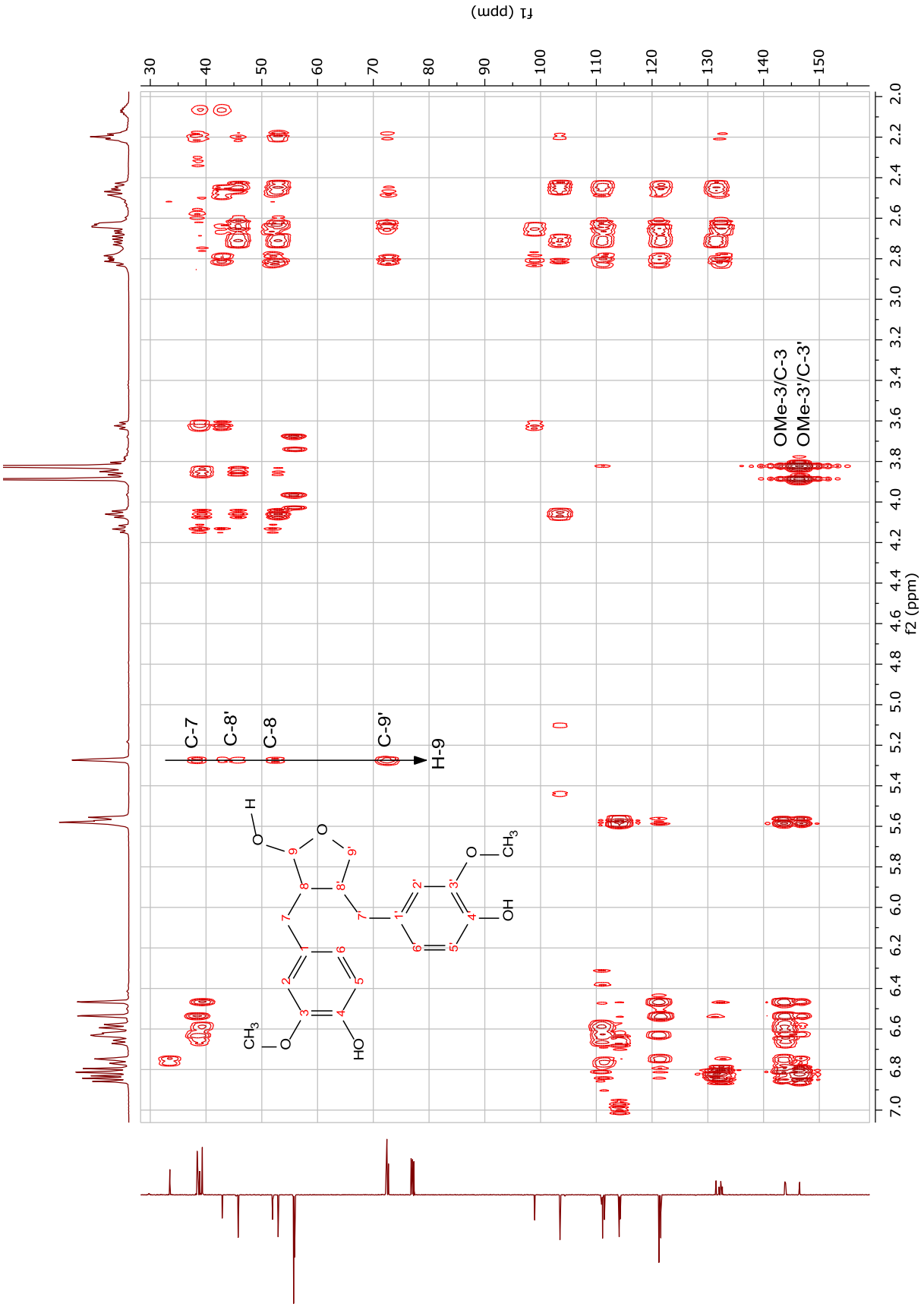


Figura 28. Espectro de HMBC de **Sb7** (500 MHz, $CDCl_3$).

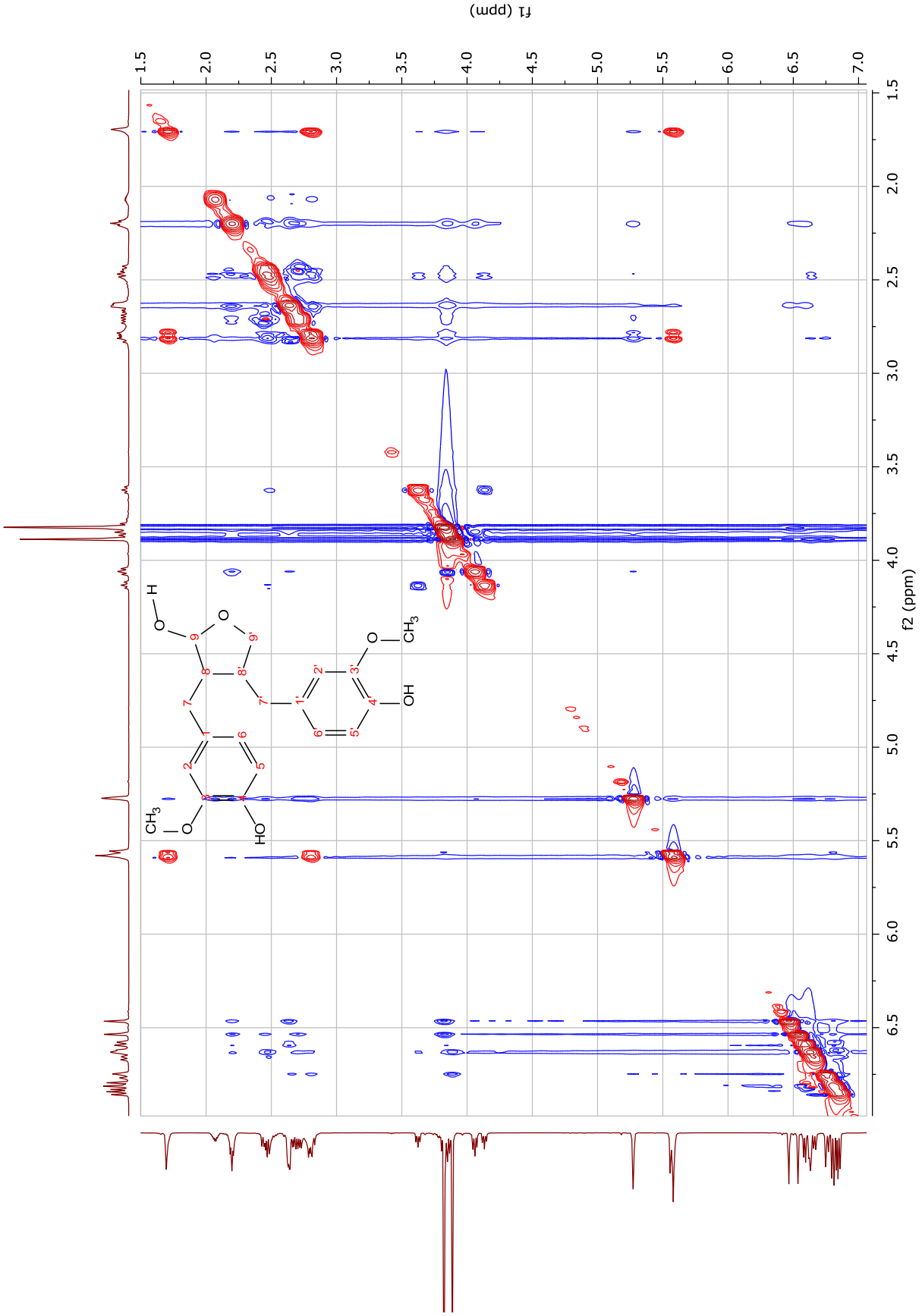


Figura 29. Espectro de NOESY de **Sb7** (500 MHz, $CDCl_3$).

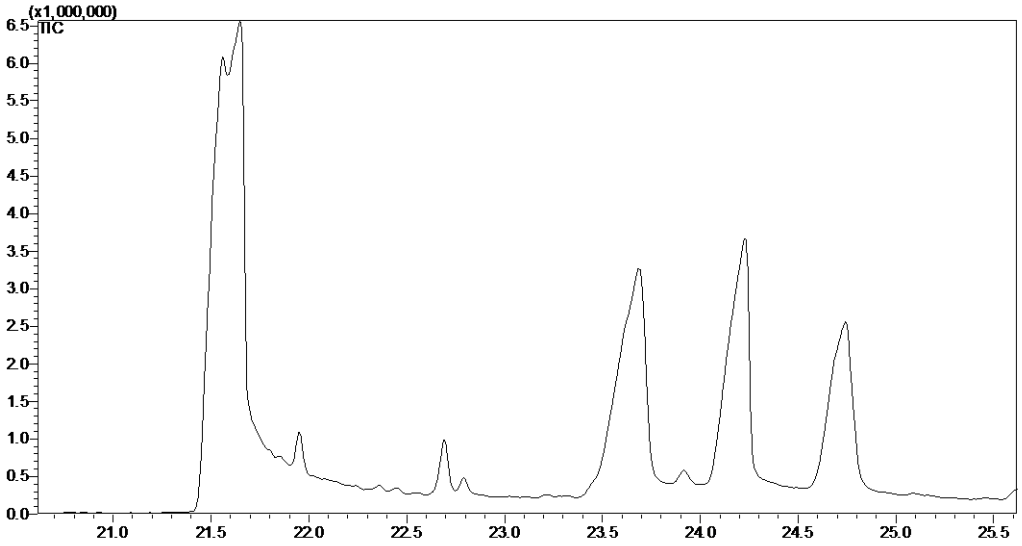


Figura 30. Cromatograma de CG-EM de **Sb7**.

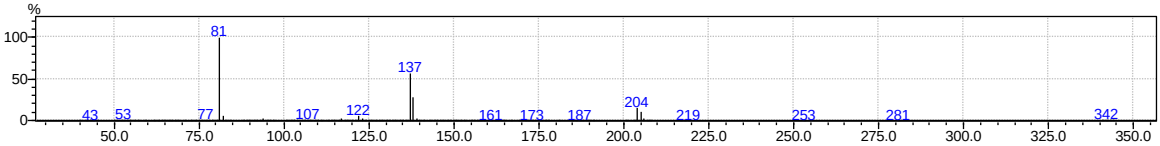


Figura 31. Espectro de massas do pico 1 de **Sb7** (i.e. 70 eV).

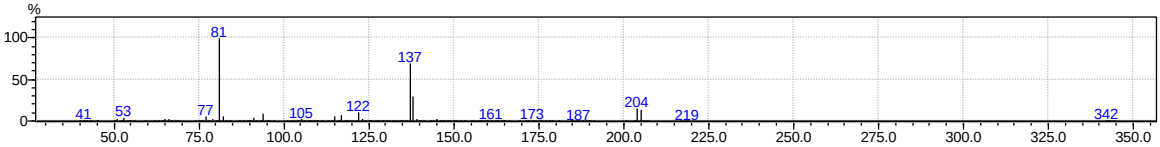


Figura 32. Espectro de massas do pico 2 de **Sb7** (i.e. 70 eV).

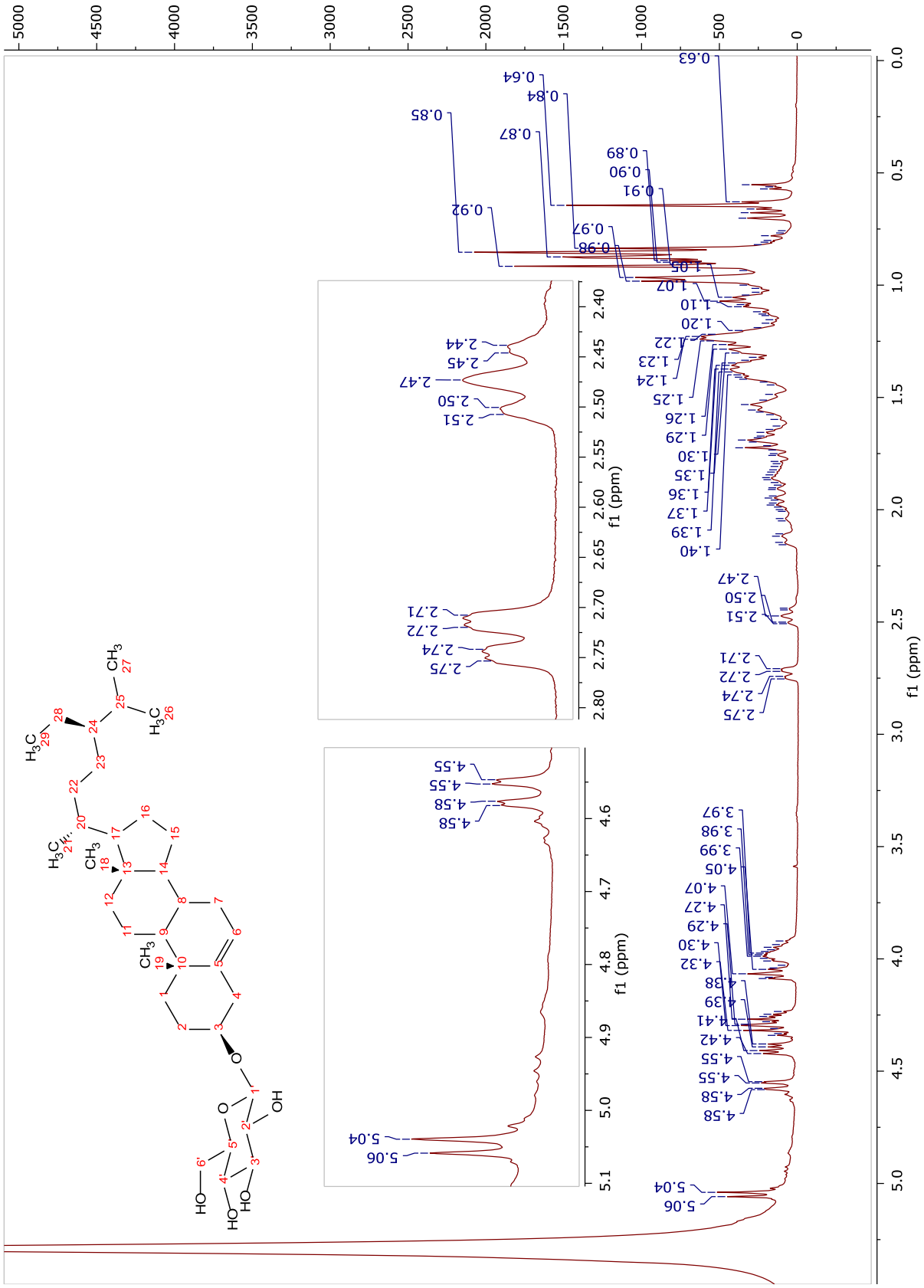


Figura 33. Espectro de RMN ^{1}H de **Sb8** (500 MHz, C_5D_5N).

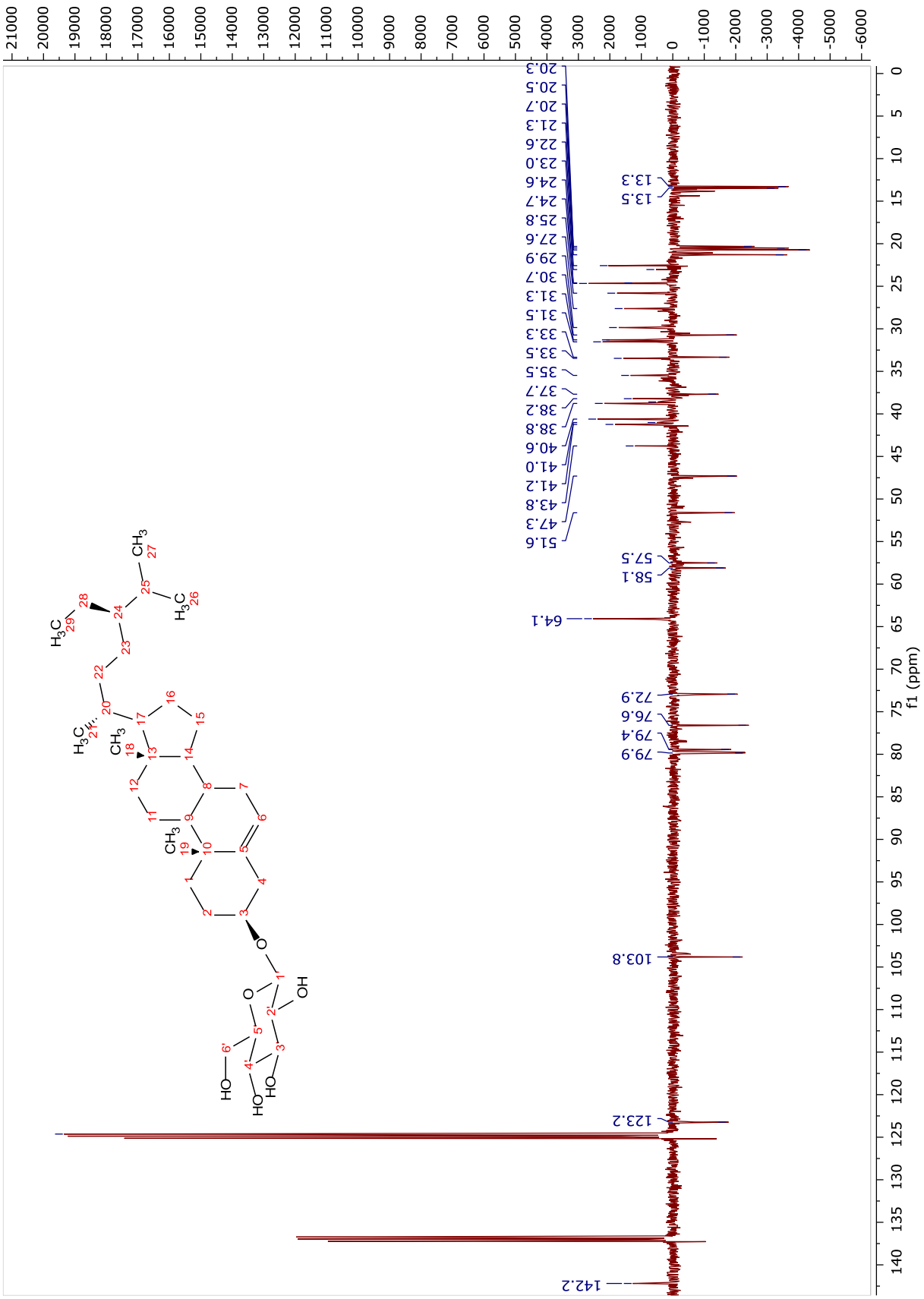


Figura 34. Espectro de DEPTQ de **Sb8** (100 MHz, C_5D_5N).

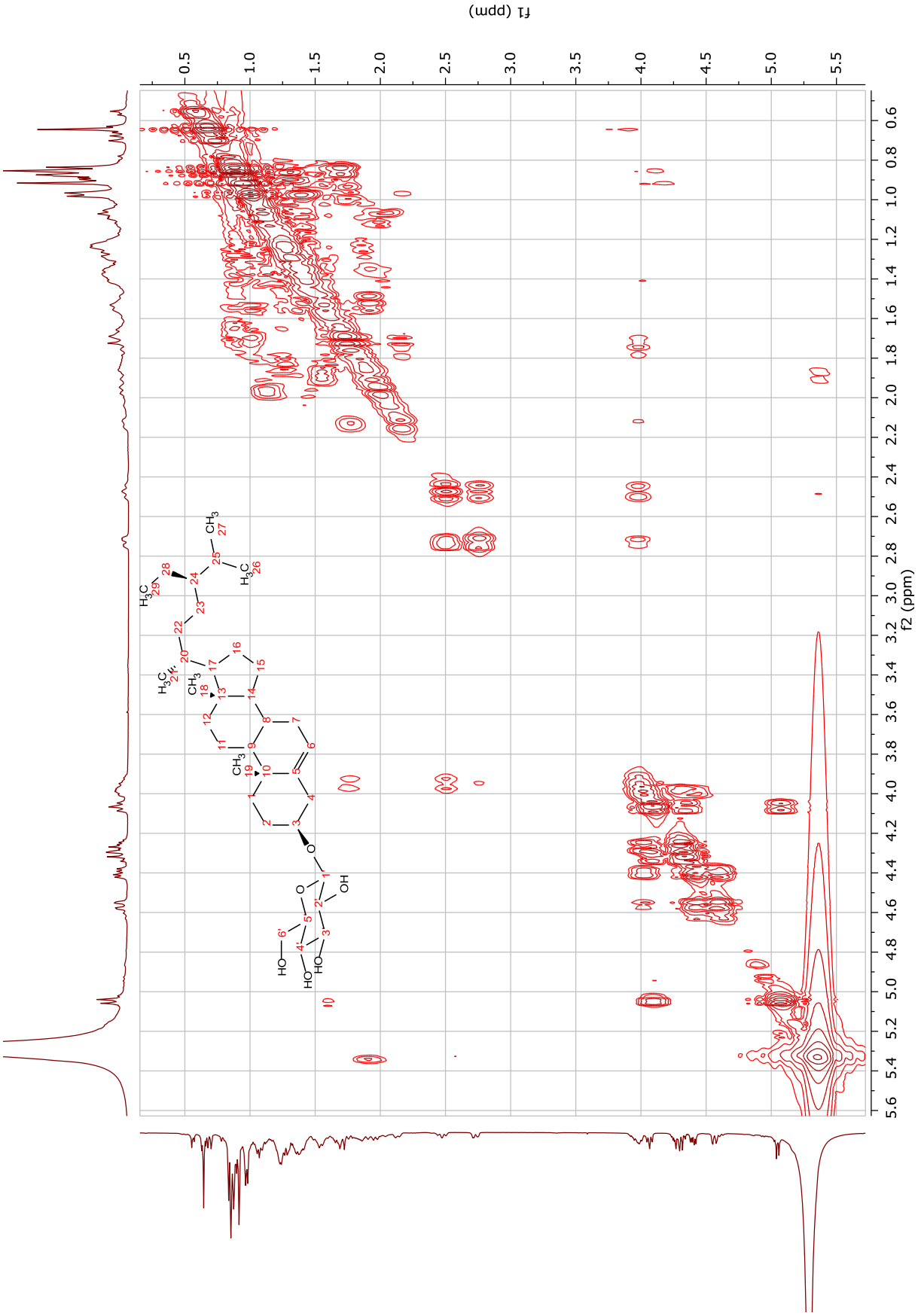


Figura 35. Espectro de COSY de **Sb8** (400 MHz, C_5D_5N).

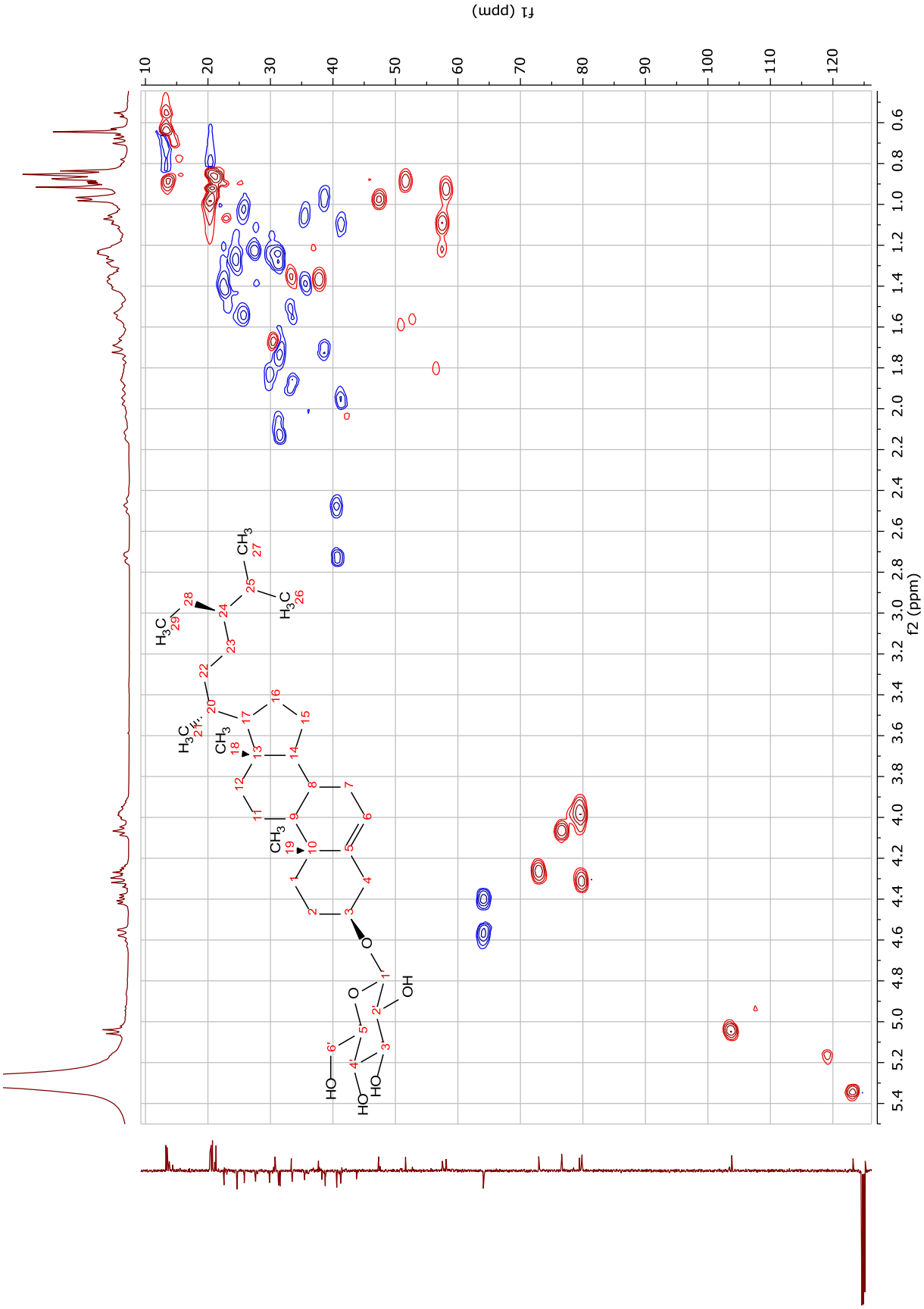


Figura 36. Espectro de HSQC de **Sb8** (400 MHz, C_5D_5N).

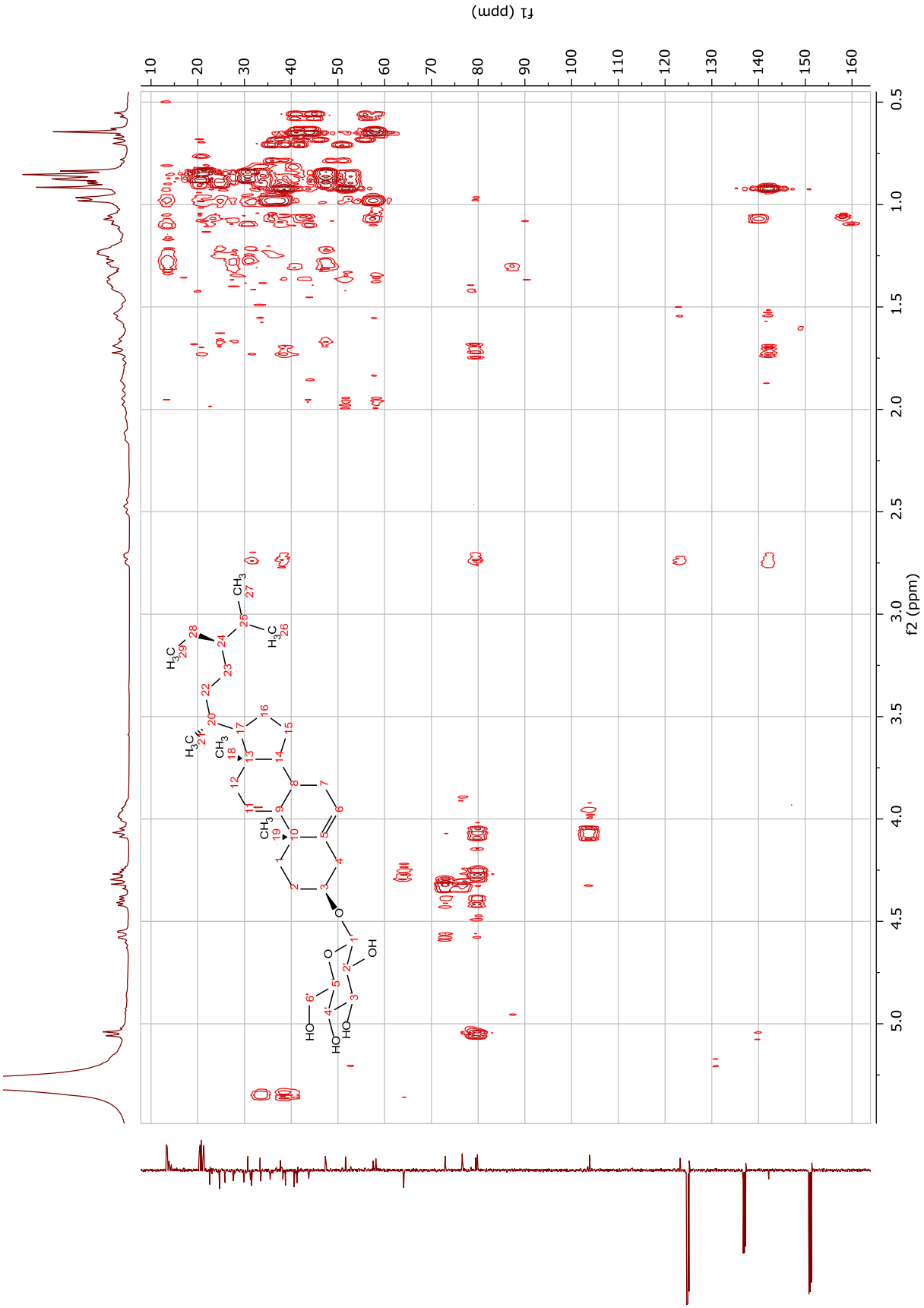


Figura 37. Espectro de HMBC de **Sb8** (400 MHz. C_5D_5N).

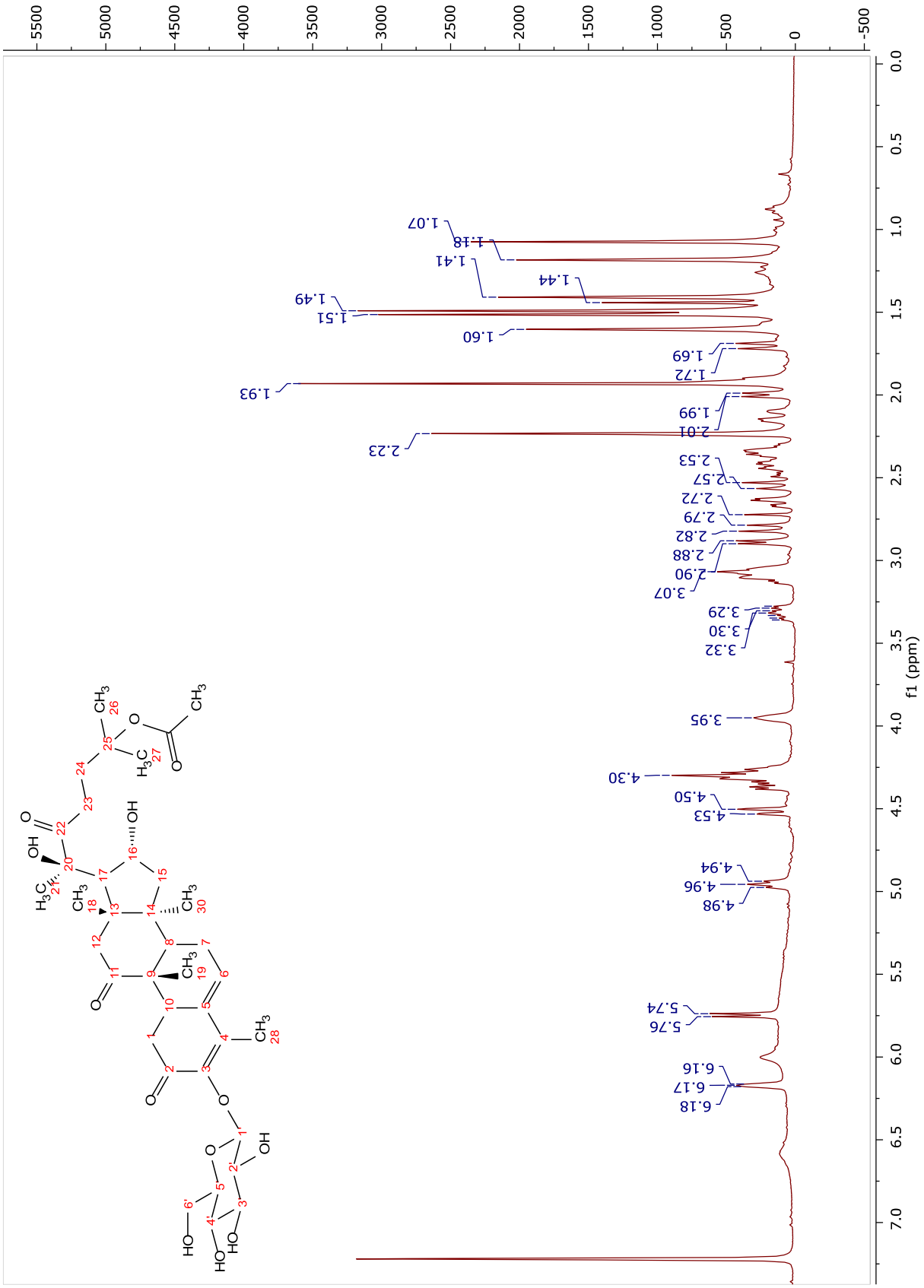


Figura 38. Espectro de RMN ^{1}H de **Sb9** (400 MHz, C_5D_5N).

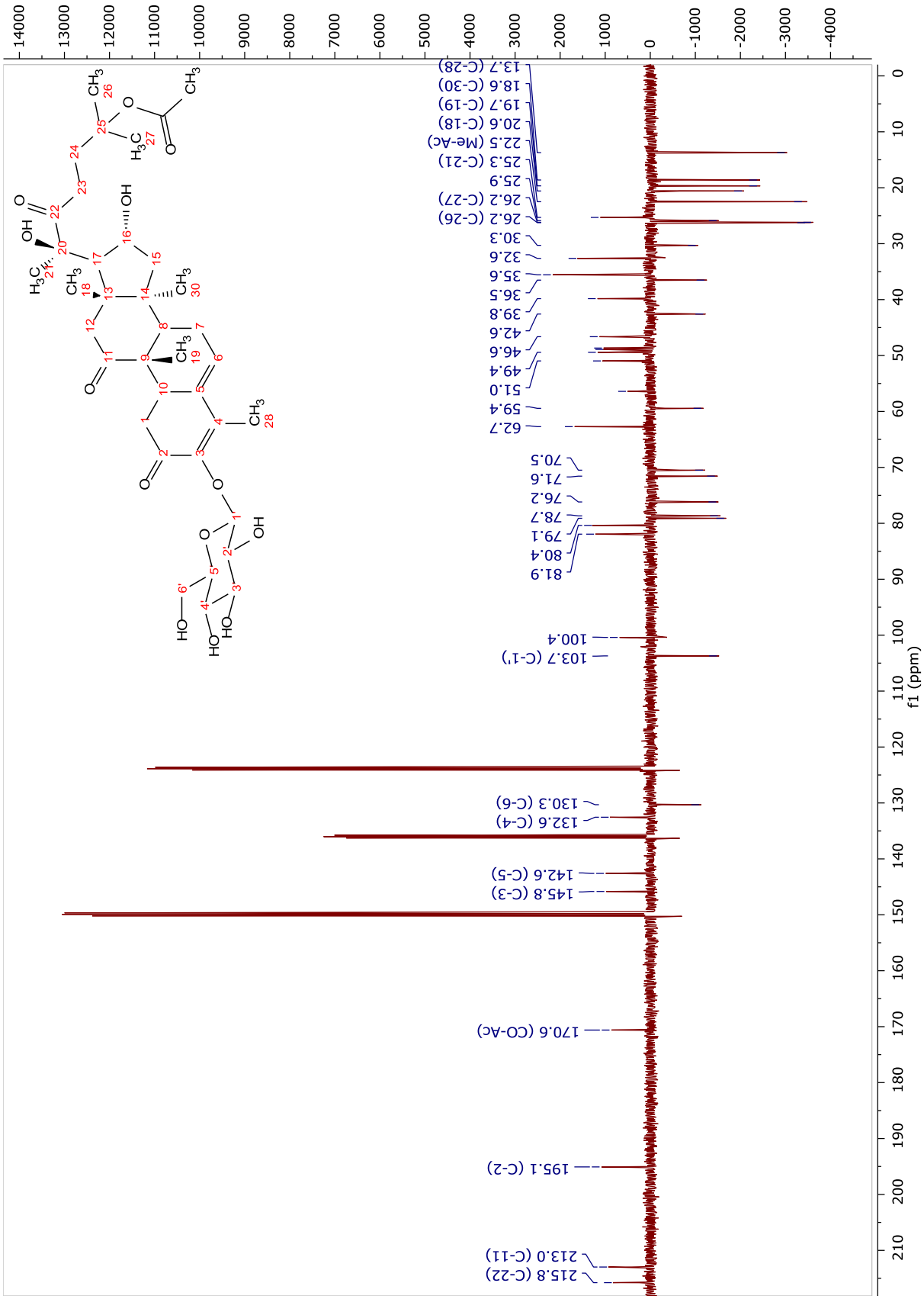


Figura 39. Espectro de DEPTQ de **Sb9** (100 MHz, C_5D_5N).

Figura 40. Espectro de COSY de **Sb9** (400 MHz, C_5D_5N).

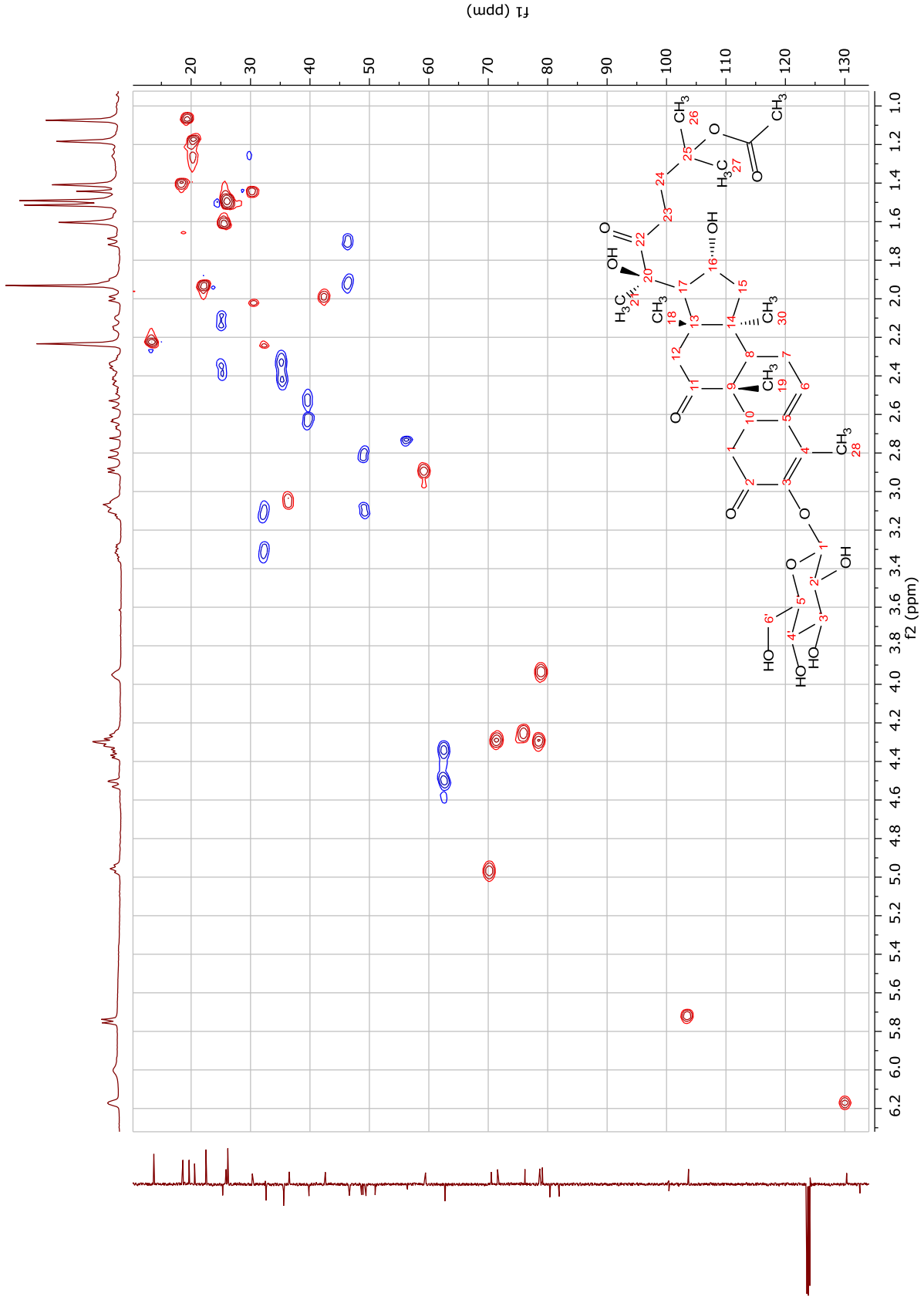


Figura 41. Espectro de HSQC de **Sb9** (400 MHz, C_5D_5N).

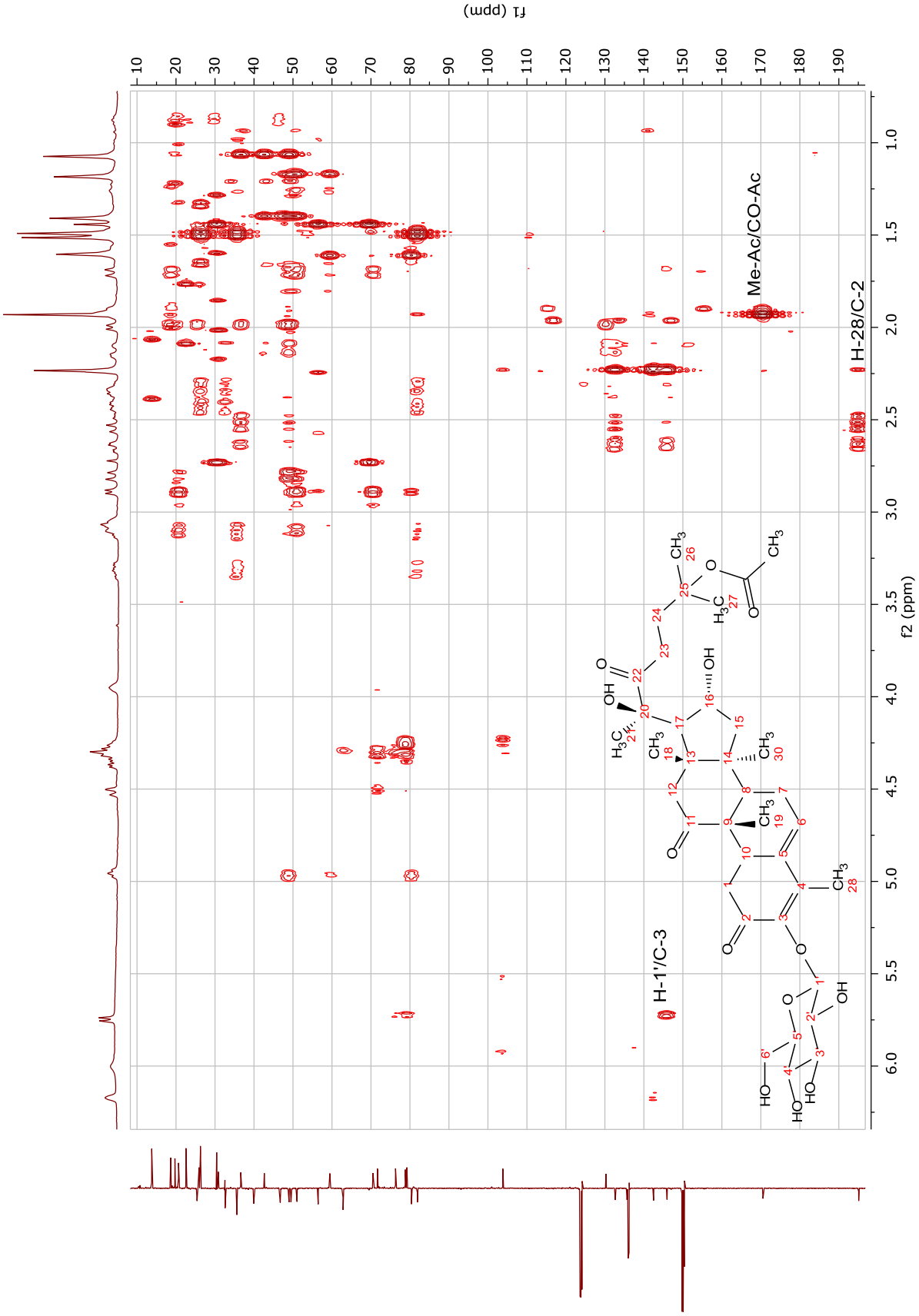


Figura 42. Espectro de HMBC de **Sb9** (400 MHz, C_5D_5N).

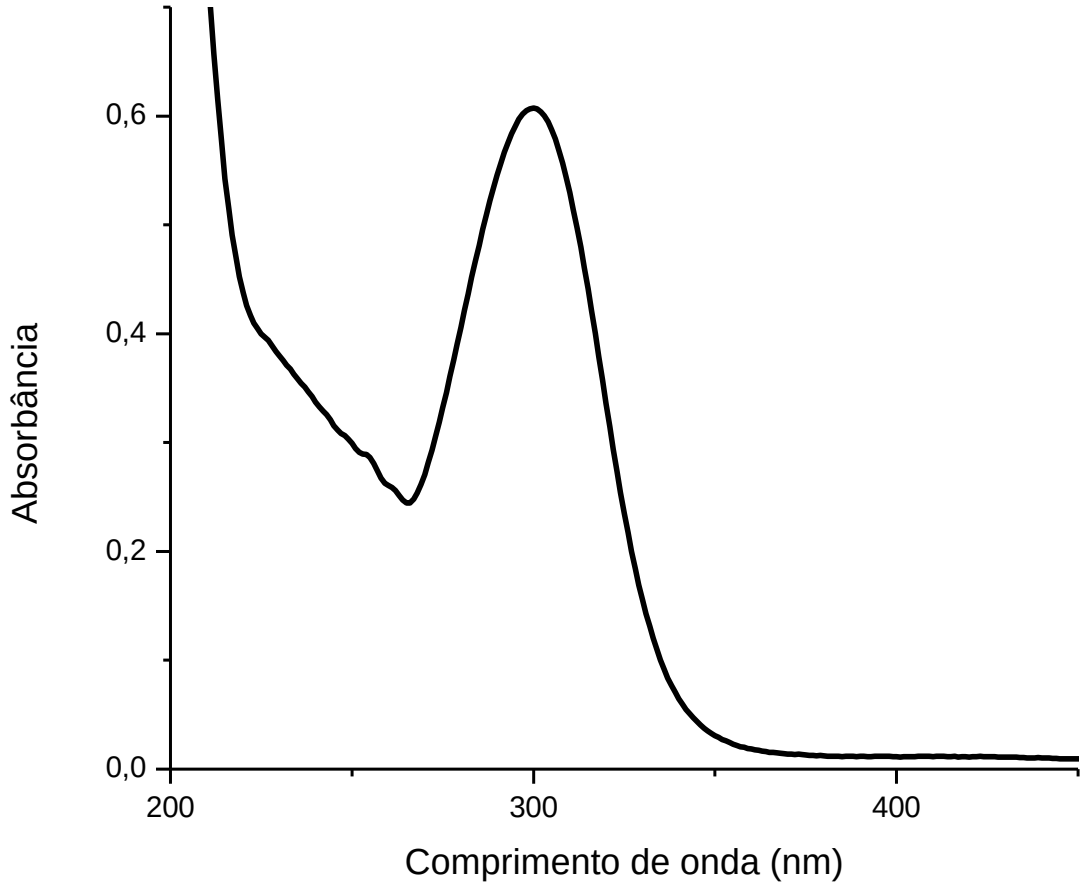


Figura 43. Espectro de UV de **Sb9** (propanol).

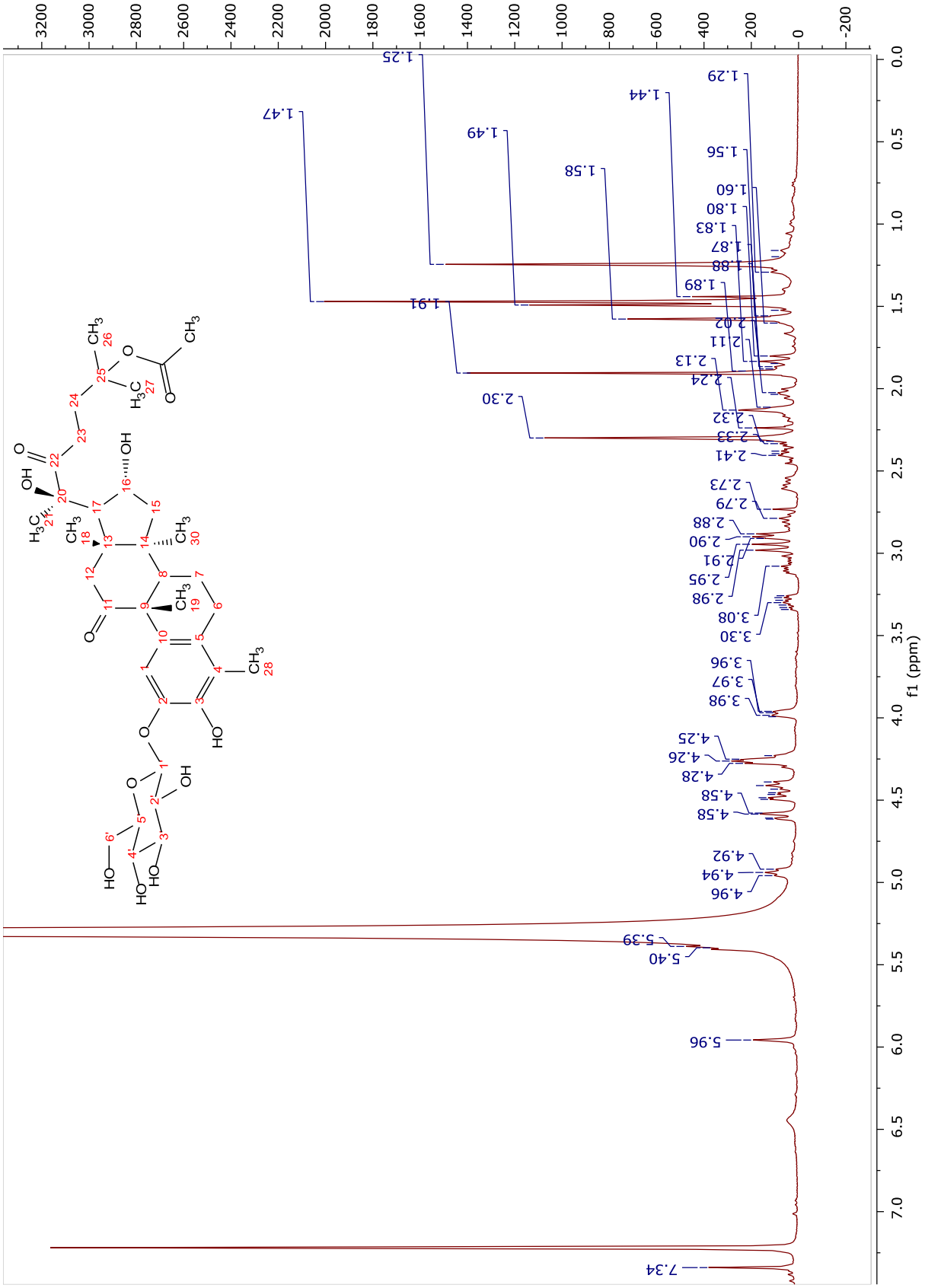


Figura 44. Espectro de RMN ^{1}H de **Sb10** (400 MHz, C_5D_5N).

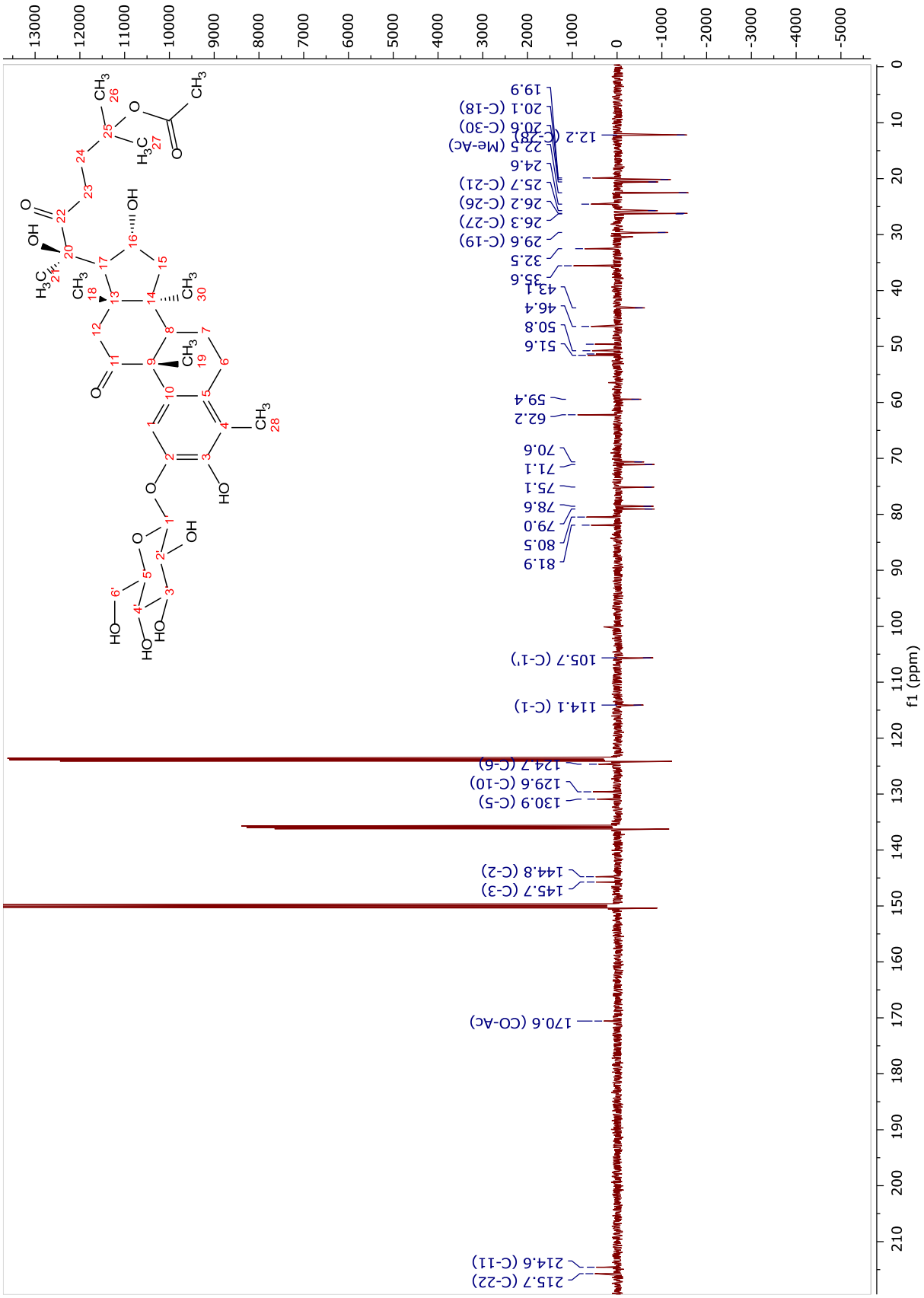


Figura 45. Espectro de DEPTQ de **Sb10** (100 MHz, C_5D_5N).

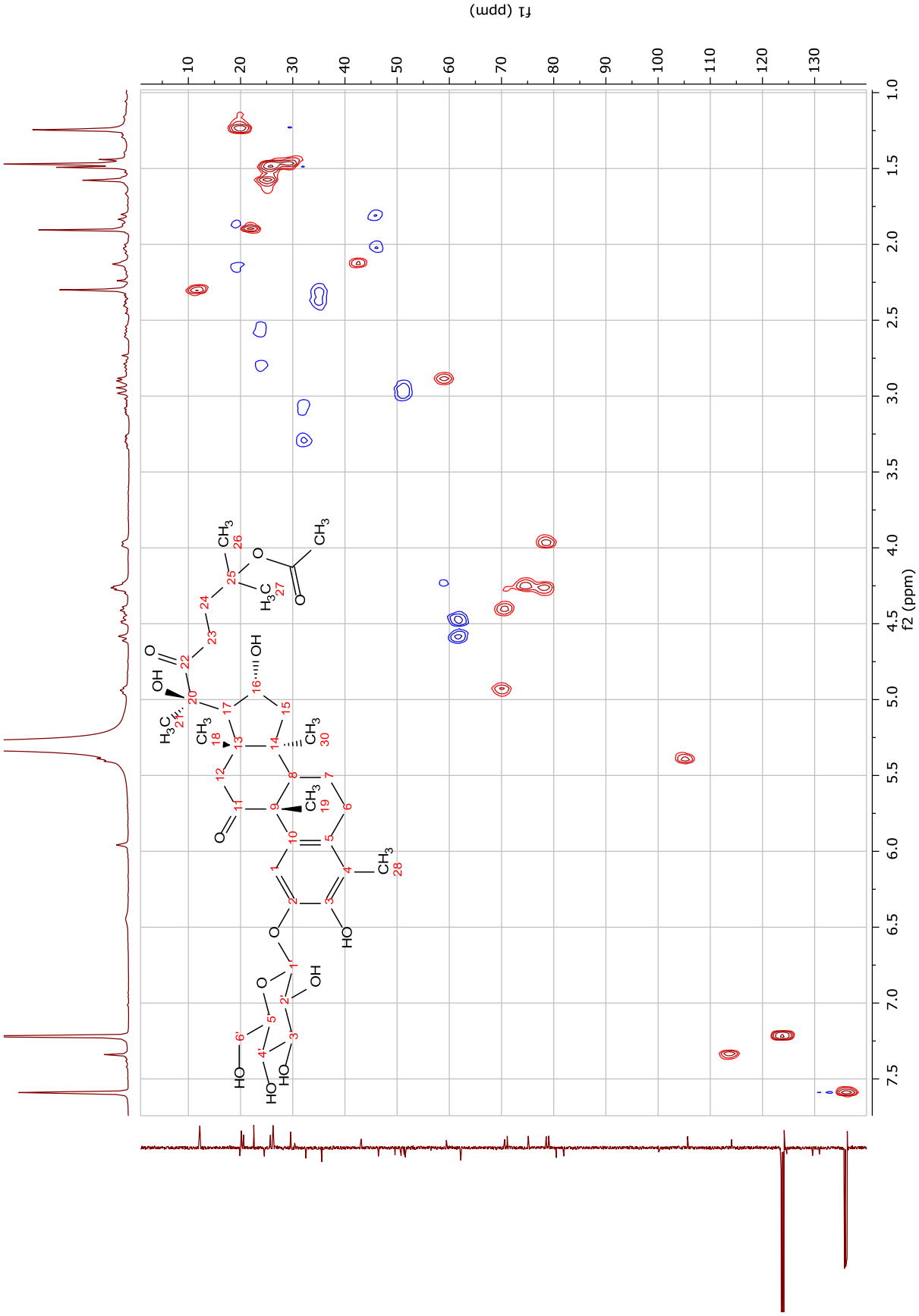


Figura 46. Espectro de HSQC de **Sb10** (400 MHz, C_5D_5N).

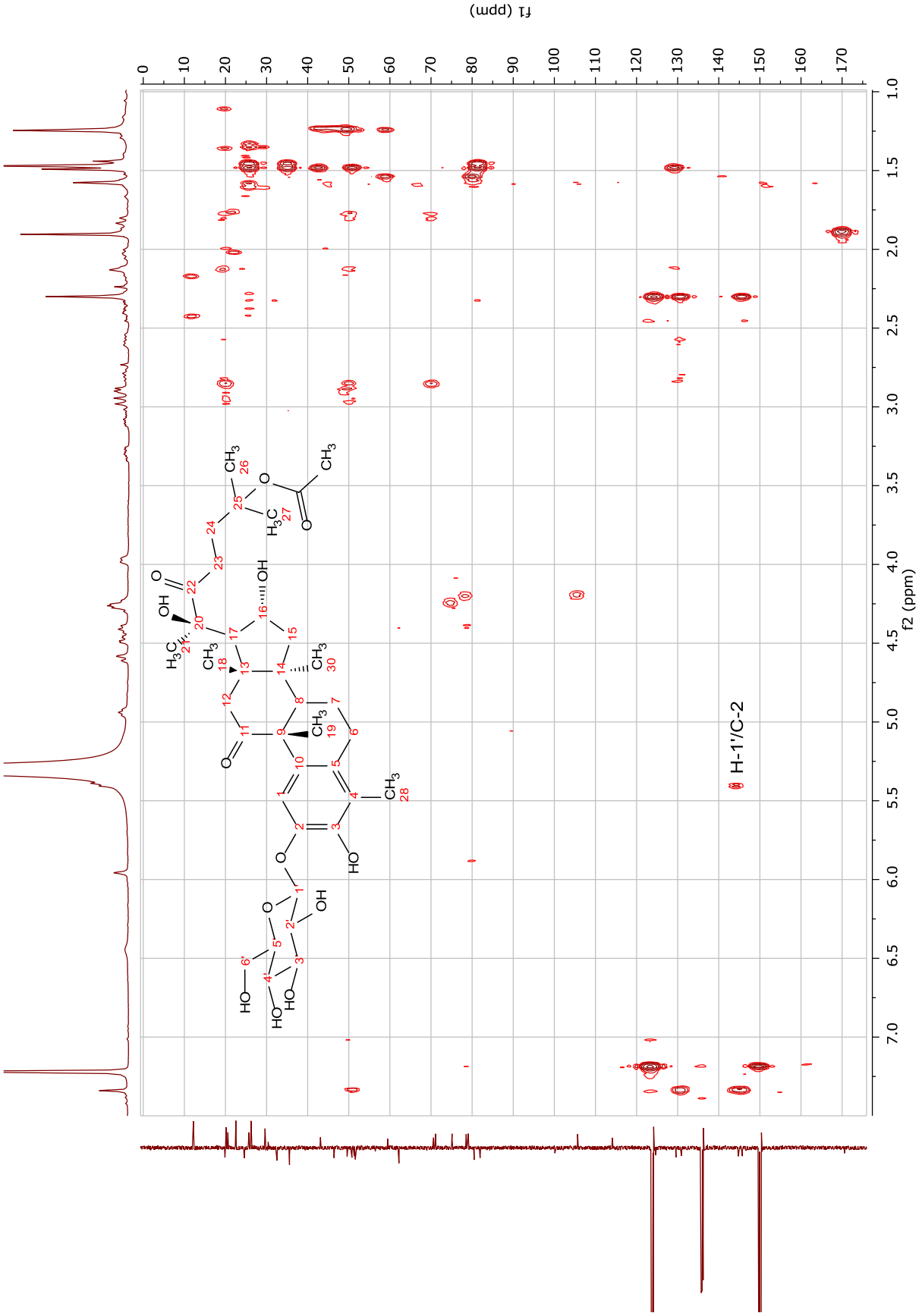


Figura 47. Espectro de HMBC de **Sb10** (400 MHz, C_5D_5N).

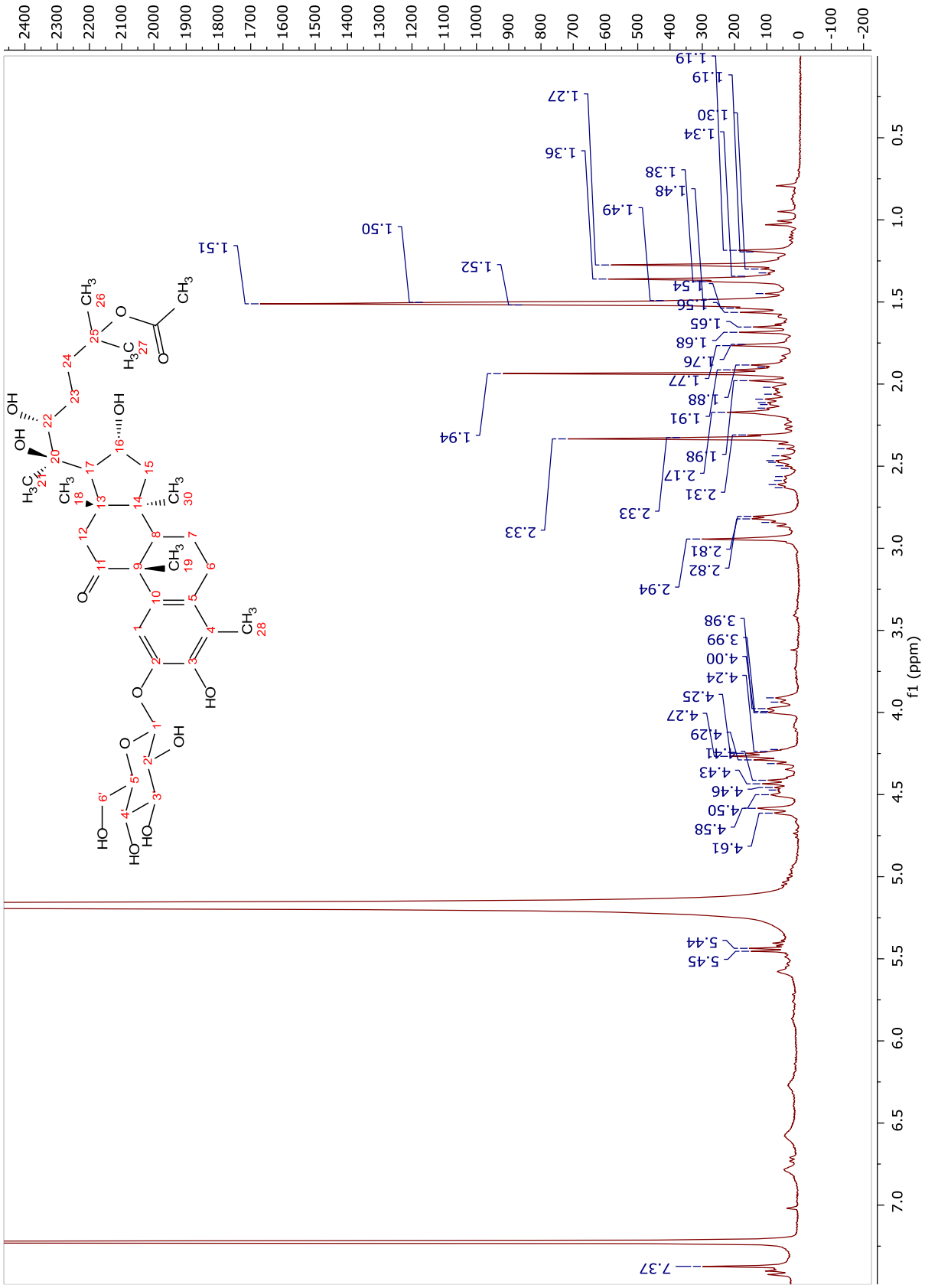


Figura 48. Espectro de RMN ^{1}H de **Sb11** (400 MHz, C_5D_5N).

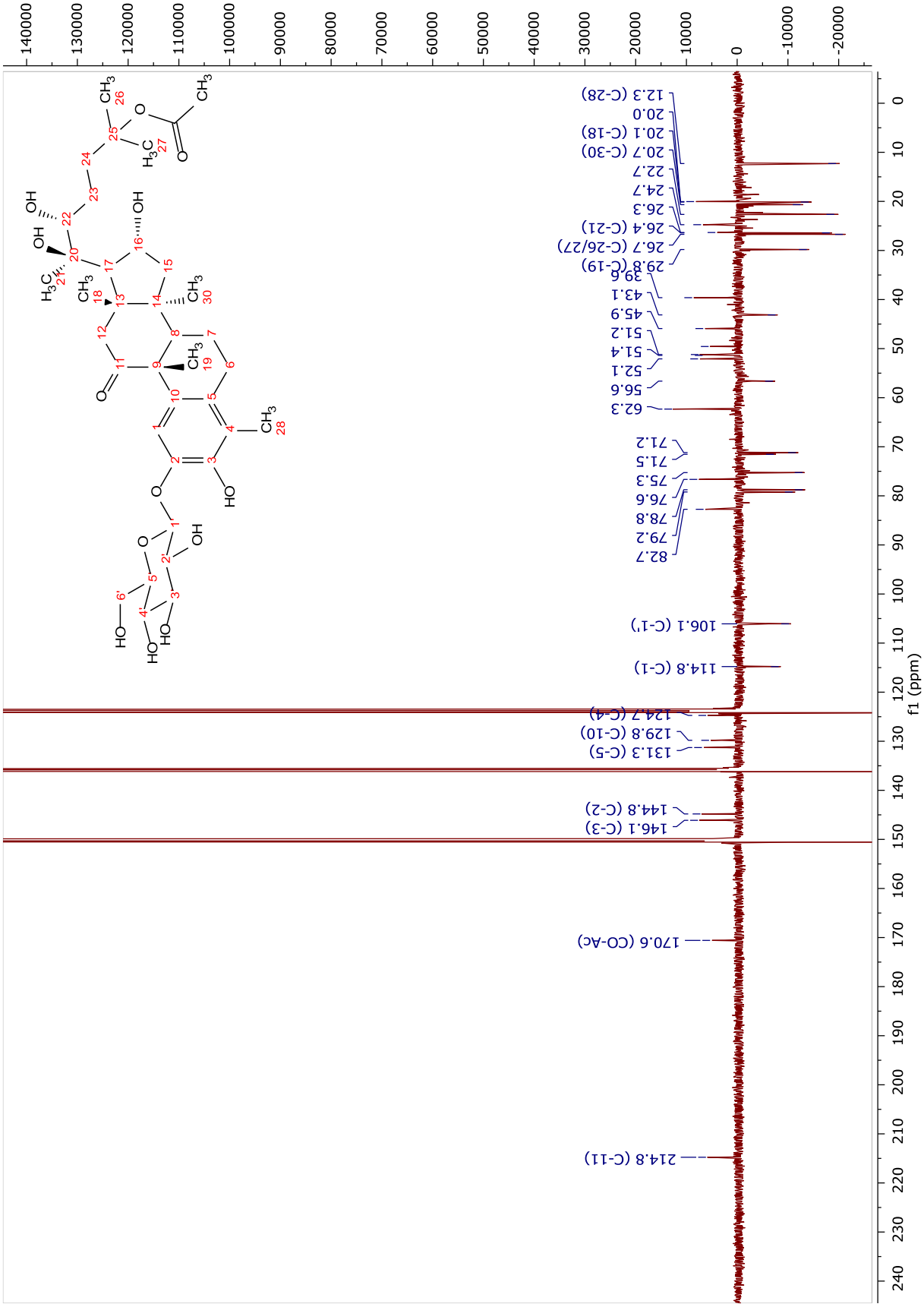


Figura 49. Espectro de DEPTQ de **Sb11** (100 MHz, C_5D_5N).

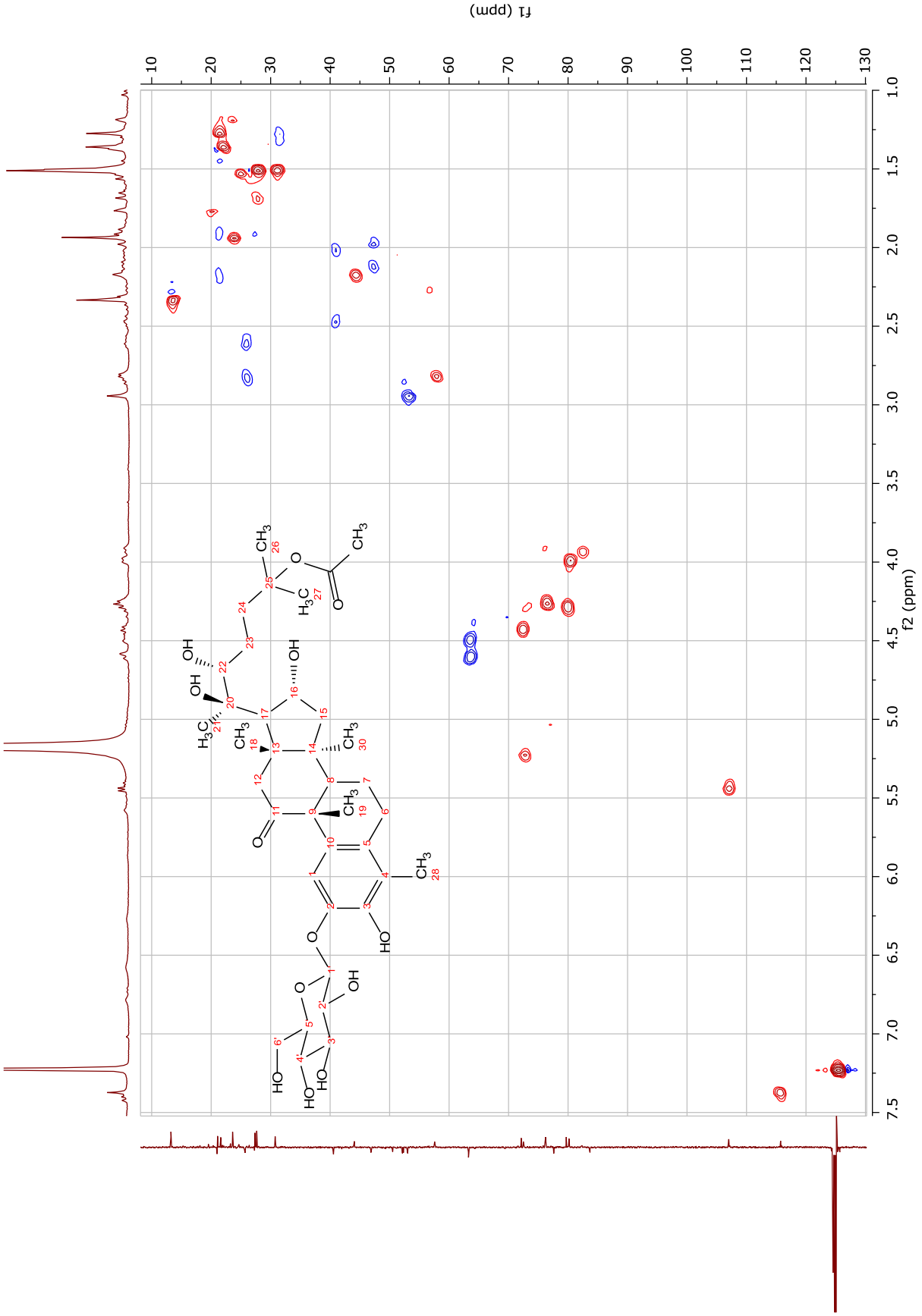


Figura 50. Espectro de HSQC de **Sb11** (400 MHz, C_5D_5N).

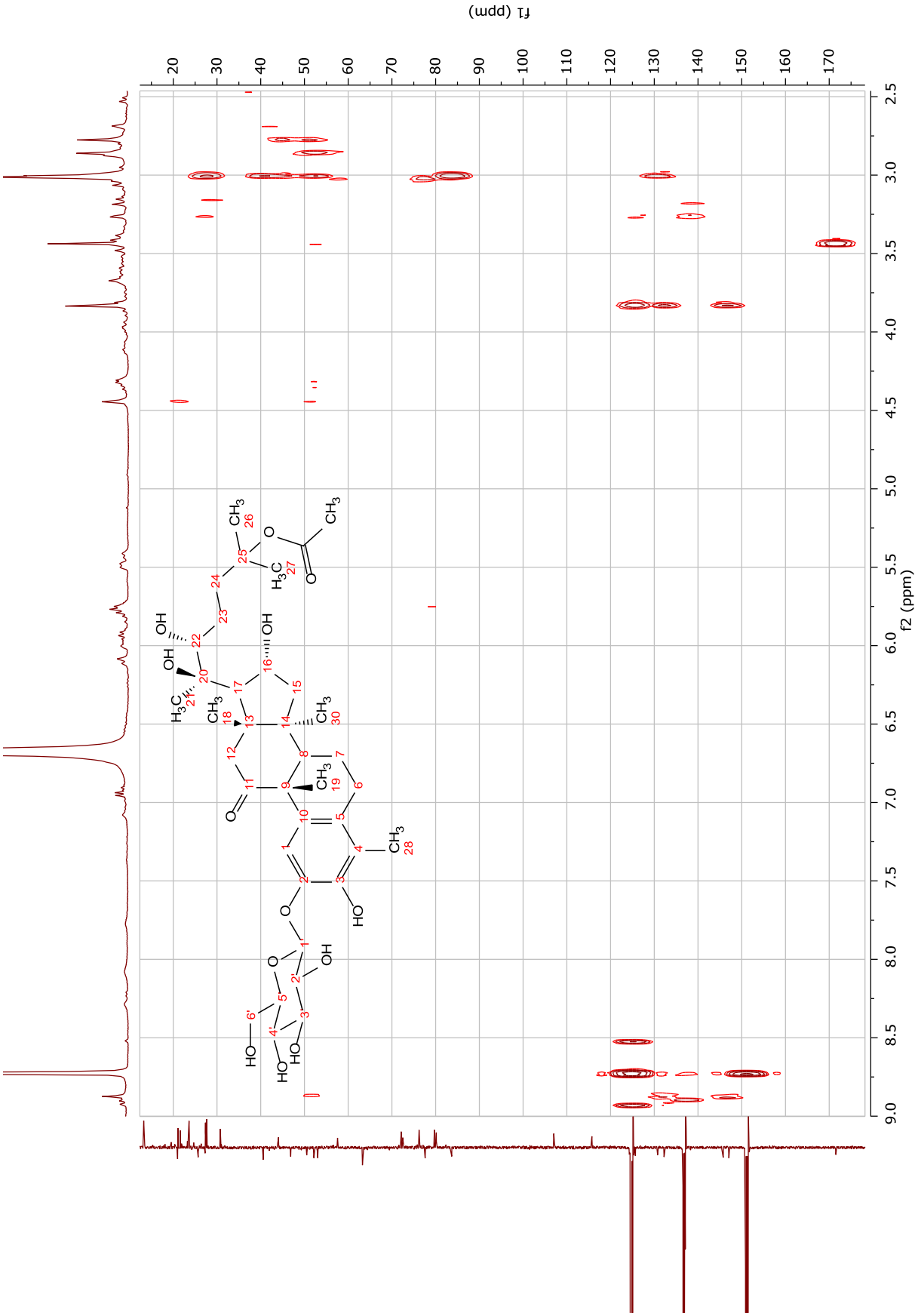


Figura 51. Espectro de HMBC de **Sb11** (400 MHz, C_5D_5N).

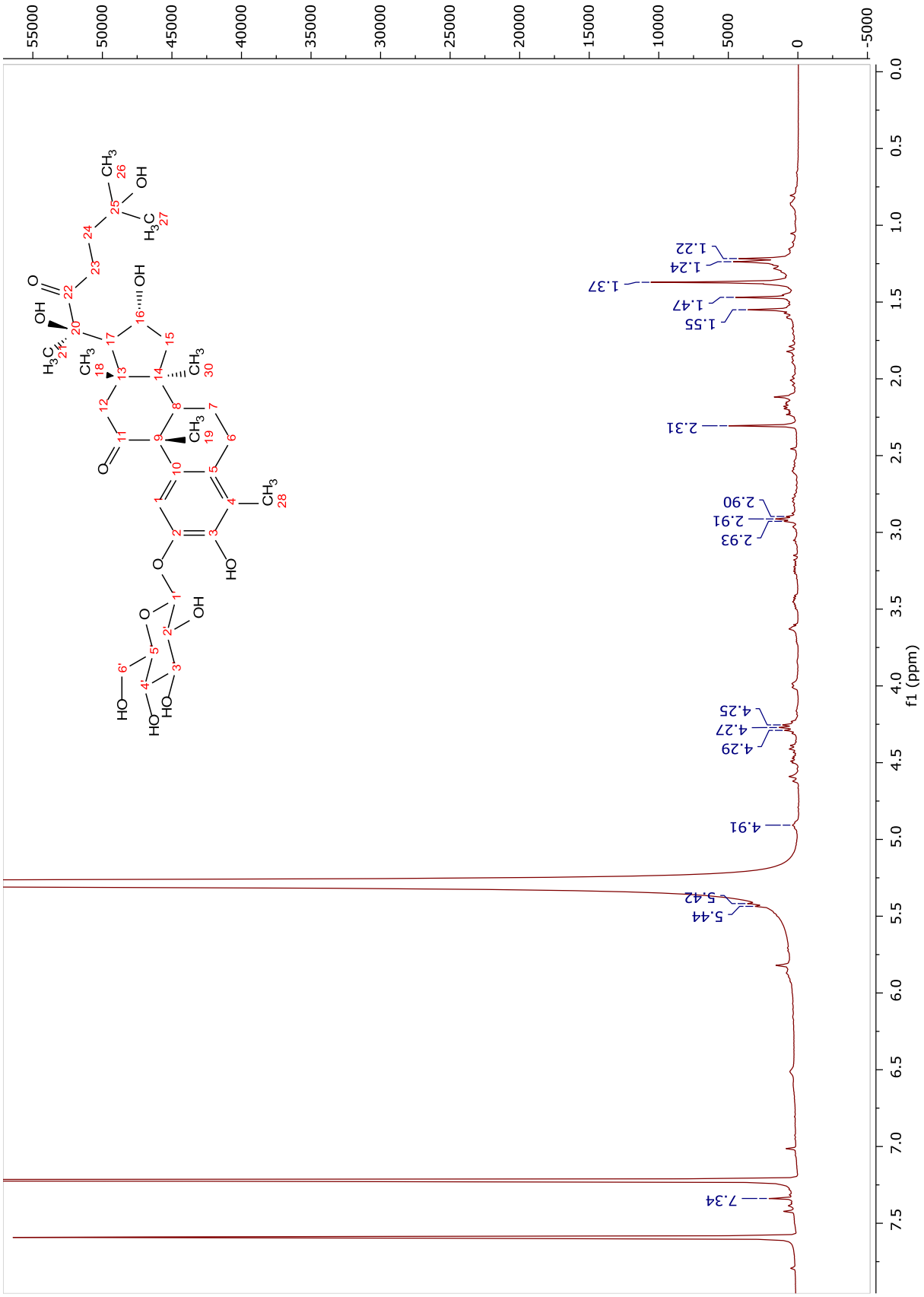


Figura 52. Espectro de RMN ^{1}H de **Sb12** (400 MHz, C_5D_5N).

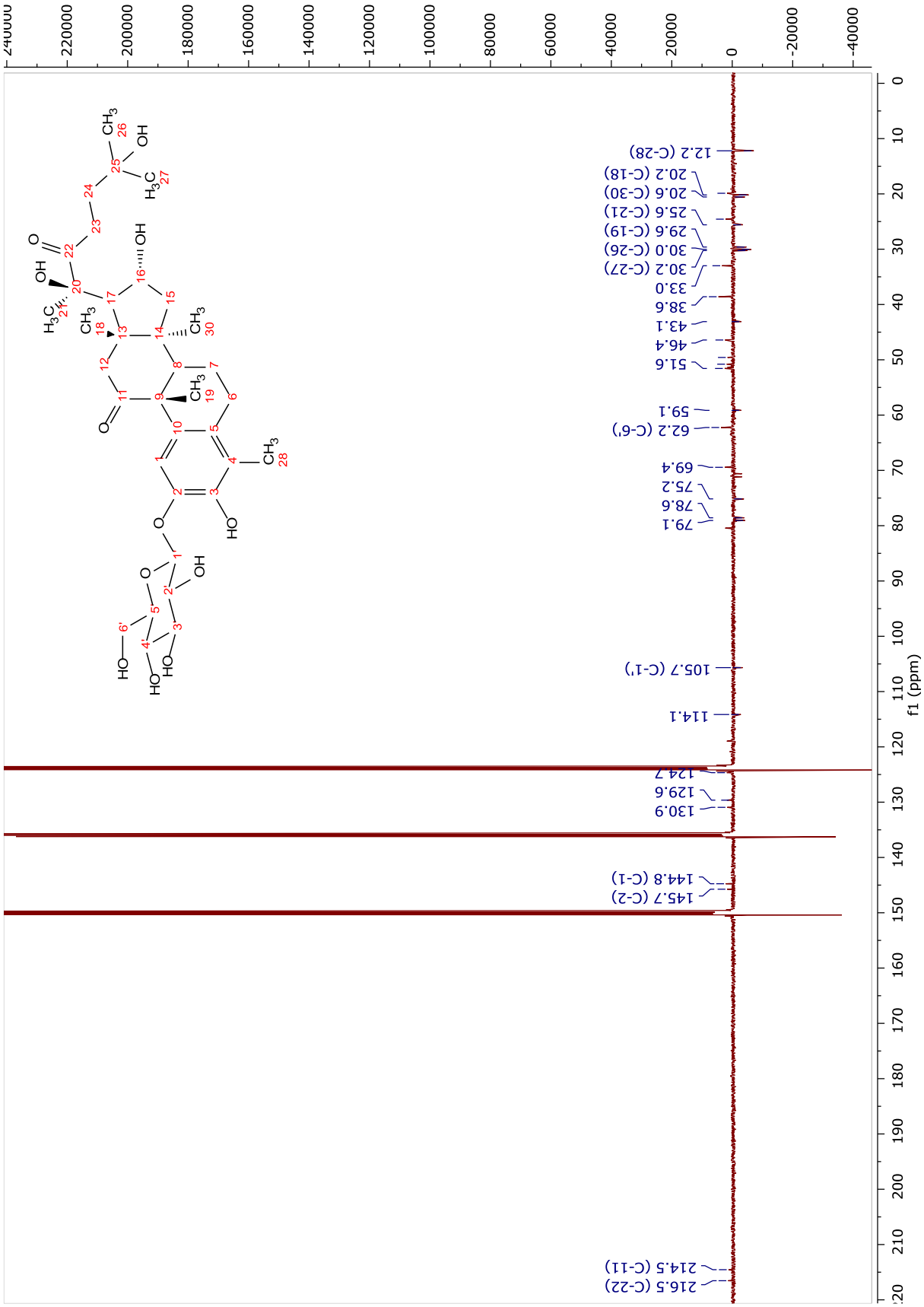


Figura 53. Espectro de DEPTQ de **Sb12** (100 MHz, C_5D_5N).

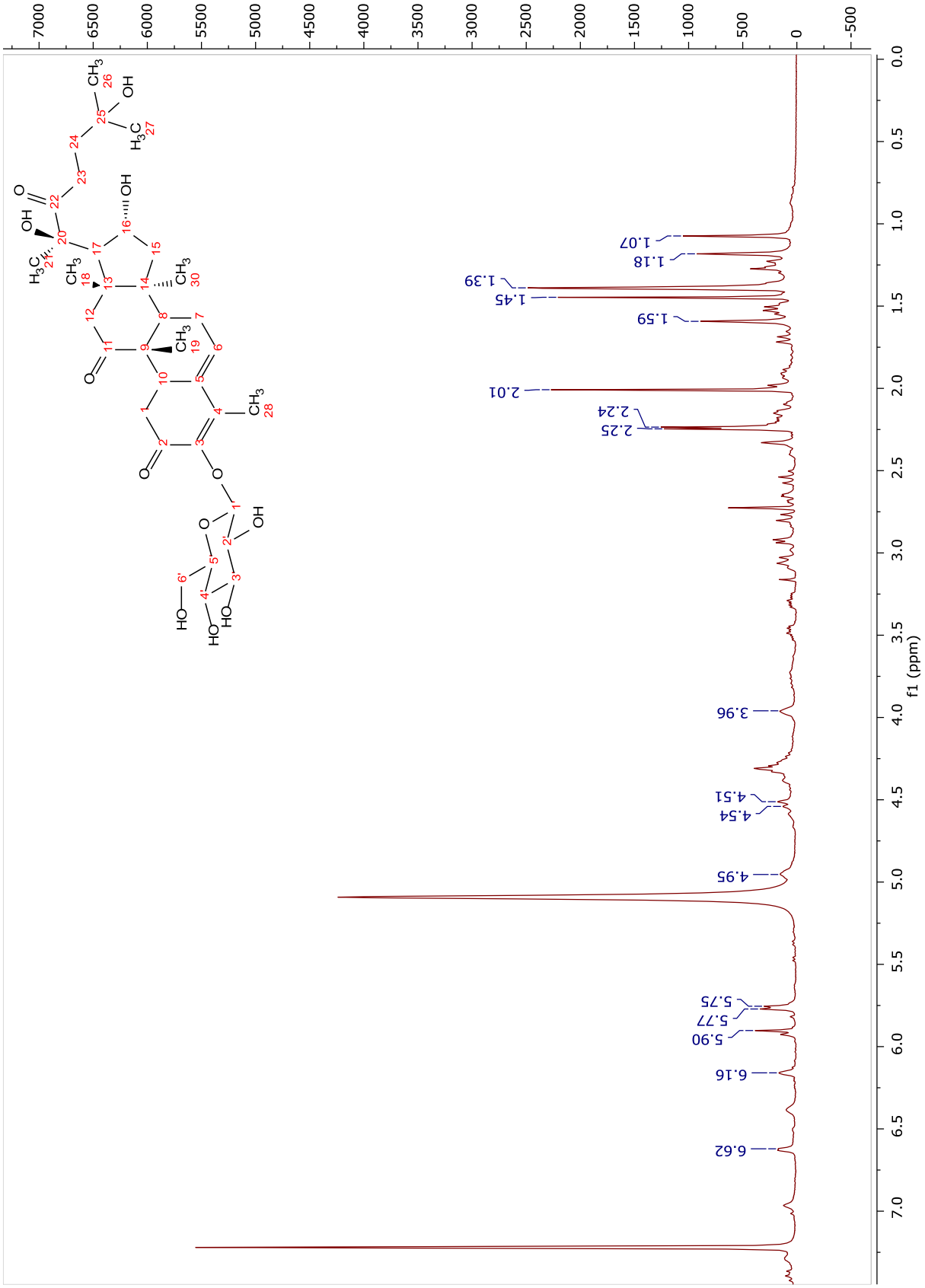


Figura 54. Espectro de RMN ^{1}H de **Sb13** (400 MHz, C_5D_5N).

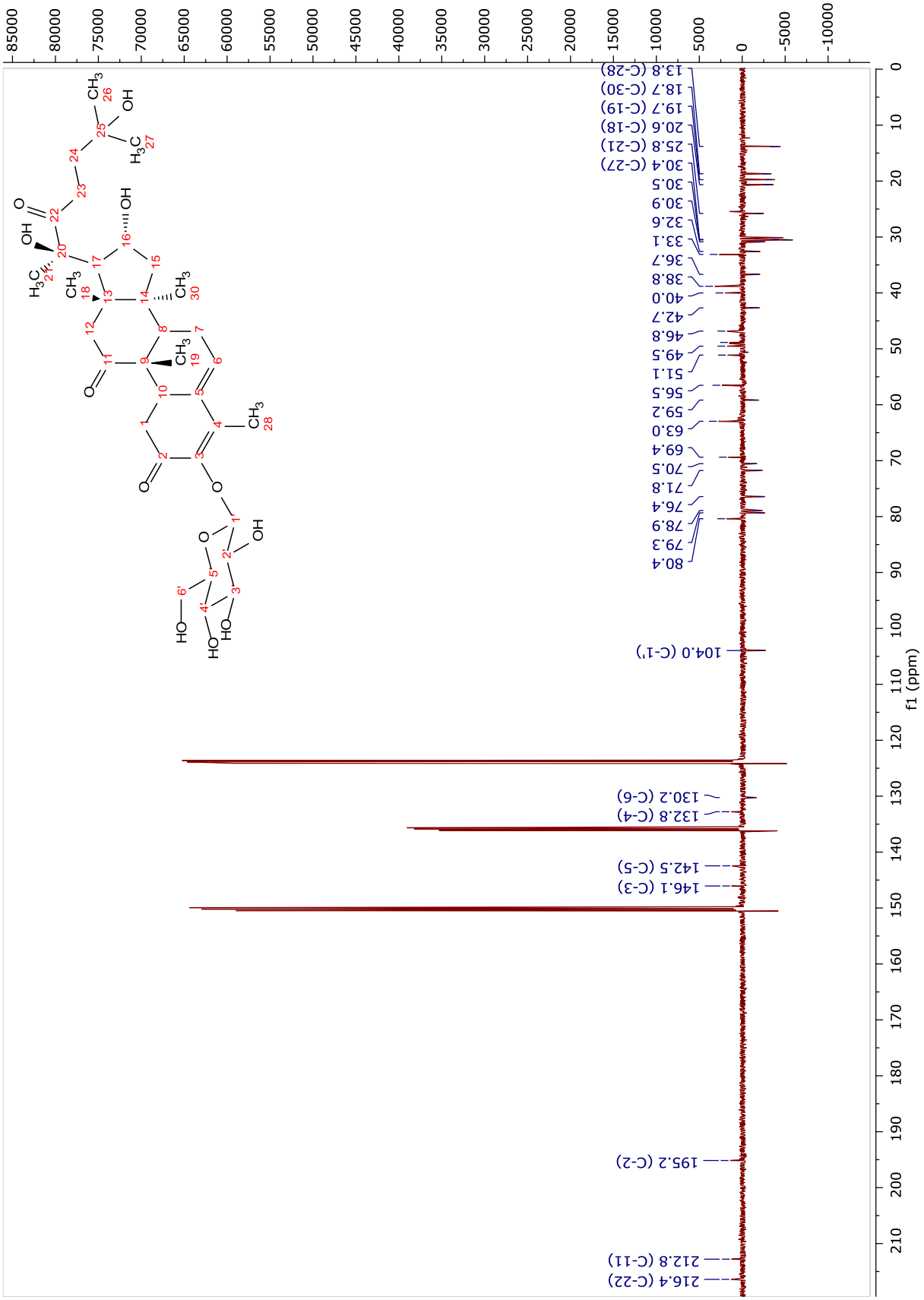


Figura 55. Espectro de DEPTQ de **Sb13** (100 MHz, C_5D_5N).

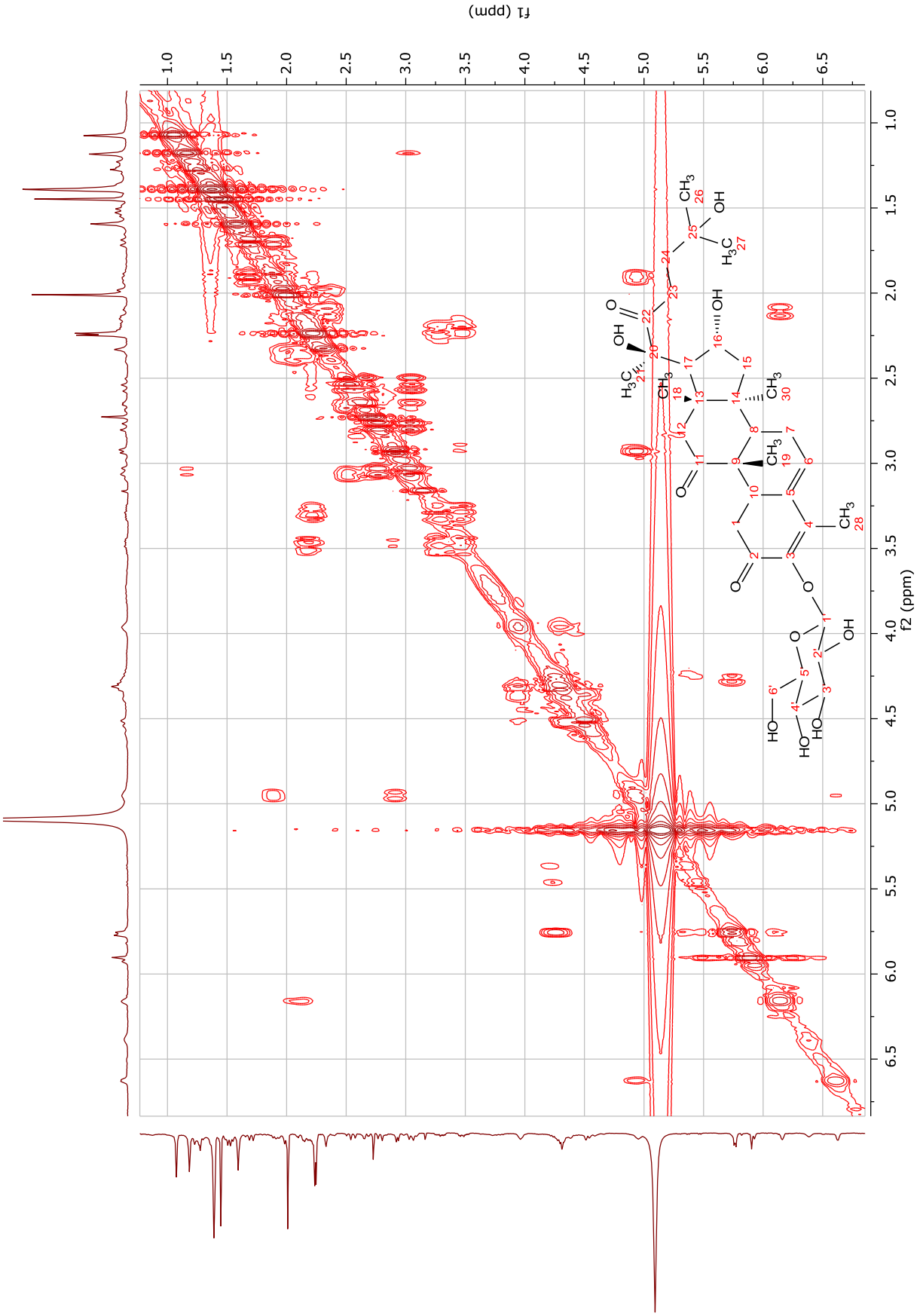


Figura 56. Espectro de COSY de **Sb13** (400 MHz, C_5D_5N).

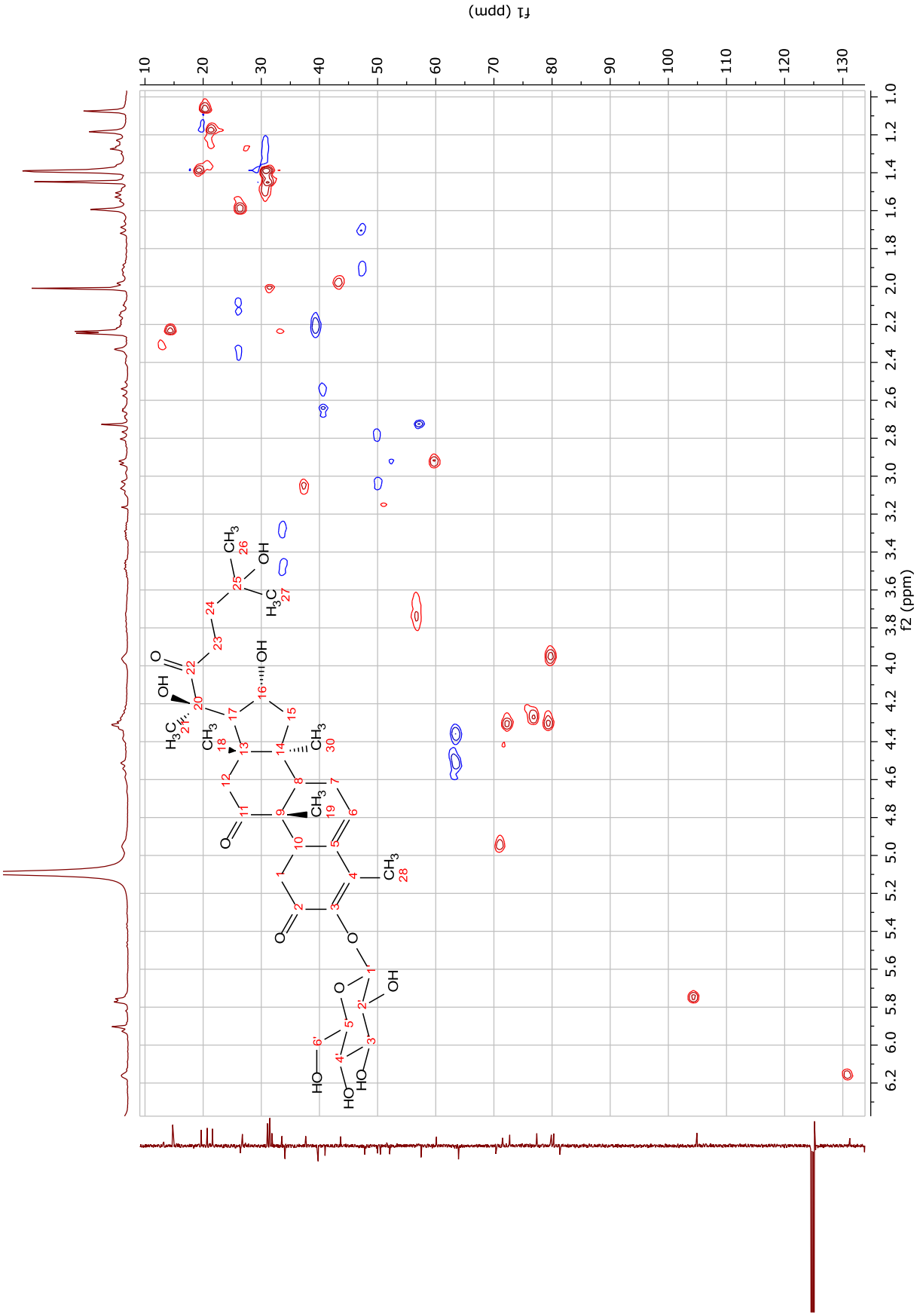


Figura 57. Espectro de HSQC de **Sb13** (400 MHz, C_5D_5N).

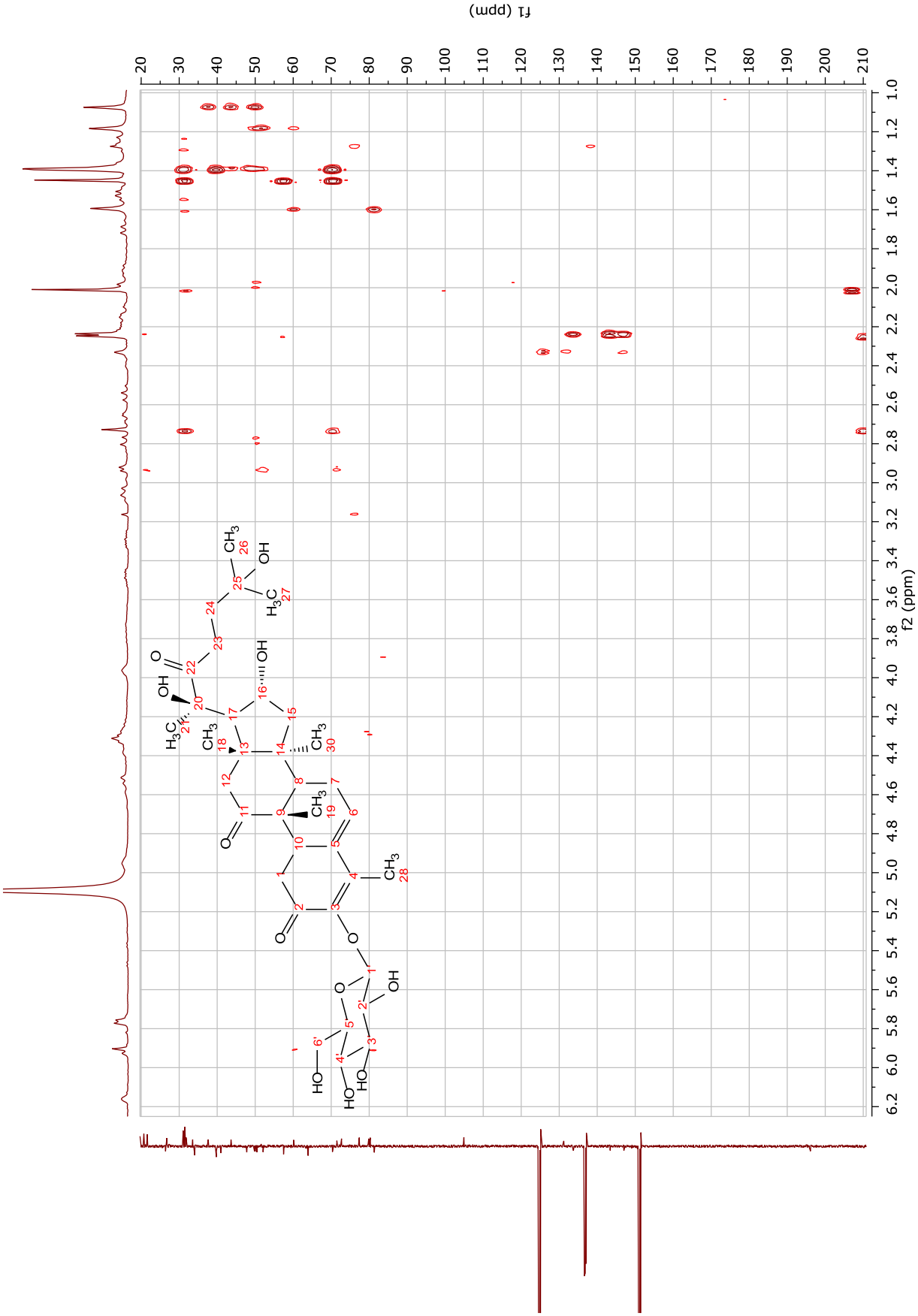


Figura 58. Espectro de HMBC de **Sb13** (400 MHz, C_5D_5N).

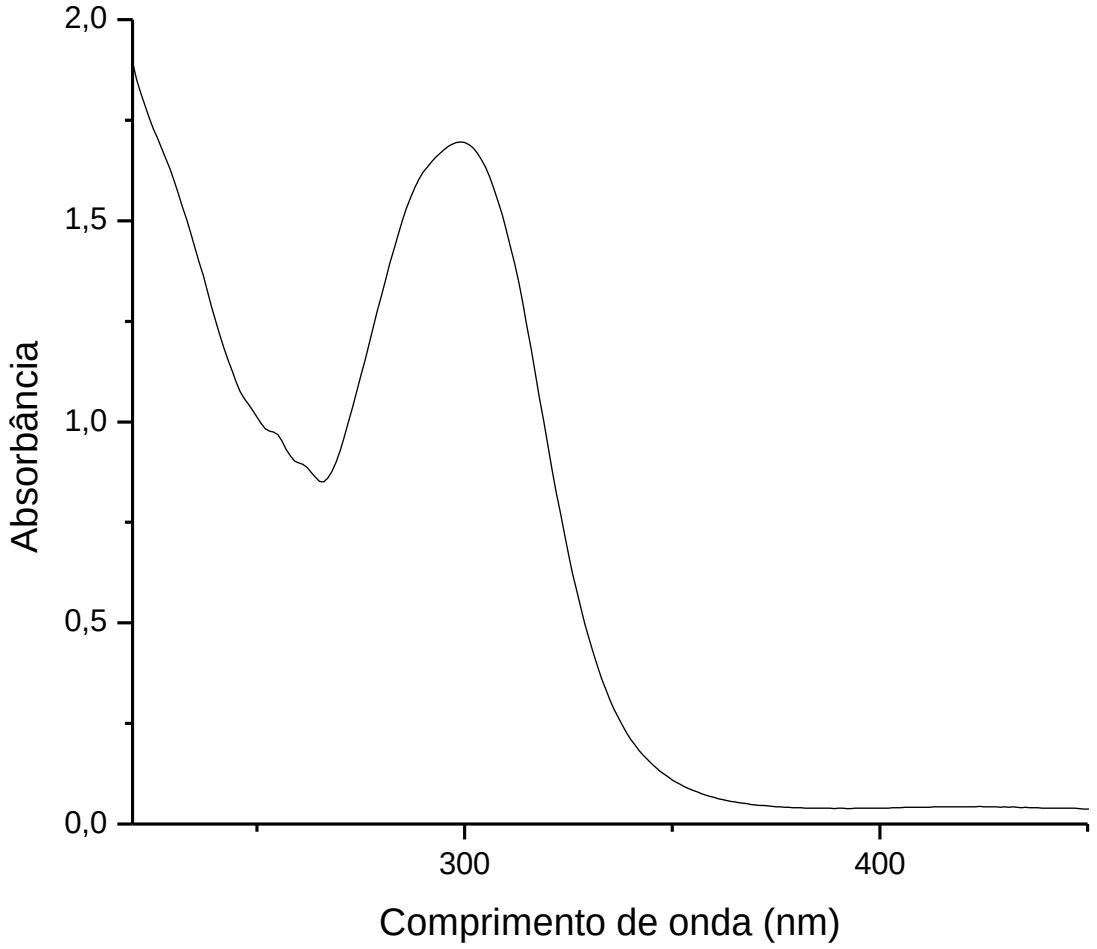


Figura 59. Espectro de UV de **Sb13** (propanol).

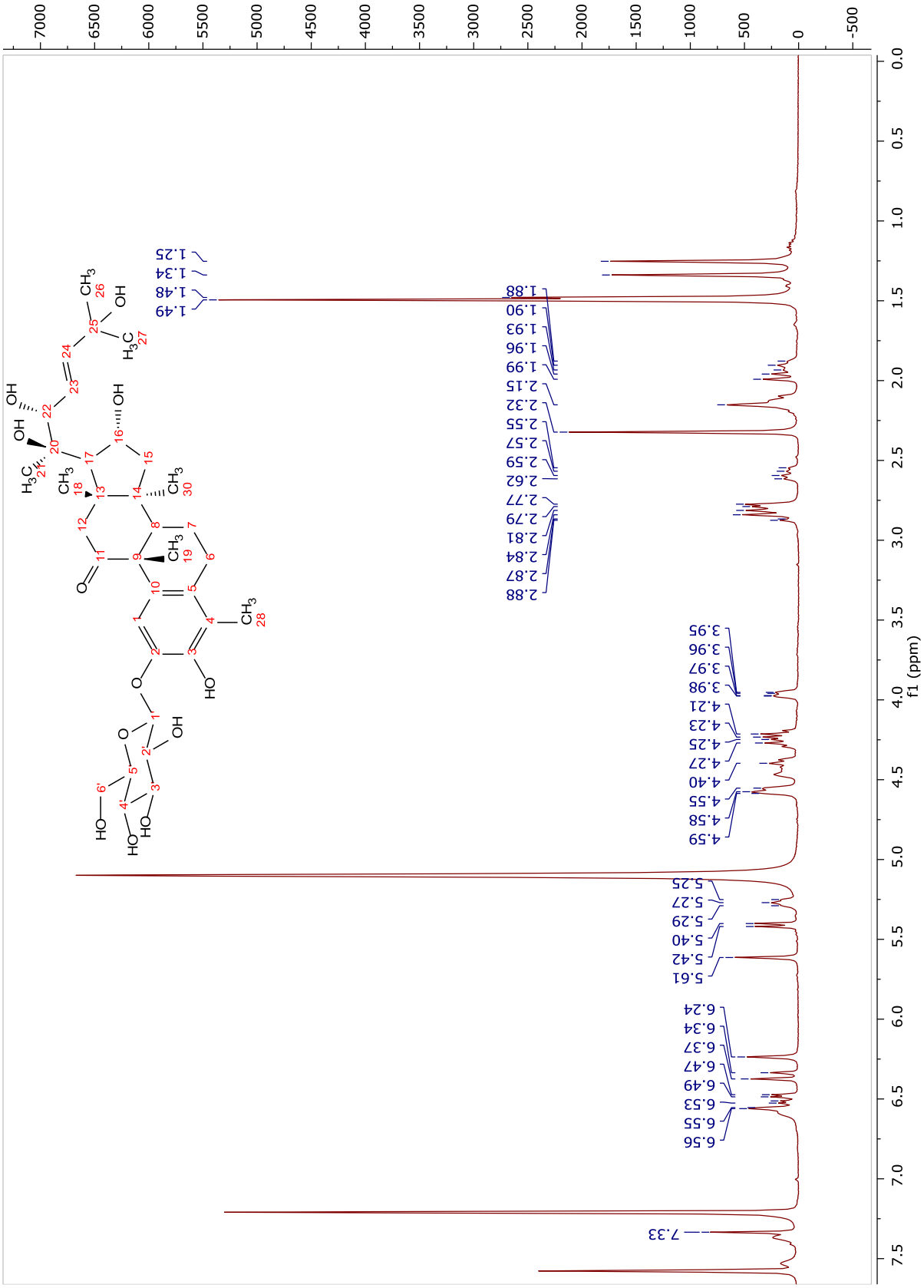


Figura 60. Espectro de RMN ^{1}H de **Sb14** (400 MHz, C_5D_5N).

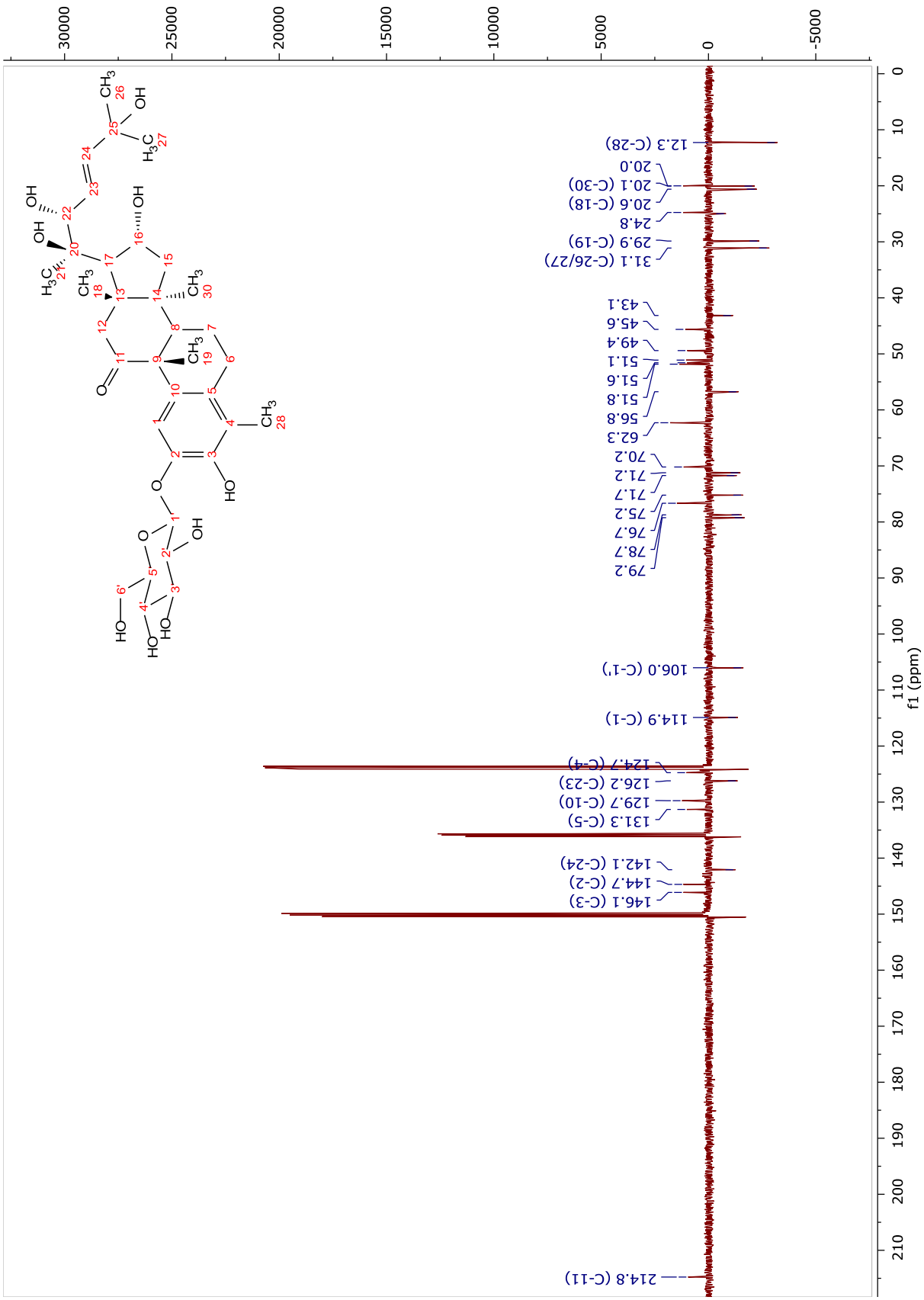


Figura 61. Espectro de DEPTQ de **Sb14** (100 MHz, C_5D_5N).

