Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Information

Application of the Curtius rearrangement to the synthesis of 1'-aminoferrocene-1-carboxylic acid derivatives

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Substrates' syntheses

Dimethyl ferrocene-1,1'-dicarboxylate – SI1. Under argon, BuLi (~1.6 M in hexanes, 78.1 mL, 125 mmol, 2.5 equiv) was added to a stirred solution of ferrocene (9.3 g, 50 mmol, 1.0 equiv) and TMEDA (18.7 mL, 14.5 g, 125 mmol, 2.5 equiv) in hexane (250 mL) and the reaction was stirred overnight at room temperature to give a deep red suspension. THF (100 mL) was added and the reaction mixture was cooled to -78 °C. Carbon dioxide was bubbled in the reaction mixture for 15 min and the reaction mixture was slowly warmed to room temperature upon bubbling. EtOAc (150 mL) was added and the organic phase was extracted with NaOH (10%, 3 x 100 mL). The combined aqueous layers were washed with EtOAc (2 x 100 mL) and acidified with HCl (12 M) until pH 1 was reached. The resulting solids were filtrated, washed with H_2O and dried under high vacuum over P_2O_5 to give crude ferrocene-1,1'-dicarboxylic acid. the title product as an orange solid containing 3-5% of ferrocenecarboxylic acid.

The crude product was dissolved in MeOH (150 mL), H_2SO_4 (96%, 1.0 mL) was added dropwise and the reaction mixture was heated at methanol reflux overnight. The reaction mixture was cooled to room temperature and volatiles were removed under vacuum. EtOAc (100 mL) and $NaHCO_3$ (sat., 100 mL) were added and the layers were separated. The aqueous layer was further extracted with EtOAc (2 x 100 mL). The combined organic layers were dried over $MgSO_4$, filtrated and concentrated under vacuum to give the crude product. This was purified by column chromatography on silica, eluting with EtOAc/heptane (80:20 to 70:30) to give ferrocene-1,1'-dimethylcarboxylate **SI1** (16.6 g, 70.5%) and methyl ferrocene carboxylate **SI2** (337.0 mg, 3%) as orange solids.

Dimethyl ferrocene-1,1'-dicarboxylate (**SI1**): mp 112-114 °C (lit.[1] 113.5-114.5 °C); IR (ATR): 3087, 2958, 1698, 1468, 1434, 1373, 1278, 1196, 1143, 1029, 964, 779 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 4.78 (t, *J* = 2.0 Hz, 4H, 4 x FcCH), 4.36 (t, *J* = 2.0 Hz, 4H, 4 x FcCH) 3.78 (s, 6H, 2 x CH_3); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 170.9 (2 x C=O), 73.1 (2 x FcC), 72.8 (4 x FcCH), 71.7 (4 x FcCH), 51.8 (2 x CH_3). **Methyl ferrocene carboxylate** (**SI2**): mp 57-58 °C (lit.[2] 50-56 °C); IR (ATR): 2954, 1709, 1699, 1463, 1373, 1276, 1189, 1136, 1105, 1025, 961, 823 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) δ 4.78 (t, *J* = 1.7 Hz, 2H, 2 x FcCH), 4.37 (t, *J* = 1.7 Hz, 2H, 2 x FcCH), 4.18 (s, 5H, 5 x FcCH), 3.78 (s, 3H, CH_3); ^{13}C NMR (125.7 MHz, $CDCl_3$) δ 172.4 (C=O), 71.4 (FcC), 71.2 (2 x FcCH), 70.3 (2 x FcCH), 69.9 (5 x FcCH), 51.7 (CH_3).

Sodium ferrocene-1,1'-dicarboxylate (**SI3**)**.** A solution of NaOH (2.17 g, 54.3 mmol, 8.2 equiv) in water (10 mL) was added to a solution of dimethyl ferrocene-1,1'-dicarboxylate (**SI1**, 2.0 g, 6.6 mmol, 1.0 equiv) in EtOH (10.0 ml) at 70 °C. After 2h at 75 °C, the reaction mixture was cooled to 0 °C and the resulting solids were filtrated, washed with cold EtOH (5 mL), Et_2O (10 mL) and dried under vacuum to give the title product as a yellow solid (2.0 g, 95%). mp > 250 °C; IR (ATR): 3087, 1556, 1477, 1380, 1190, 1067, 1026, 806, 796 cm^{-1}; ^1H NMR (300 MHz, D_2O) δ 4.75 (s, 4H, 4 x FcCH), 4.43 (s, 4H, x FcCH) ; ^{13}C NMR (75.4 MHz, D_2O) δ 179.4 (2 x C=O), 77.4 (2 x FcC), 73.1 (4 x FcCH), 71.0 (4 x FcCH).