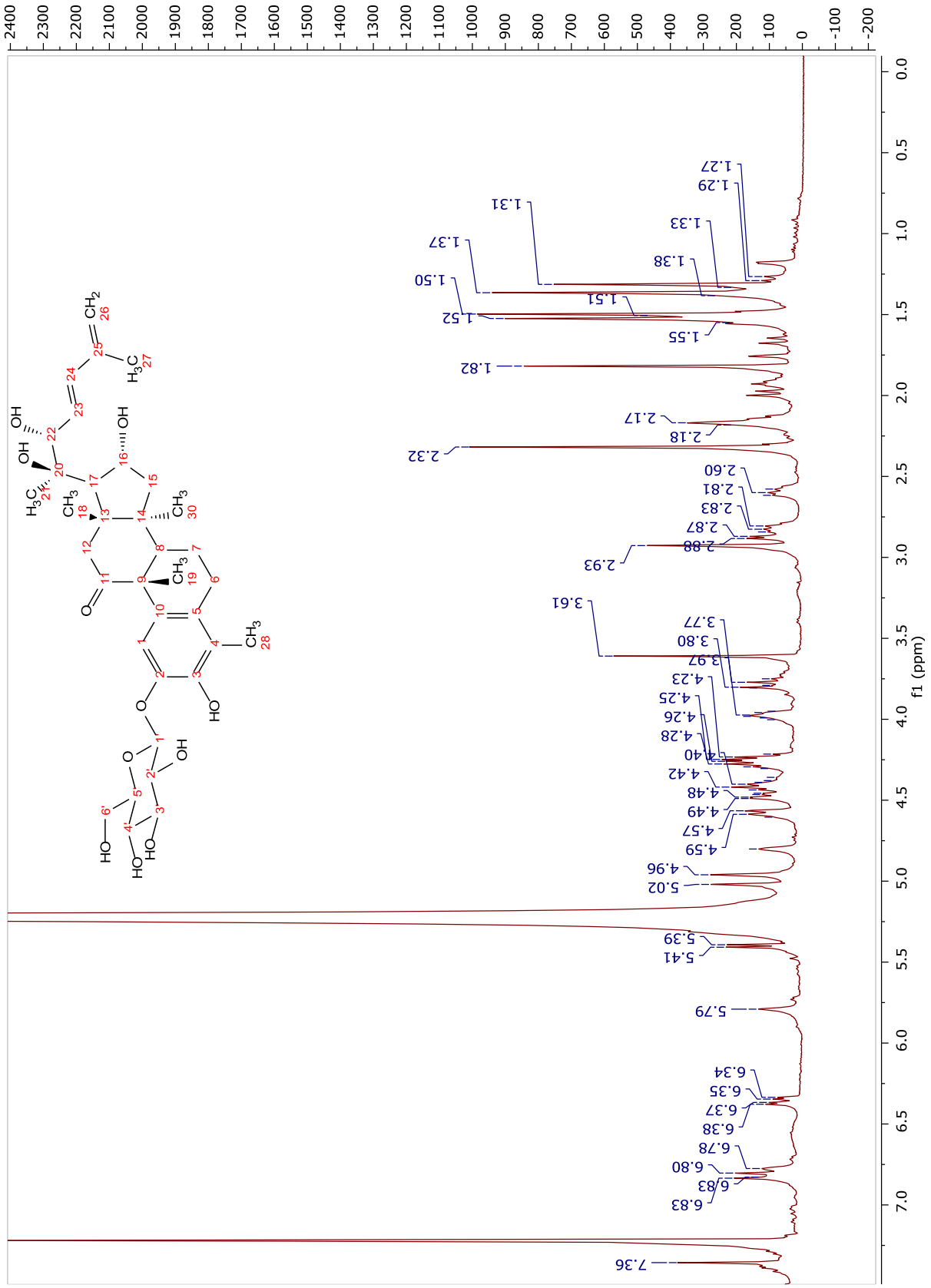


Figura 62. Espectro de RMN ^{1}H de **Sb15** (500 MHz, C_5D_5N).

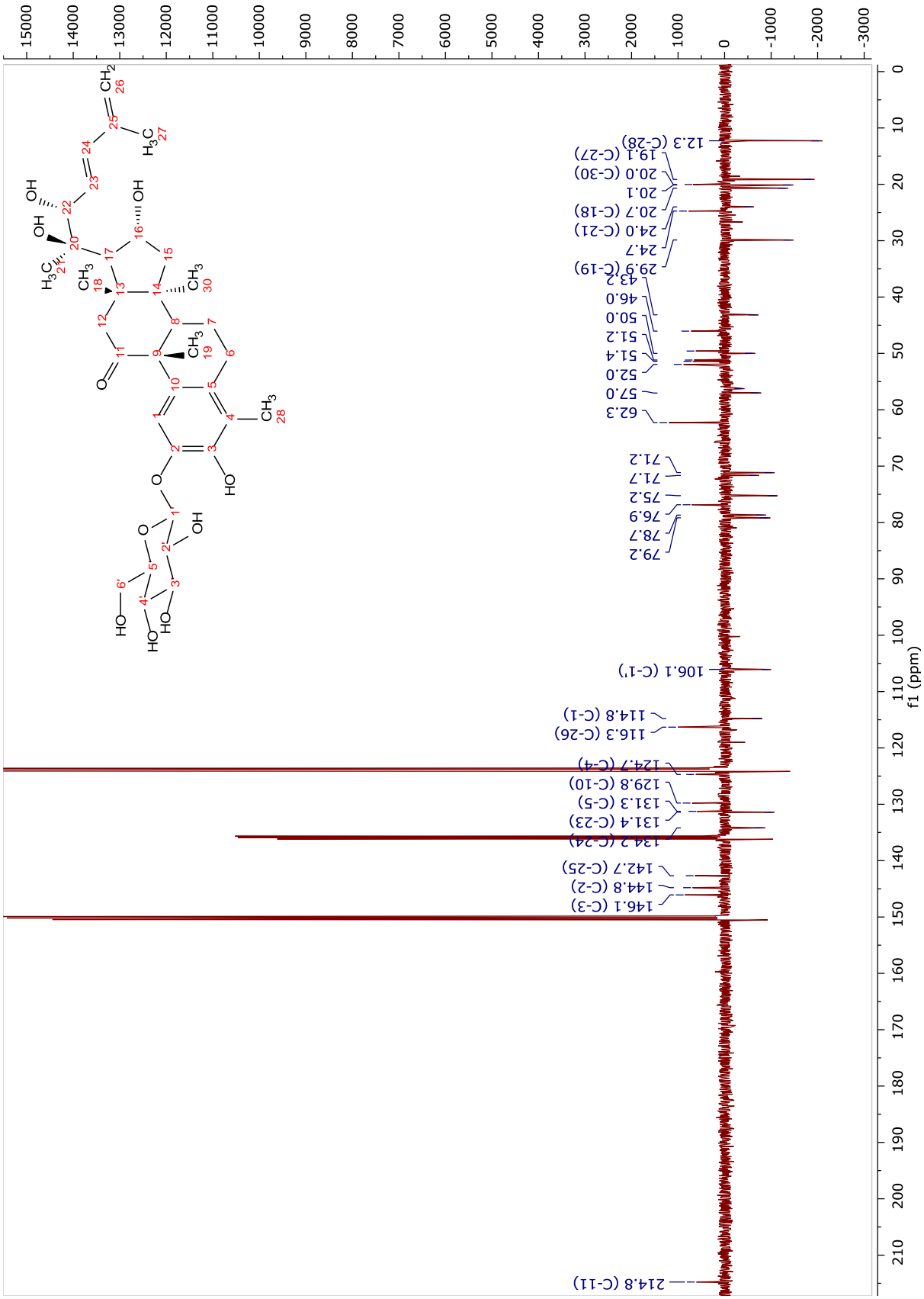


Figura 63. Espectro de DEPTQ de **Sb15** (125 MHz, C_5D_5N).

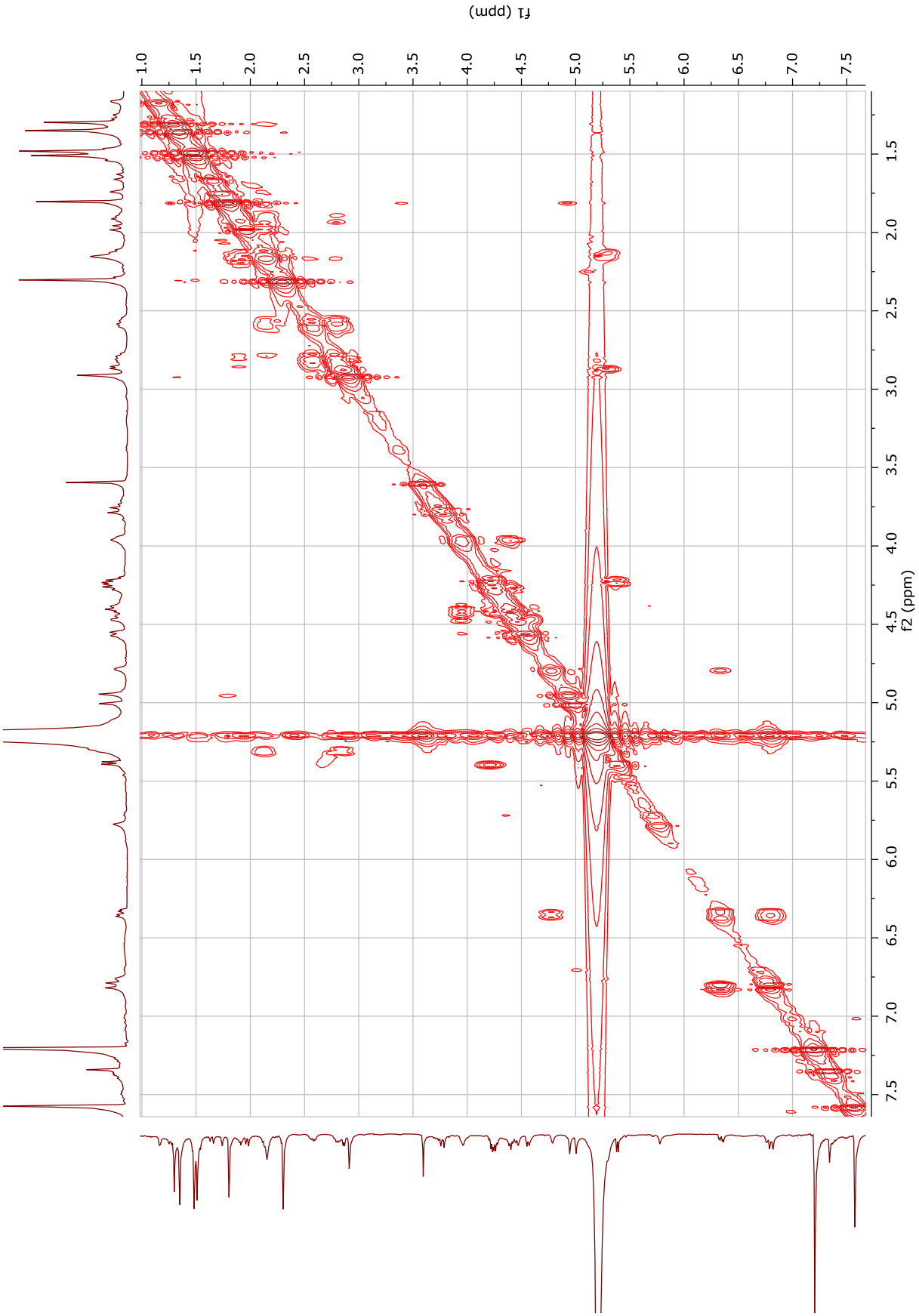


Figura 64. Espectro de COSY de **Sb15** (500 MHz, C_5D_5N).

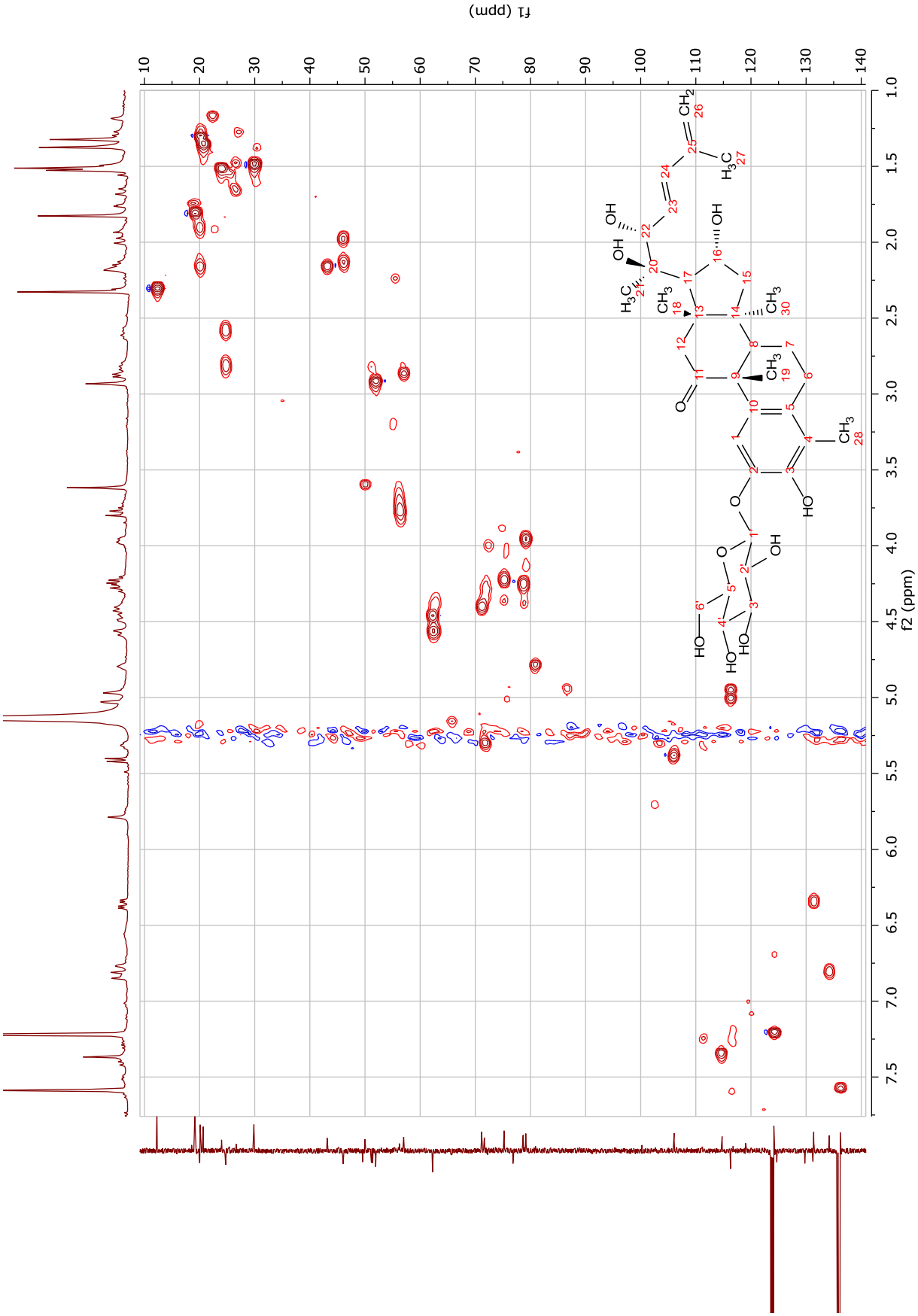


Figura 65. Espectro de HSQC de **Sb15** (500 MHz, C_5D_5N).

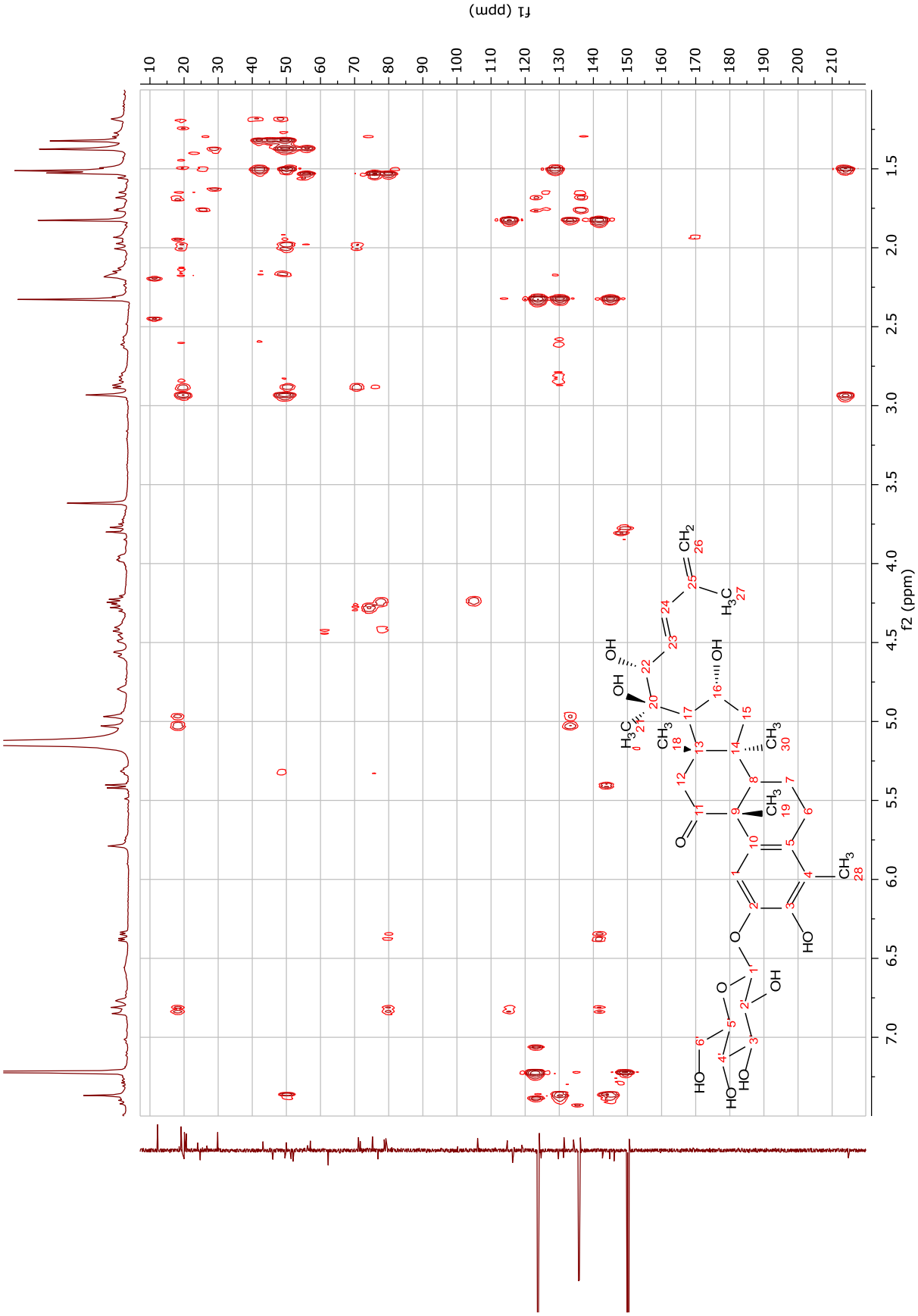


Figura 66. Espectro de HMBC de **Sb15** (500 MHz, C_5D_5N).

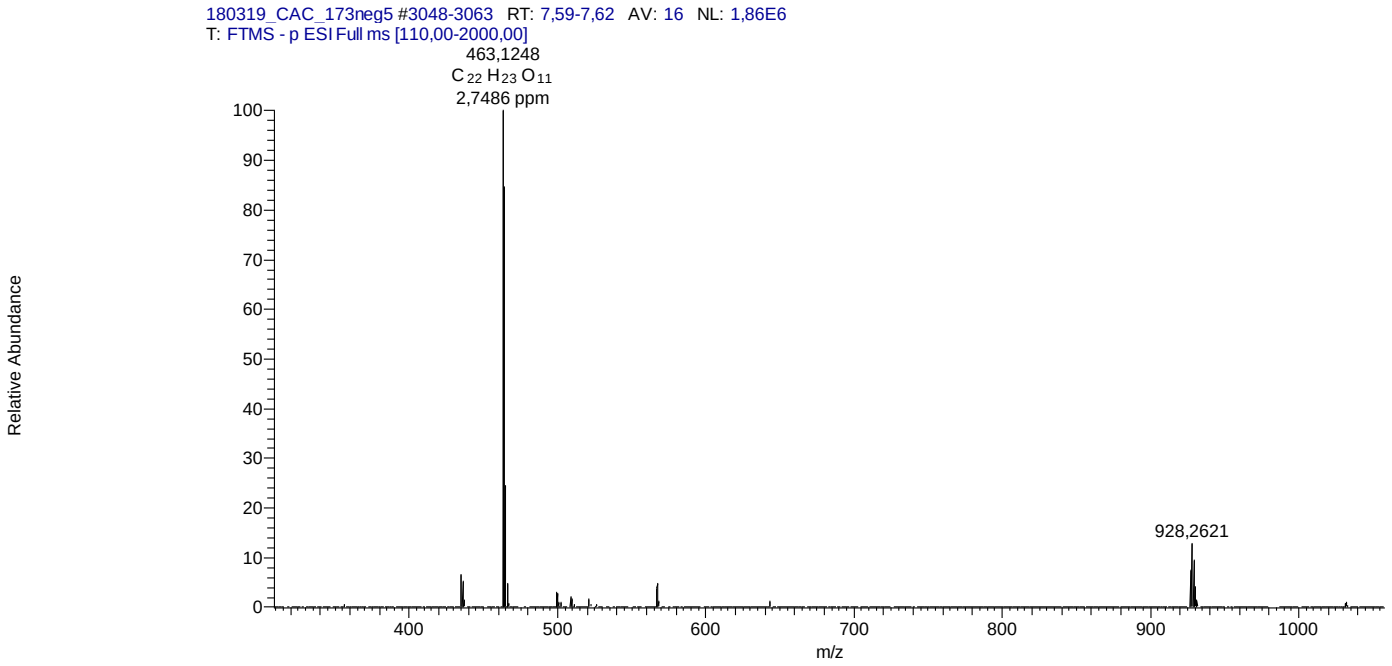


Figura 67. Espectro de massas de alta resolução de **Sb16** (ESI, modo negativo).

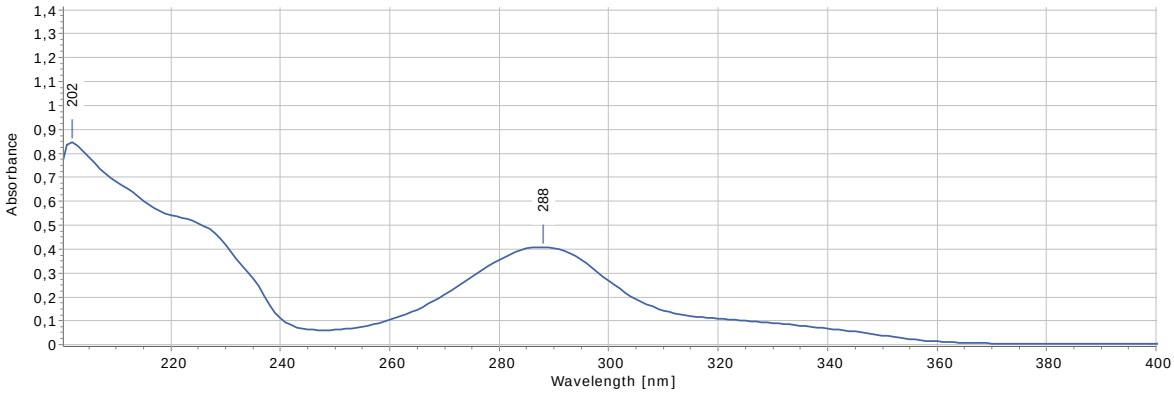


Figura 68. Espectro de ultravioleta de **Sb16** (metanol).

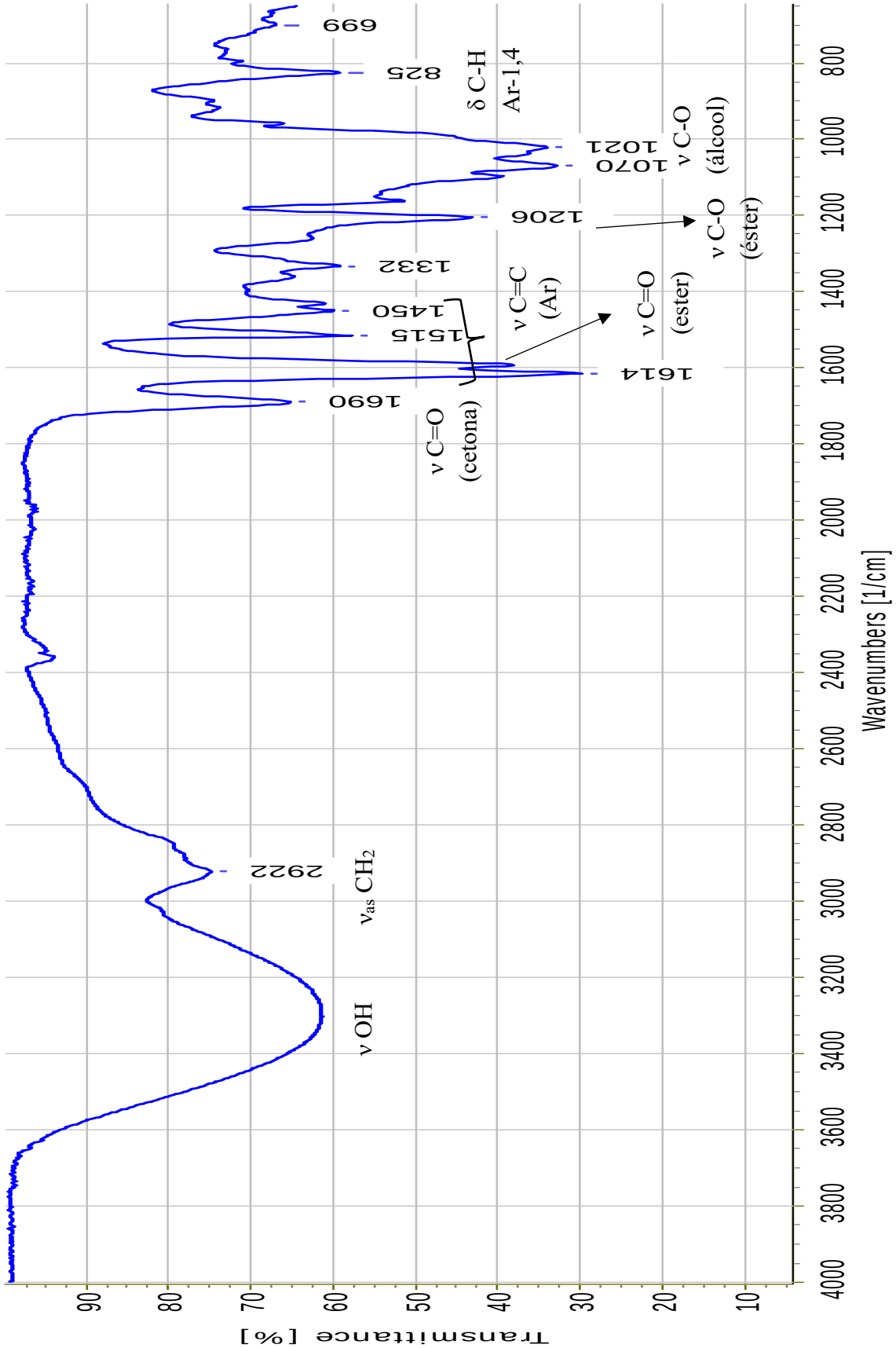


Figura 69. Espectro de Infravermelho de **Sb16** (FTIR-ATR).

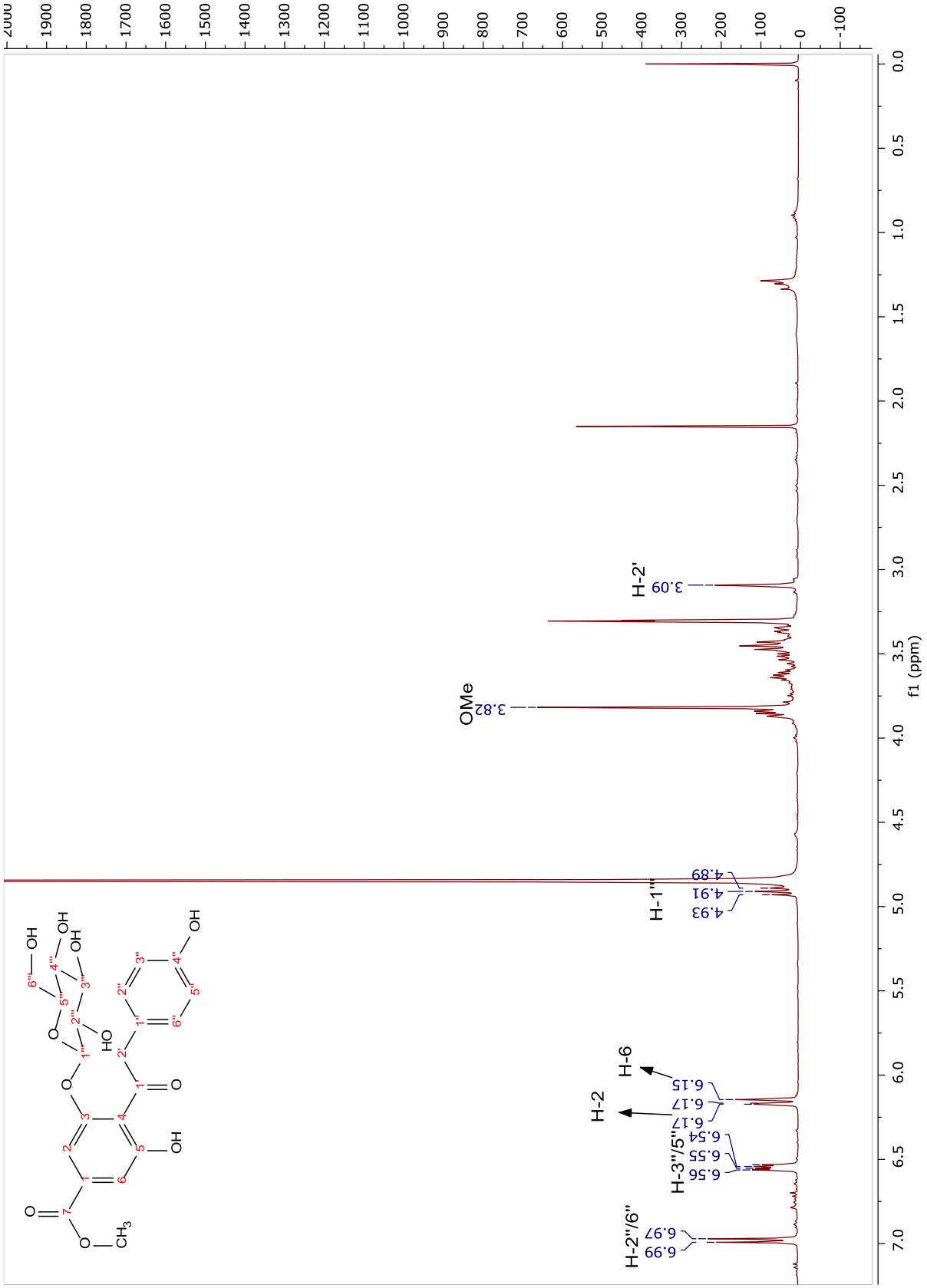


Figura 70. Espectro de RMN ^{1}H de **Sb16** (400 MHz, CD_3OD).

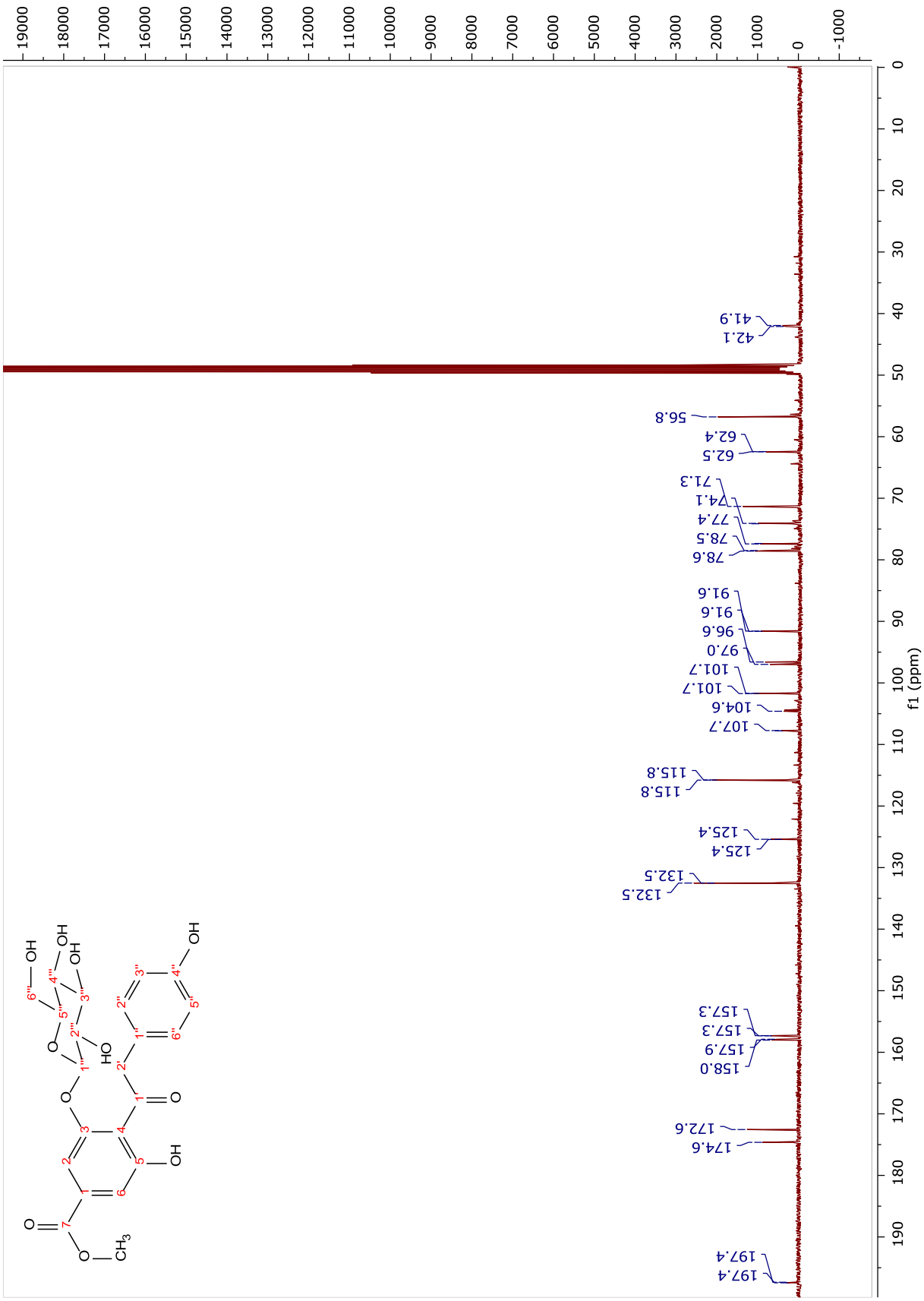


Figura 71. Espectro de RMN ^{13}C de **Sb16** (100 MHz, CD_3OD).

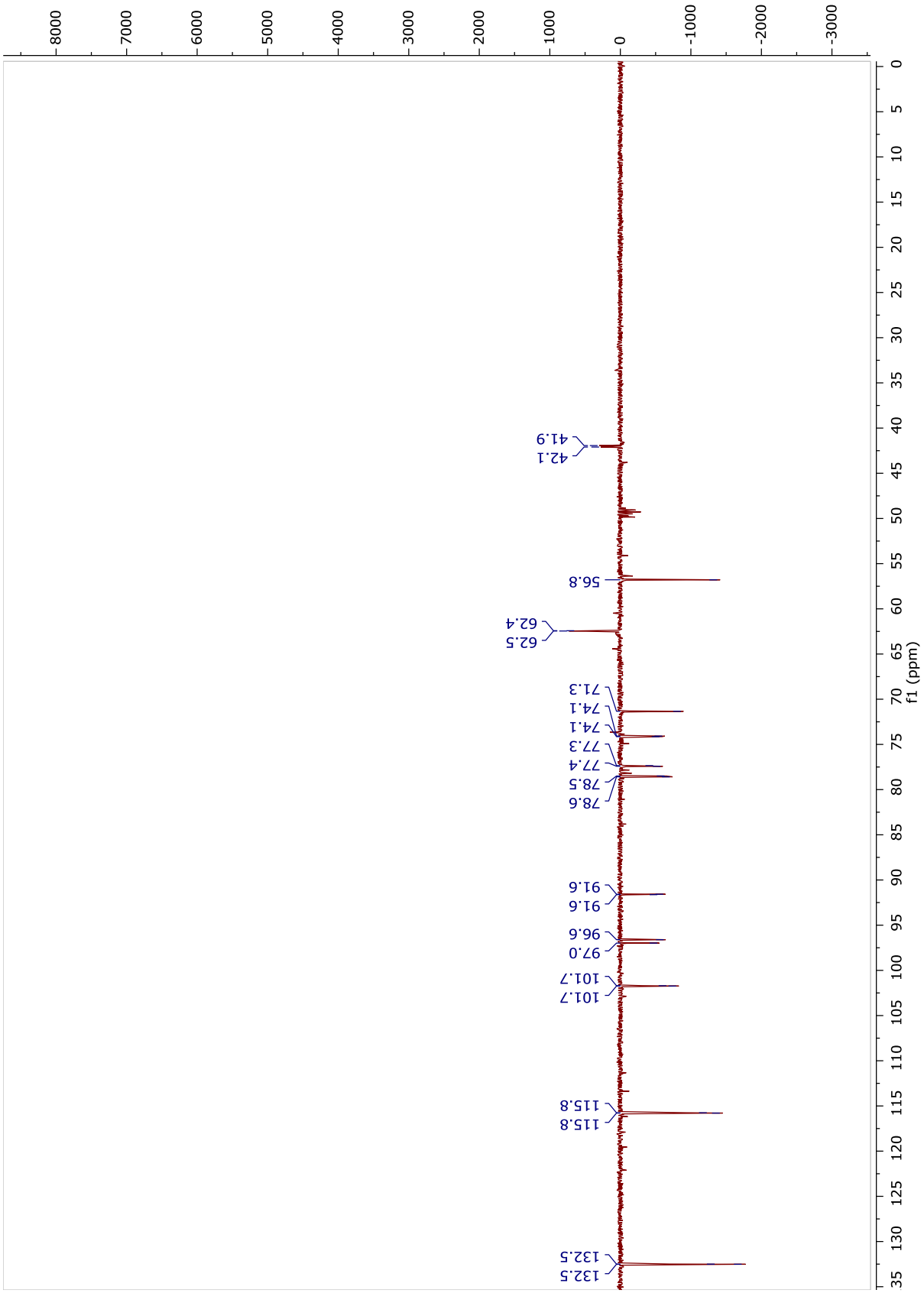


Figura 72. Espectro de DEPT-135 de **Sb16** (100 MHz, CD_3OD).

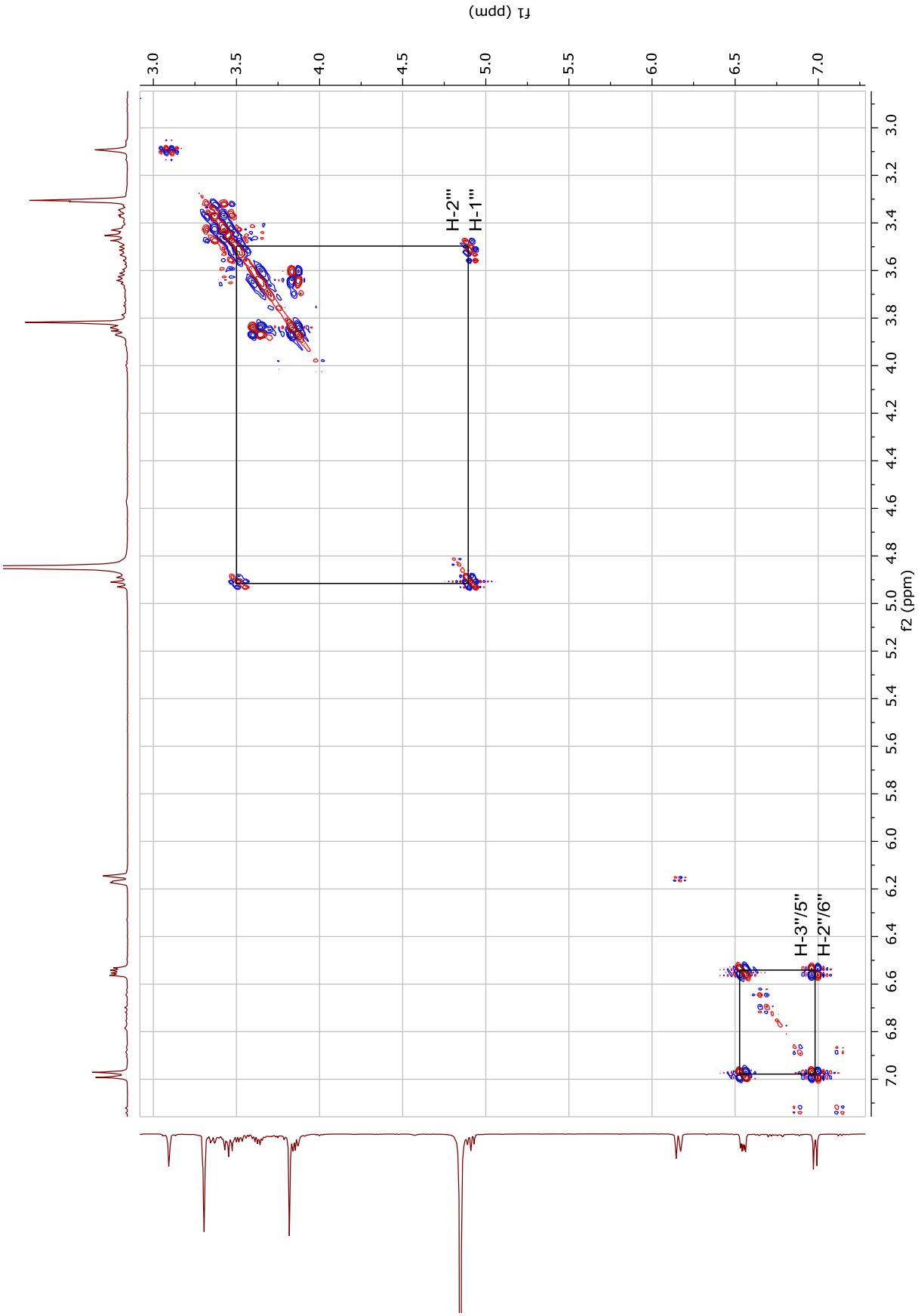


Figura 73. Espectro de COSY de **Sb16** (400 MHz, C_5D_5N).

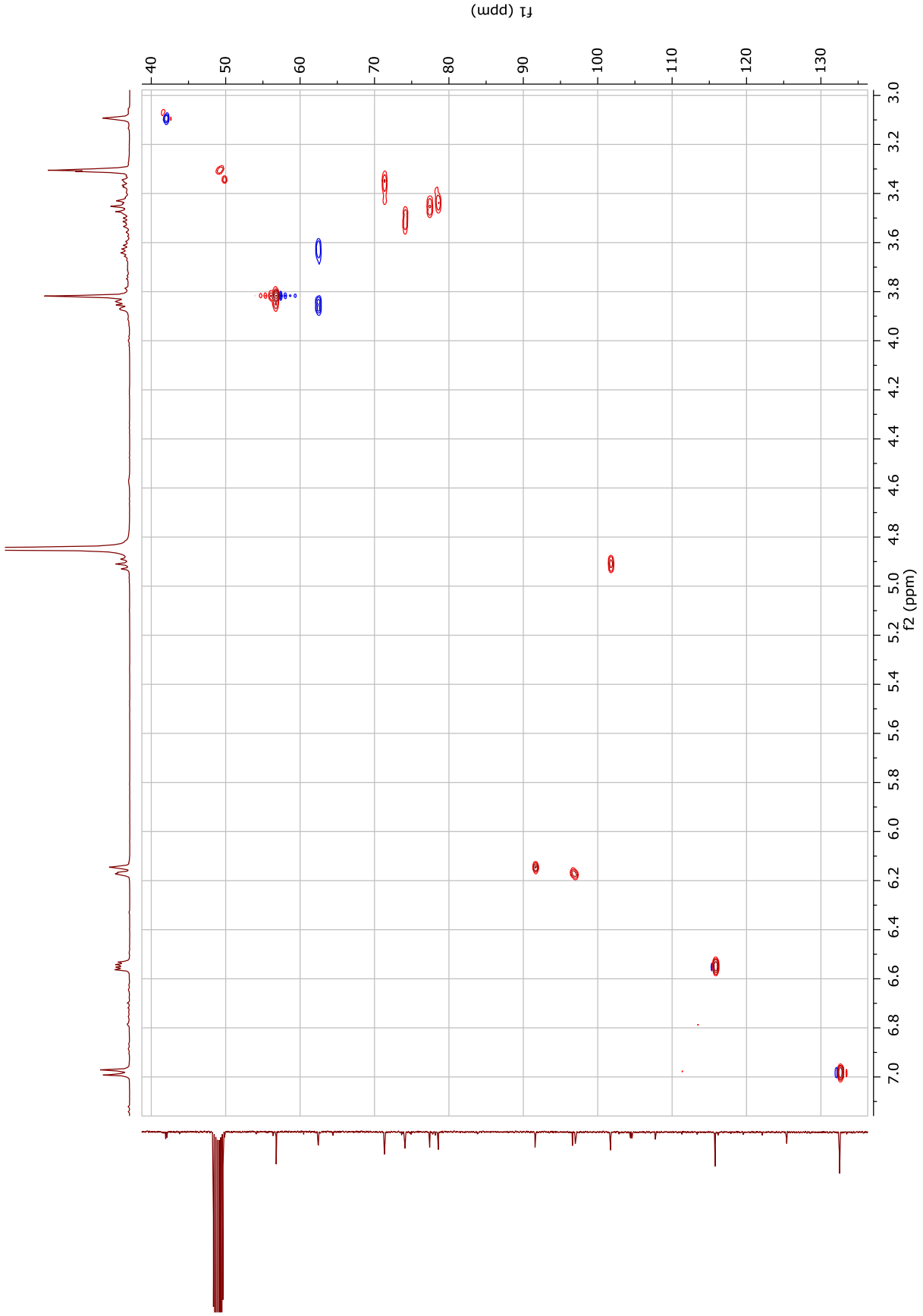


Figura 74. Espectro de HSQC de **Sb16** (400 MHz, CD_3OD).

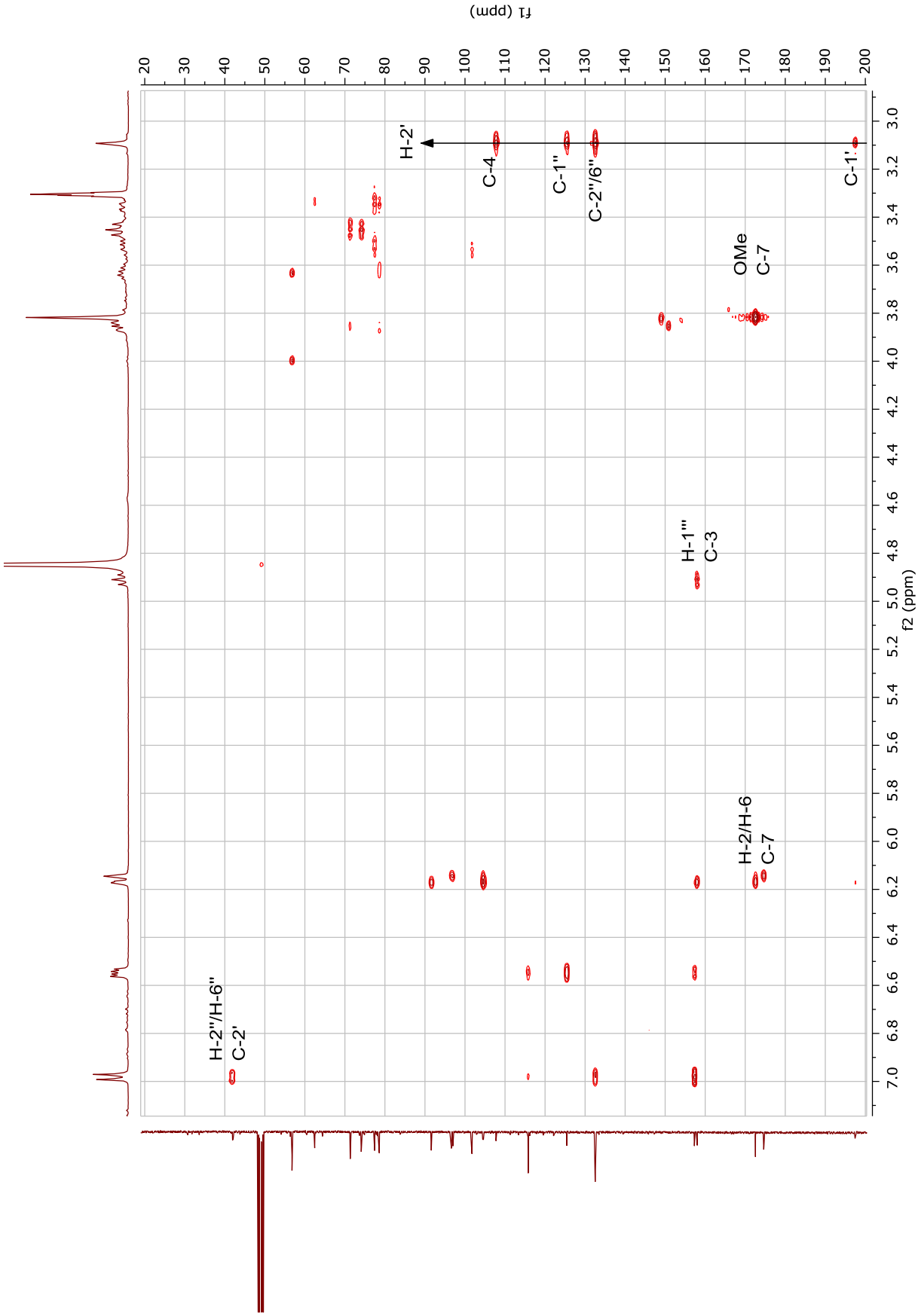


Figura 75. Espectro de HMBC de **Sb16** (400 MHz, CD_3OD).

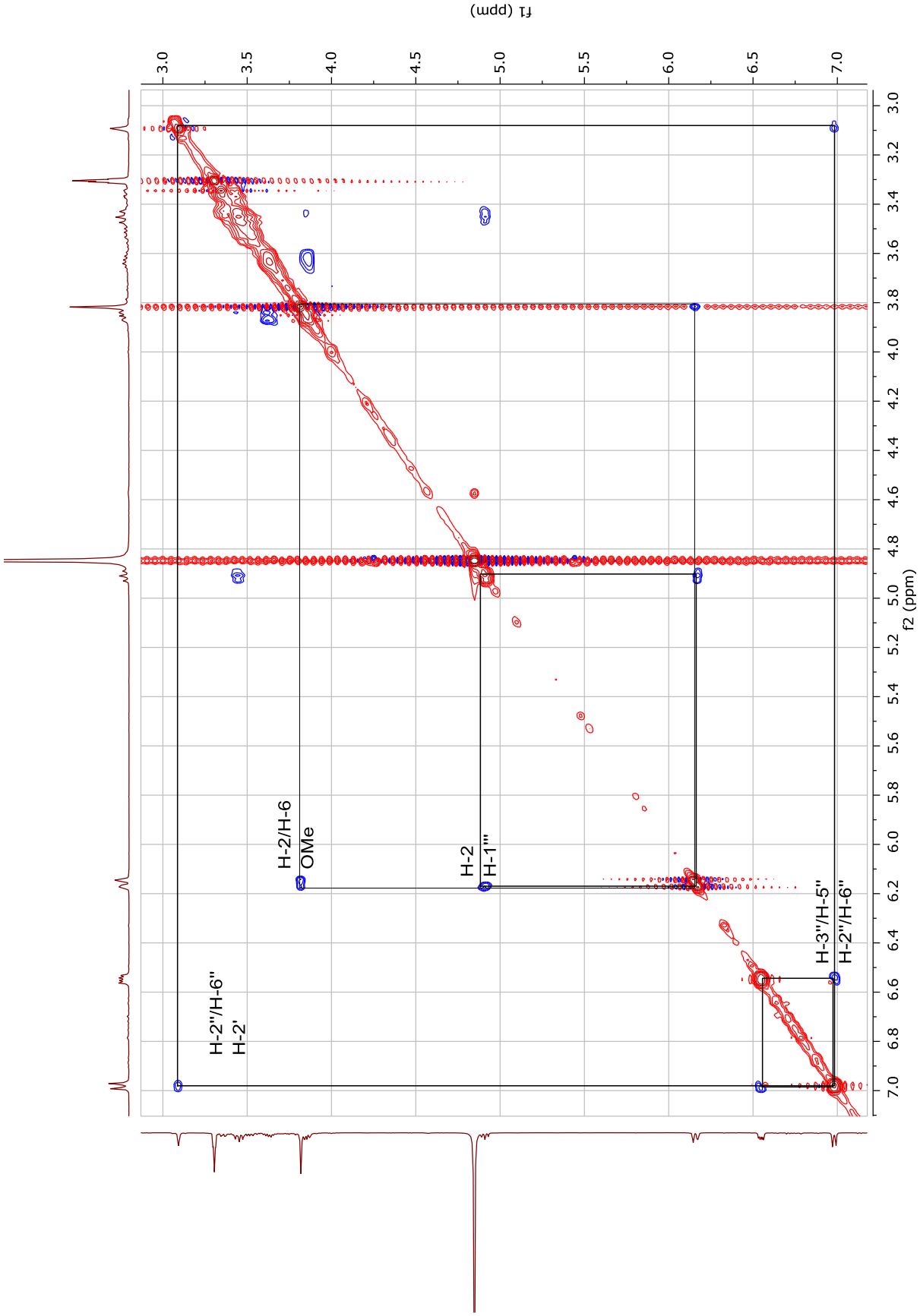
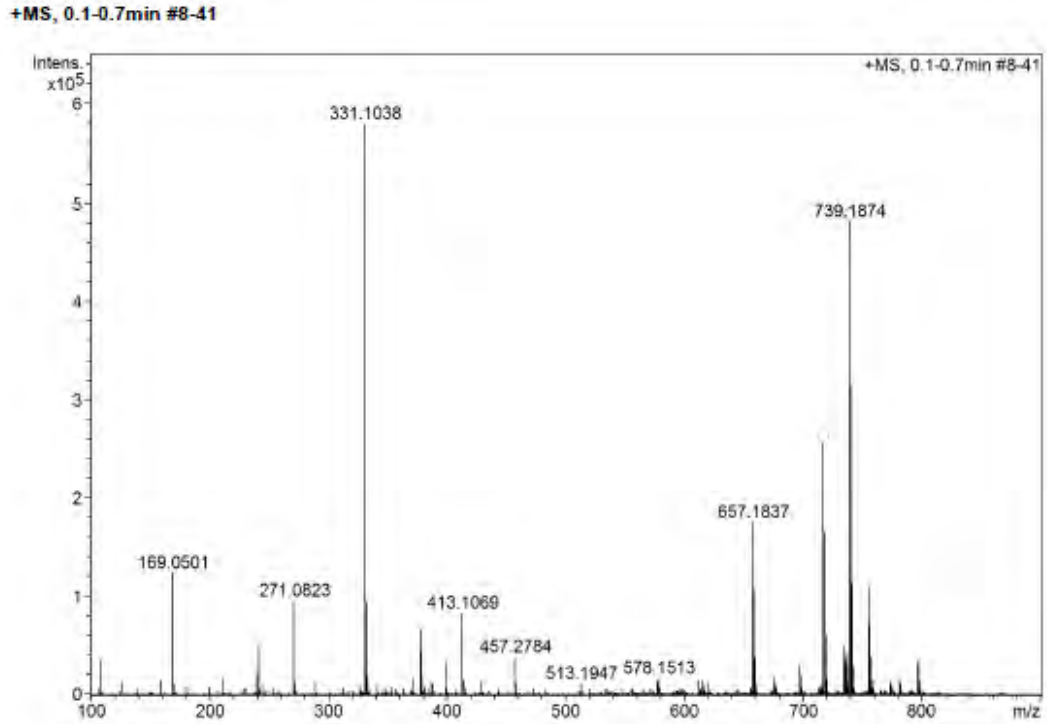


Figura 76. Espectro de NOESY de **Sb16** (400 MHz, CD_3OD).



Meas. m/z	#	Ion Formula	m/z err [ppm]		Mean err [ppm]	rdb	N-Rule	e⁻ Conf	mSigma	Std i	Std Mean m/z	Std i VarNorm	Std m/z Diff	Std Comb Dev
717.205180	1	C34H37O17	717.202526	-3.7	-5.3	16.5	ok	even	152.5	181.2	n.a.	n.a.	n.a.	n.a.
	2	C23H37N6O20	717.205714	0.7	-1.5	8.5	ok	even	201.3	257.9	n.a.	n.a.	n.a.	n.a.
	3	C22H41N2O24	717.204377	-1.1	-3.2	3.5	ok	even	211.6	273.7	n.a.	n.a.	n.a.	n.a.
	4	C19H33N12O18	717.203029	-3.0	-5.6	9.5	ok	even	213.7	281.0	n.a.	n.a.	n.a.	n.a.
739.187386	1	C34H36NaO17	739.184470	-3.9	-5.4	16.5	ok	even	153.9	181.7	n.a.	n.a.	n.a.	n.a.
	2	C27H40NaO22	739.190344	4.0	2.4	7.5	ok	even	190.3	236.3	n.a.	n.a.	n.a.	n.a.
	3	C23H36N6NaO20	739.187658	0.4	-1.7	8.5	ok	even	202.6	258.6	n.a.	n.a.	n.a.	n.a.
	4	C22H40N2NaO24	739.186321	-1.4	-3.3	3.5	ok	even	213.2	274.6	n.a.	n.a.	n.a.	n.a.

Figura 77. Espectro de massas de alta resolução do derivado acetilado de **Sb16** (ESI, modo positivo).

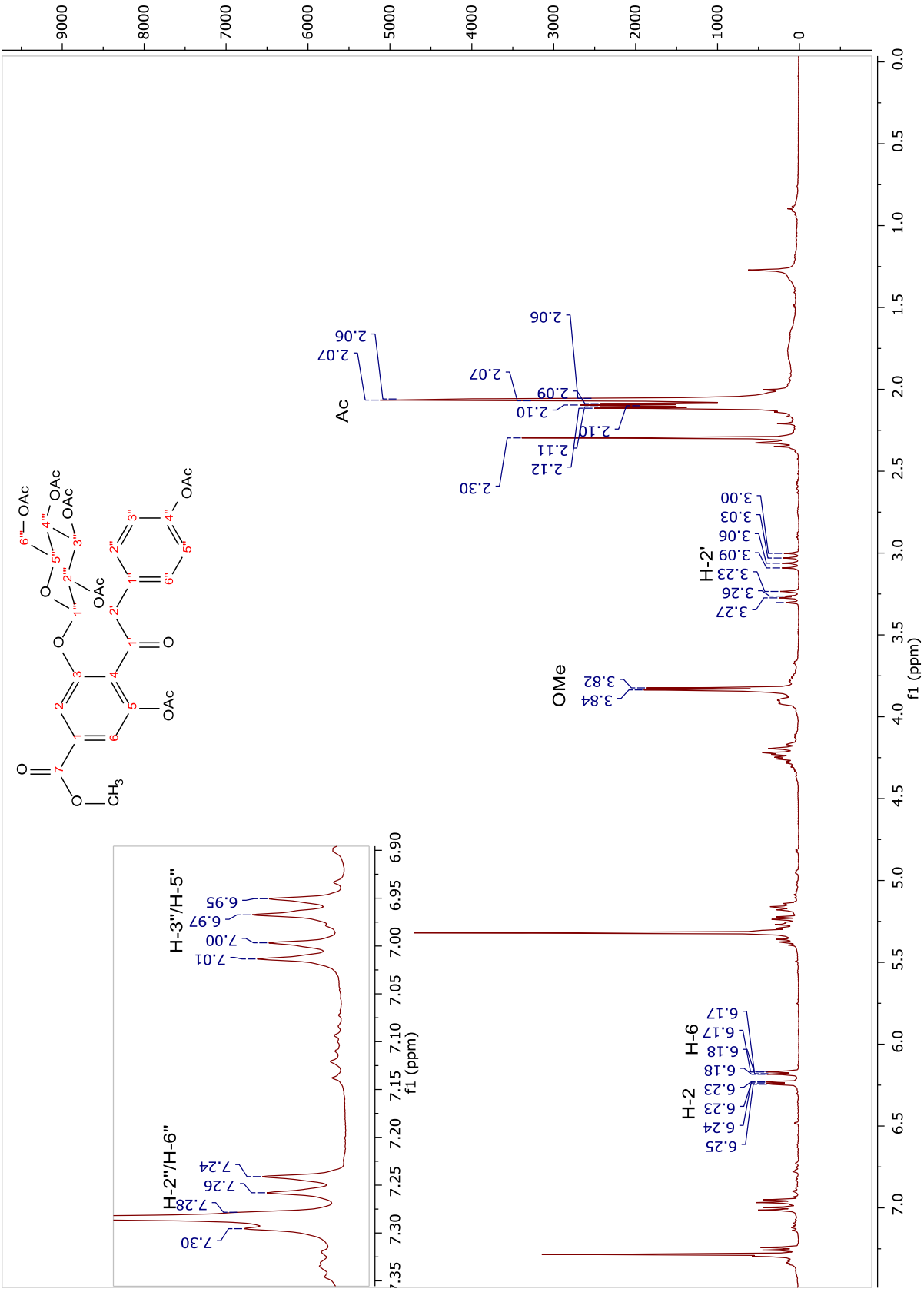


Figura 78. Espectro de RMN ^{1}H do derivado acetilado de **Sb16** (500 MHz, $CDCl_3$).

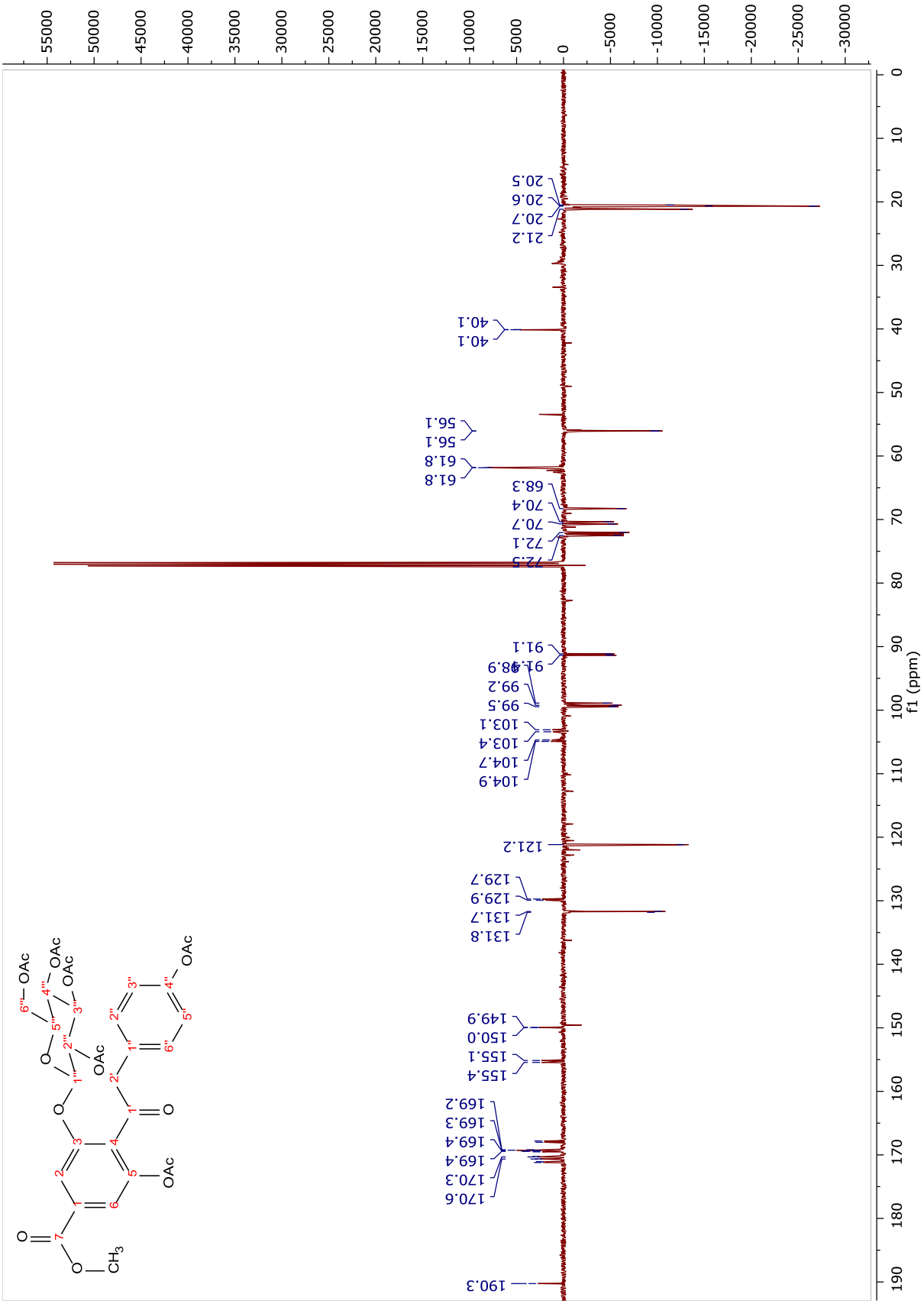


Figura 79. Espectro de DEPTQ do derivado acetilado de **Sb16** (125 MHz, $CDCl_3$).

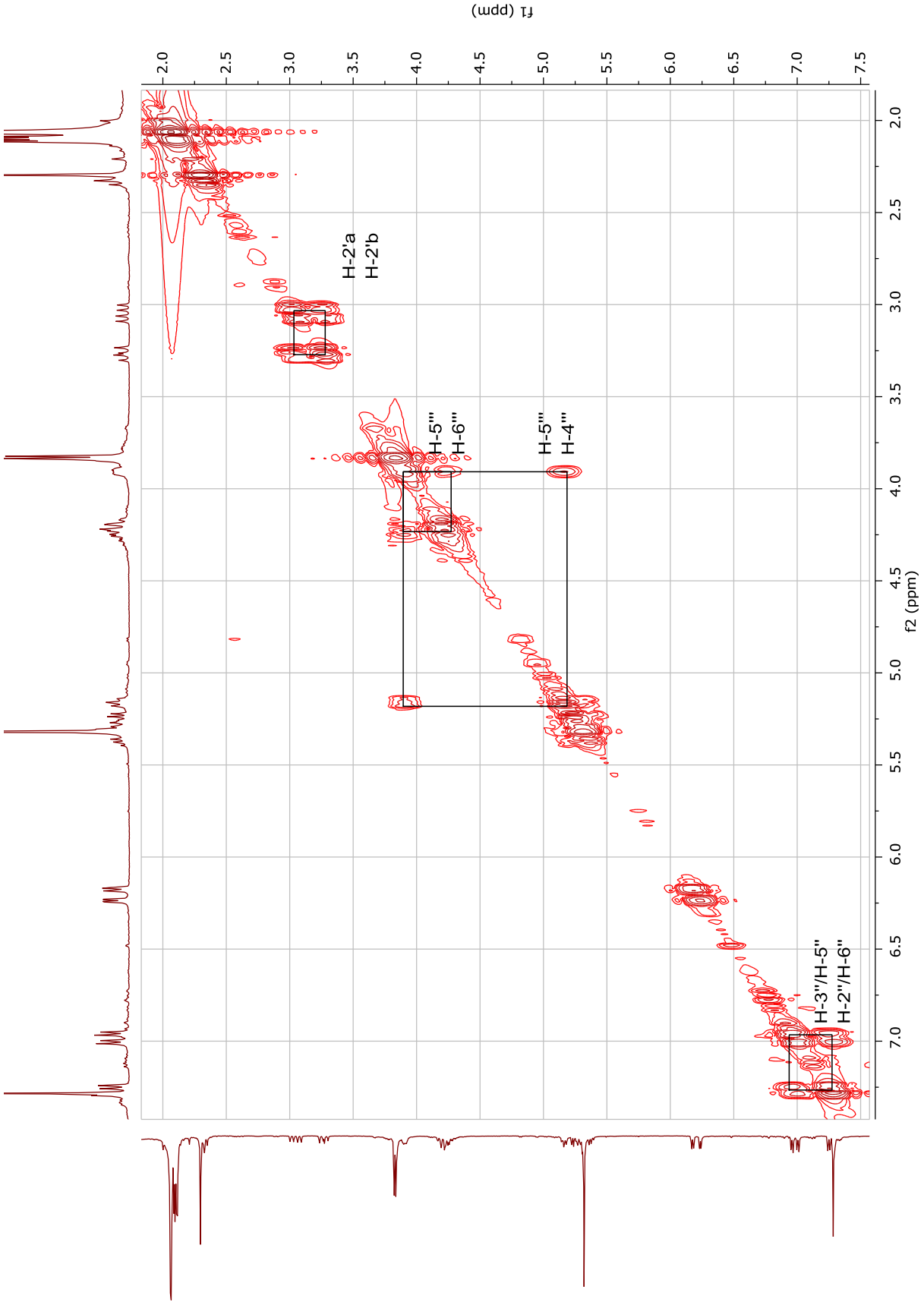


Figura 80. Espectro de COSY do derivado acetilado de **Sb16** (500 MHz, $CDCl_3$).

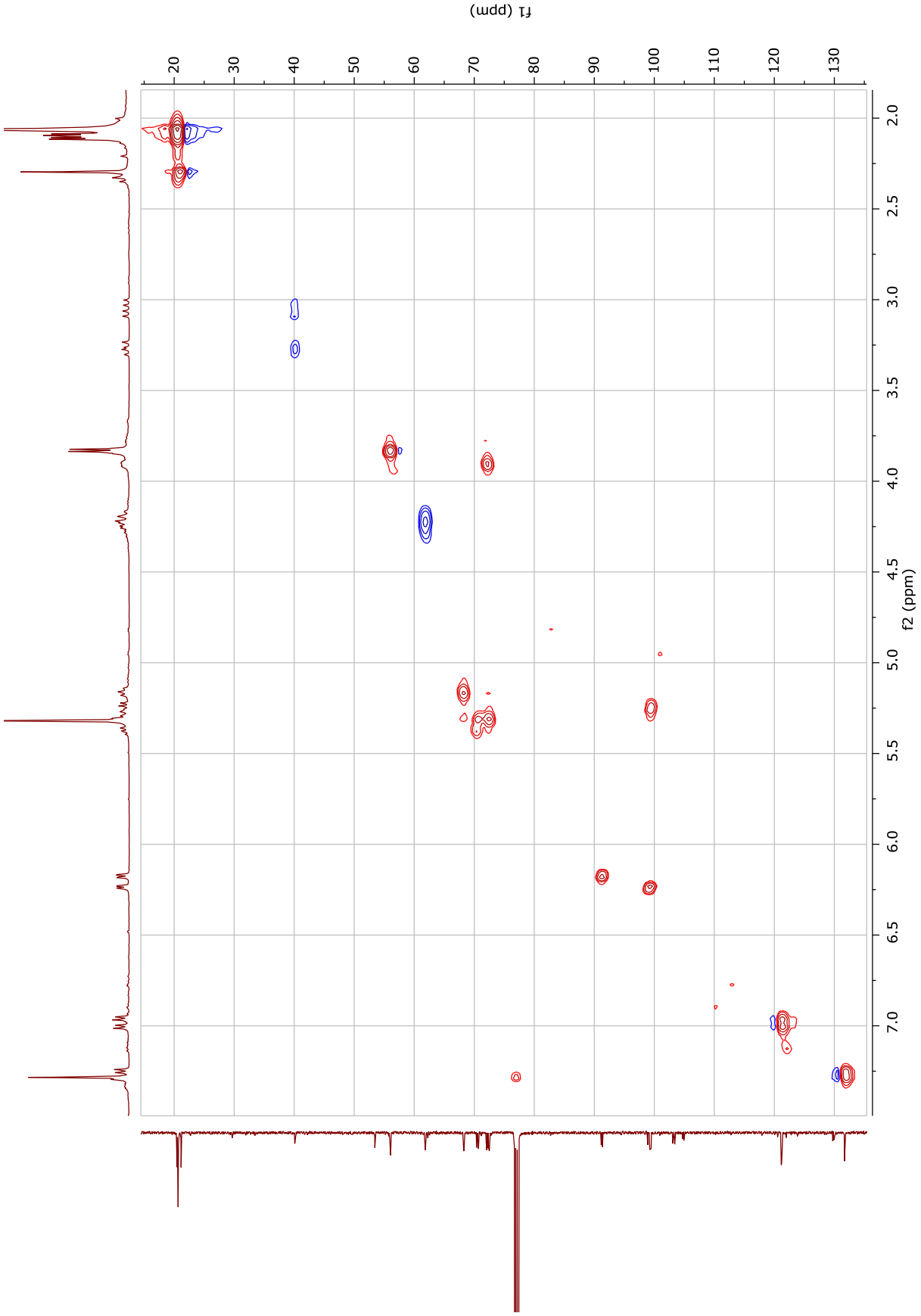


Figura 81. Espectro de HSQC do derivado acetilado de **Sb16** (500 MHz, $CDCl_3$).

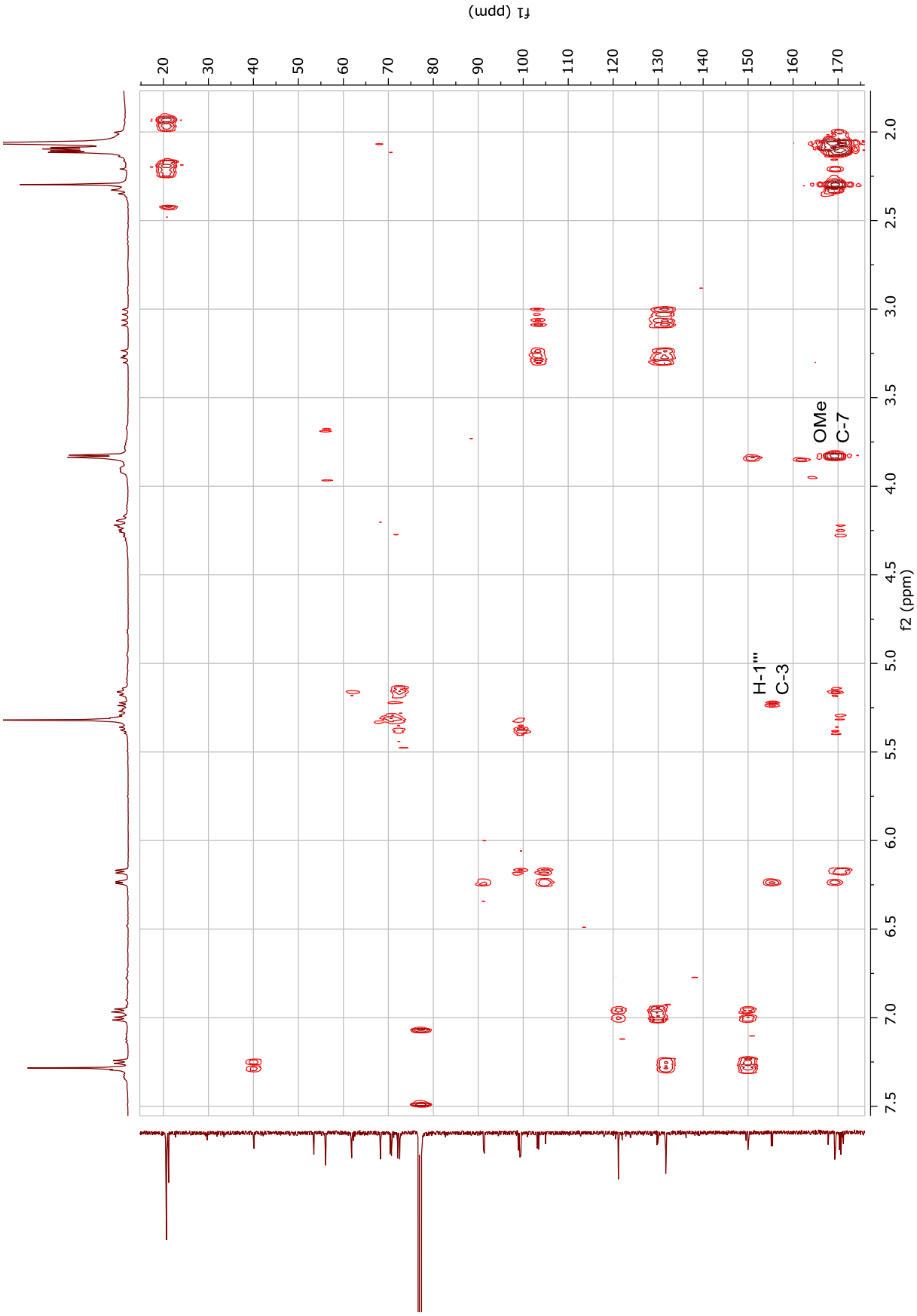


Figura 82. Espectro de HMBC do derivado acetilado de **Sb16** (500 MHz, $CDCl_3$).

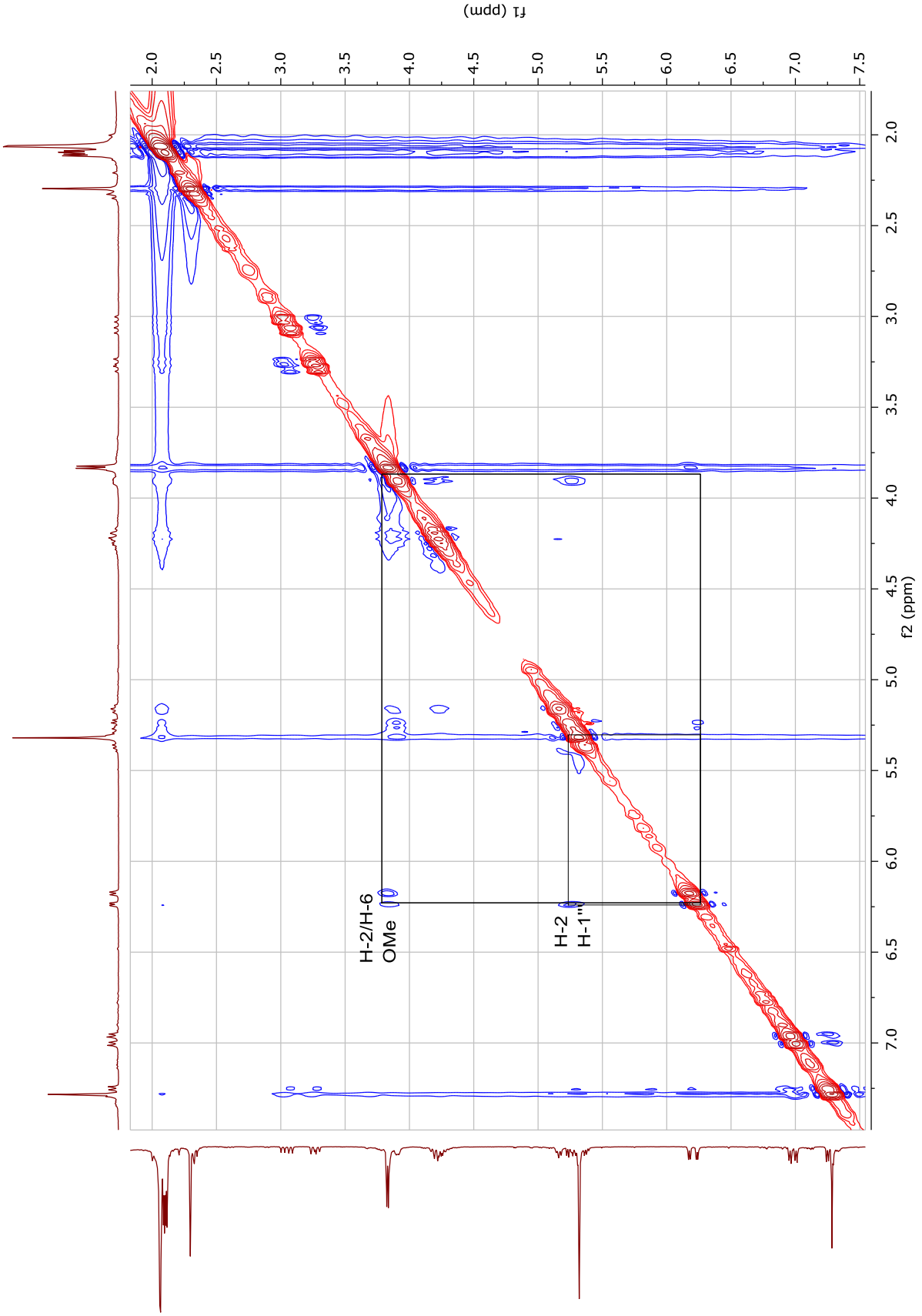


Figura 83. Espectro de ROESY do derivado acetilado de **Sb16** (500 MHz, $CDCl_3$).

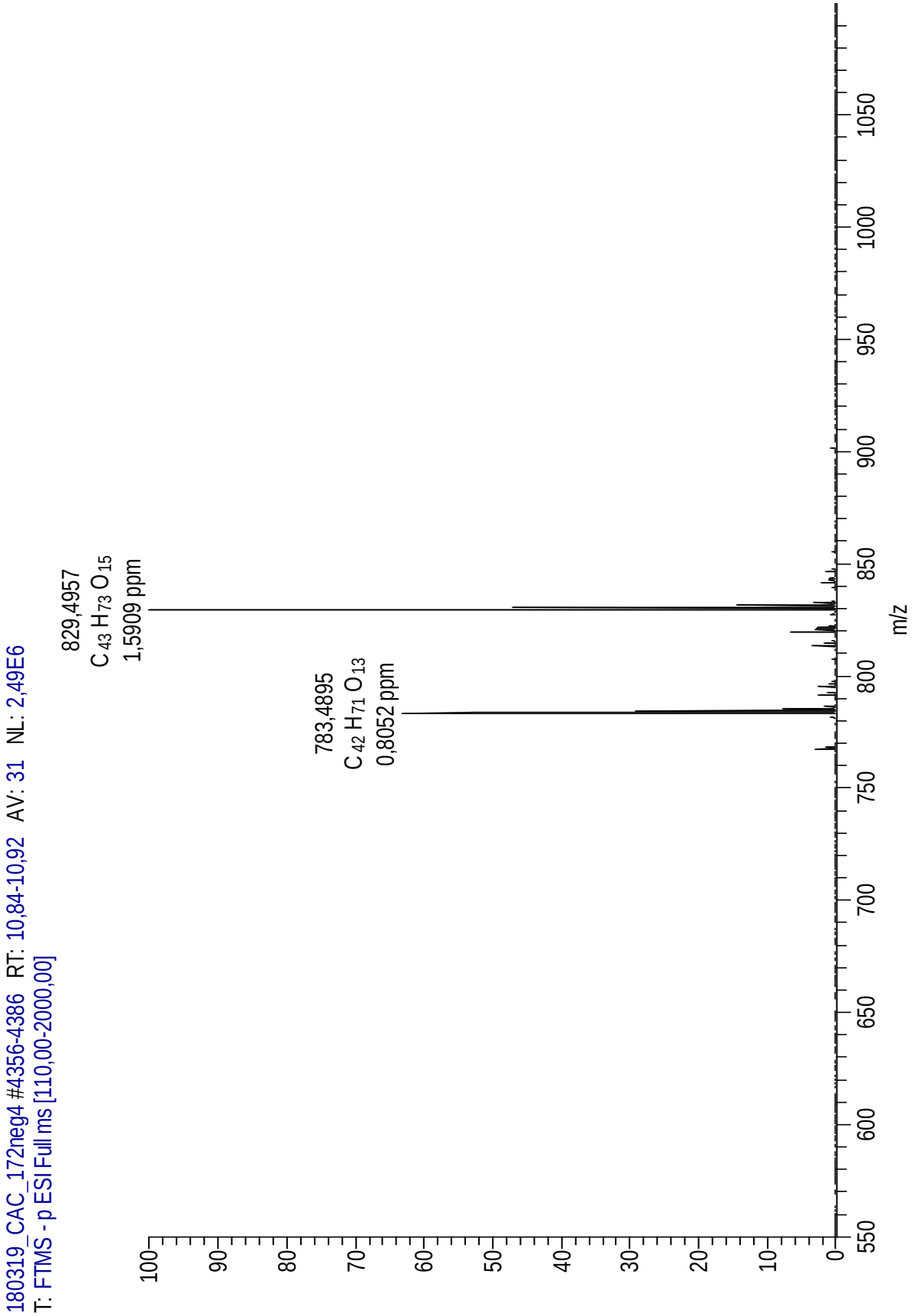


Figura 84. Espectro de massas de alta resolução de **Sb17** (ESI, modo negativo).

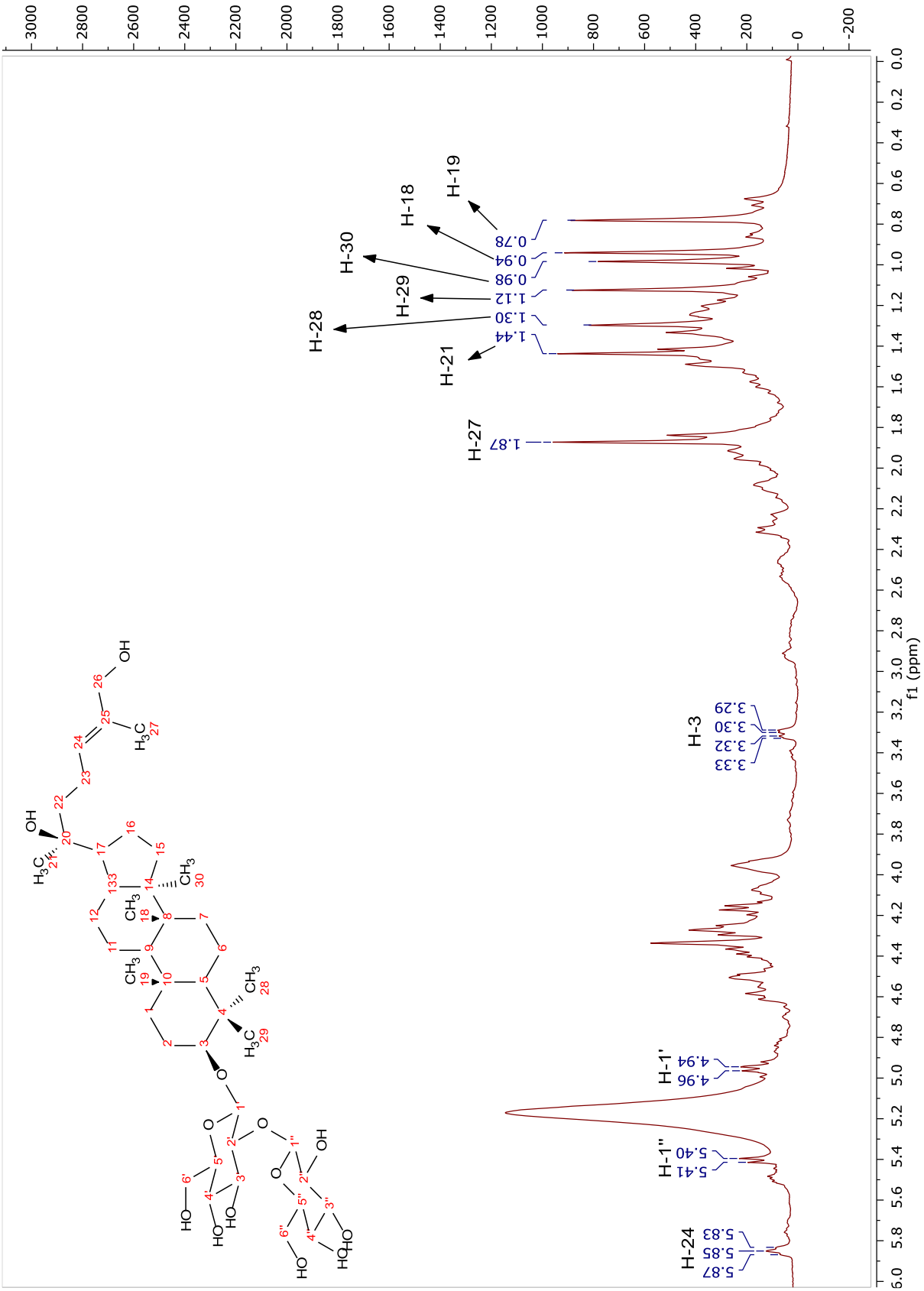


Figura 85. Espectro de RMN ^{1}H de **Sb17** (400 MHz, C_5D_5N).

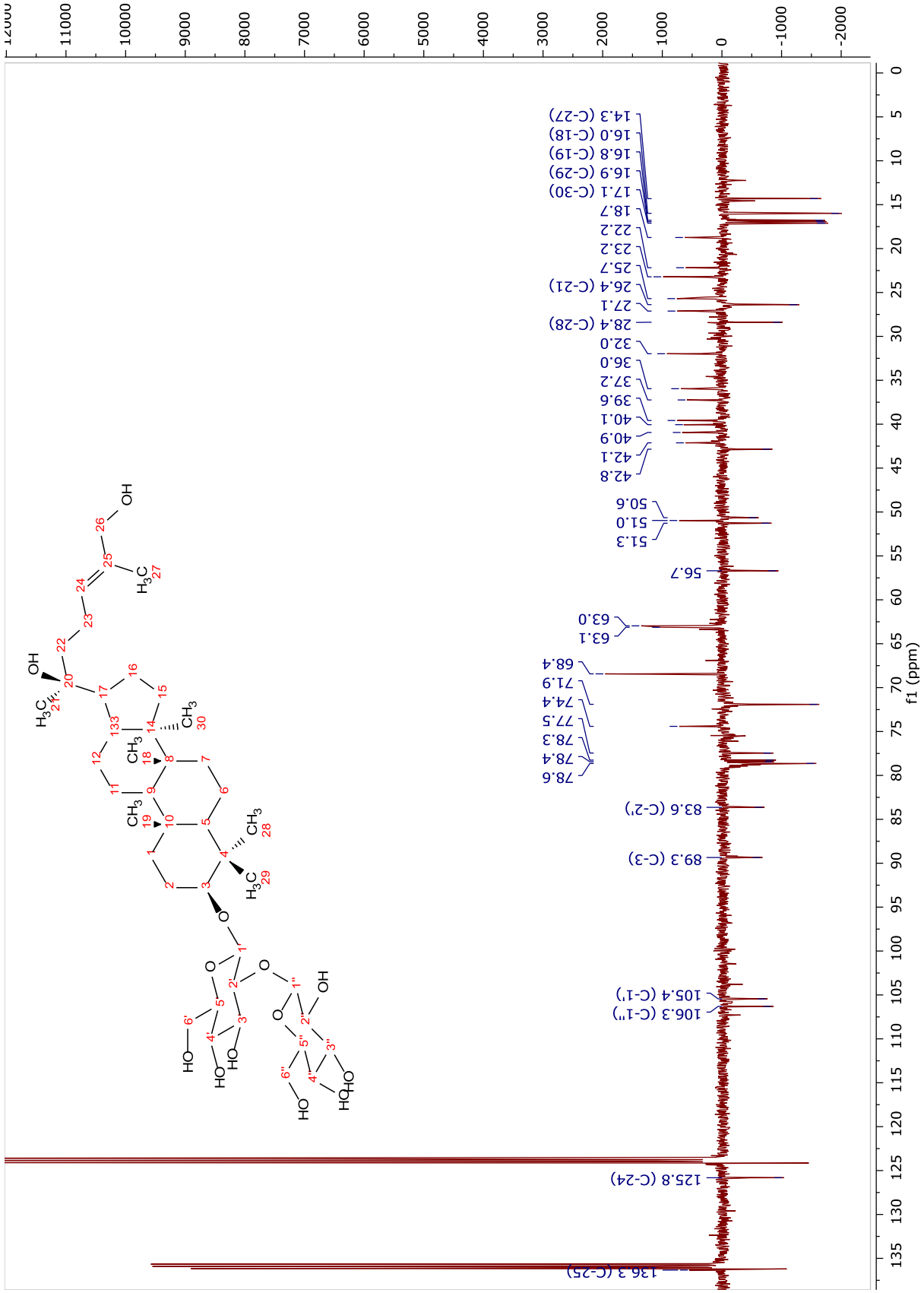


Figura 86. Espectro de DEPTQ de **Sb17** (100 MHz, C_5D_5N).

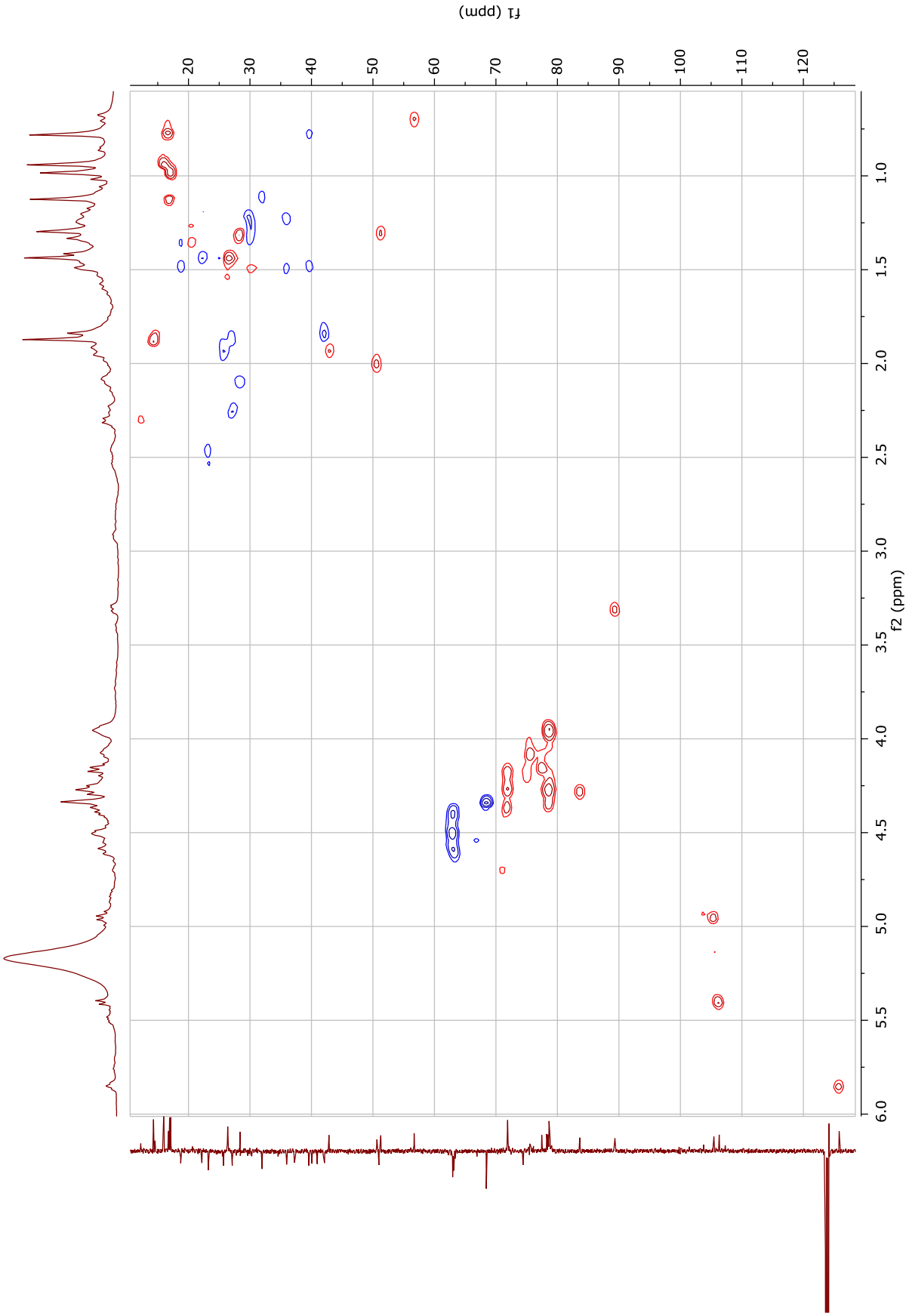


Figura 87. Espectro de HSQC de **Sb17** (400 MHz, C_5D_5N).

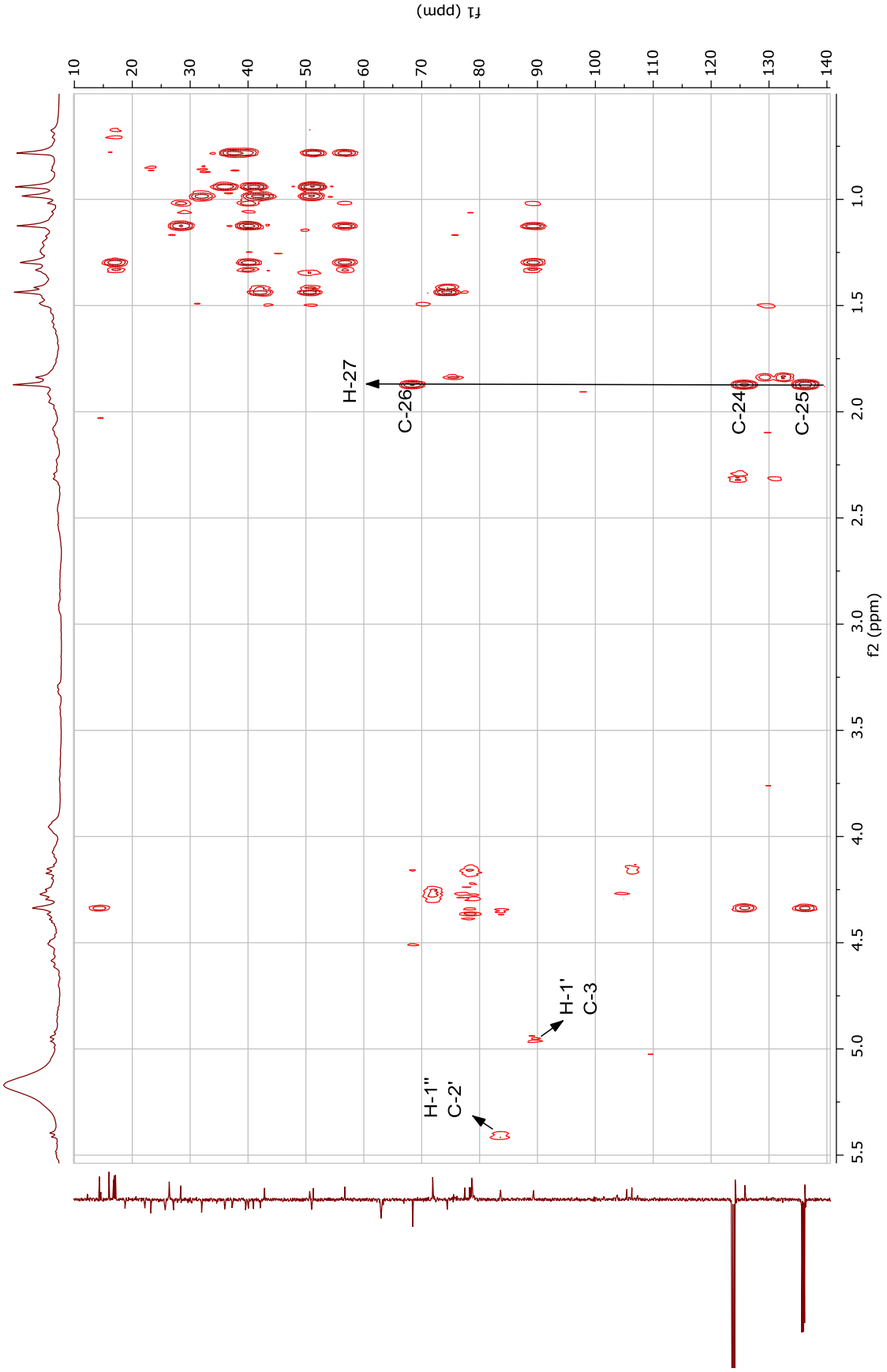


Figura 88. Espectro de HMBC de **Sb17** (400 MHz, C_5D_5N).

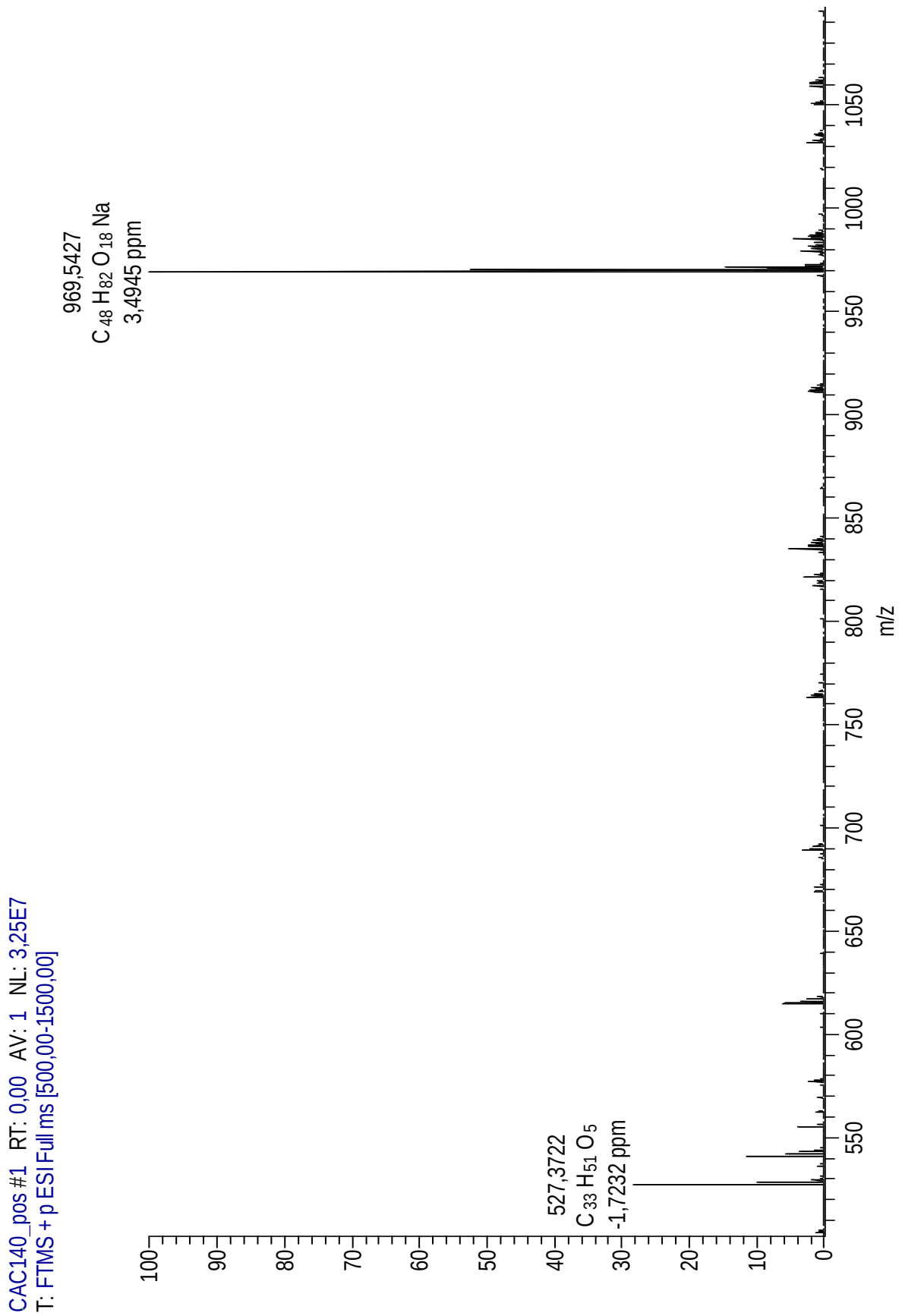


Figura 89. Espectro de massas de alta resolução de **Sb18** (ESI, modo positivo).

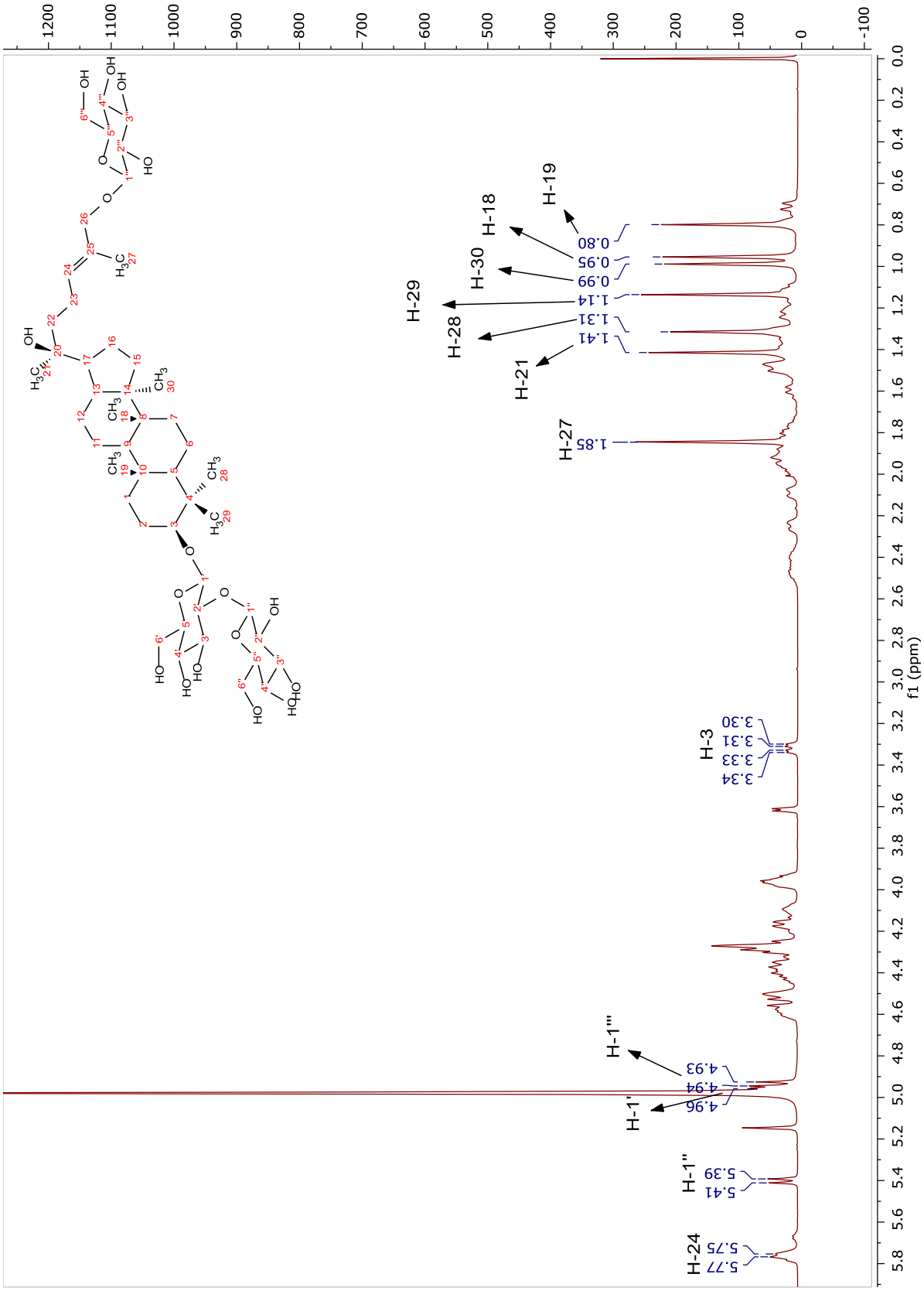


Figura 90. Espectro de RMN ^{1}H de **Sb18** (400 MHz, C_5D_5N).

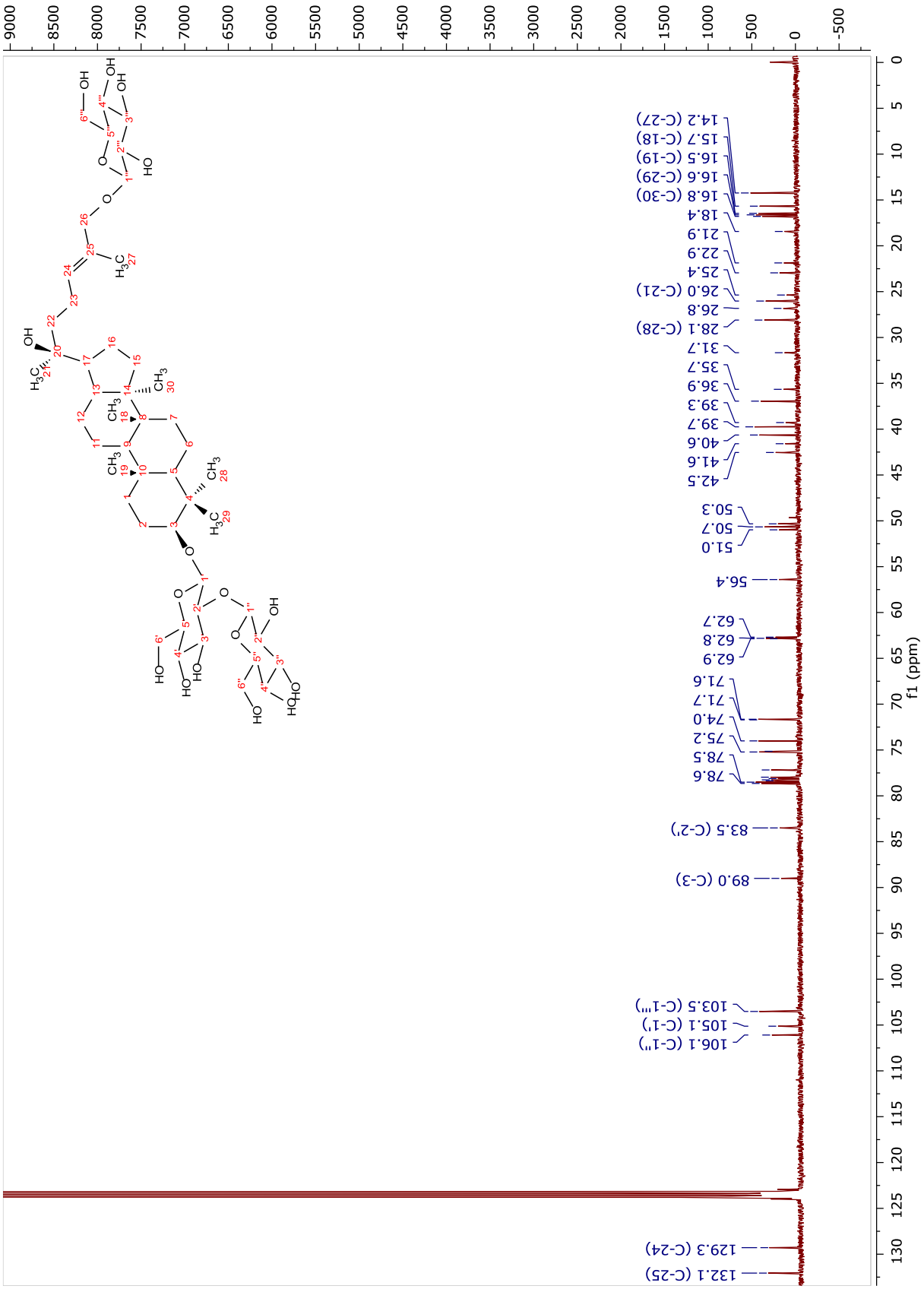


Figura 91. Espectro de RMN ^{13}C de **Sb18** (100 MHz, C_5D_5N).

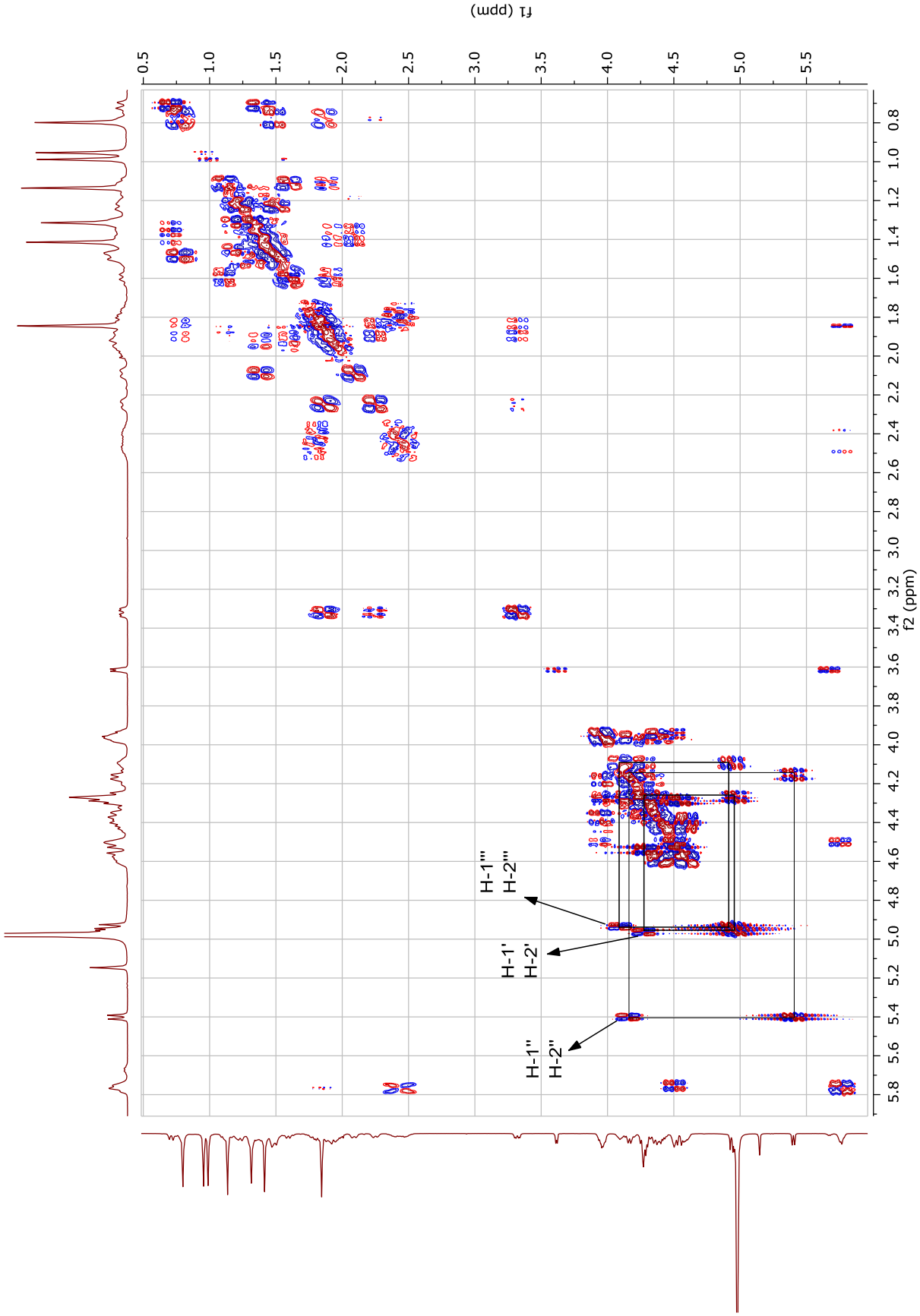


Figura 92. Espectro de COSY de **Sb18** (400 MHz, C_5D_5N).

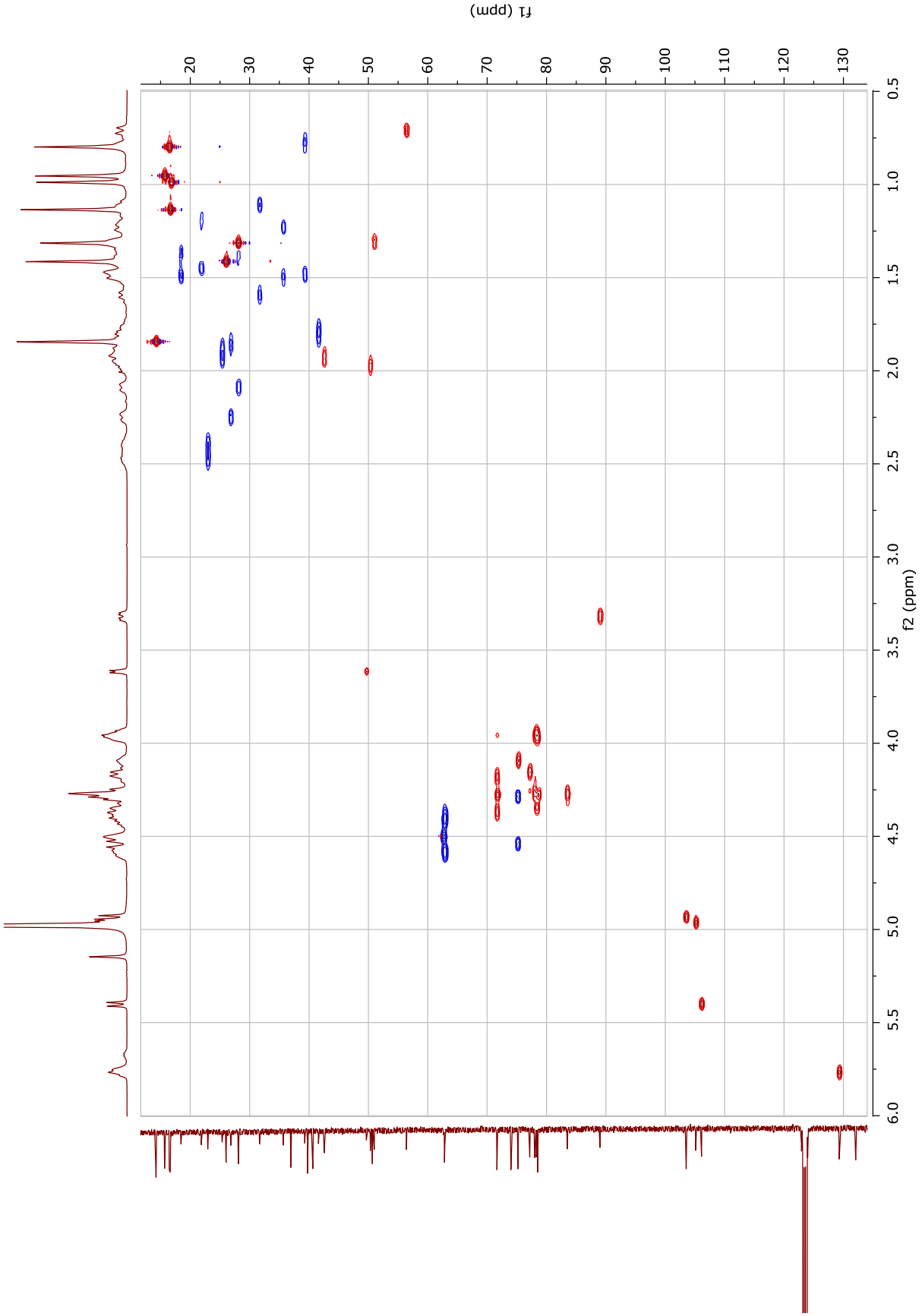


Figura 93. Espectro de HSQC de **Sb18** (400 MHz, C_5D_5N).

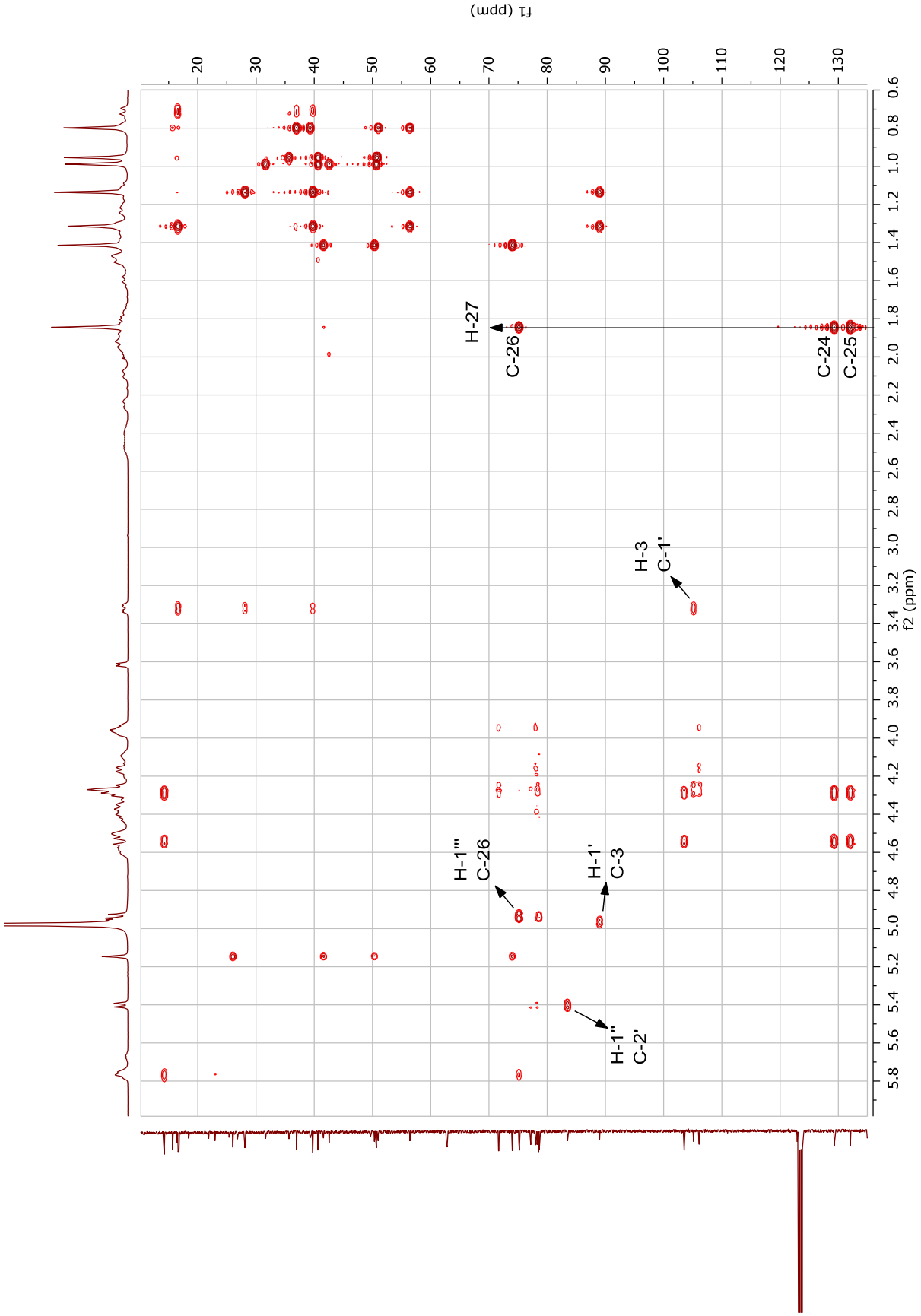


Figura 94. Espectro de HMBC de **Sb18** (400 MHz, C_5D_5N).

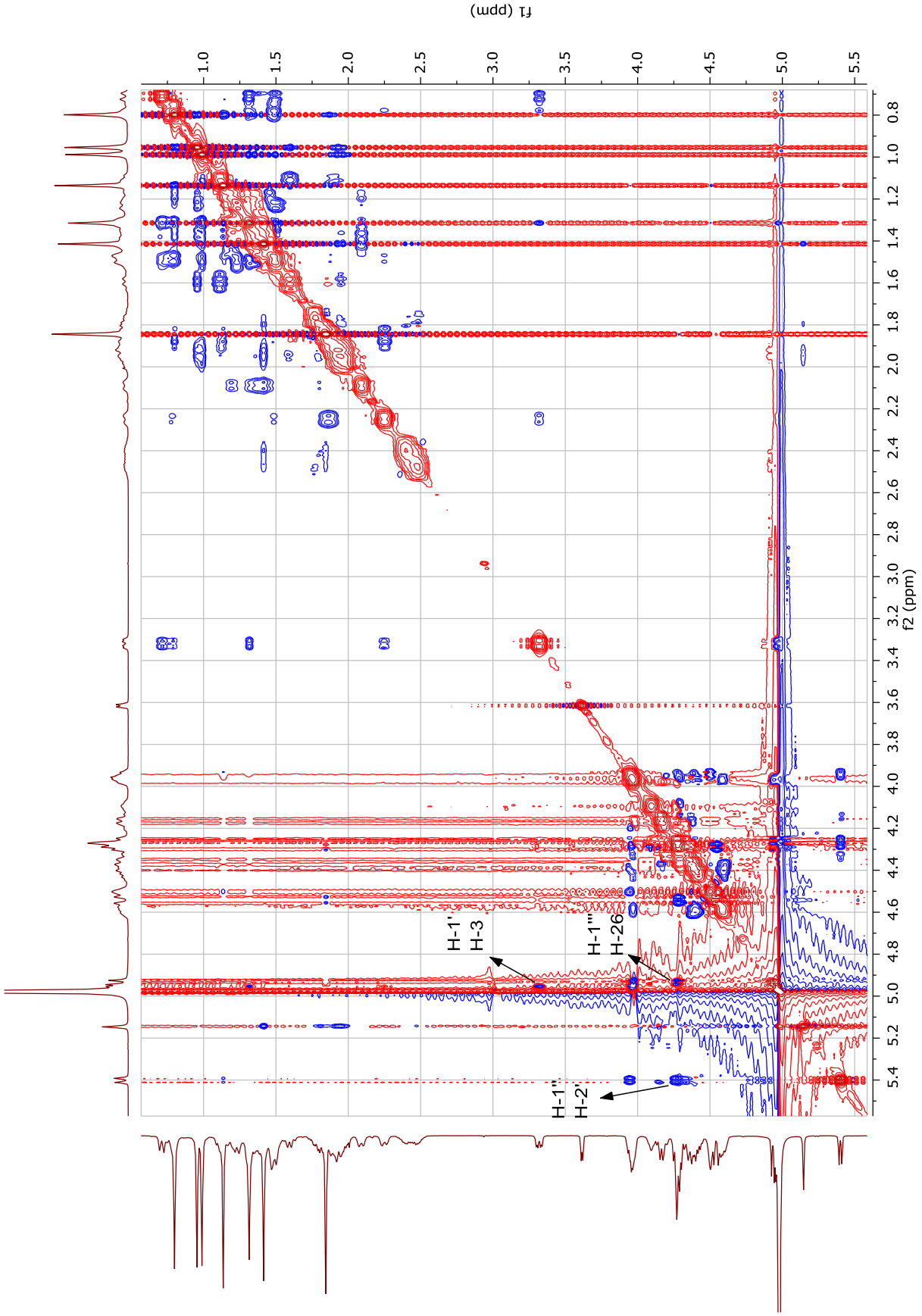


Figura 95. Espectro de ROESY de **Sb18** (400 MHz, C_5D_5N).

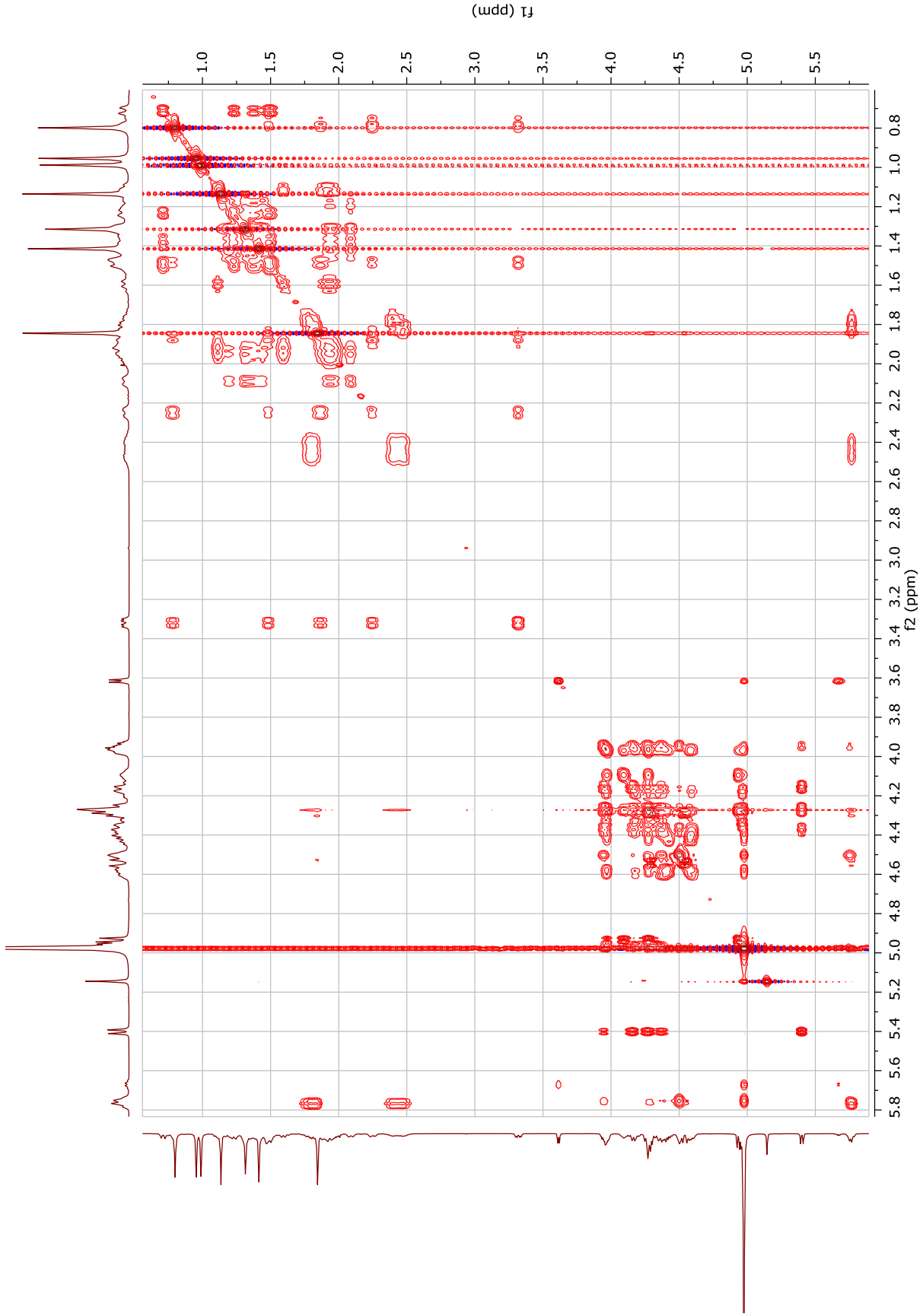


Figura 96. Espectro de TOCSY de **Sb18** (400 MHz, C_5D_5N).

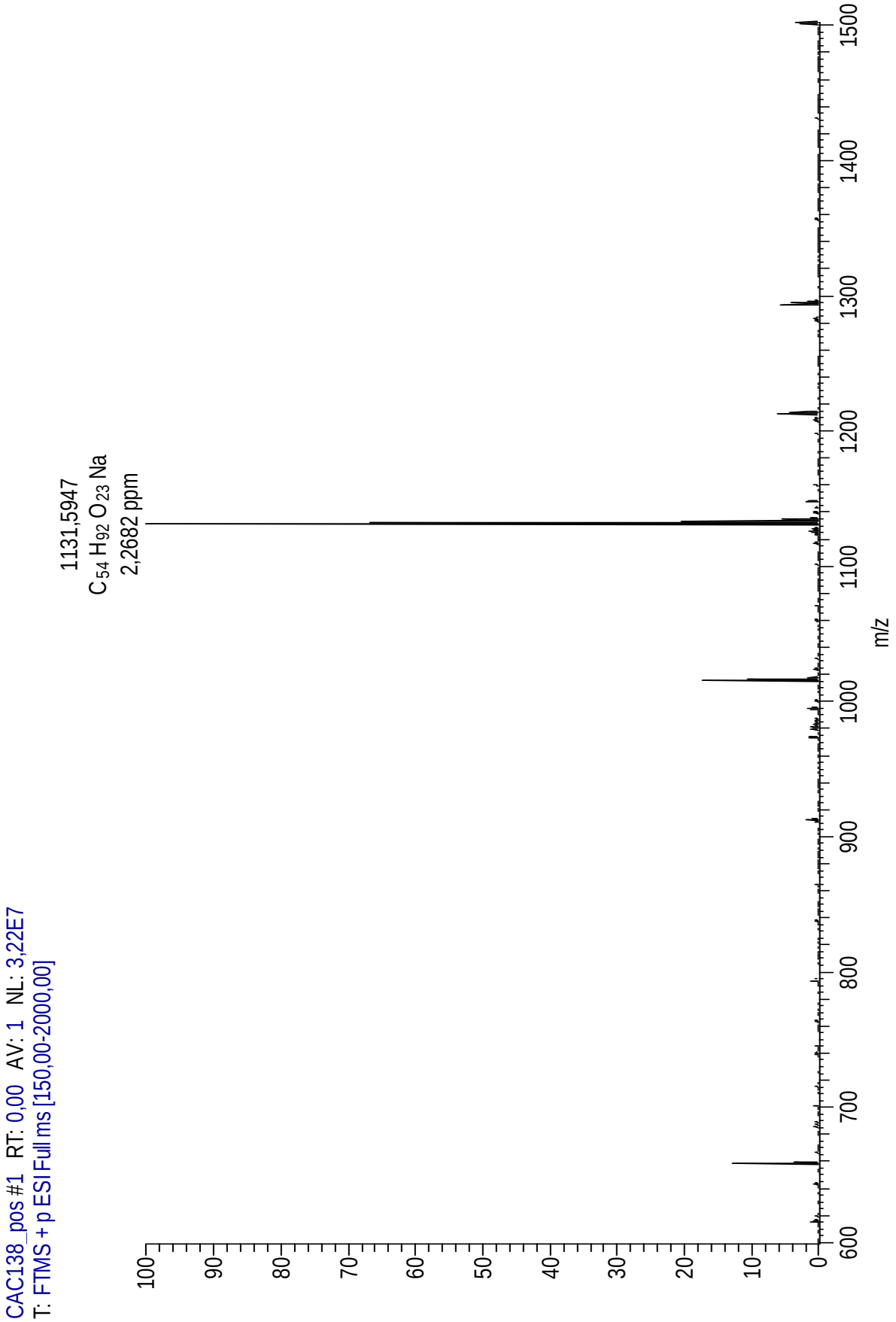


Figura 97. Espectro de massas de alta resolução de **Sb19** (ESI, modo positivo).

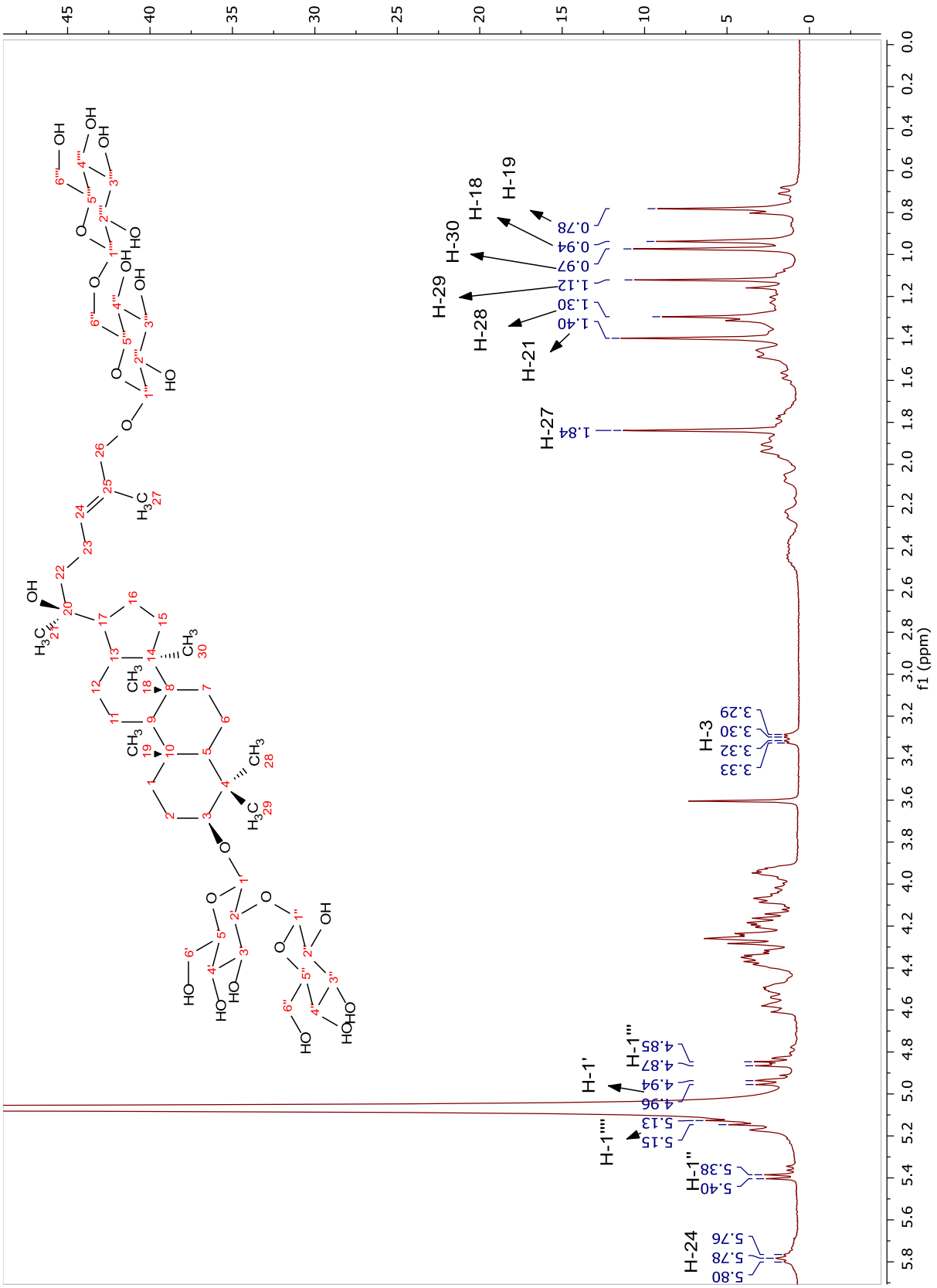


Figura 98. Espectro de RMN ^{1}H de **Sb19** (400 MHz, C_5D_5N).

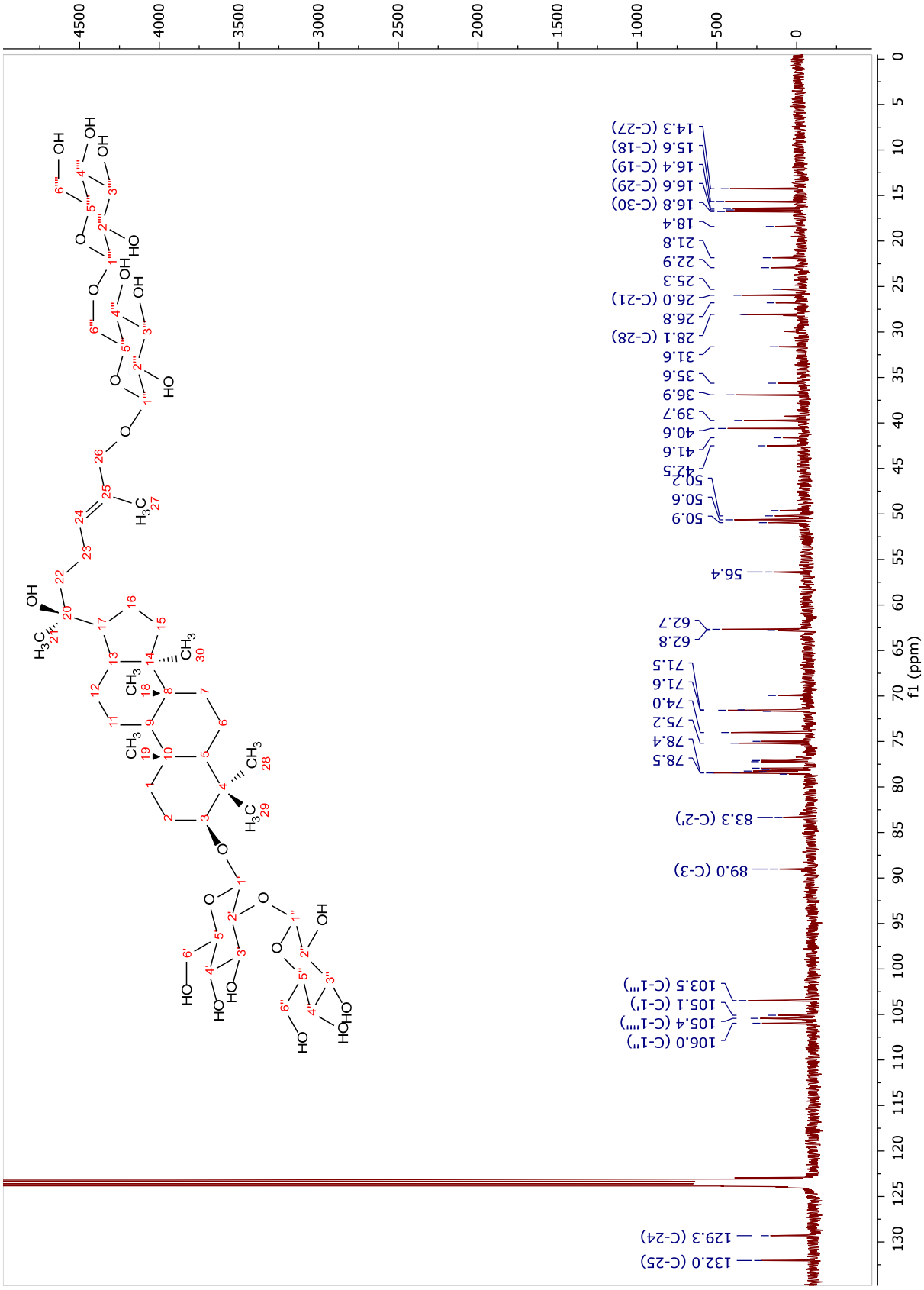


Figura 99. Espectro de RMN ^{13}C de **Sb19** (100 MHz, C_5D_5N).

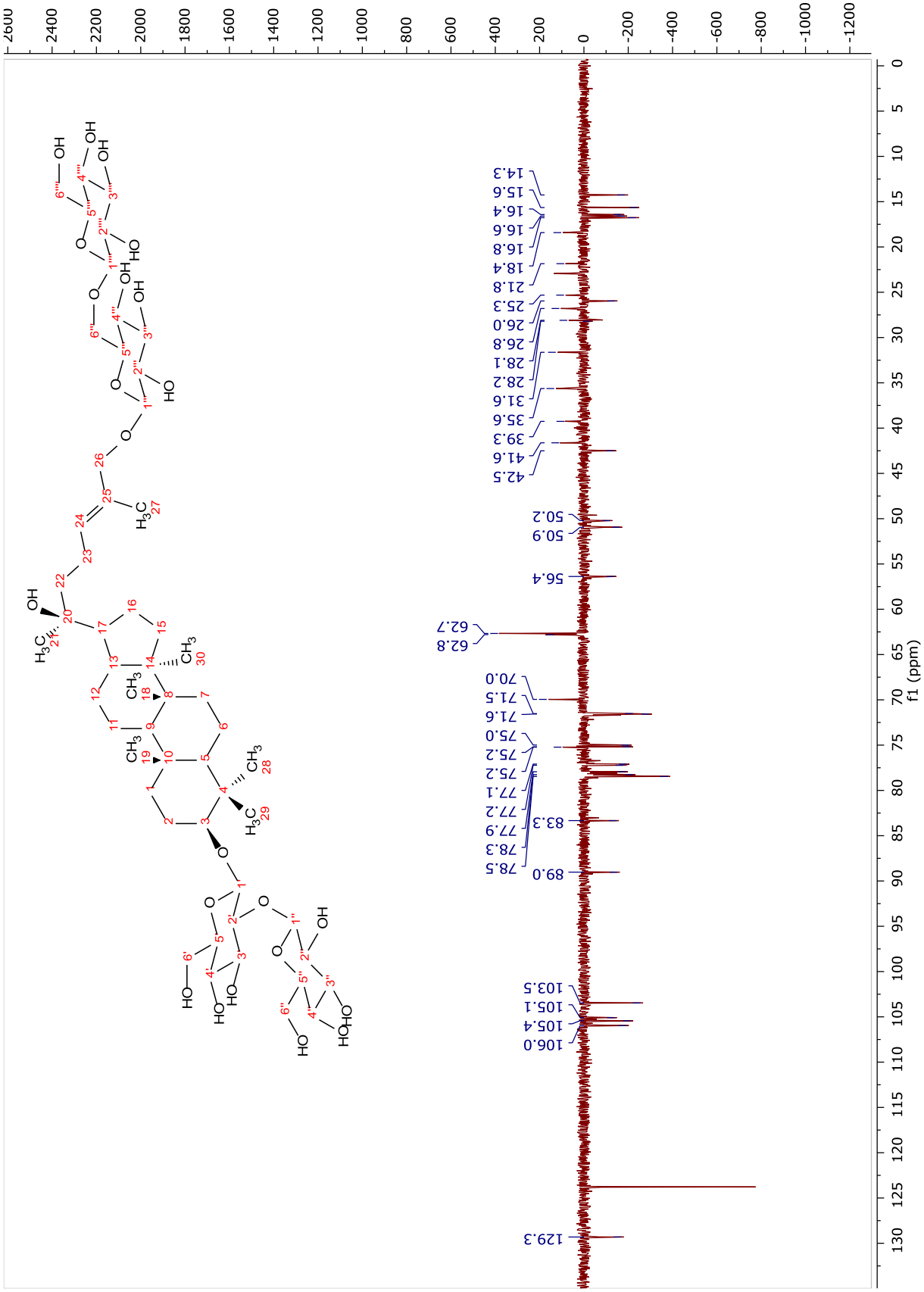


Figura 100. Espectro de DEPT-135 de **Sb19** (100 MHz, C_5D_5N).

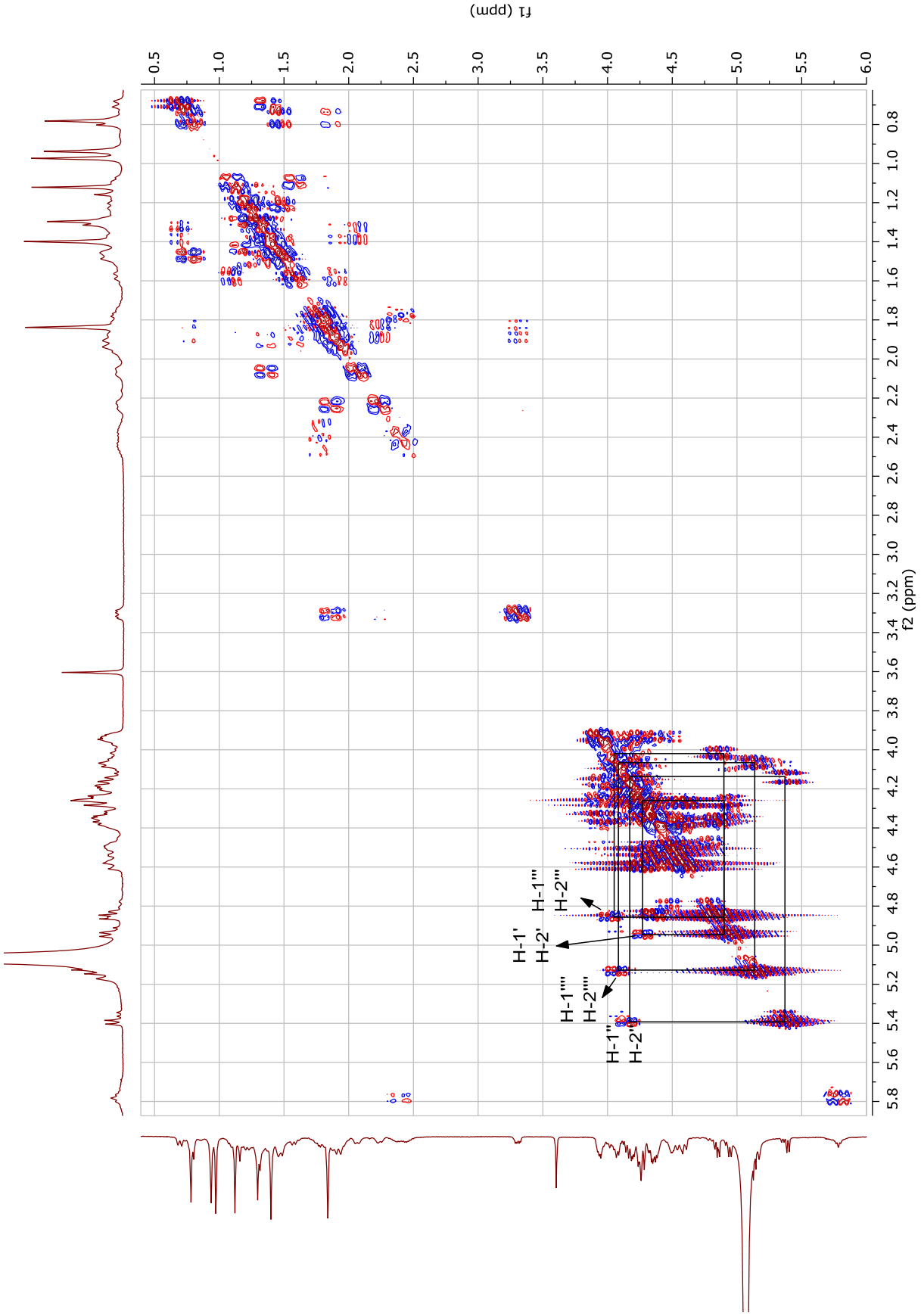


Figura 101. Espectro de COSY de **Sb19** (400 MHz, C_5D_5N).

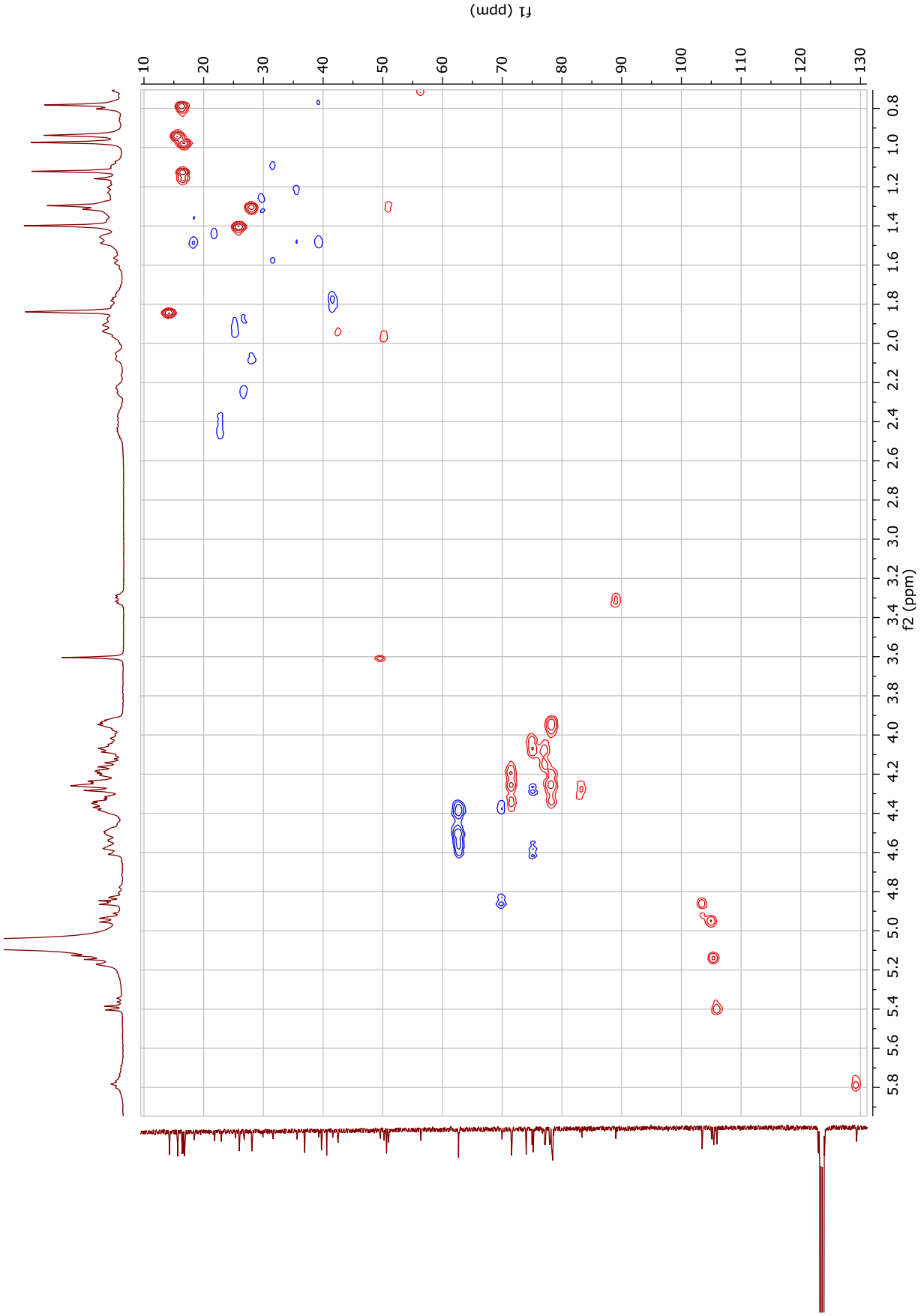


Figura 102. Espectro de HSQC de **Sb19** (400 MHz, C_5D_5N).

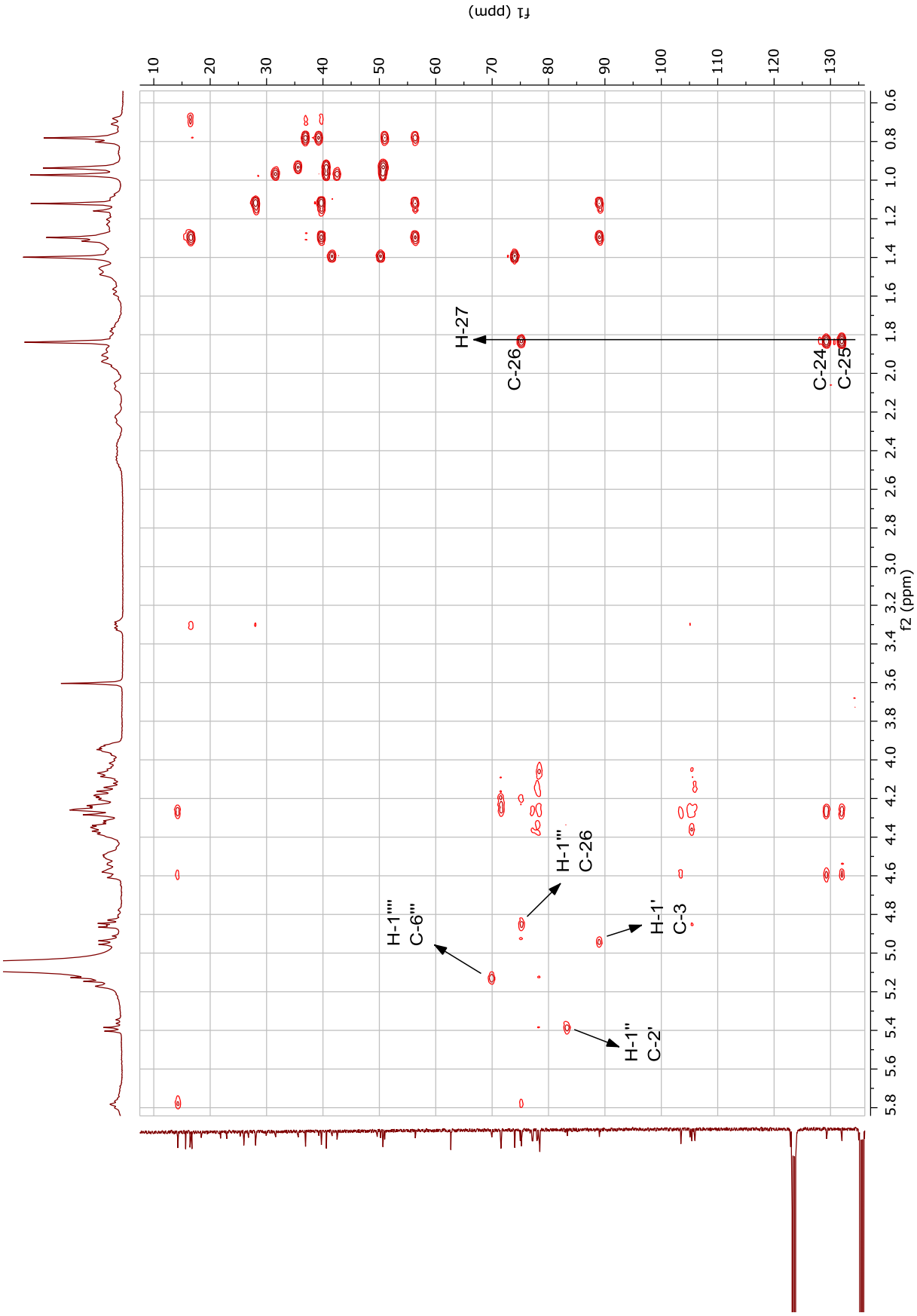


Figura 103. Espectro de HMBC de **Sb19** (400 MHz, C_5D_5N).

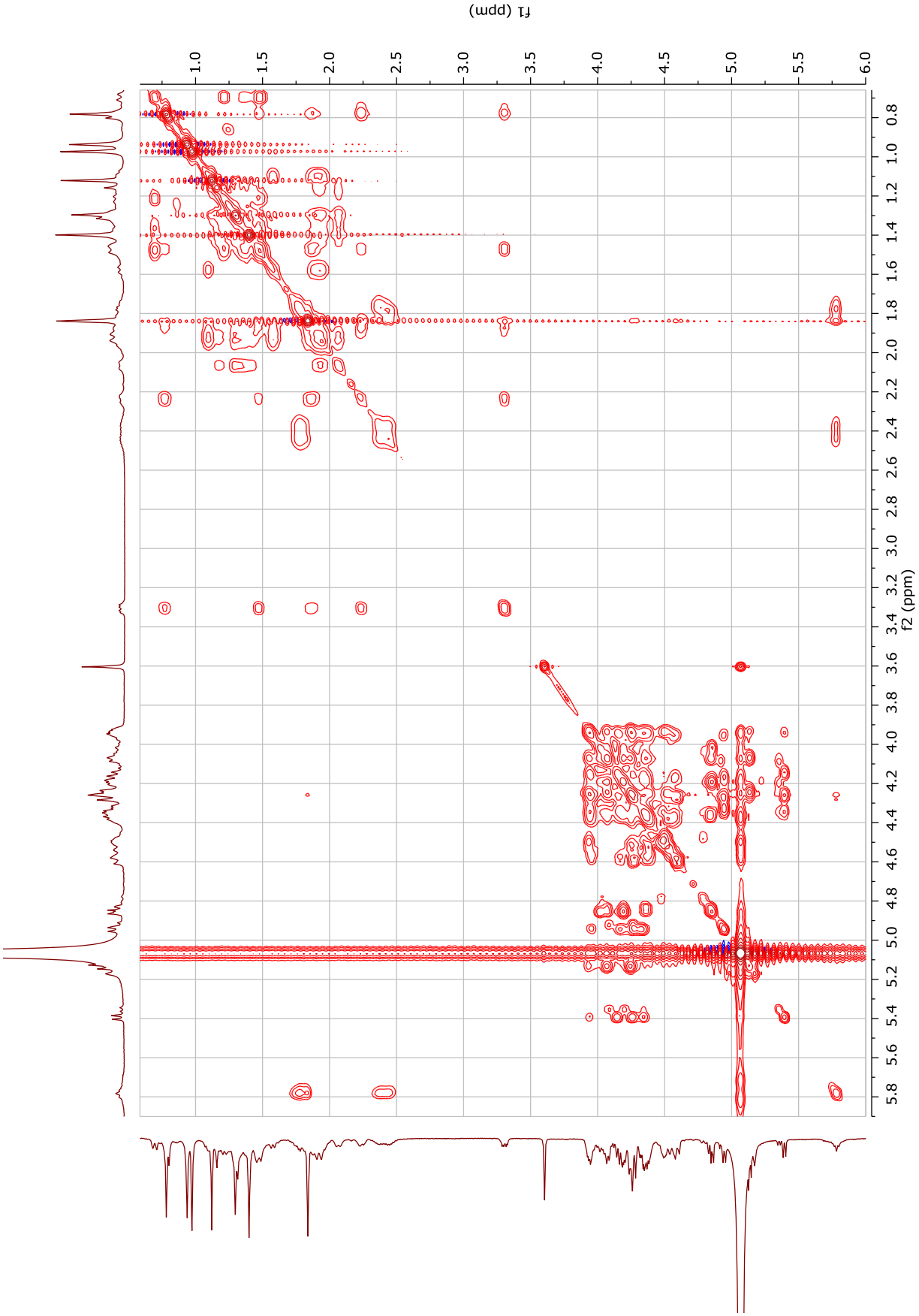


Figura 104. Espectro de TOCSY (2D) de **Sb19** (400 MHz, C_5D_5N).

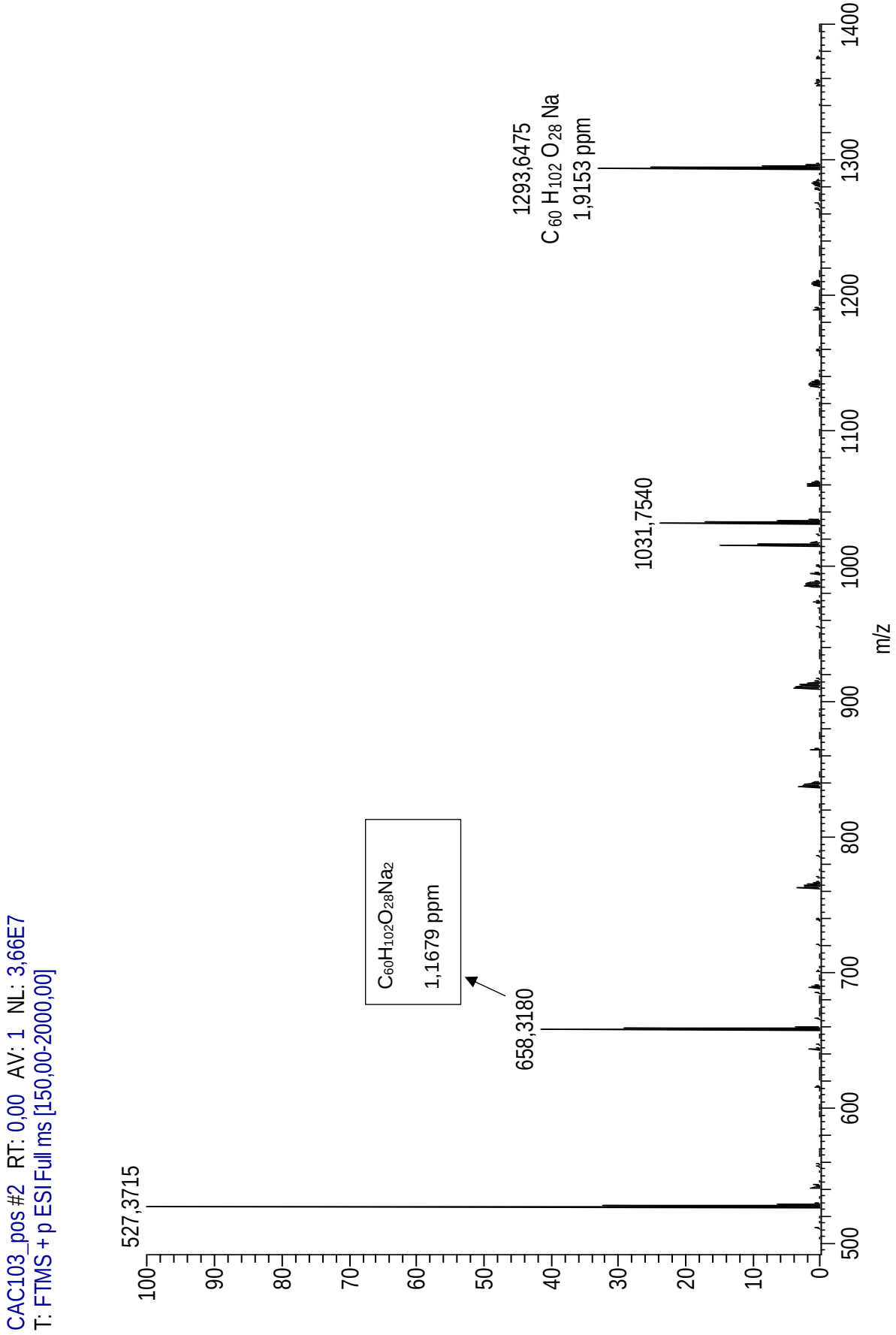


Figura 105. Espectro de massas de alta resolução de **Sb20** (ESI, modo positivo).

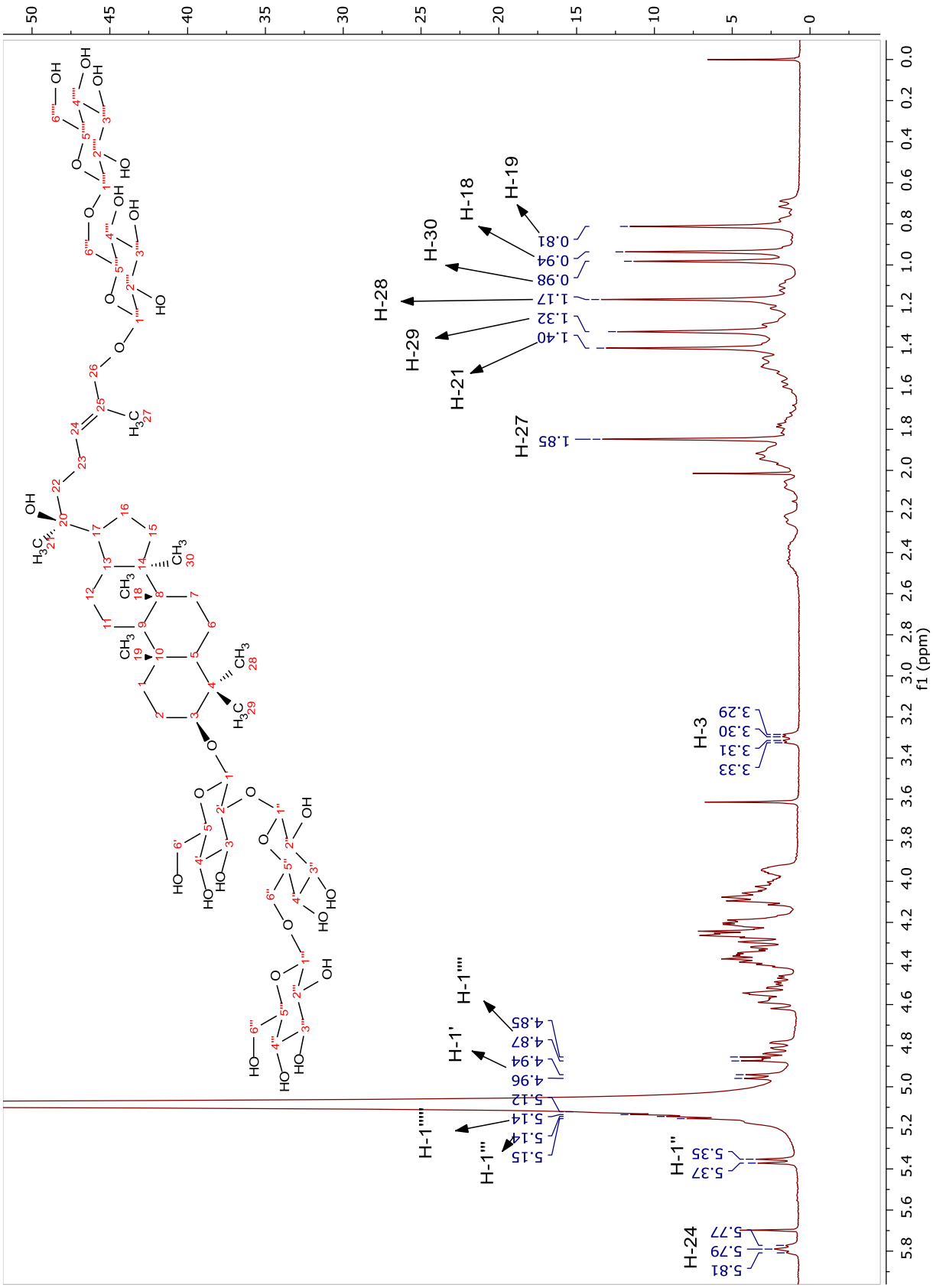


Figura 106. Espectro de RMN ^{1}H de **Sb20** (400 MHz, C_5D_5N).

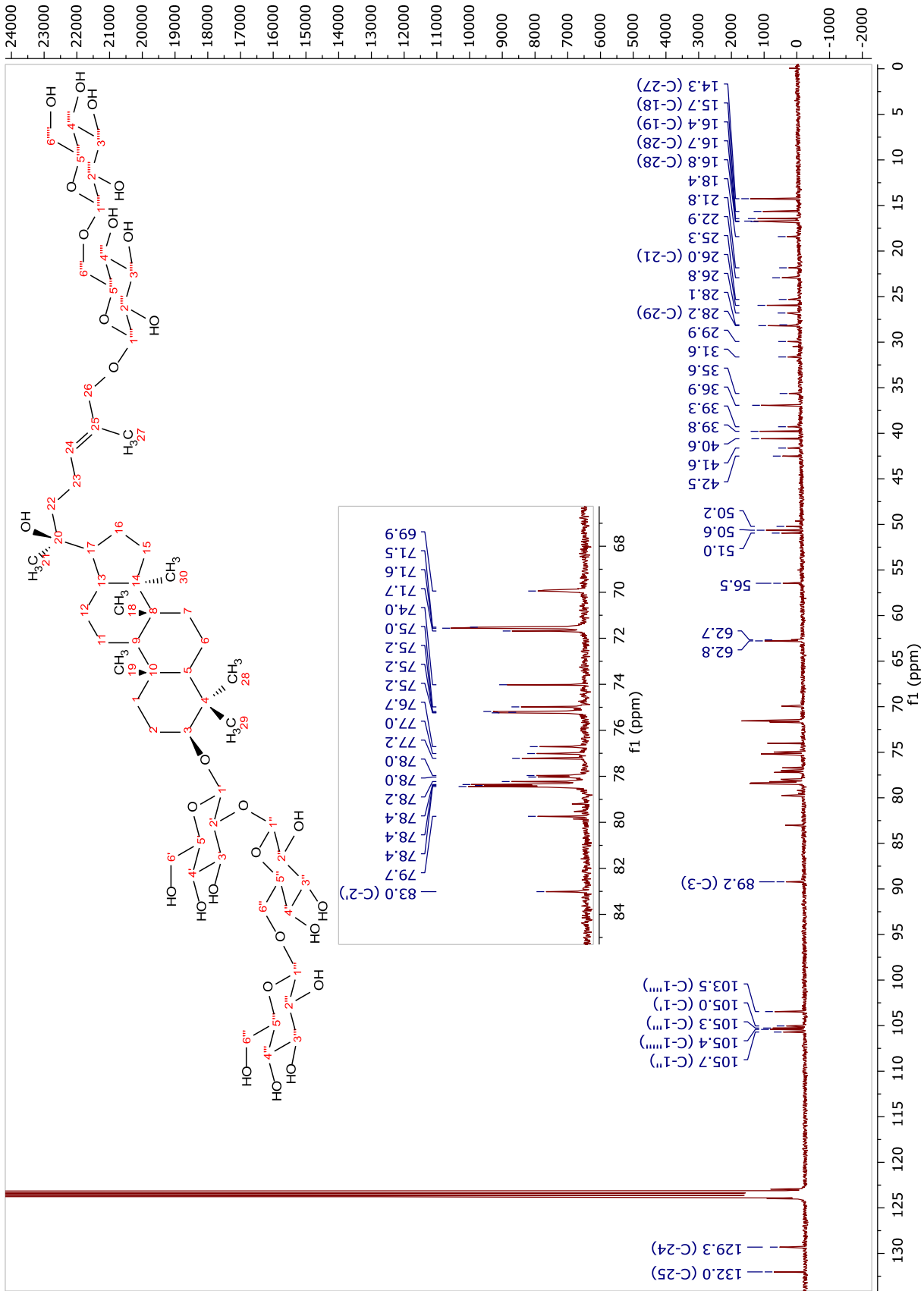


Figura 107. Espectro de RMN ^{13}C de **Sb20** (100 MHz, C_5D_5N).

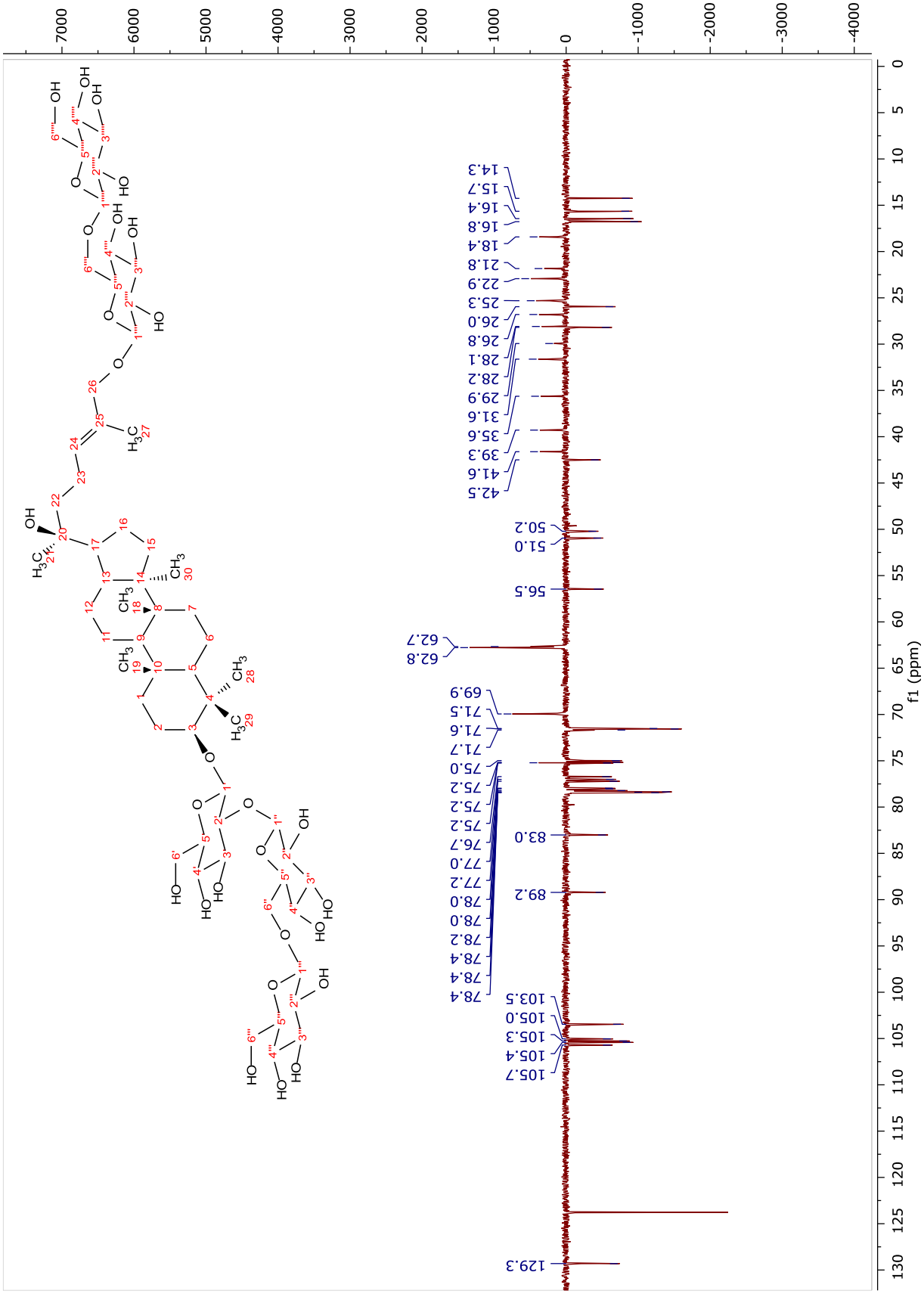


Figura 108. Espectro de DEPT-135 de **Sb20** (100 MHz, C_5D_5N).

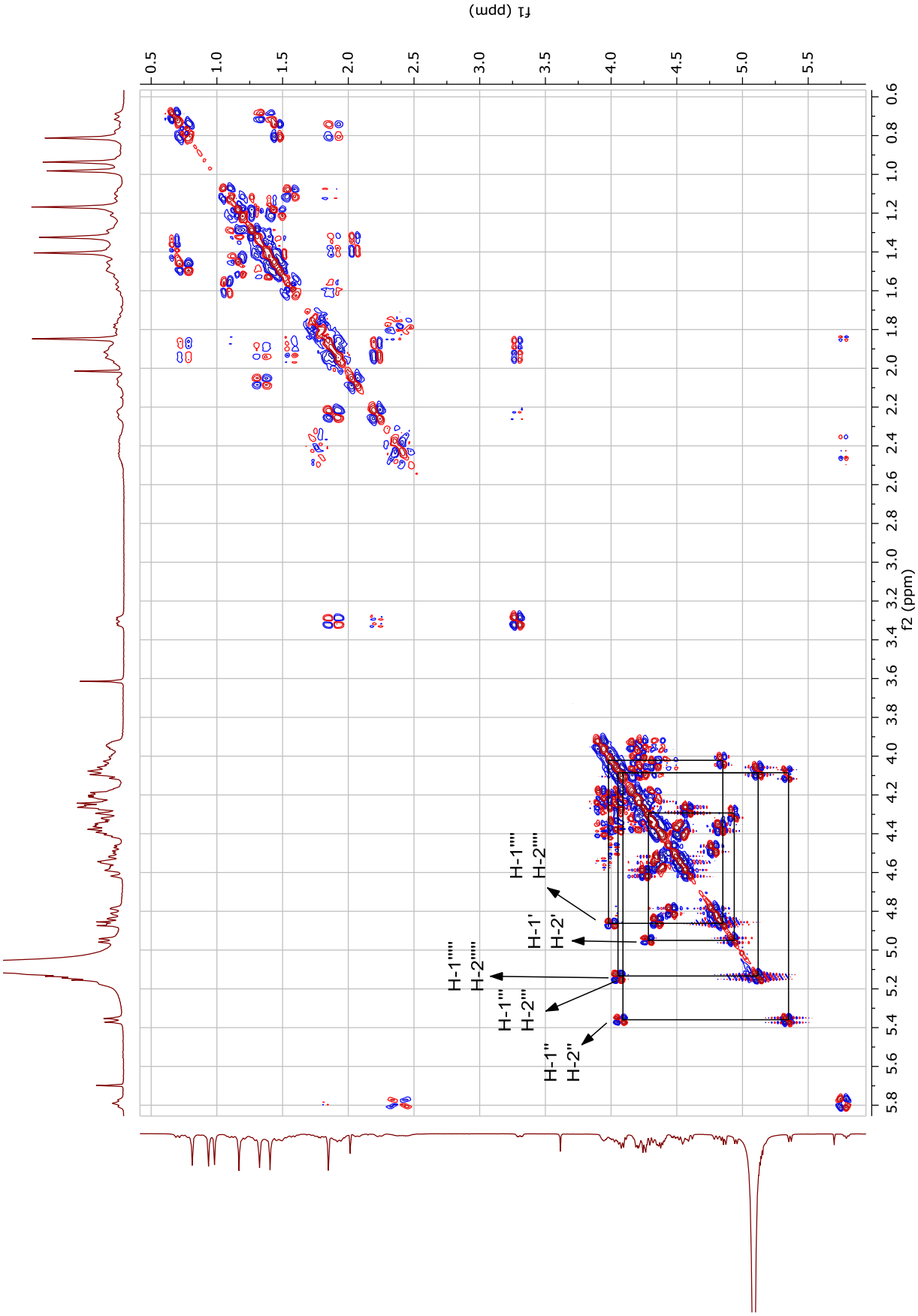


Figura 109. Espectro de COSY de **Sb20** (400 MHz, C_5D_5N).

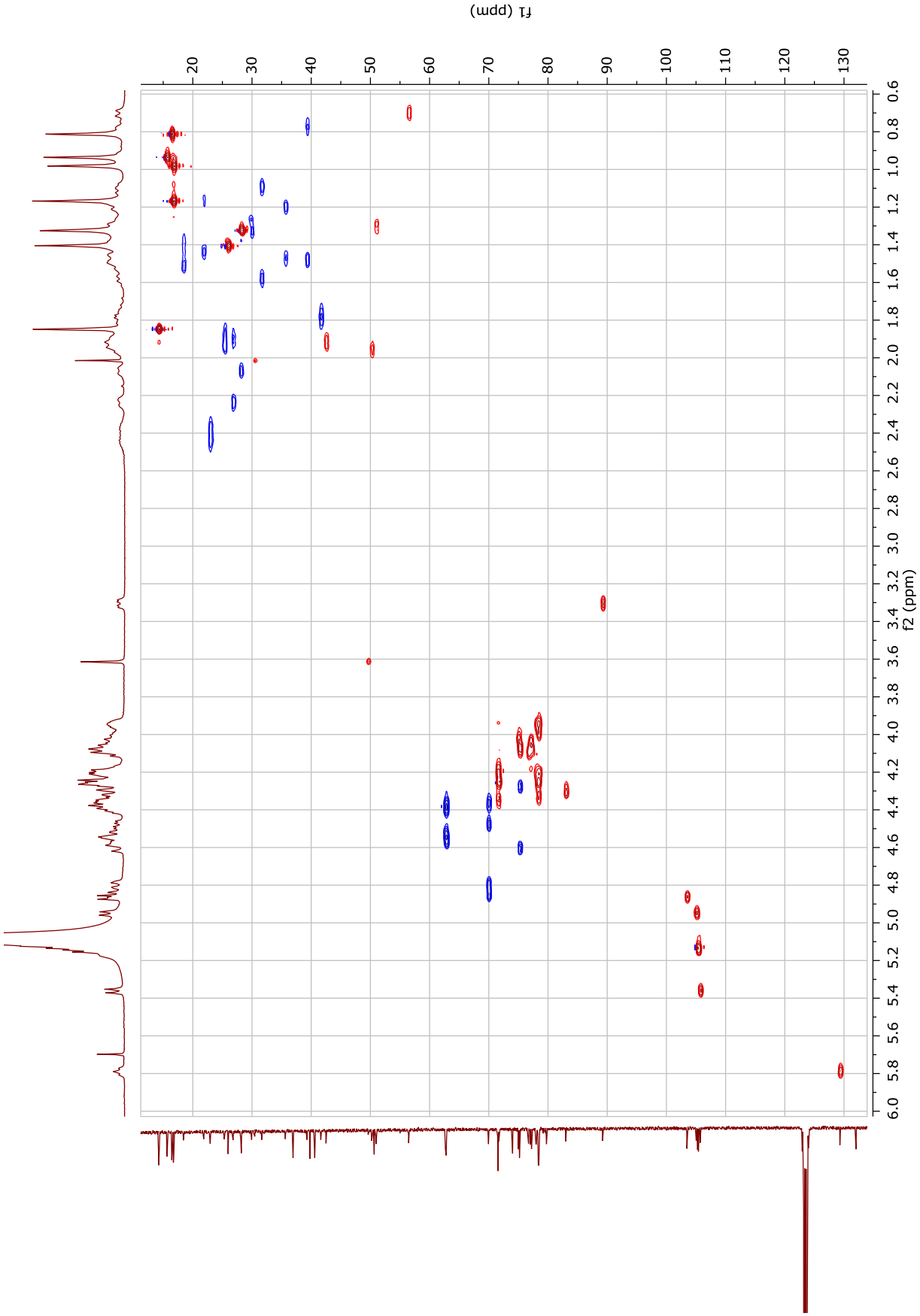


Figura 110. Espectro de HSQC de **Sb20** (400 MHz, C_5D_5N).

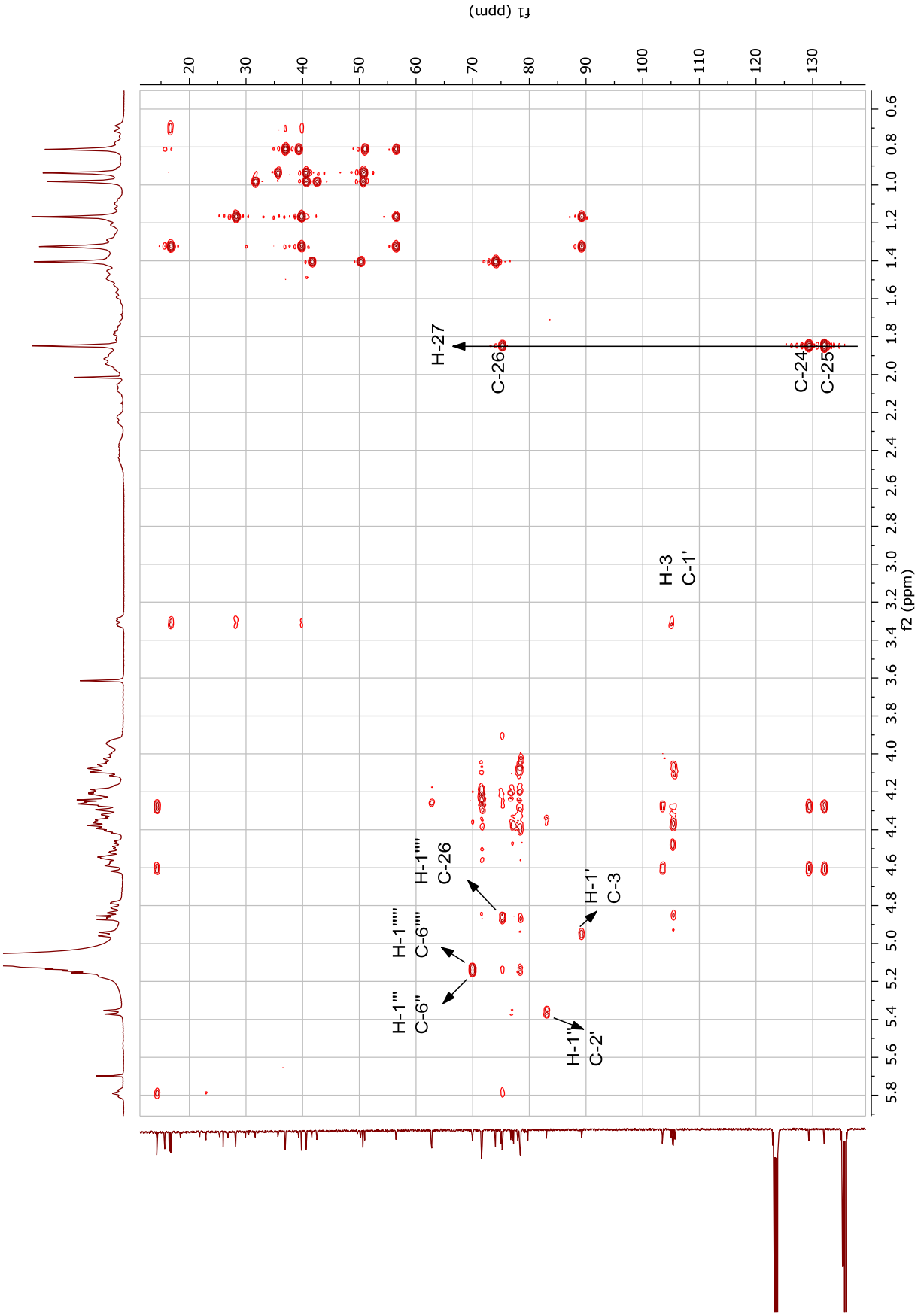


Figura 111. Espectro de HMBC de **Sb20** (400 MHz, C_5D_5N).

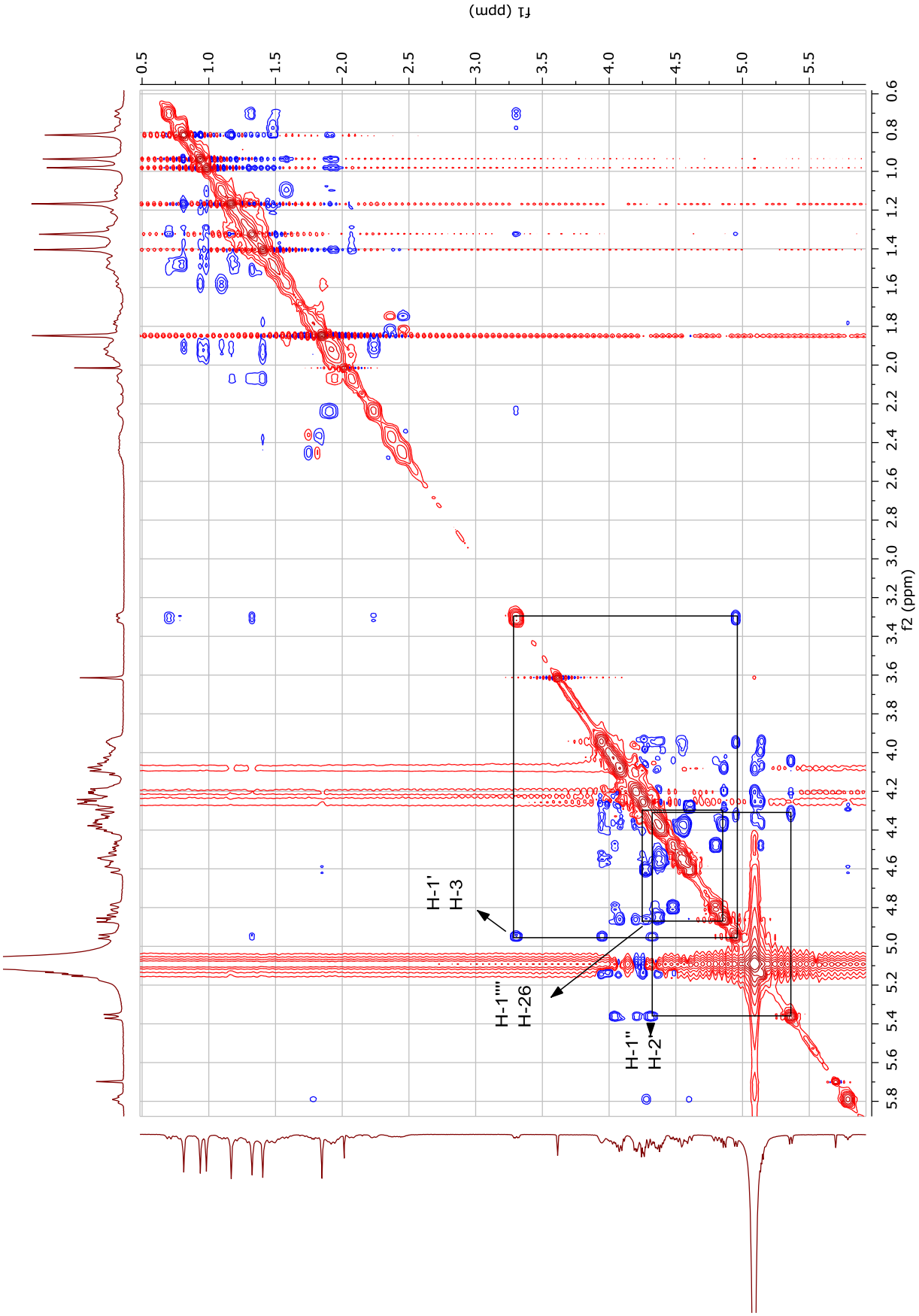


Figura 112. Espectro de ROESY de **Sb20** (400 MHz, C_5D_5N).

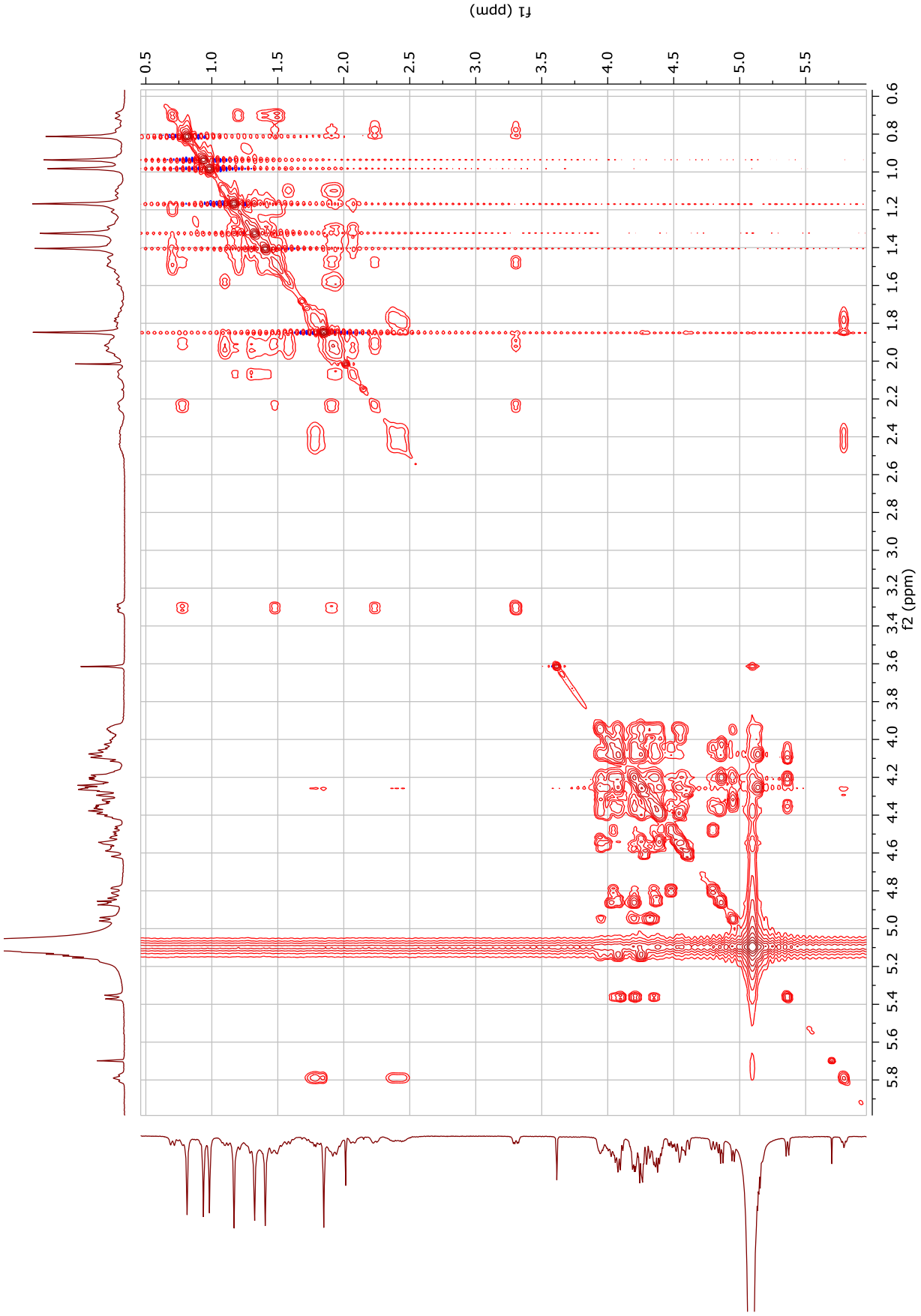


Figura 113. Espectro de TOCSY (2D) de **Sb20** (400 MHz, C_5D_5N).

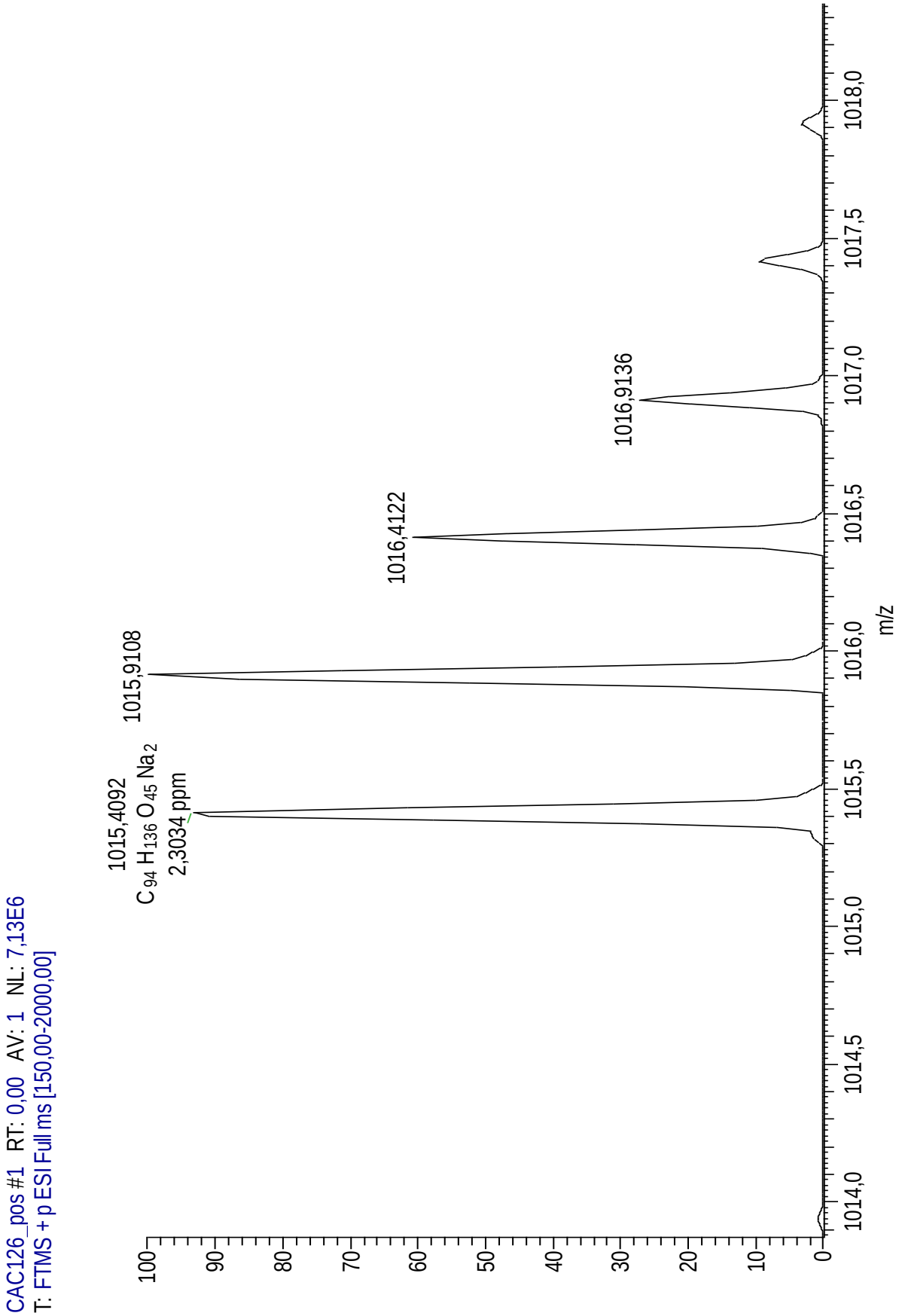


Figura 114. Espectro de massas de alta resolução do derivado acetilado de **Sb20** (modo positivo).

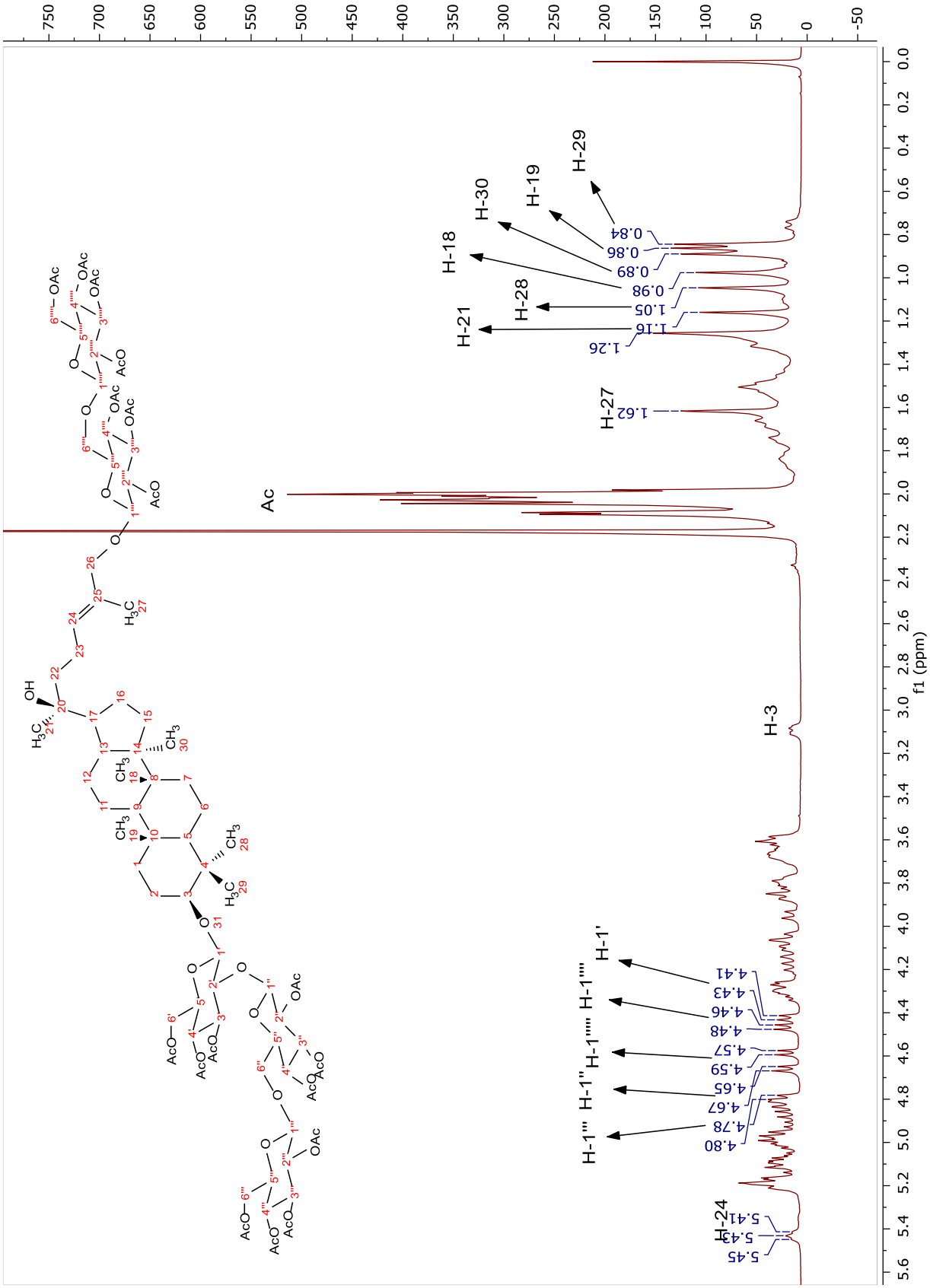


Figura 115. Espectro de RMN ^{1}H do derivado acetilado de **Sb20** (400 MHz, $CDCl_3$).

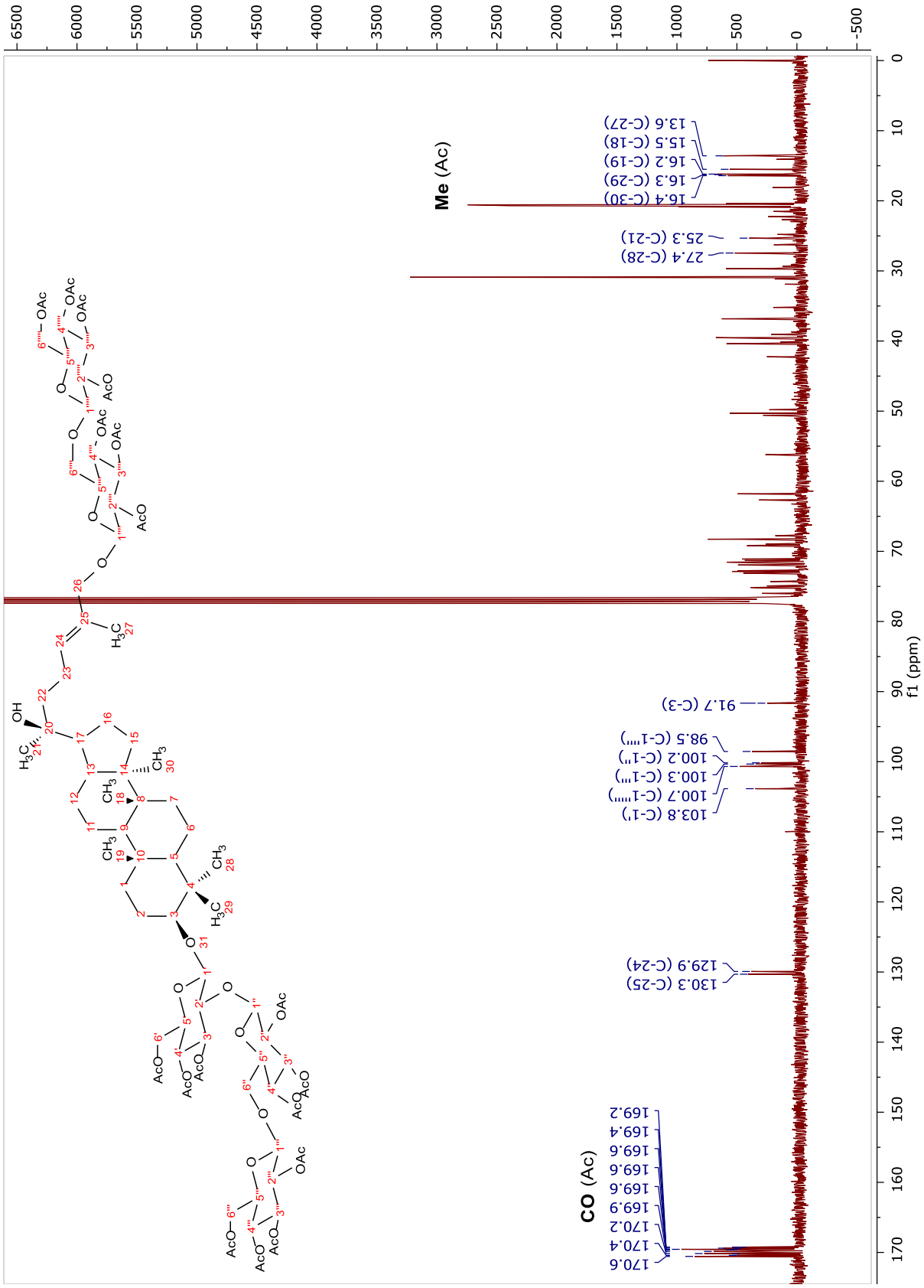


Figura 116. Espectro de RMN ^{13}C do derivado acetilado de **Sb20** (100 MHz, $CDCl_3$).

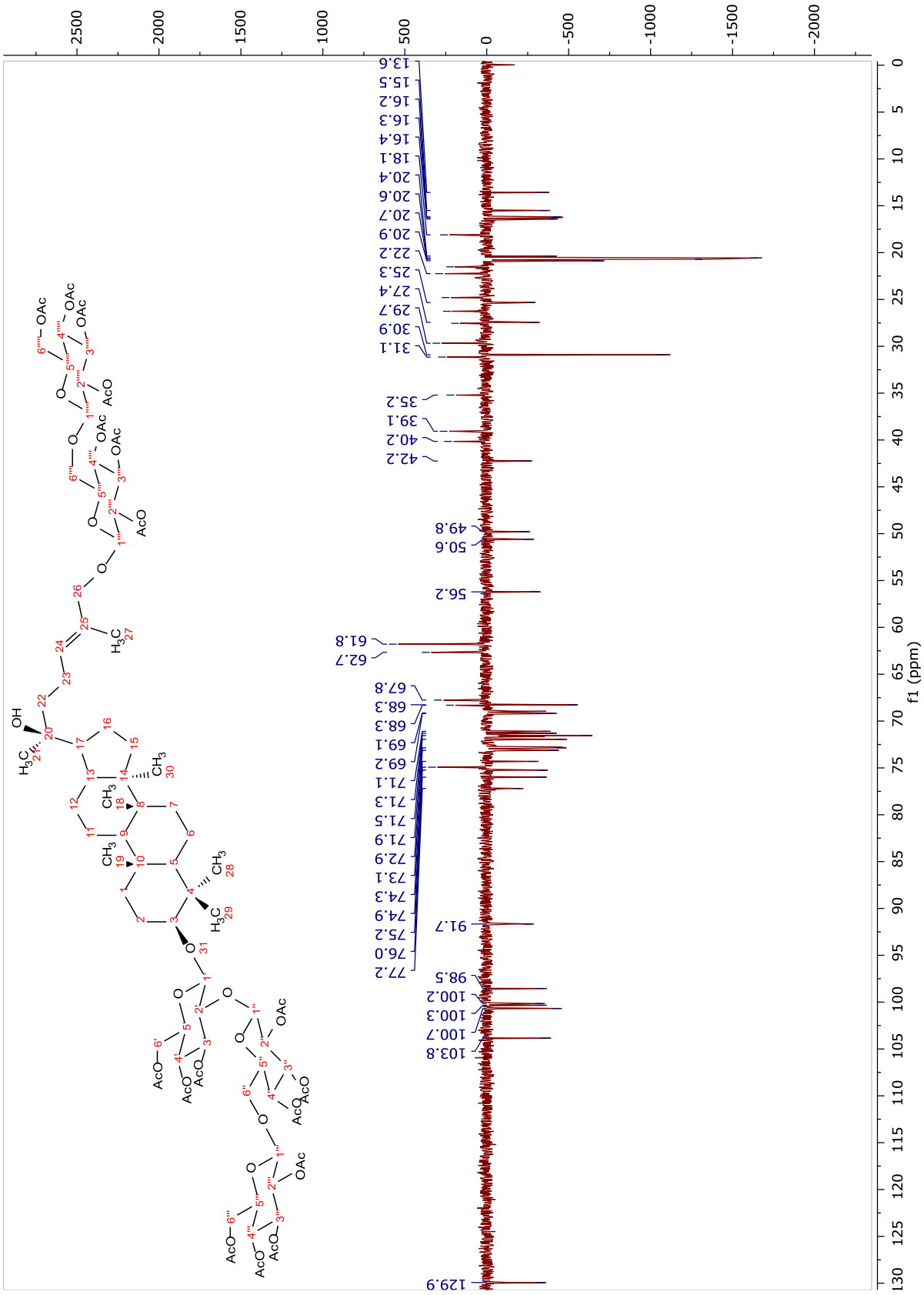


Figura 117. Espectro de DEPT-135 do derivado acetilado de **Sb20** (100 MHz, $CDCl_3$).

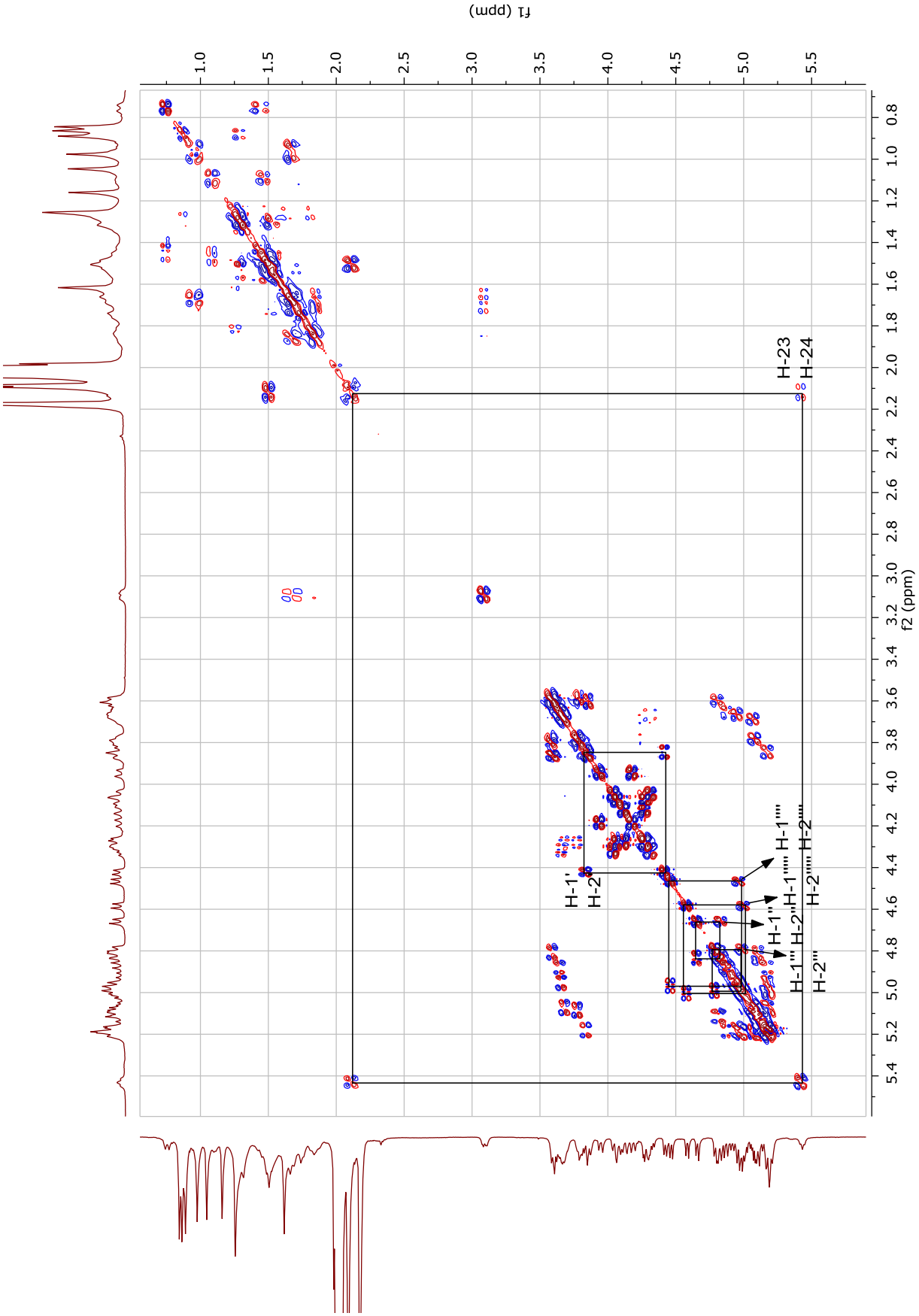


Figura 118. Espectro de COSY do derivado acetilado de **Sb20** (400 MHz, $CDCl_3$).

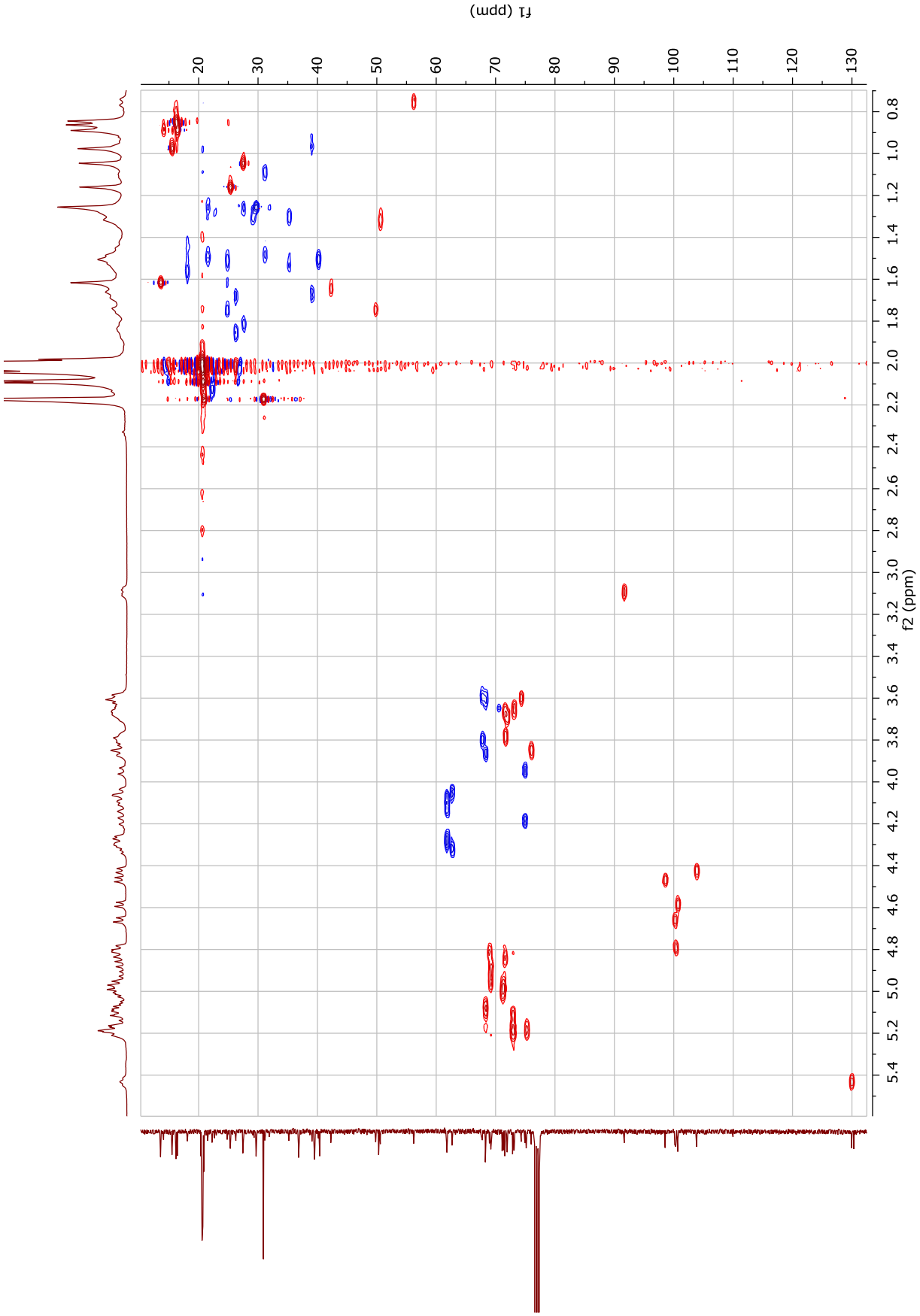


Figura 119. Espectro de HSQC do derivado acetilado de **Sb20** (400 MHz, $CDCl_3$).

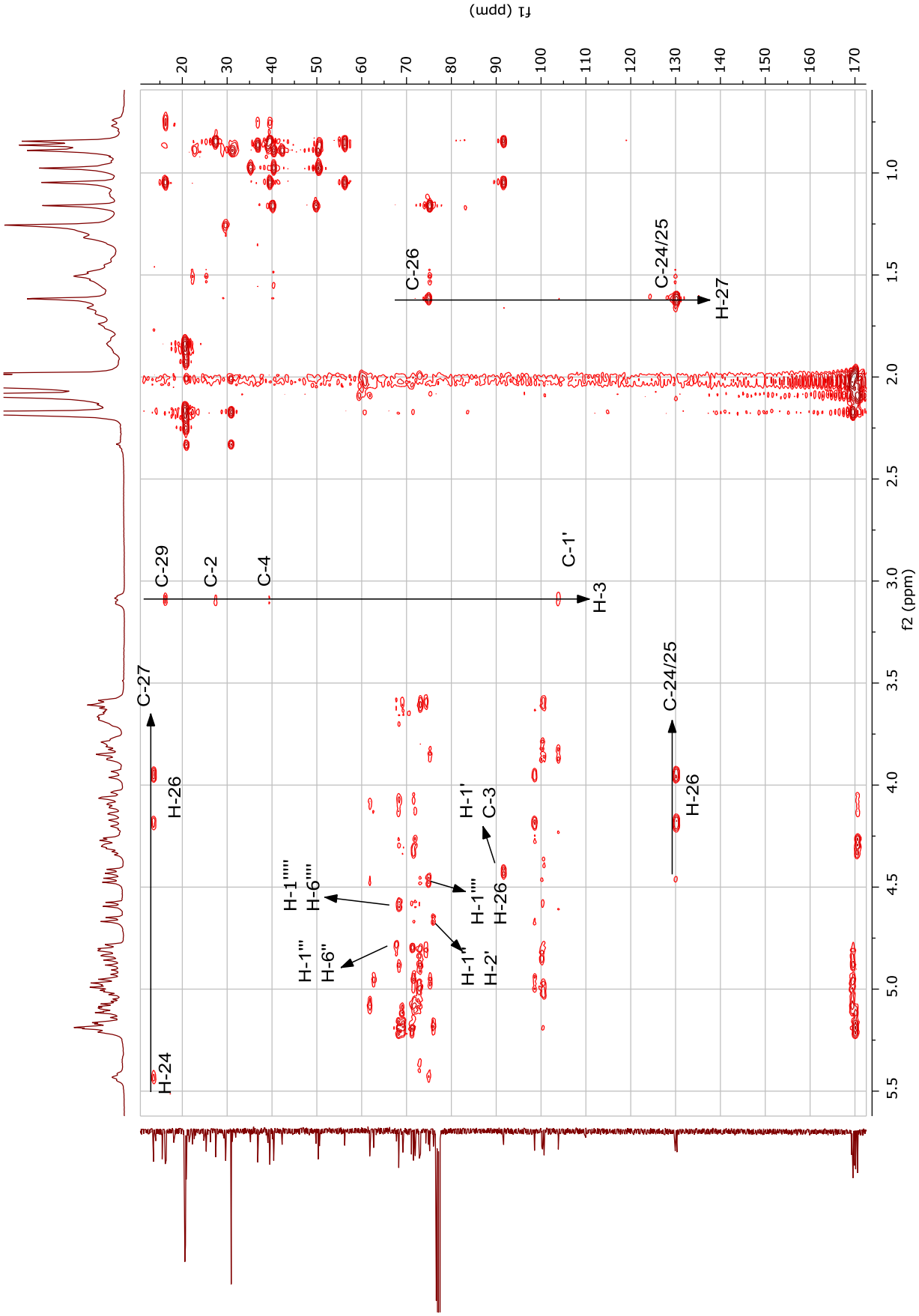


Figura 120. Espectro de HMBC do derivado acetilado de **Sb20** (400 MHz, $CDCl_3$).

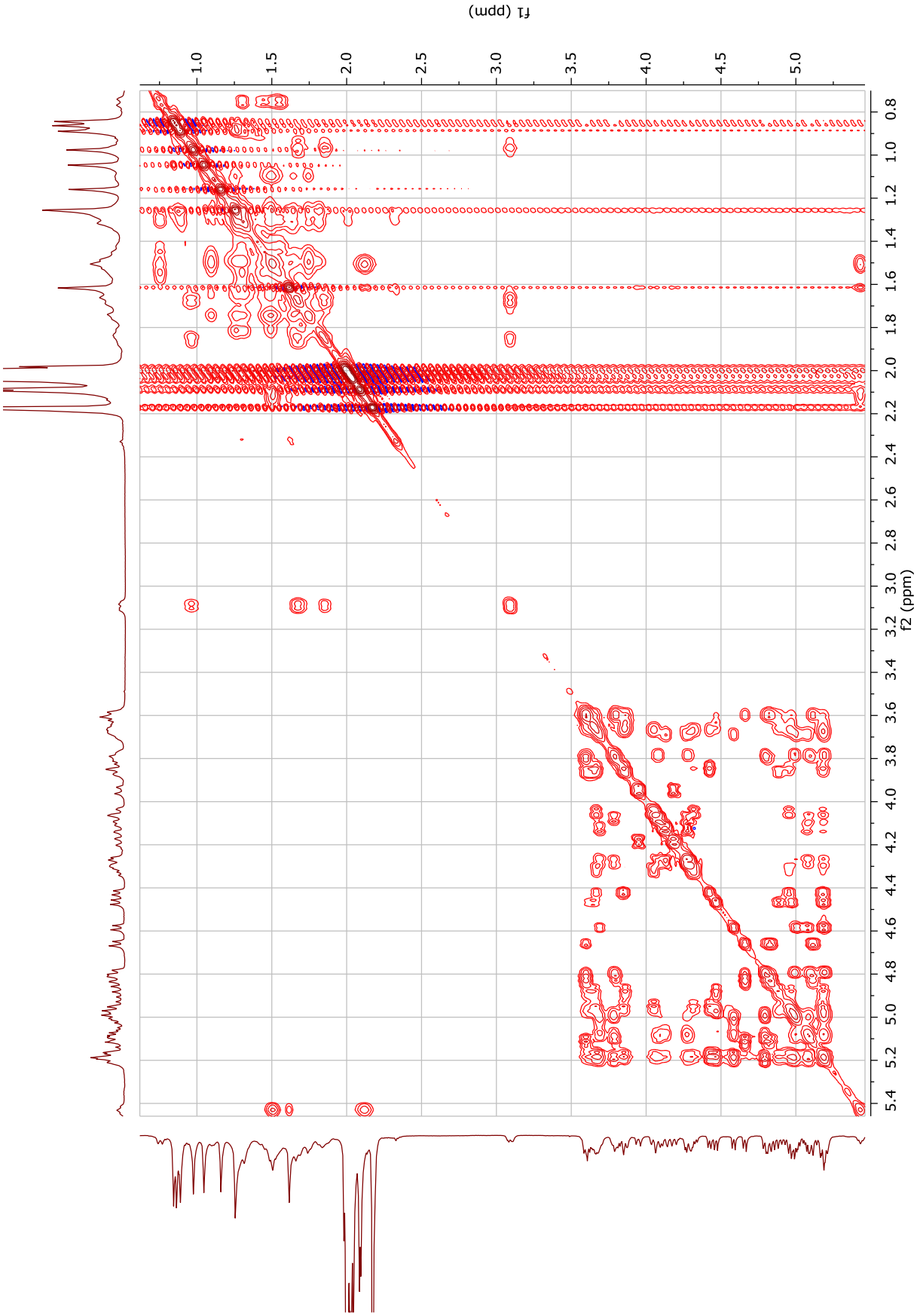


Figura 121. Espectro de TOCSY 2D do derivado acetilado de Sb20 (400 MHz, $CDCl_3$).

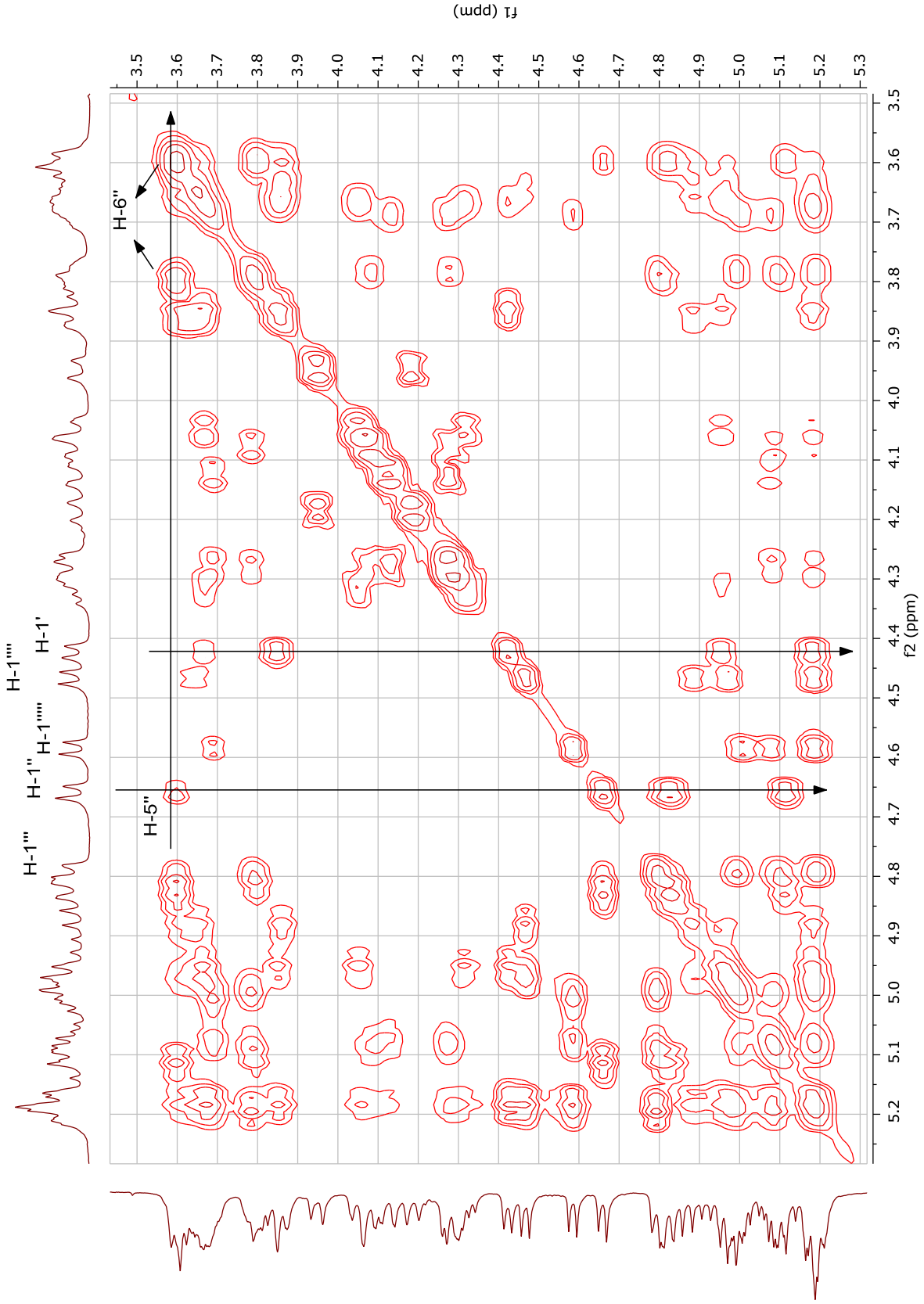


Figura 122. Expansão do espectro de TOCSY 2D do derivado acetilado de **Sb20** (400 MHz, $CDCl_3$).