(9*H*-Fluoren-9-yl)methanol (**SI4**)**.** A modified procedure of Chong was followed:[3] BuLi (~1.6 M in hexanes, 37.5 mL, 60.0 mmol, 1.0 equiv) was added to a solution of fluorene (10.0 g, 60.0 mmol, 1.0 equiv) in anhydrous THF (250 mL) at 0 °C over 5 min. After 3 min stirring at 0 °C, paraformaldehyde (2.0 g, 66.0 mmol, 1.1 equiv) was added in one portion. The reaction mixture was warmed to room temperature and stirred for 90 min. $NaHCO_3$ sat. (150 mL) was added and the reaction mixture was extracted with Et_2O (3 x 100 mL). The combined organic layers were dried over $MgSO_4$, filtrated and concentrated under vacuum to give the crude product. This was purified by recrystallization in hexane/EtOH (600:8) to give the title product as a white solid (3.6 g, 30.5%). mp 100-102 °C (lit.[3] 100-101 °C); IR (ATR): 3252 (br), 1444, 1363, 1314, 1048, 1024, 754, 77, 725 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 7.77 (d, J = 7.4 Hz, 2H, ArH), 7.60 (d, *J* = 7.4 Hz, 2H, 2 x ArH), 7.40 (dt, *J* = 7.4, 0.7 Hz, 2H, 2 x ArH), 7.32 (dt, *J* = 7.4, 1.1 Hz, 2H, 2 x ArCH), 4.10 (t, *J* = 6.0 Hz, 1H, CH), 4.01 (t, *J* = 6.0 Hz, 2H, CH_2), 1.64 (t, *J* = 6.0 Hz, 1H, OH); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.5 (2 x ArC), 141.7 (2 x ArC), 127.7 (2 x ArCH), 127.3 (2 x ArCH), 124.9 (2 x ArCH), 120.2 (2 x ArCH), 65.3 (CH_2), 50.6 (CH).

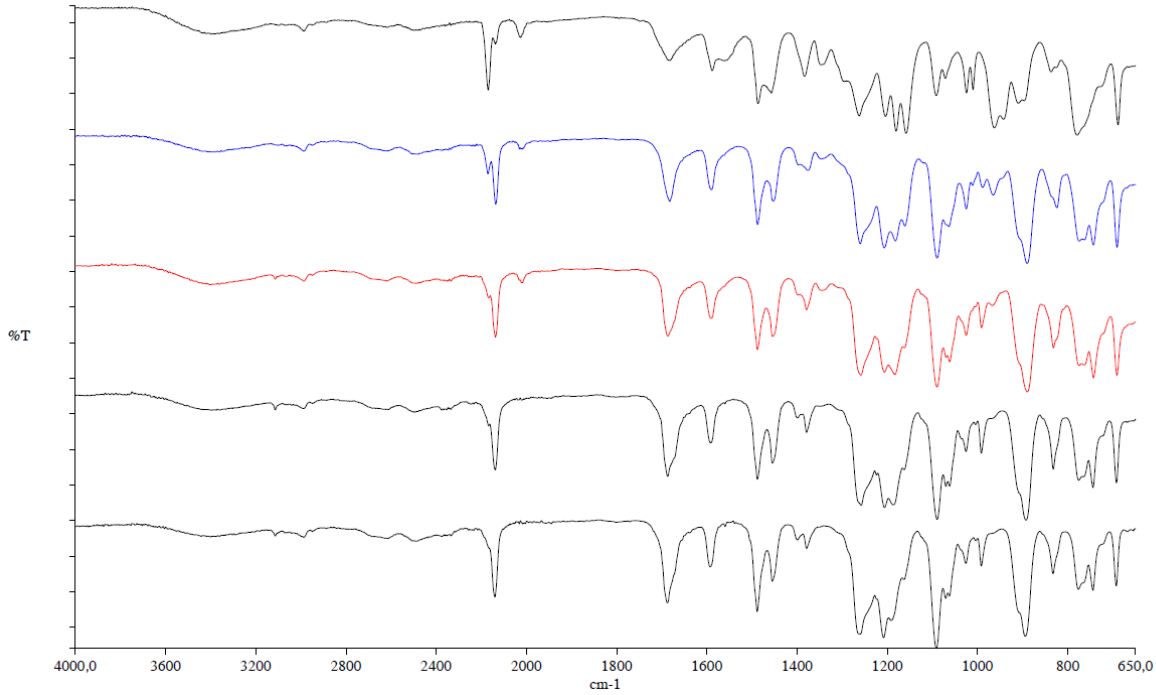
Ferrocene-1,1'-dicarboxylic acid (**2**)**.** HCl (12 M) was added dropwise to a solution of sodium ferrocene-1,1'-dicarboxylate (**SI3**, 1.0 g, 3.1 mmol, 1.0 equiv) in water (20 mL) at 0 °C until pH 1 was