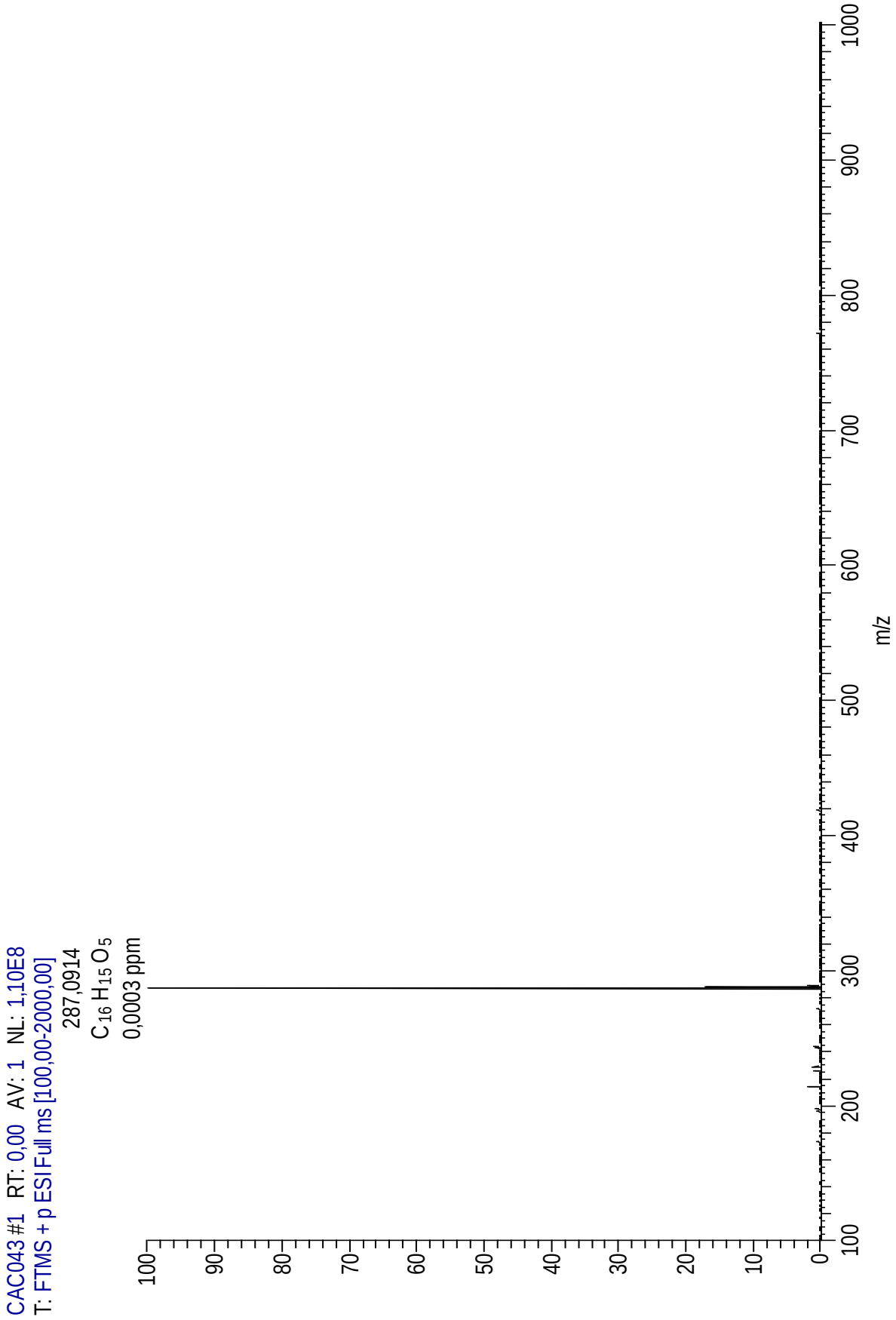


Figura 123. Espectro de massas de alta resolução de **Zg1** (ESI, modo positivo).

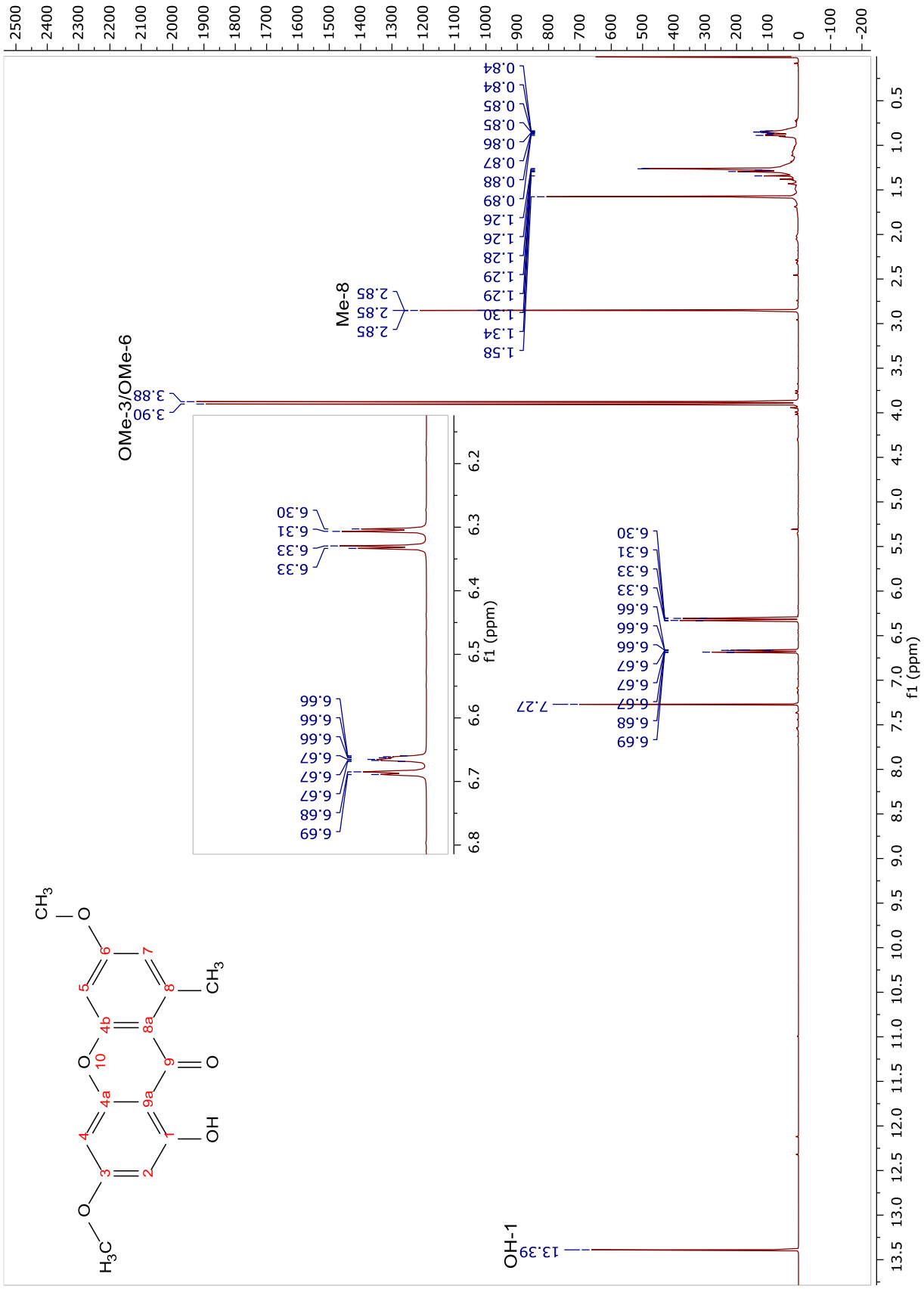


Figura 124. Espectro de RMN ^{1}H de **Zg1** (400 MHz, $CDCl_3$).

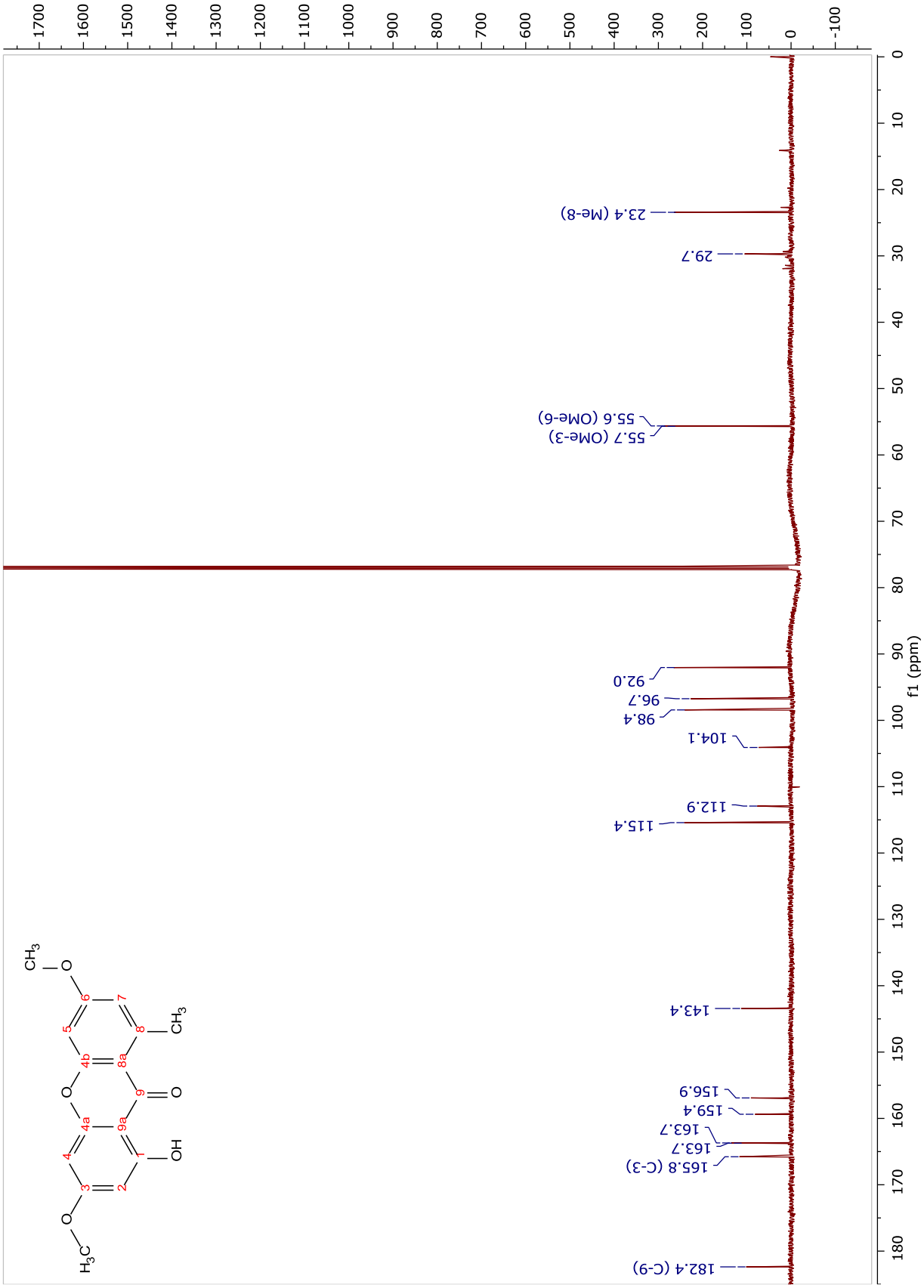


Figura 125. Espectro de RMN ^{13}C de **Zg1** (100 MHz, $CDCl_3$).

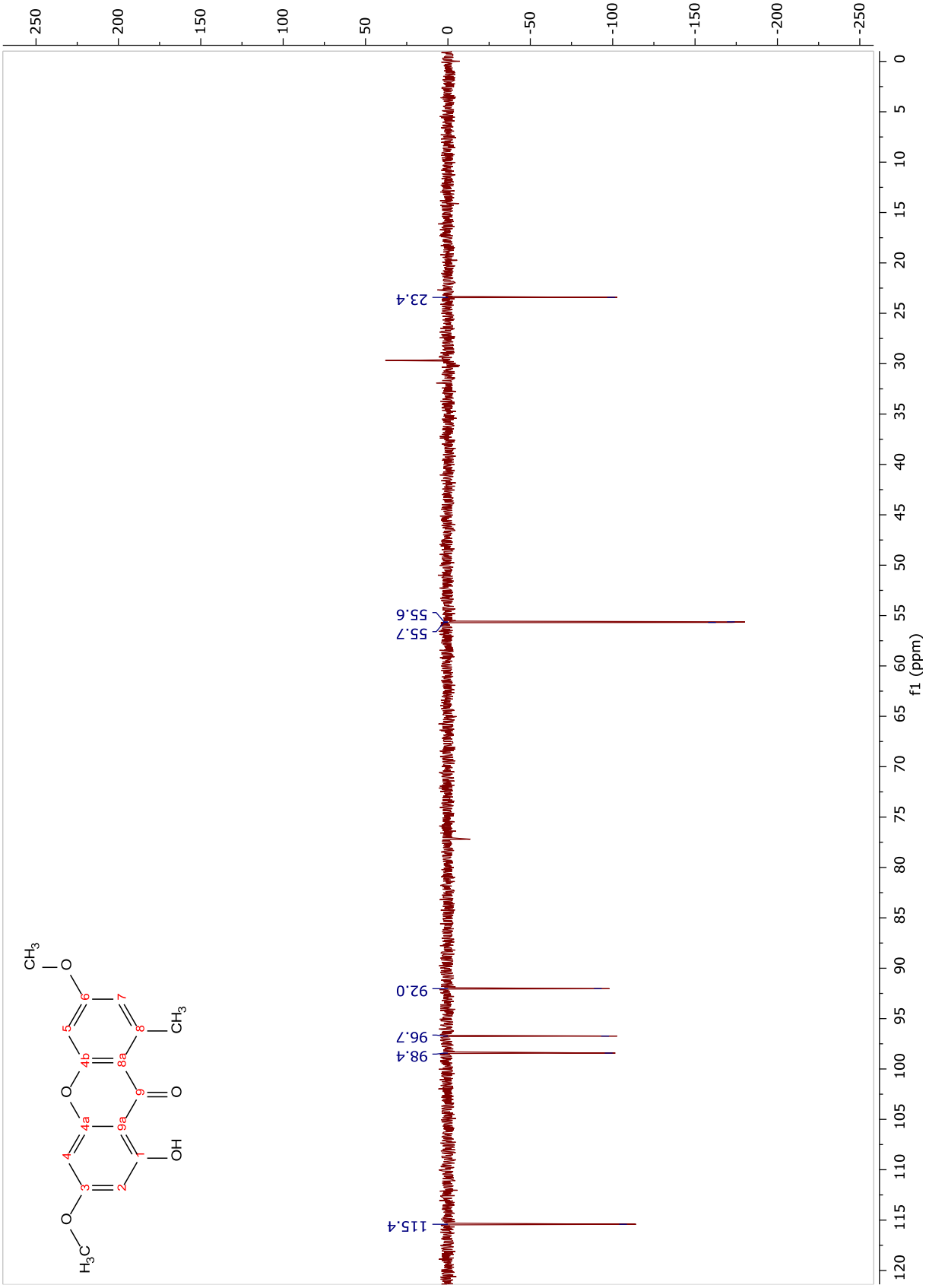


Figura 126. Espectro de DEPT-135 de **Zg1** (100 MHz, $CDCl_3$).

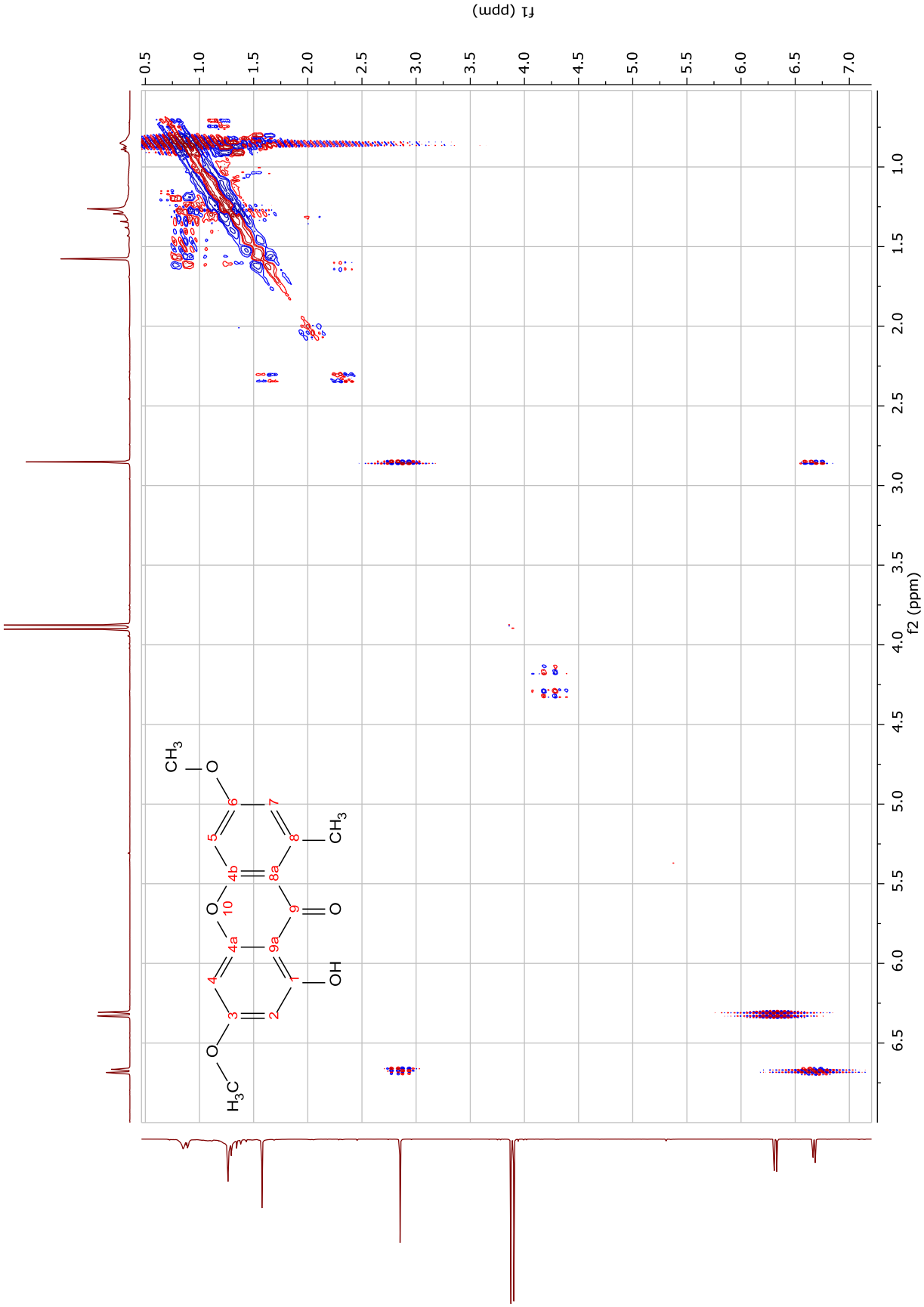


Figura 127. Espectro de COSY de **Zg1** (400 MHz, $CDCl_3$).

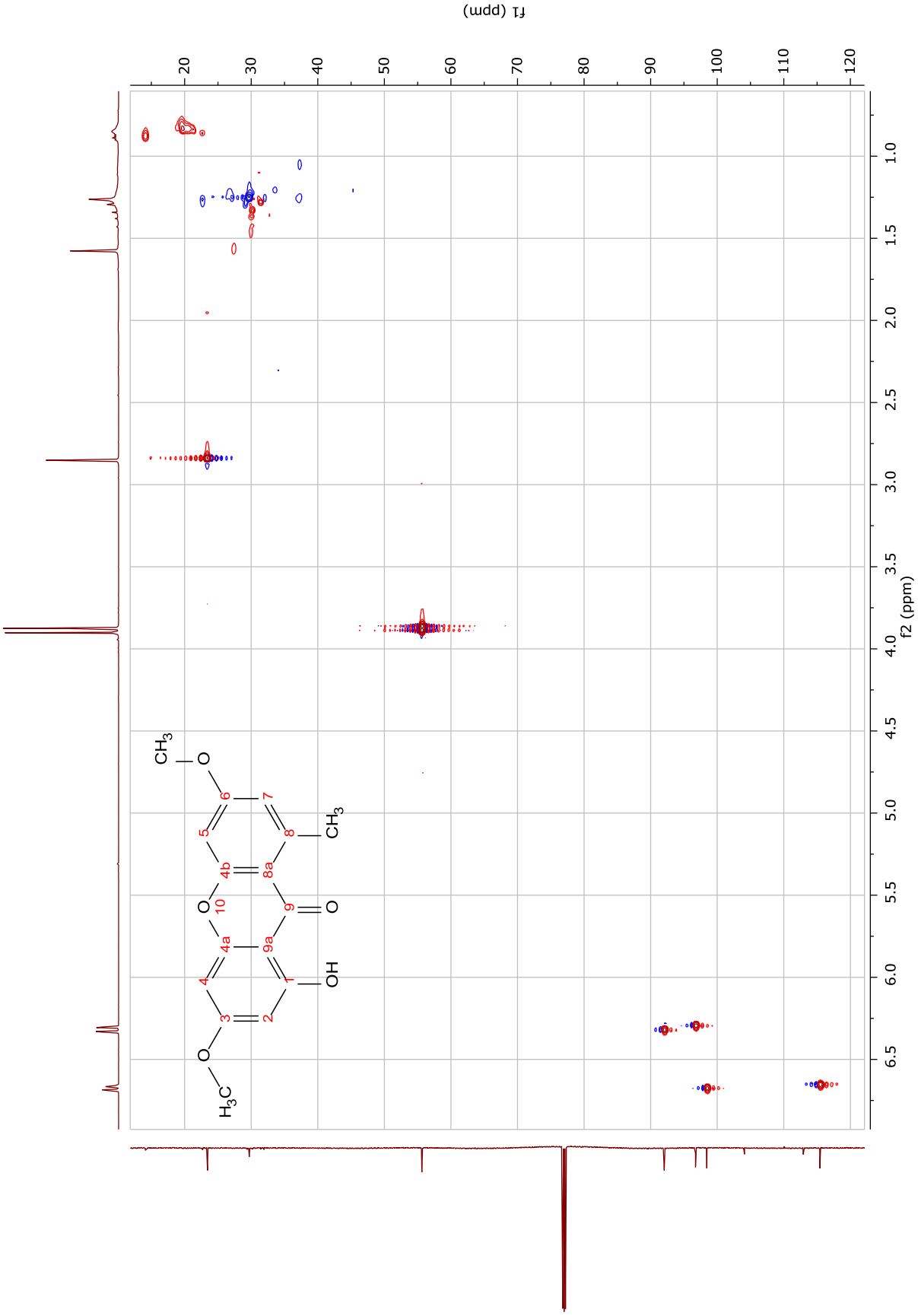


Figura 128. Espectro de HSQC de **Zg1** (400 MHz, $CDCl_3$).

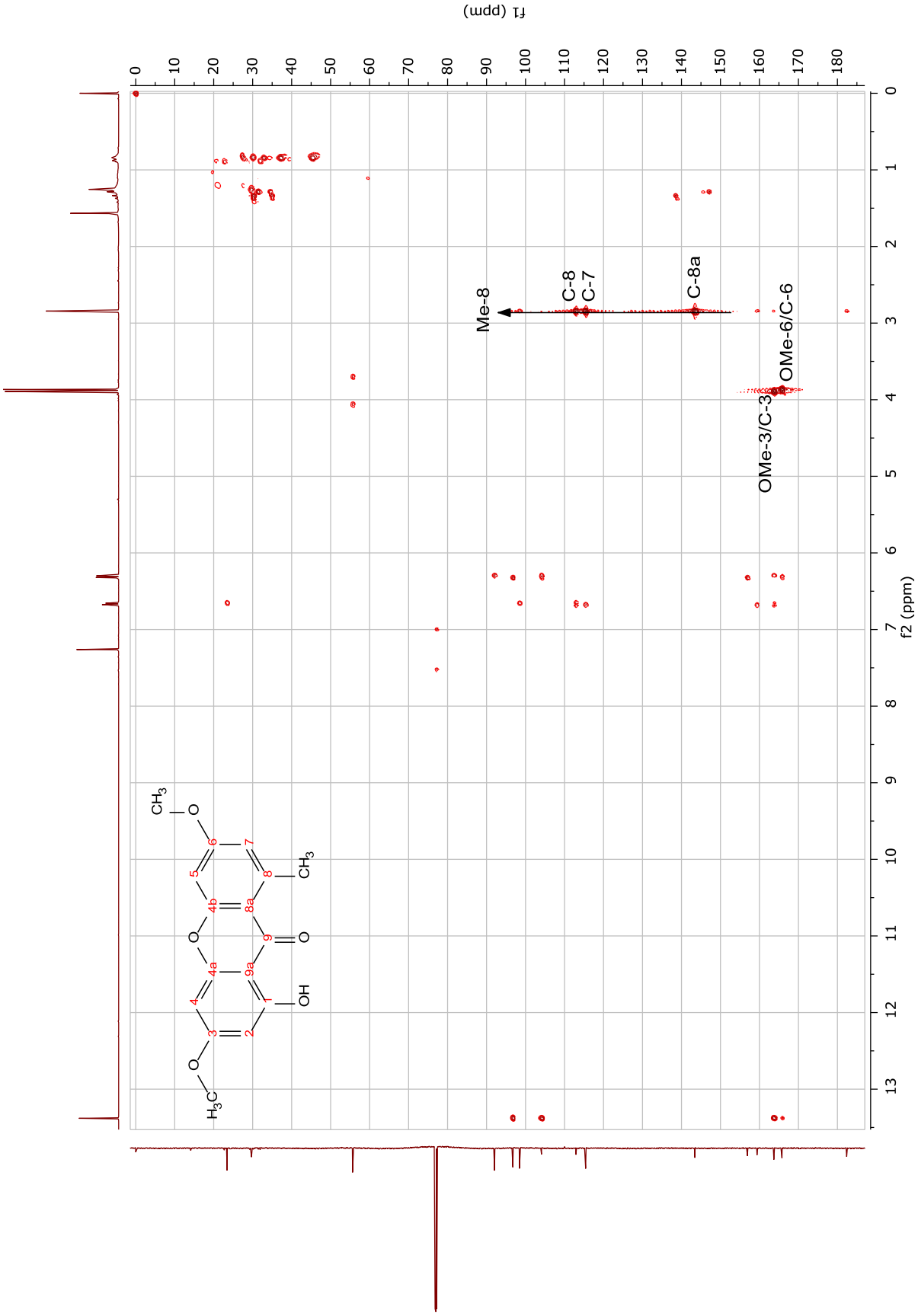


Figura 129. Espectro de HMBC de **Zg1** (400 MHz, $CDCl_3$).

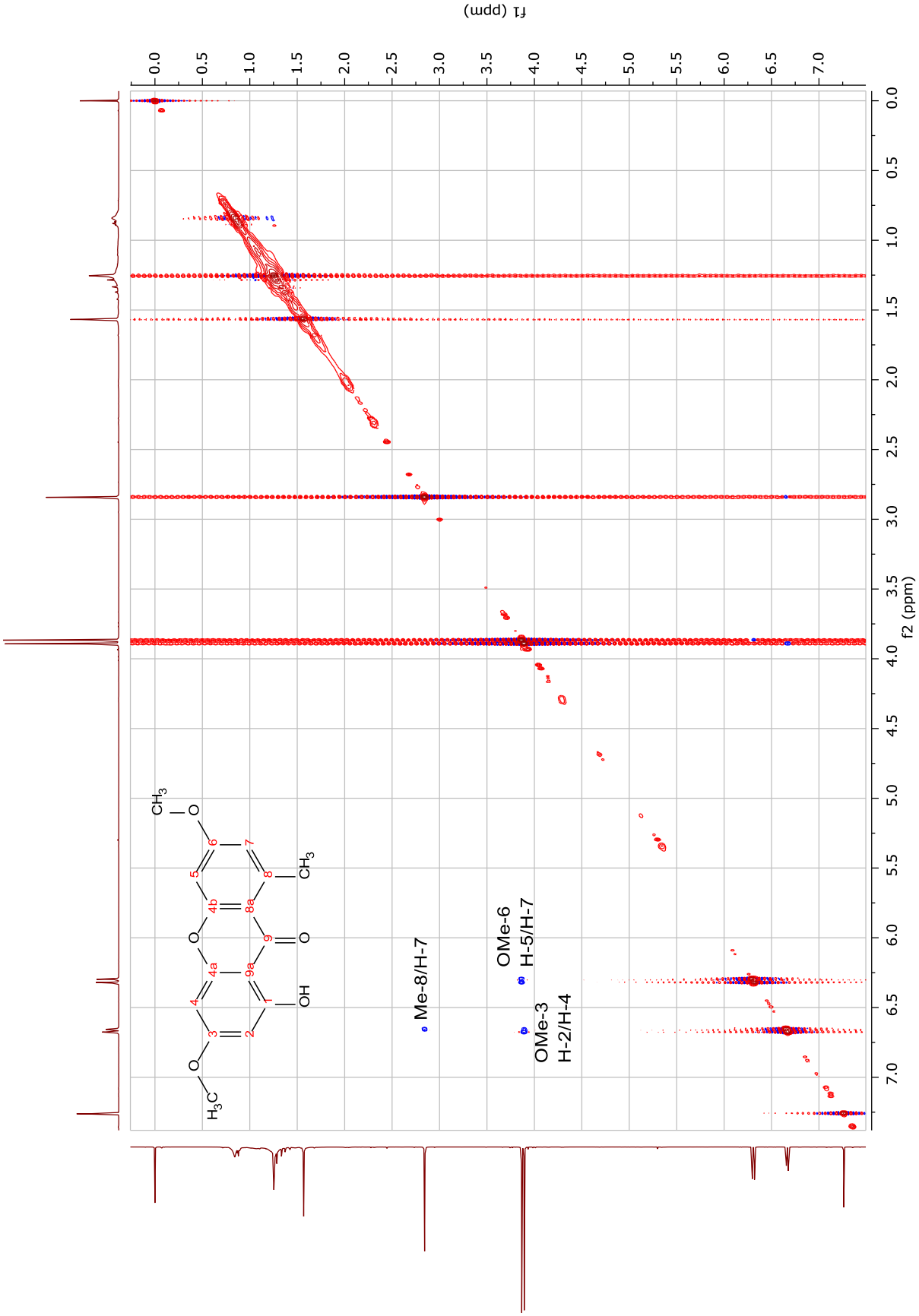


Figura 130. Espectro de NOESY de **Zg1** (400 MHz, $CDCl_3$).

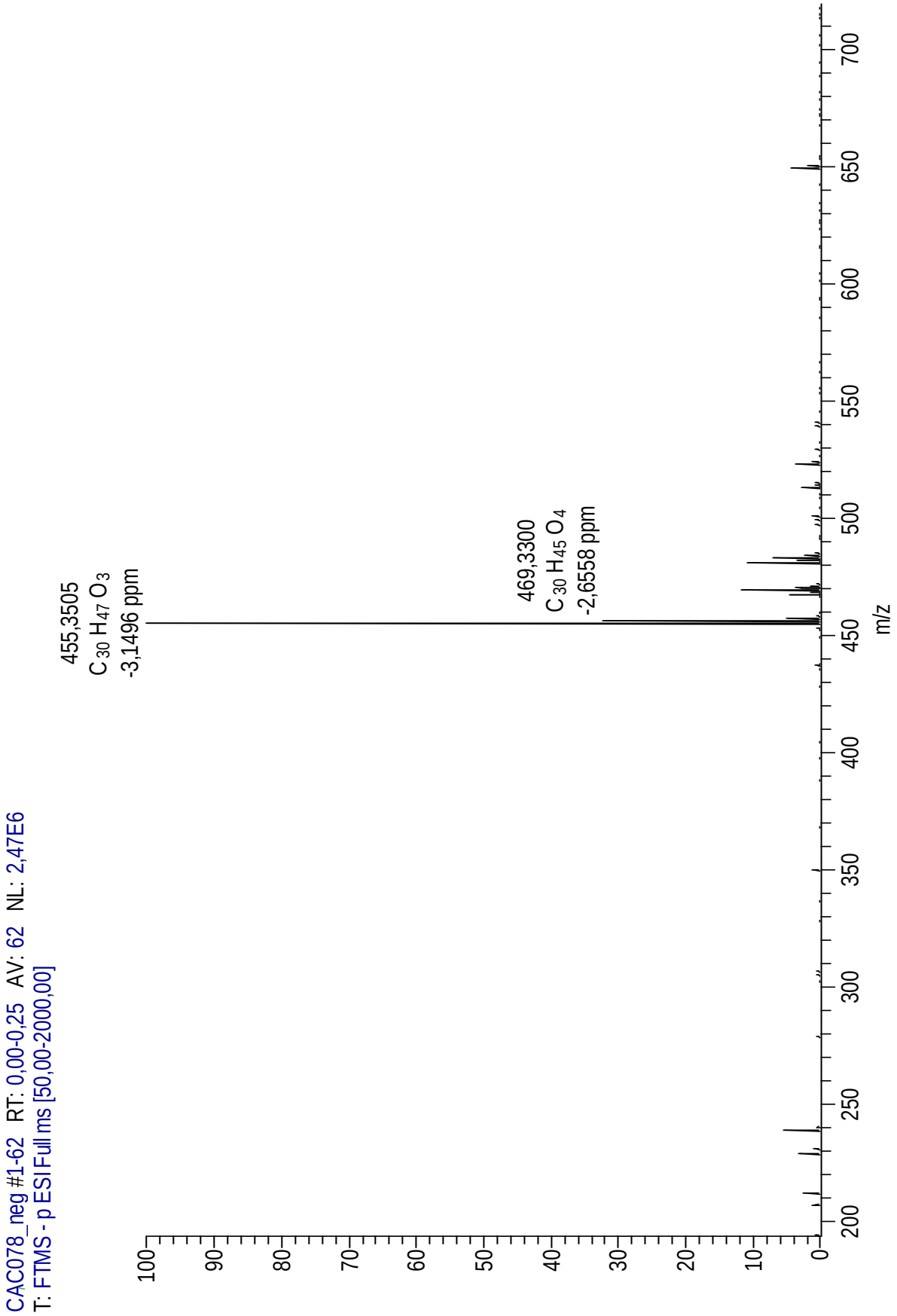


Figura 131. Espectro de massas de alta resolução de **Zg2** (ESI, modo negativo).

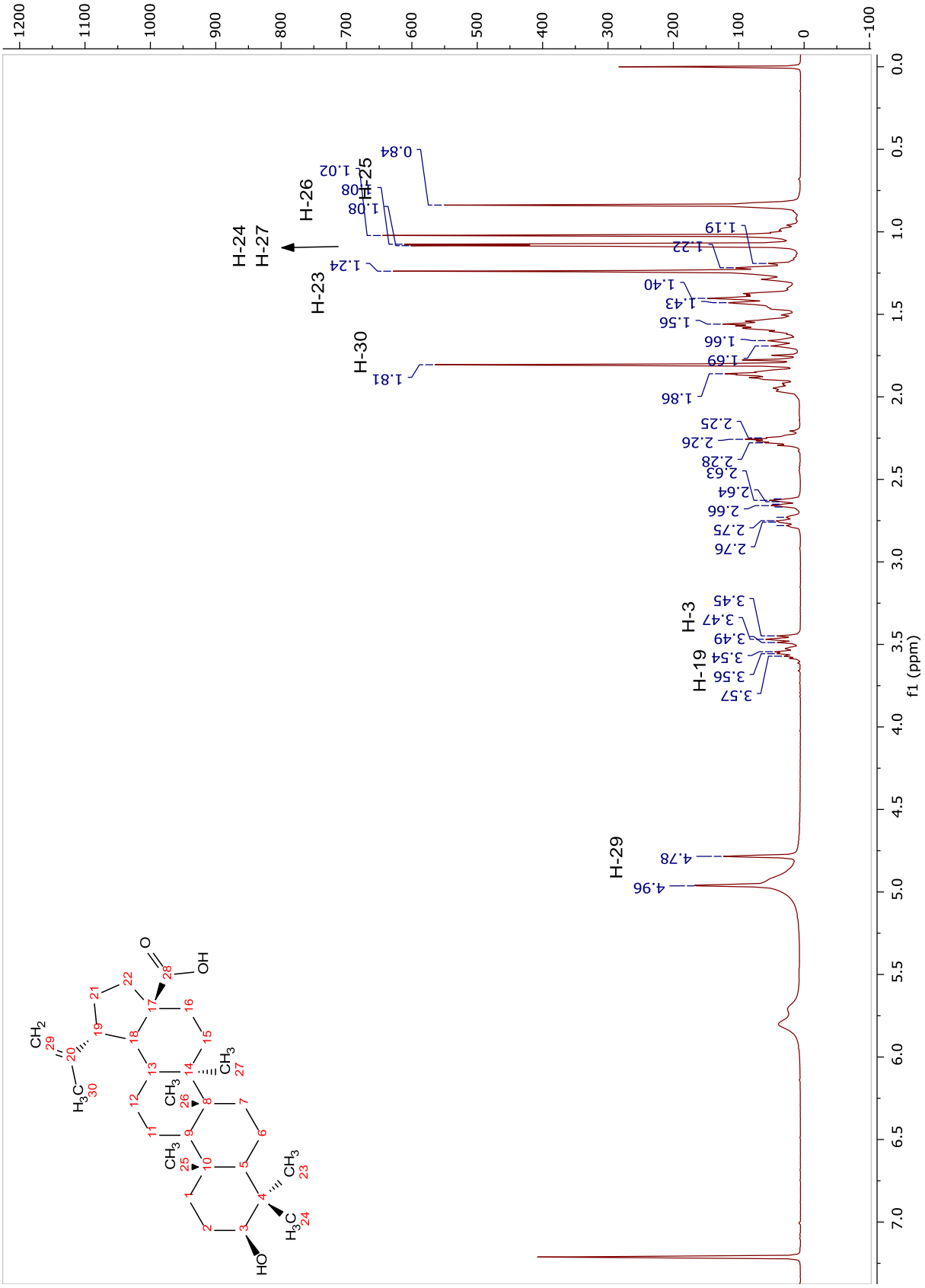


Figura 132. Espectro de RMN ^{1}H de **Zg2** (400 MHz, C_5D_5N).

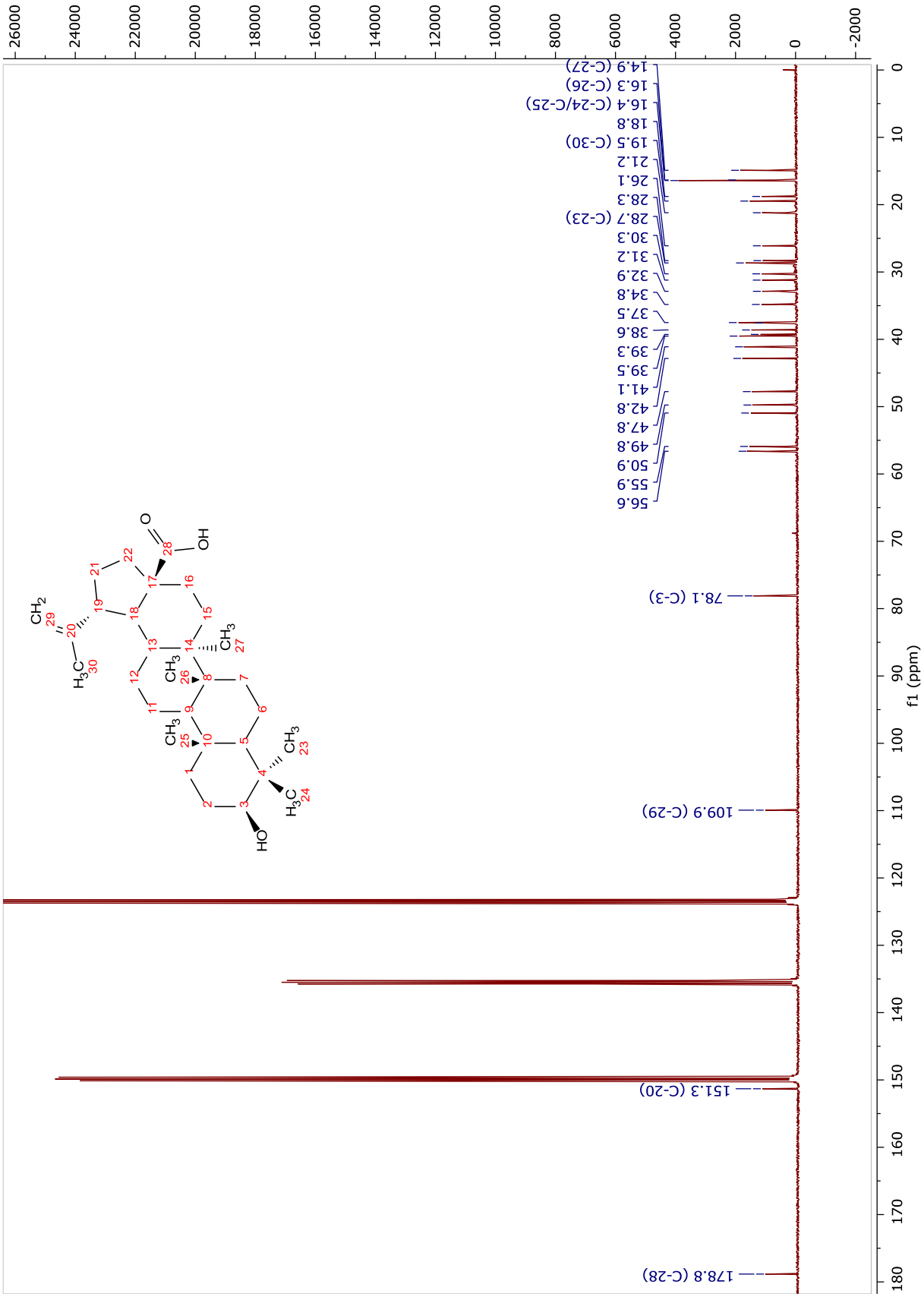


Figura 133. Espectro de RMN ^{13}C de **Zg2** (100 MHz, C_5D_5N).

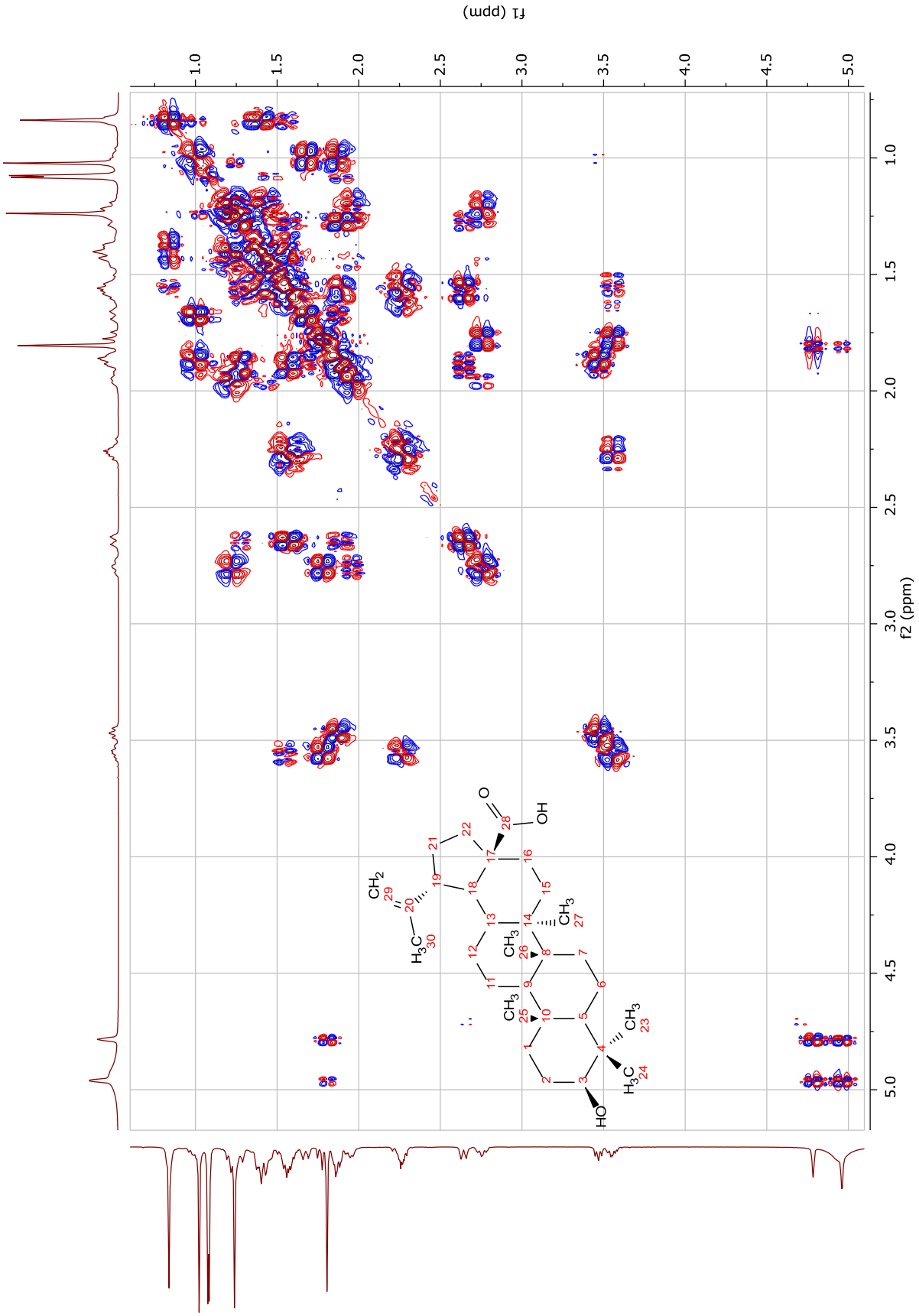


Figura 134. Espectro de COSY de **Zg2** (400 MHz, C_5D_5N).

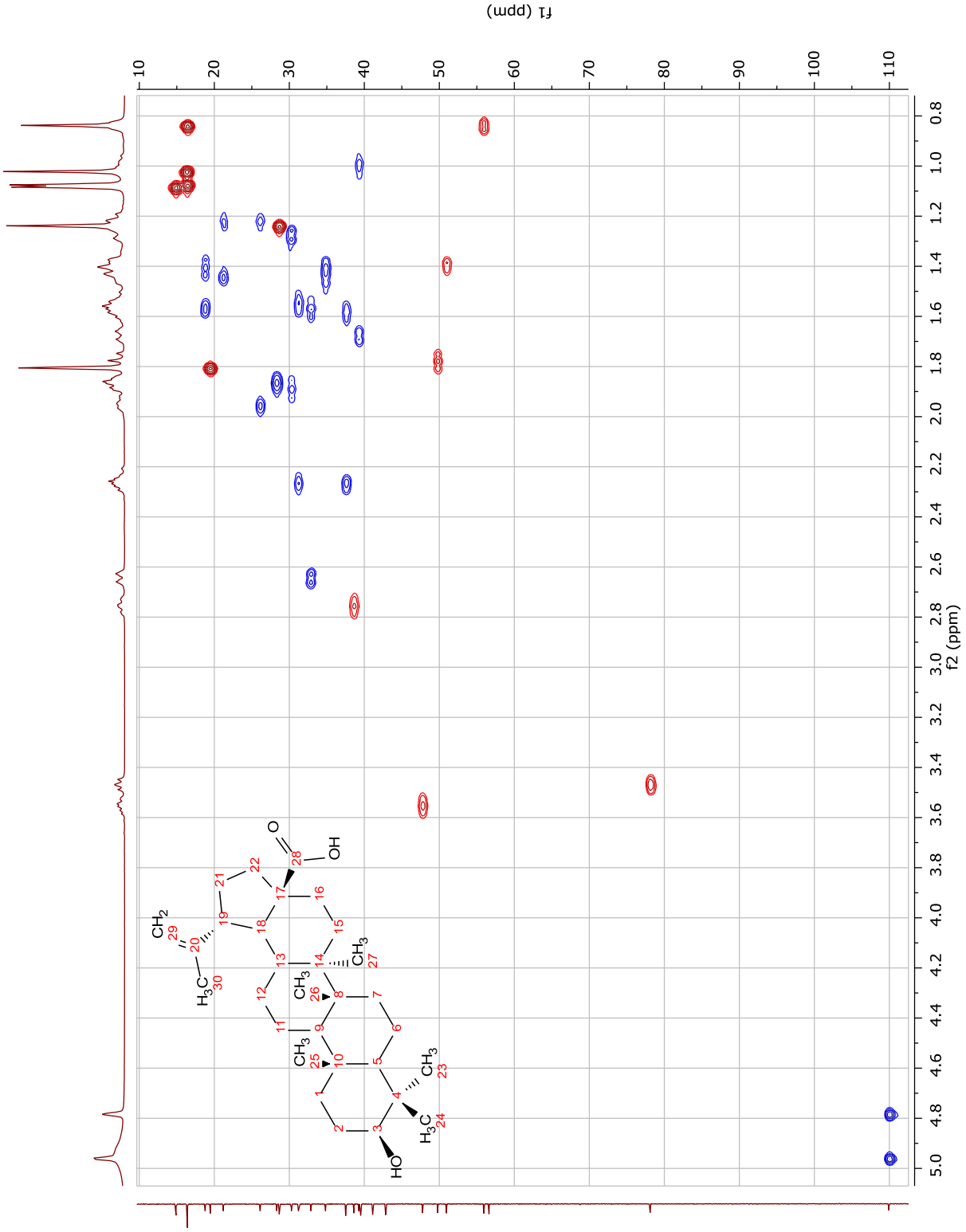


Figura 135. Espectro de HSQC de **Zg2** (400 MHz, C_5D_5N).

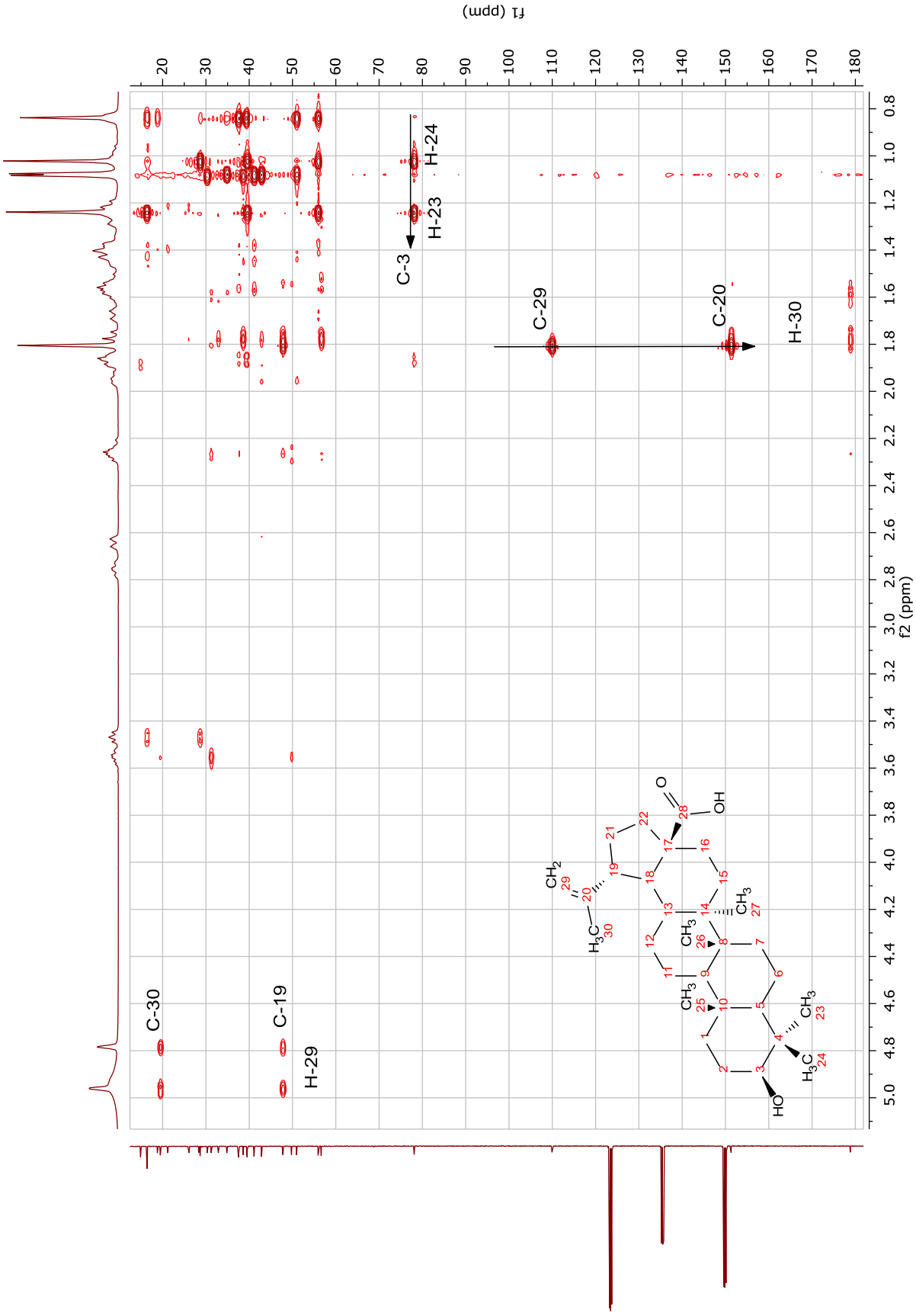


Figura 136. Espectro de HMBC de **Zg2** (400 MHz, C_5D_5N).

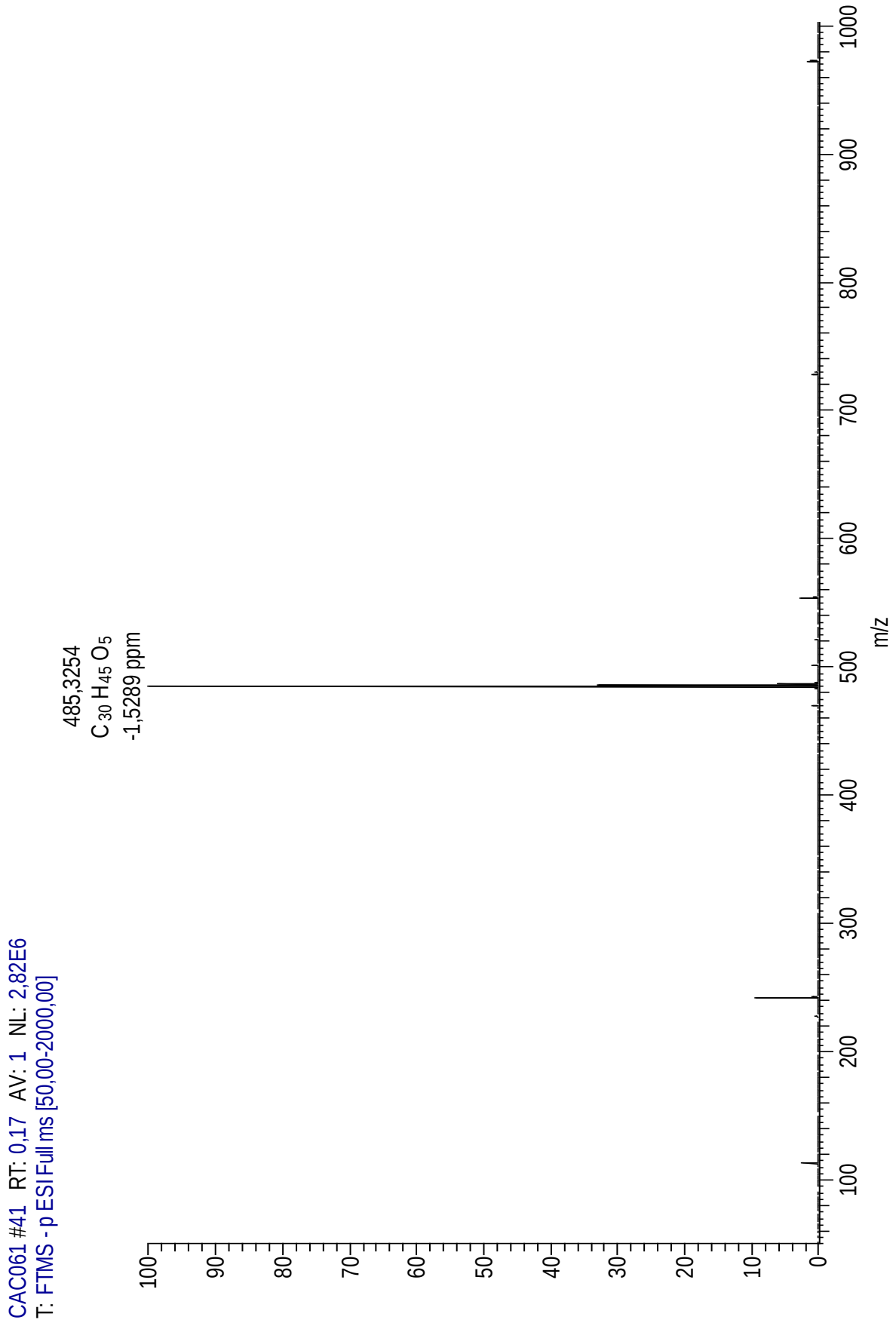


Figura 137. Espectro de massas de alta resolução de **Zg3** (ESI, modo negativo).

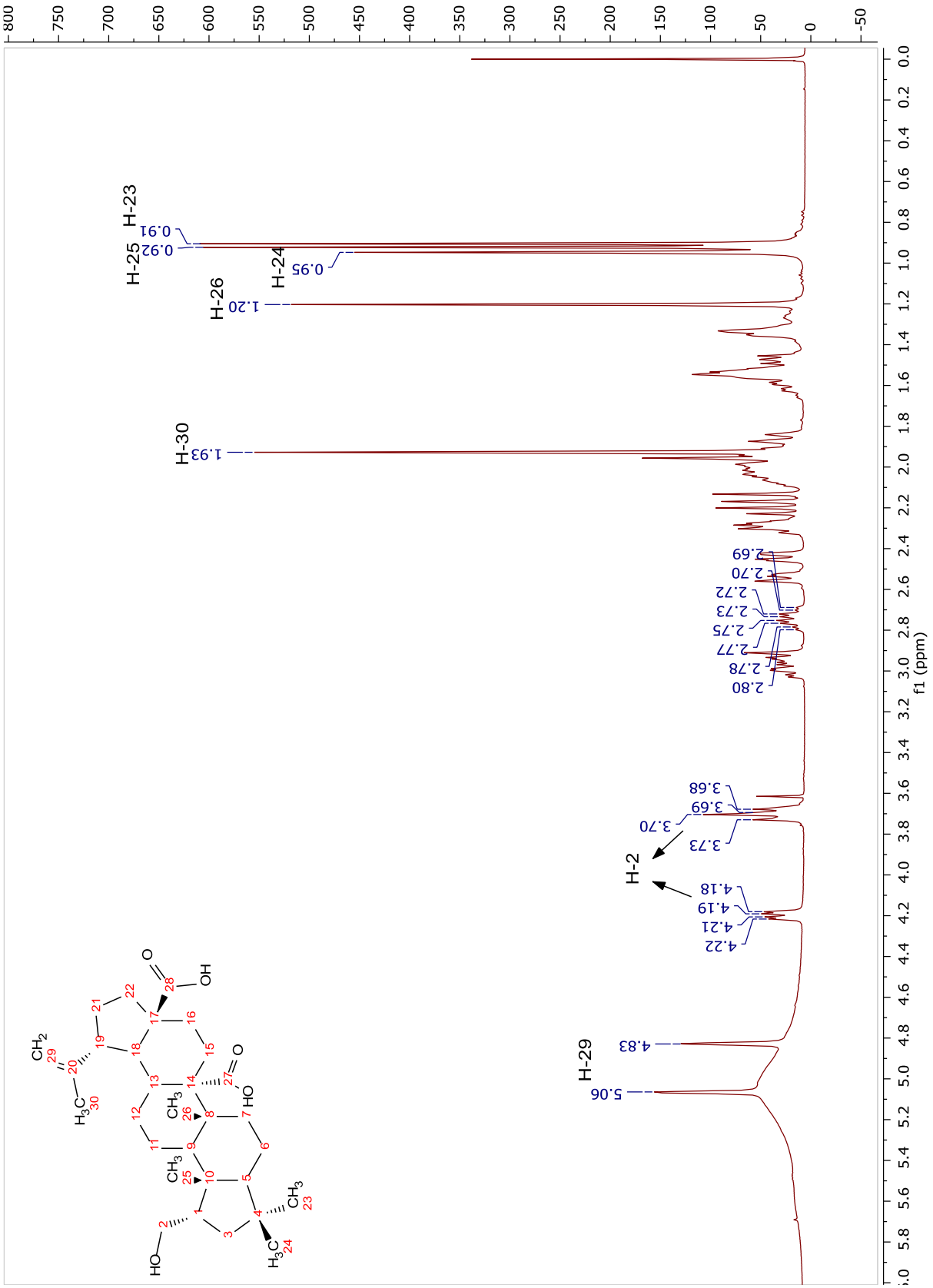


Figura 138. Espectro de RMN ^{1}H de **Zg3** (400 MHz, C_5D_5N).

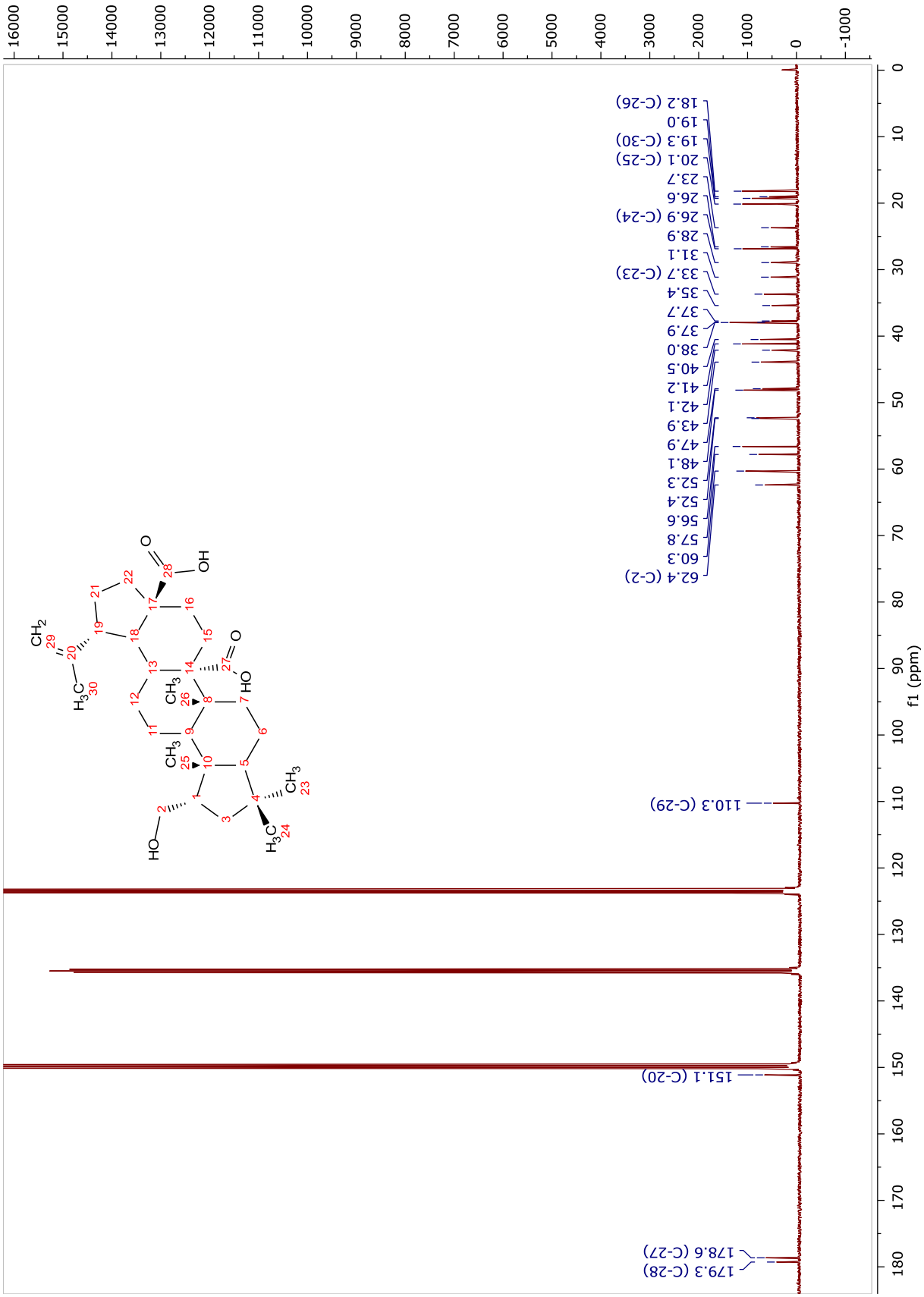


Figura 139. Espectro de RMN ^{13}C de **Zg3** (100 MHz, C_5D_5N).

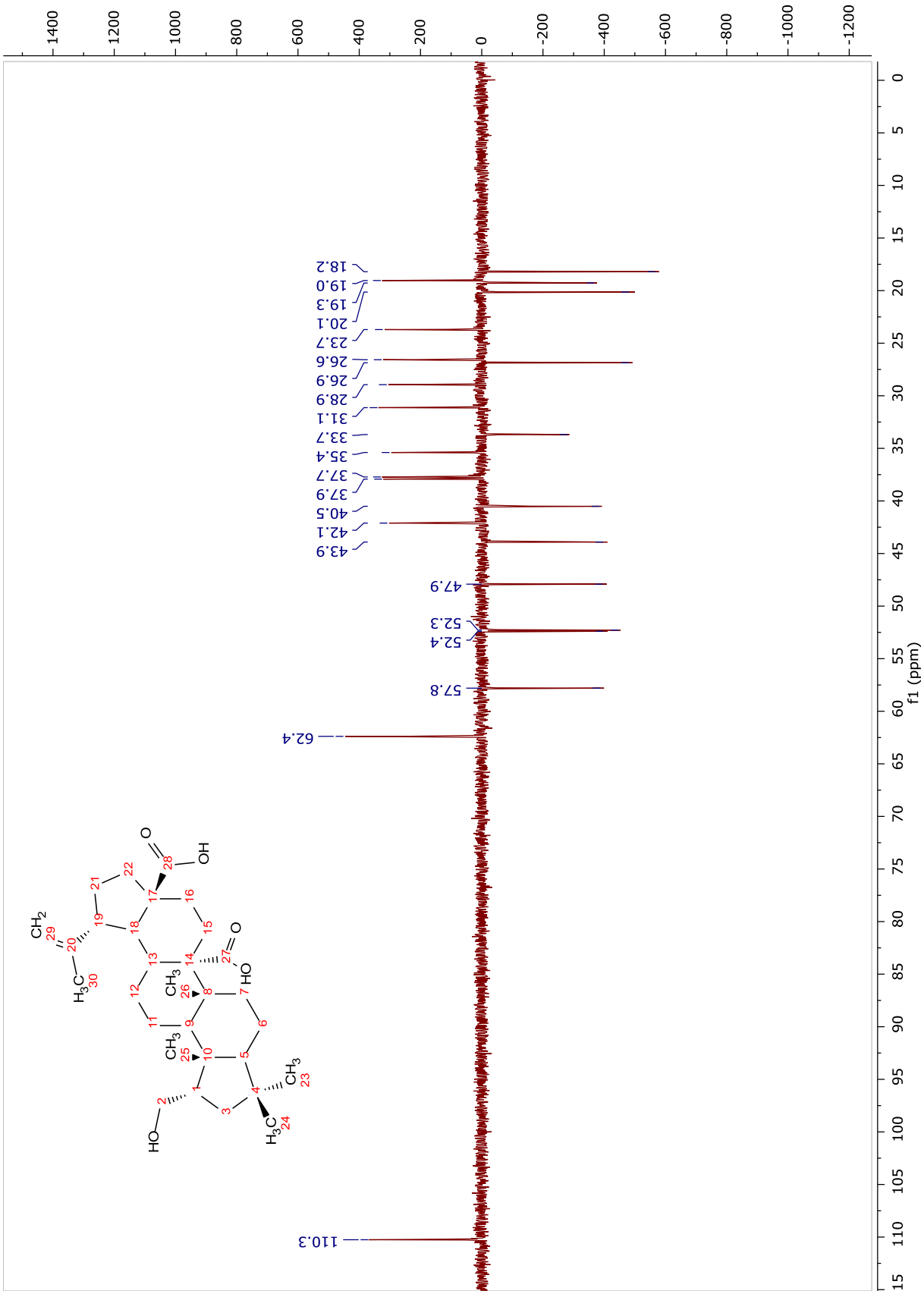


Figura 140. Espectro de DEPT-135 de **Zg3** (100 MHz, C_5D_5N).

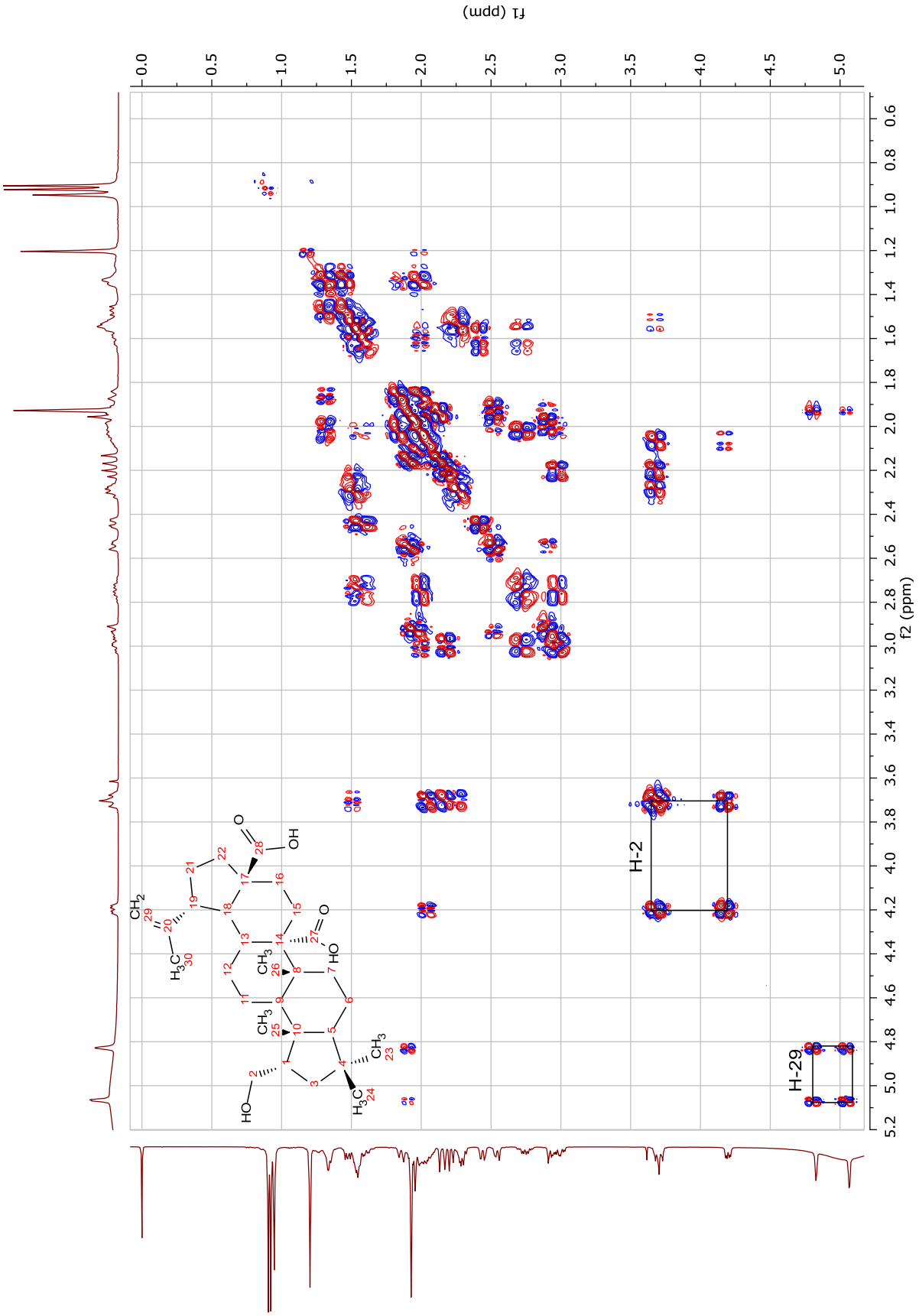


Figura 141. Espectro de COSY de **Zg3** (400 MHz, C_5D_5N).

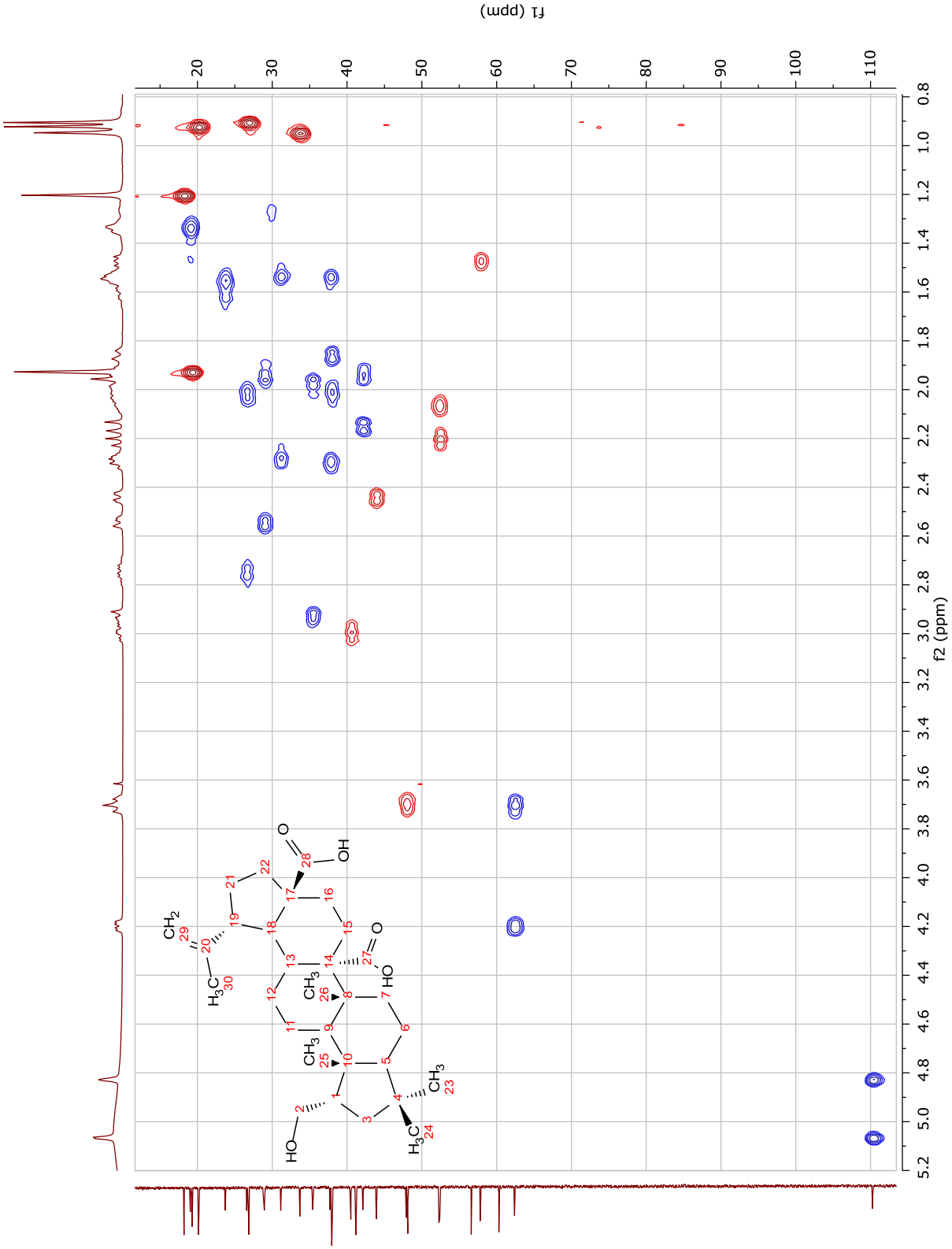


Figura 142. Espectro de HSQC de **Zg3** (400 MHz, C_5D_5N).

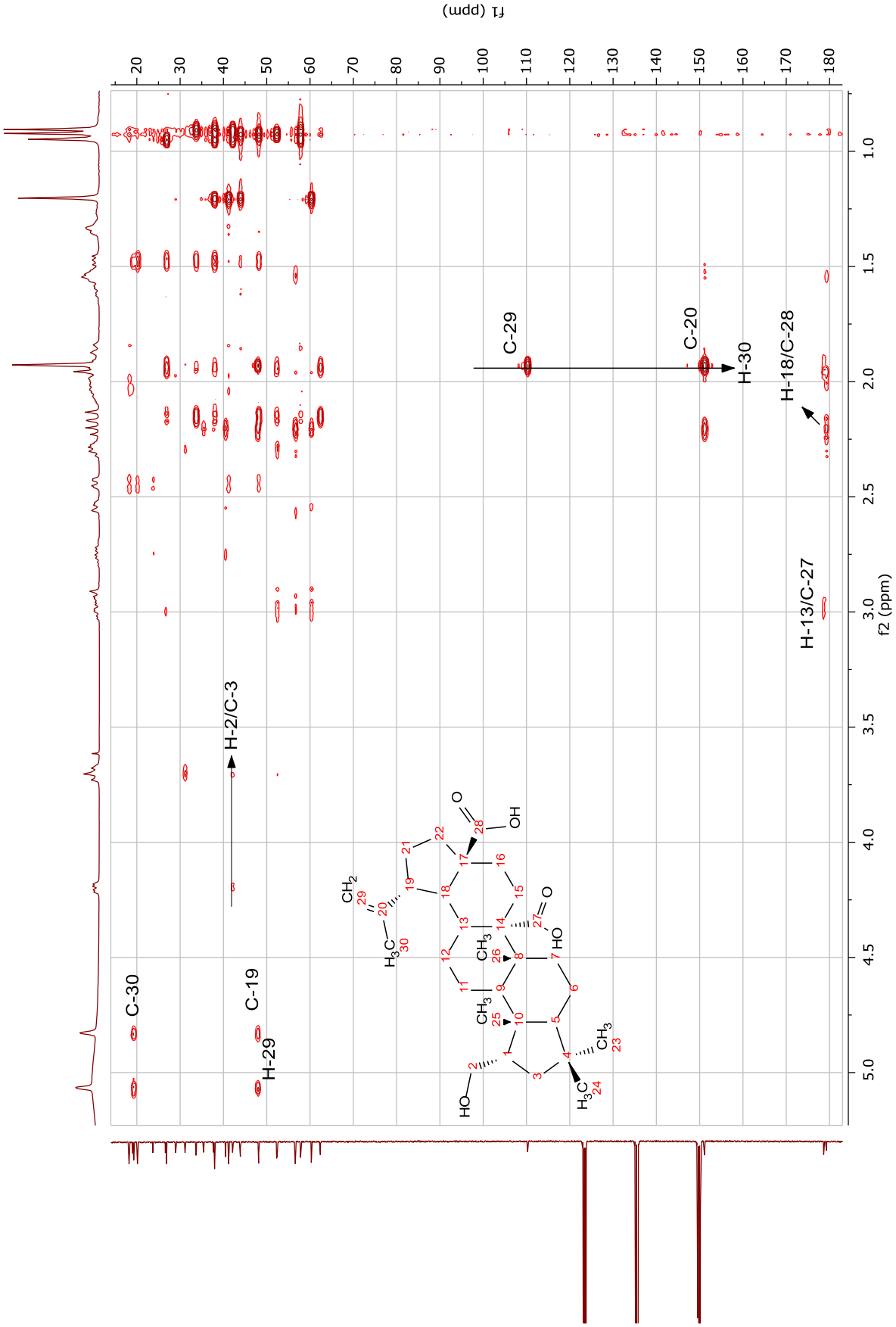


Figura 143. Espectro de HMBC de **Zg3** (400 MHz, C_5D_5N).

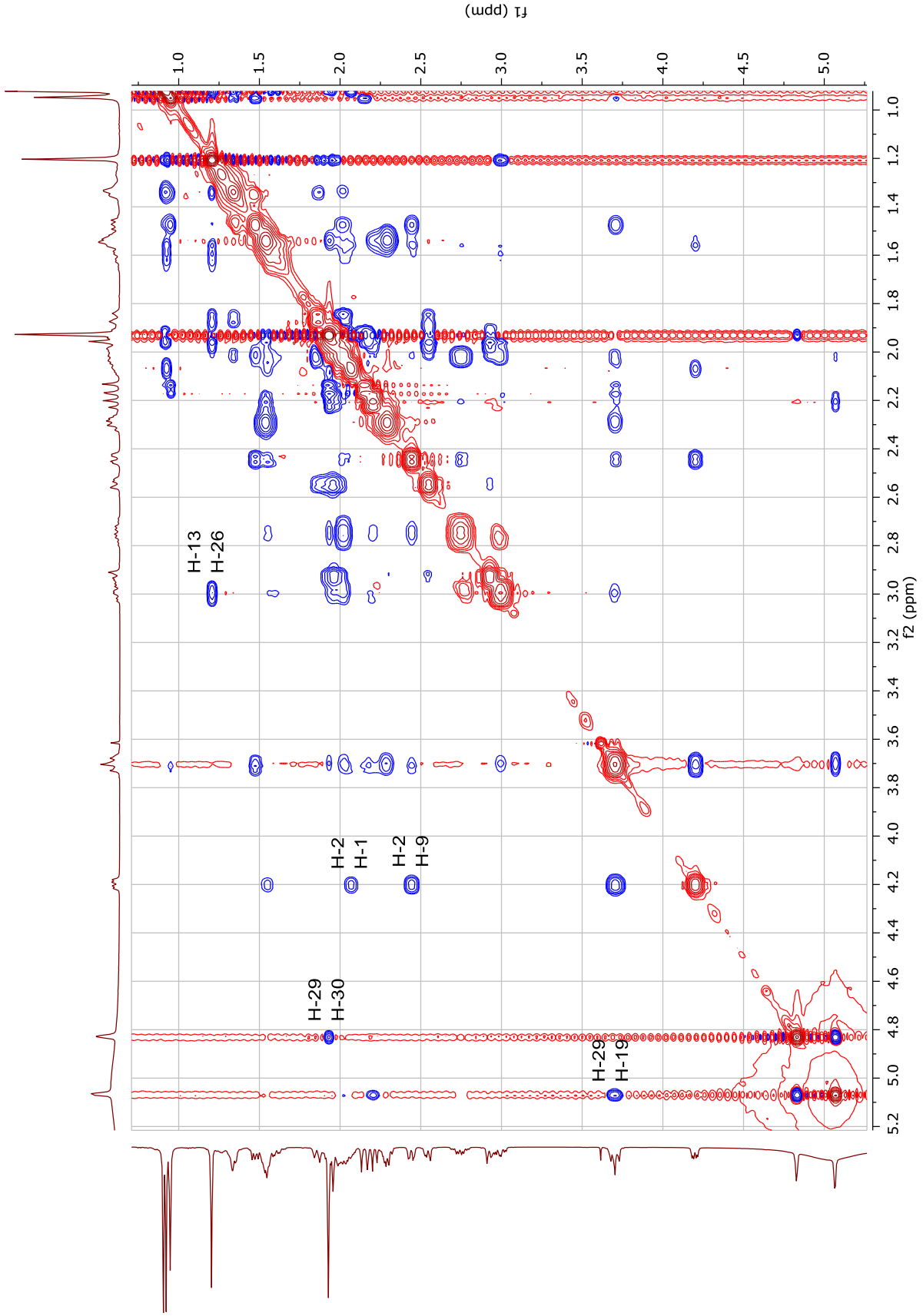


Figura 144. Espectro de NOESY de **Zg3** (400 MHz, C_5D_5N).

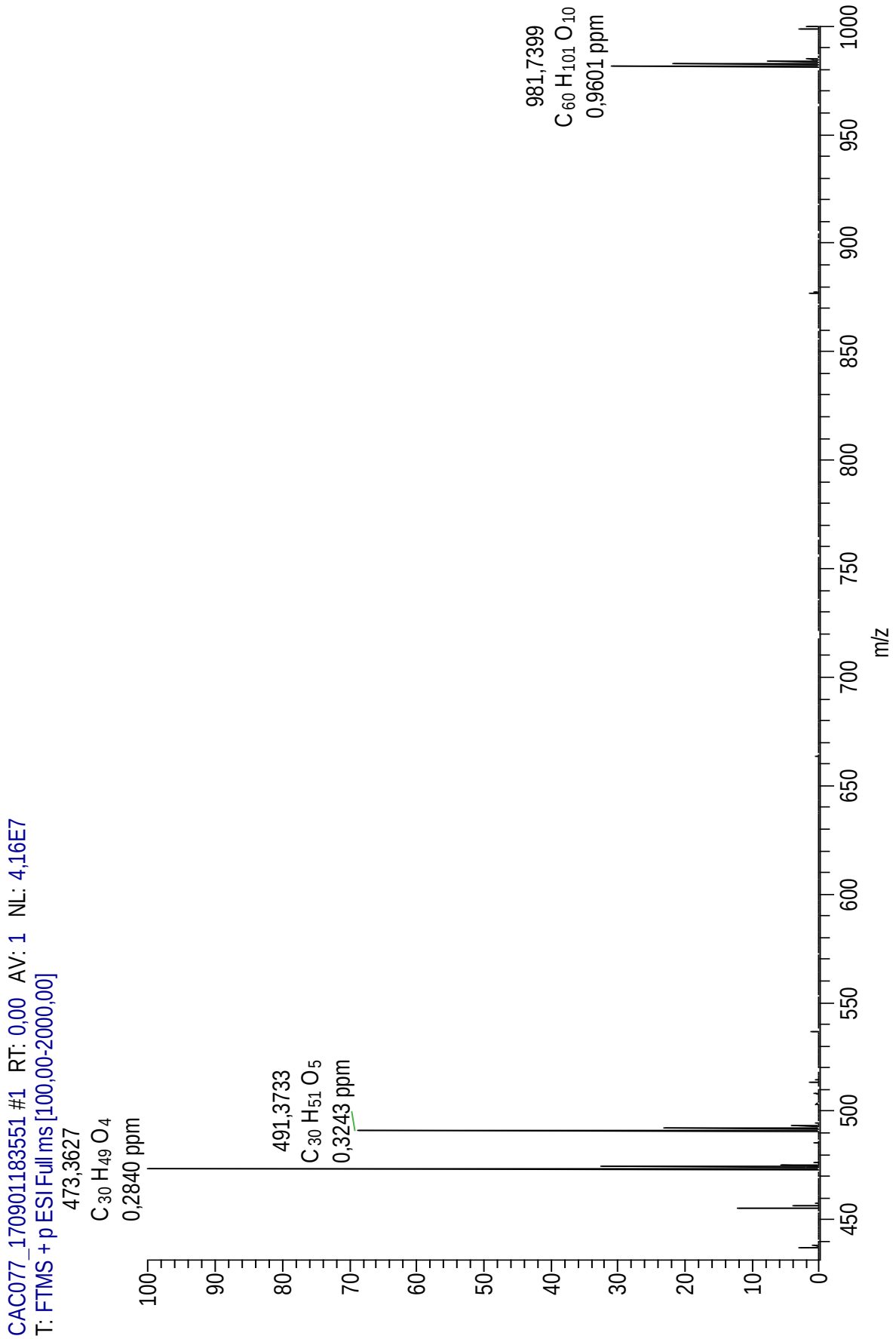


Figura 145. Espectro de massas de alta resolução de **Zg4** (ESI, modo positivo).

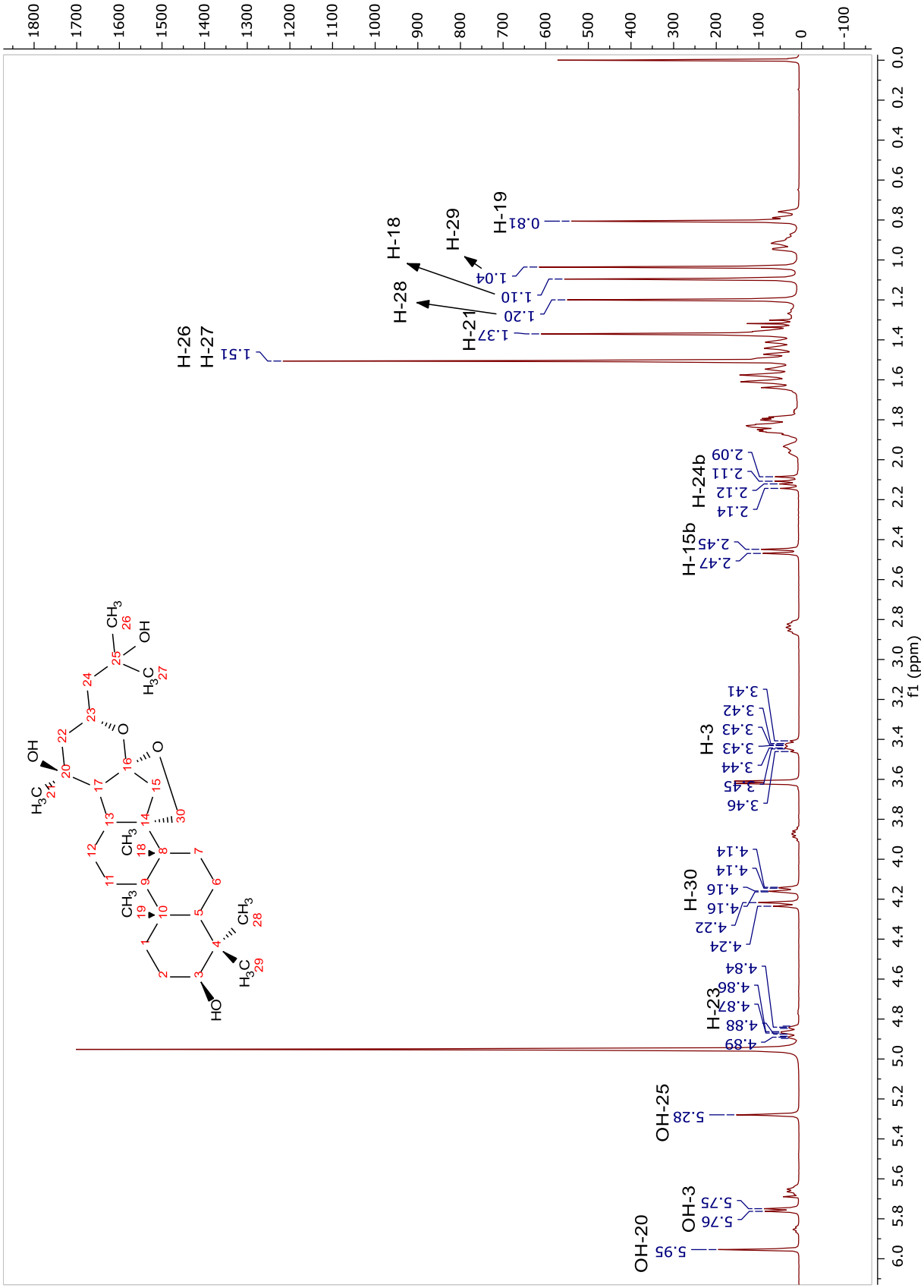


Figura 146. Espectro de RMN ^{1}H de **Zg4** (400 MHz, C_5D_5N).

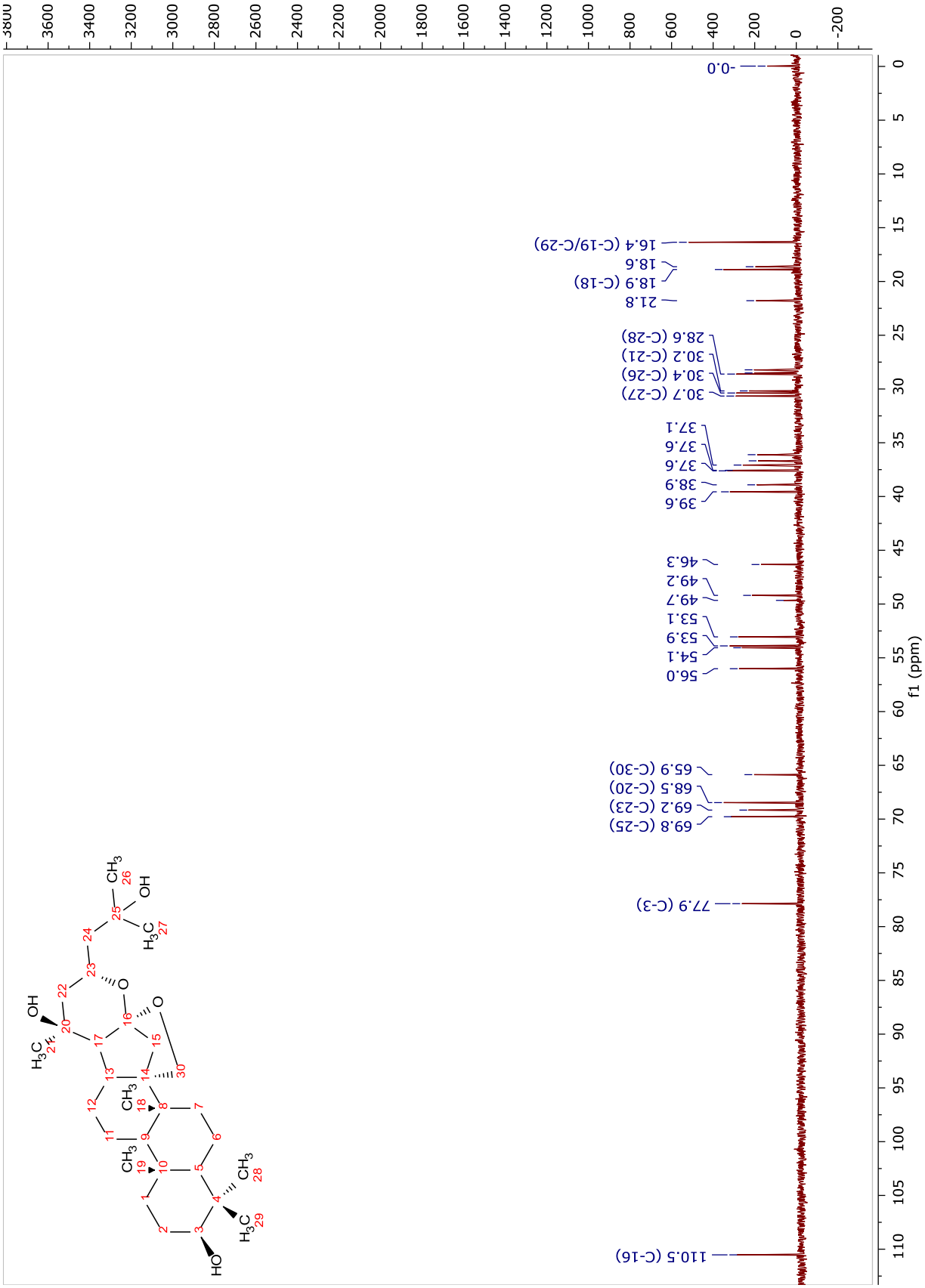


Figura 147. Espectro de RMN ^{13}C de **Zg4** (100 MHz, C_5D_5N).

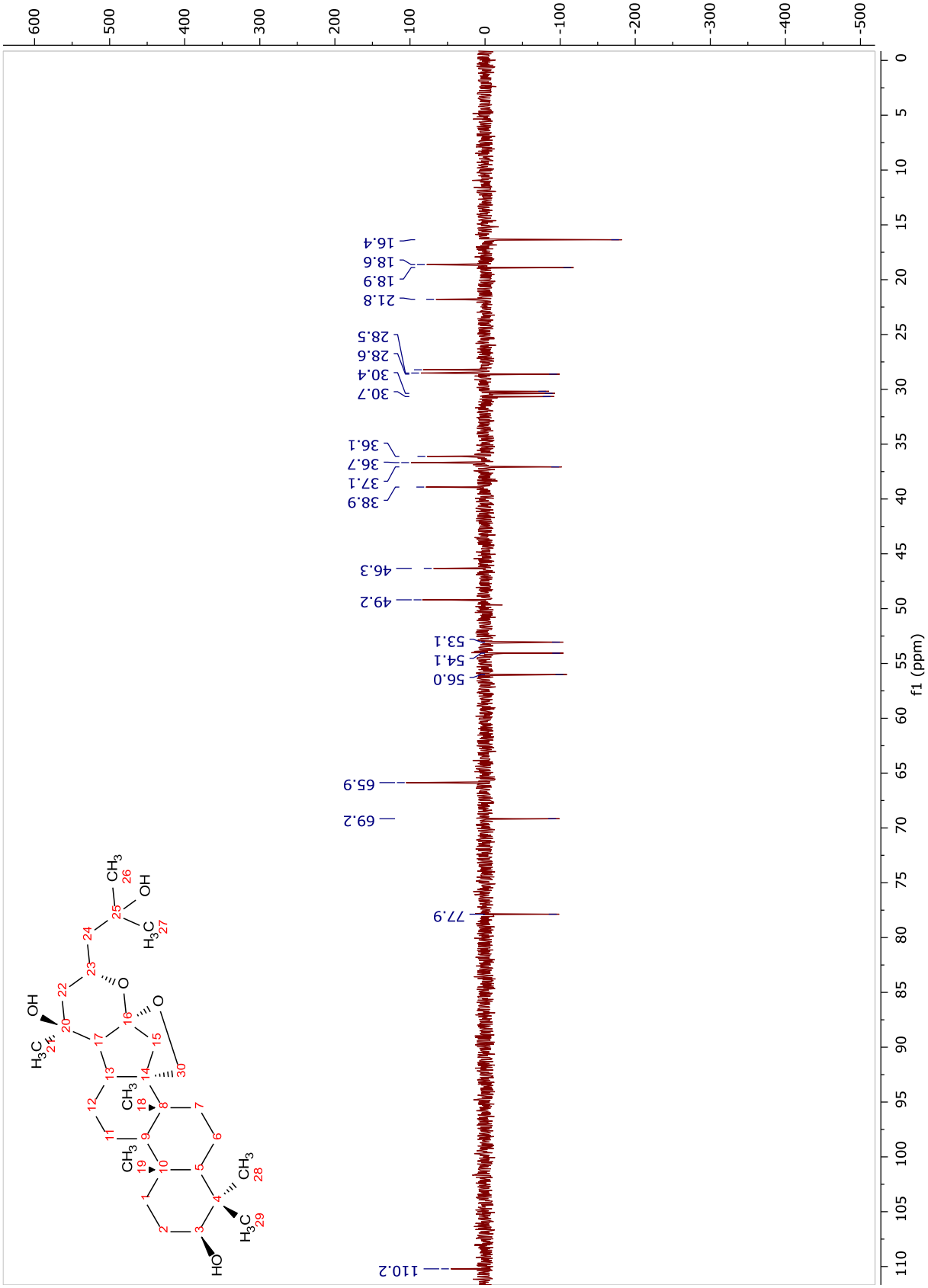


Figura 148. Espectro de DEPT-135 de **Zg4** (100 MHz, C_5D_5N).

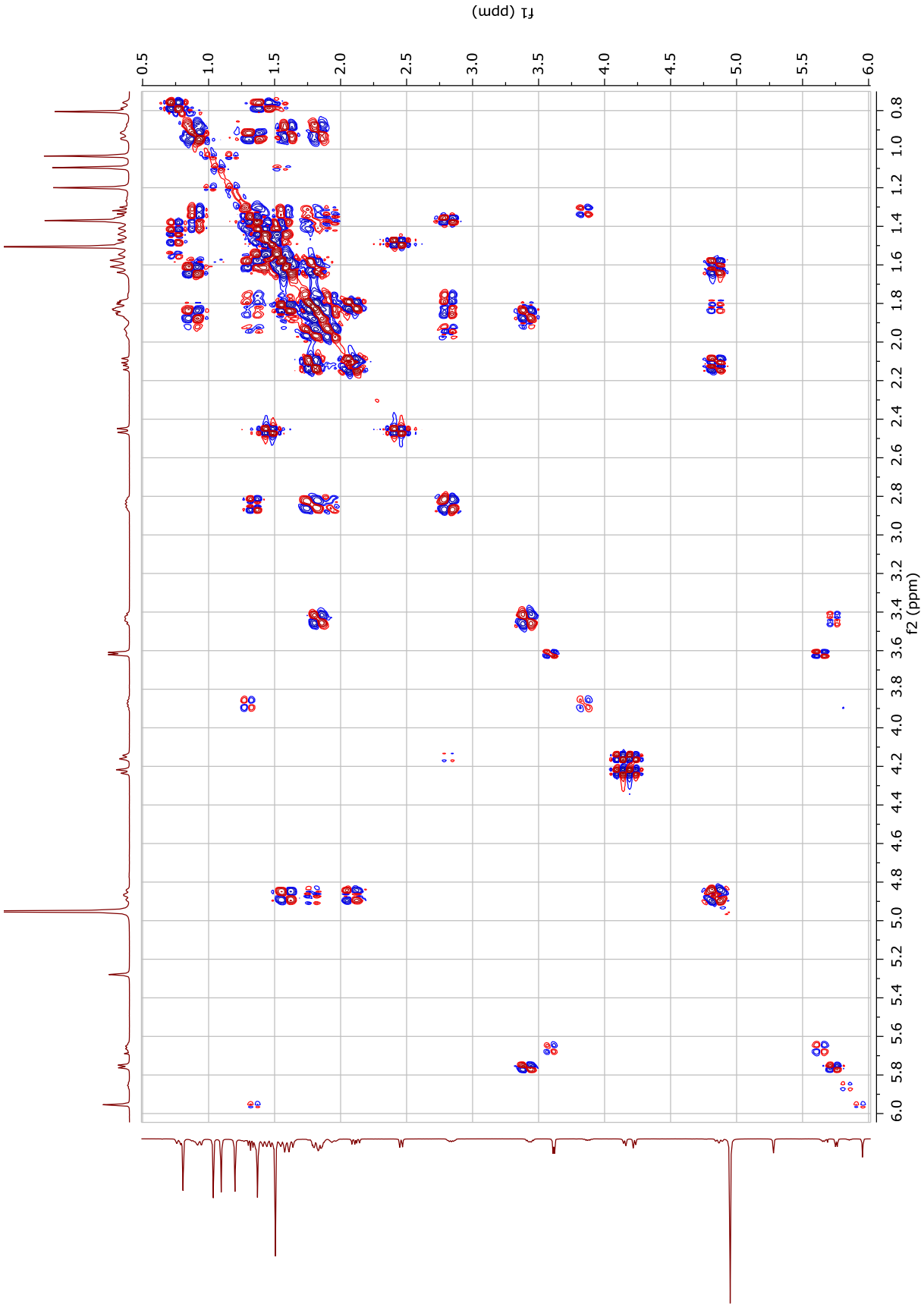


Figura 149. Espectro de COSY de **Zg4** (400 MHz, C_5D_5N).

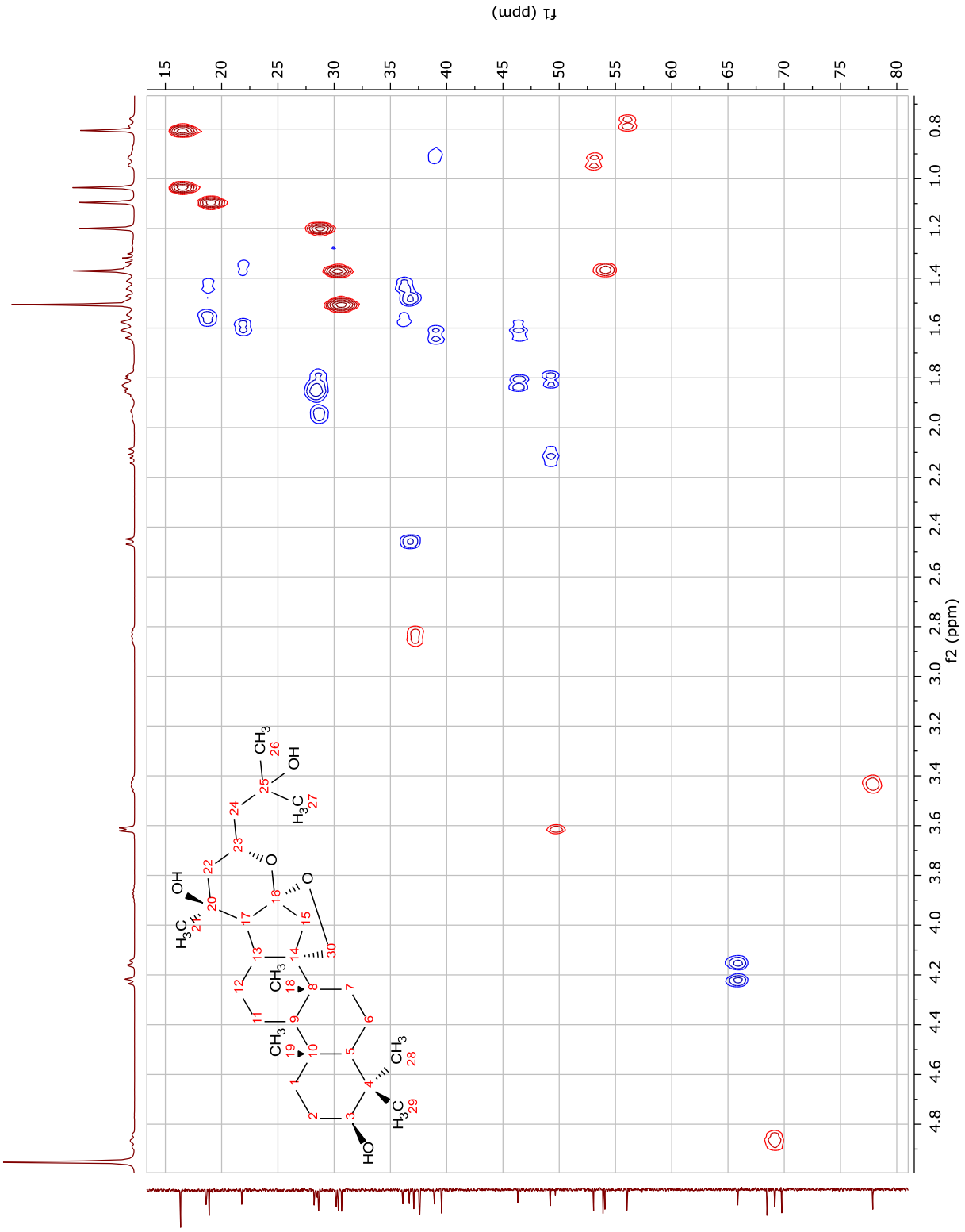


Figura 150. Espectro de HSQC de **Zg4** (400 MHz, C_5D_5N).

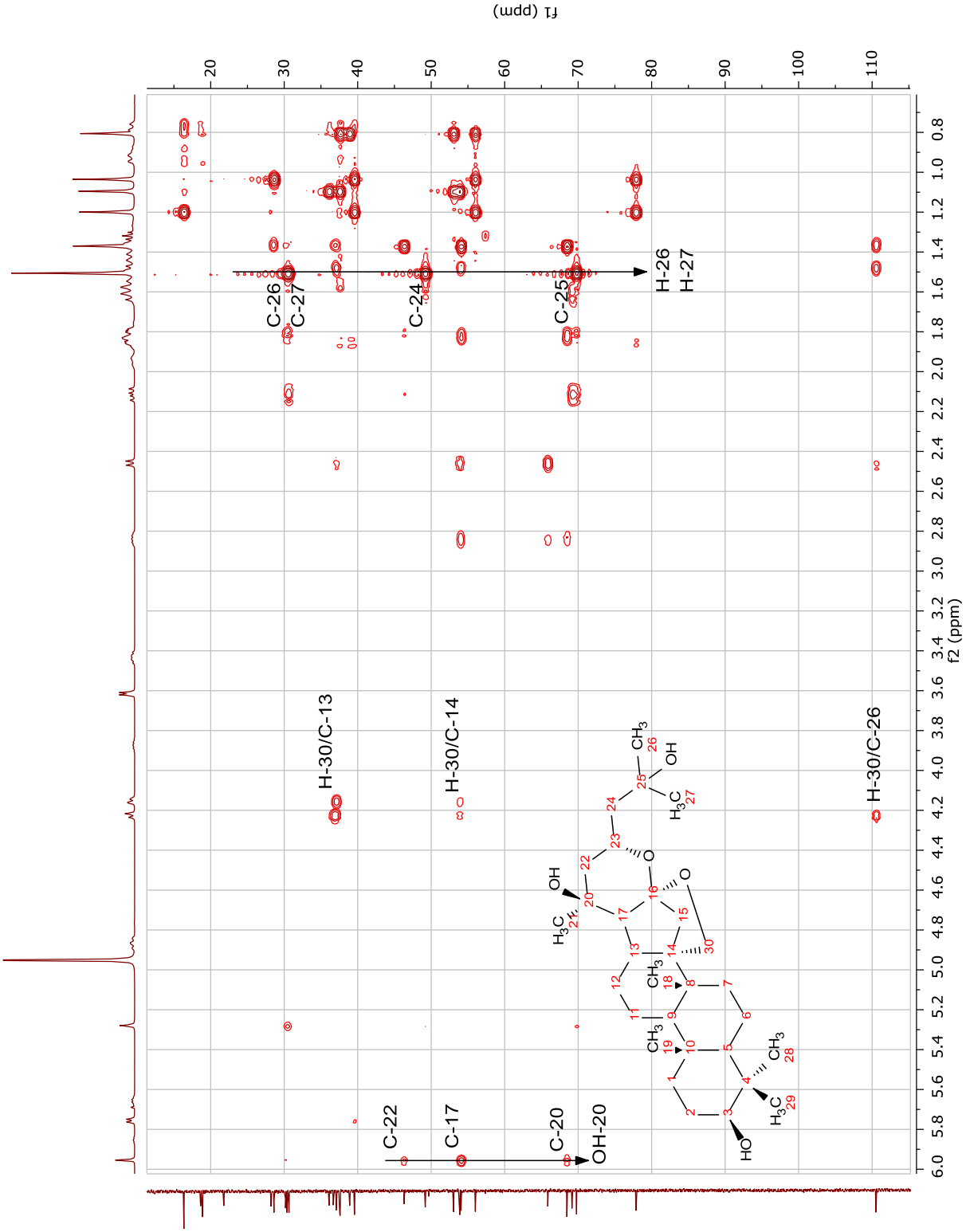


Figura 151. Espectro de HMBC de **Zg4** (400 MHz, C_5D_5N).

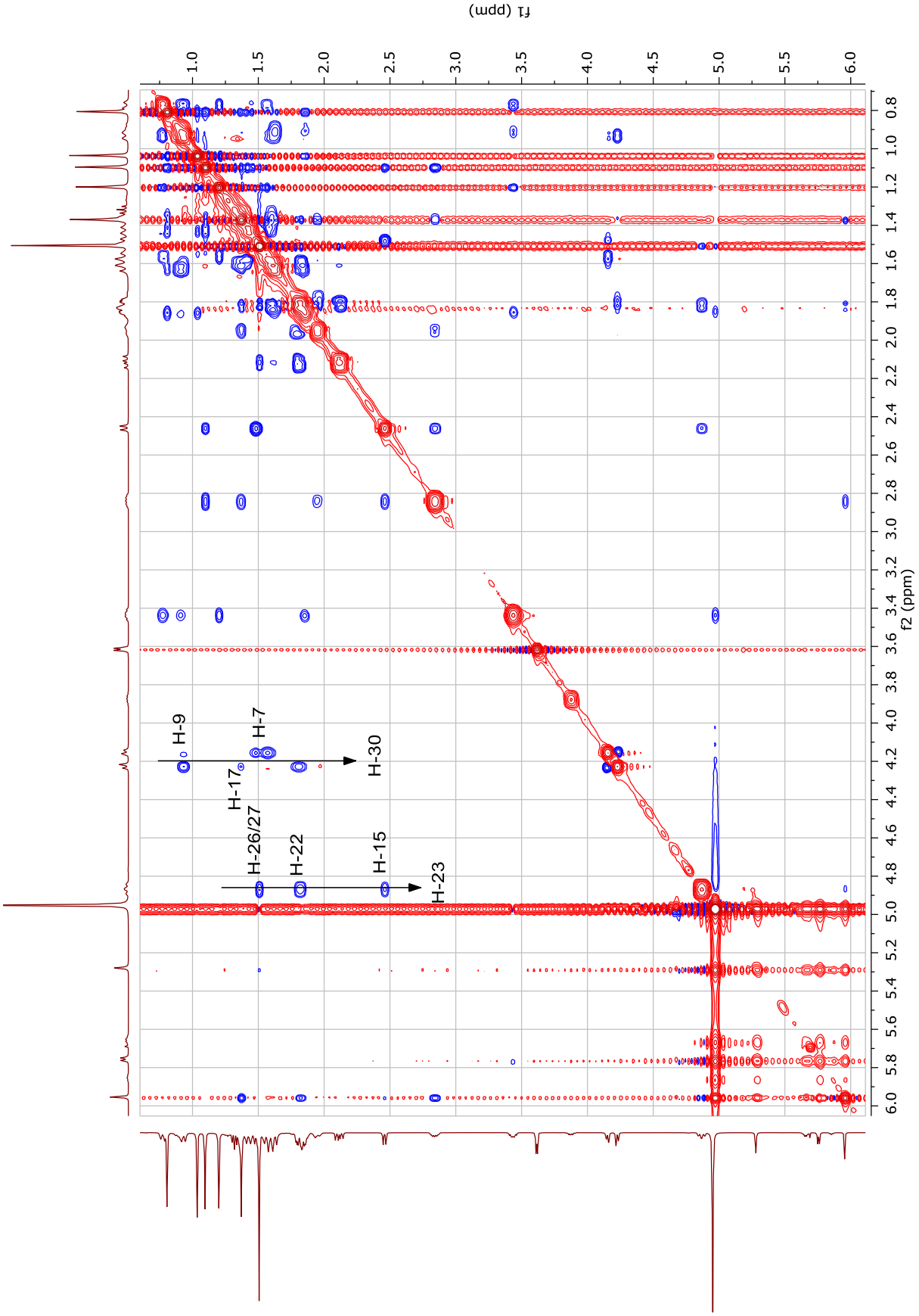


Figura 152. Espectro de NOESY de **Zg4** (400 MHz, C_5D_5N).

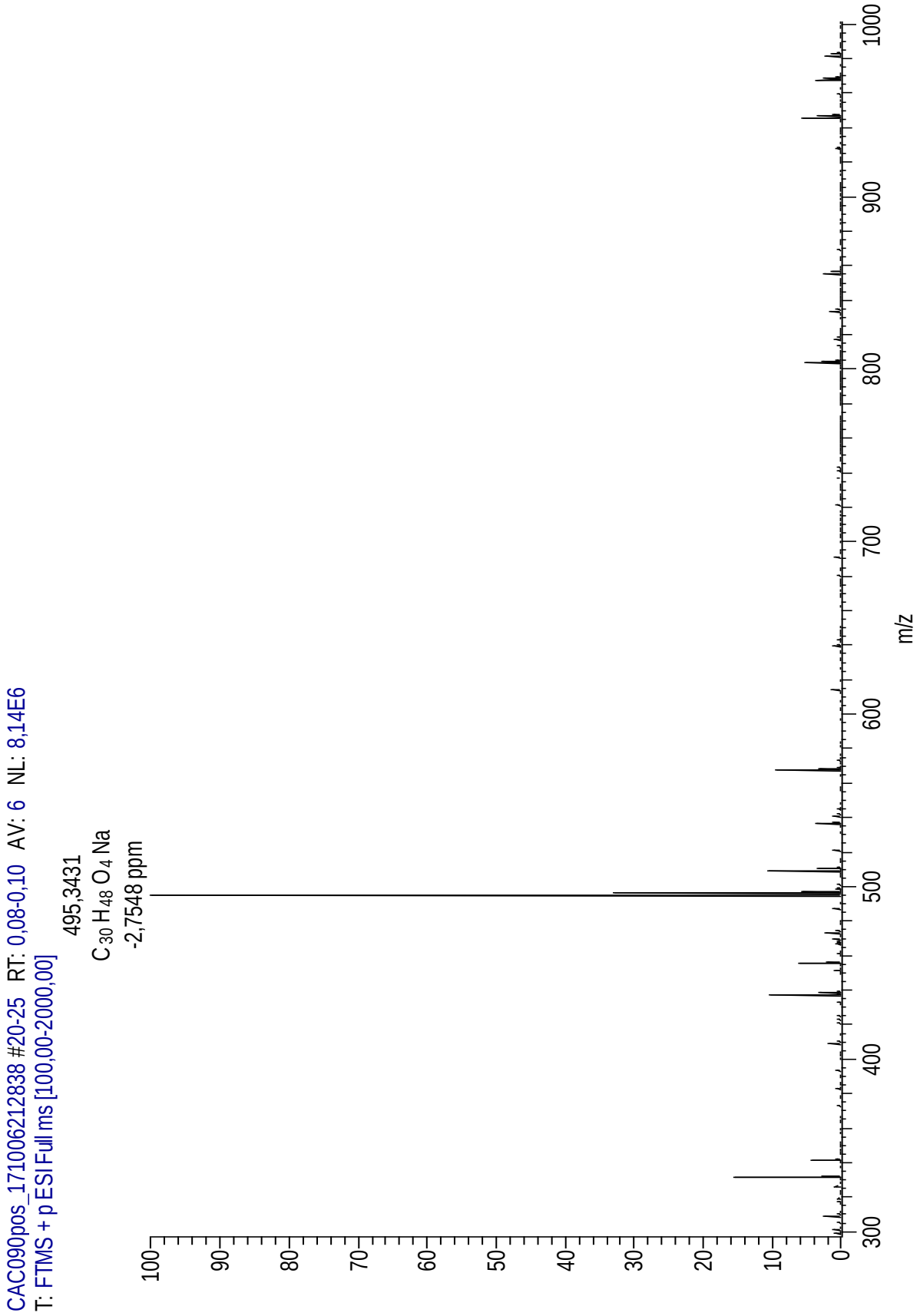


Figura 153. Espectro de massas de alta resolução de **Zg5** (ESI, modo positivo).

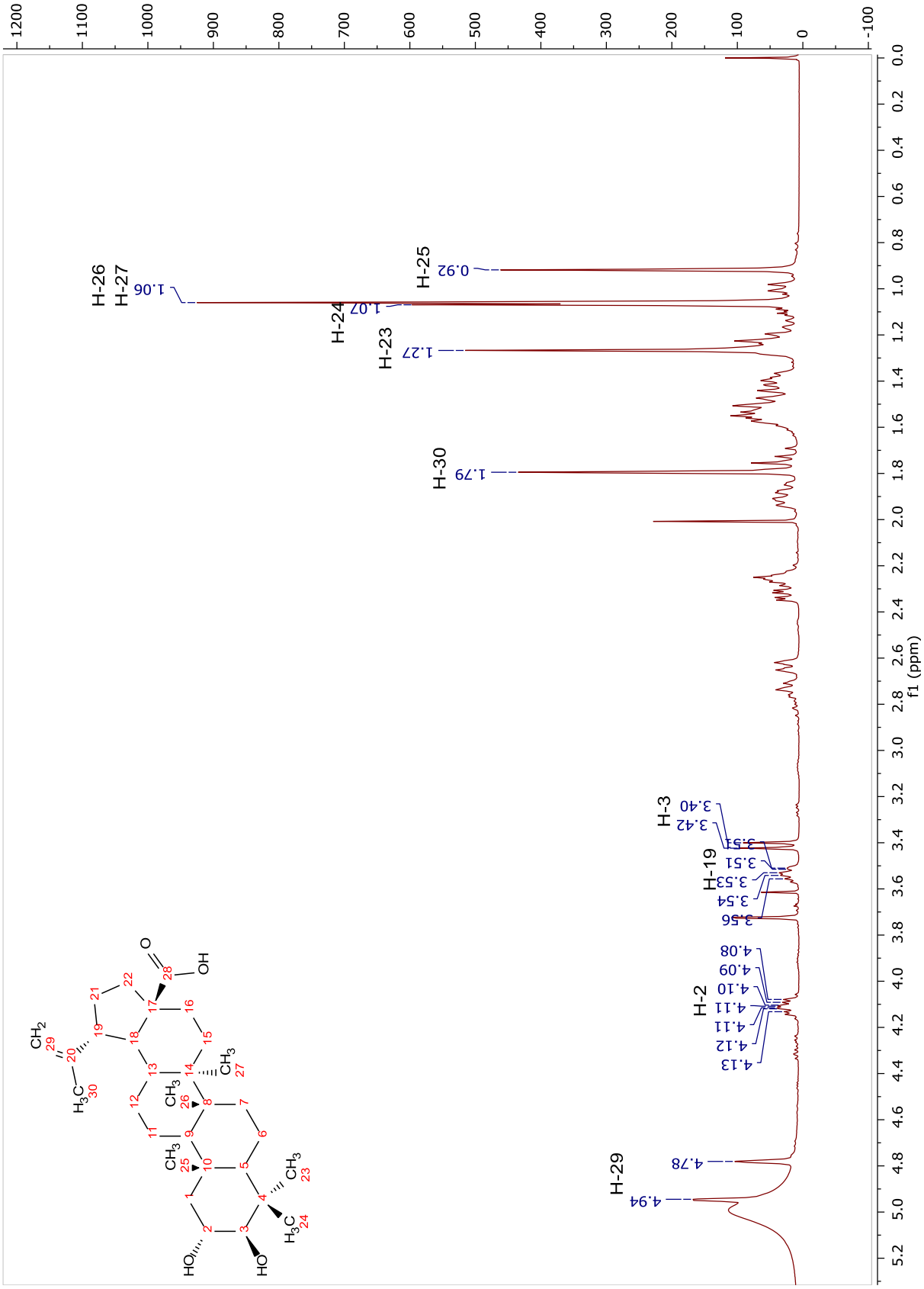


Figura 154. Espectro de RMN ^{1}H de **Zg5** (400 MHz, C_5D_5N).

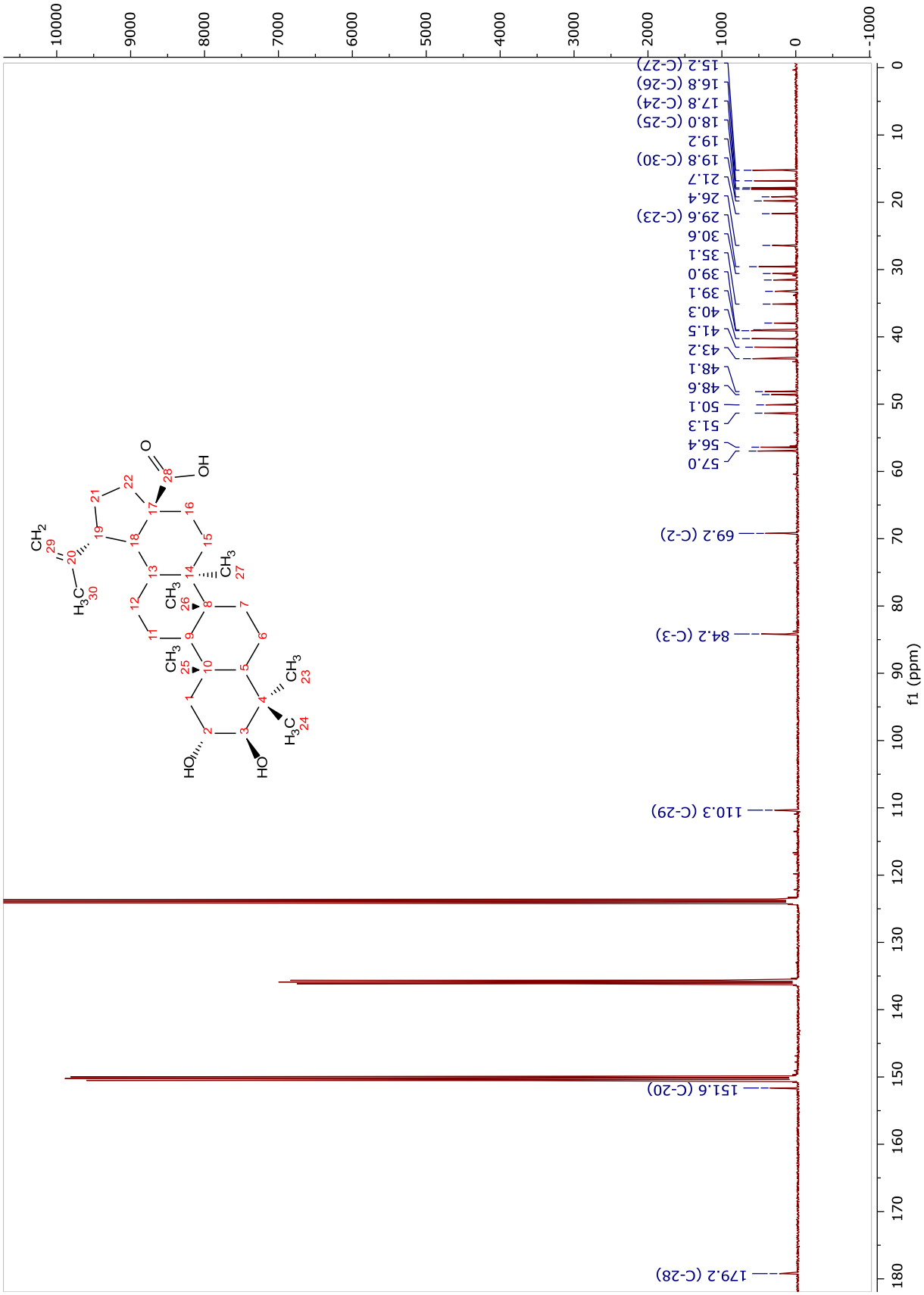


Figura 155. Espectro de RMN ^{13}C de **Zg5** (100 MHz, C_5D_5N).

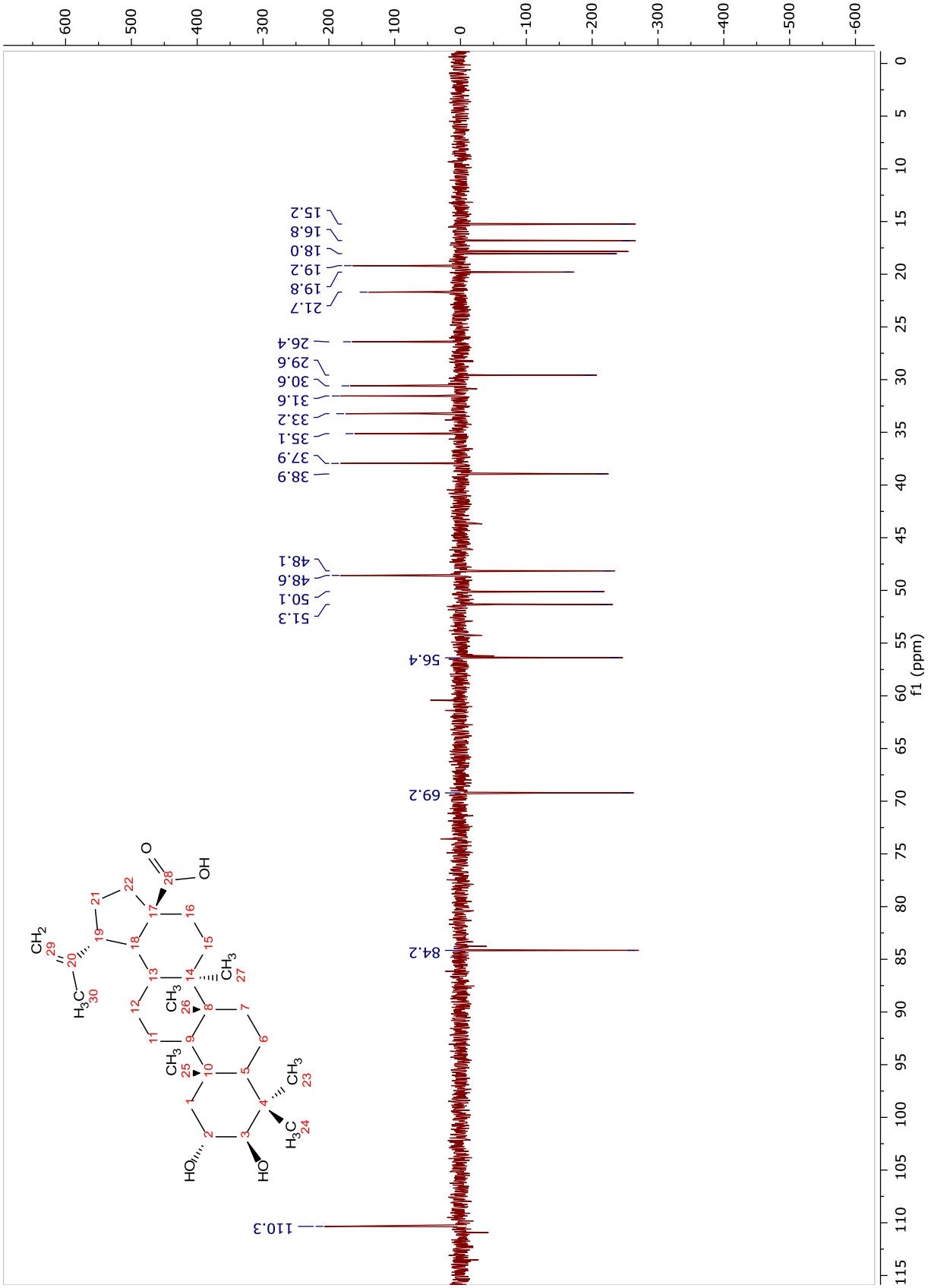


Figura 156. Espectro de DEPT-135 de **Zg5** (100 MHz, C_5D_5N).

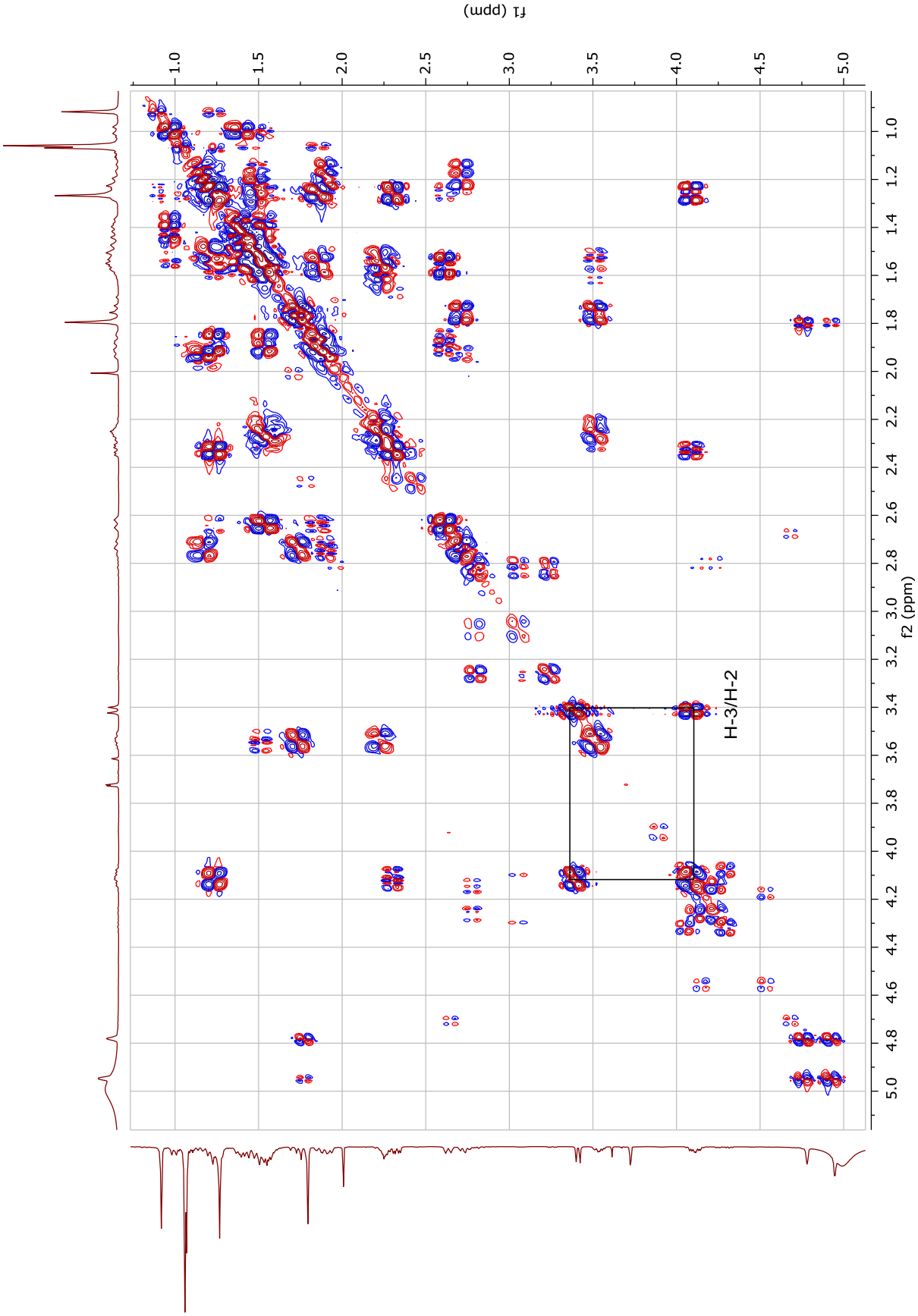


Figura 157. Espectro de COSY de **Zg5** (400 MHz, C_5D_5N).

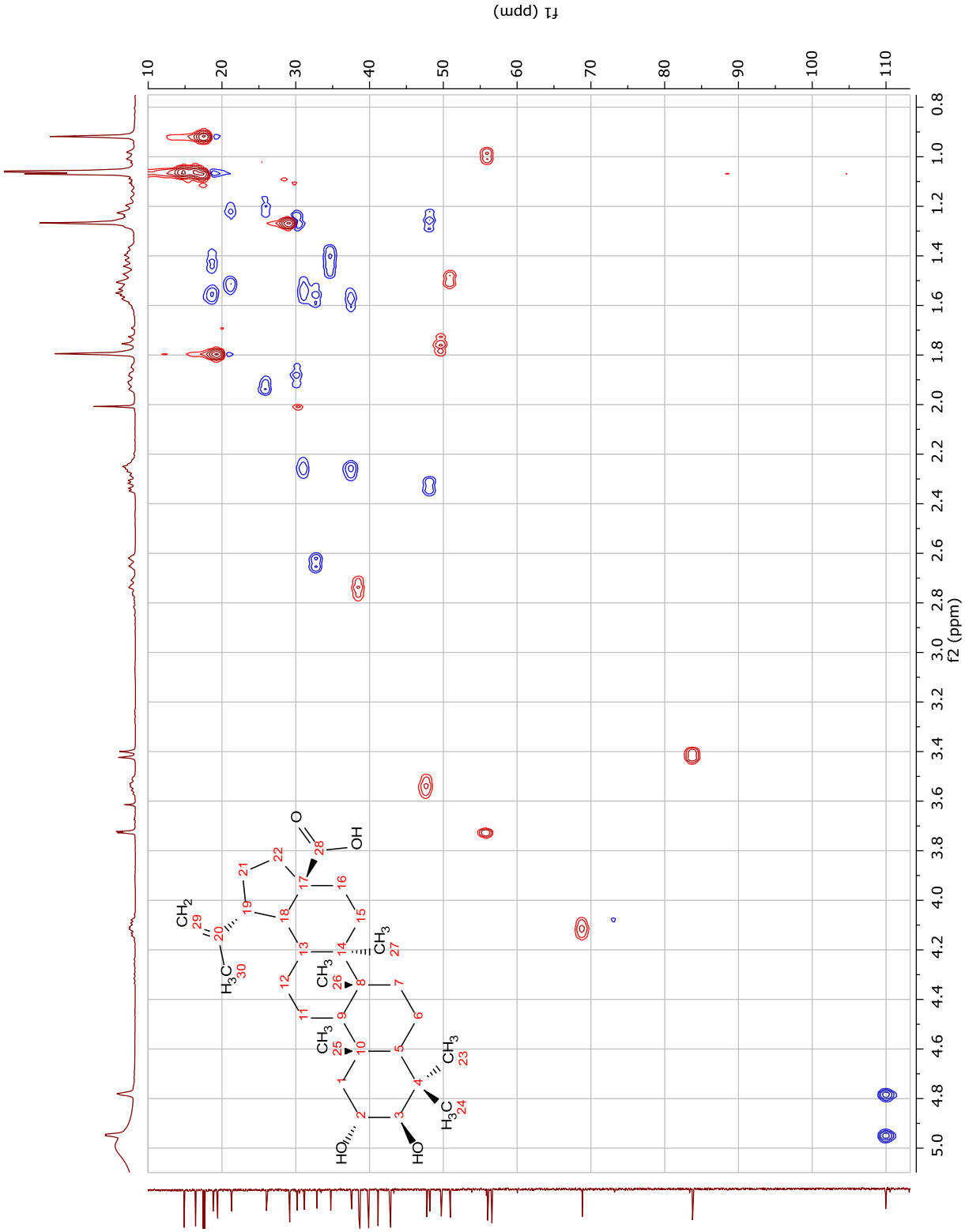


Figura 158. Espectro de HSQC de **Zg5** (400 MHz, C_5D_5N).

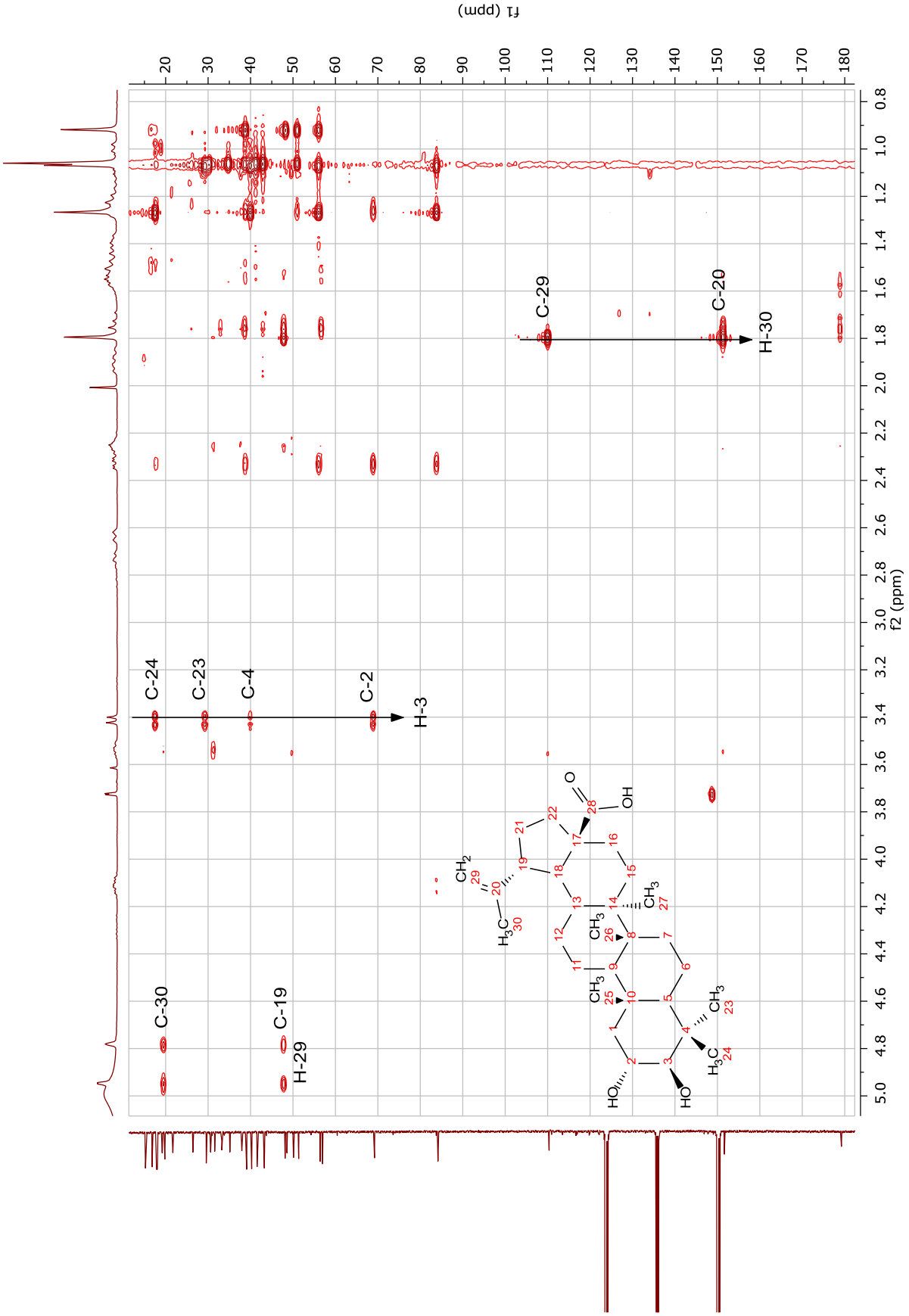


Figura 159. Espectro de HMBC de **Zg5** (400 MHz, C_5D_5N).

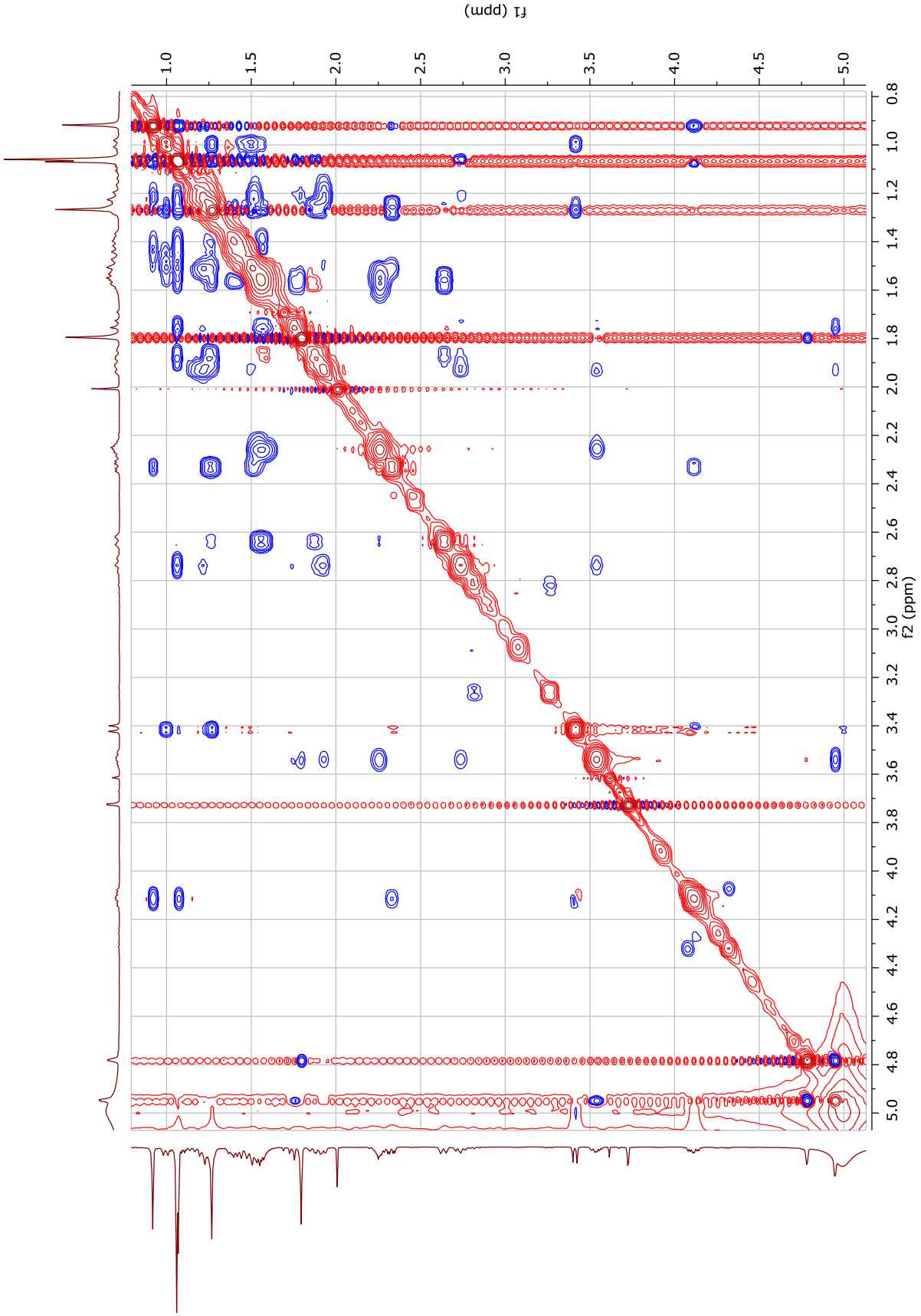


Figura 160. Espectro de NOESY de **Zg5** (400 MHz, C_5D_5N).

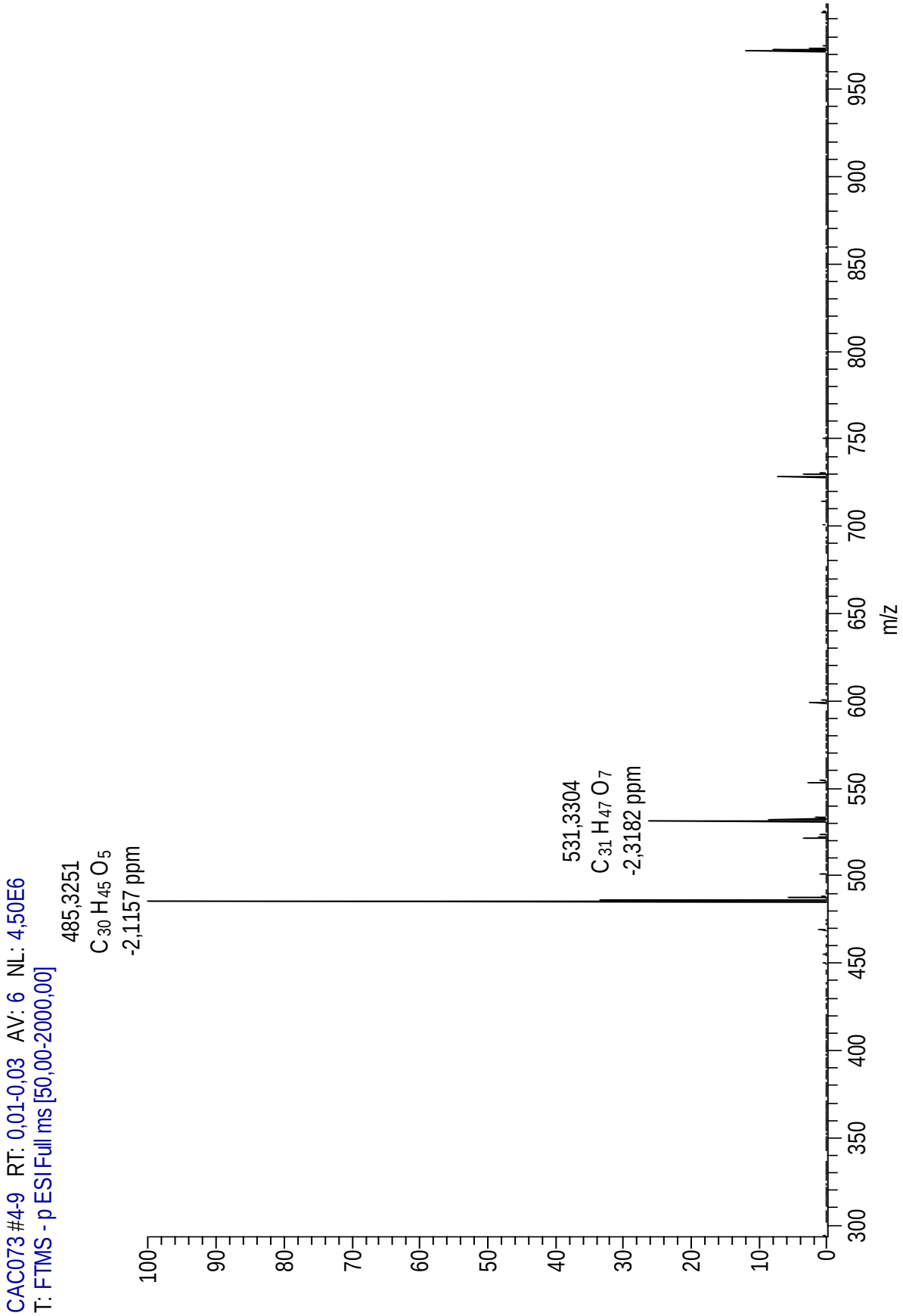


Figura 161. Espectro de massas de alta resolução de **Zg6** (ESI, modo negativo).

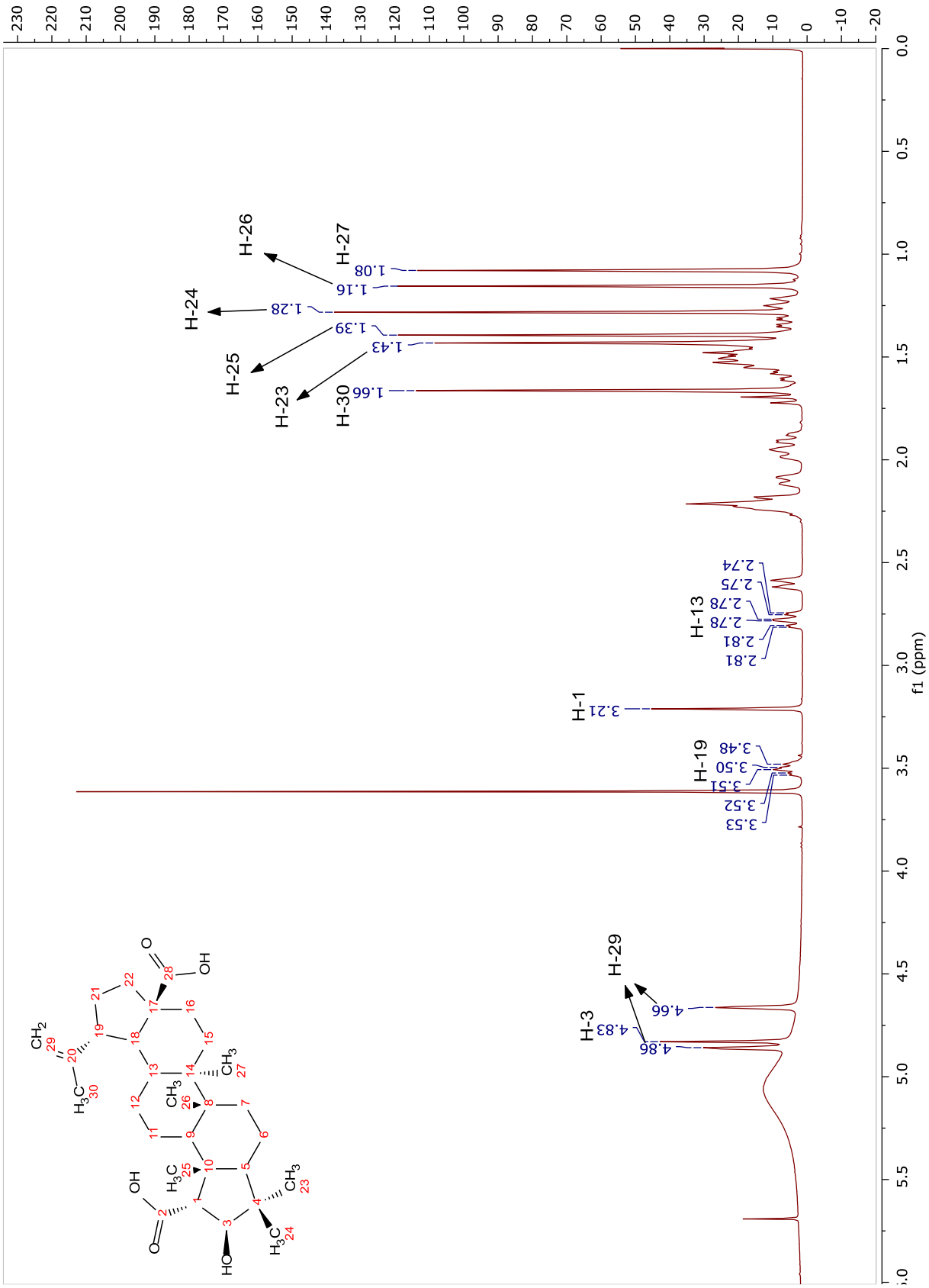


Figura 162. Espectro de RMN ^{1}H de **Zg6** (400 MHz, C_5D_5N).

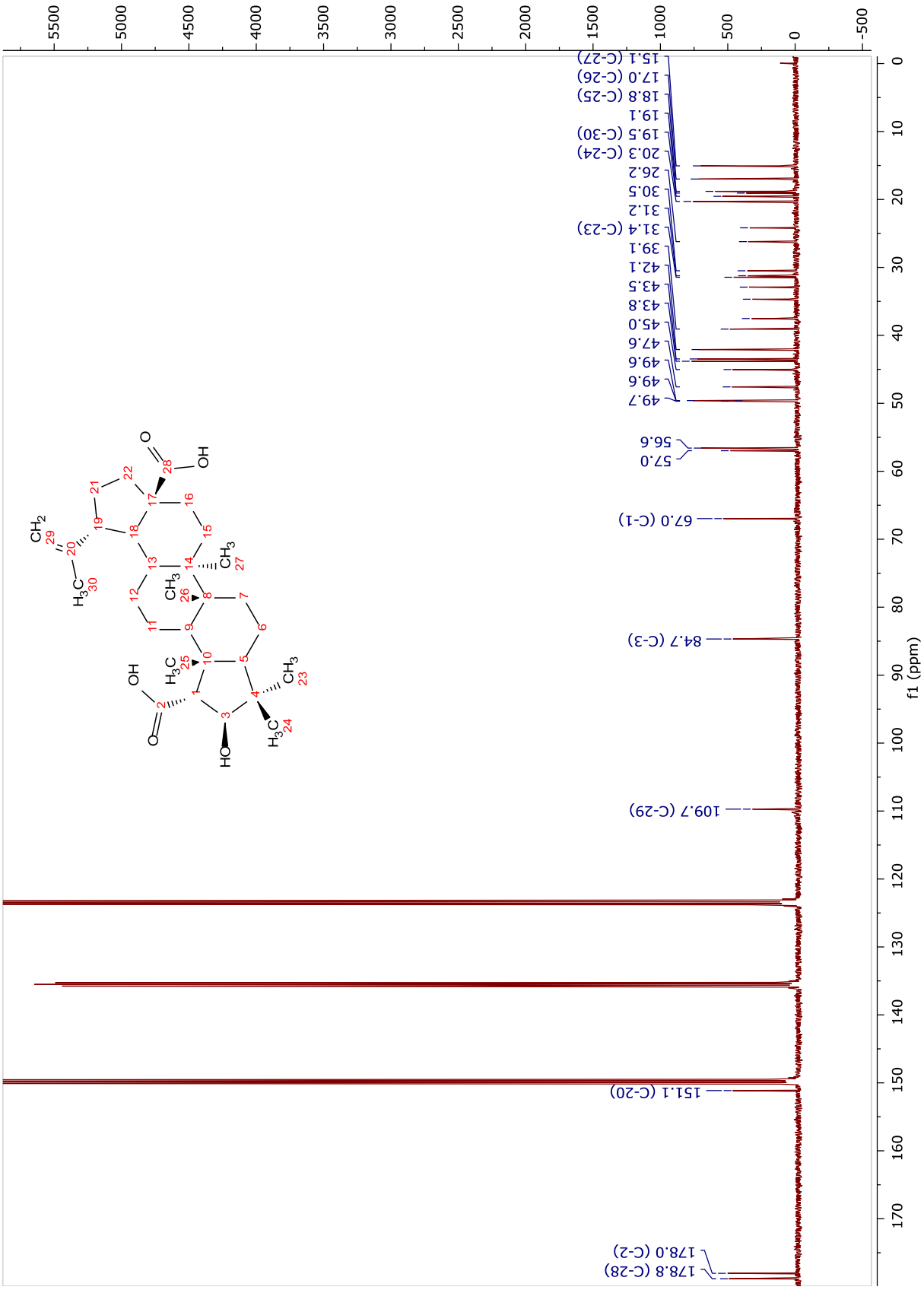


Figura 163. Espectro de RMN ^{13}C de **Zg6** (100 MHz, C_5D_5N).

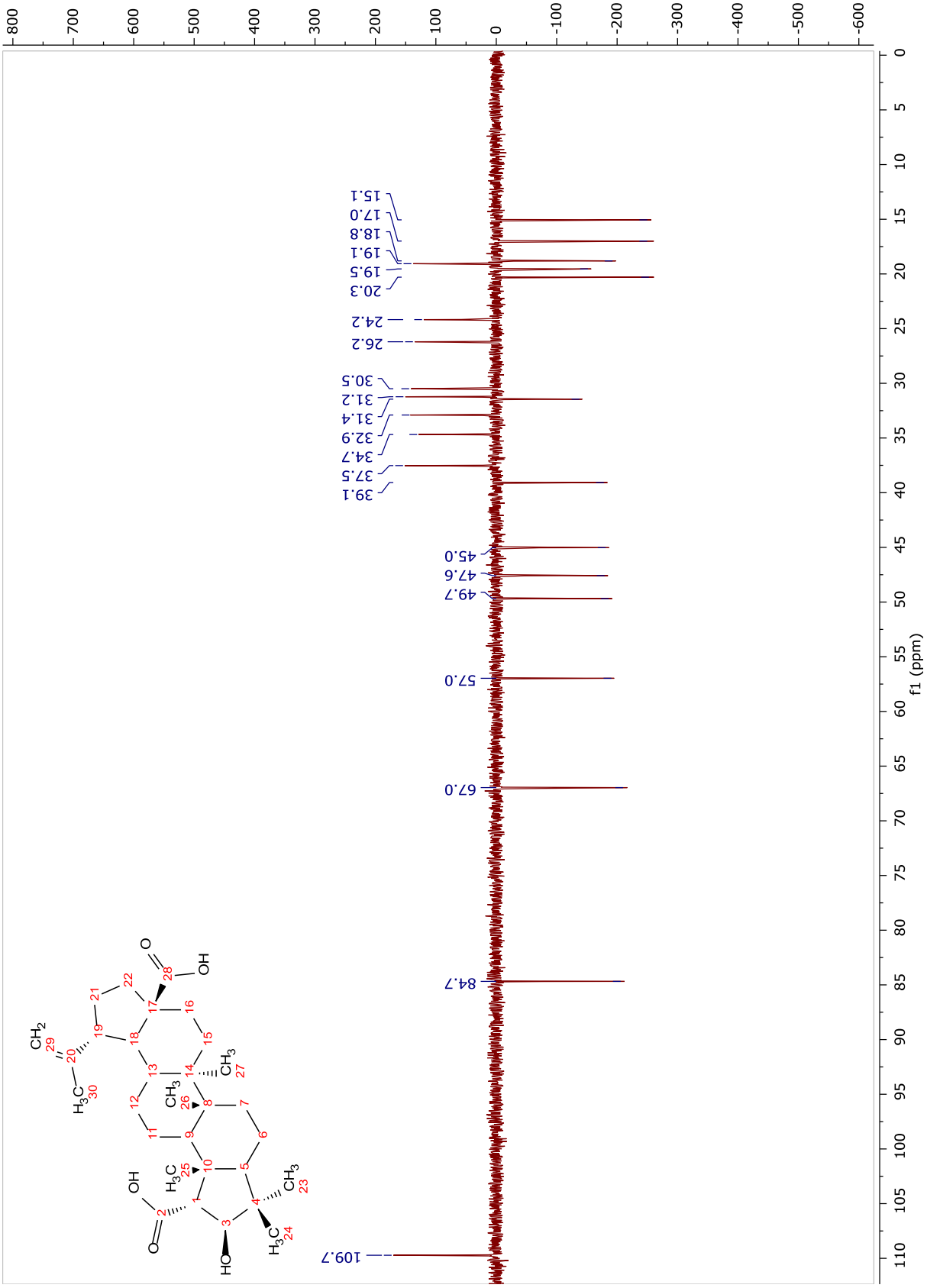


Figura 164. Espectro de DEPT-135 de **Zg6** (100 MHz, C_5D_5N).

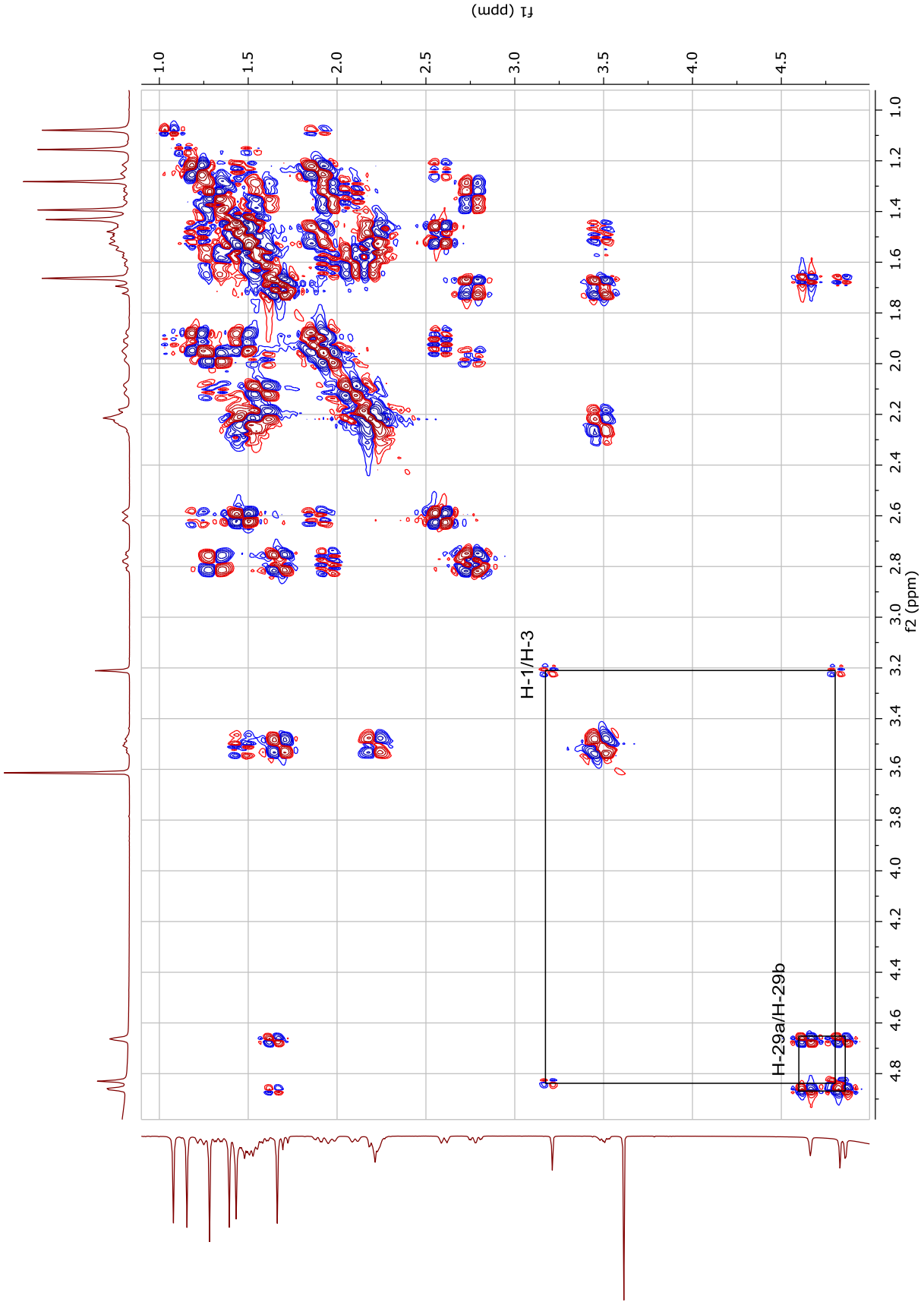


Figura 165. Espectro de COSY de **Zg6** (400 MHz, C_5D_5N).

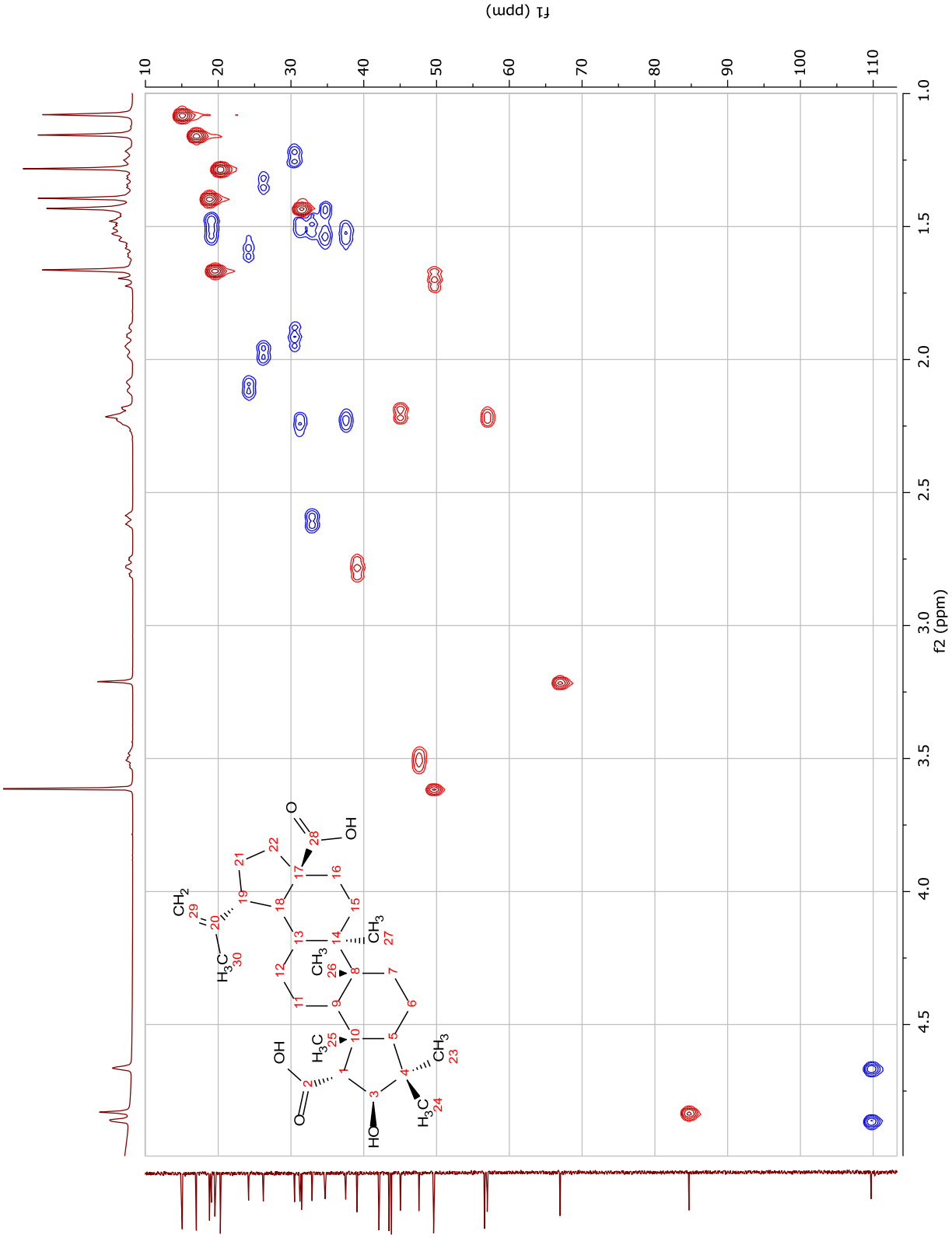


Figura 166. Espectro de HSQC de **Zg6** (400 MHz, C_5D_5N).

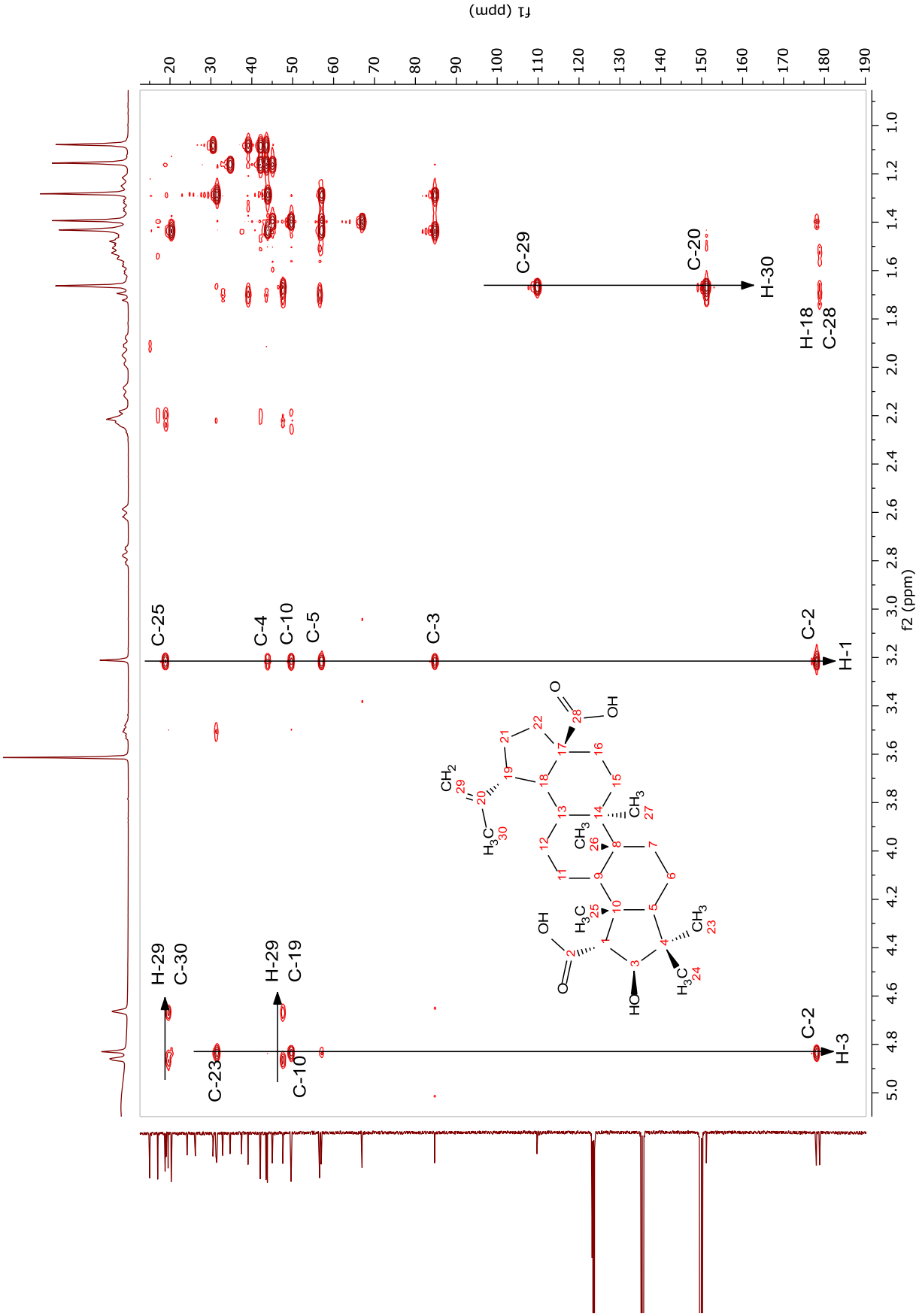


Figura 167. Espectro de HMBC de **Zg6** (400 MHz, C_5D_5N).

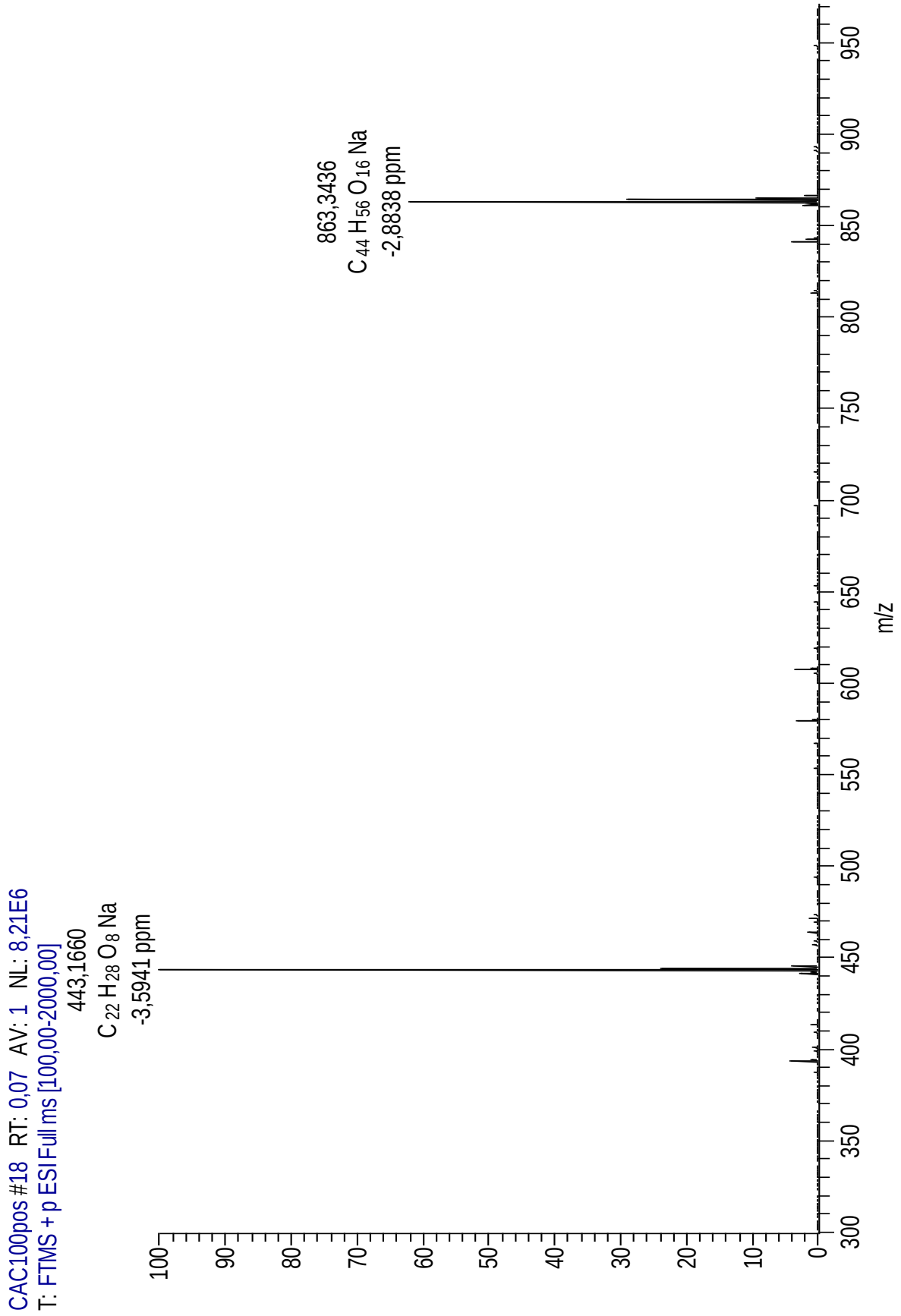


Figura 168. Espectro de massas de alta resolução de **Zg7** (ESI, modo positivo).

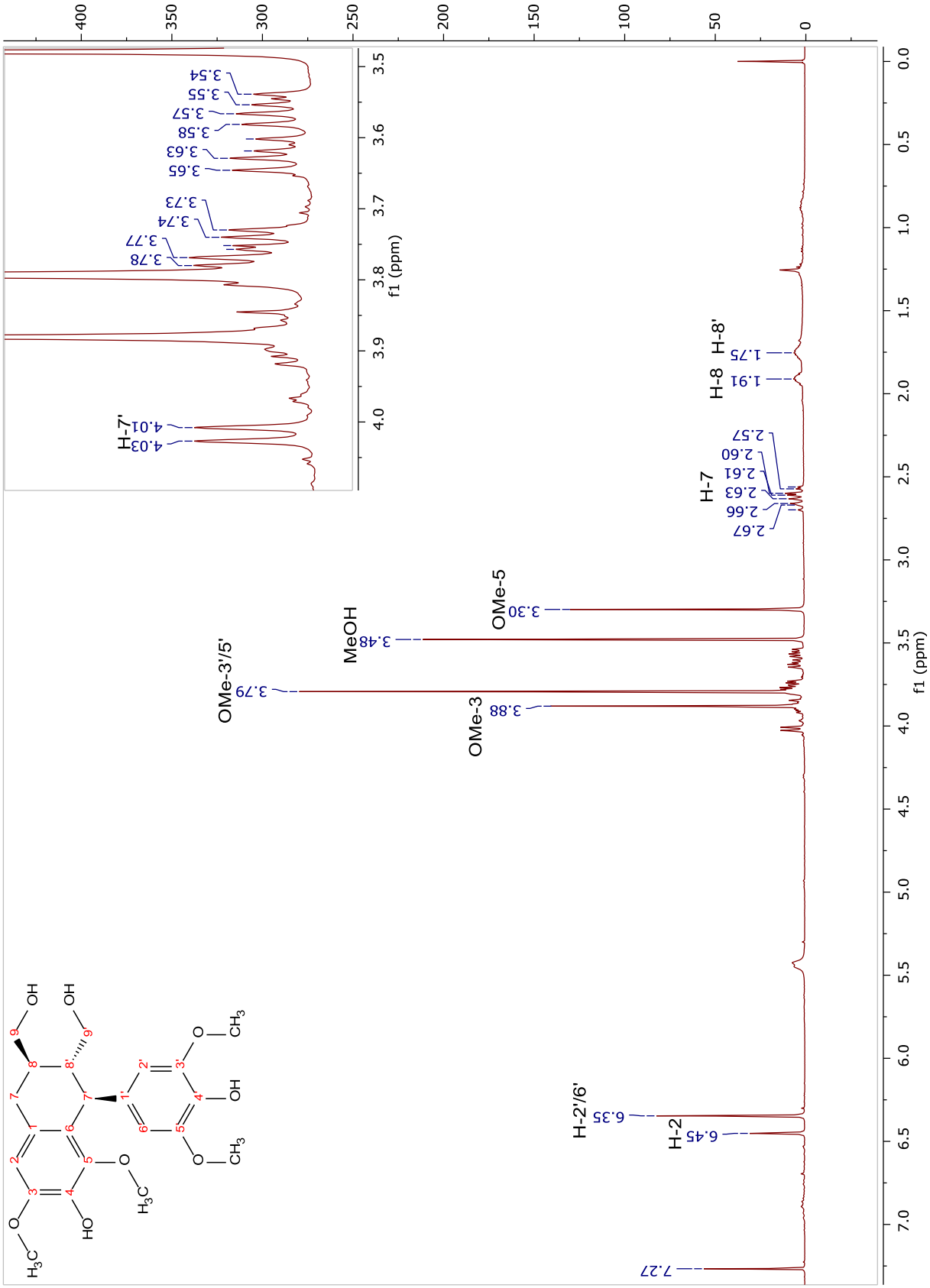


Figura 169. Espectro de RMN ^{1}H de **Zg7** (400 MHz, $CDCl_3$).

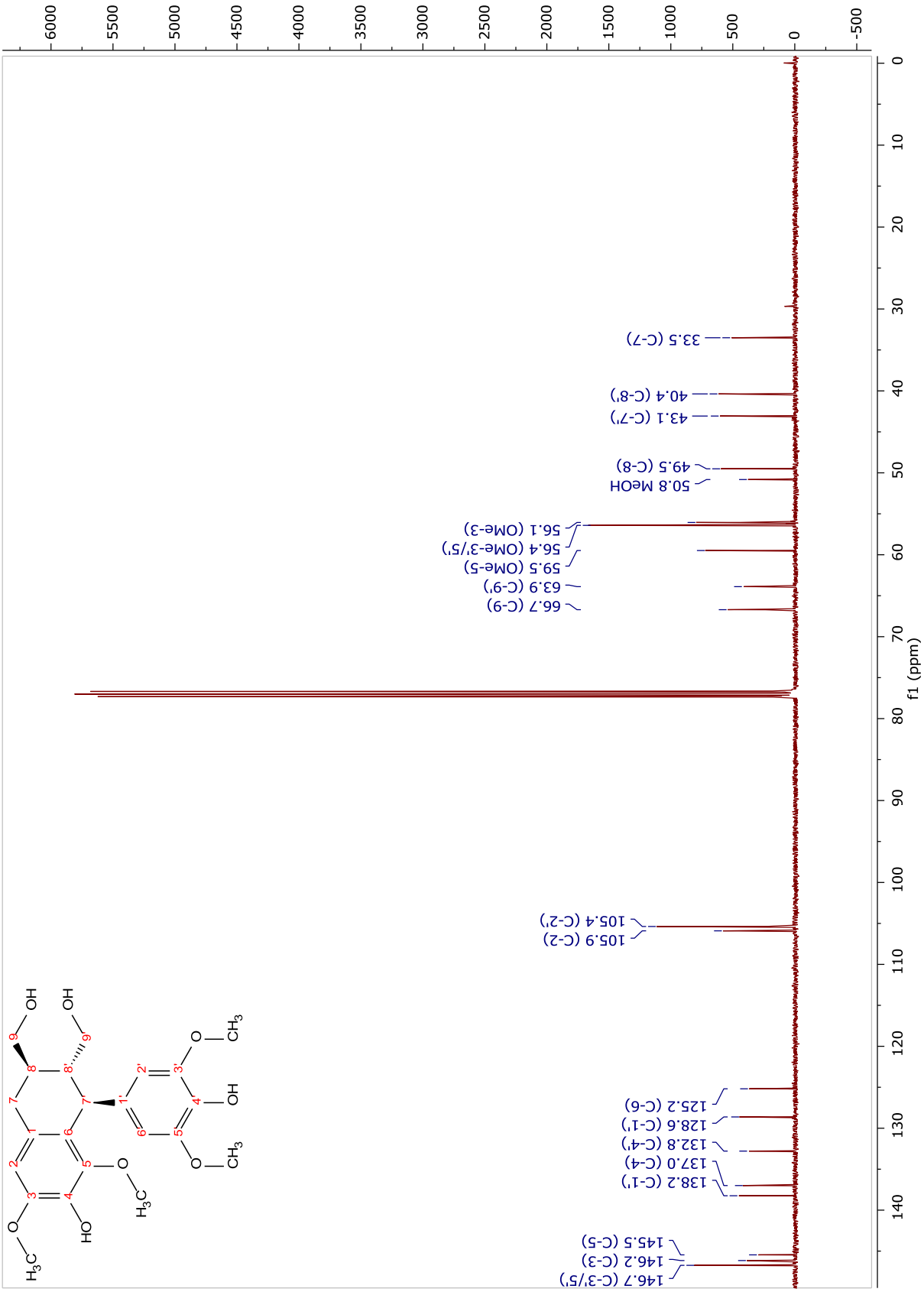


Figura 170. Espectro de RMN ^{13}C de **Zg7** (100 MHz, $CDCl_3$).

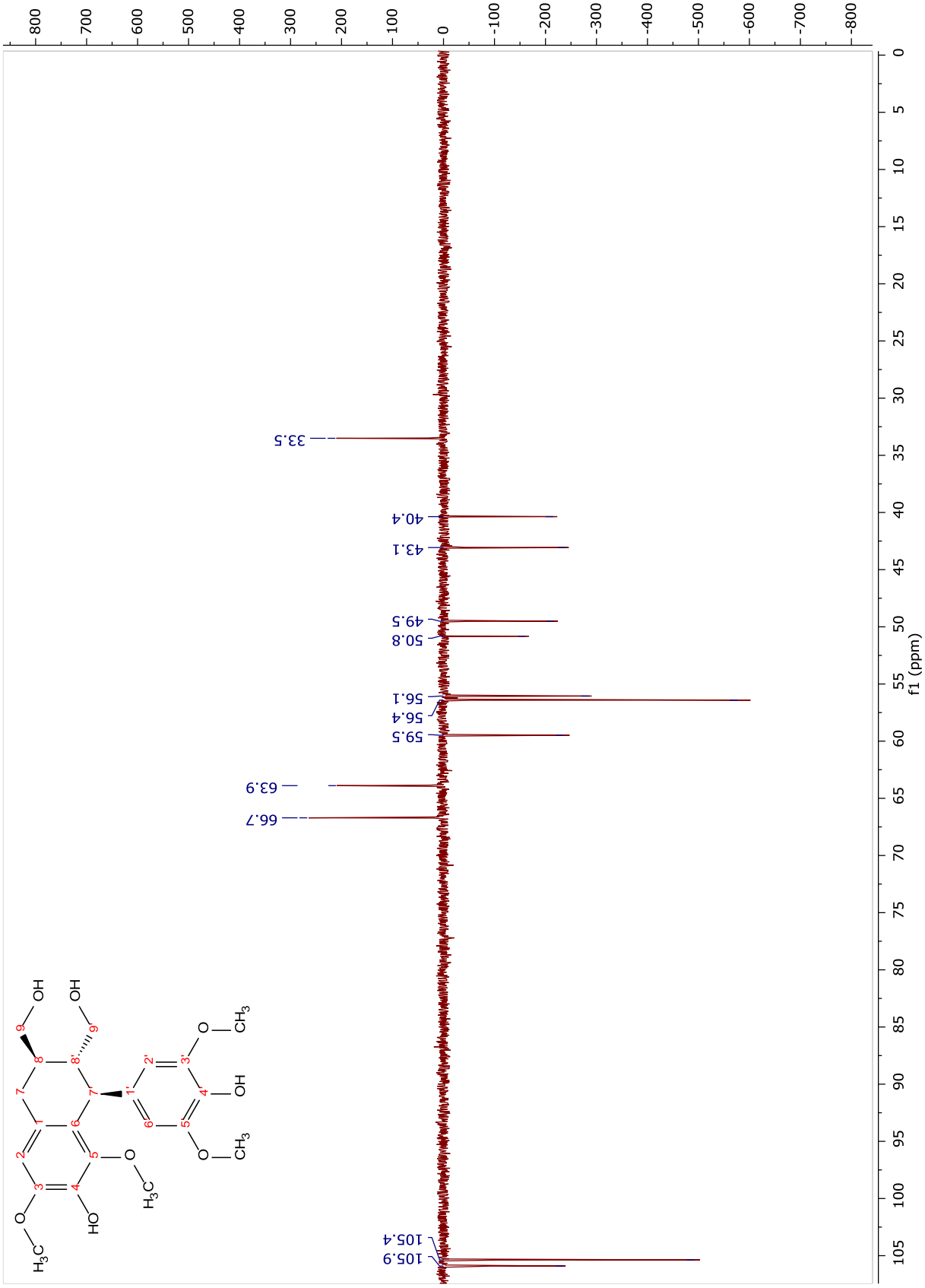


Figura 171. Espectro de DEPT-135 de **Zg7** (100 MHz, $CDCl_3$).

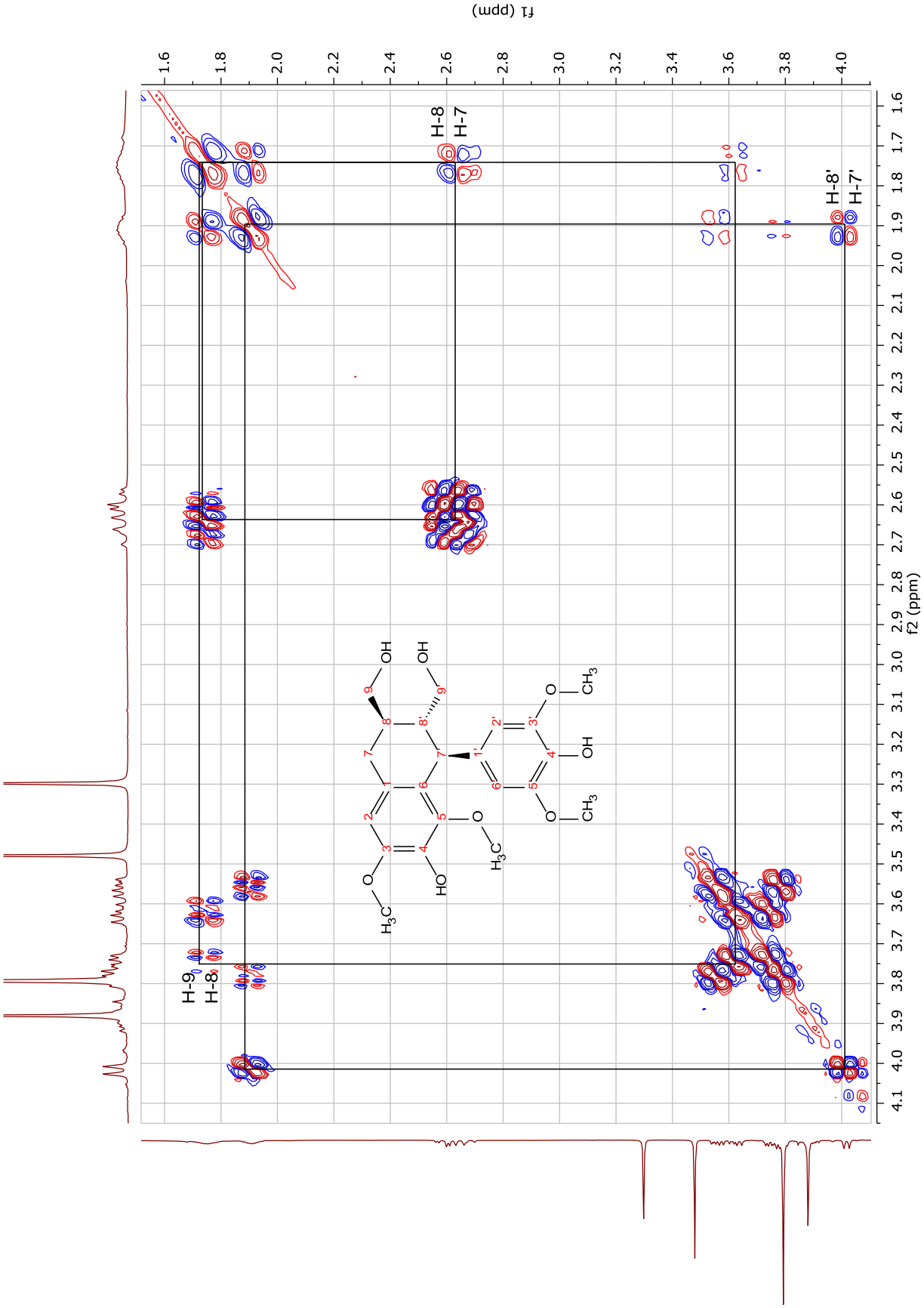


Figura 172. Espectro de COSY de **Zg7** (400 MHz, $CDCl_3$).

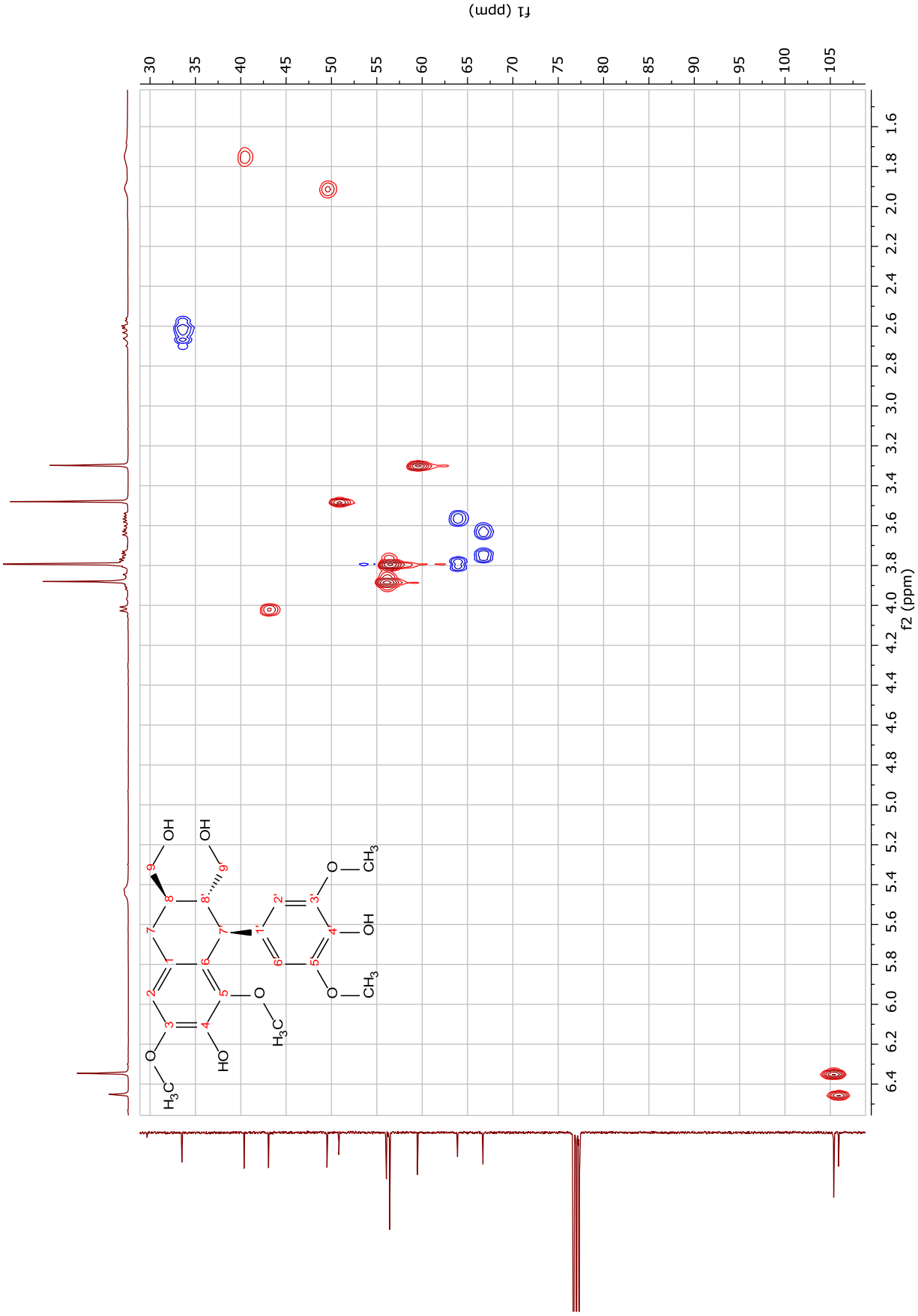


Figura 173. Espectro de HSQC de **Zg7** (400 MHz, $CDCl_3$).

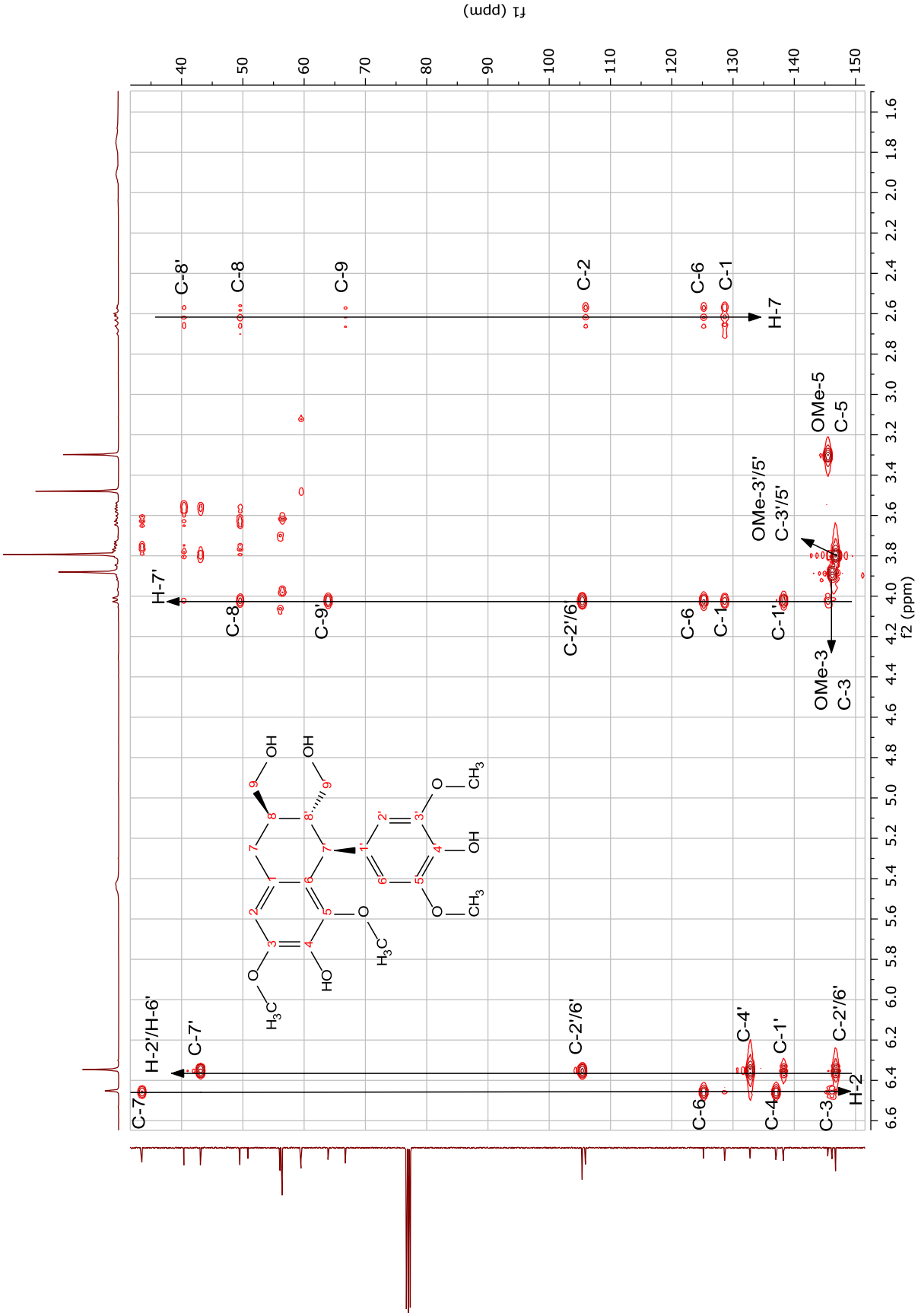


Figura 174. Espectro de HMBC de **Zg7** (400 MHz, $CDCl_3$).

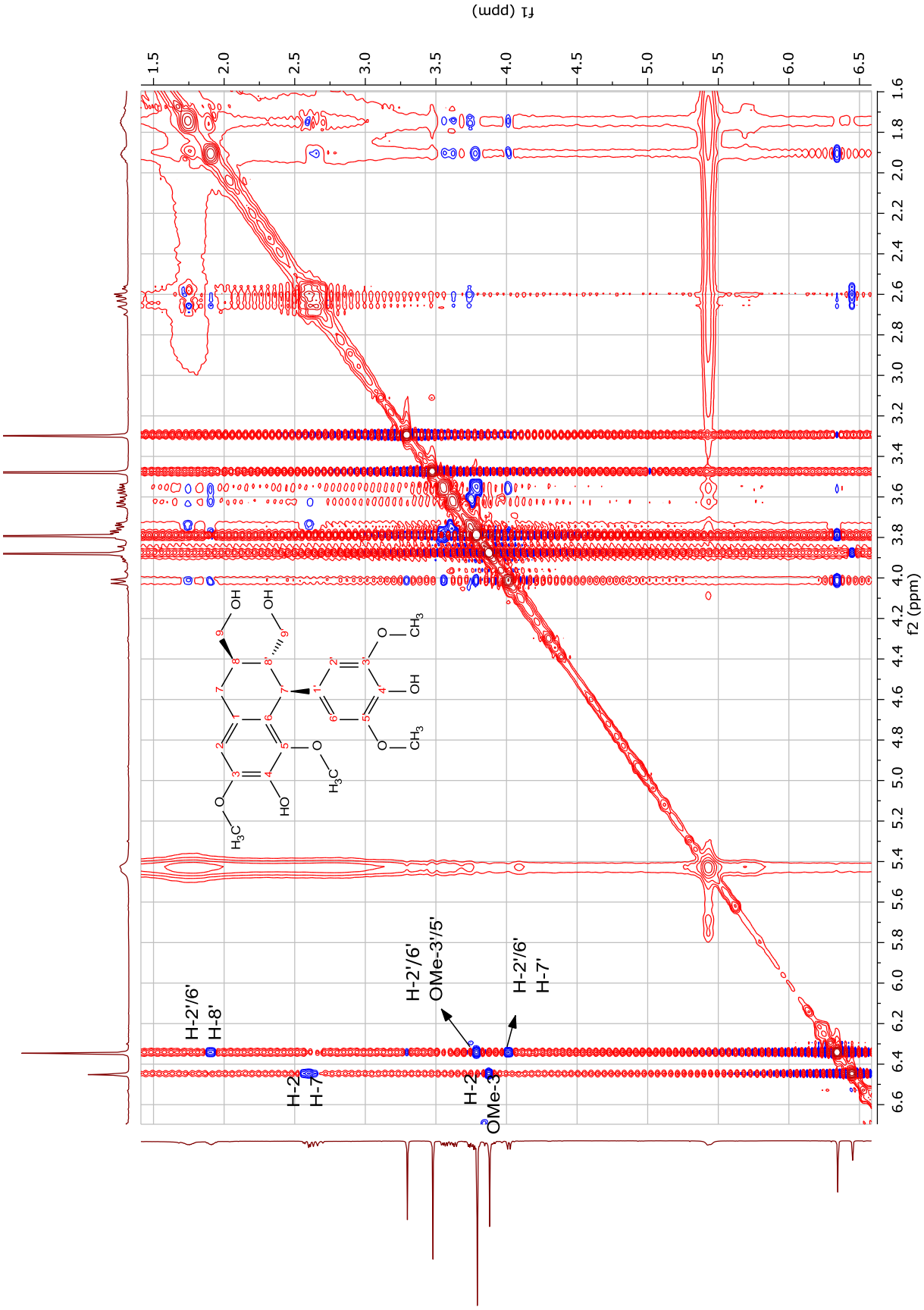


Figura 175. Espectro de NOESY de **Zg7** (400 MHz, $CDCl_3$).

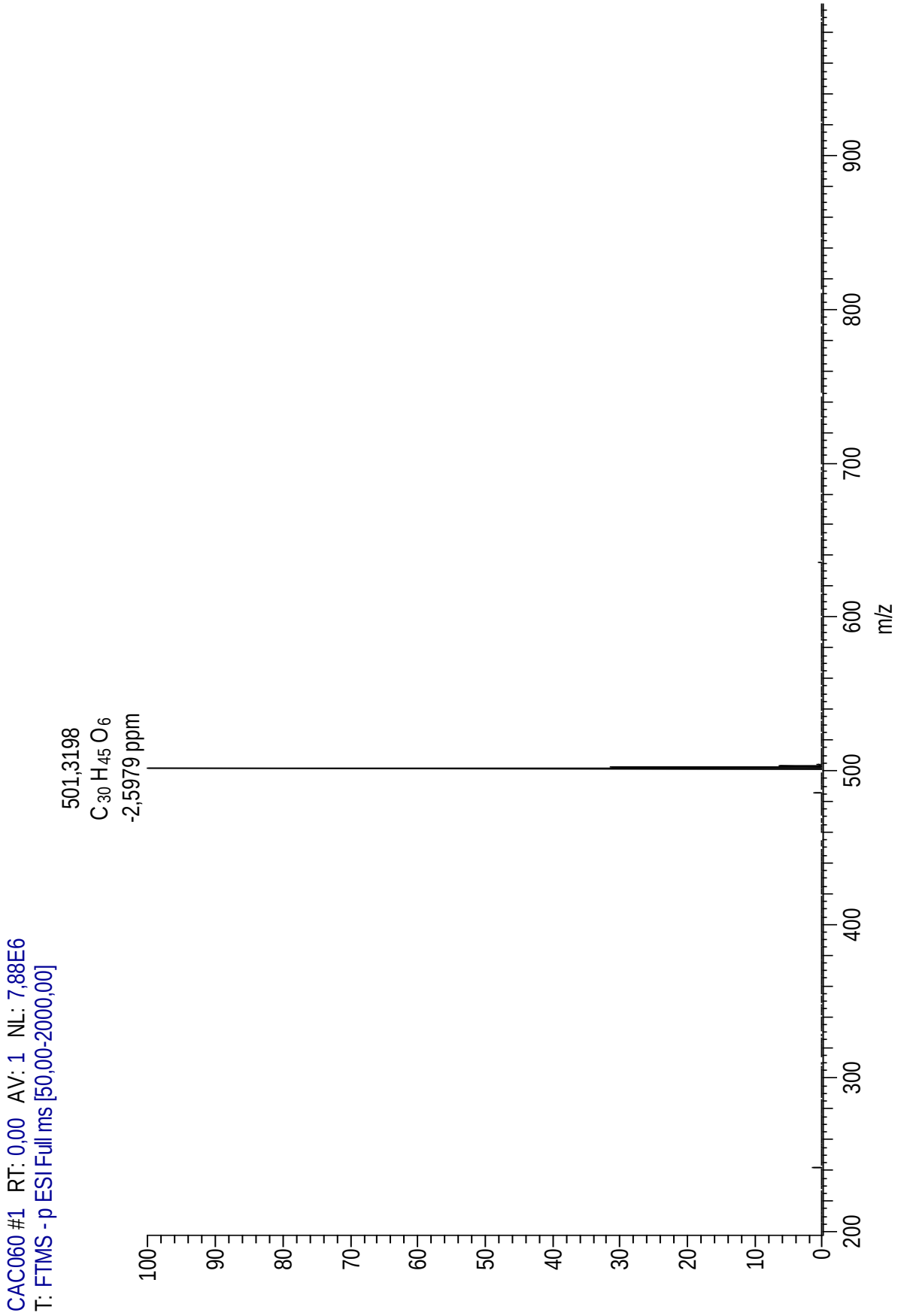


Figura 176. Espectro de massas de alta resolução de **Zg8** (ESI, modo negativo).

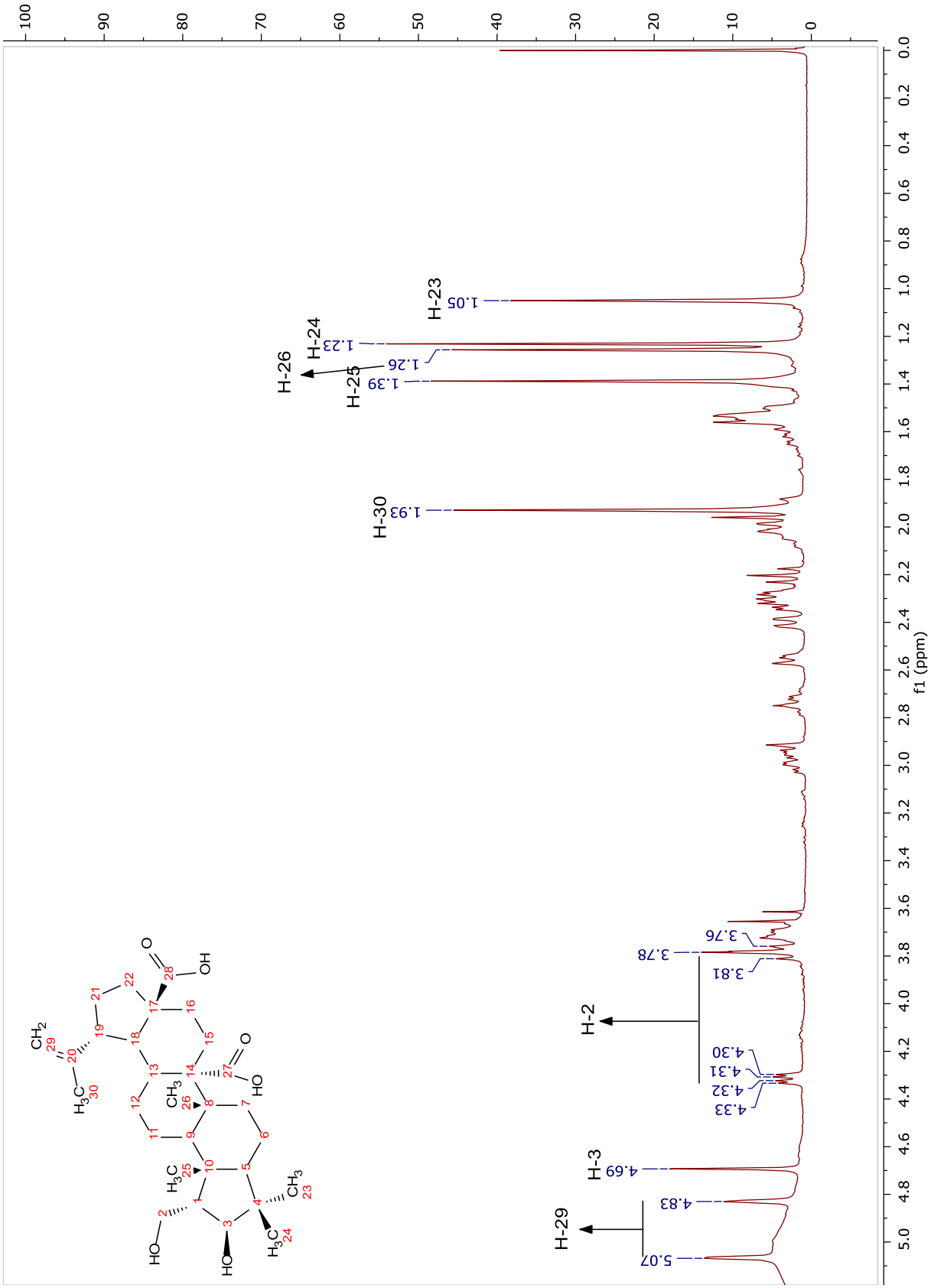


Figura 177. Espectro de RMN ^{1}H de **Zg8** (400 MHz, C_5D_5N).

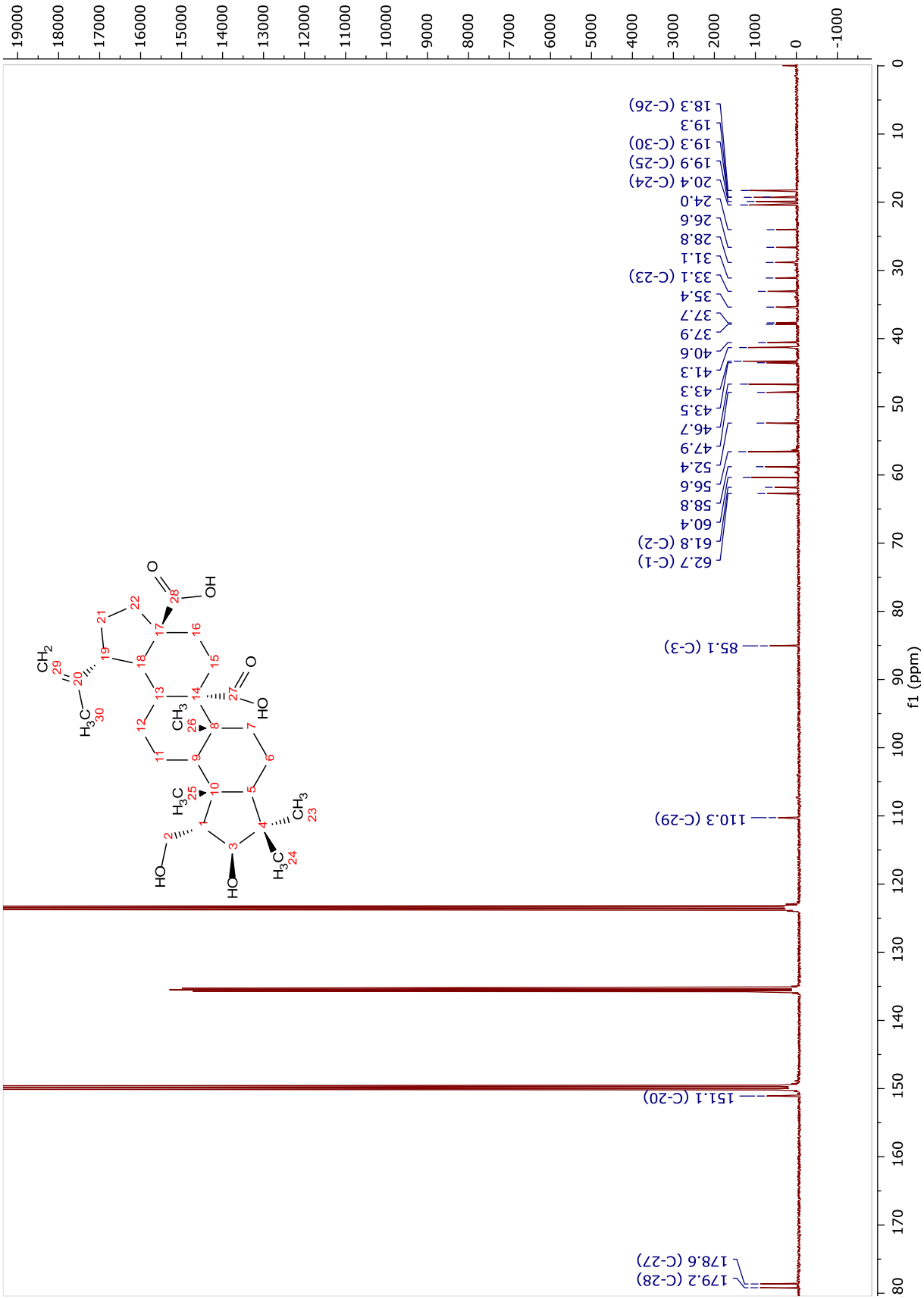


Figura 178. Espectro de RMN ^{13}C de **Zg8** (100 MHz, C_5D_5N).

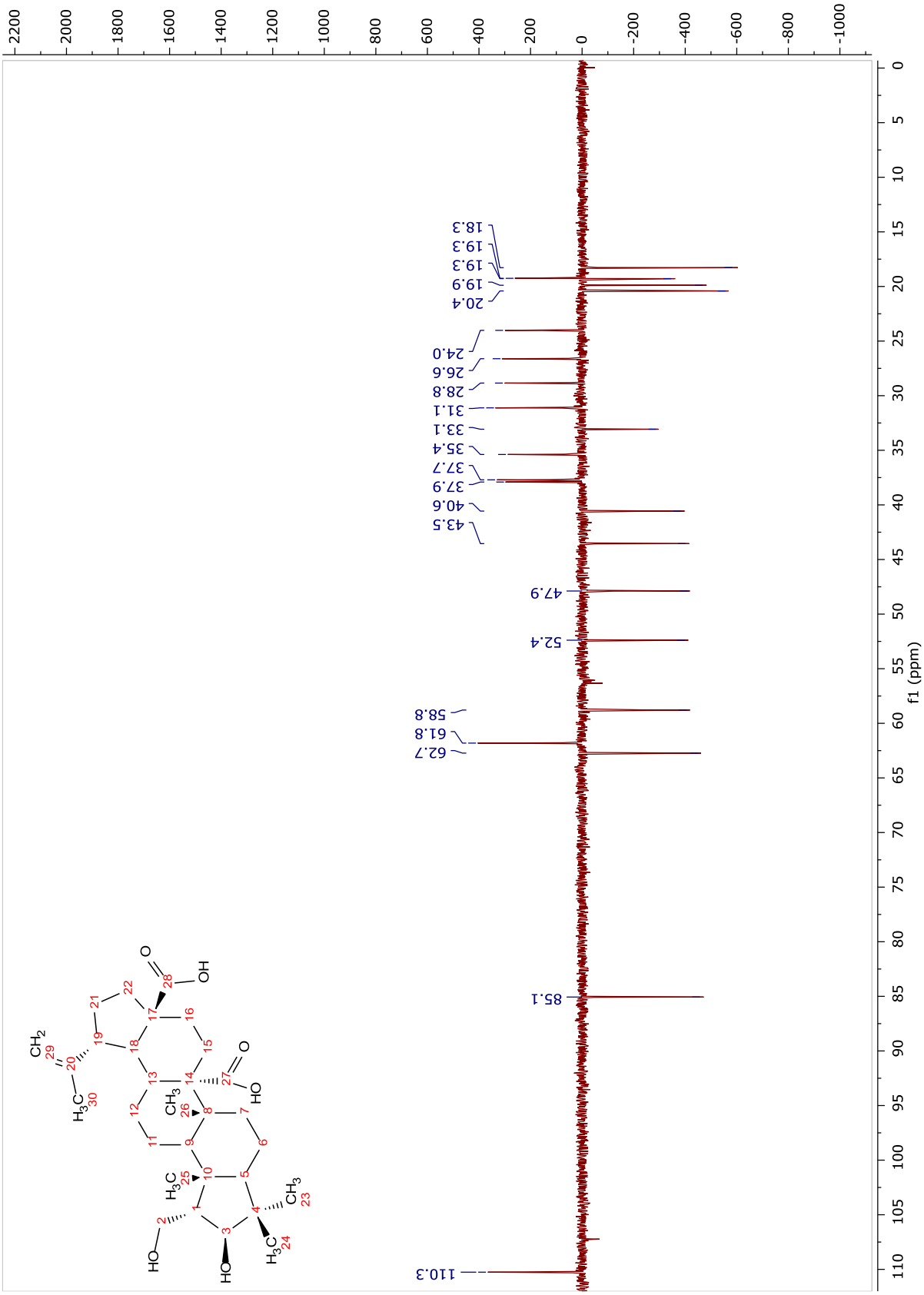


Figura 179. Espectro de DEPT-135 de **Zg8** (100 MHz, C_5D_5N).

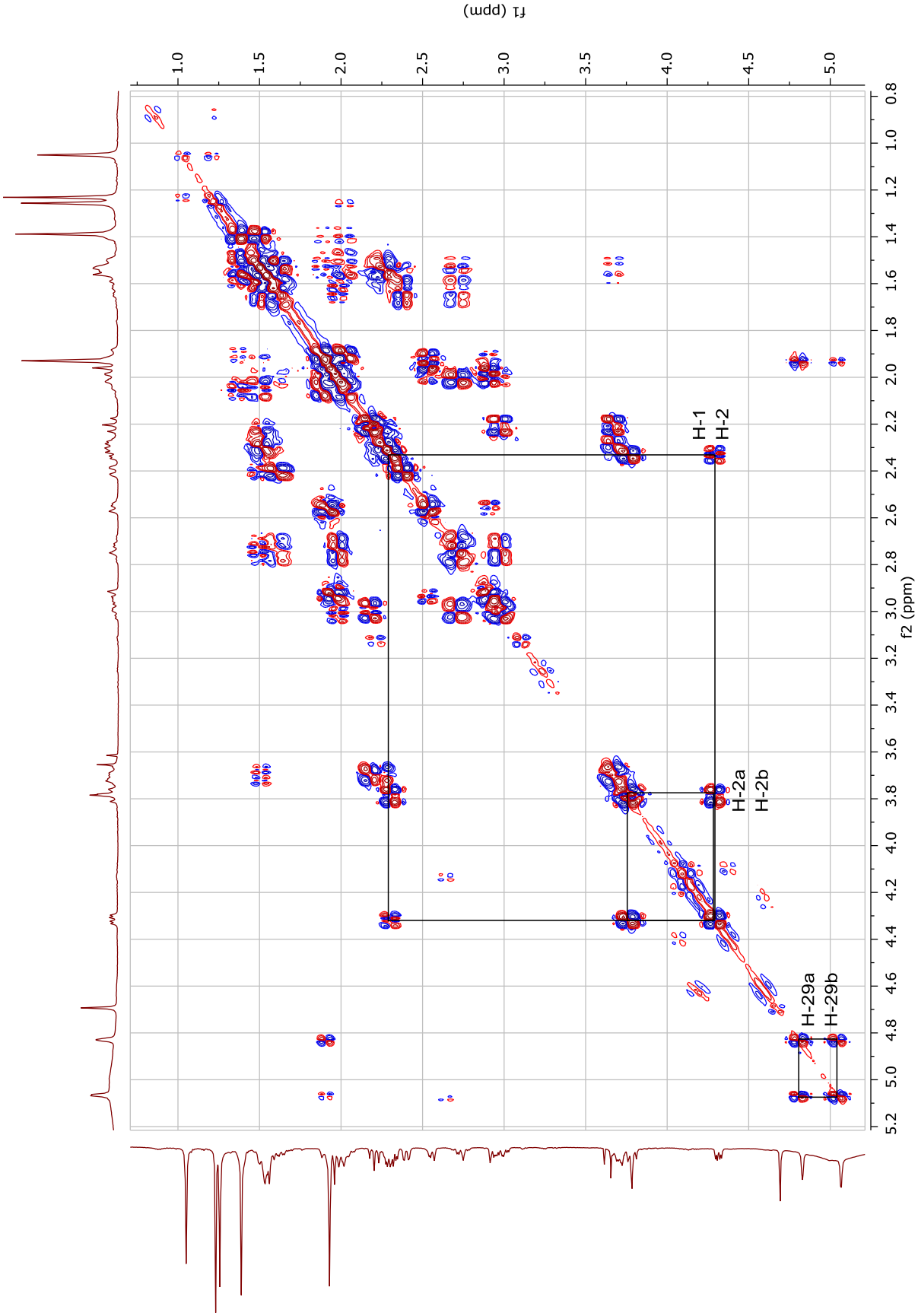


Figura 180. Espectro de COSY de **Zg8** (400 MHz, C_5D_5N).

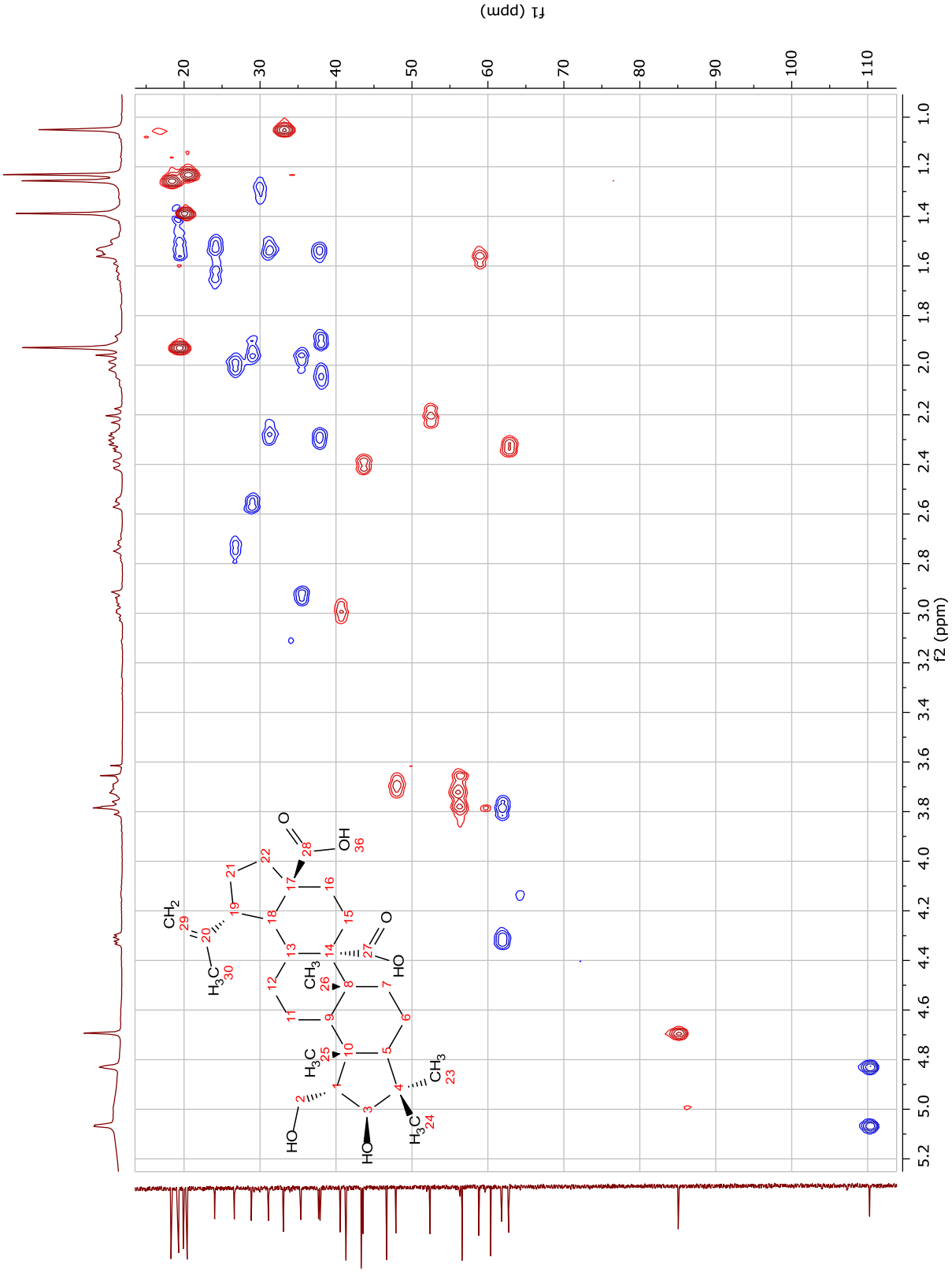


Figura 181. Espectro de HSQC de **Zg8** (400 MHz, C_5D_5N).

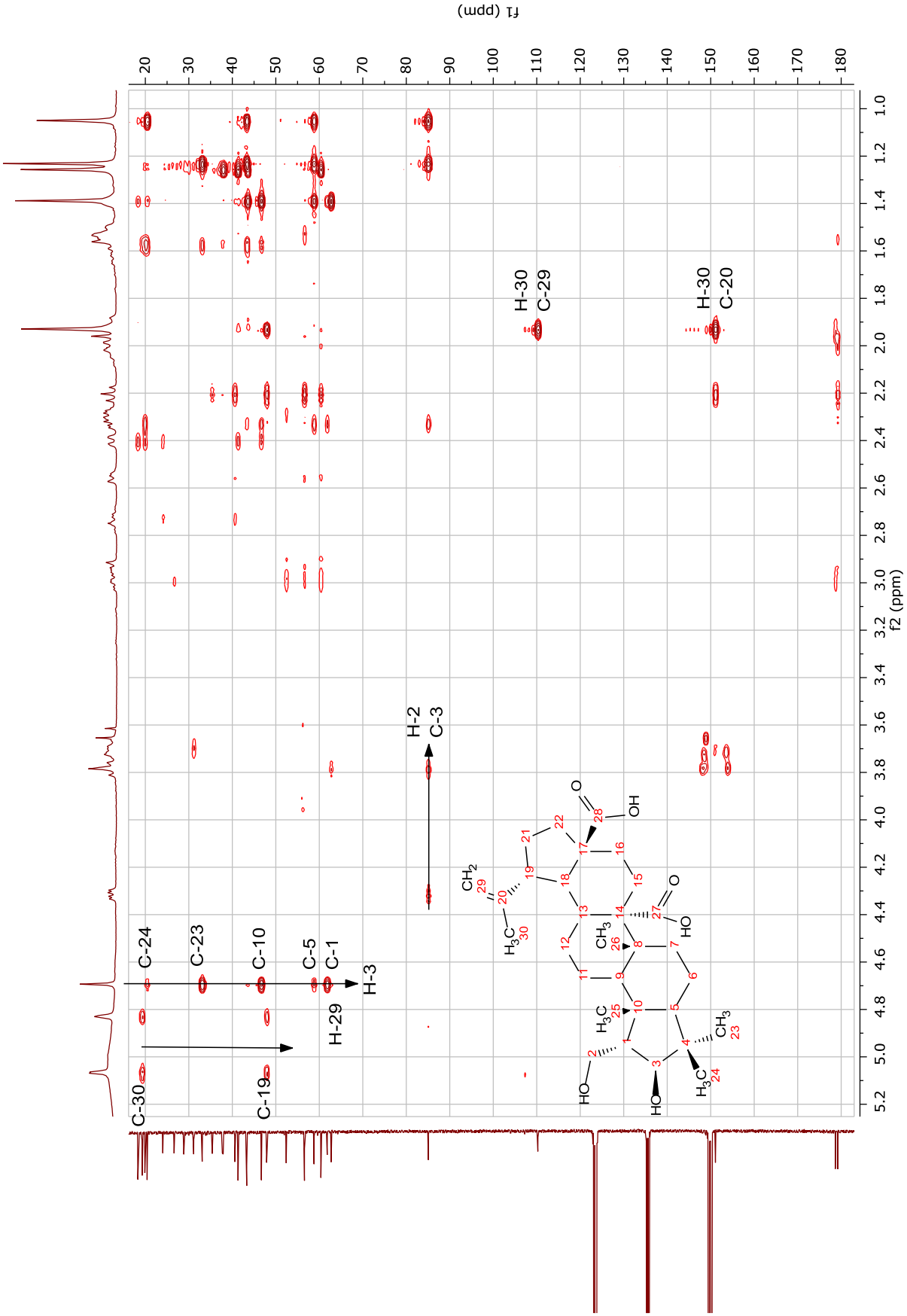


Figura 182. Espectro de HMBC de **Zg8** (400 MHz, C_5D_5N).

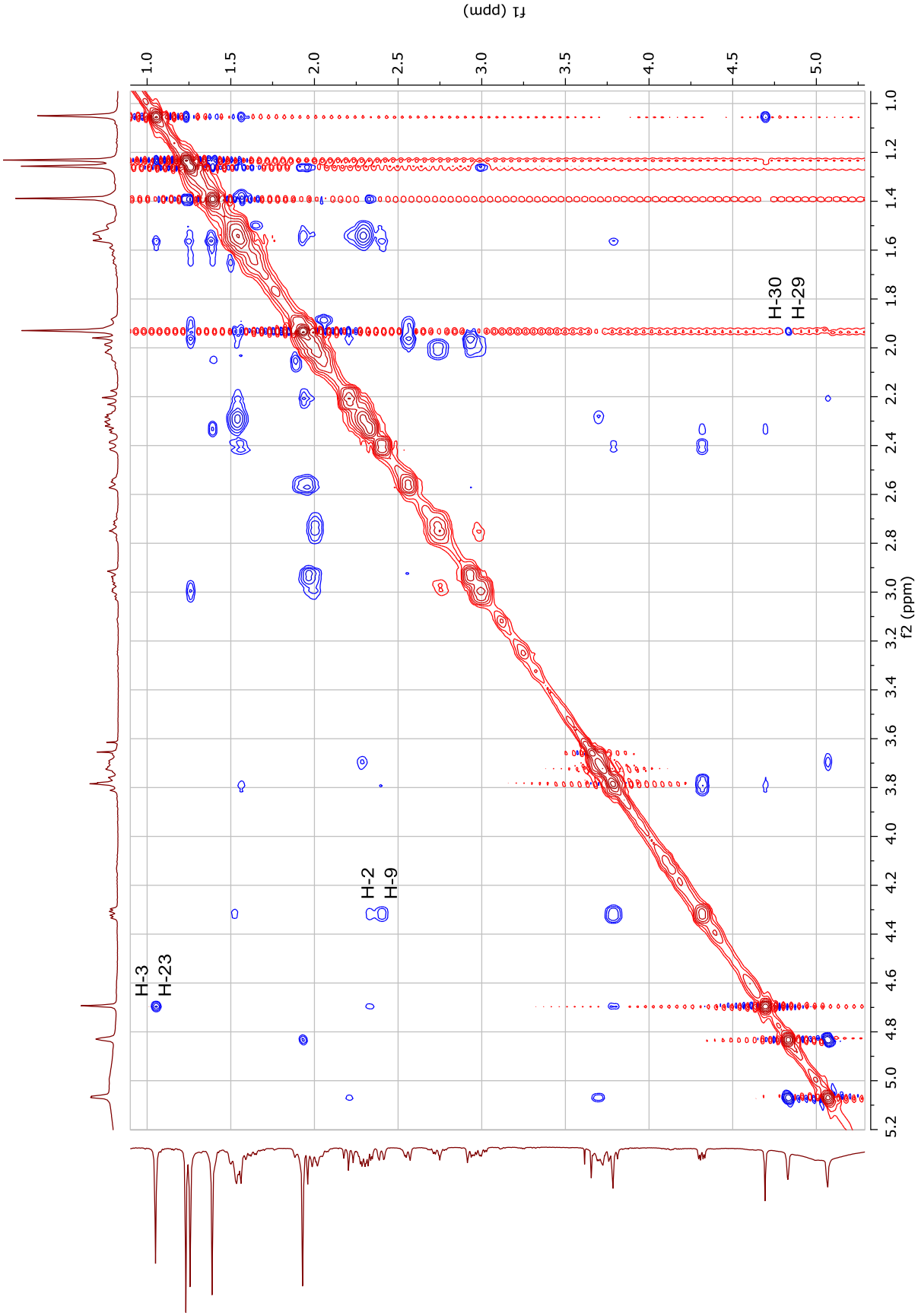


Figura 183. Espectro de ROESY de **Zg8** (400 MHz, C_5D_5N).

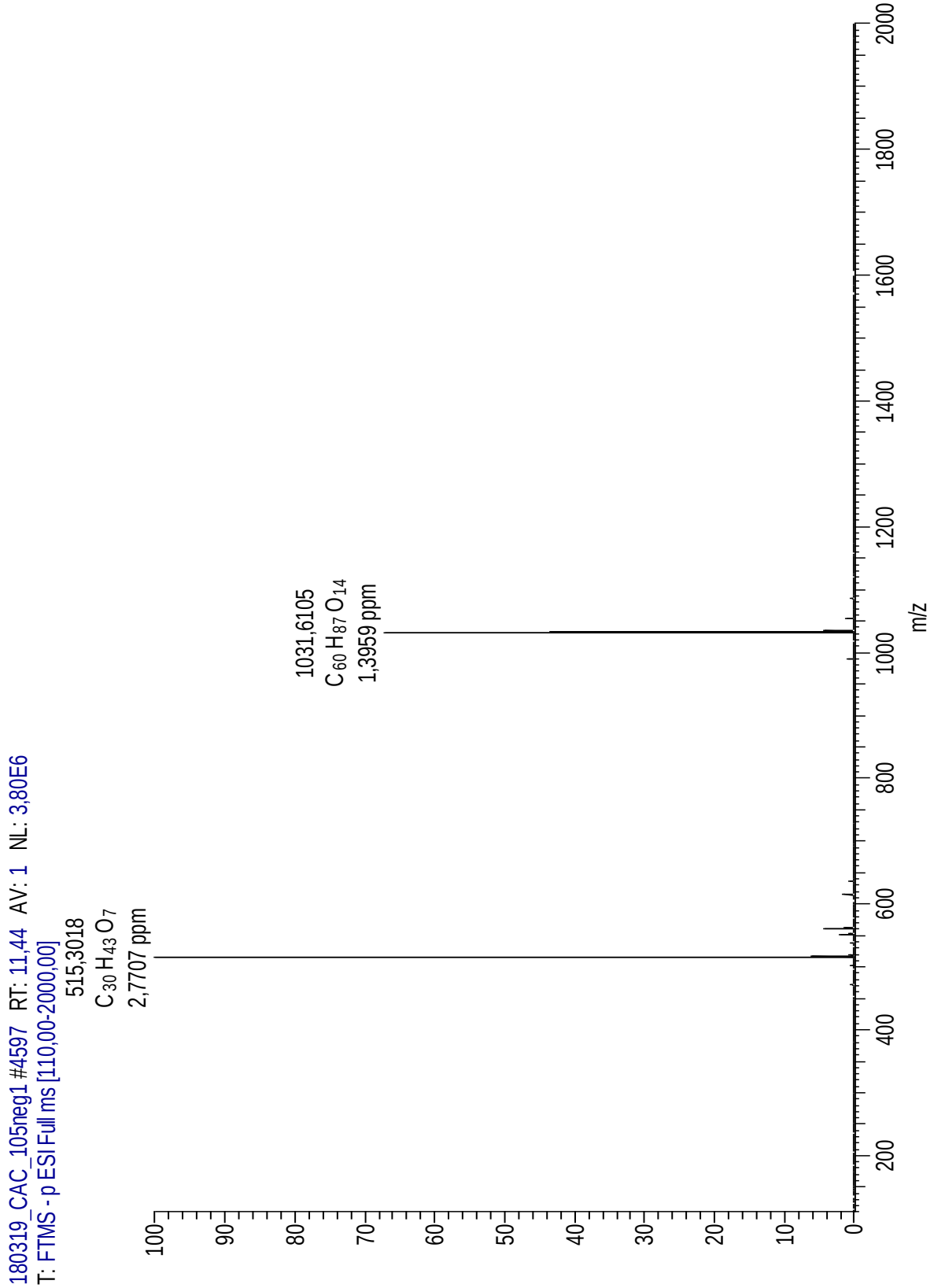


Figura 184. Espectro de massas de alta resolução de **Zg9** (ESI, modo negativo).

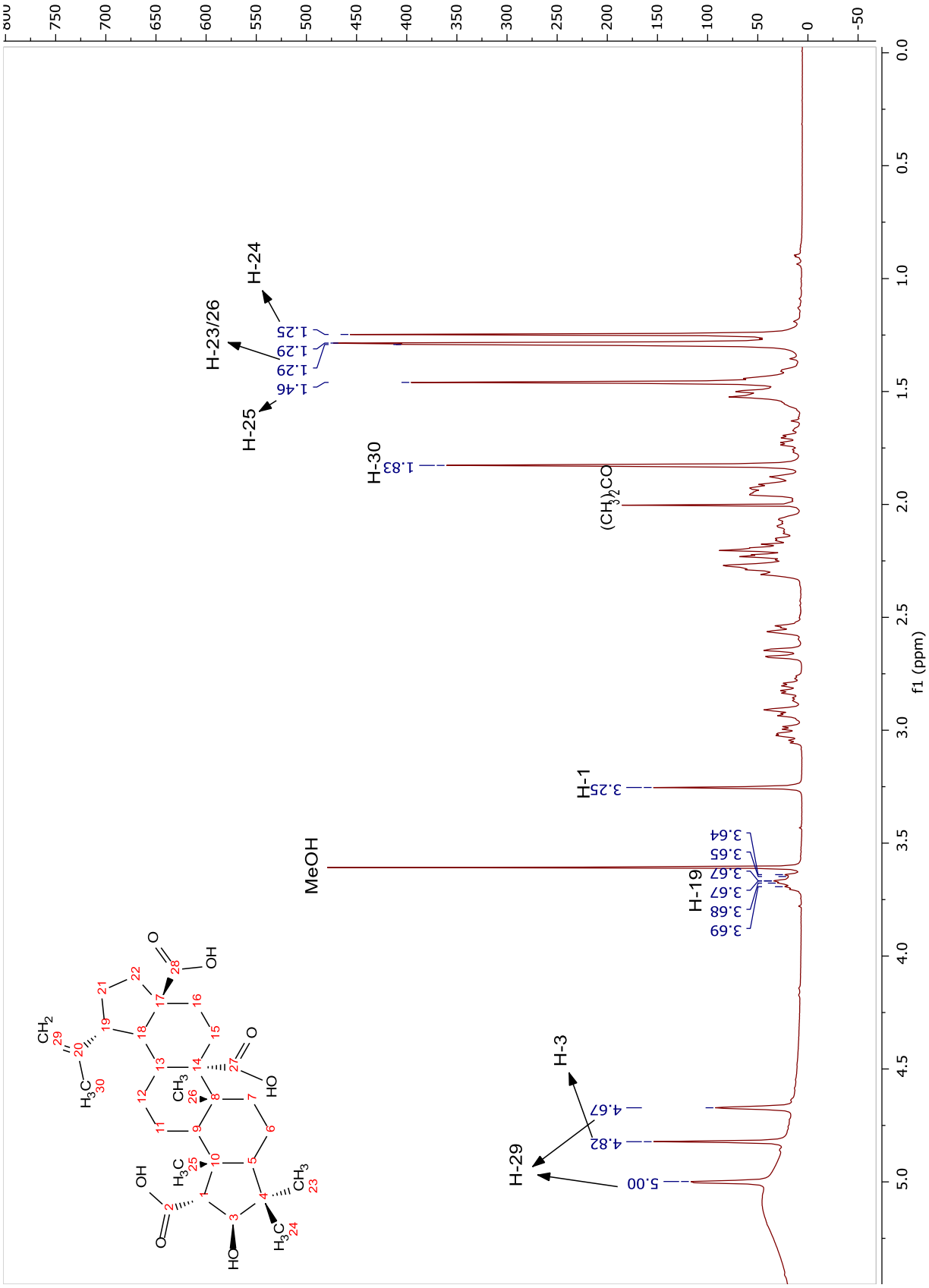


Figura 185. Espectro de RMN ^{1}H de **Zg9** (400 MHz, C_5D_5N).

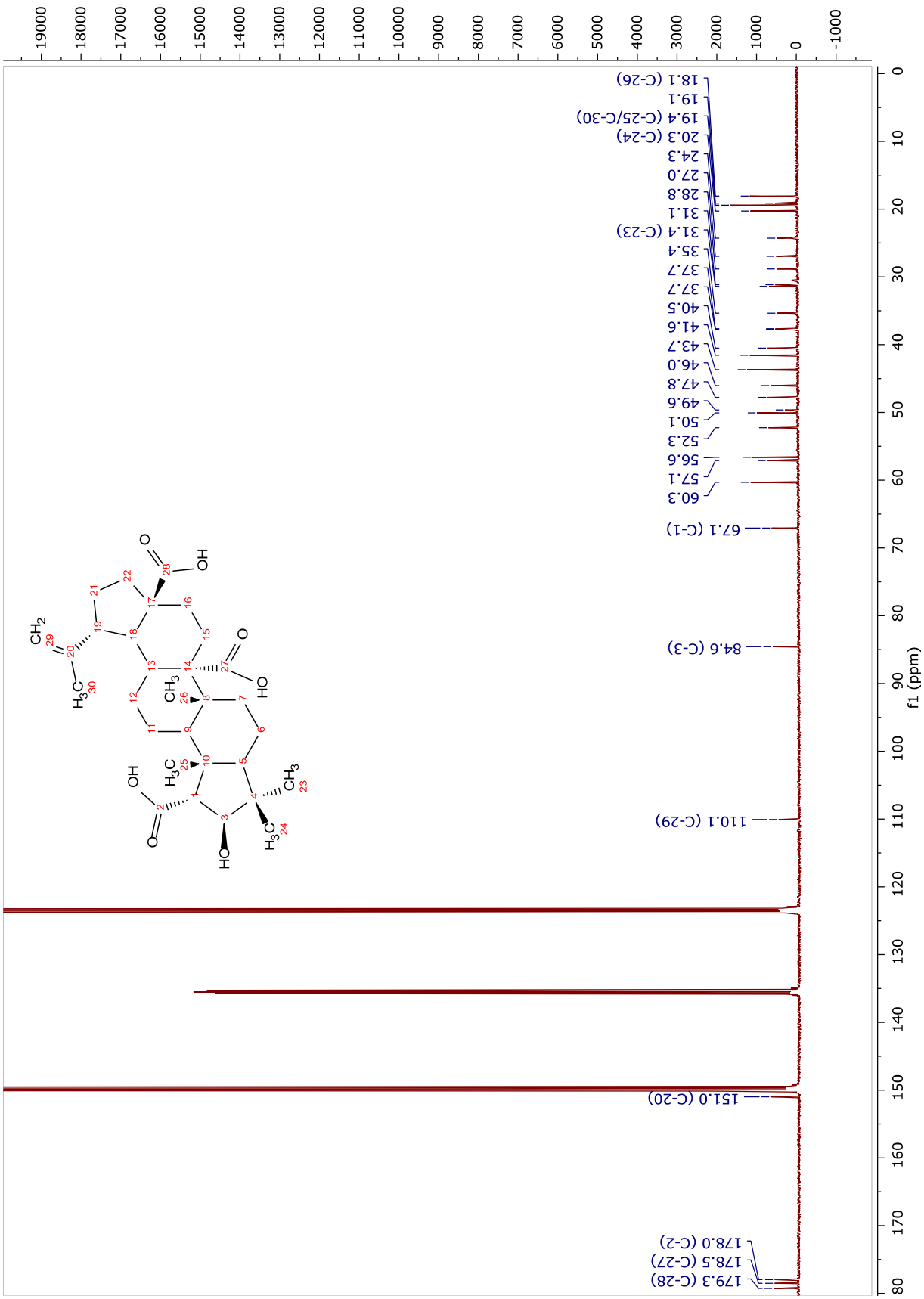


Figura 186. Espectro de RMN ^{13}C de **Zg9** (100 MHz, C_5D_5N).

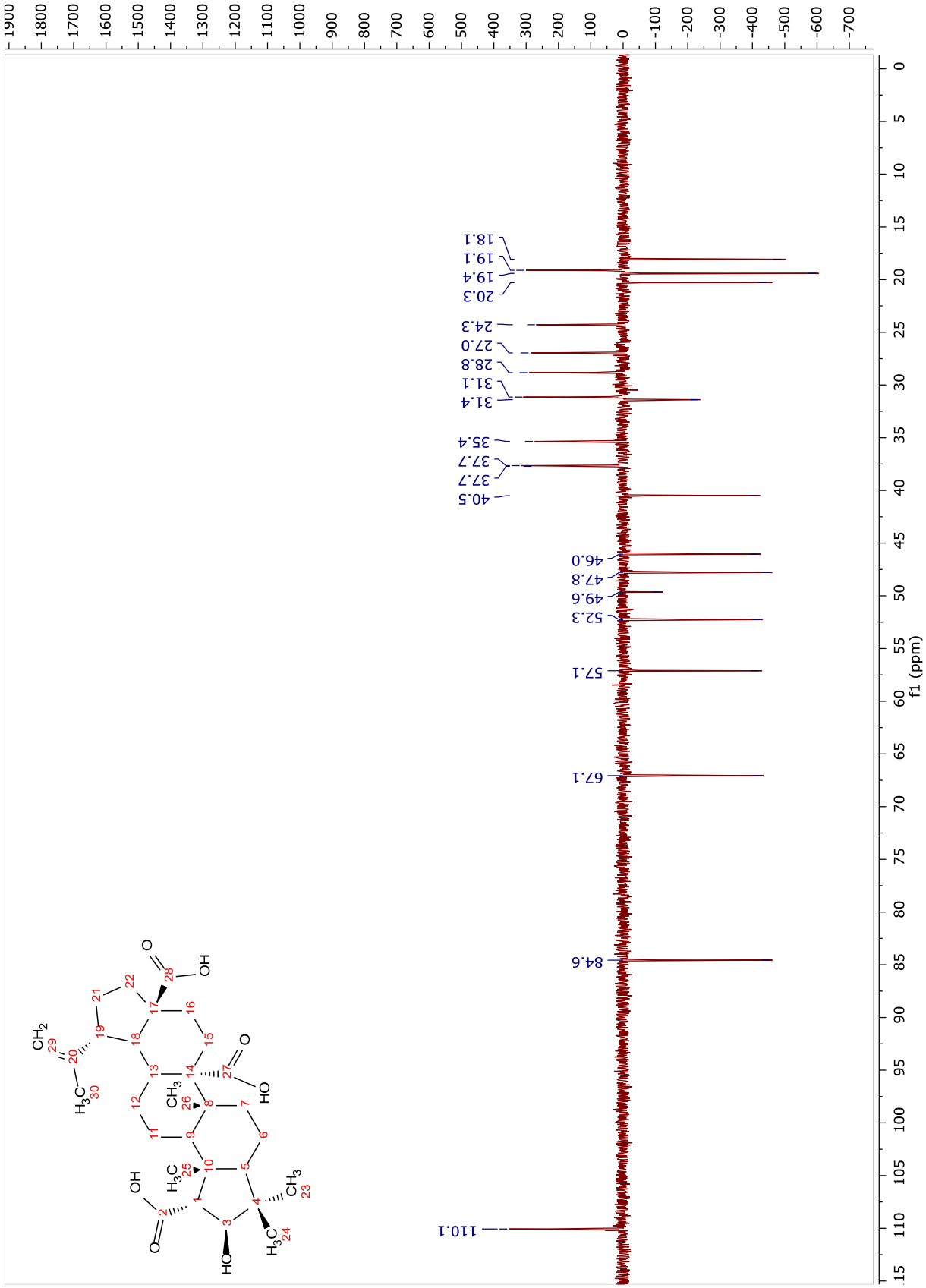


Figura 187. Espectro de DEPT-135 de **Zg9** (100 MHz, C_5D_5N).

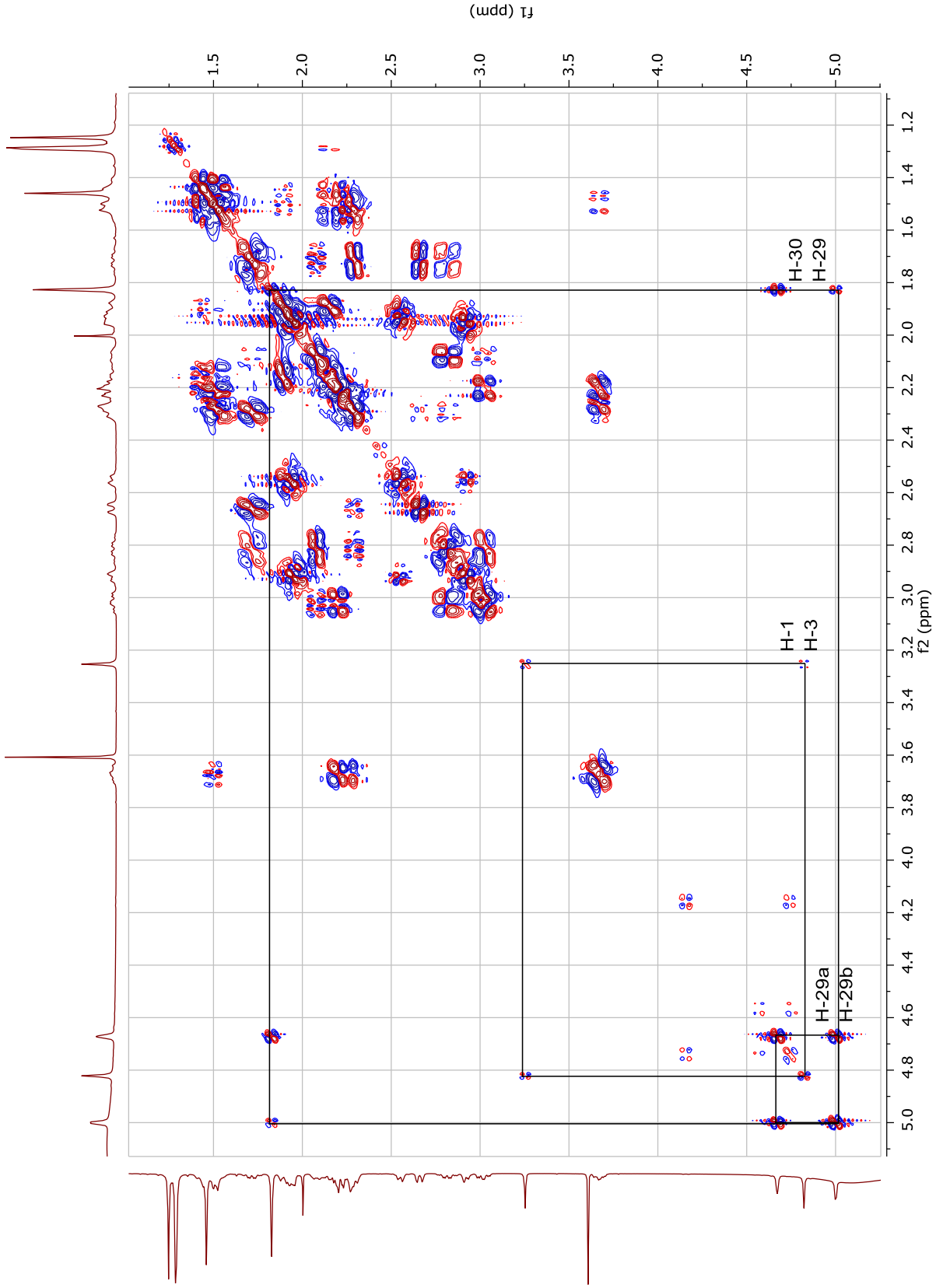


Figura 188. Espectro de COSY de **Zg9** (400 MHz, C_5D_5N).

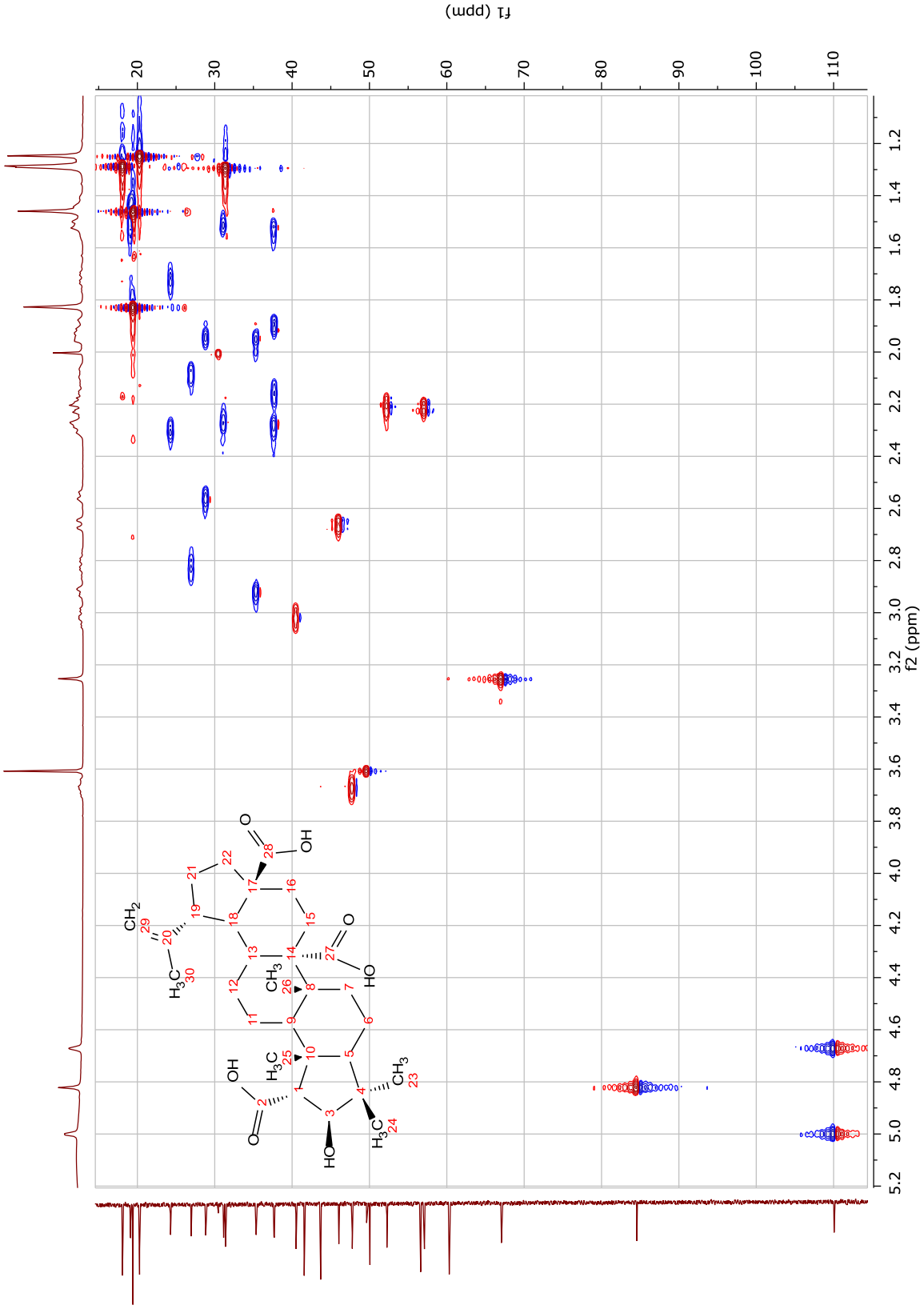


Figura 189. Espectro de HSQC de **Zg9** (400 MHz, C_5D_5N).

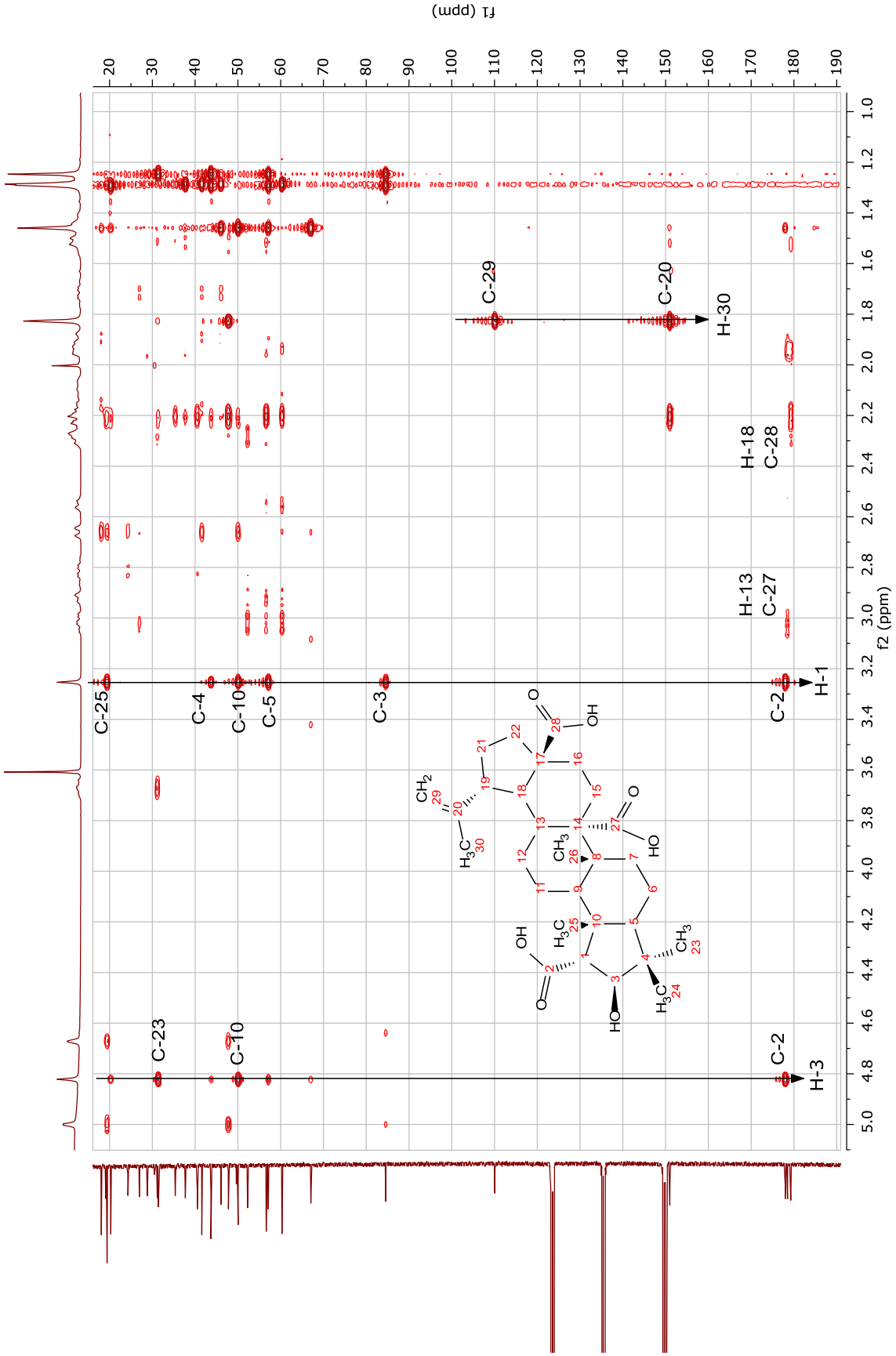


Figura 190. Espectro de HMBC de **Zg9** (400 MHz, C_5D_5N).

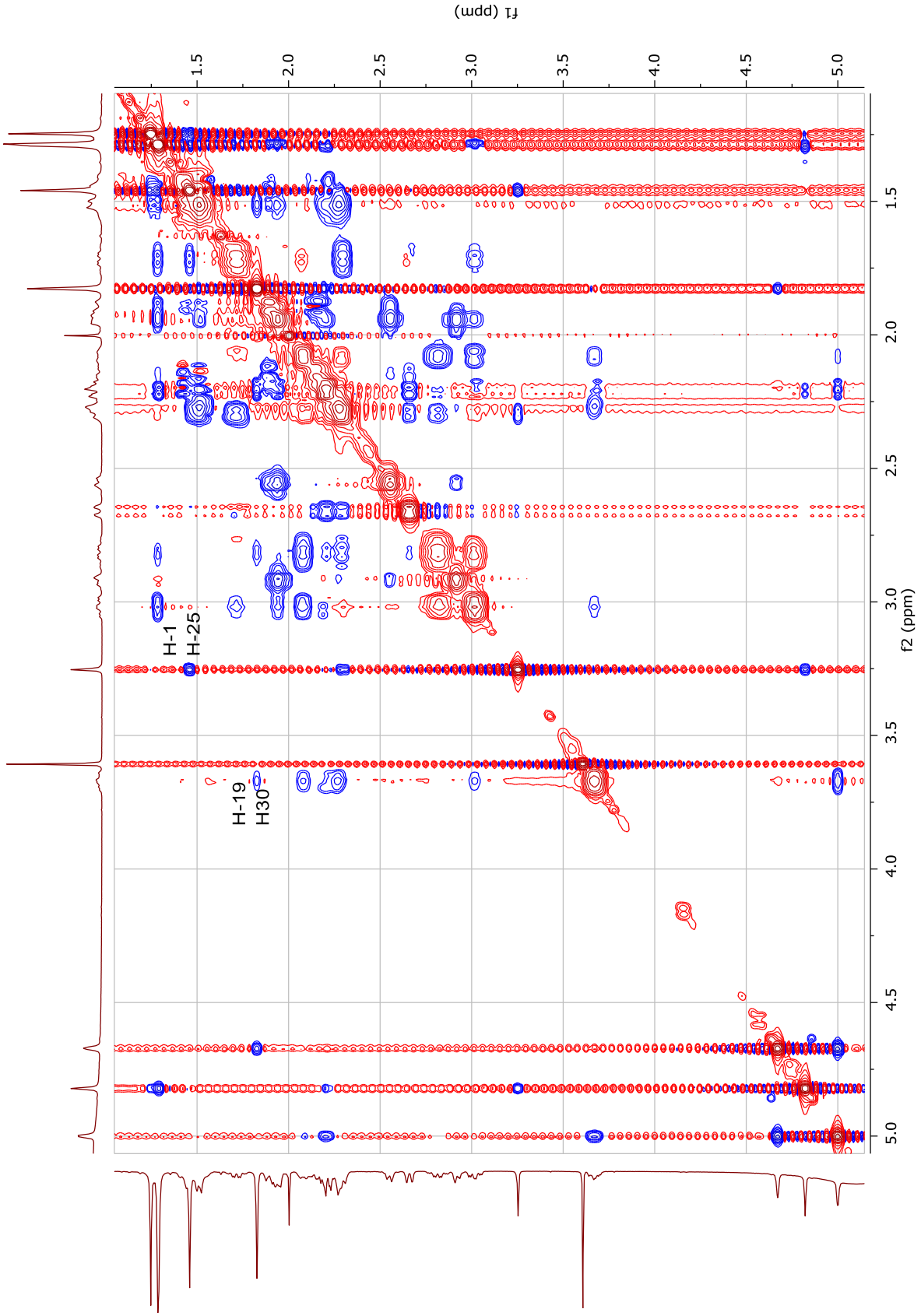


Figura 191. Espectro de ROESY de **Zg9** (400 MHz, C_5D_5N).

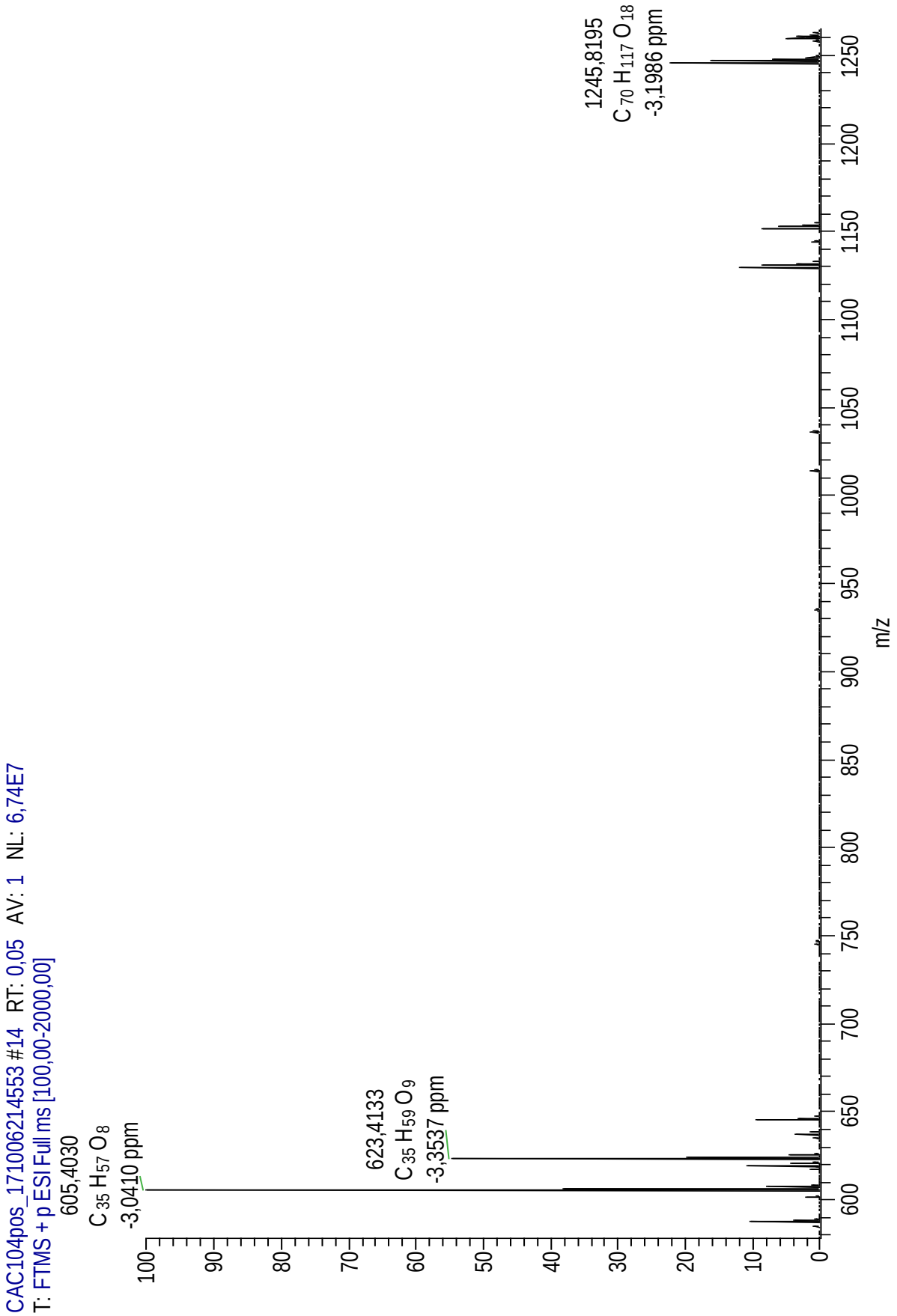


Figura 192. Espectro de massas de alta resolução de **Zg10** (ESI, modo positivo).

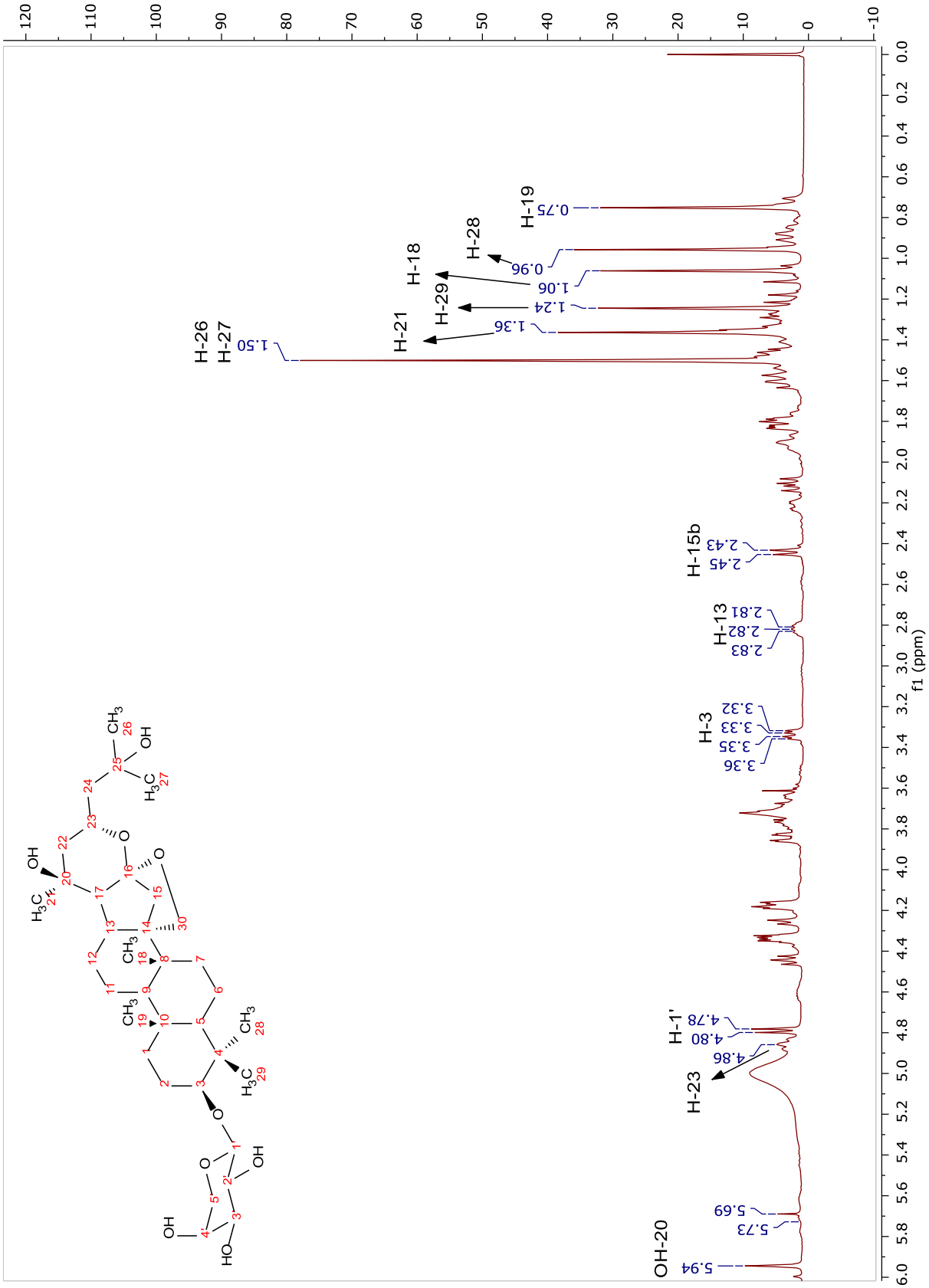


Figura 193. Espectro de RMN ^{1}H de **Zg10** (400 MHz, C_5D_5N).

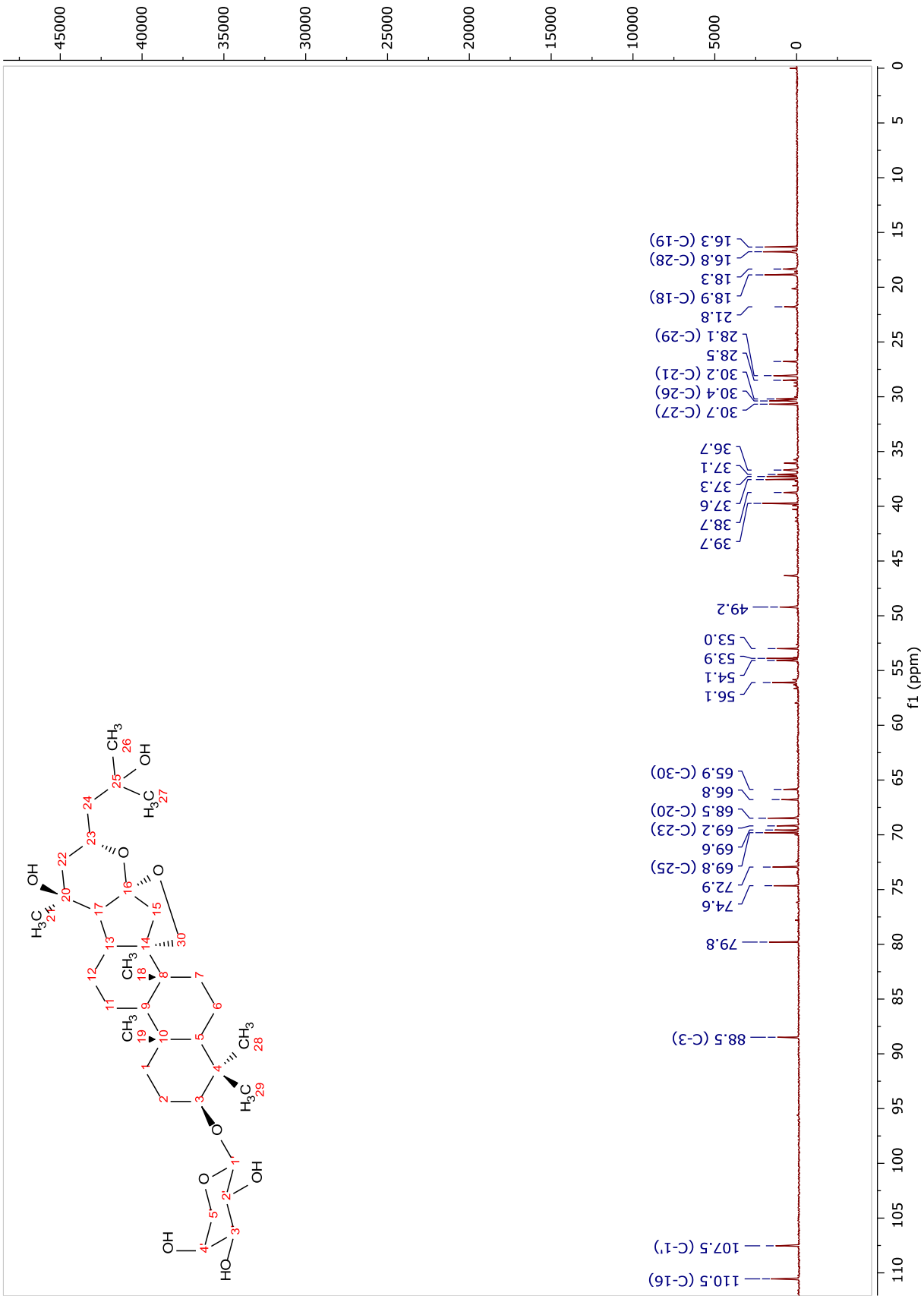


Figura 194. Espectro de RMN ^{13}C de **Zg10** (100 MHz, C_5D_5N).

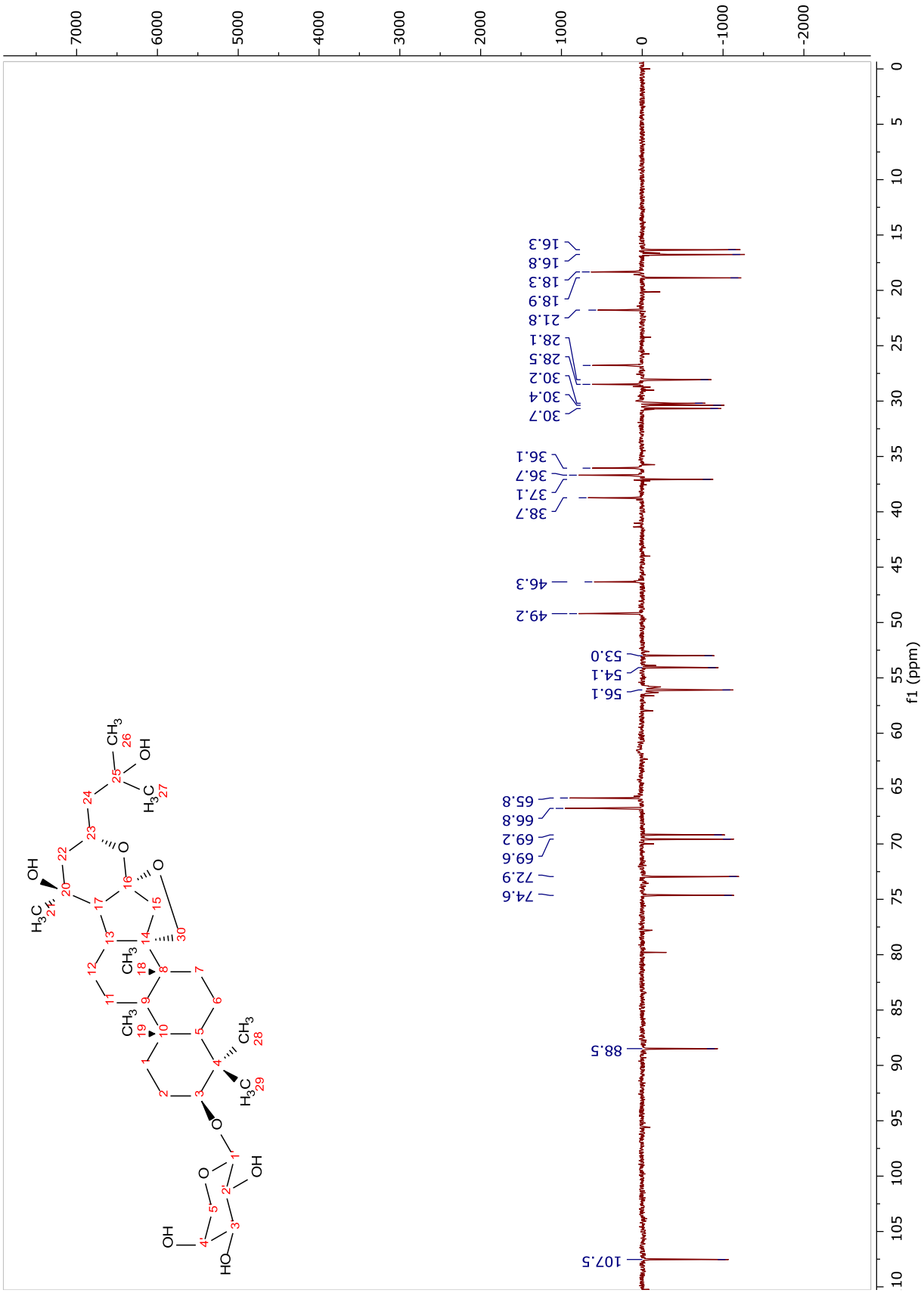


Figura 195. Espectro de DEPT-135 de **Zg10** (100 MHz, C_5D_5N).

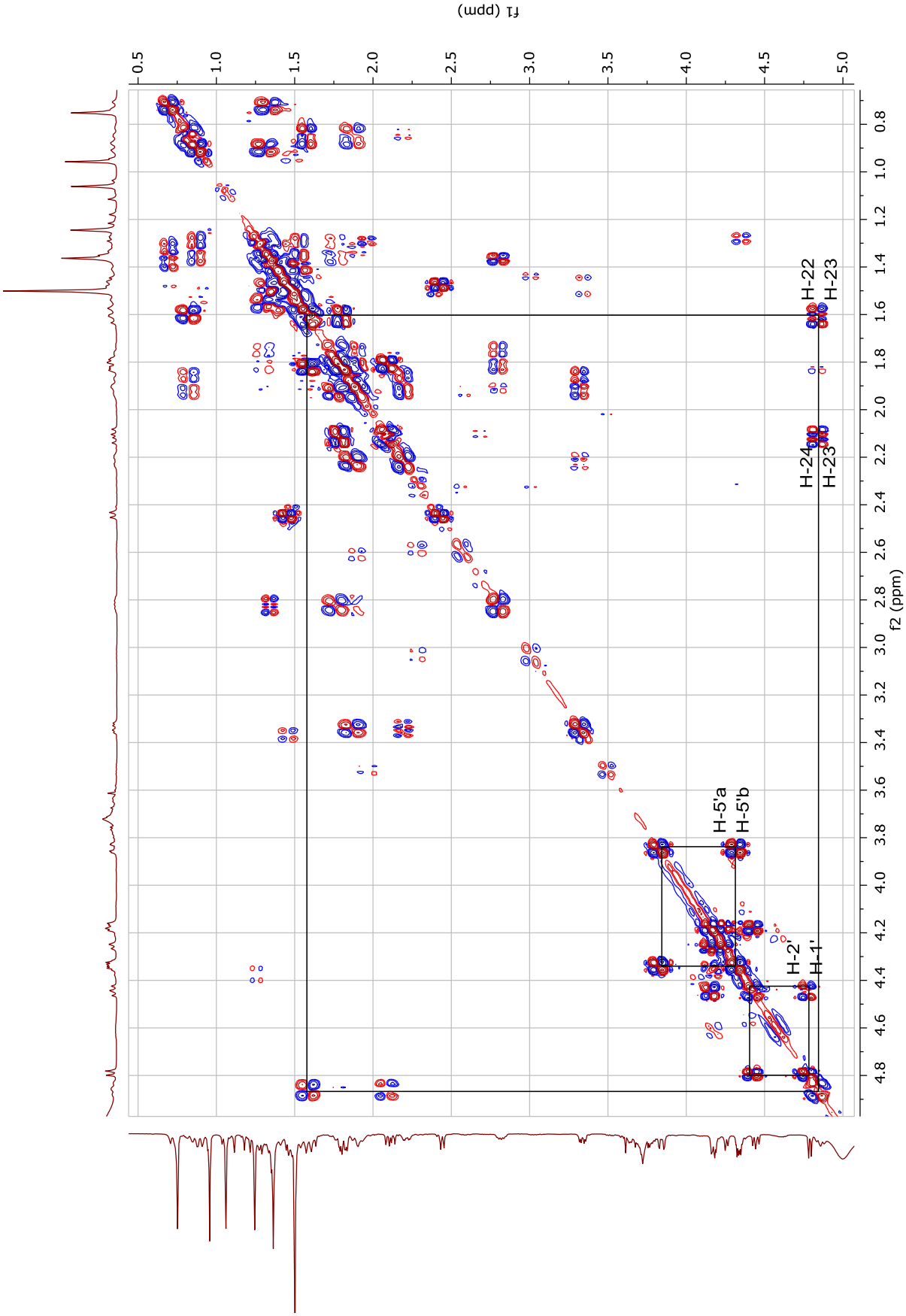


Figura 196. Espectro de COSY de **Zg10** (400 MHz, C_5D_5N).

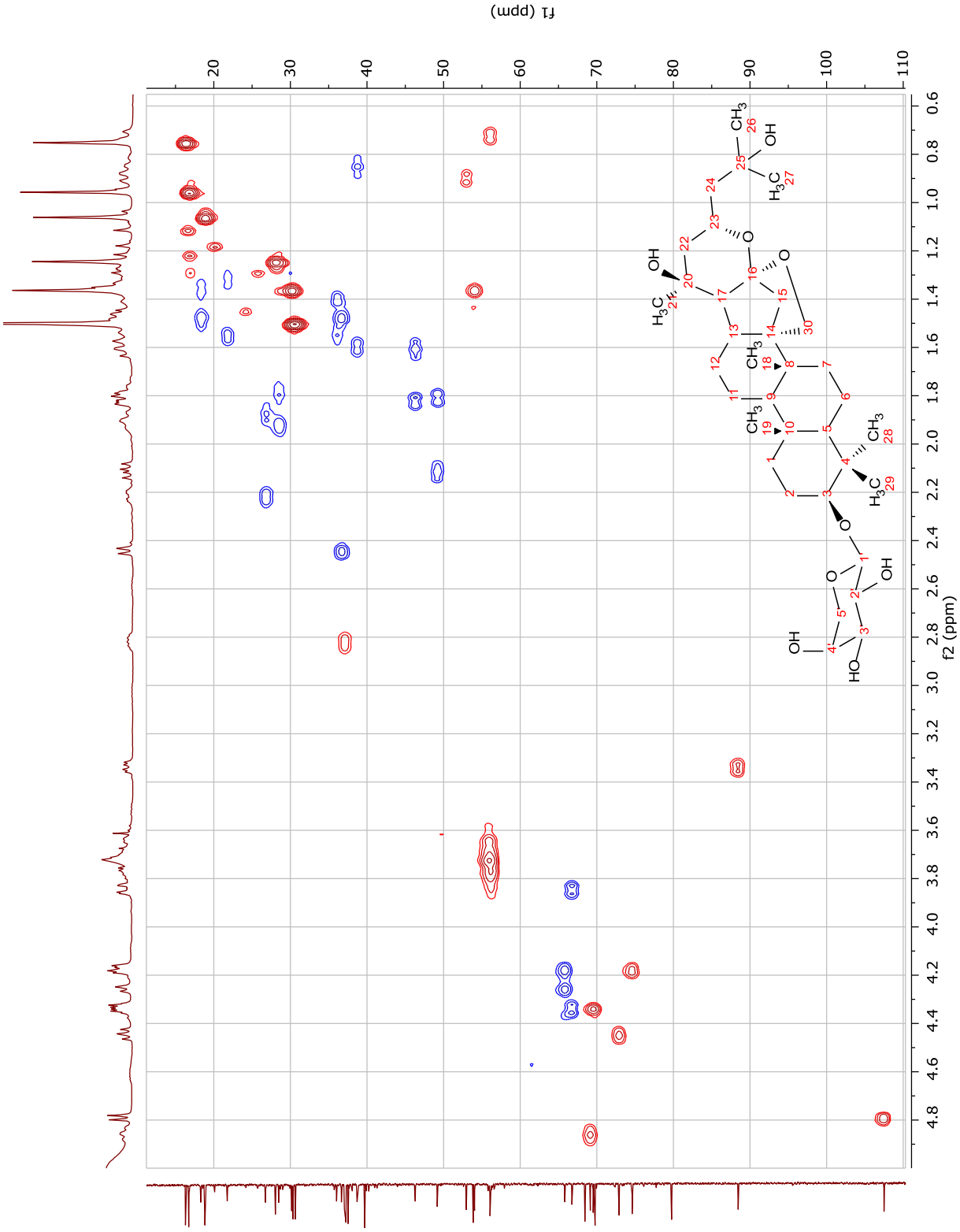


Figura 197. Espectro de HSQC de **Zg10** (400 MHz, C_5D_5N).

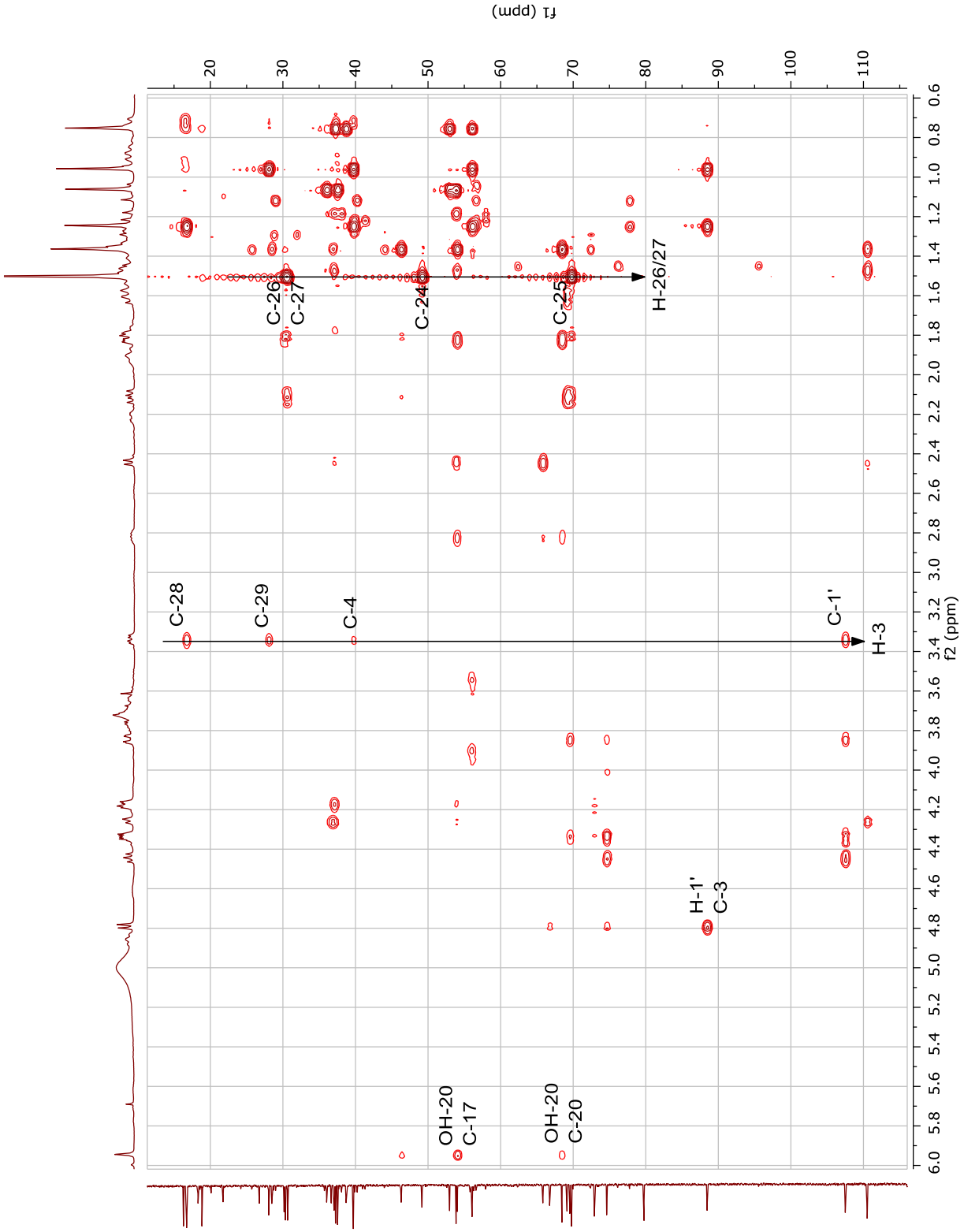


Figura 198. Espectro de HMBC de **Zg10** (400 MHz, C_5D_5N).

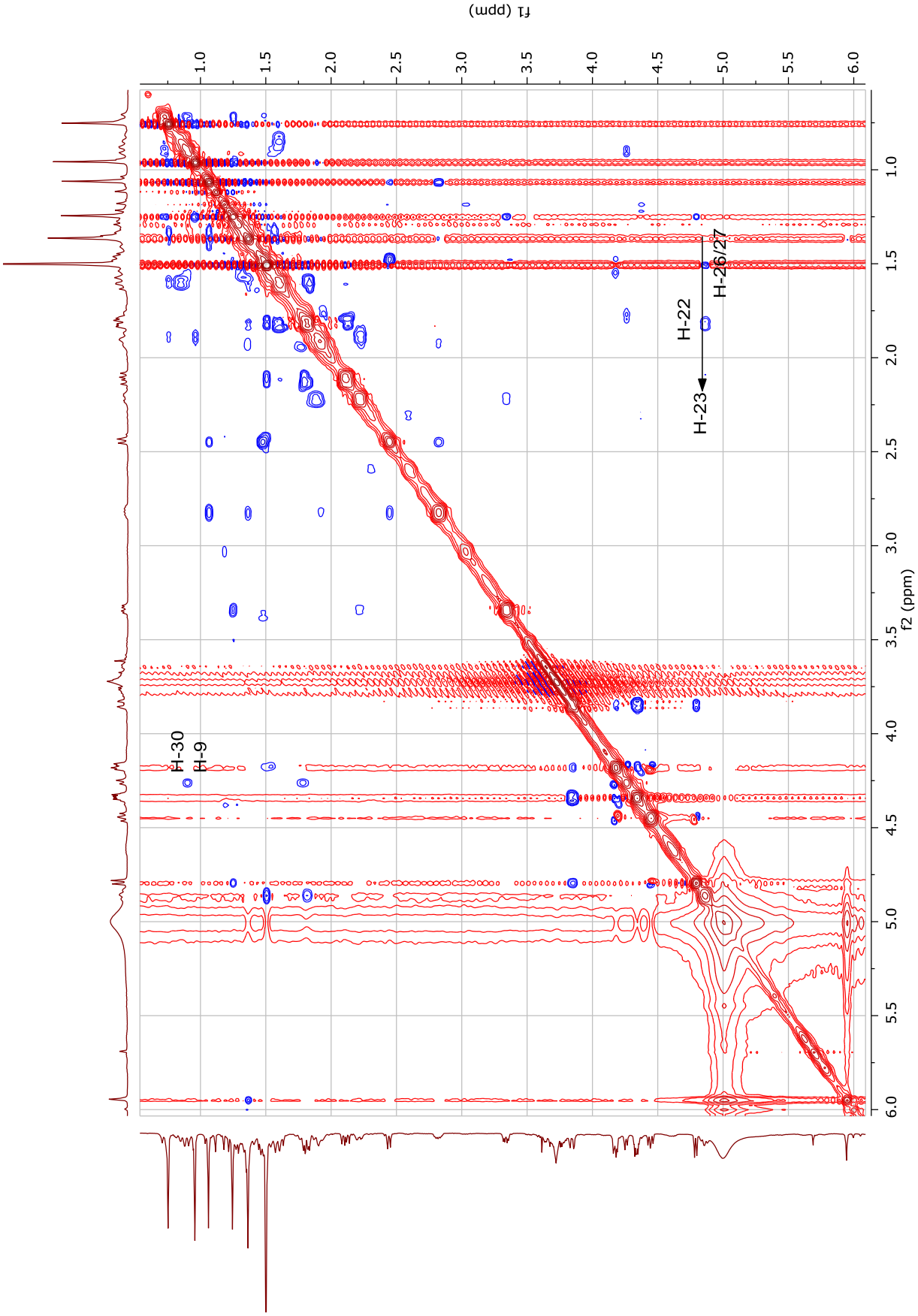


Figura 199. Espectro de NOESY de **Zg10** (400 MHz, C_5D_5N).

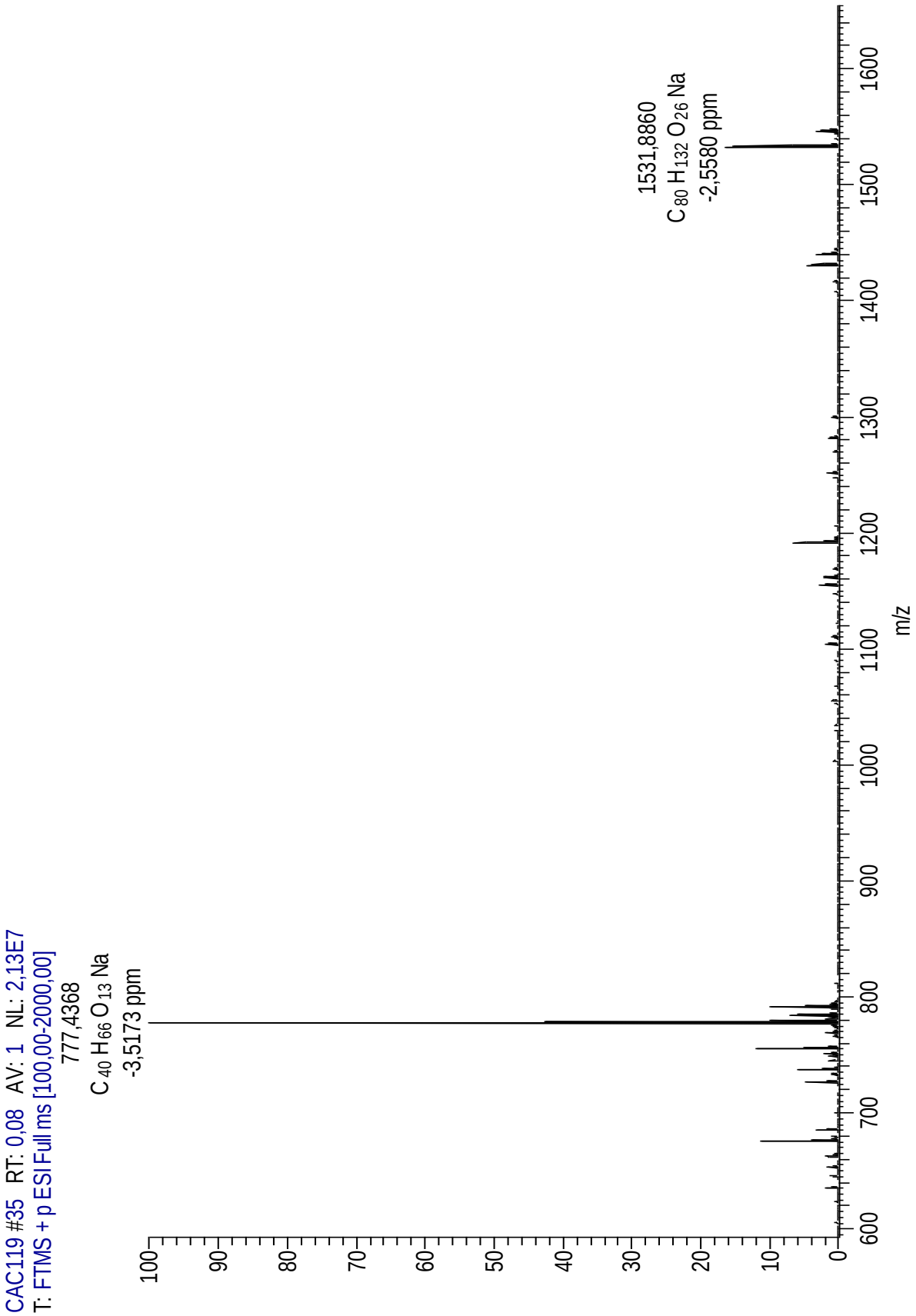


Figura 200. Espectro de massas de alta resolução de **Zg11** (ESI, modo positivo).

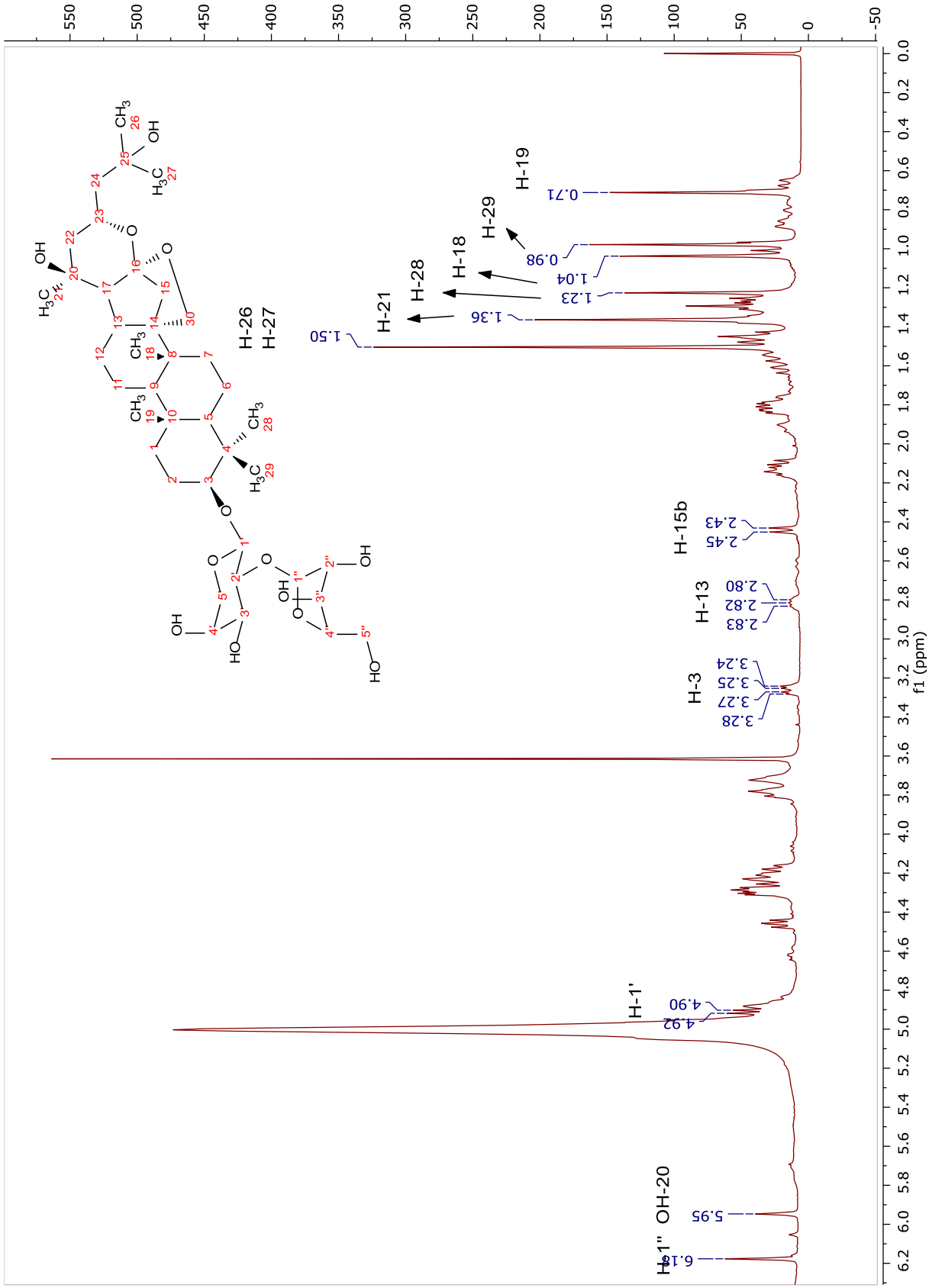


Figura 201. Espectro de RMN ^{1}H de **Zg11** (400 MHz, C_5D_5N).

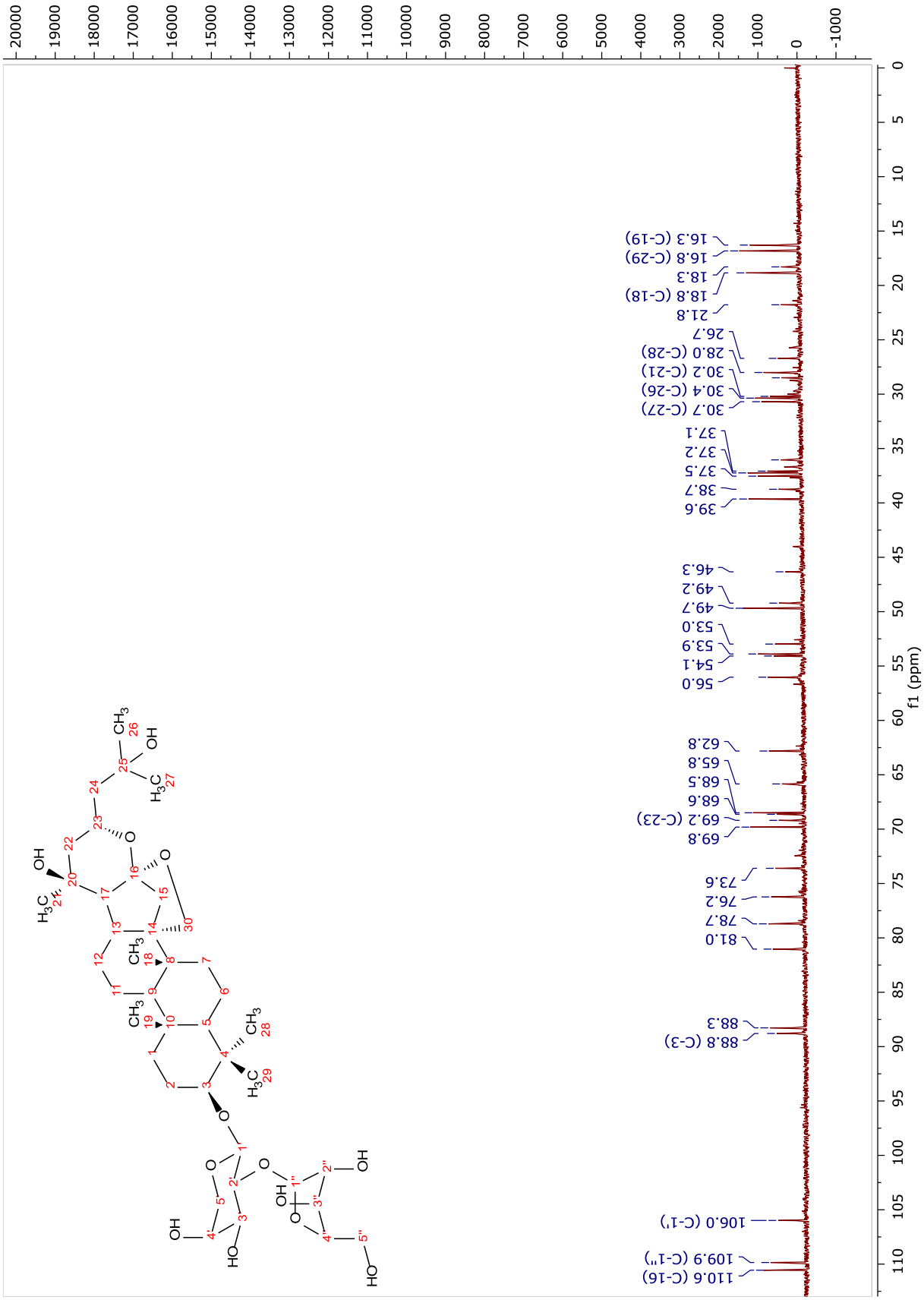


Figura 202. Espectro de RMN ^{13}C de **Zg11** (100 MHz, C_5D_5N).

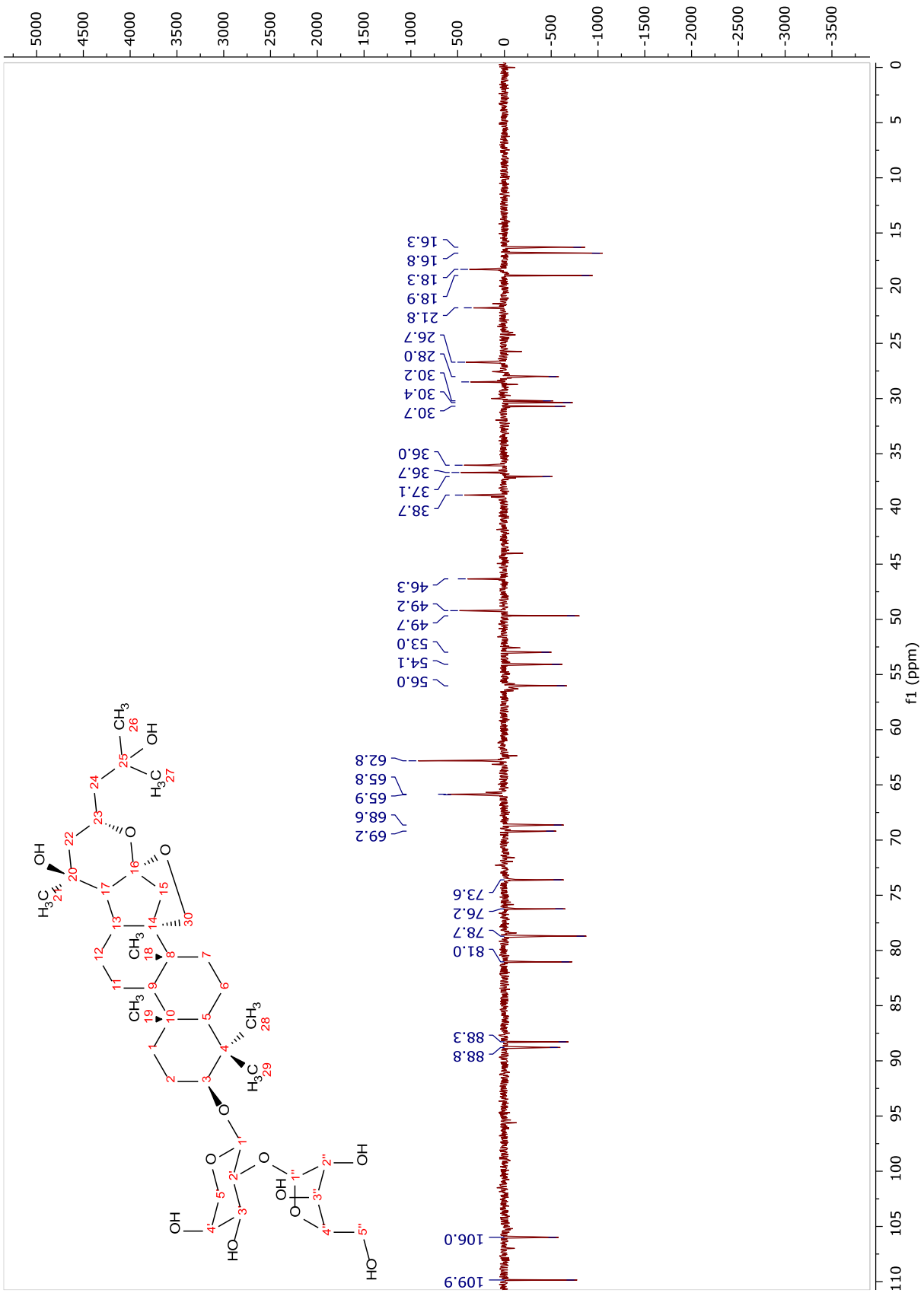


Figura 203. Espectro de DEPT-135 de **Zg11** (100 MHz, C_5D_5N).

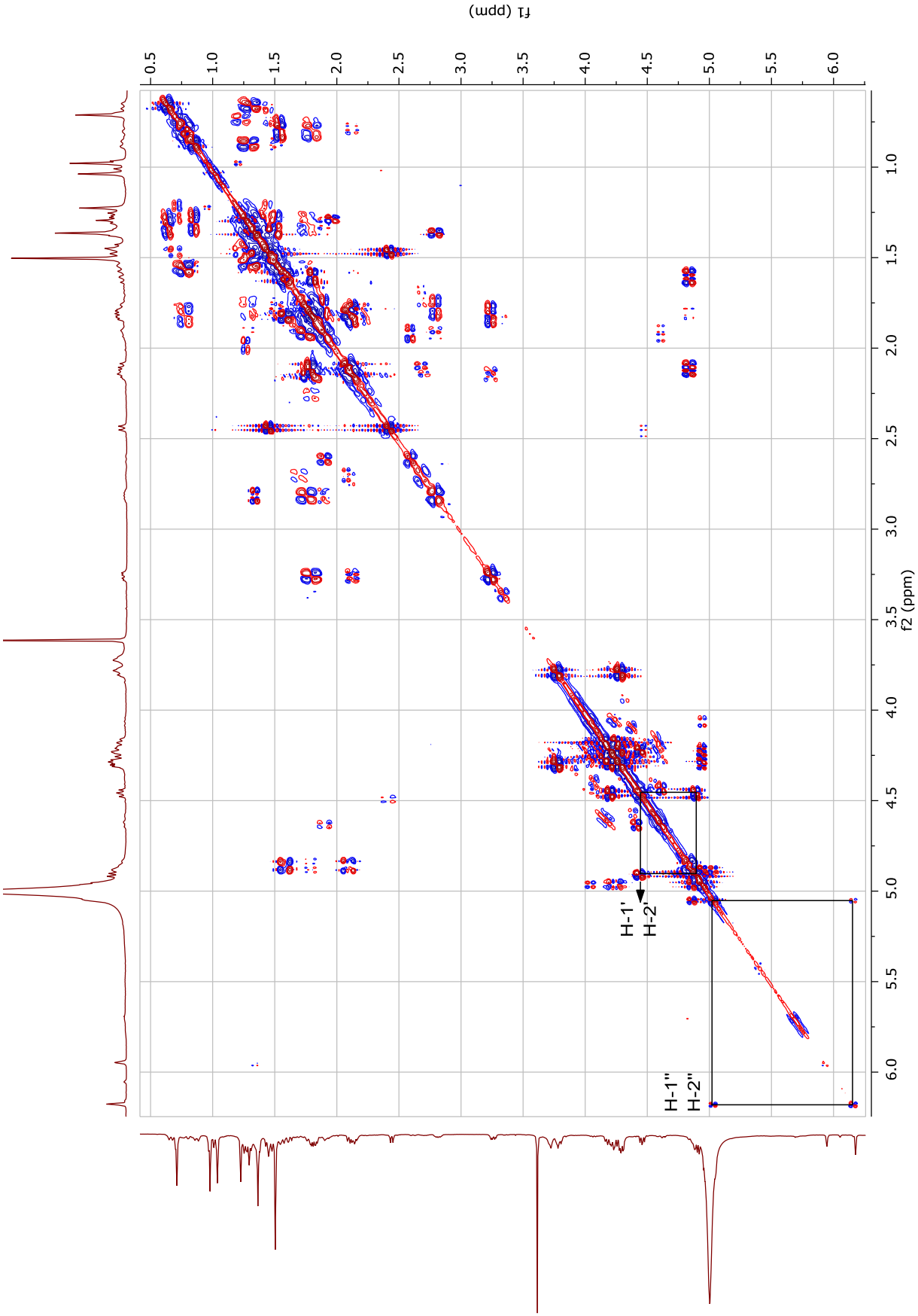


Figura 204. Espectro de COSY de **Zg11** (400 MHz, C_5D_5N).

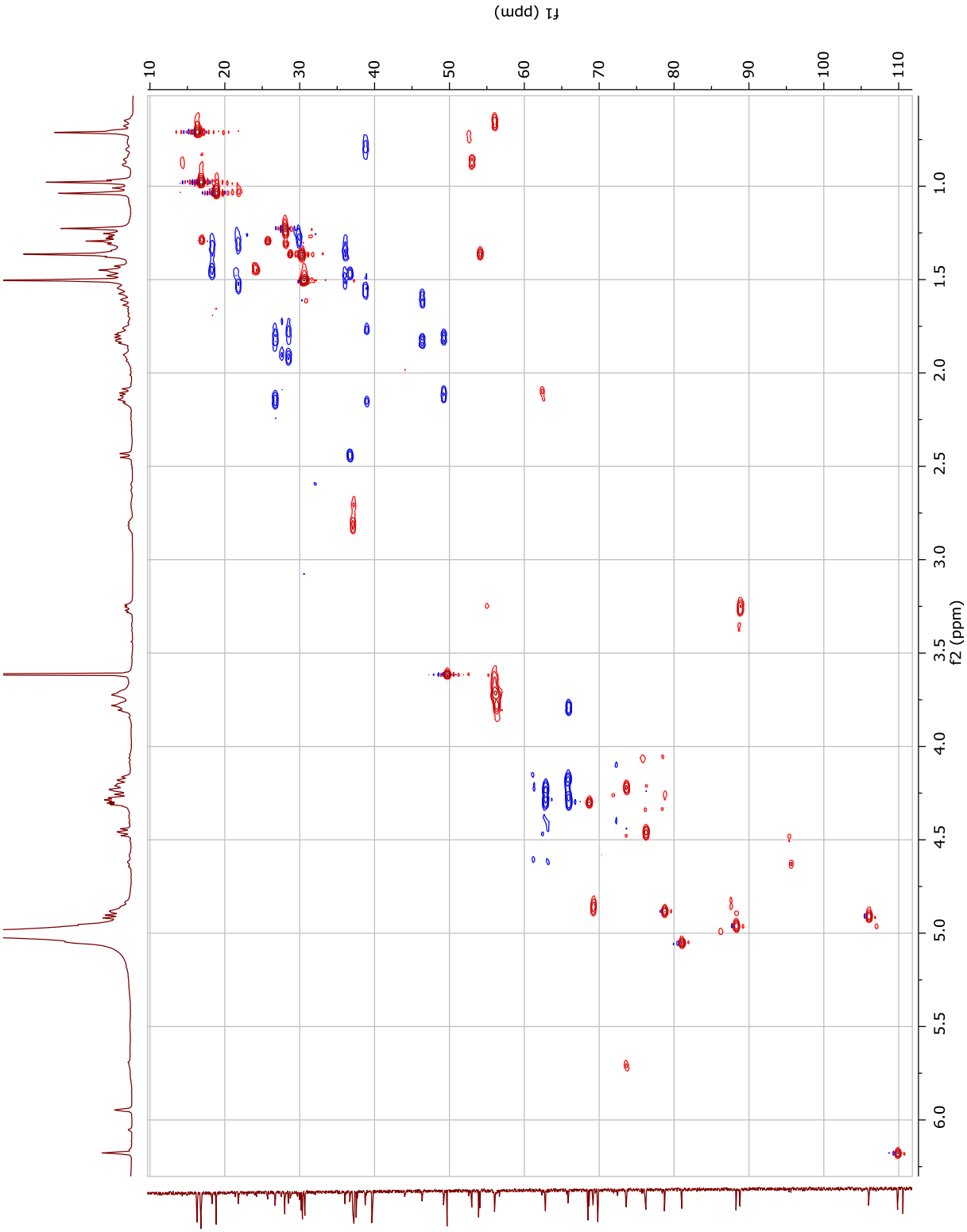


Figura 205. Espectro de HSQC de **Zg11** (400 MHz, C_5D_5N).

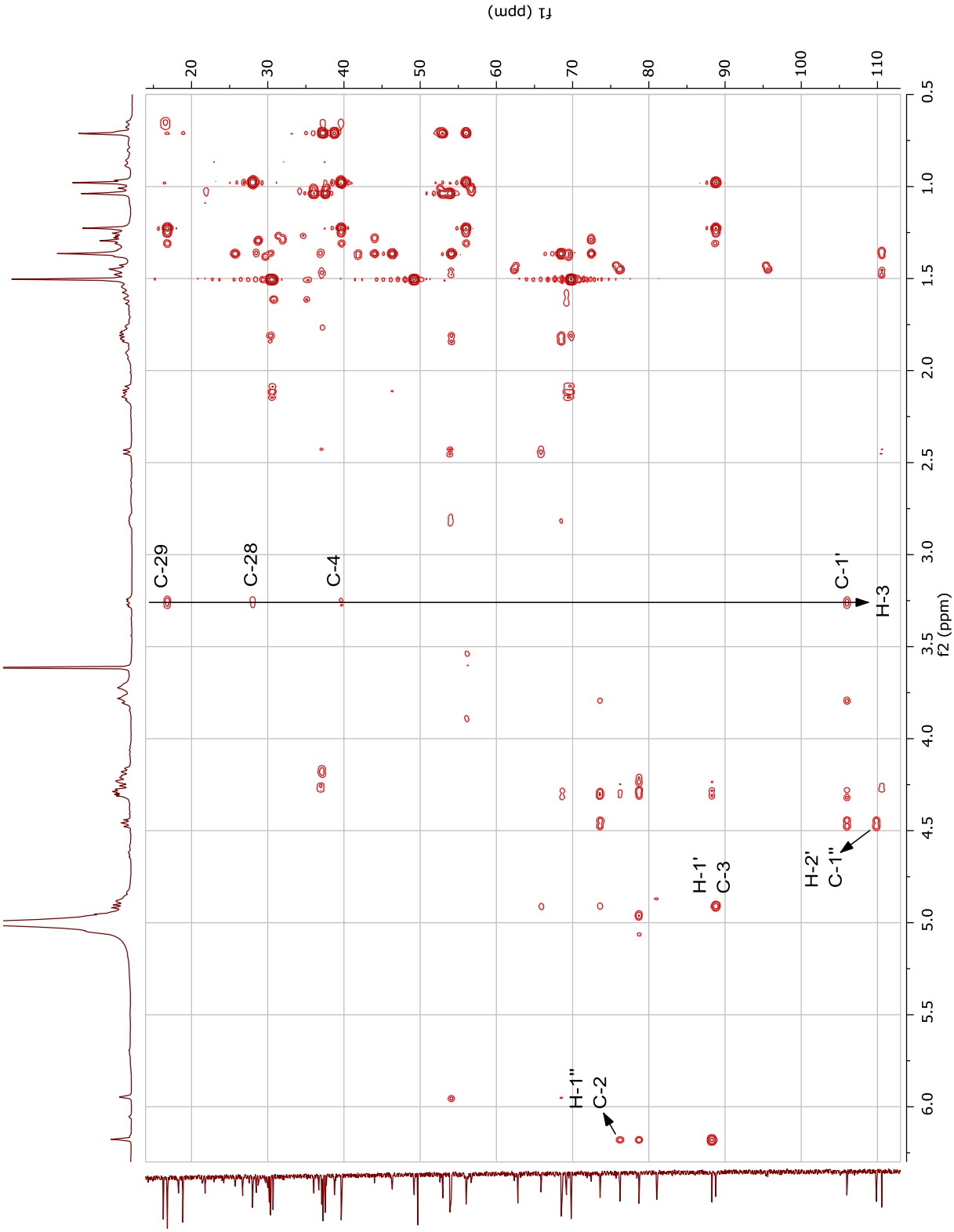


Figura 206. Espectro de HMBC de **Zg11** (400 MHz, C_5D_5N).

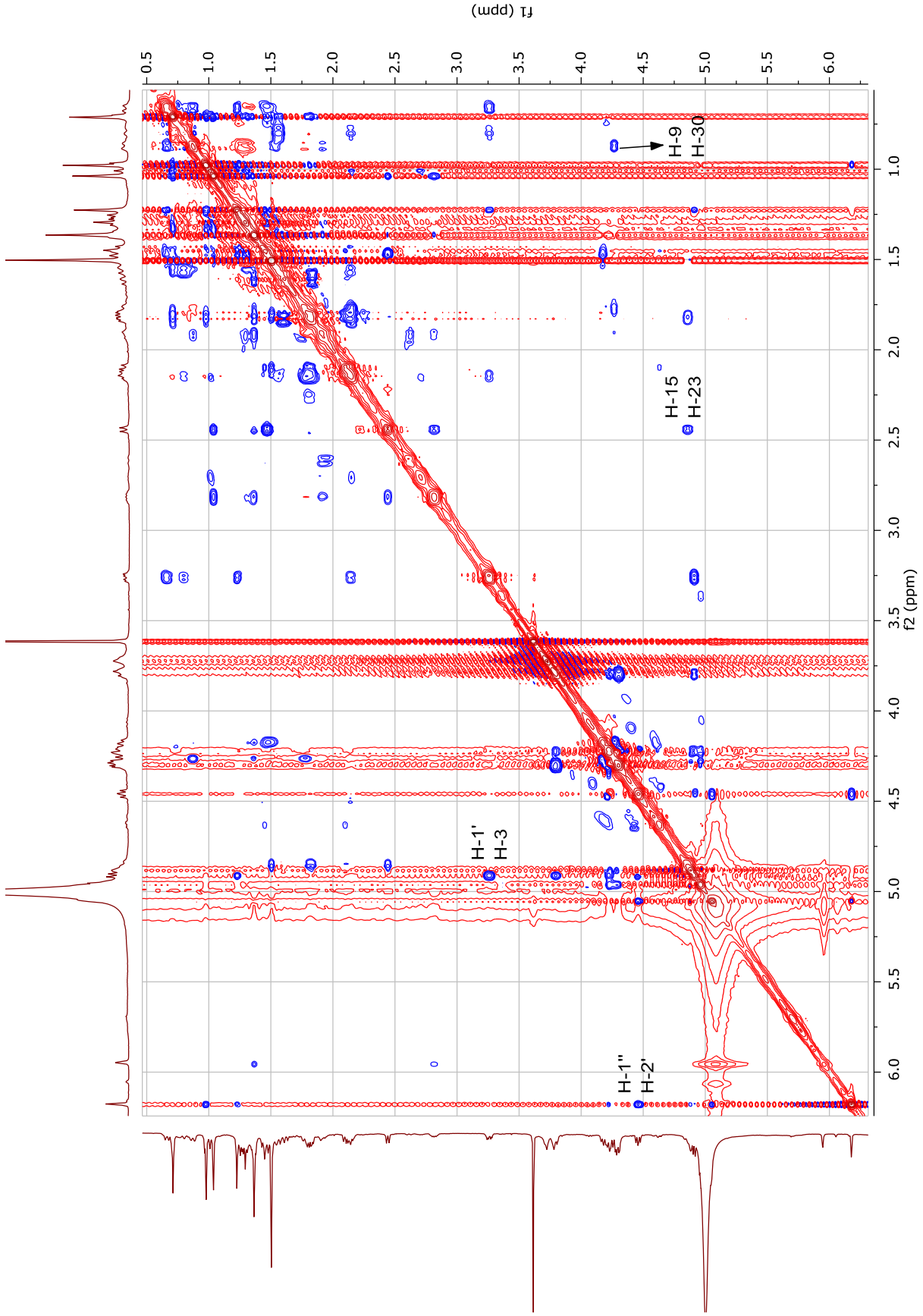


Figura 207. Espectro de ROESY de **Zg11** (400 MHz, C_5D_5N).

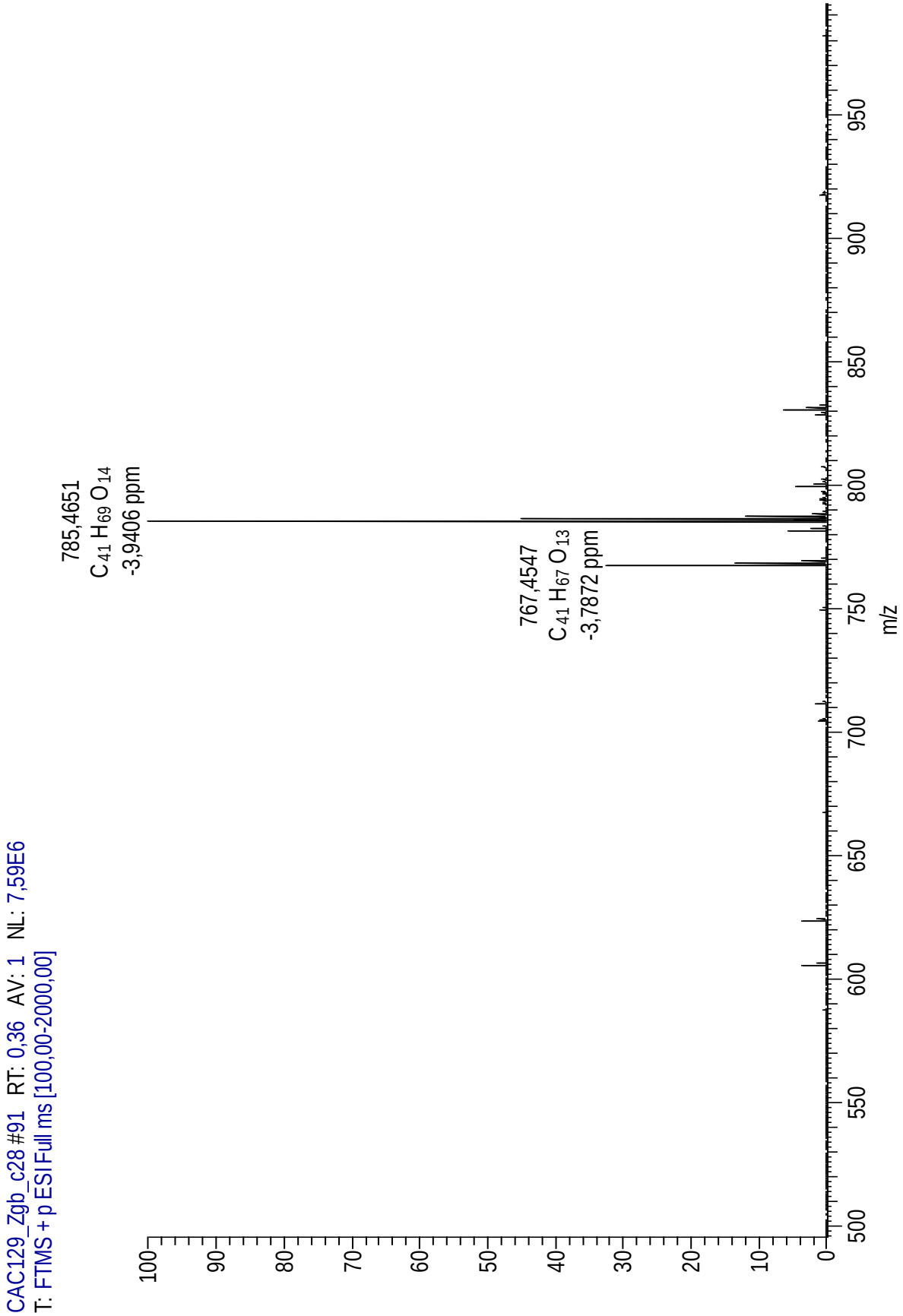


Figura 208. Espectro de massas de alta resolução de **Zg12** (ESI, modo positivo).

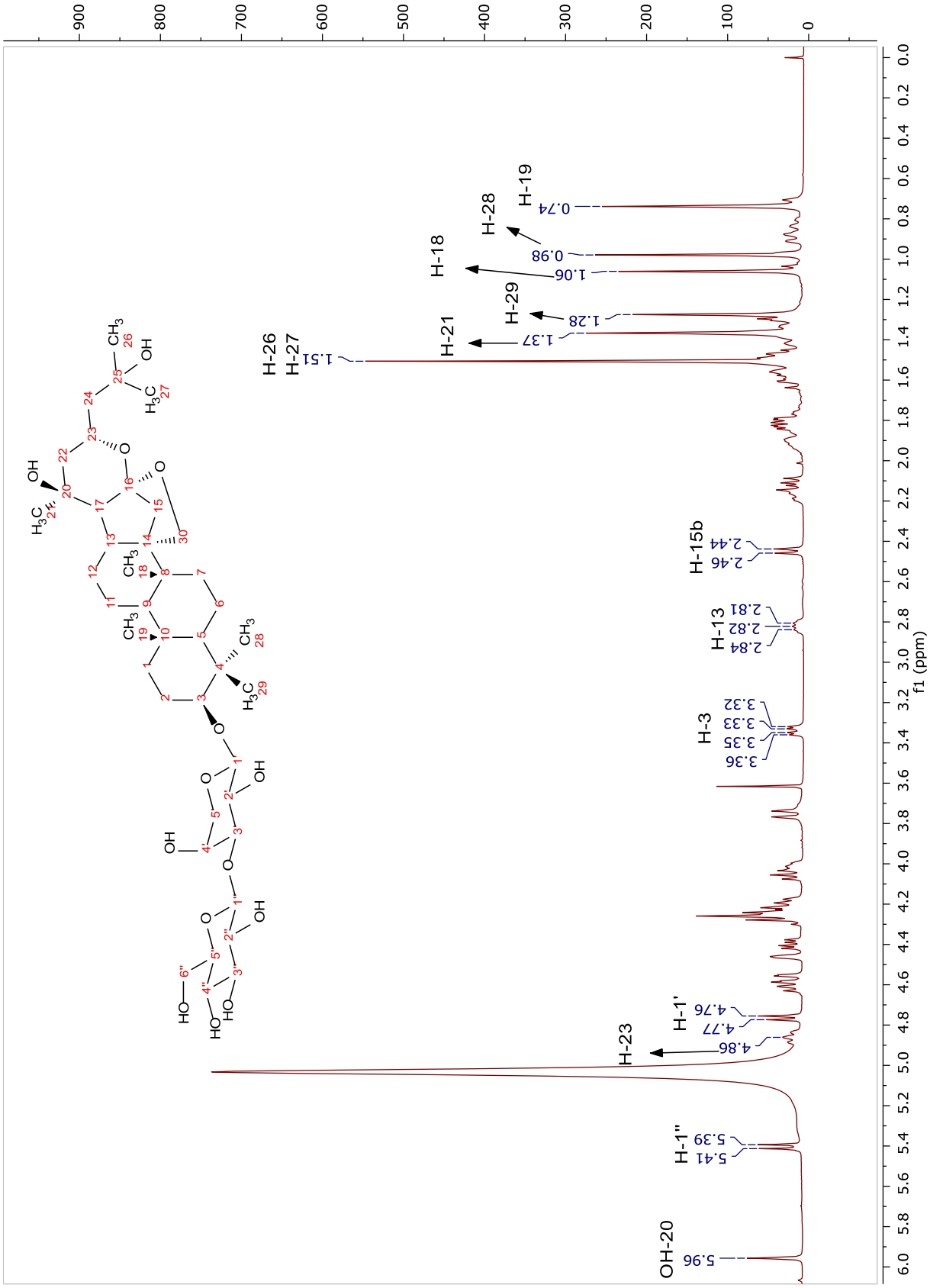


Figura 209. Espectro de RMN ^{1}H de **Zg12** (400 MHz, C_5D_5N).

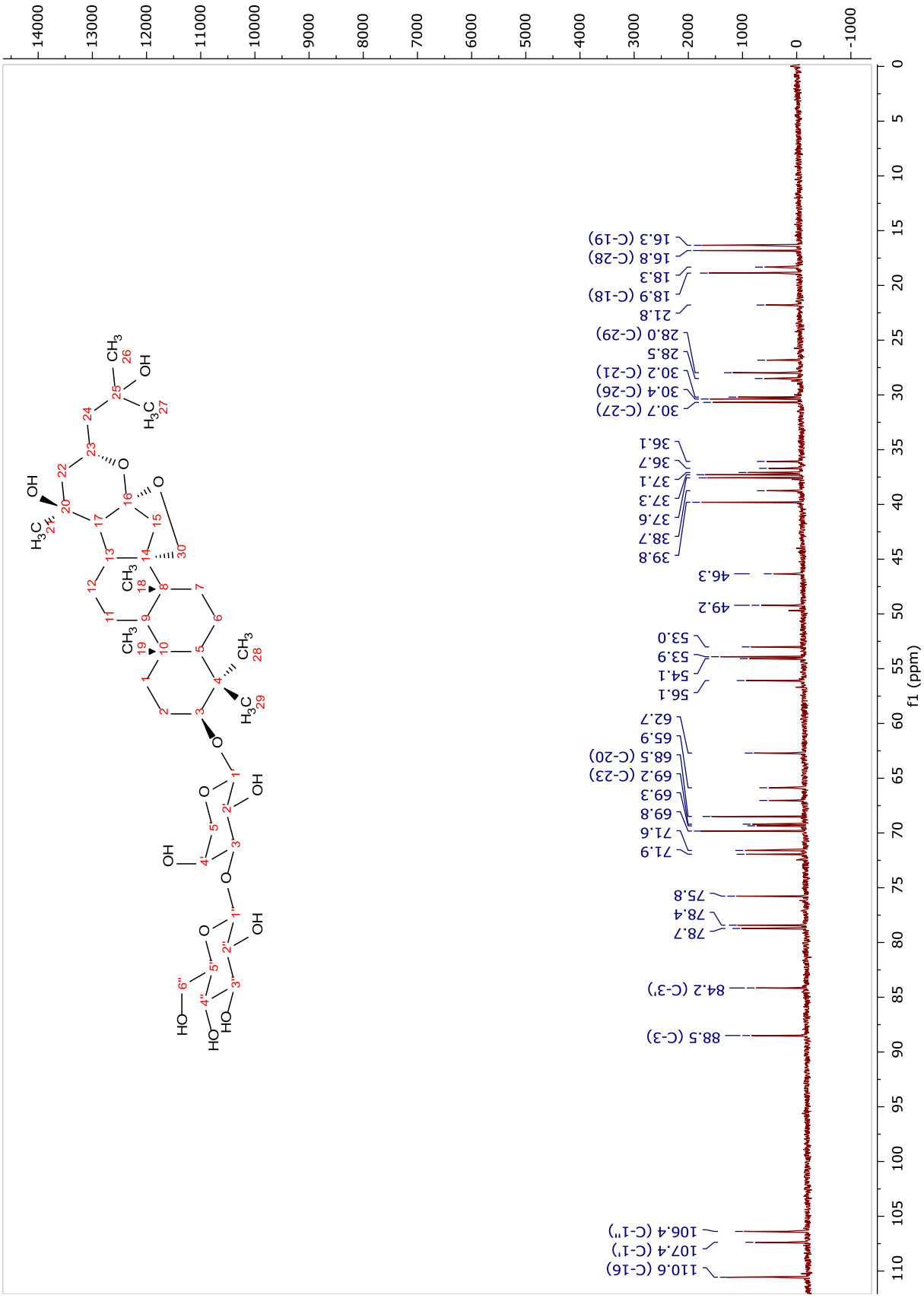


Figura 210. Espectro de RMN ^{13}C de **Zg12** (100 MHz, C_5D_5N).

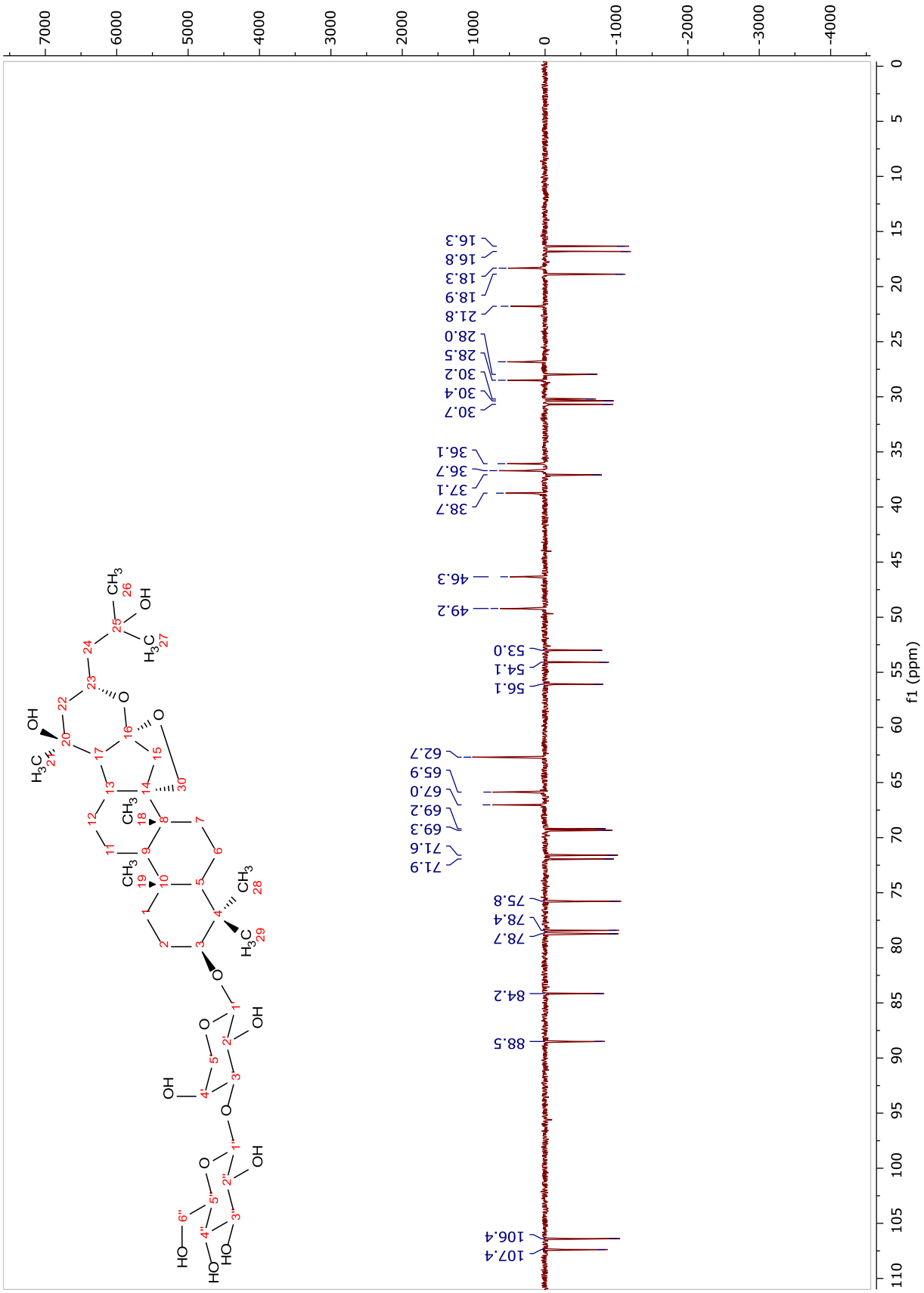


Figura 211. Espectro de DEPT-135 de **Zg12** (100 MHz, C_5D_5N).

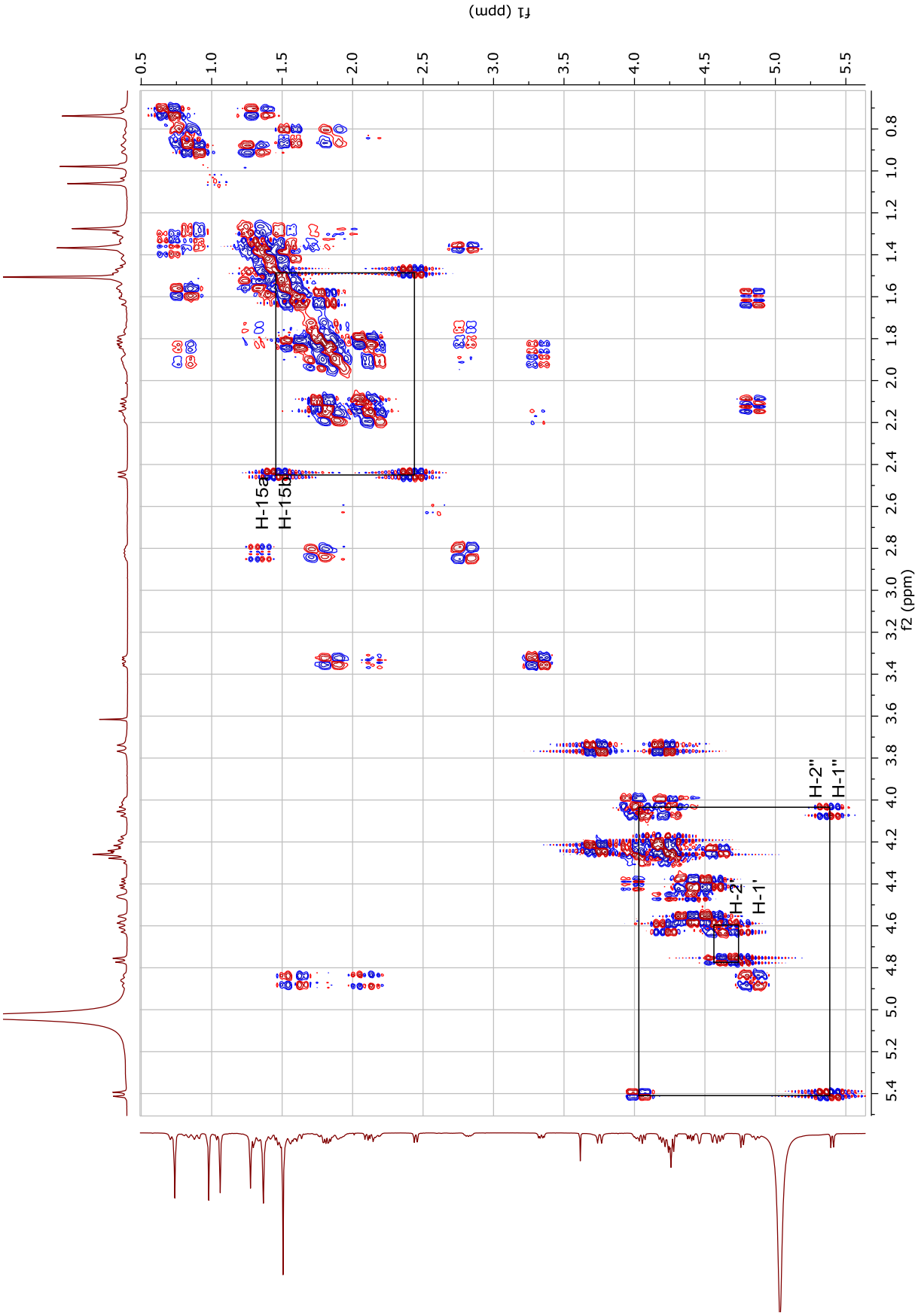


Figura 212. Espectro de COSY de **Zg12** (400 MHz, C_5D_5N).

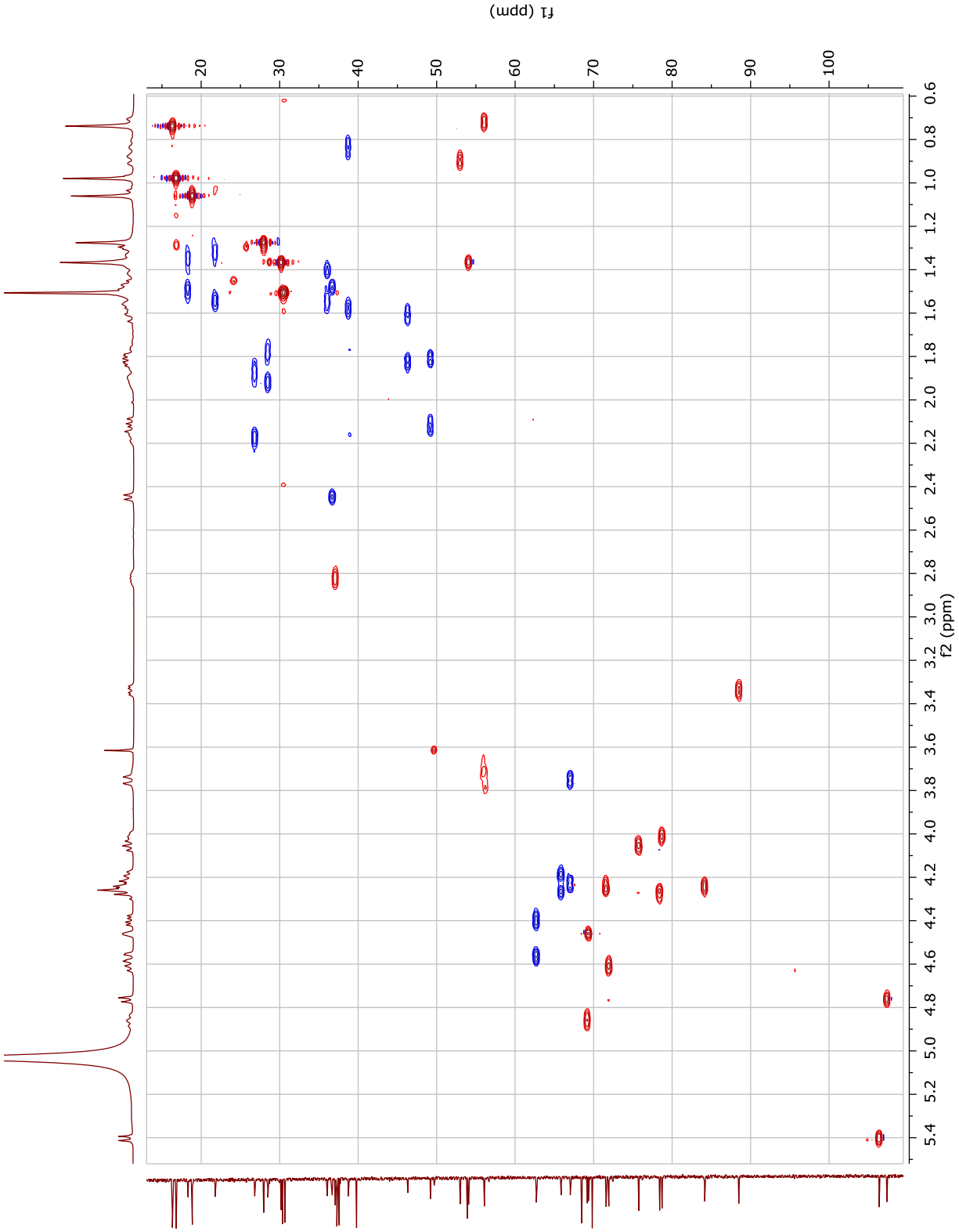


Figura 213. Espectro de HSQC de **Zg12** (400 MHz, C_5D_5N).

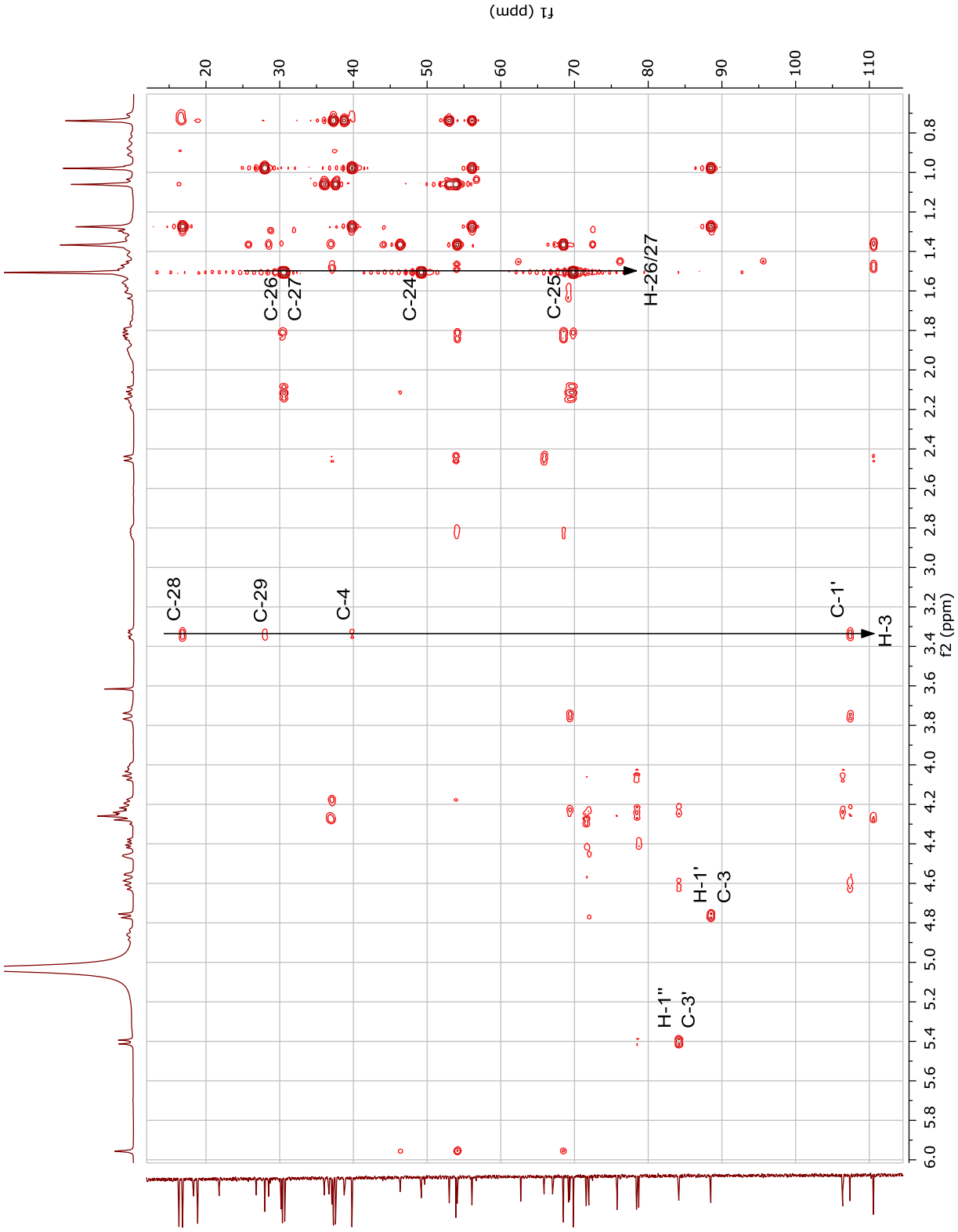


Figura 214. Espectro de HMBC de **Zg12** (400 MHz, C_5D_5N).

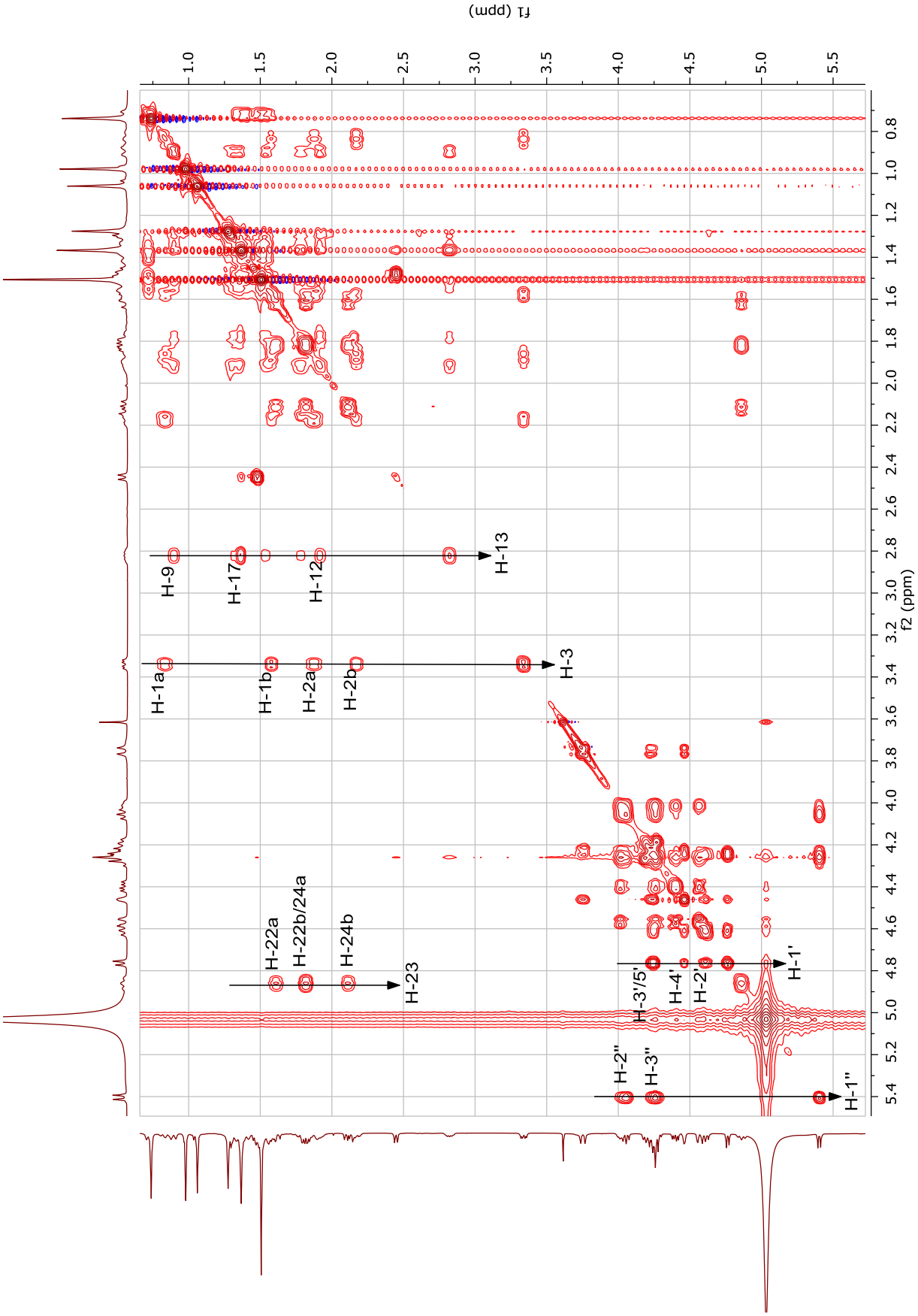


Figura 215. Espectro de TOCSY (2D) de **Zg12** (400 MHz, C_5D_5N).

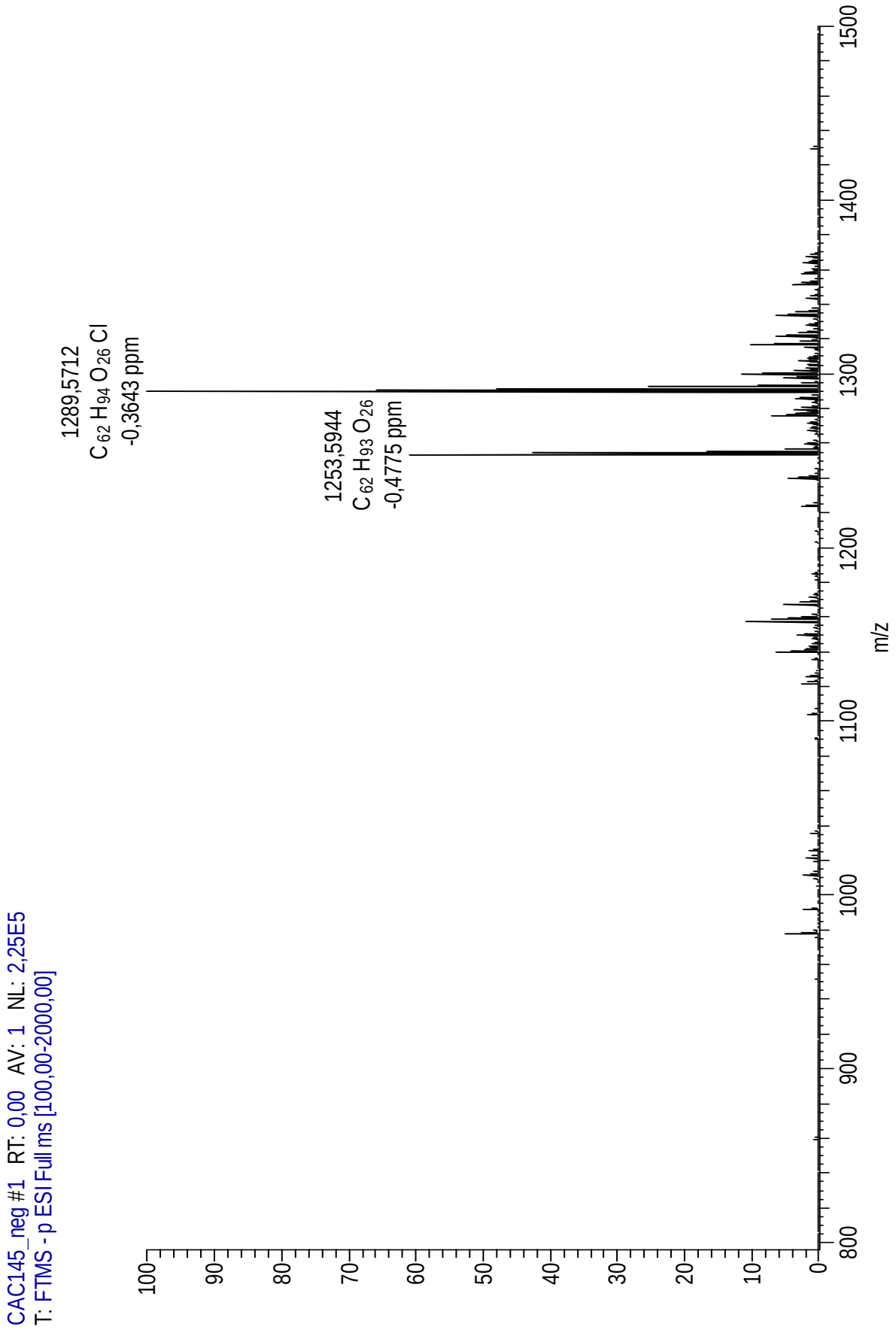


Figura 216. Espectro de massas de alta resolução de **Zg13** (ESI, modo positivo).

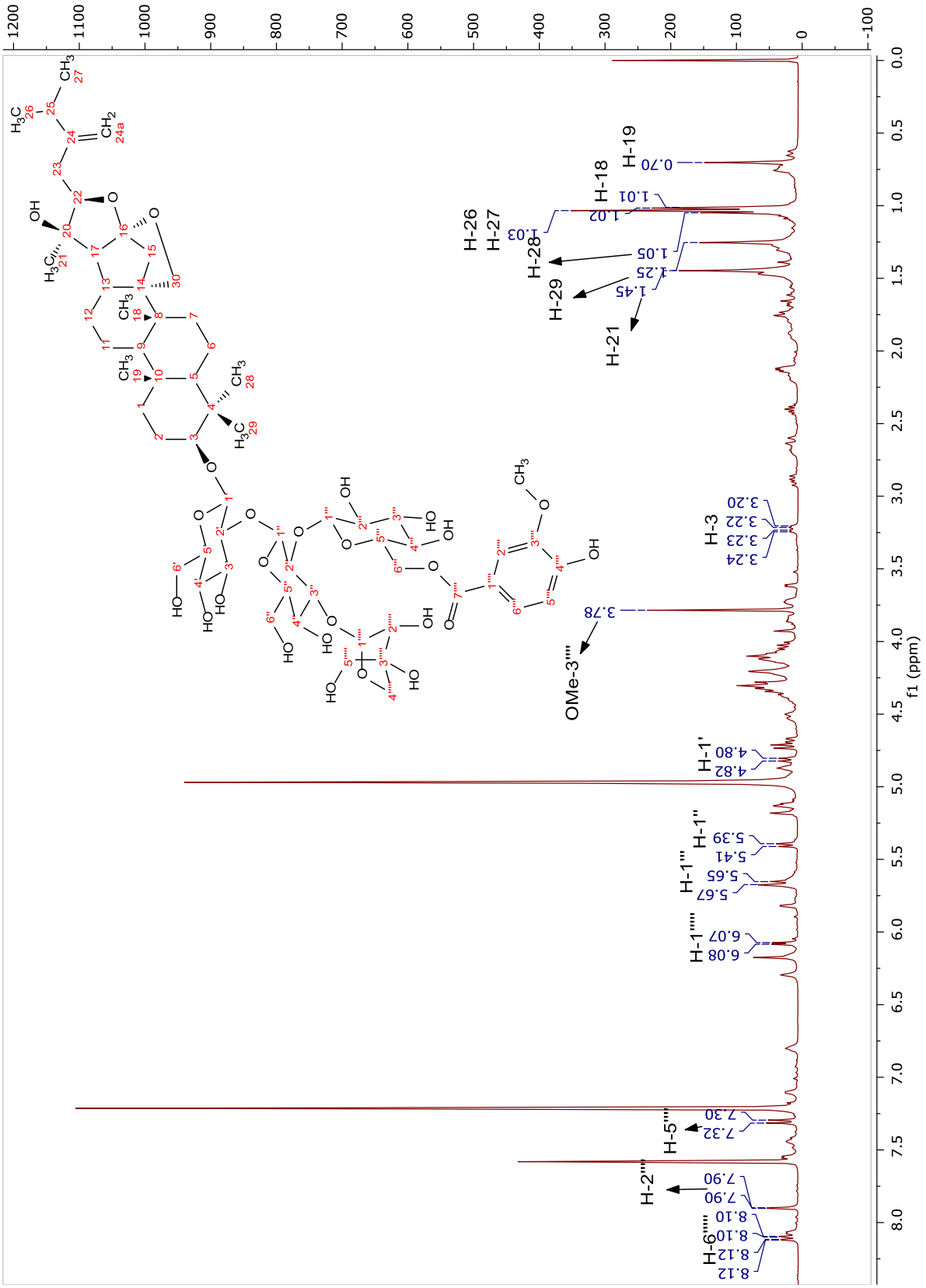


Figura 217. Espectro de RMN ^{1}H de **Zg13** (400 MHz, C_5D_5N).

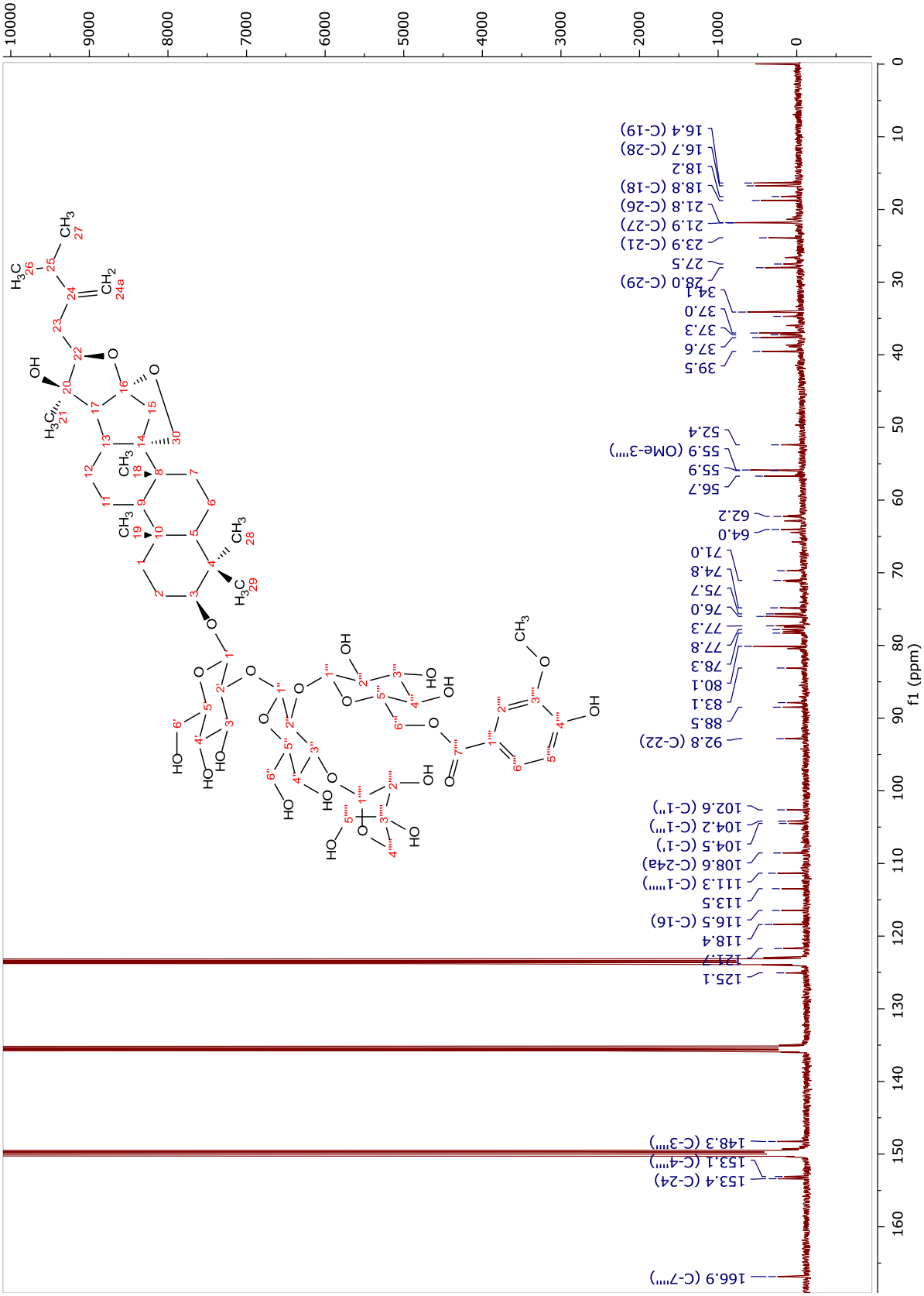


Figura 218. Espectro de RMN ^{13}C de **Zg13** (100 MHz, C_5D_5N).

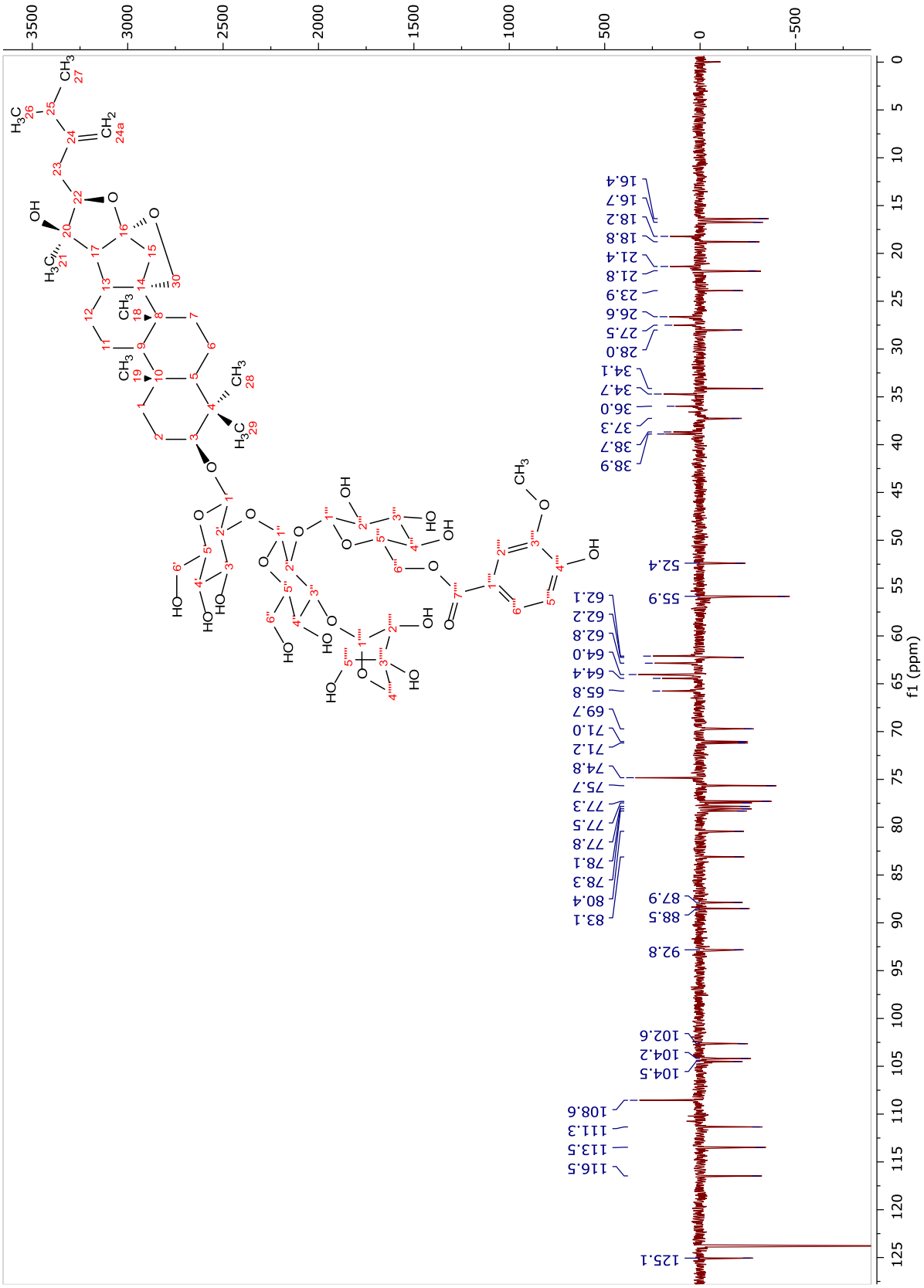


Figura 219. Espectro de DEPT-135 de **Zg13** (100 MHz, C_5D_5N).

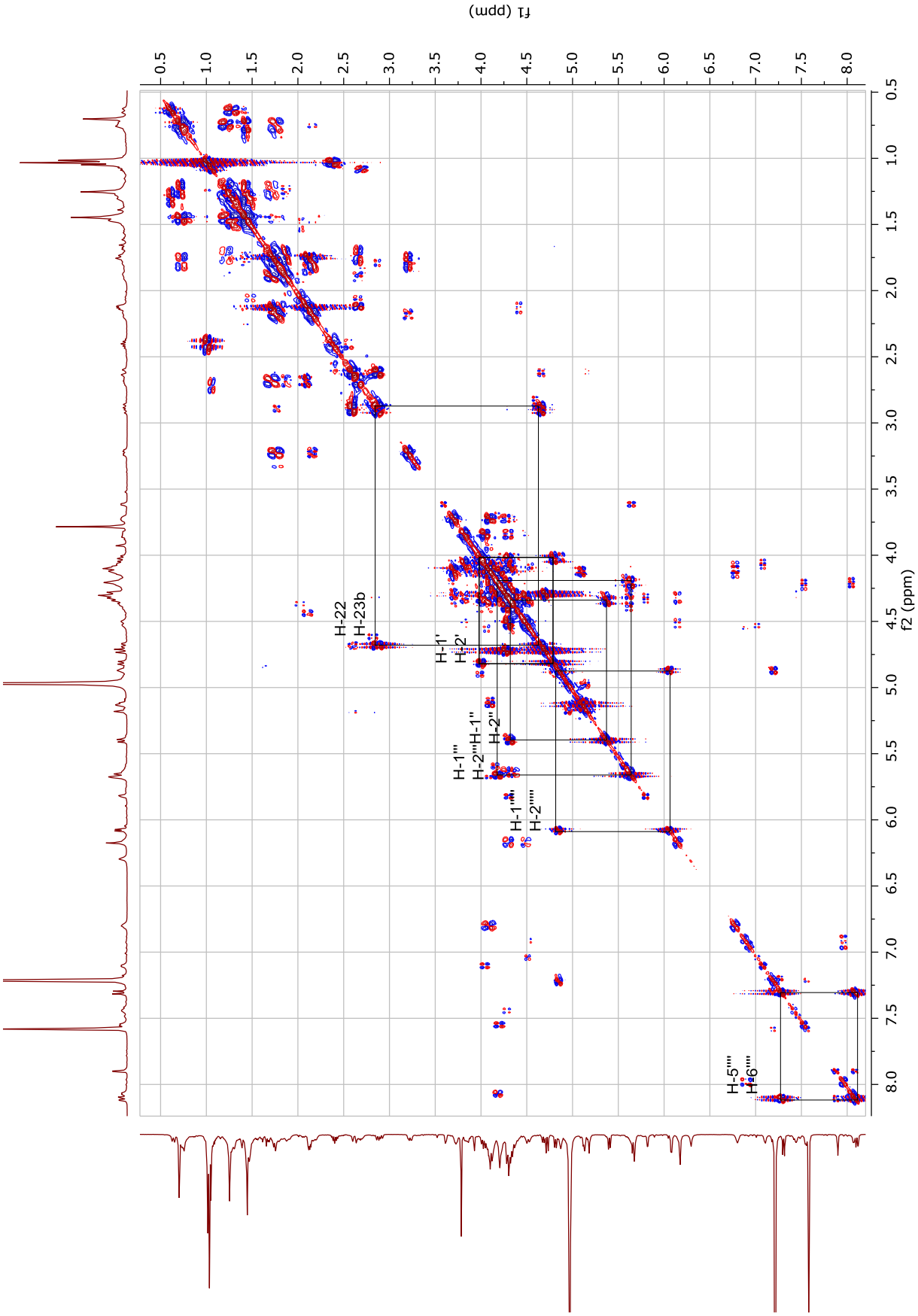


Figura 220. Espectro de COSY de **Zg13** (400 MHz, C_5D_5N).

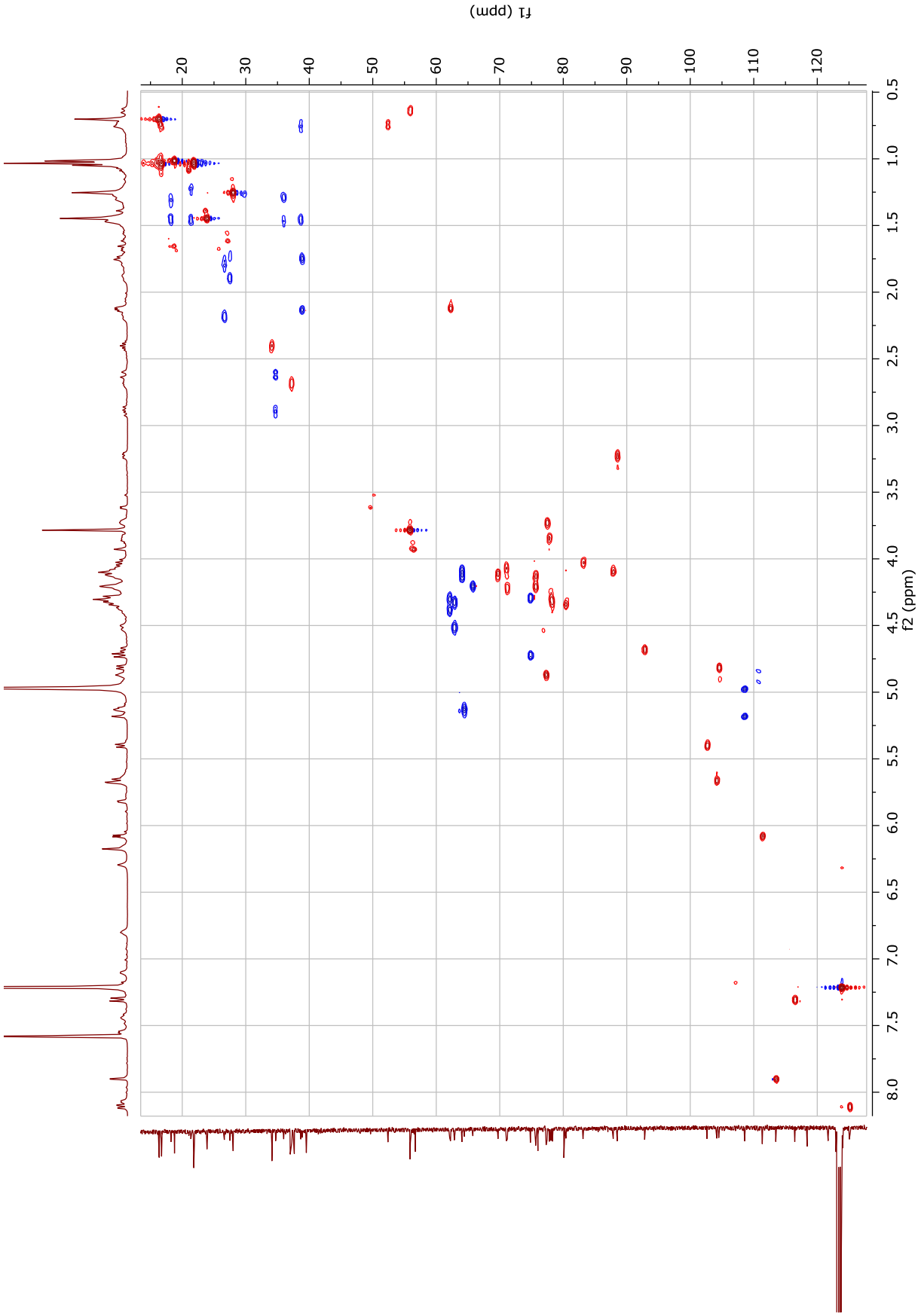


Figura 221. Espectro de HSQC de **Zg13** (400 MHz, C_5D_5N).

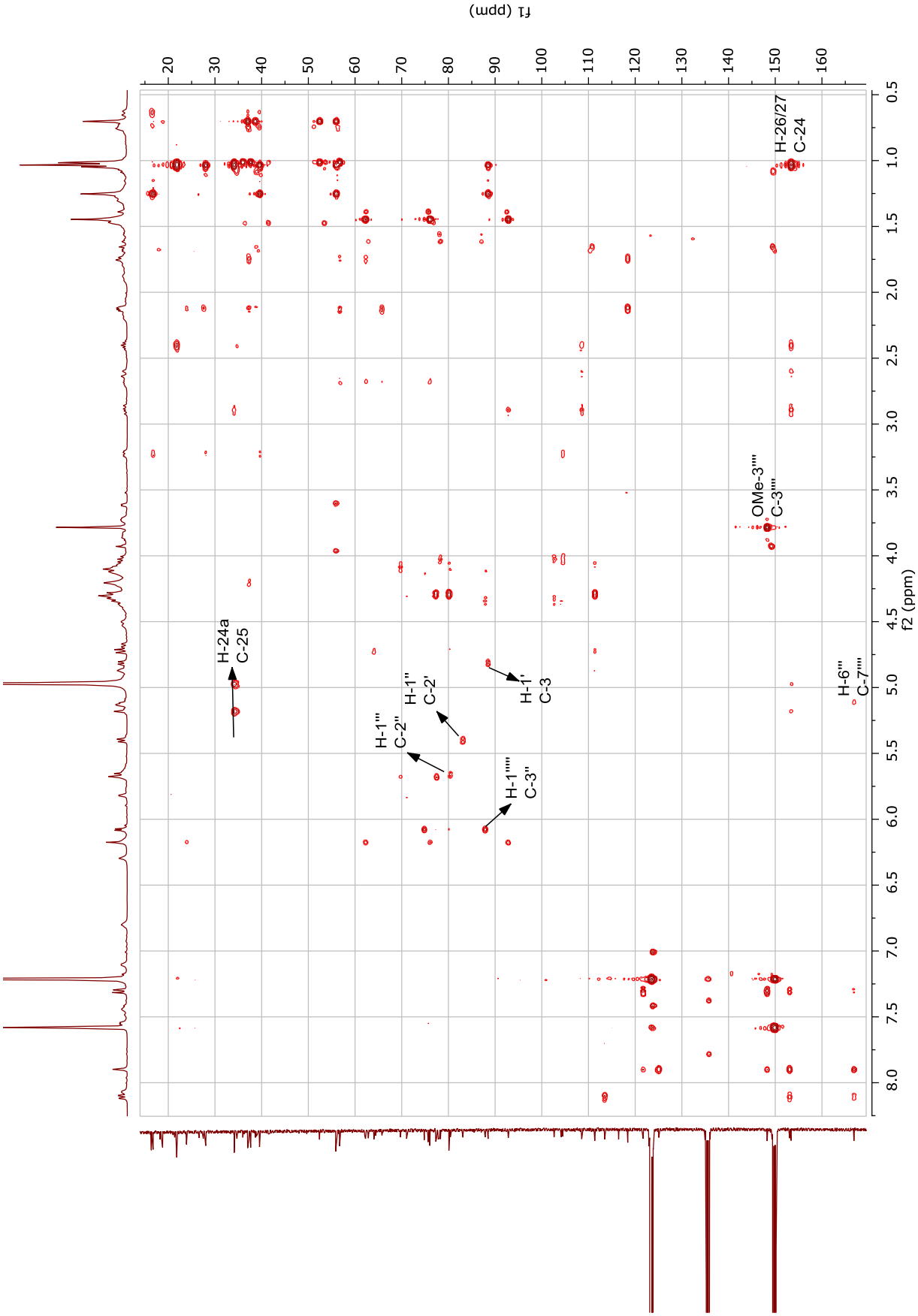


Figura 222. Espectro de HMBC de **Zg13** (400 MHz, C_5D_5N).

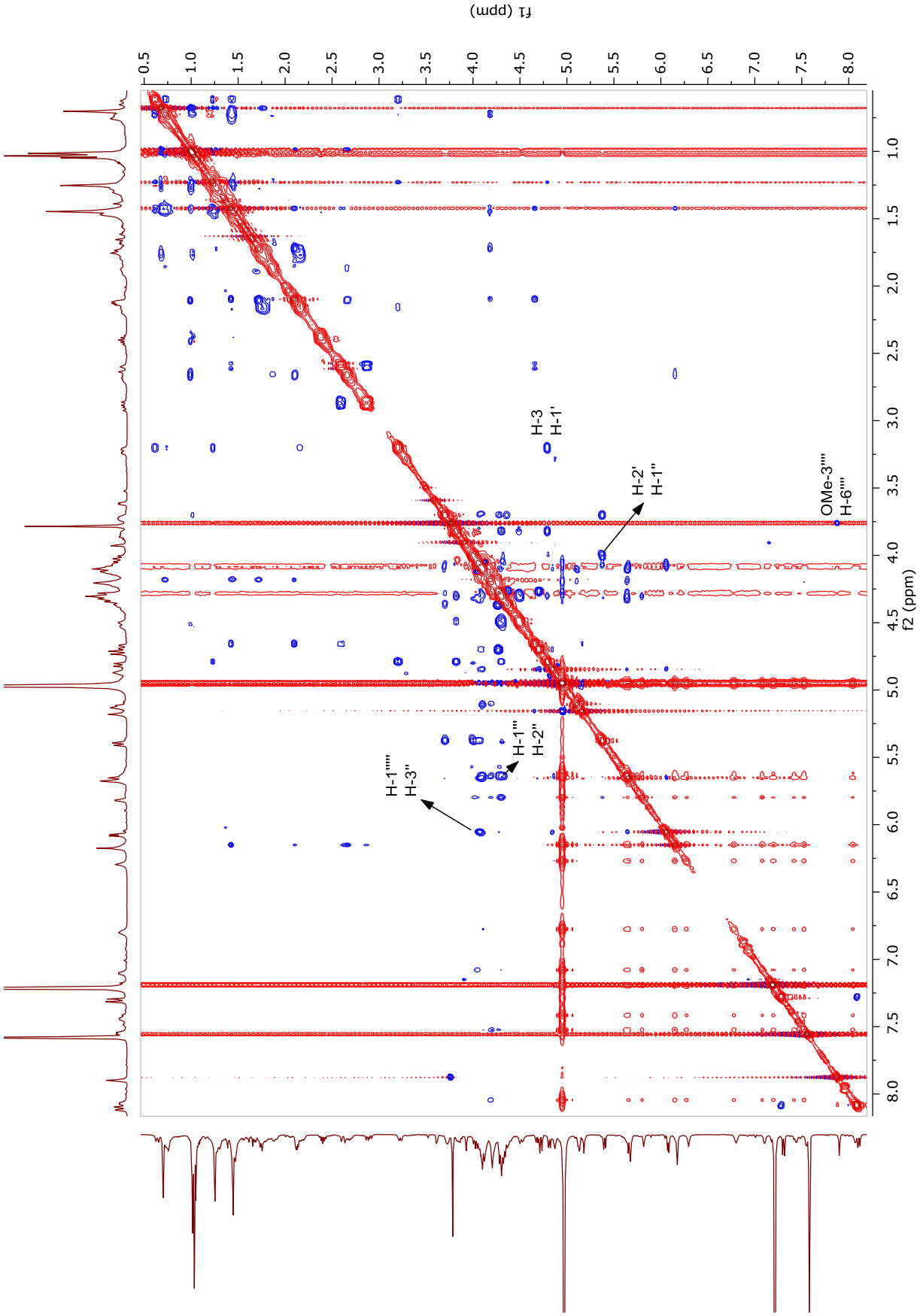


Figura 223. Espectro de ROESY de **Zg13** (400 MHz, C_5D_5N).

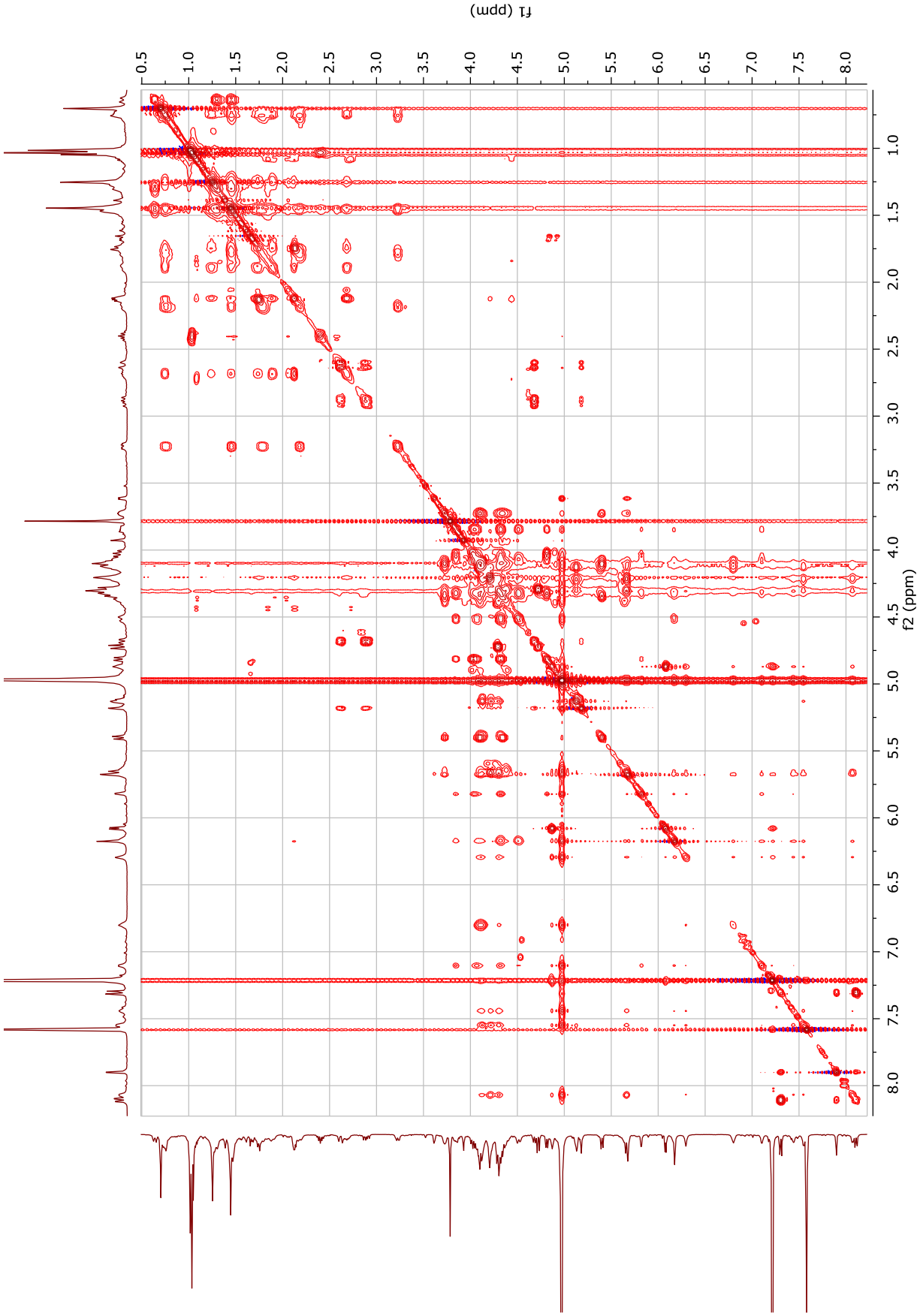


Figura 224. Espectro de TOCSY (2D) de **Zg13** (400 MHz, C_5D_5N).

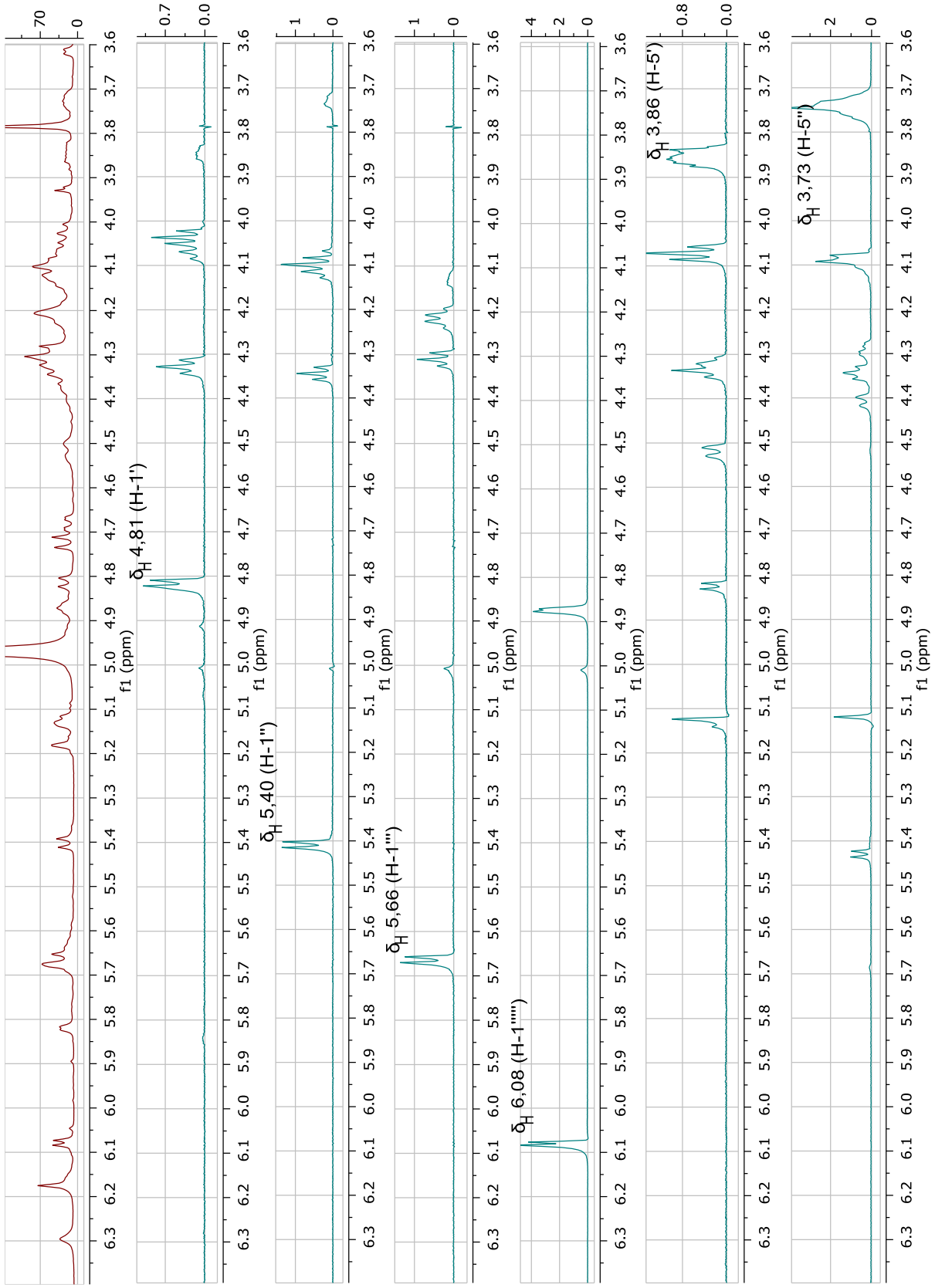


Figura 225. Espectro de TOCSY seletivo de **Zg13** (δ_H 3,6-6,4 ppm) (600 MHz, C_5D_5N).

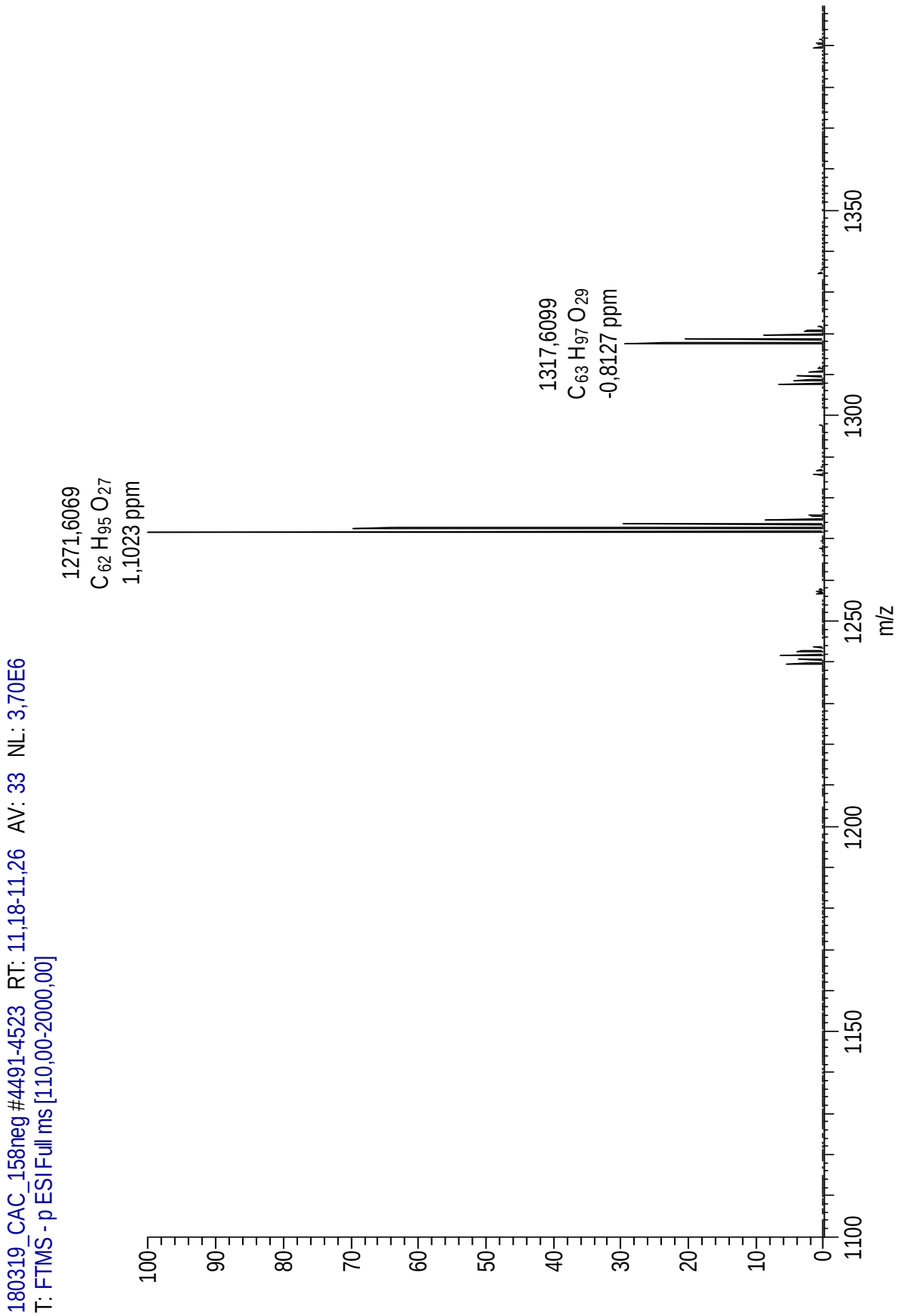


Figura 226. Espectro de massas de alta resolução de **Zg14** (ESI, modo negativo).

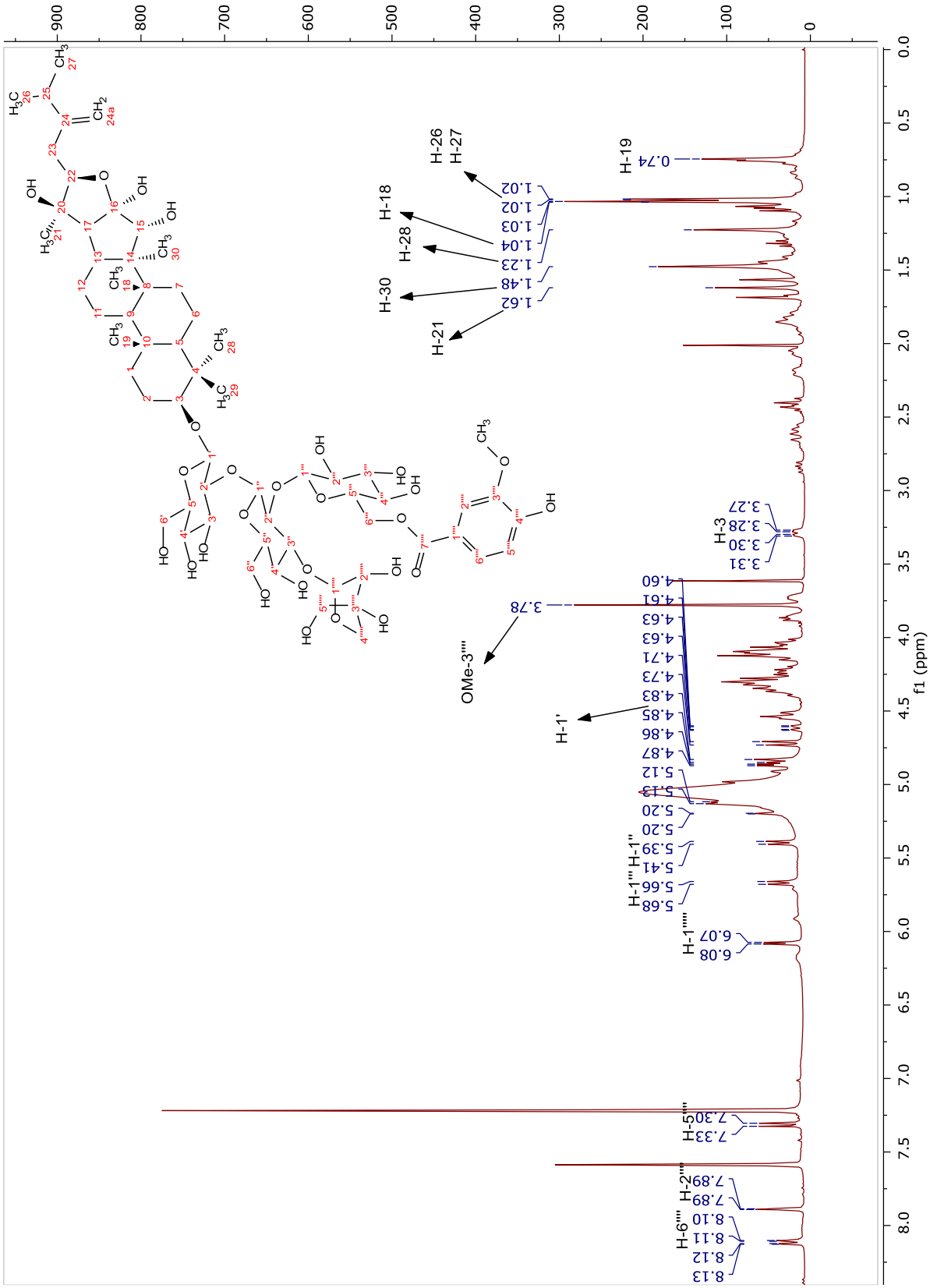


Figura 227. Espectro de RMN ^{1}H de **Zg14** (400 MHz, C_5D_5N).

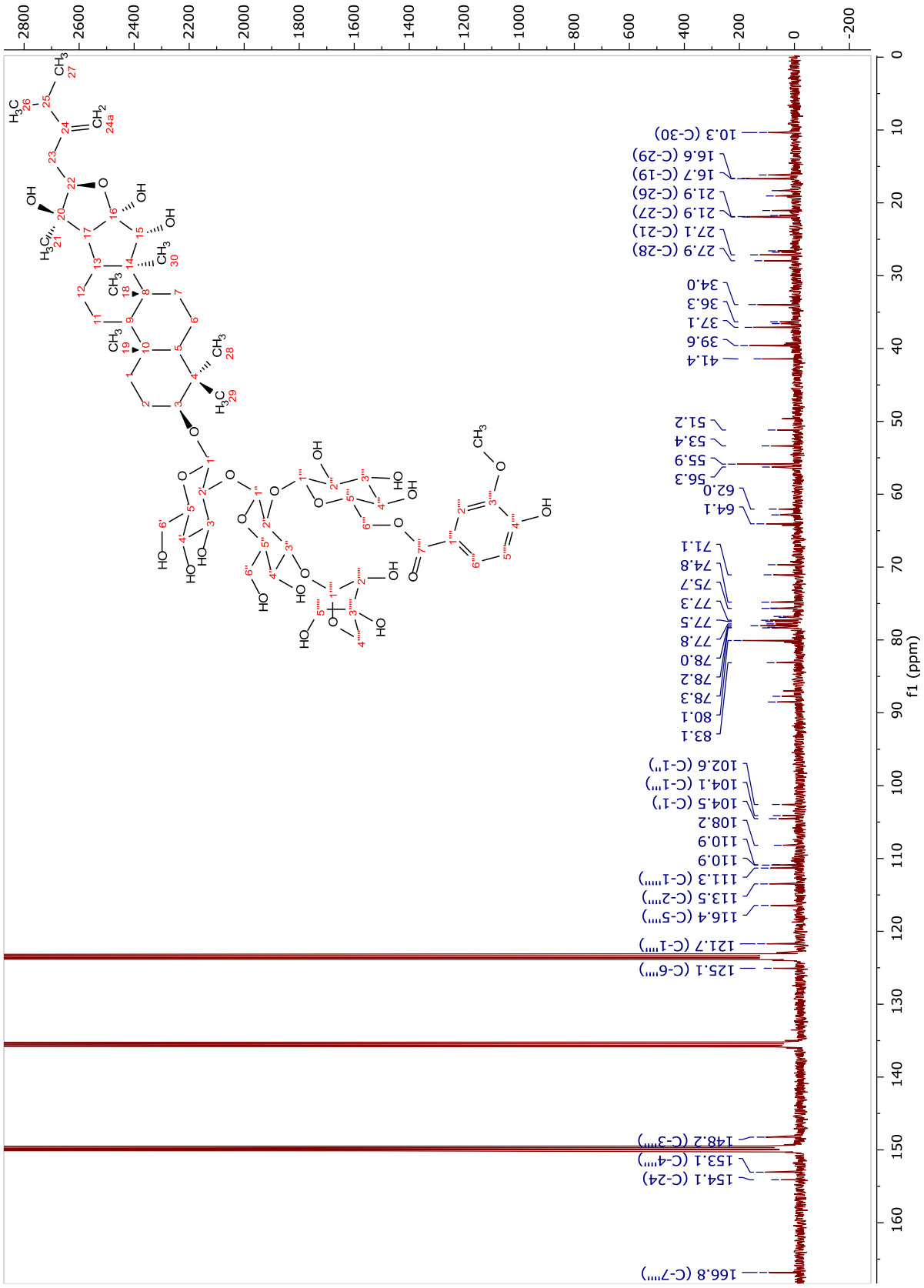


Figura 228. Espectro de RMN ^{13}C de **Zg14** (100 MHz, C_5D_5N).

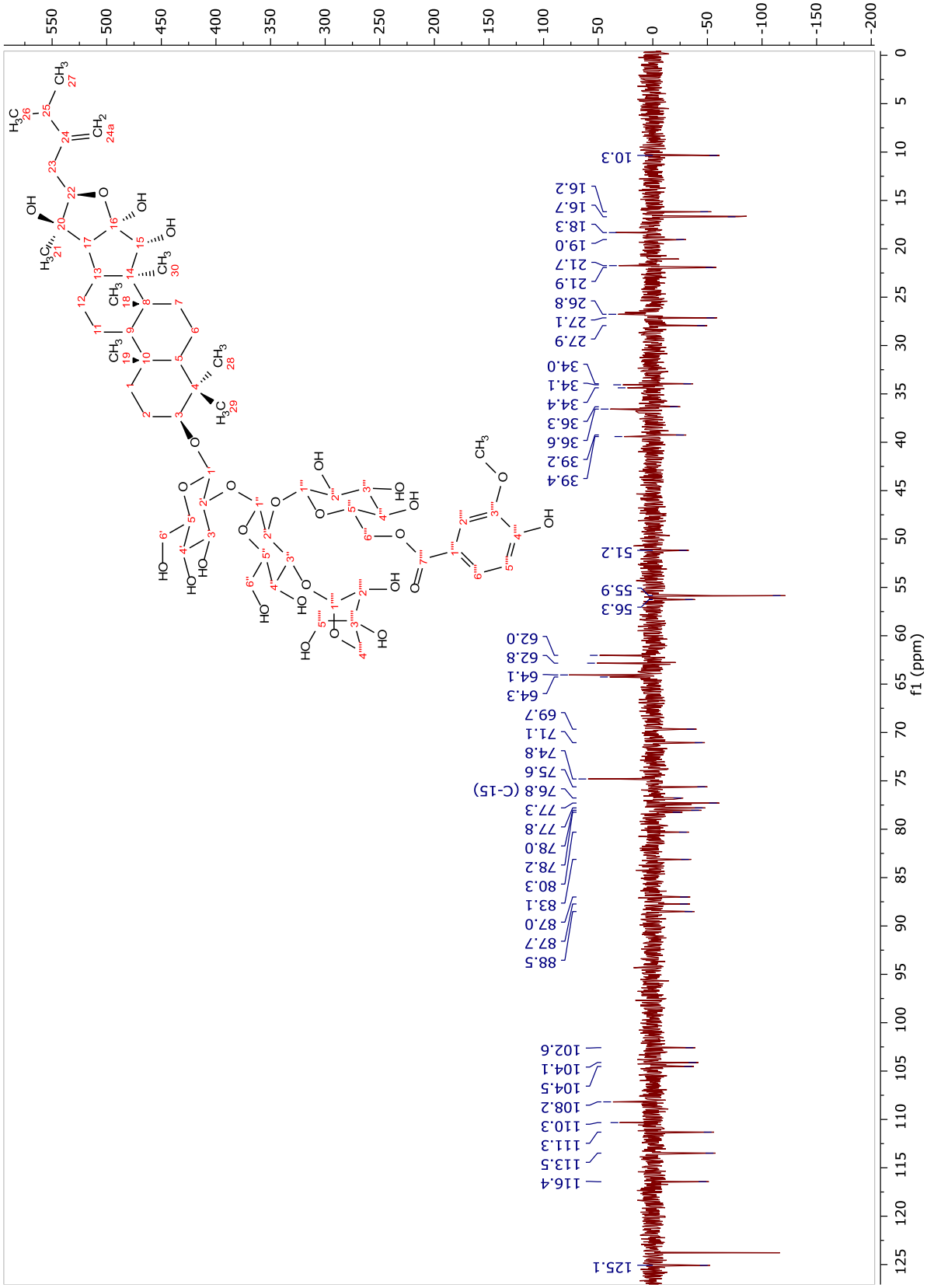


Figura 229. Espectro de DEPT-135 de **Zg14** (400 MHz, C_5D_5N).

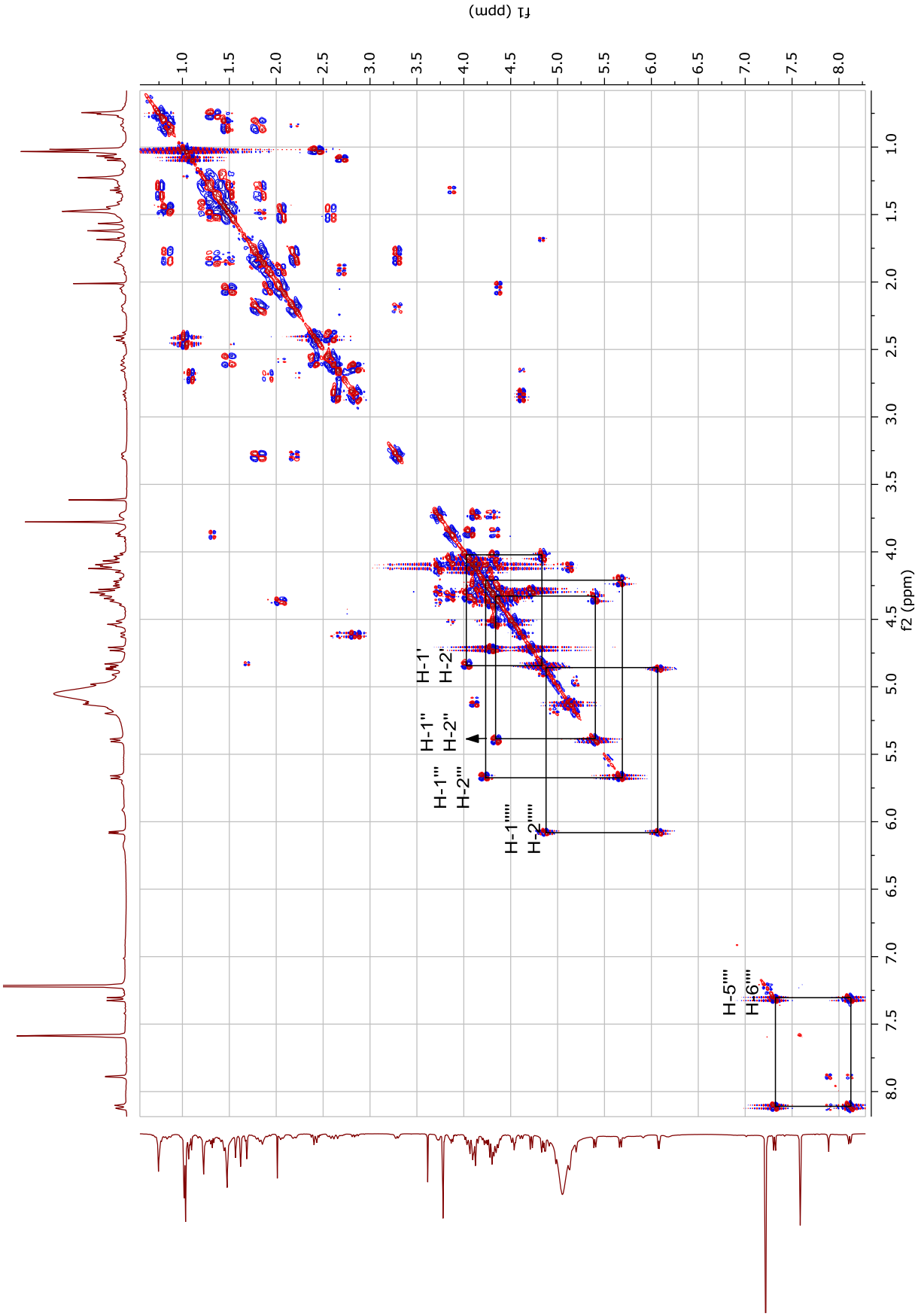


Figura 230. Espectro de COSY de **Zg14** (400 MHz, C_5D_5N).

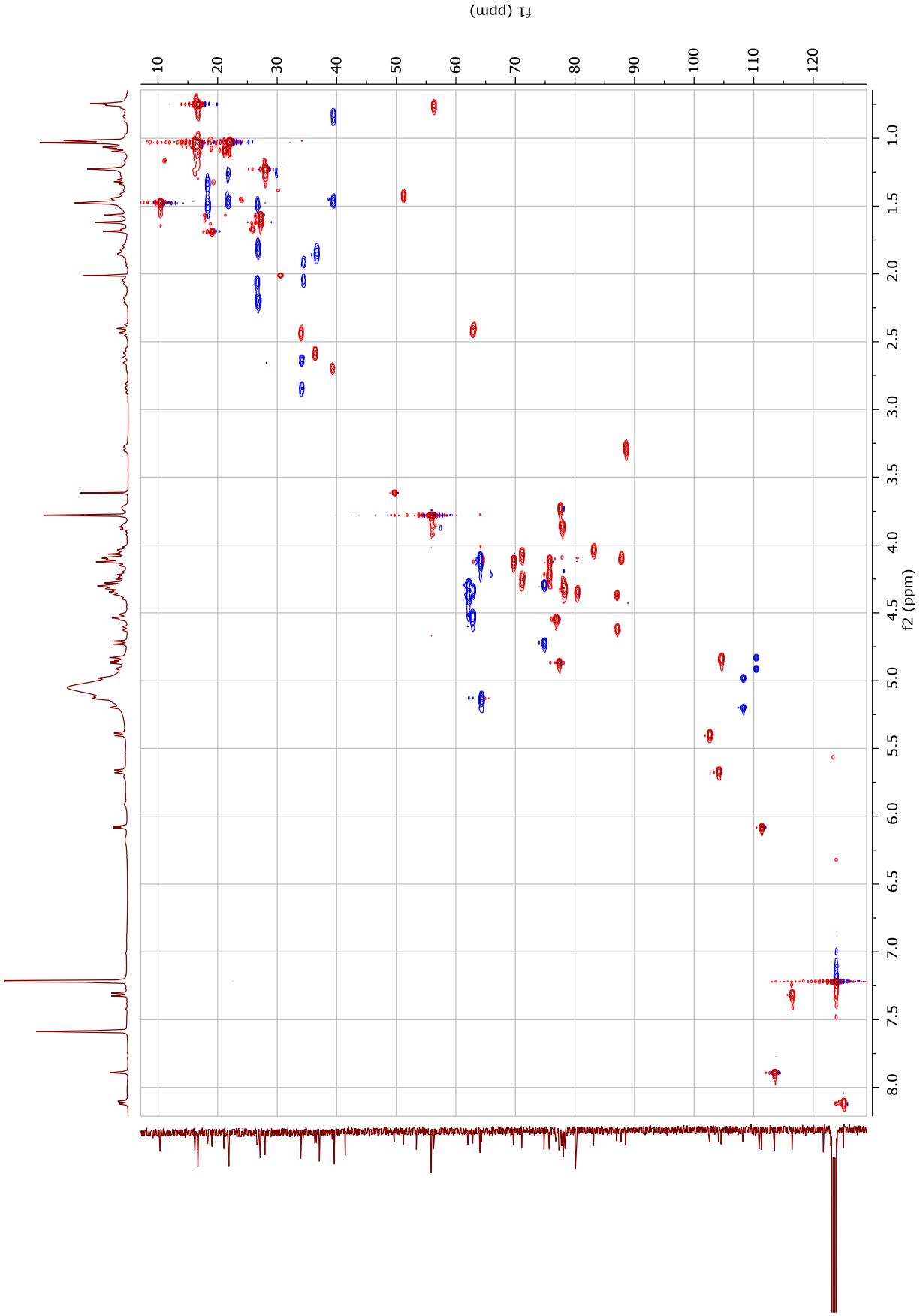


Figura 231. Espectro de HSQC de **Zg14** (400 MHz, C_5D_5N).

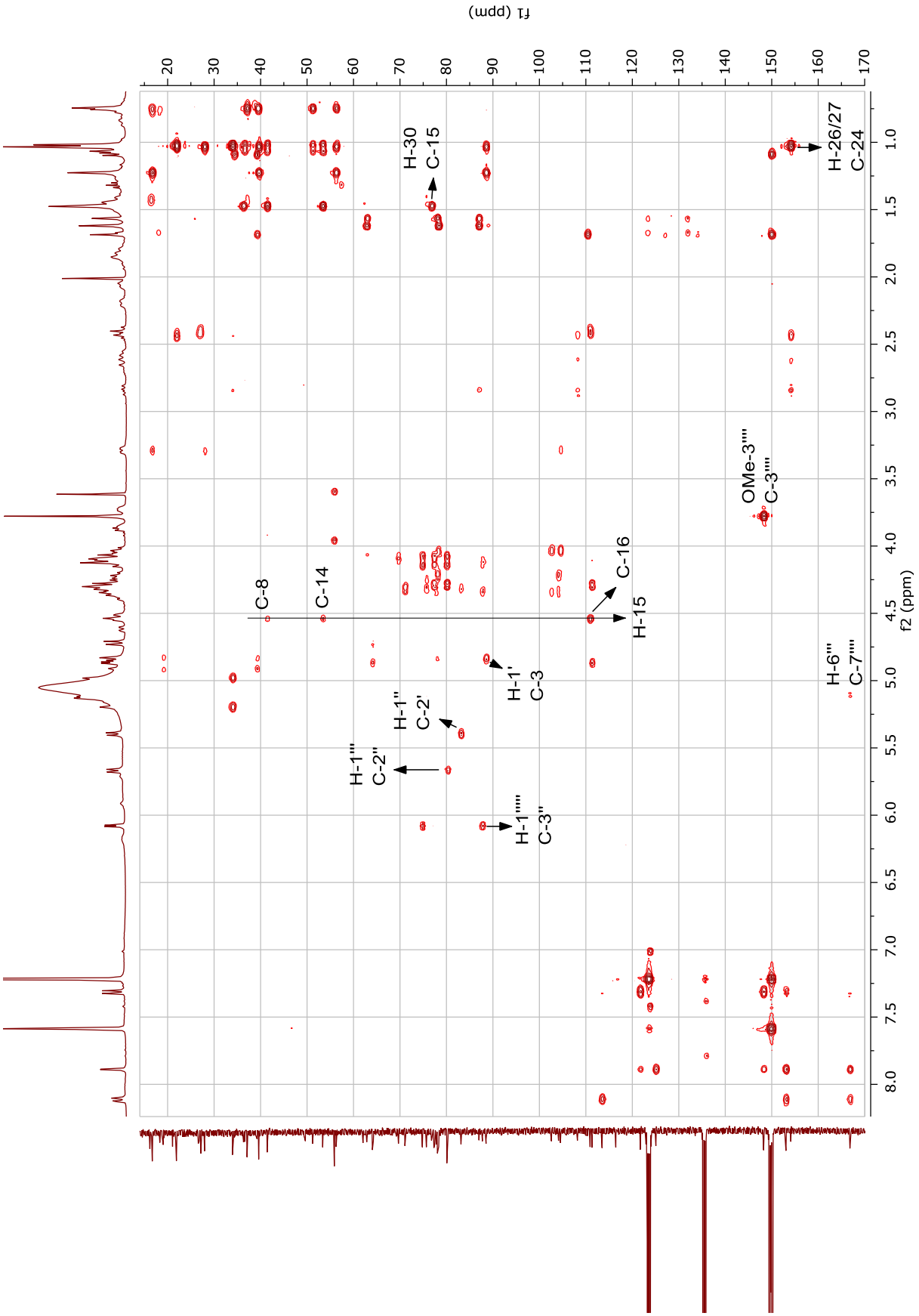


Figura 232. Espectro de HMBC de **Zg14** (400 MHz, C_5D_5N).

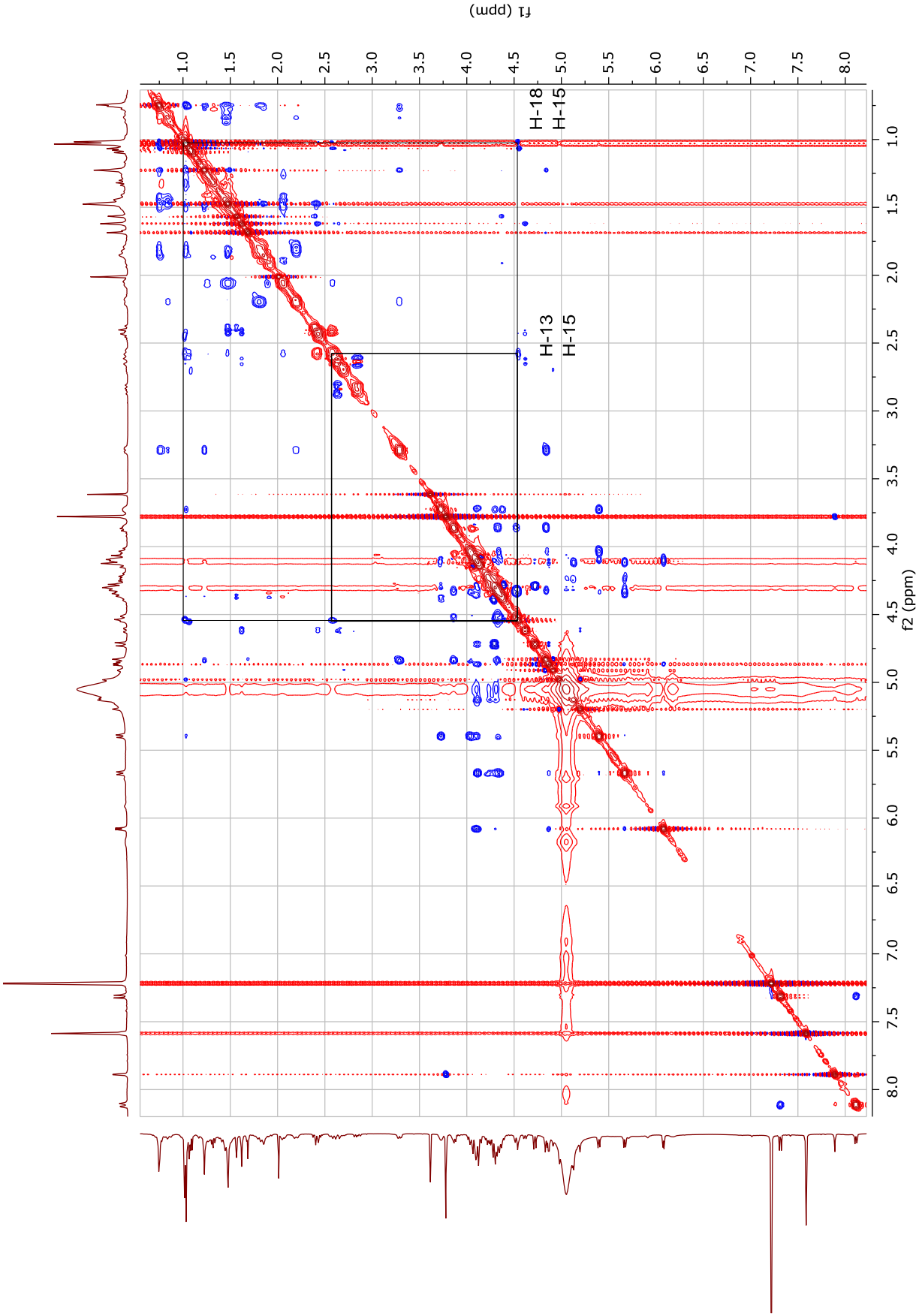


Figura 233. Espectro de ROESY de **Zg14** (400 MHz, C_5D_5N).

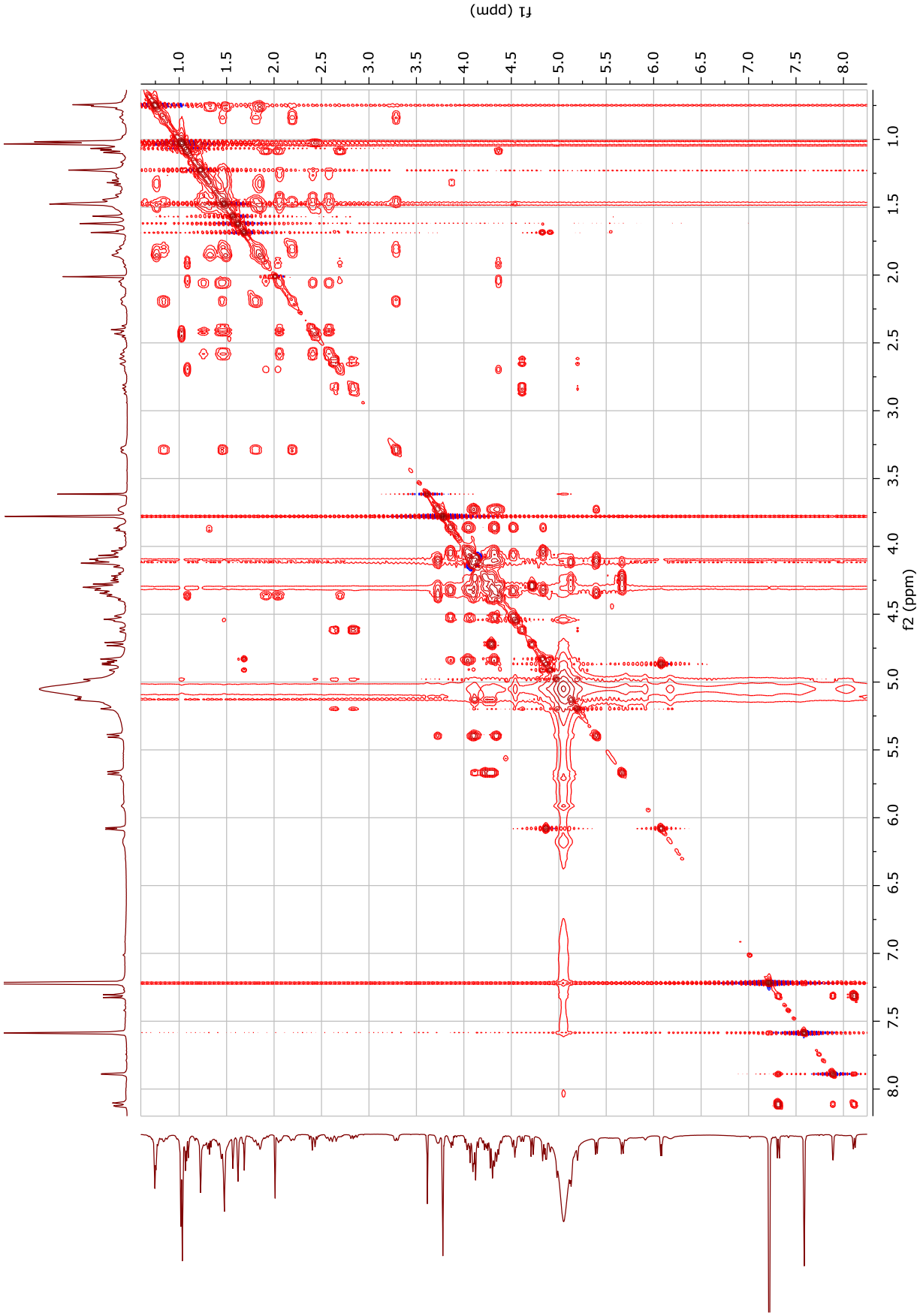


Figura 234. Espectro de TOCSY (2D) de **Zg14** (400 MHz, C5D5N).

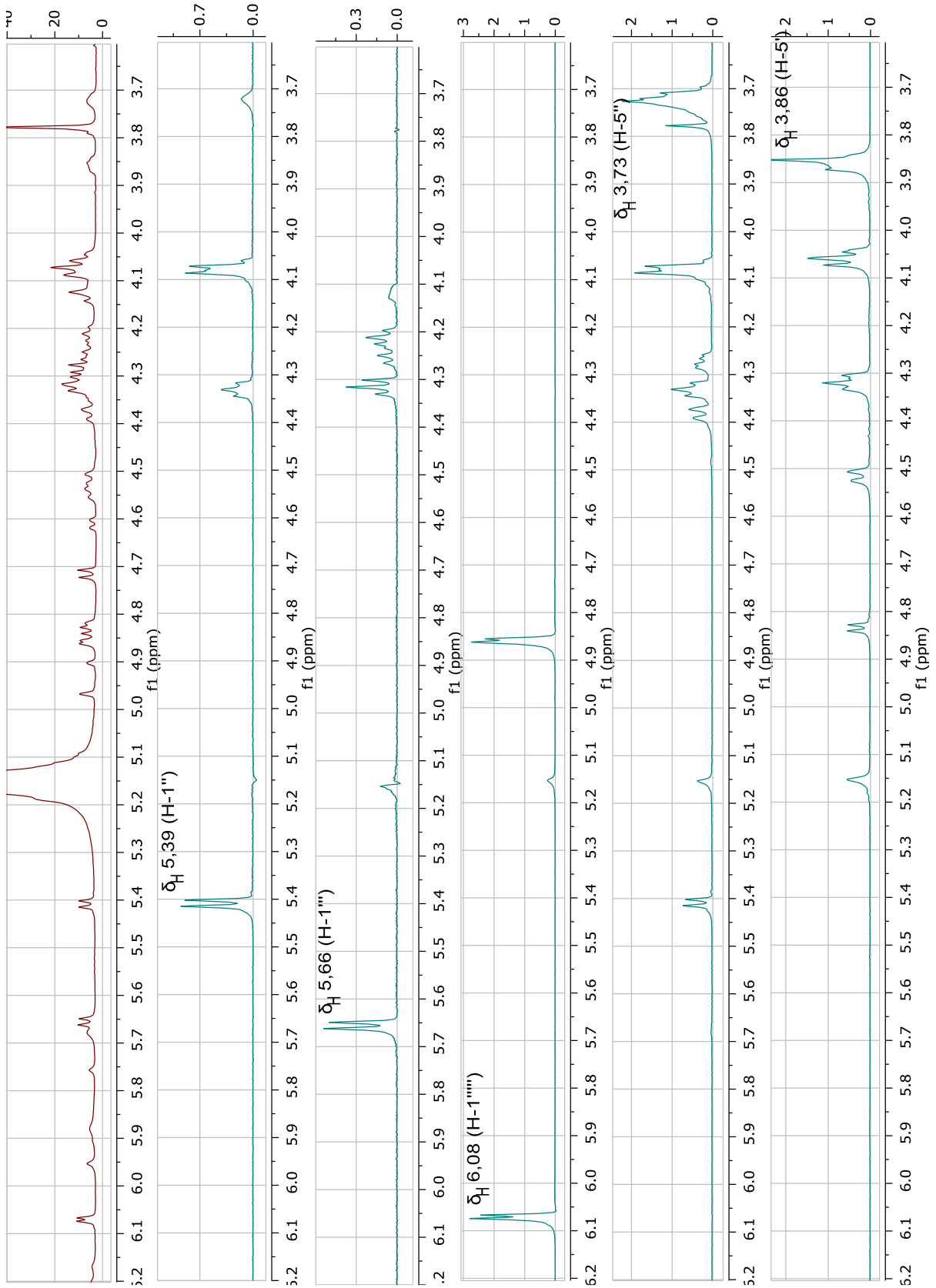


Figura 235. Espectro de TOCSY seletivo de **Zg14** (δ_H 3,6-6,2 ppm) (600 MHz, C_5D_5N).

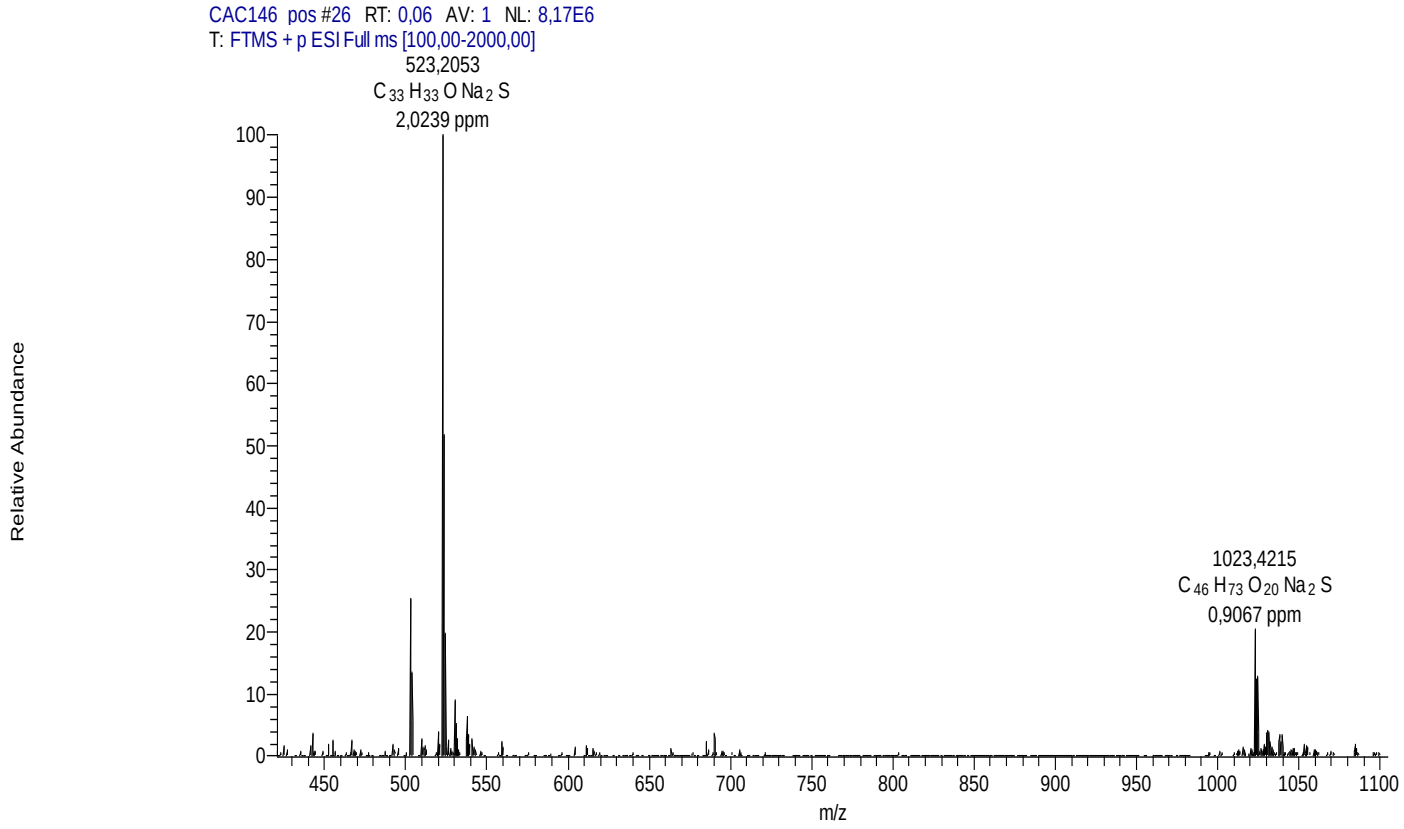


Figura 236. Espectro de massas de alta resolução de **Zg15** (ESI, modo positivo).

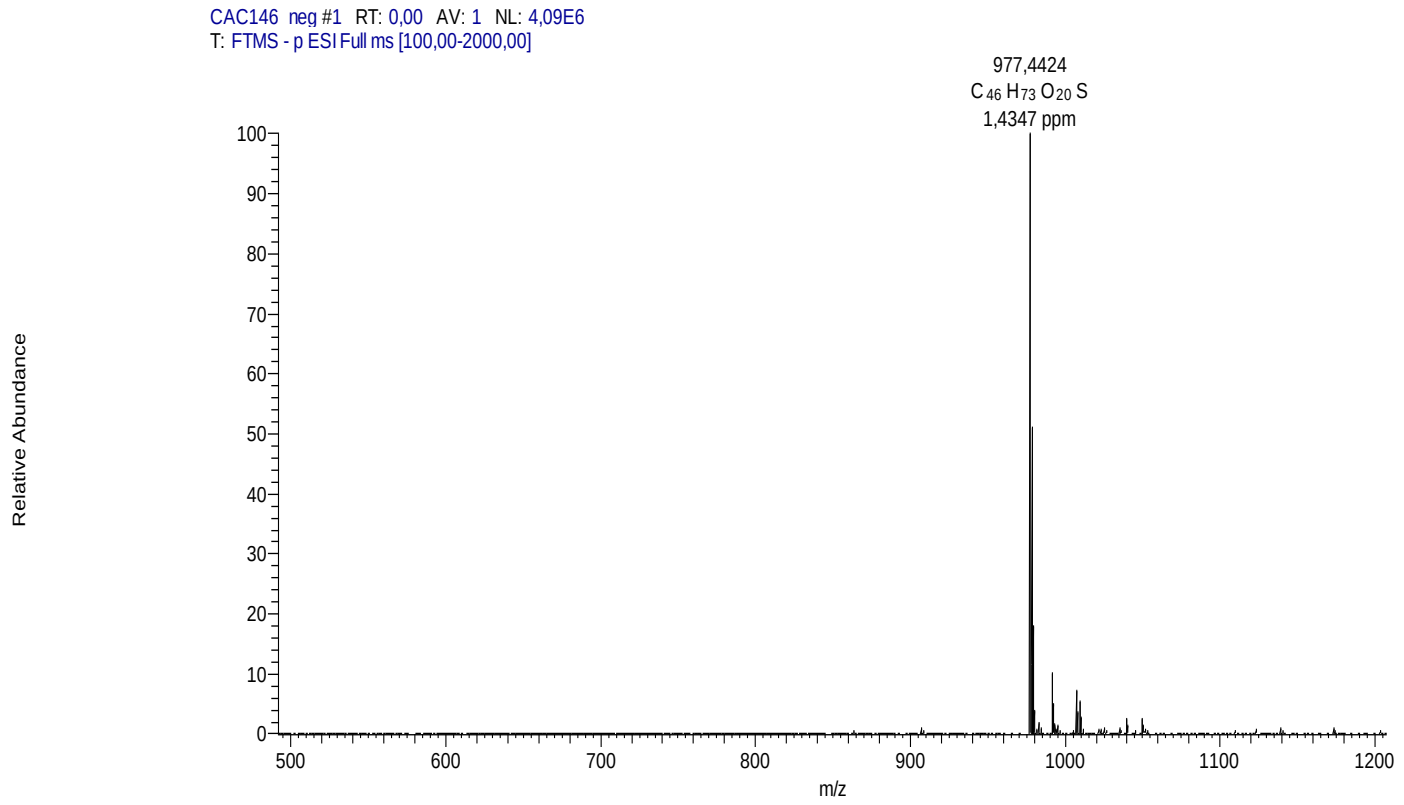


Figura 237. Espectro de massas de alta resolução de **Zg15** (ESI, modo negativo).

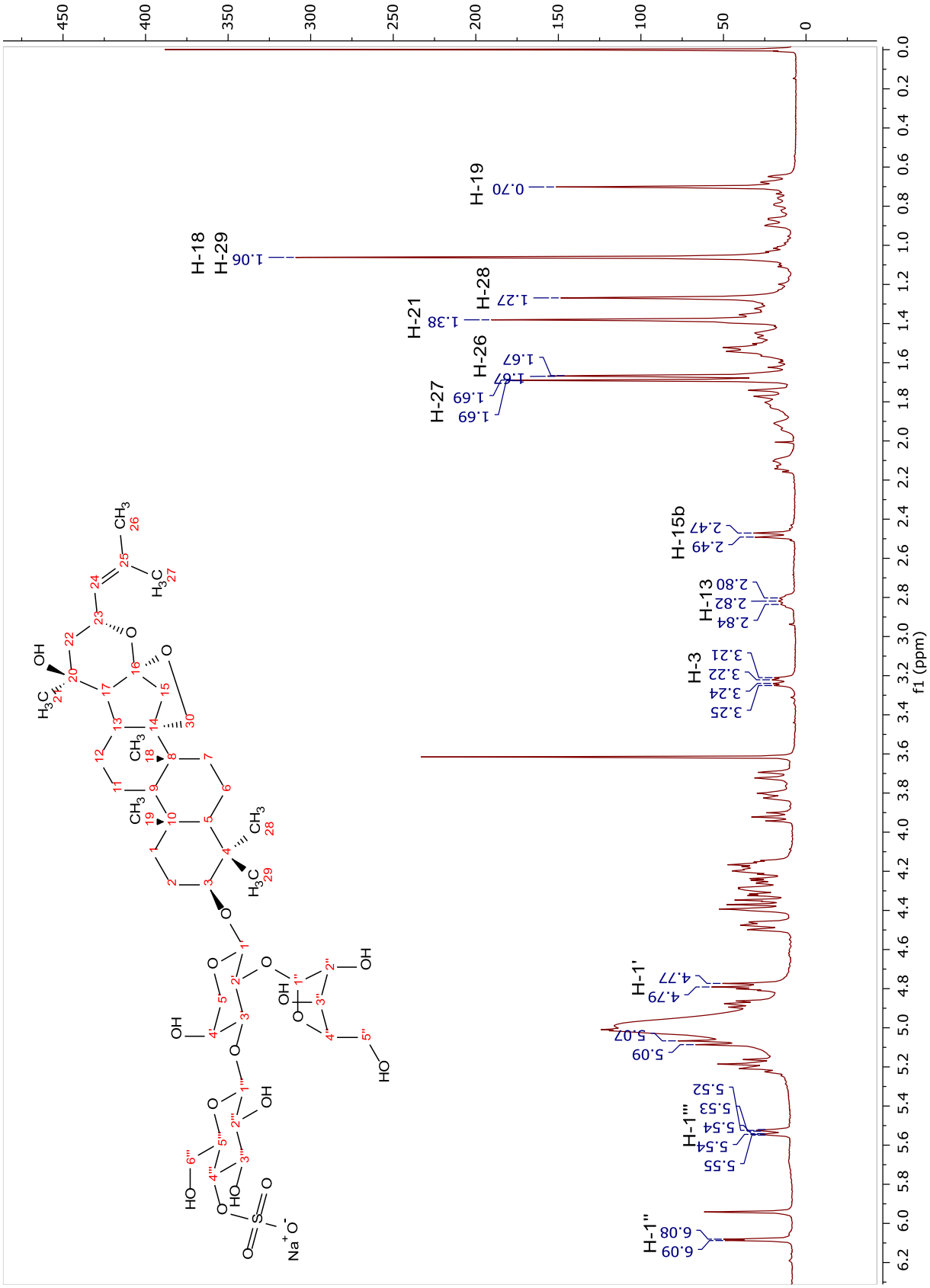


Figura 238. Espectro de RMN ^{1}H da substância **Zg15** (400 MHz, C_5D_5N).

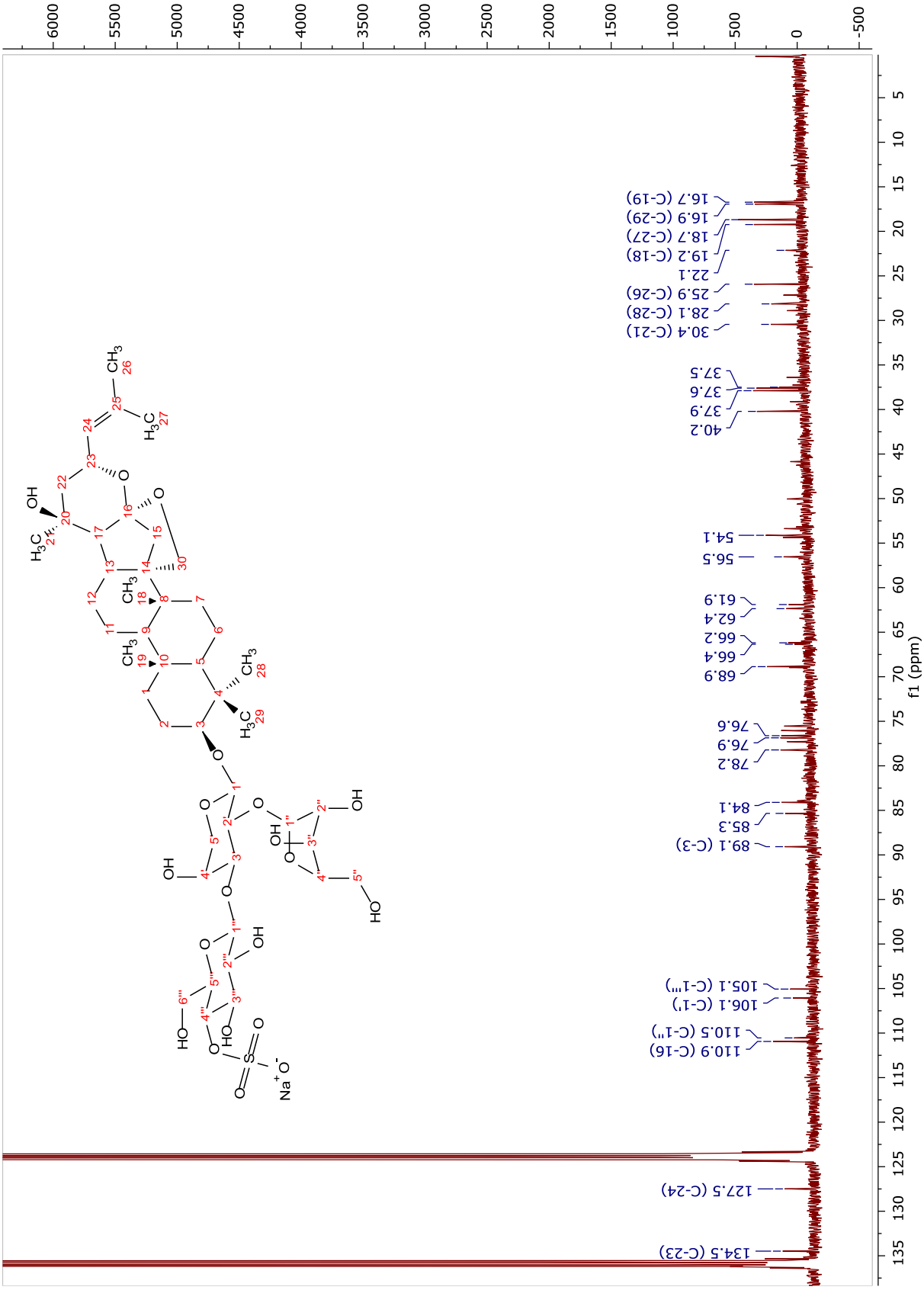


Figura 239. Espectro de RMN ^{13}C de **Zg15** (100 MHz, C_5D_5N).

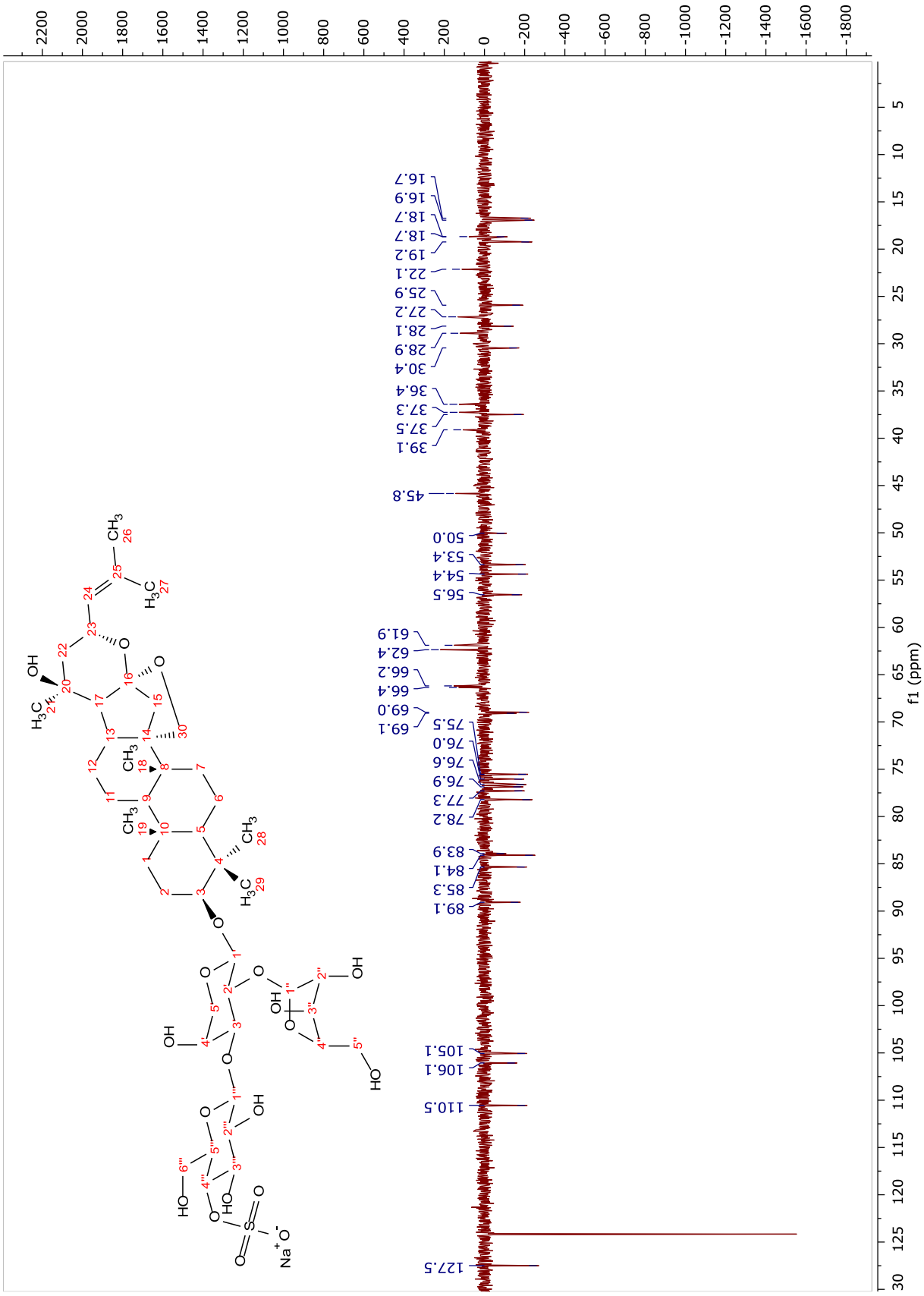


Figura 240. Espectro de DEPT-135 de **Zg15** (100 MHz, C_5D_5N).

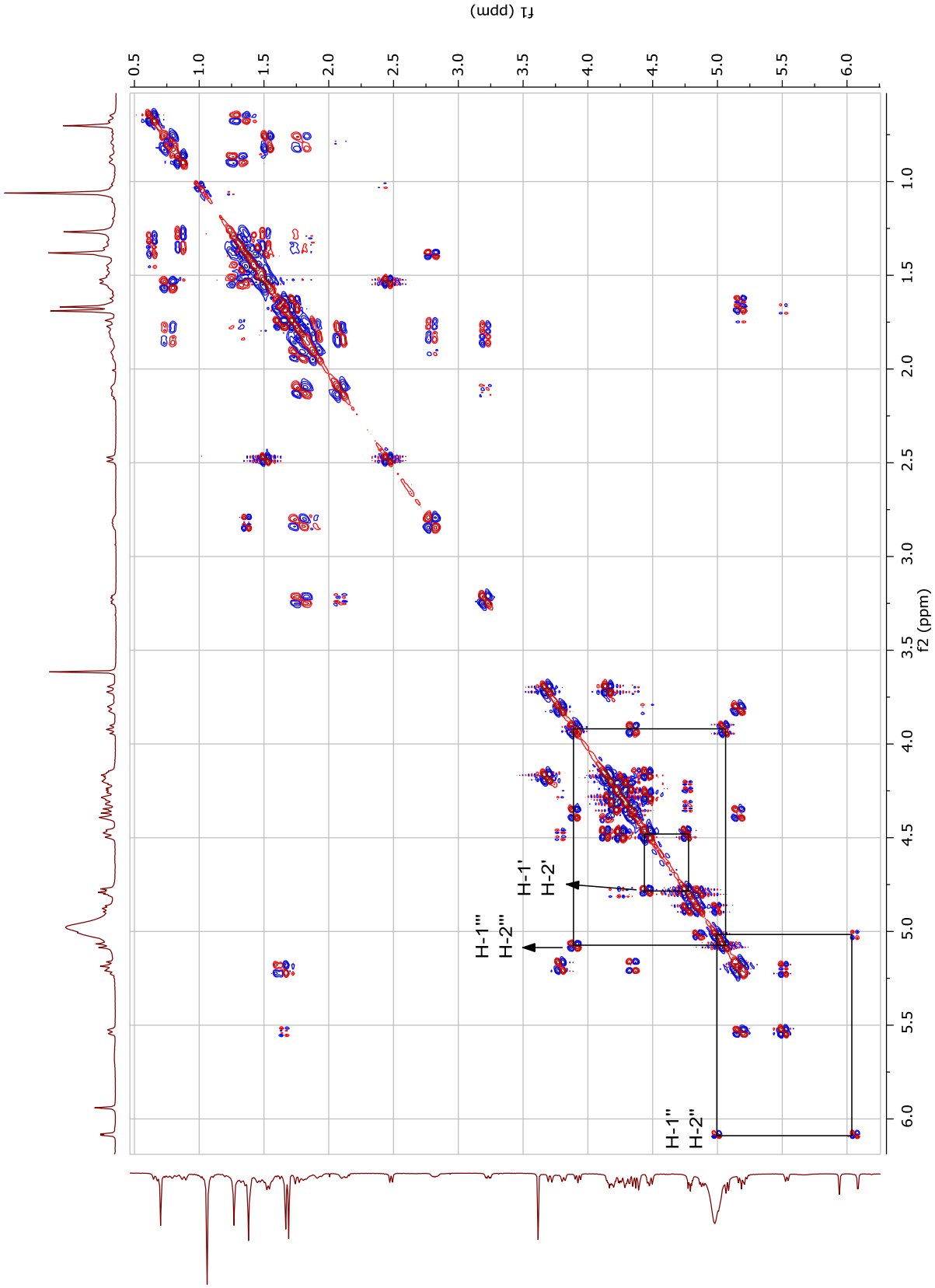


Figura 241. Espectro de COSY de **Zg15** (400 MHz, C_5D_5N).

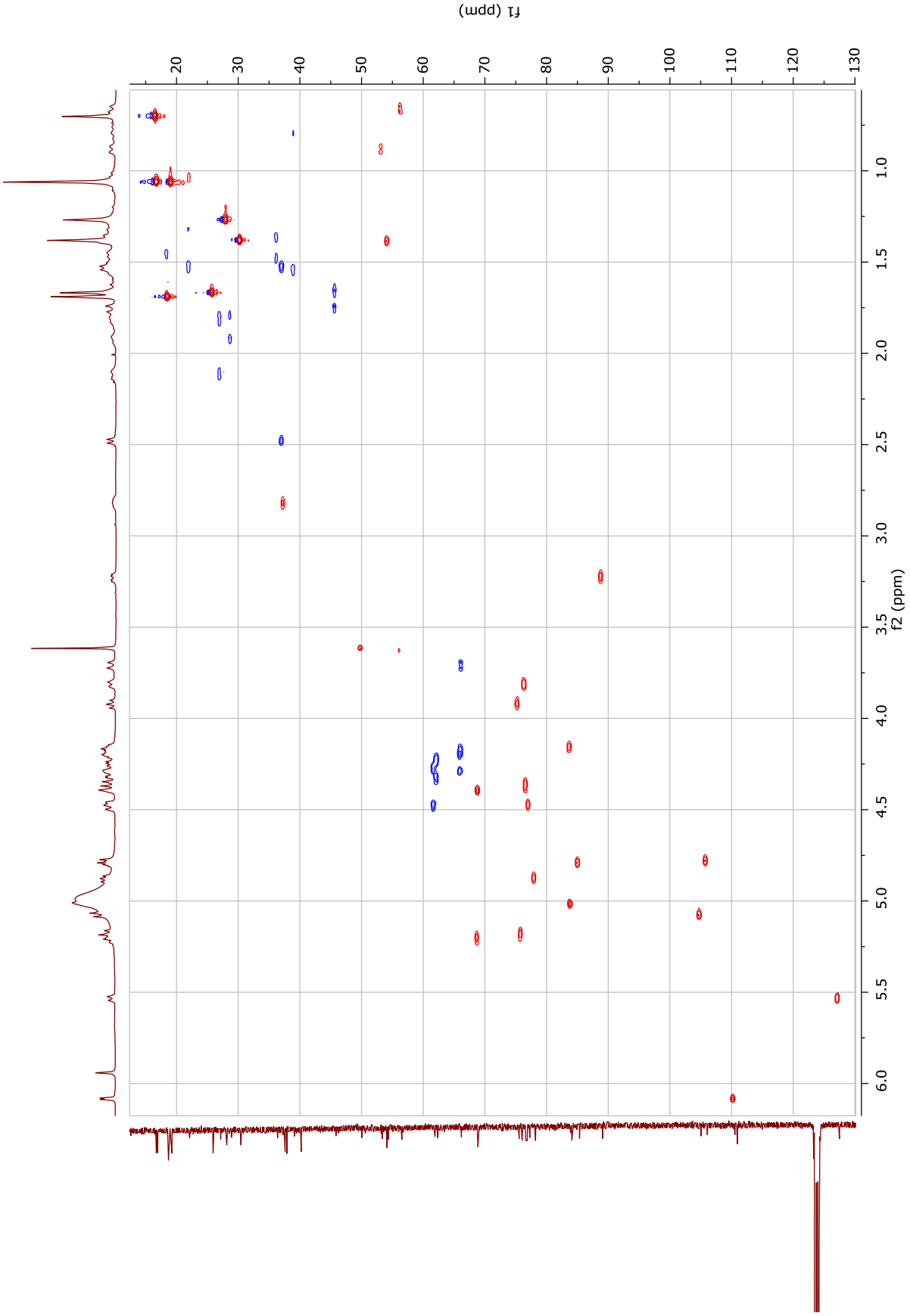


Figura 242. Espectro de HSQC de **Zg15** (400 MHz, C_5D_5N).

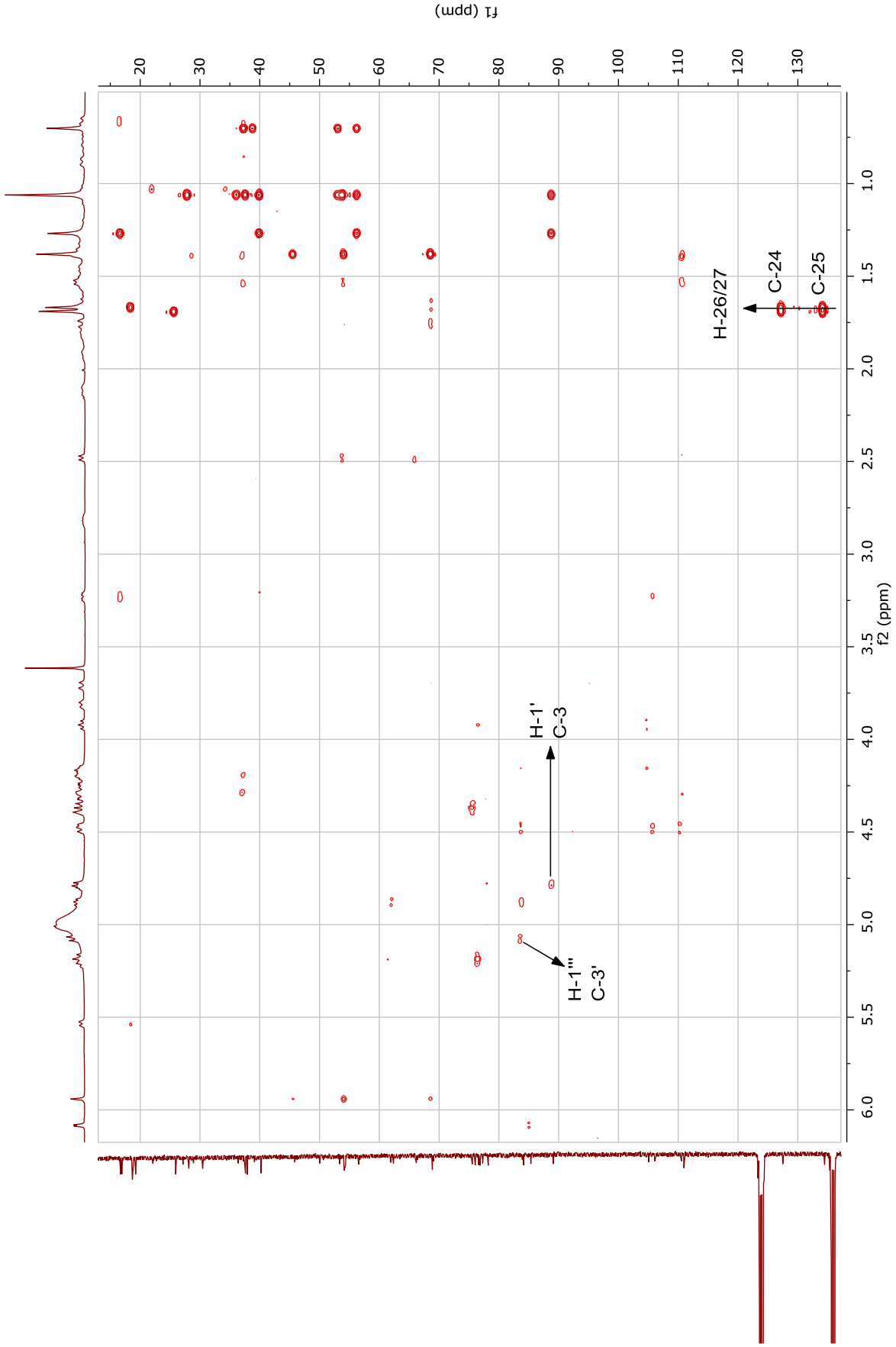


Figura 243. Espectro de HMBC de **Zg15** (400 MHz, C_5D_5N).

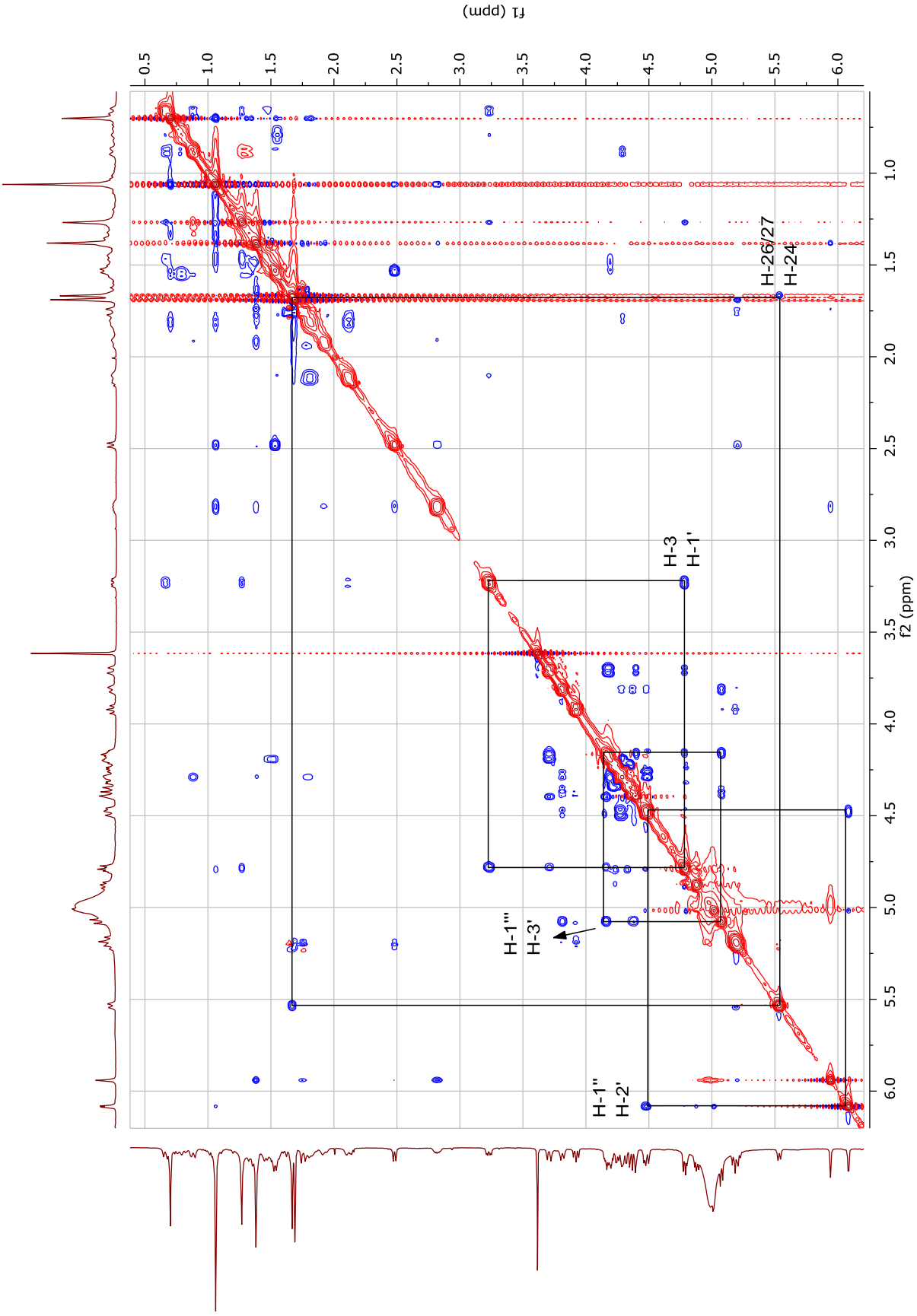


Figura 244. Espectro de ROESY de **Zg15** (400 MHz, C_5D_5N).

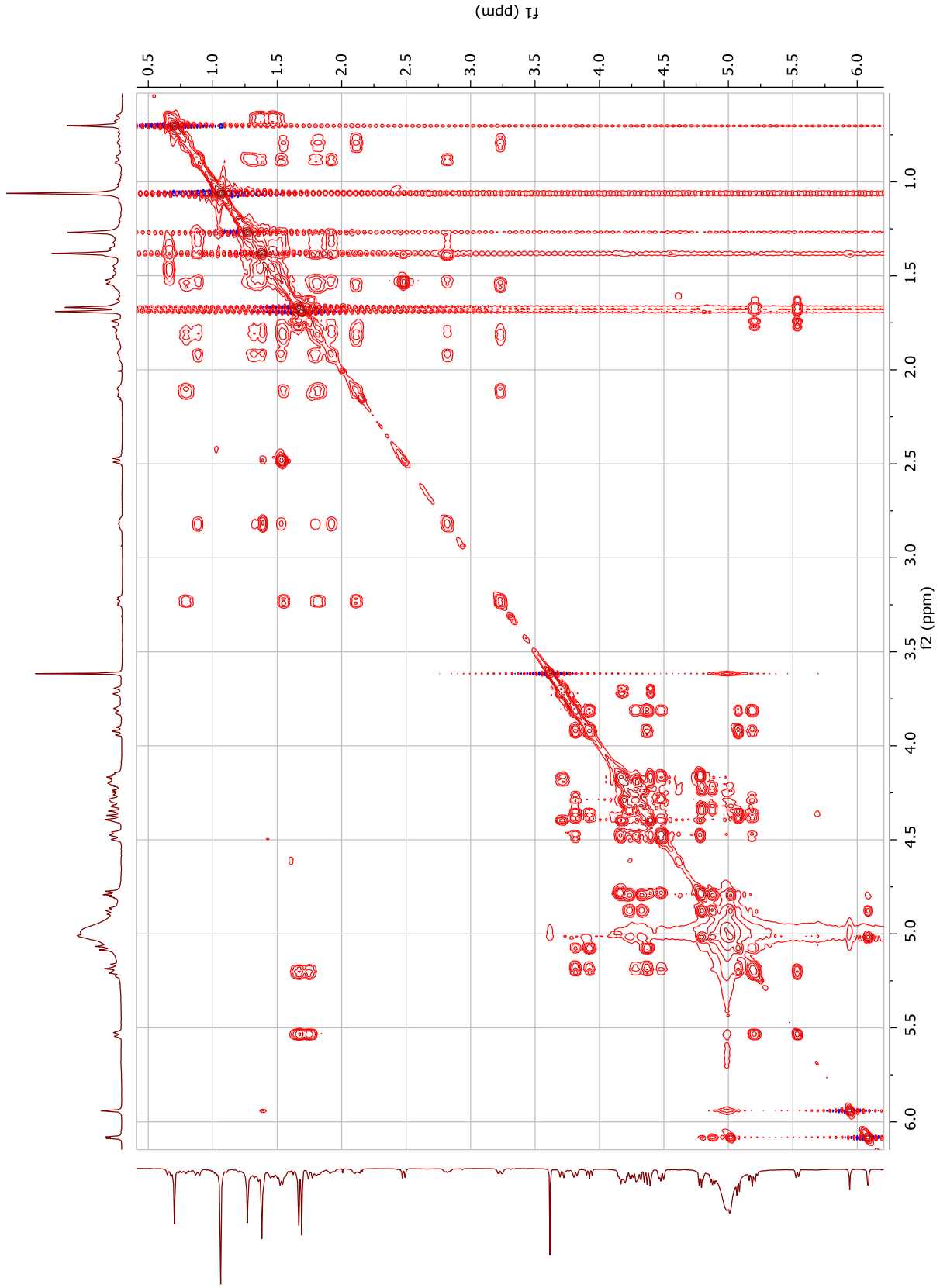


Figura 245. Espectro de TOCSY de **Zg15** (400 MHz, C_5D_5N).

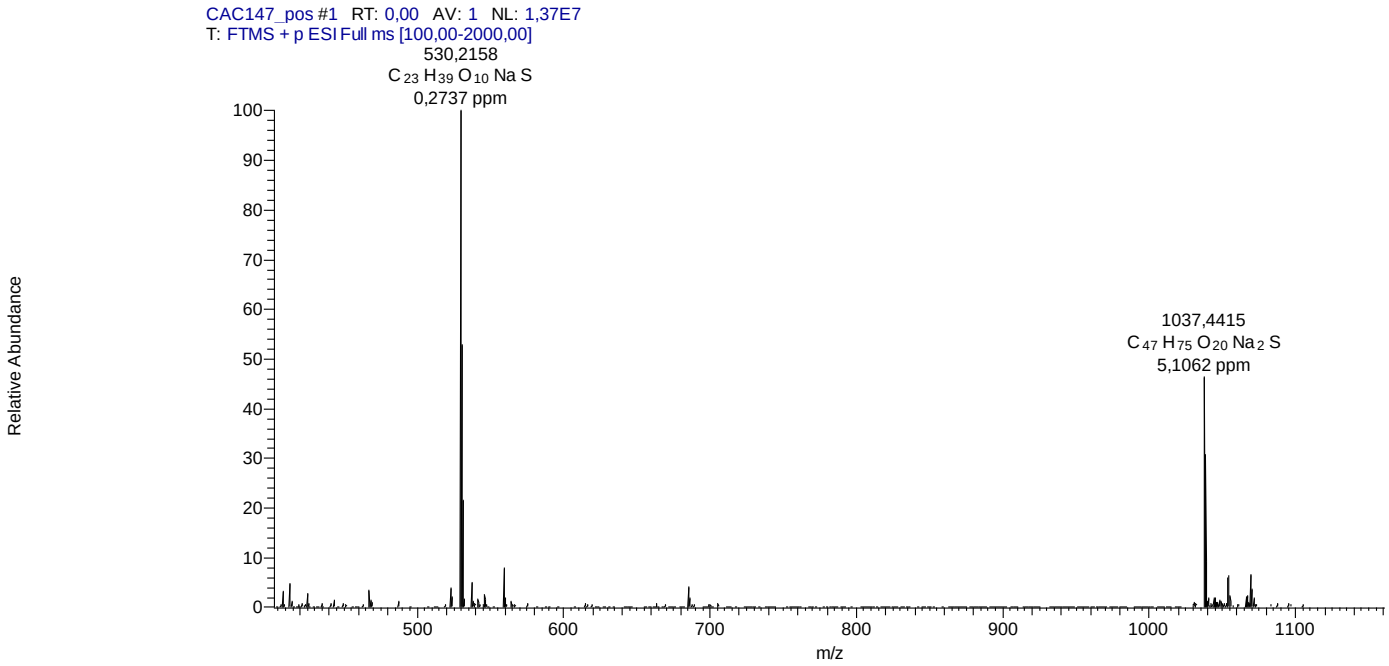


Figura 246. Espectro de massas de alta resolução **Zg16** (ESI, modo positivo).

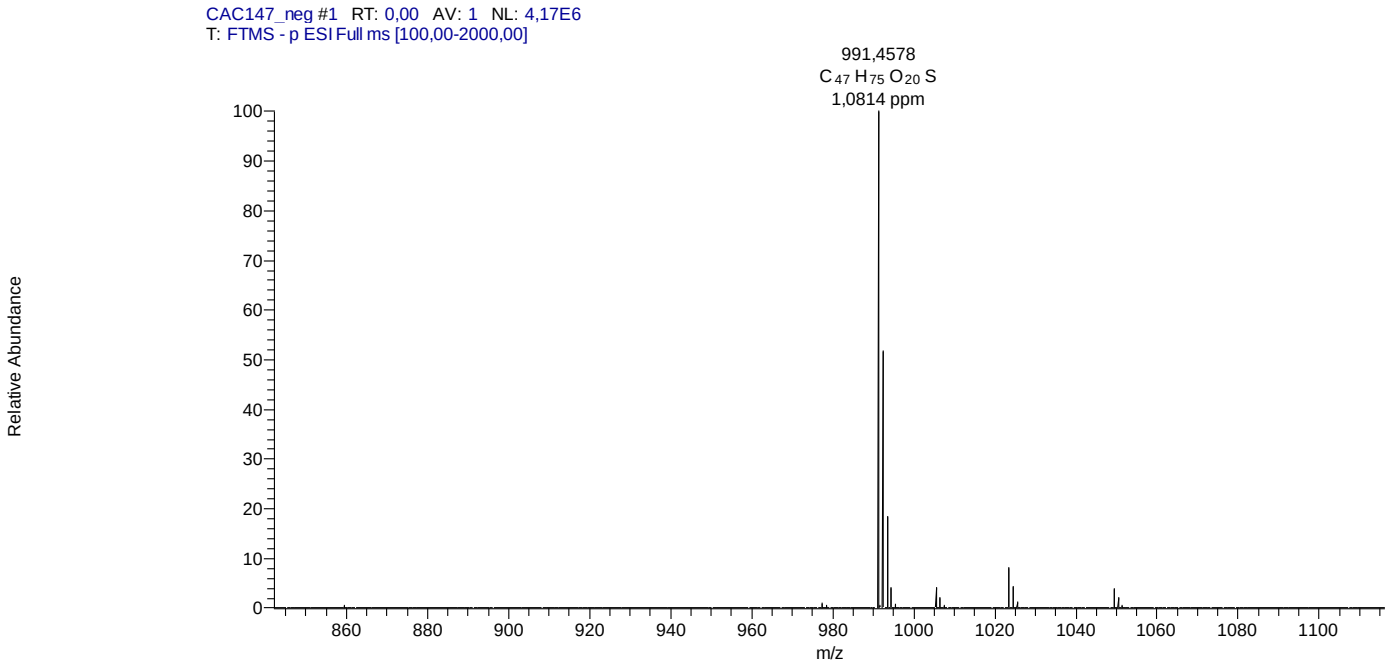


Figura 247. Espectro de massas de alta resolução de **Zg16** (ESI, modo negativo).

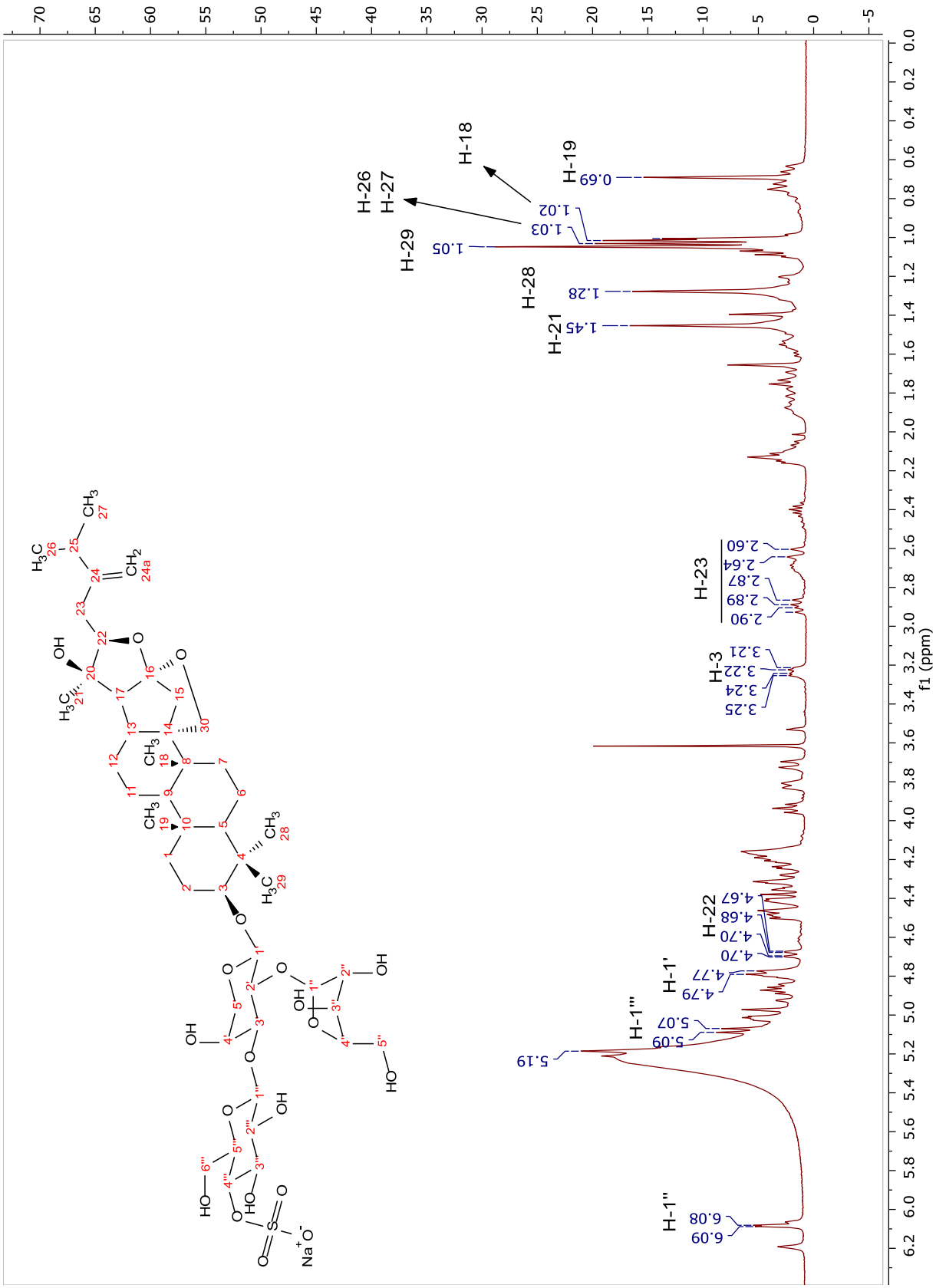


Figura 248. Espectro de RMN ^{1}H de **Zg16** (400 MHz, C_5D_5N).

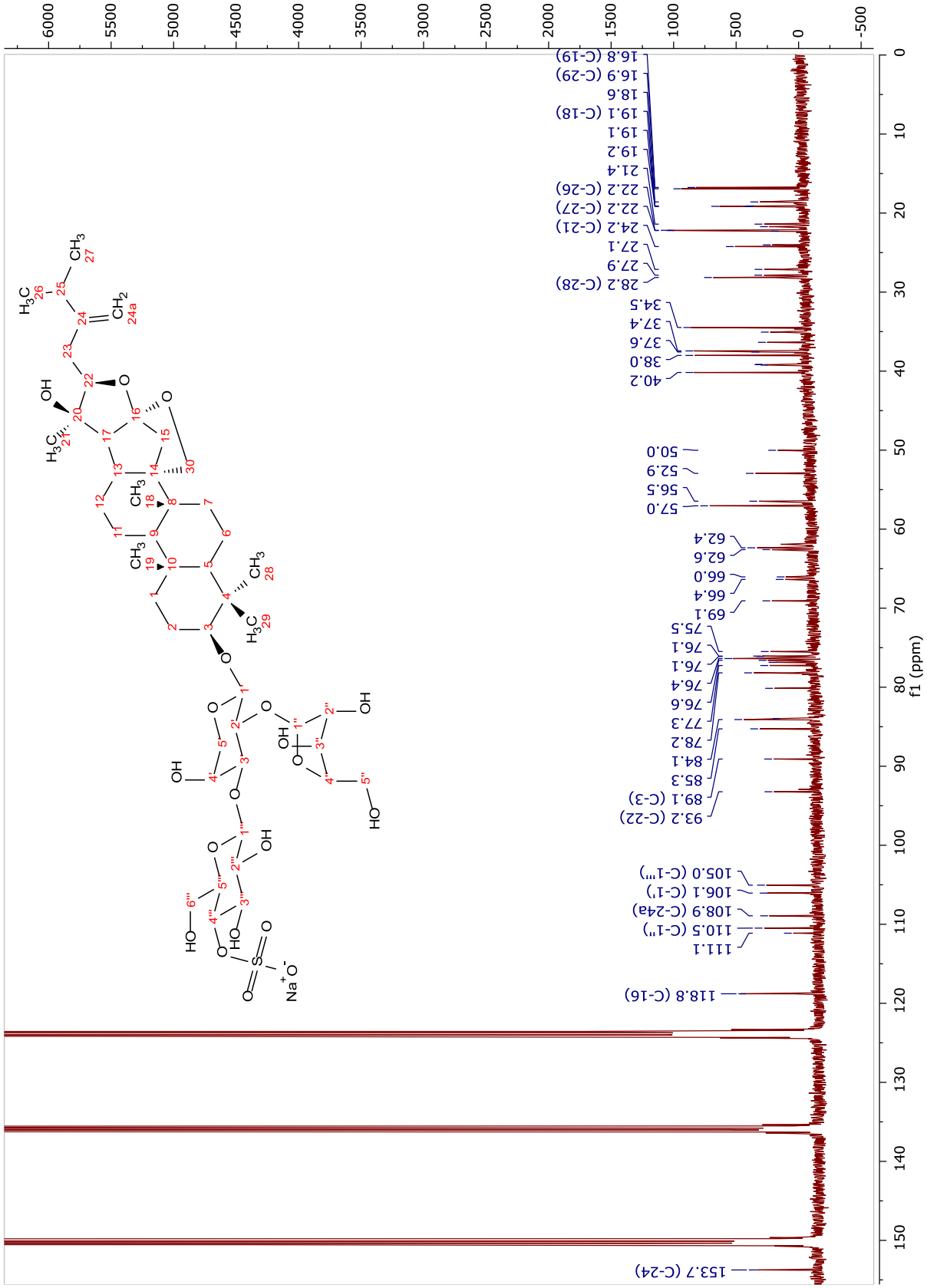


Figura 249. Espectro de RMN ^{13}C de **Zg16** (100 MHz, C_5D_5N).

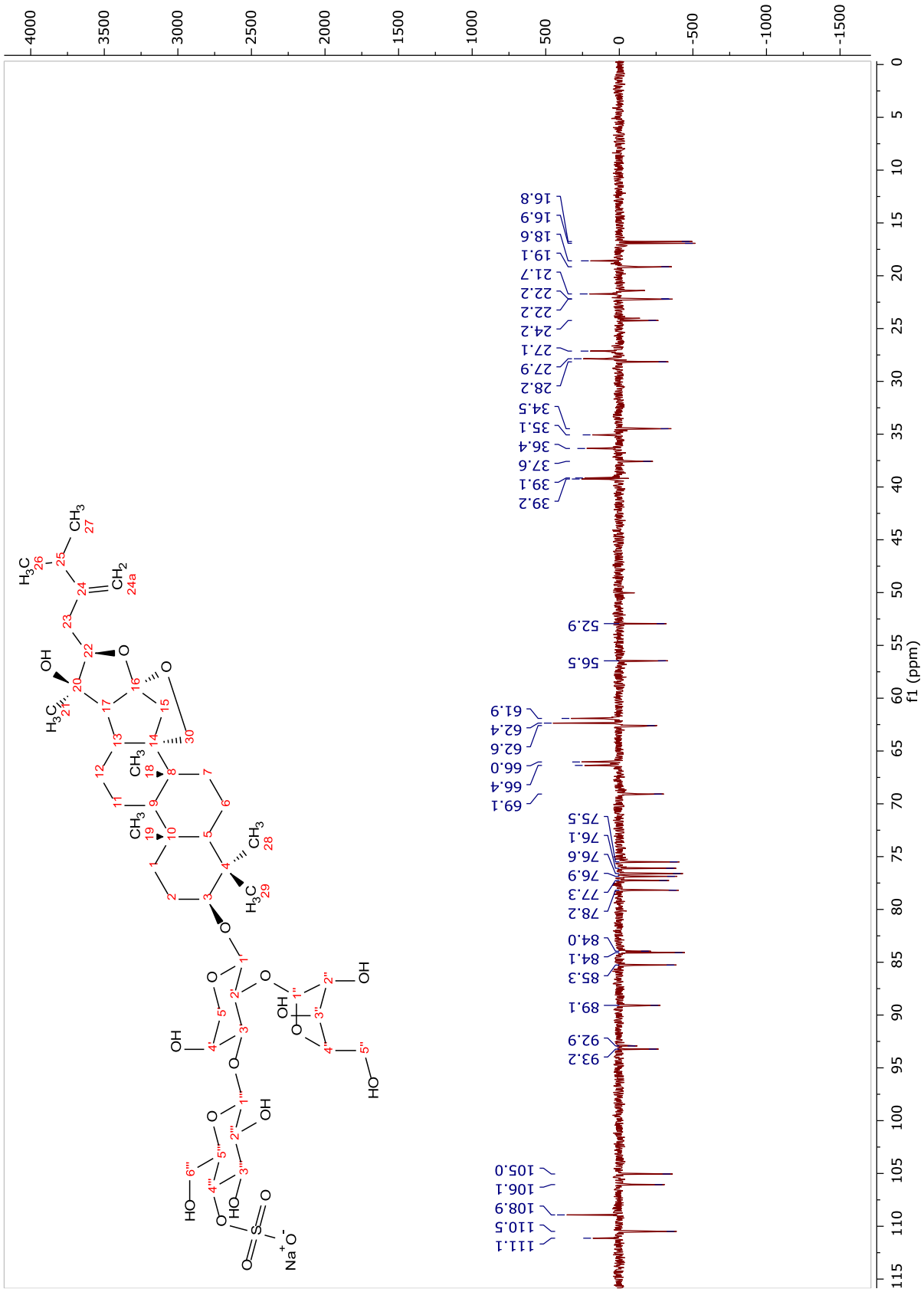


Figura 250. Espectro de DEPT-135 de **Zg16** (100 MHz, C_5D_5N).

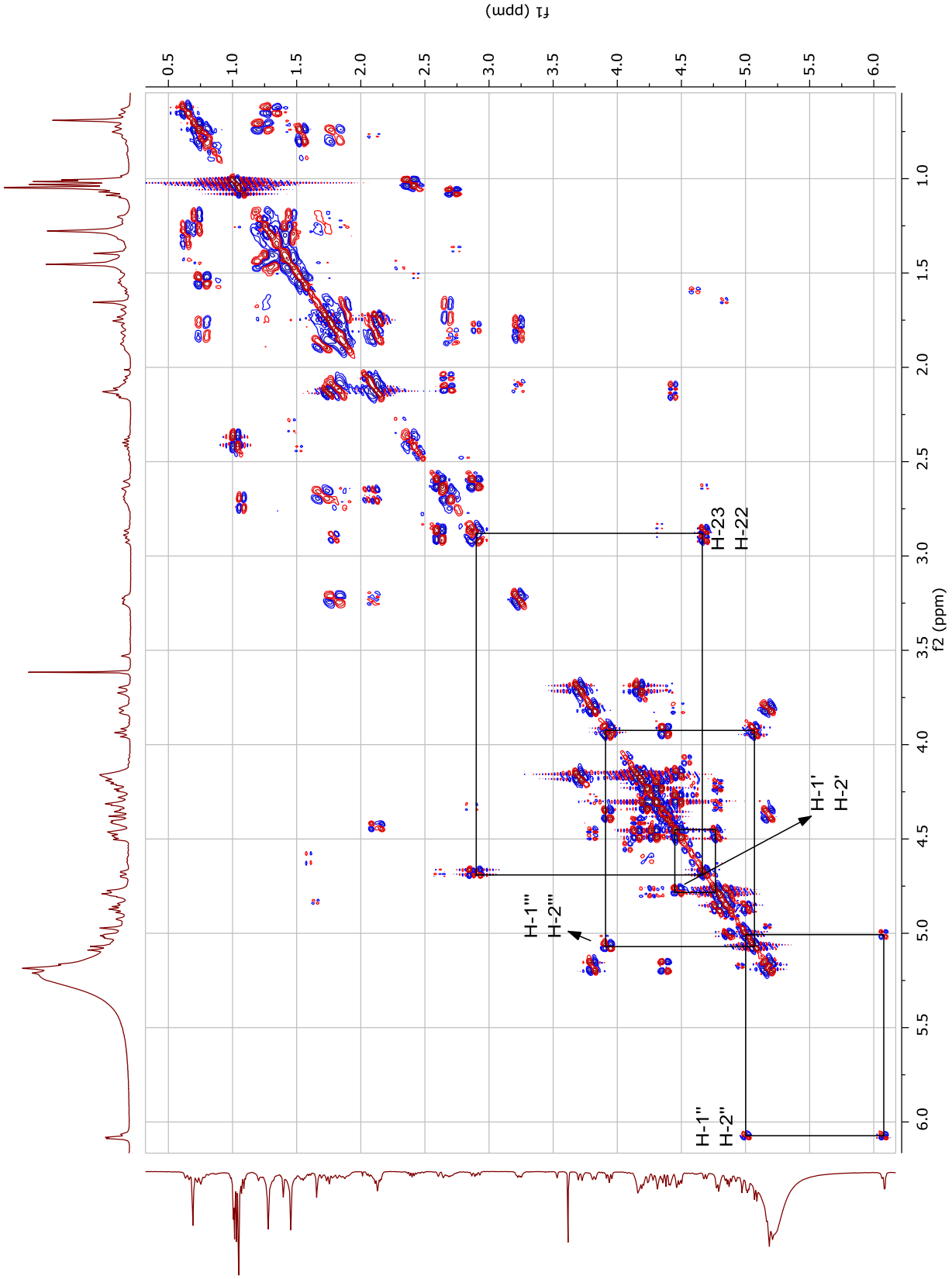


Figura 251. Espectro de COSY de **Zg16** (400 MHz, C_5D_5N).

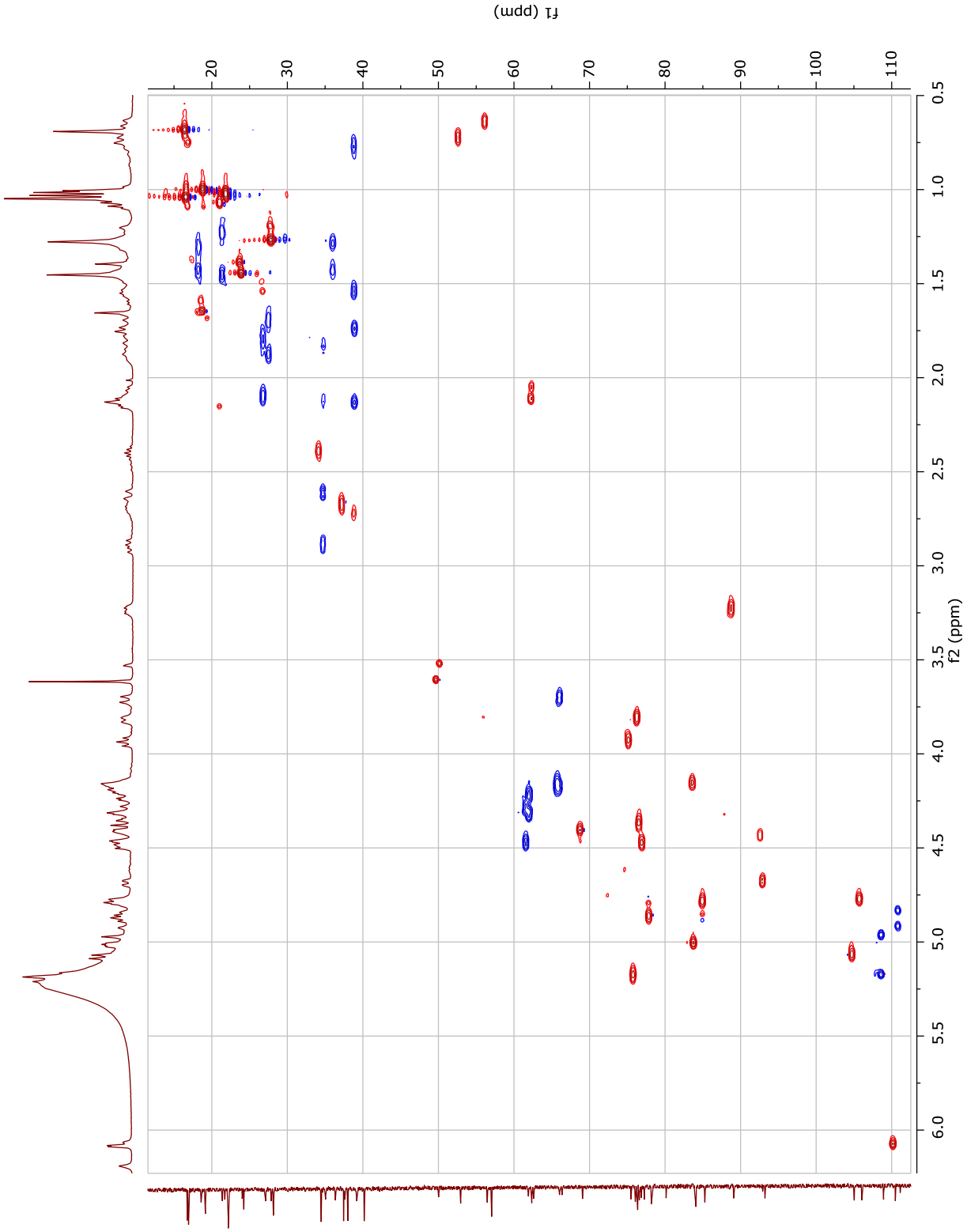


Figura 252. Espectro de HSQC de **Zg16** (400 MHz, C_5D_5N).

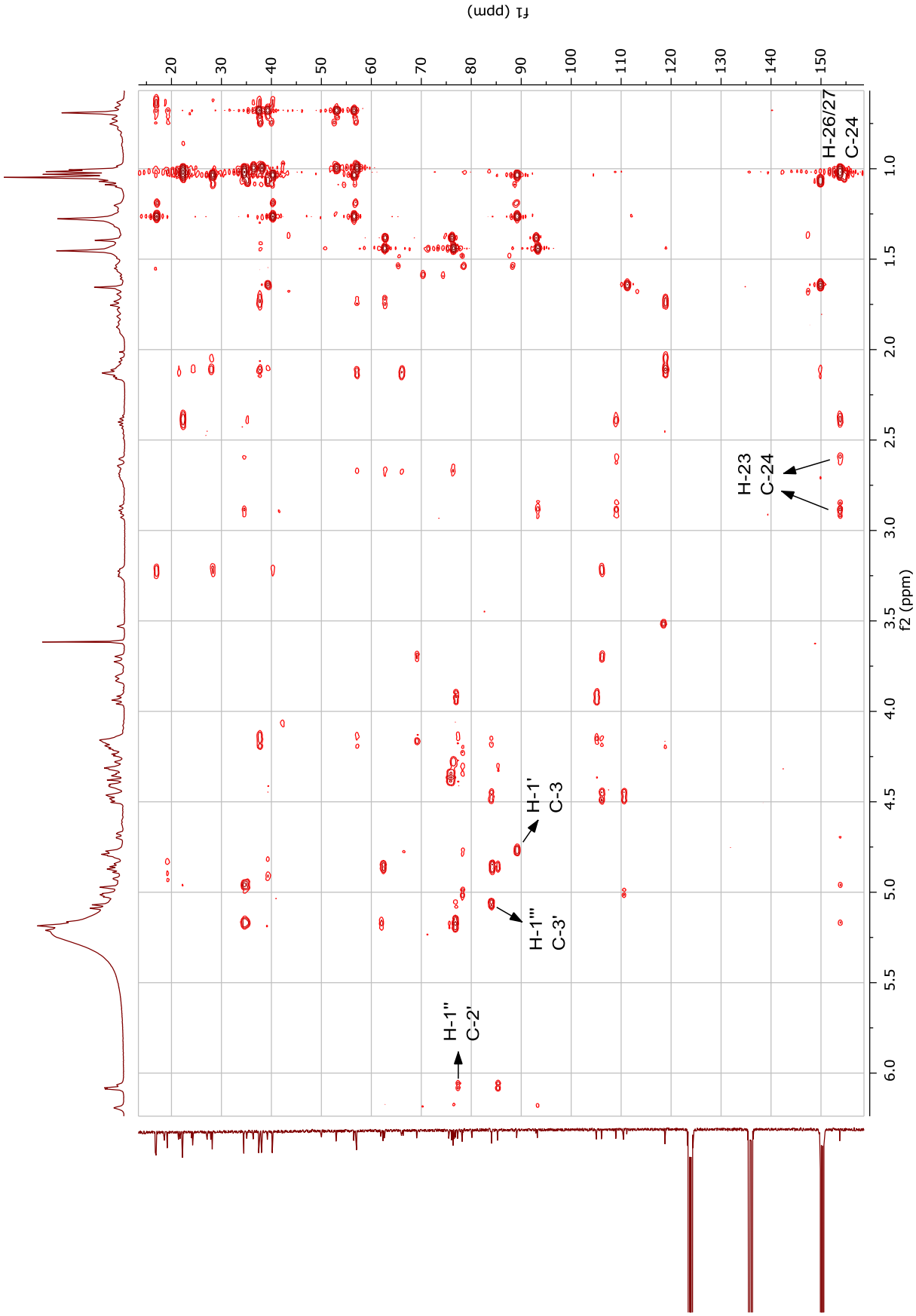


Figura 253. Espectro de HMBC de **Zg16** (400 MHz, C_5D_5N).

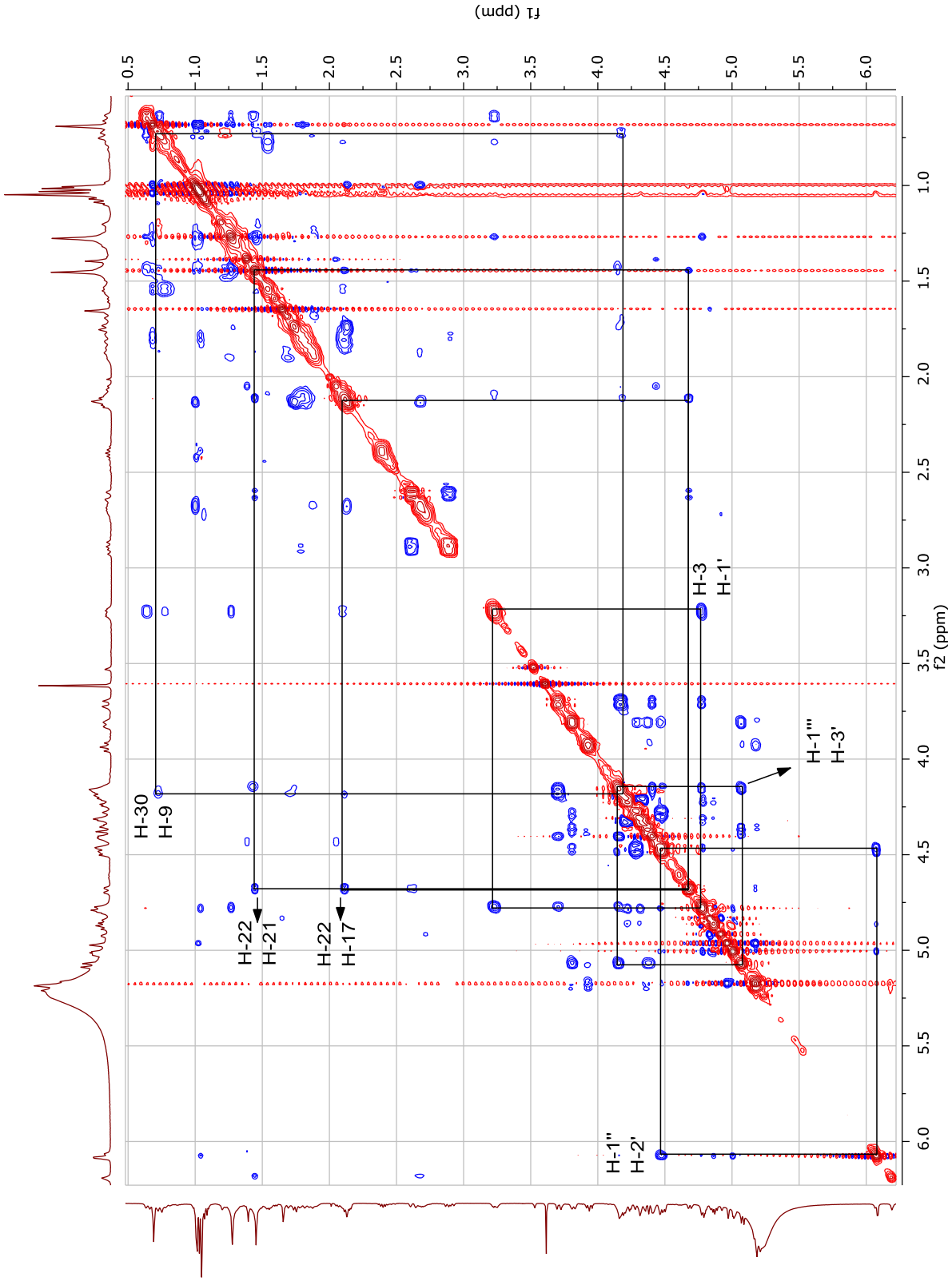


Figura 254. Espectro de ROESY de **Zg16** (400 MHz, C_5D_5N).

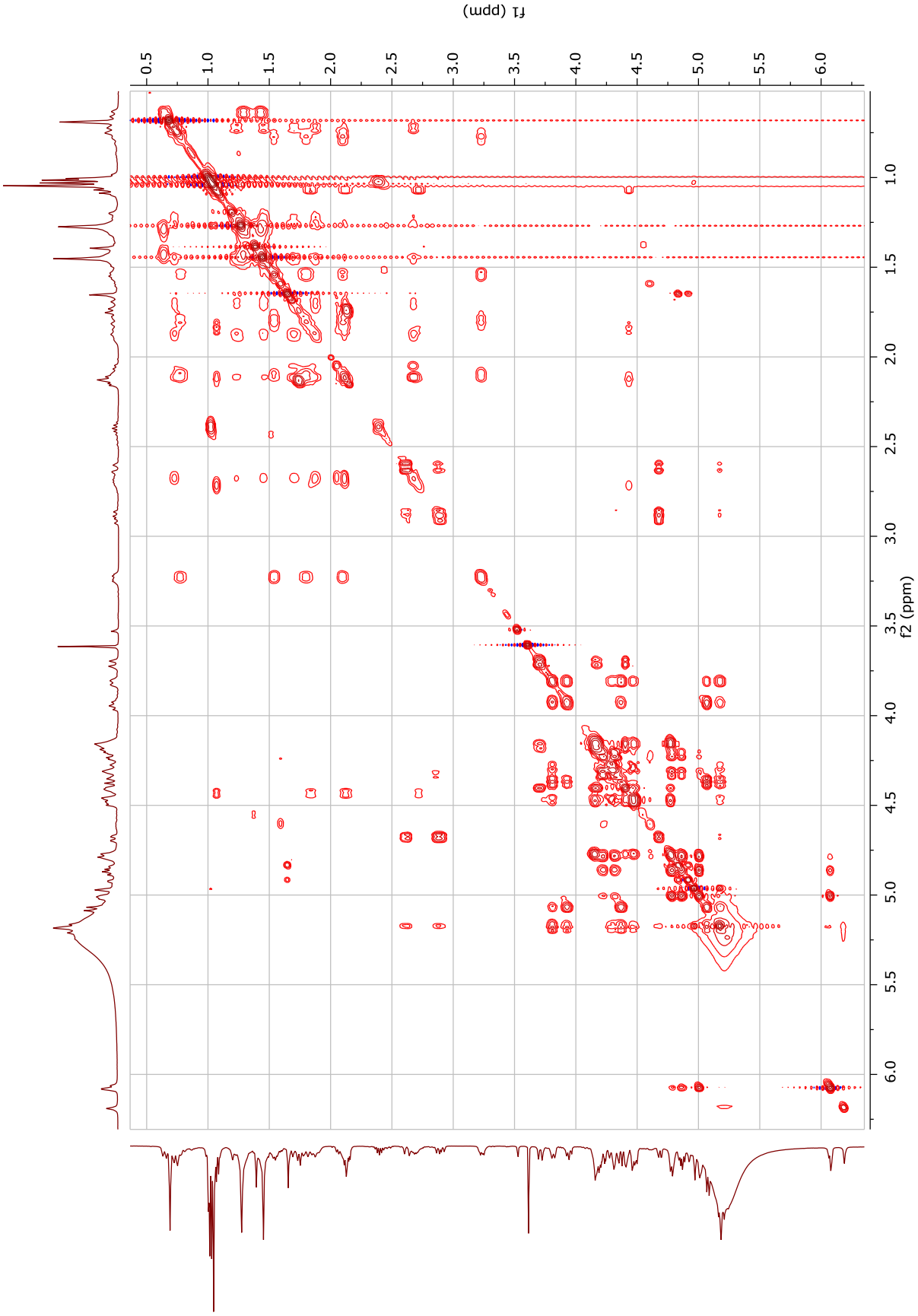


Figura 255. Espectro de TOCSY (2D) de **Zg16** (400 MHz, C_5D_5N).

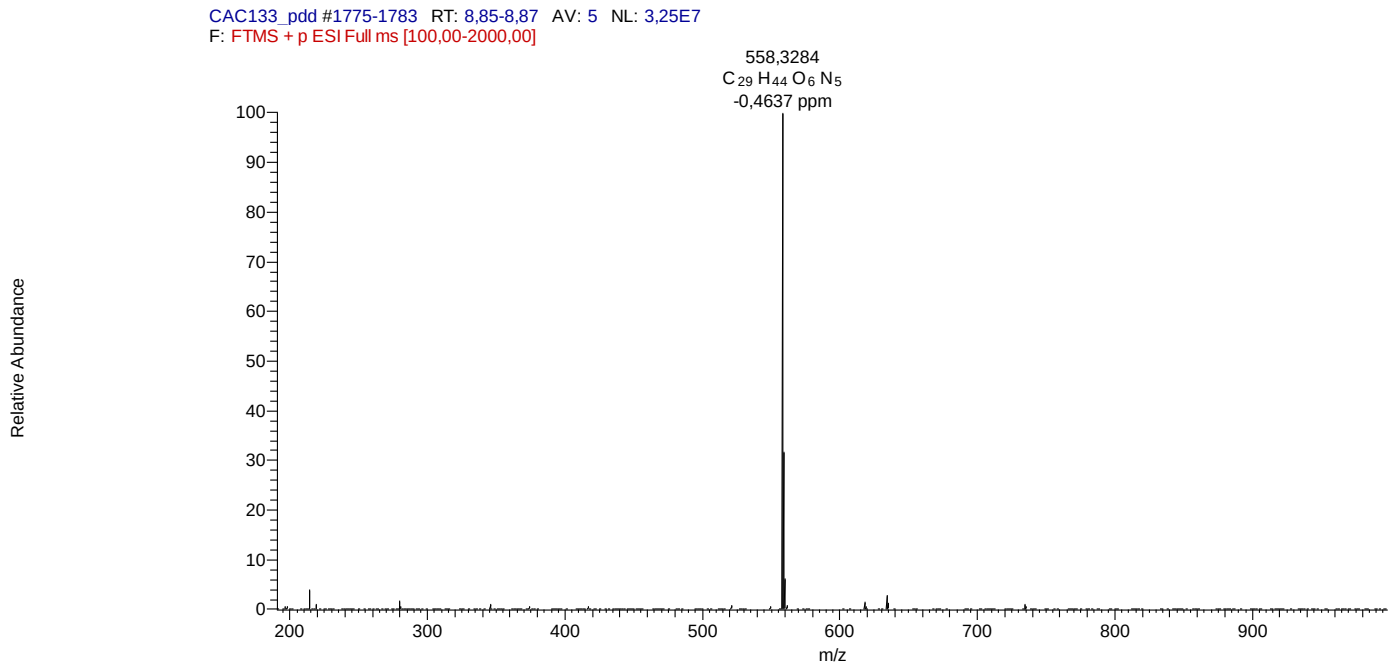


Figura 256. Espectro de massas de alta resolução (ESI) do pico em 8,86 min de **ZjC-AlcF** (modo positivo).

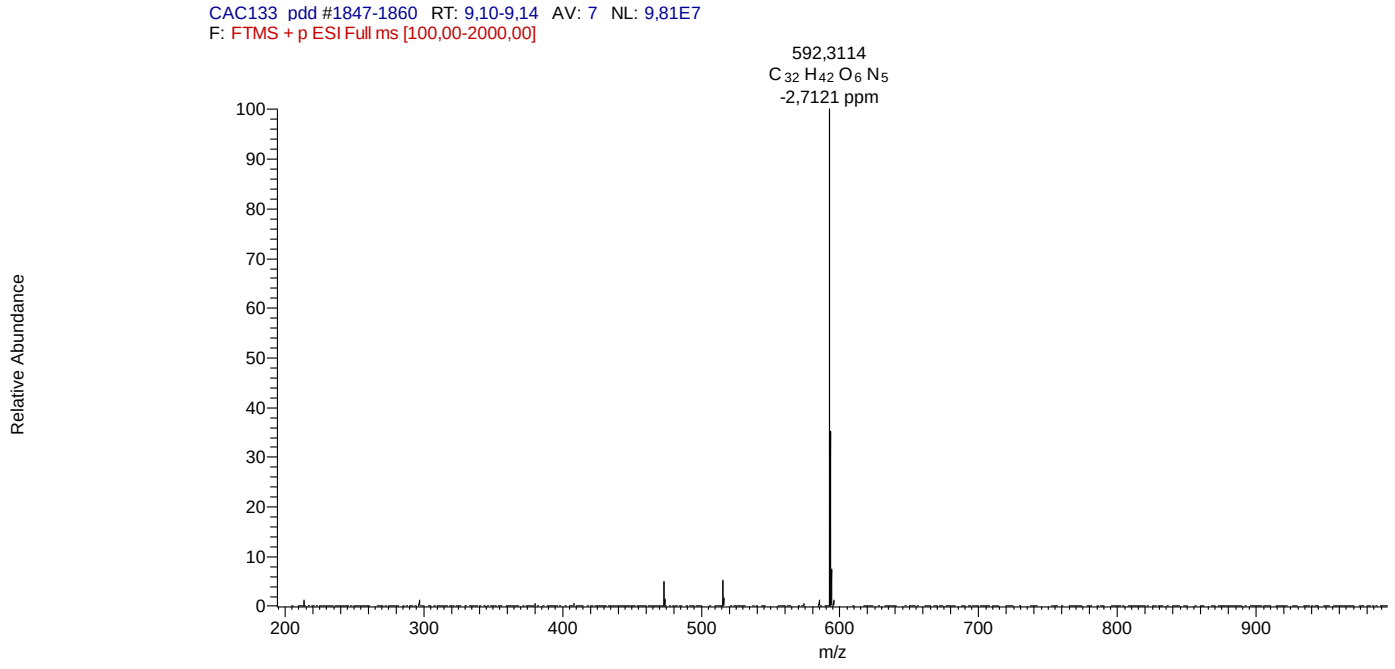


Figura 257. Espectro de massas de alta resolução (ESI) do pico em 9,13 min de **ZjC-AlcF** (modo positivo).

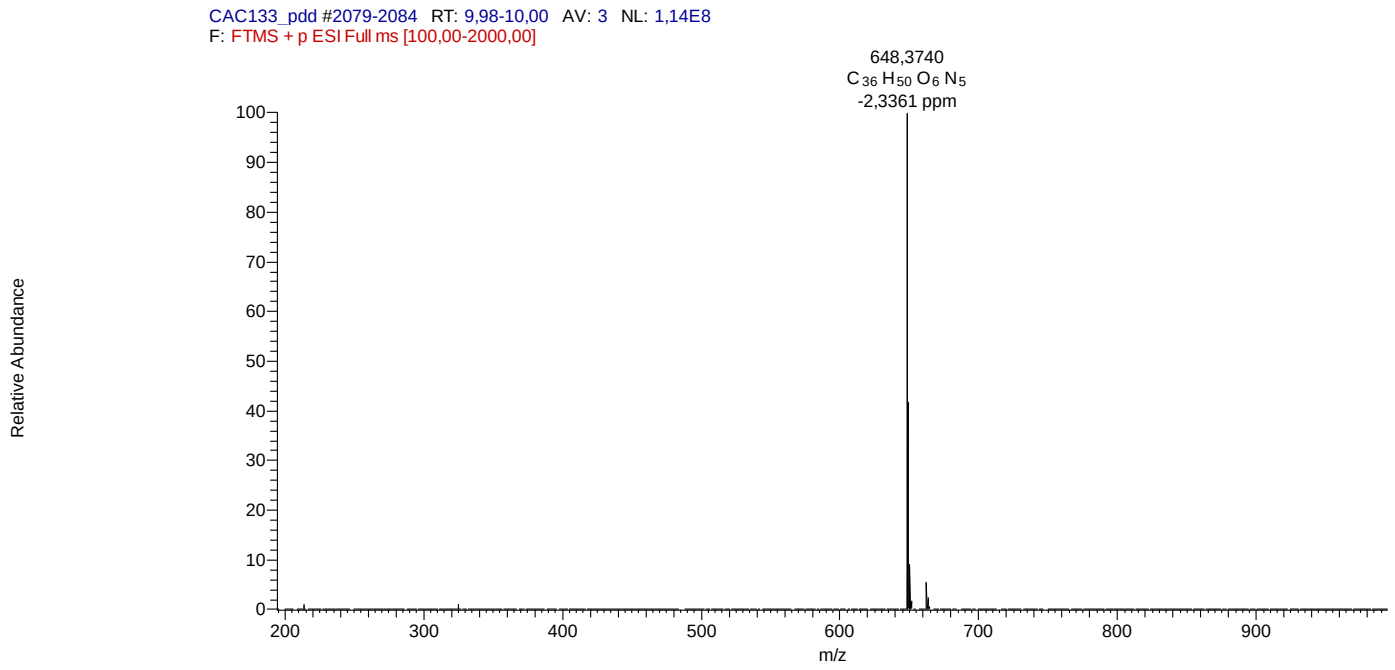


Figura 258. Espectro de massas de alta resolução (ESI) do pico em 10,00 min de **ZjC-AlcF** (modo positivo).

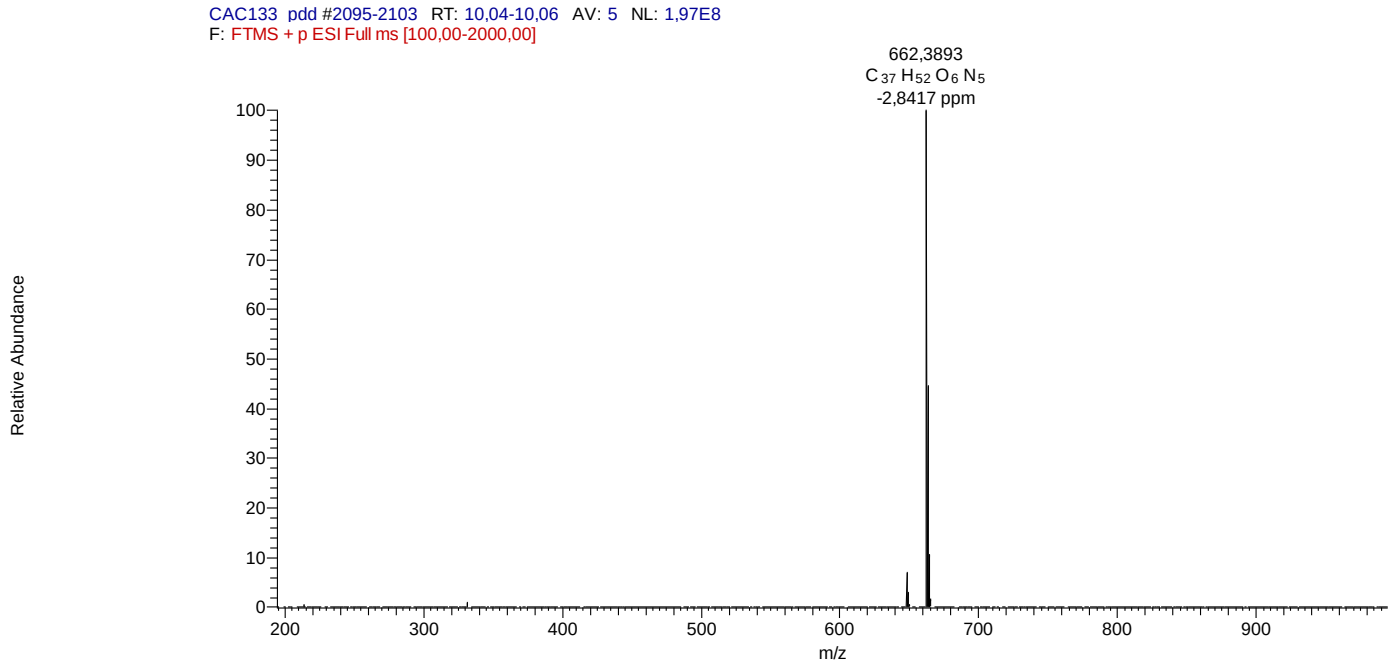


Figura 259. Espectro de massas de alta resolução (ESI) do pico em 10,06 min de **ZjC-AlcF** (modo positivo).

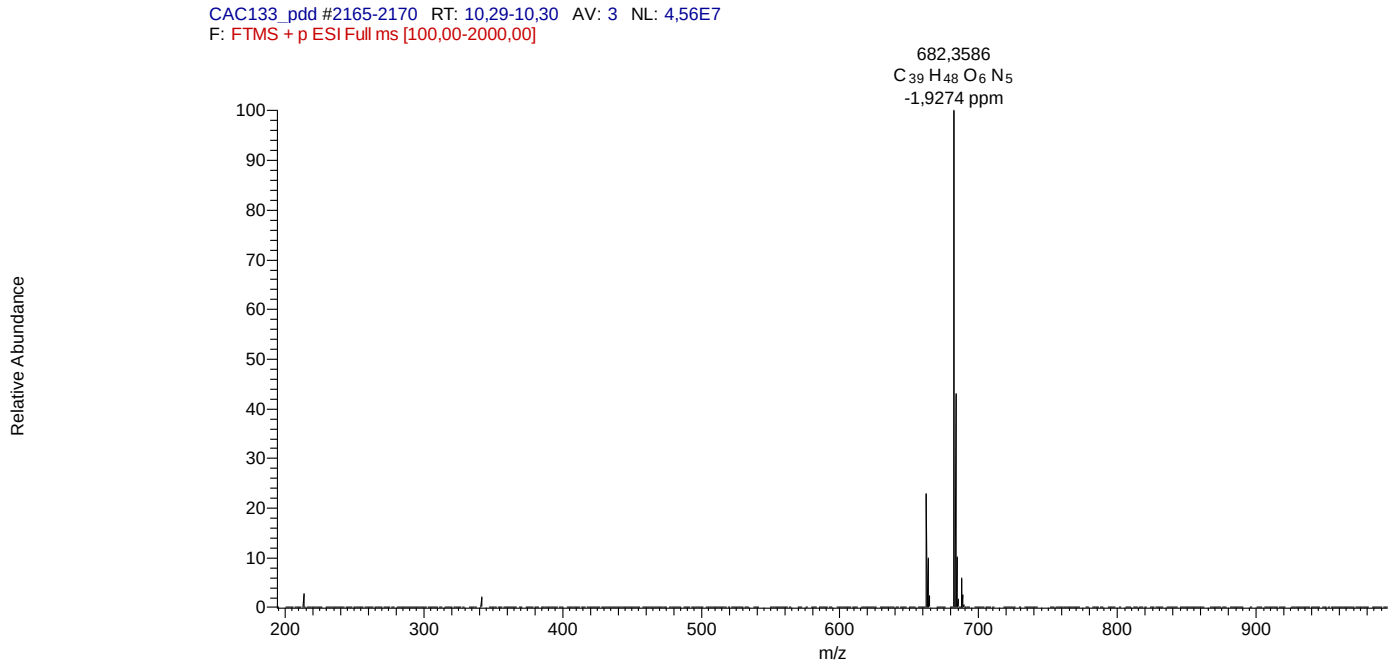


Figura 260. Espectro de massas de alta resolução (ESI) do pico em 10,30 min de **ZjC-AlcF** (modo positivo).

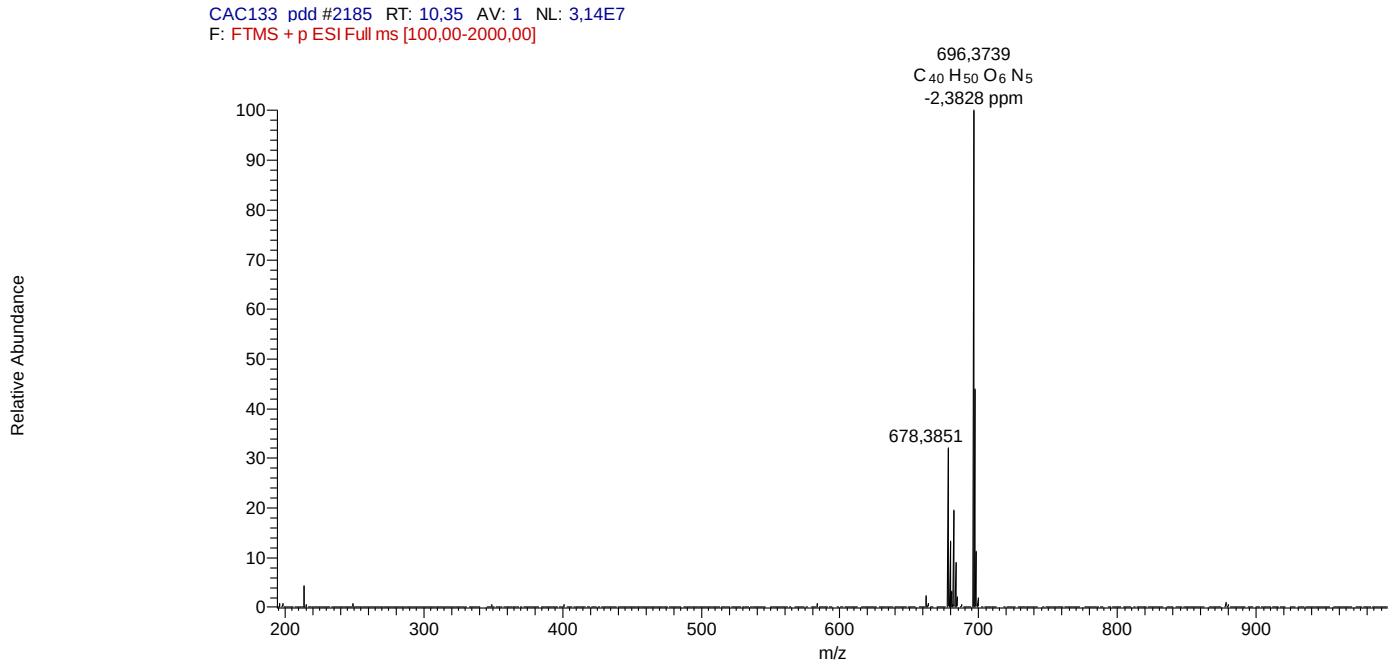


Figura 261. Espectro de massas de alta resolução (ESI) do pico em 10,37 min de **ZjC-AlcF** (modo positivo).

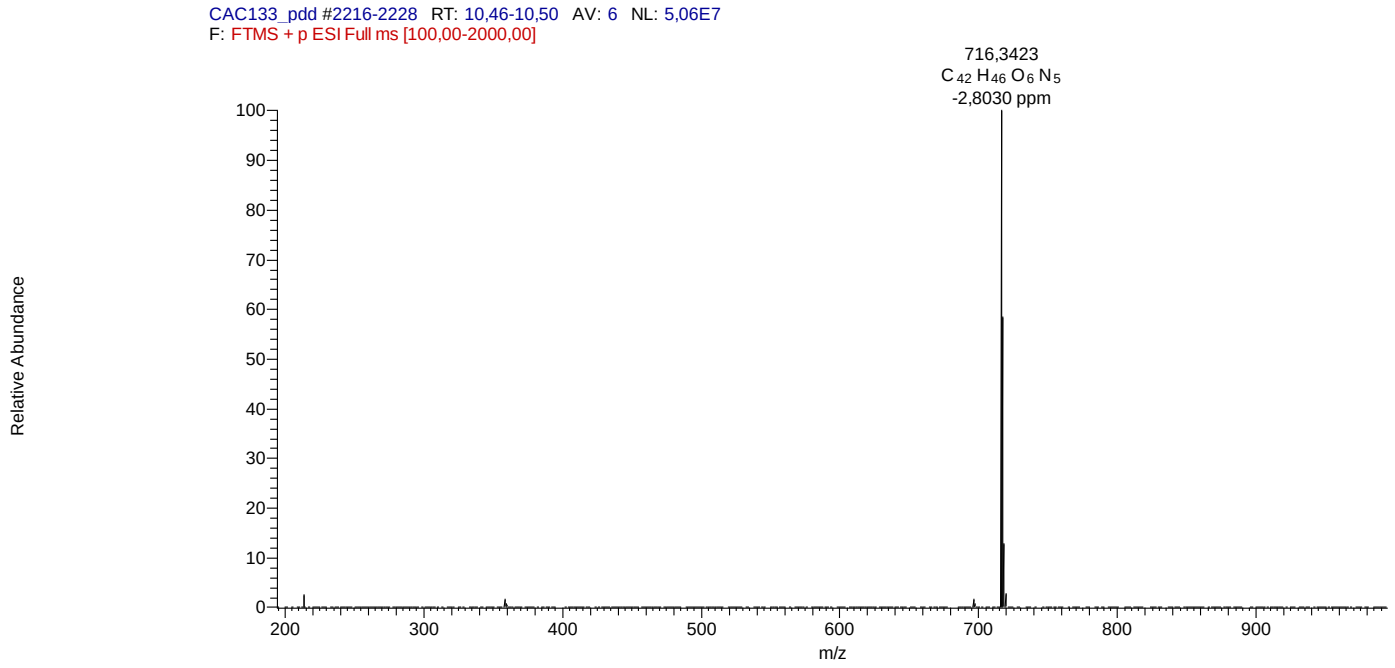


Figura 262. Espectro de massas de alta resolução (ESI) do pico em 10,48 min de **ZjC-AlcF** (modo positivo).

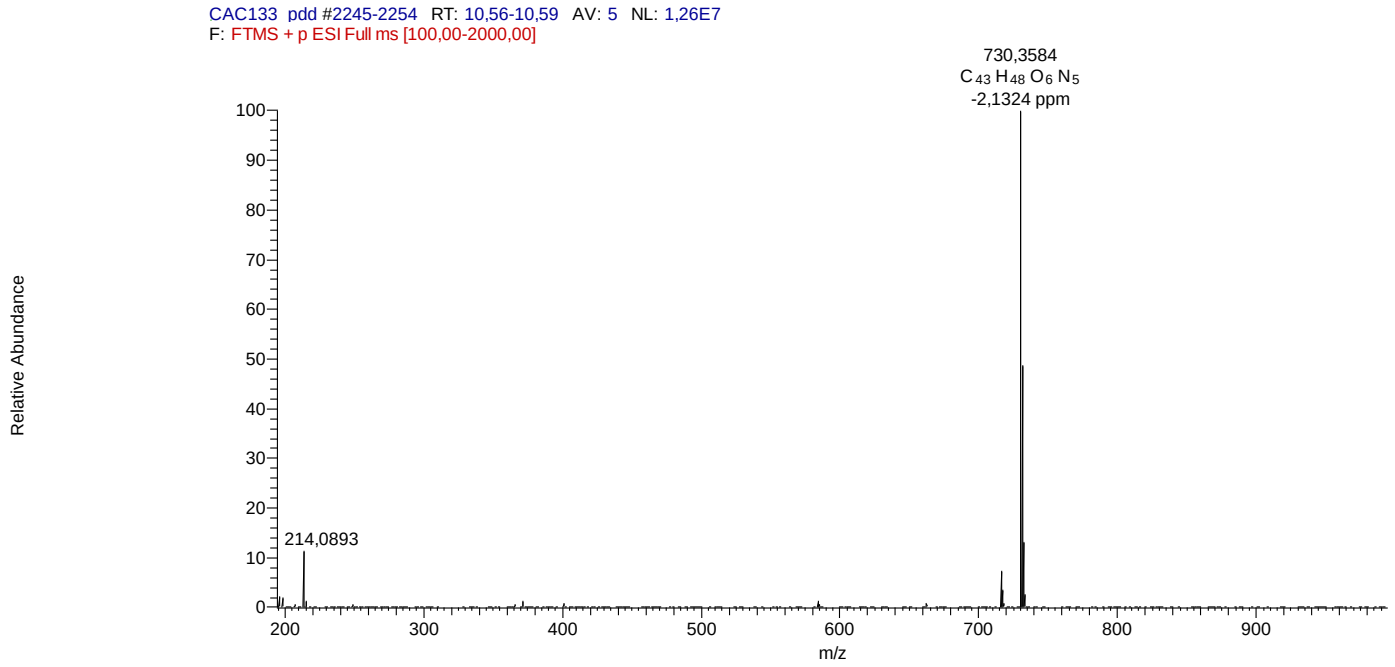


Figura 263. Espectro de massas de alta resolução (ESI) do pico em 10,57 min de **ZjC-AlcF** (modo positivo).

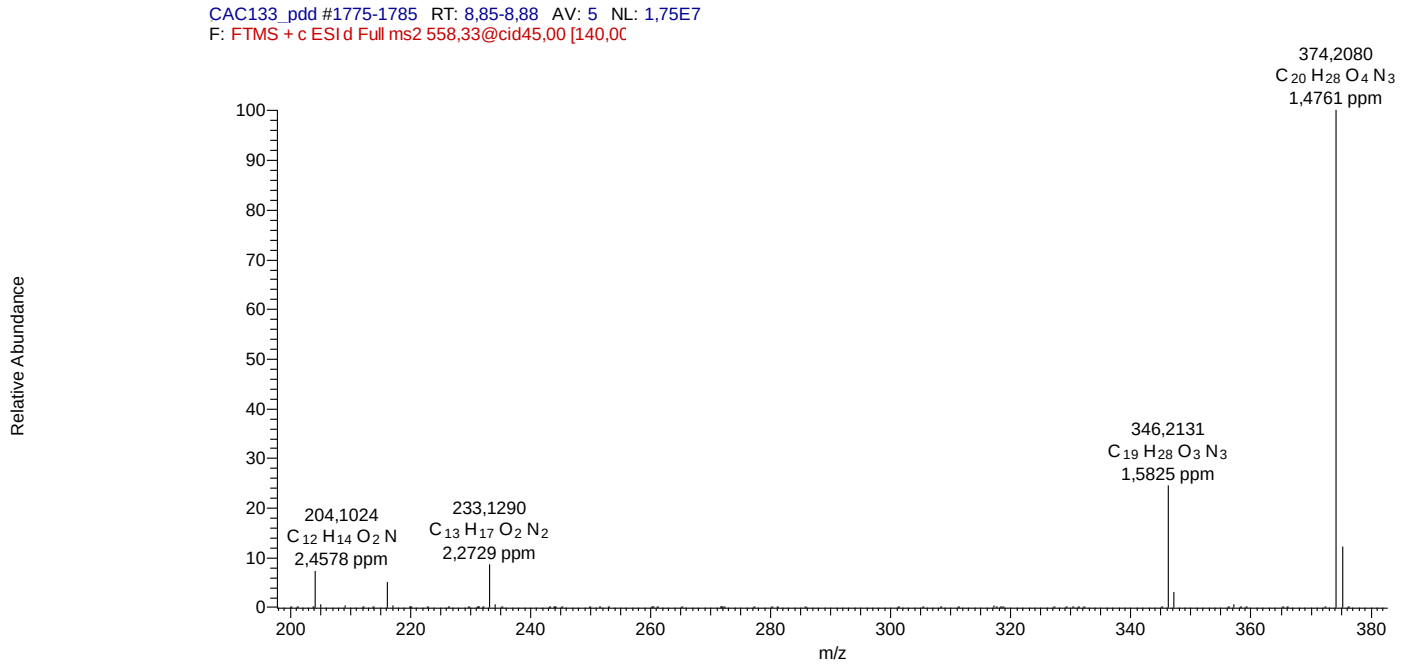


Figura 264. Espectro de massas sequencial (EM^2) de ZjC-ACP1.

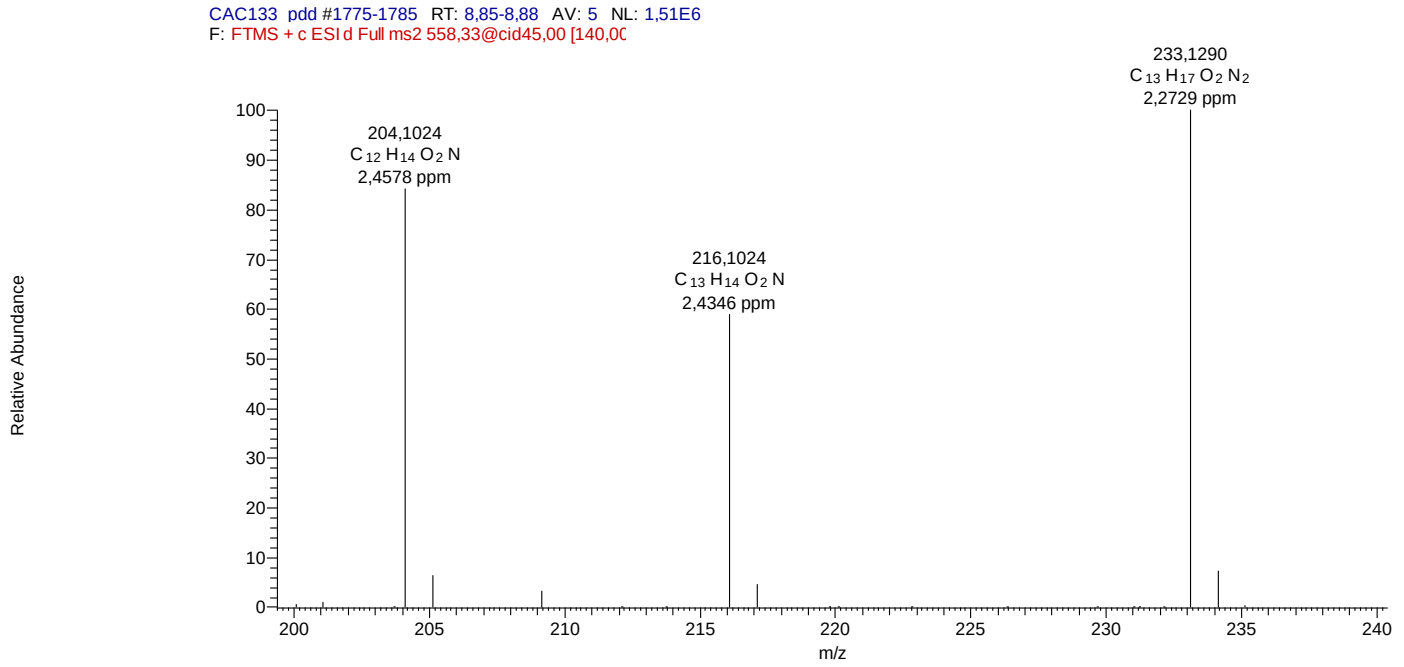


Figura 265. Espectro de massas sequencial (EM^2) de **ZjC-ACP1** (ampliação em *m/z* 200-240).

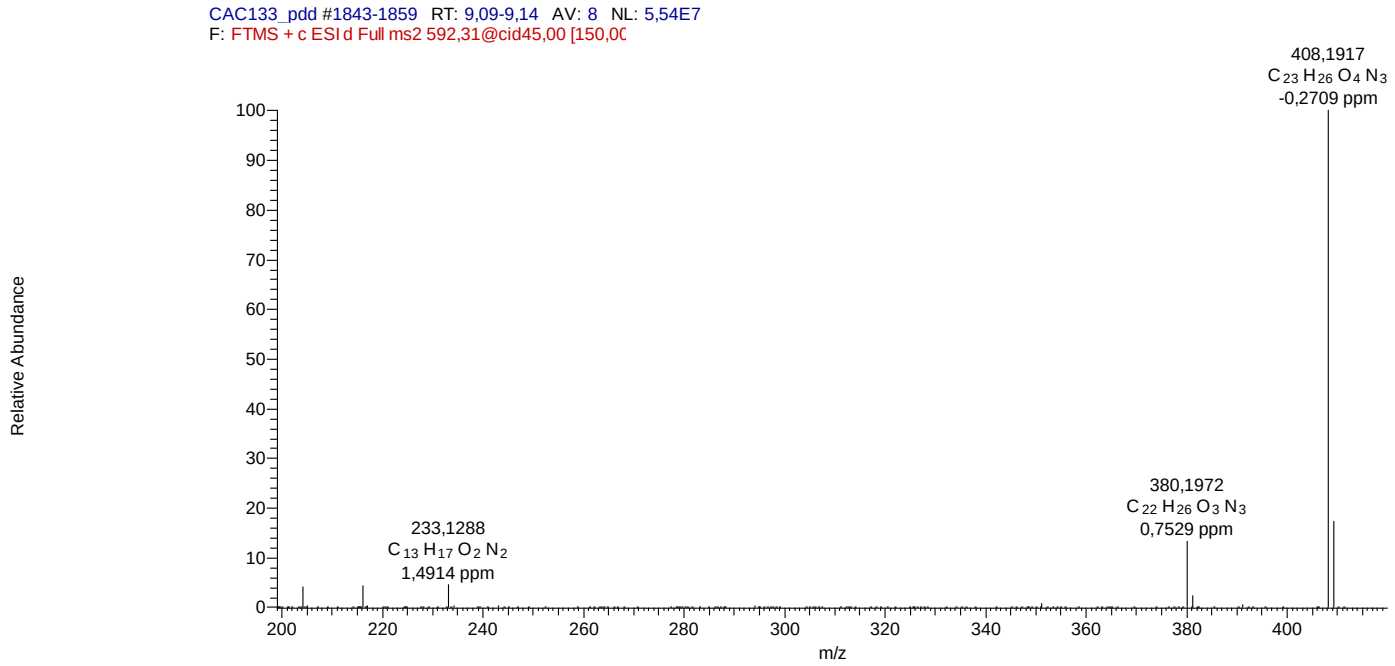


Figura 266. Espectro de massas sequencial (EM^2) de **ZjC-ACP2**.

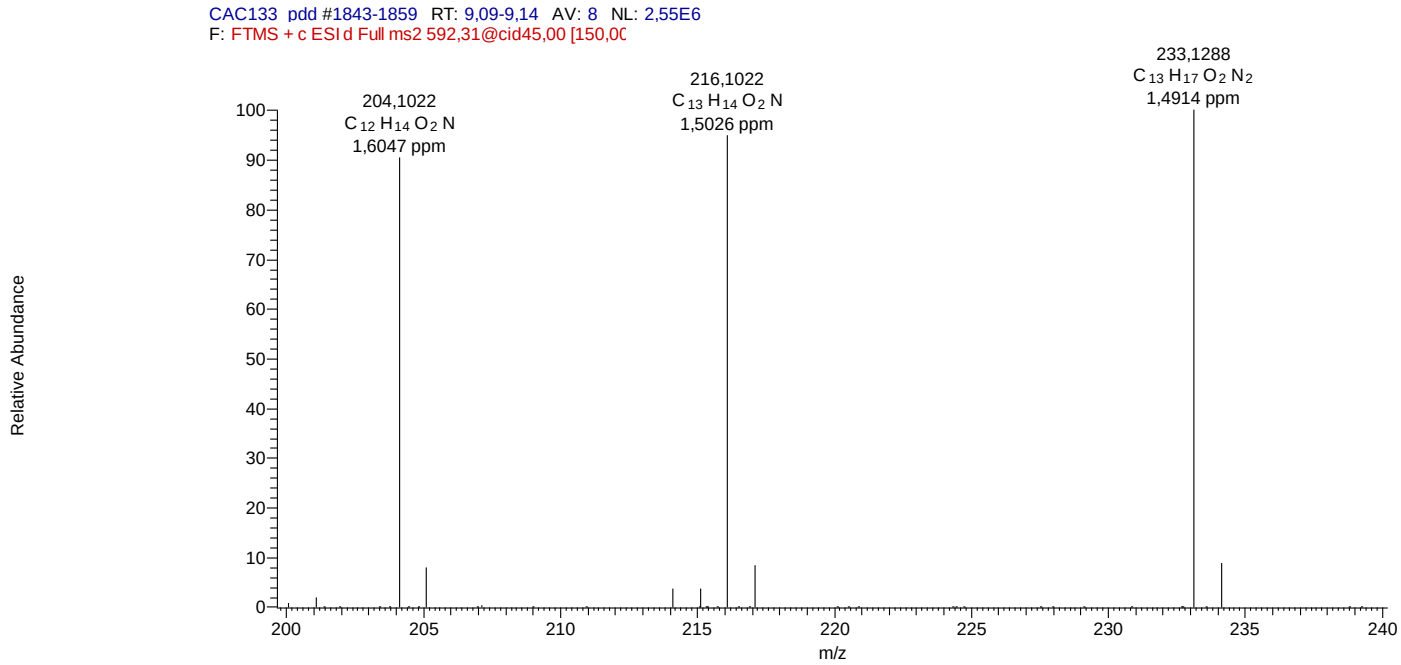


Figura 267. Espectro de massas sequencial (EM^2) de **ZjC-ACP2** (ampliação em *m/z* 200-240).

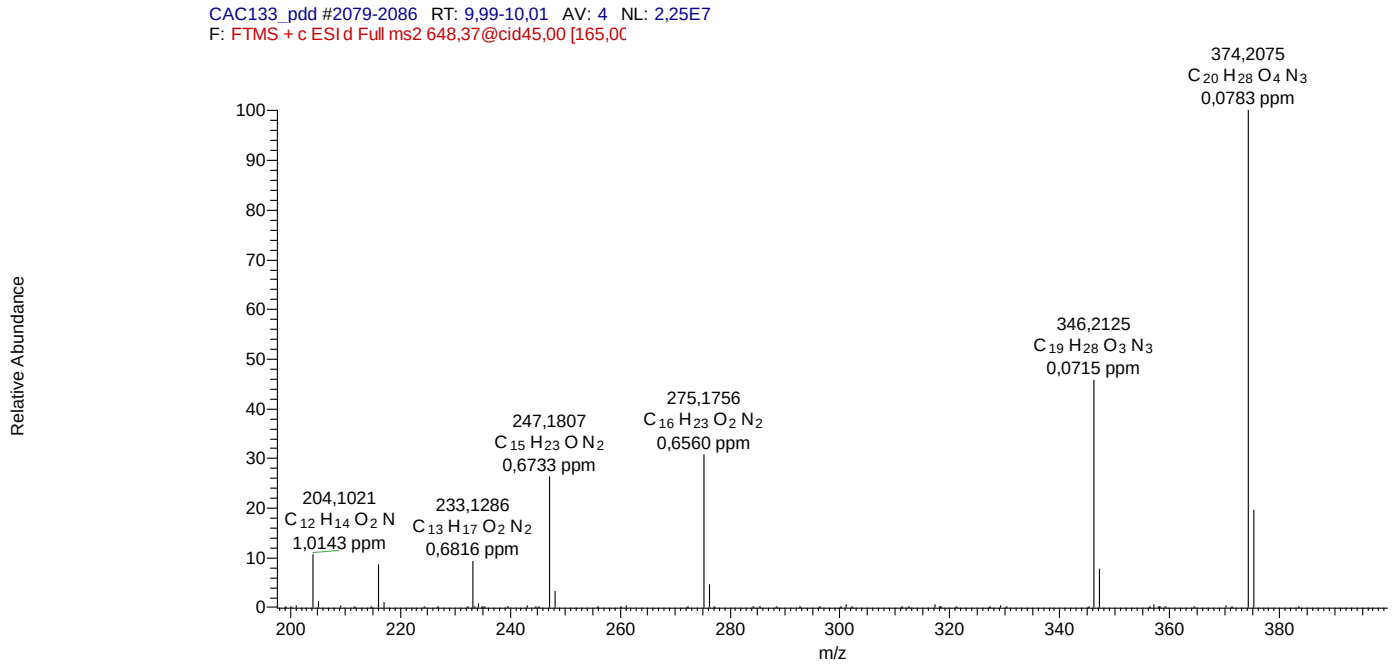


Figura 268. Espectro de massas sequencial (EM^2) de **ZjC-ACP3**.

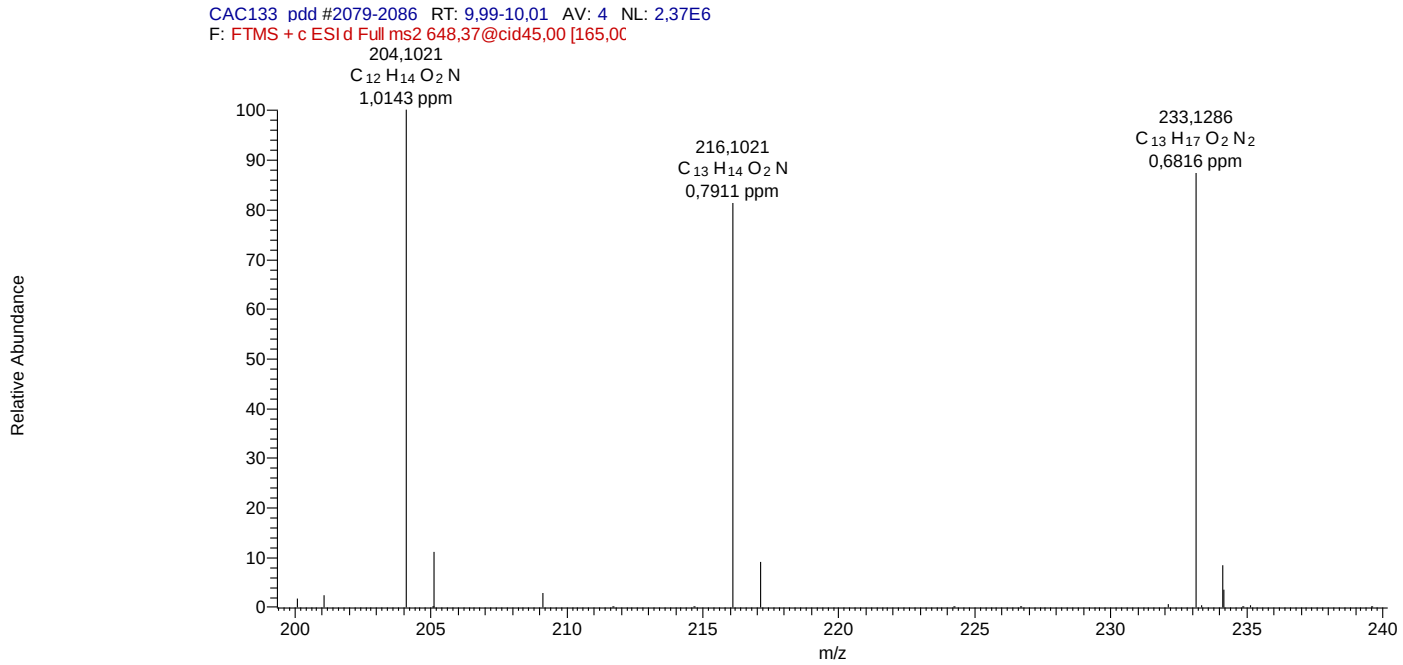


Figura 269. Espectro de massas sequencial (EM^2) de **ZjC-ACP3** (ampliação em *m/z* 200-240).

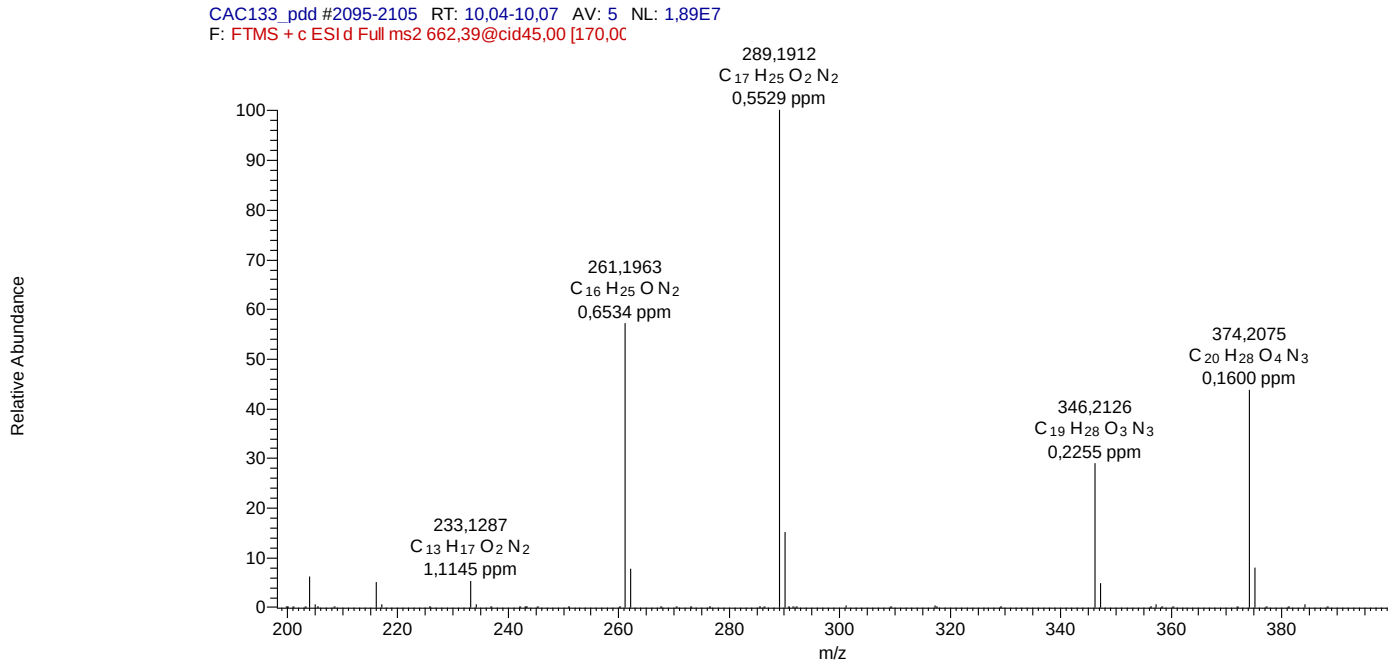


Figura 270. Espectro de massas sequencial (EM^2) de **ZjC-ACP4**.

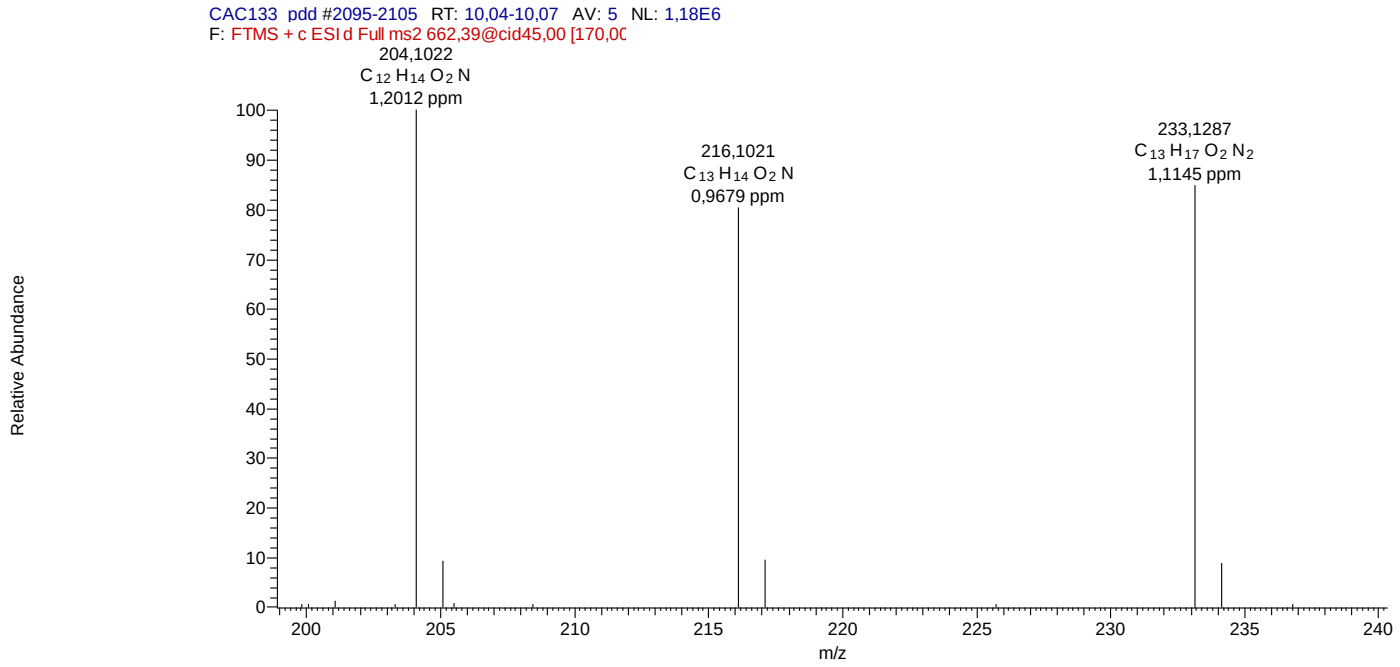


Figura 271. Espectro de massas sequencial (EM^2) de **ZjC-ACP4** (ampliação em *m/z* 200-240).

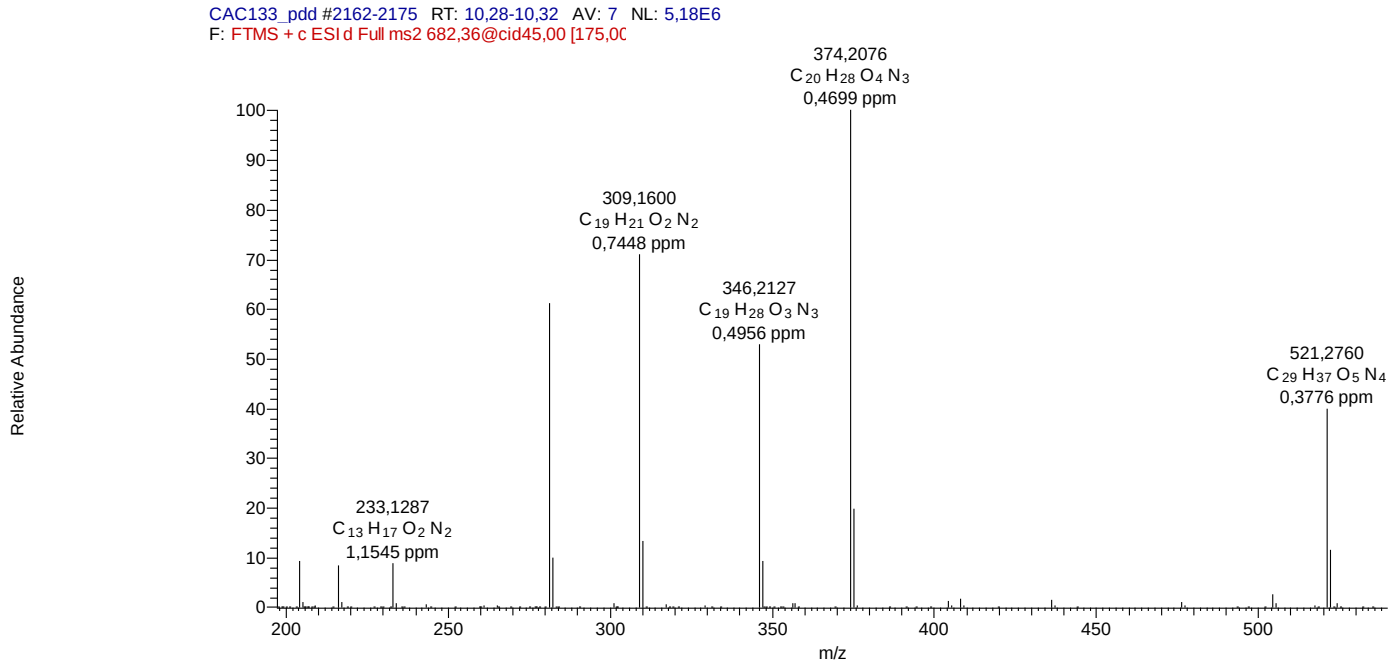


Figura 272. Espectro de massas sequencial (EM^2) de **ZjC-ACP5**.

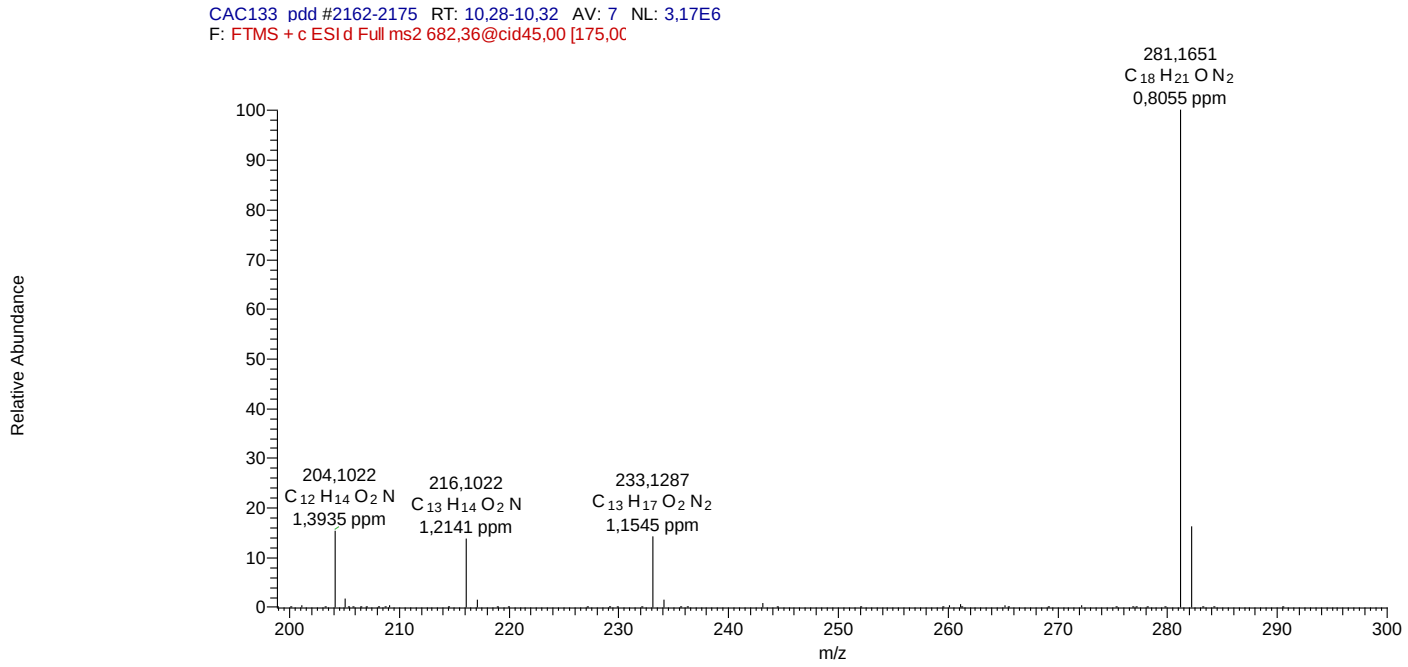


Figura 273. Espectro de massas sequencial (EM^2) de **ZjC-ACP5** (ampliação em *m/z* 200-300).

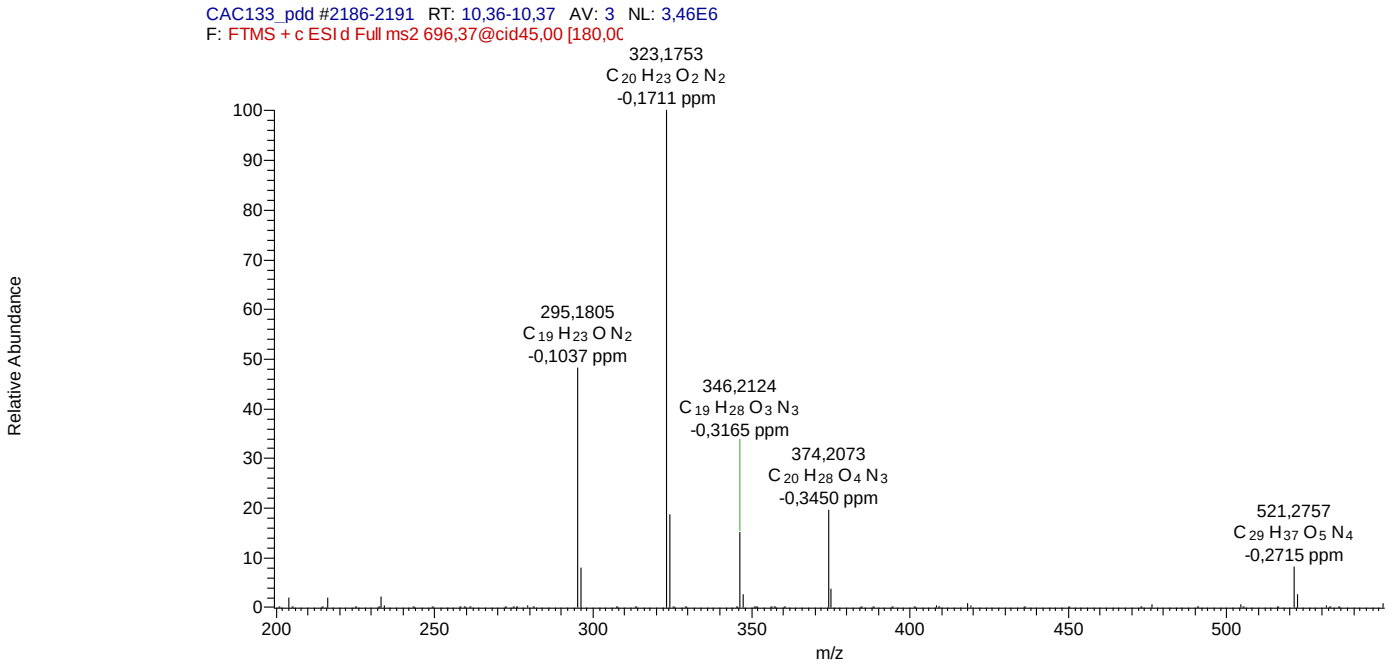


Figura 274. Espectro de massas sequencial (EM^2) de **ZjC-ACP6**.

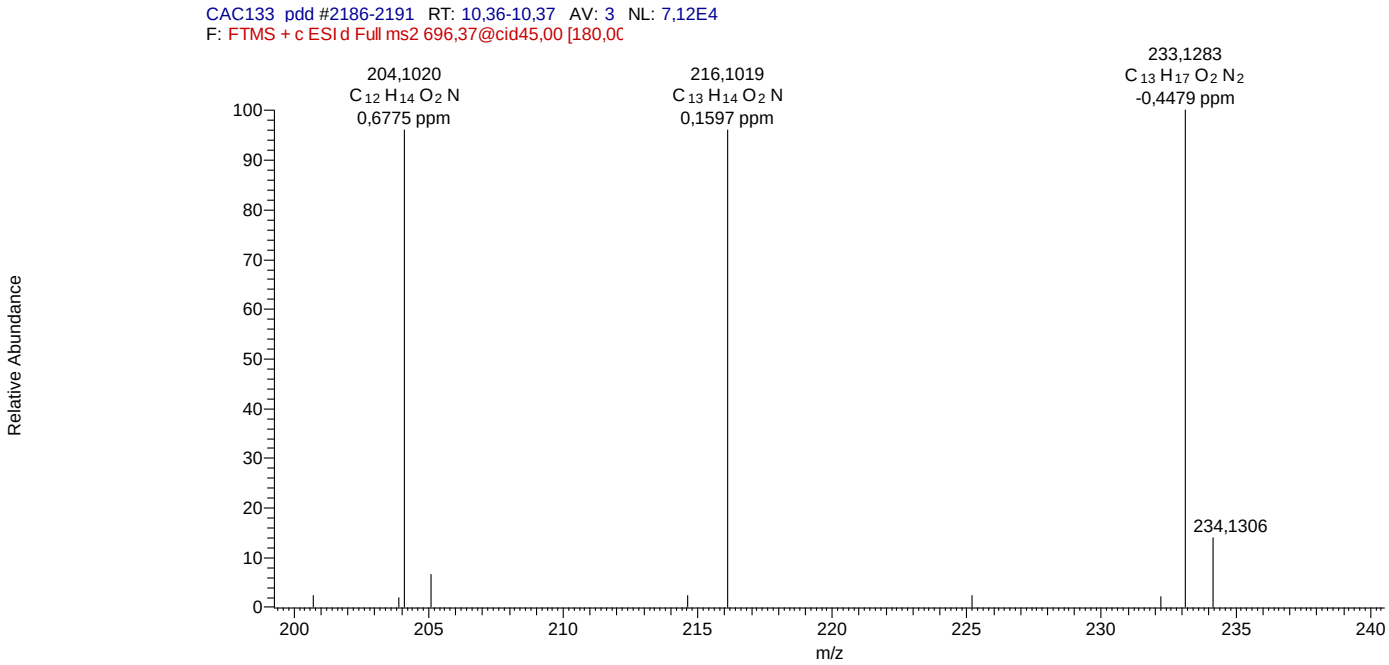


Figura 275. Espectro de massas sequencial (EM^2) de **ZjC-ACP6** (ampliação em *m/z* 200-240).

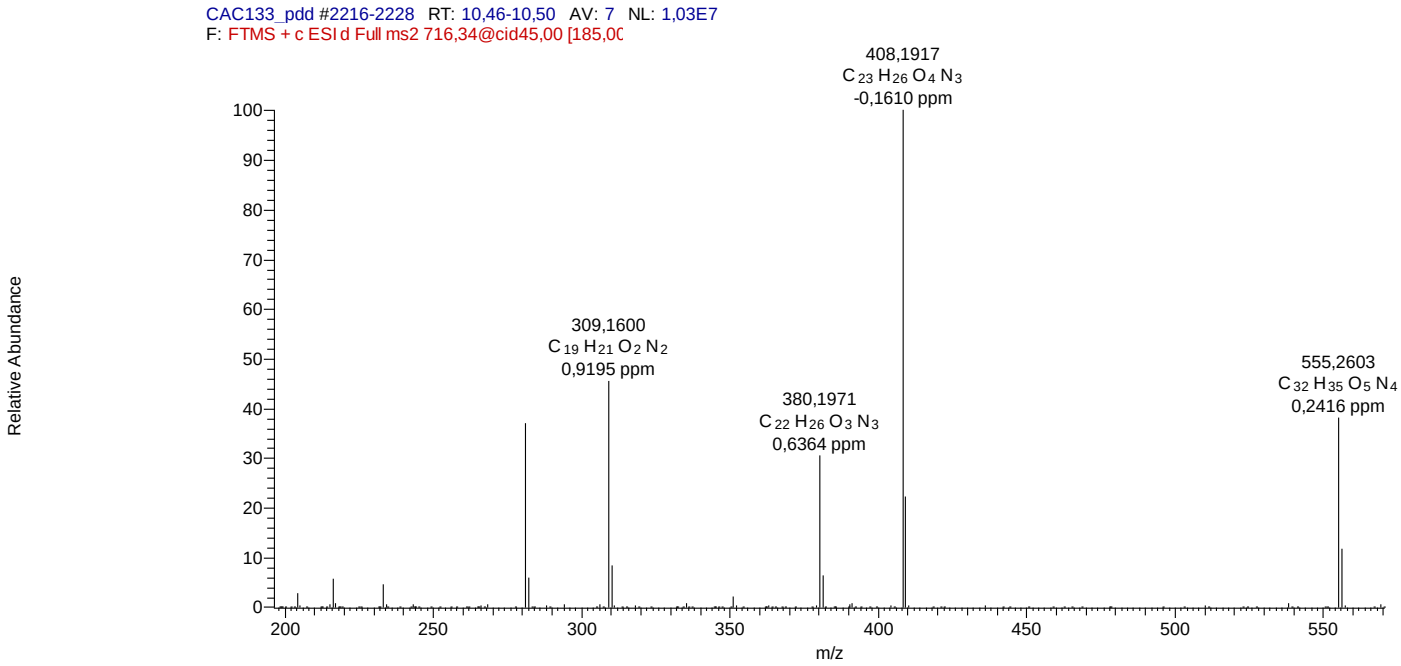


Figura 276. Espectro de massas sequencial (EM^2) de **ZjC-ACP7**.

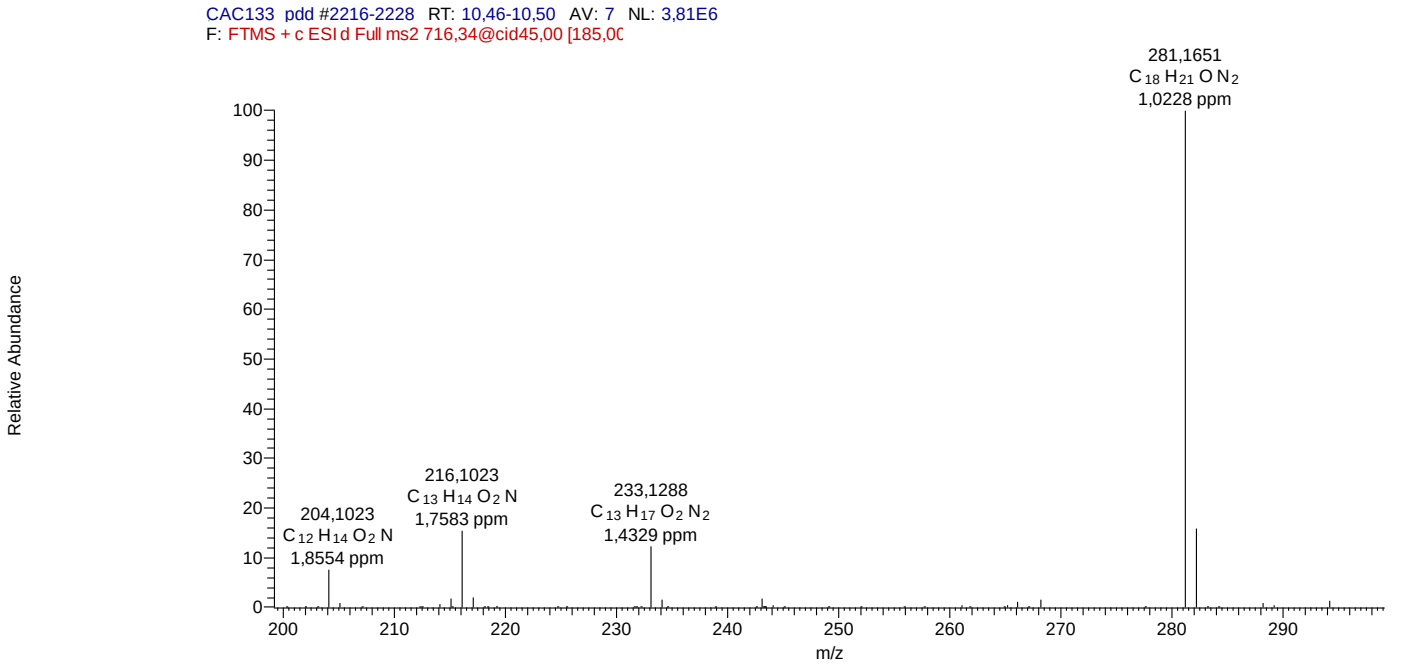


Figura 277. Espectro de massas sequencial (EM^2) de **ZjC-ACP7** (ampliação em *m/z* 200-300).

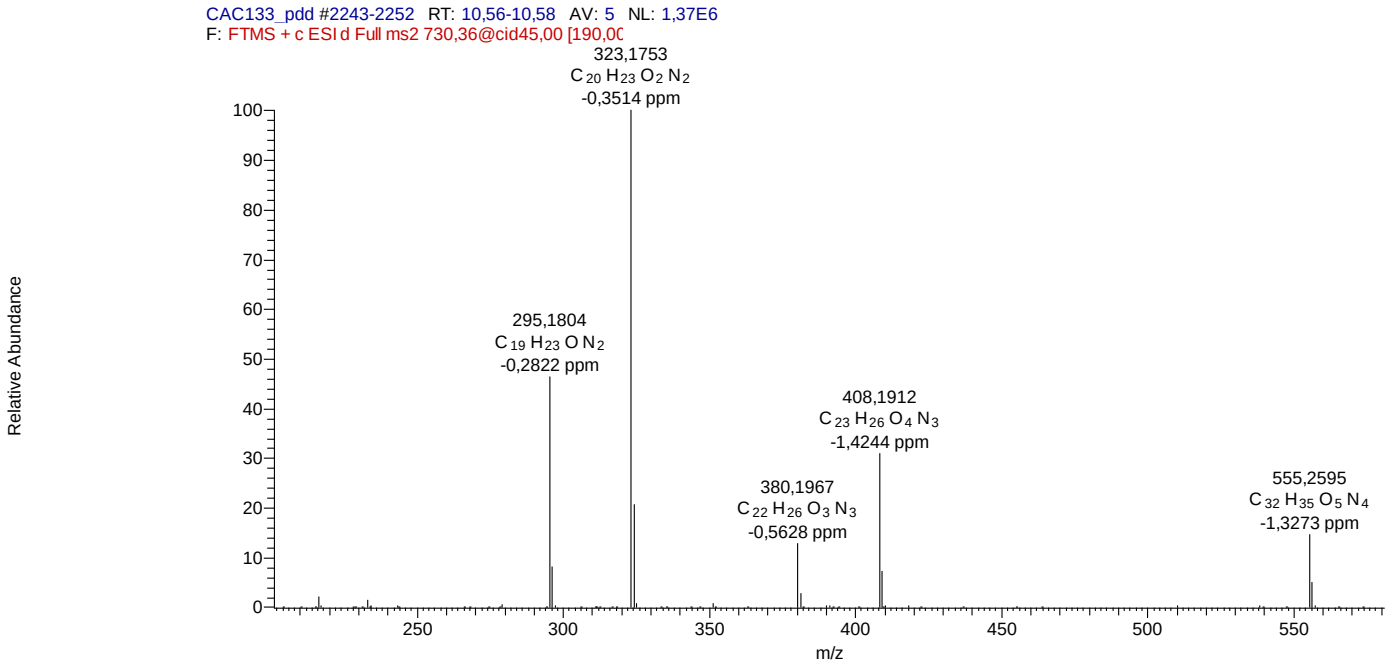


Figura 278. Espectro de massas sequencial (EM^2) de **ZjC-ACP8**.

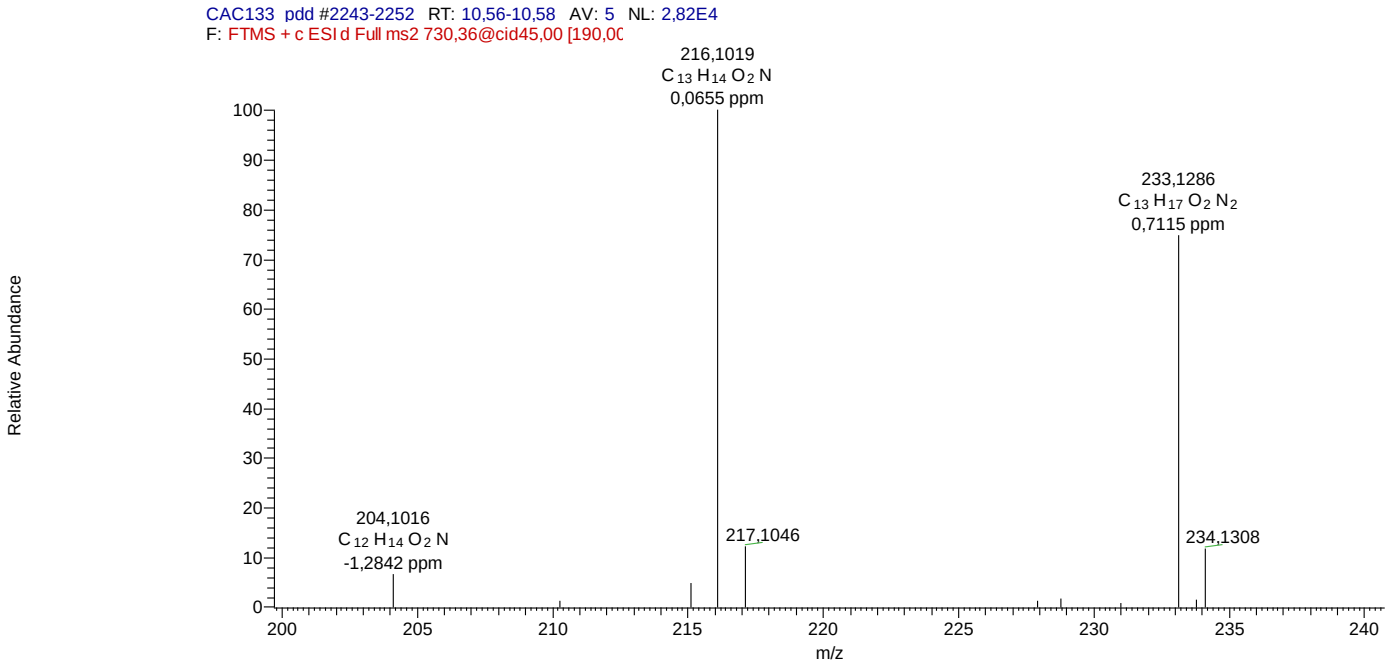


Figura 279. Espectro de massas sequencial (EM^2) de **ZjC-ACP8** (ampliação em *m/z* 200-240).