reached. The resulting solids were filtrated, washed with water and dried under high vacuum over P_2O_5 to give the title product as an orange solid (800 mg, 93%). mp > 250 °C (decomp, lit.[4] > 250 °C); IR (ATR): 2885 (br), 2557, 1668, 1488, 1404, 1297, 1168, 1032, 917, 840, 751 cm^{-1}; ^{1}H NMR (300 MHz, DMSO-d^6) δ 12.32 (br s, 2H, 2 x CO_2H), 4.69 (s, 4H, 4 x FcCH), 4.44 (s, 4H, 4 x FcCH); ^{13}C NMR (75.4 MHz, DMSO-d^6) δ 171.1 (2 x C=O), 73.5 (2 x FcC); 72.6 (4 x FcCH); 71.3 (4 x FcCH).

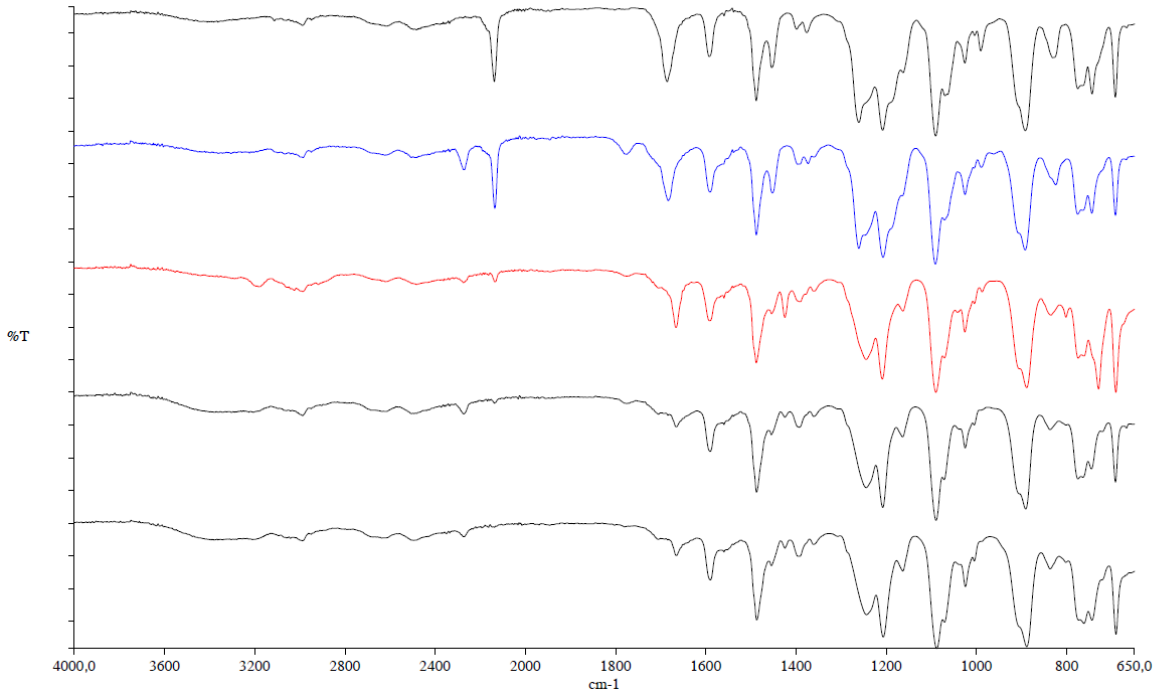
1. Fischer, D. *Acta Crystallogr.* **1964,** *17,* 619.
2. Barišić, L.; Rapić, V.; Pritzkow, H.; Pavlović, G.; Nemet, I. *J. Organomet. Chem.* **2003,** *682*, 131-142.
3. Chong, J. M.; Lajoie, G.; Tjepkema, M. W. *Synthesis* **1992,** *1992*, 819-820.
4. Gao, B.; Yang, B.; Li, T.; Zhang, B. *Synth. Commun.* **2009,** *39*, 2973-2981.

IR spectra of the formation and consumption of 3 and 4

Formation of **3** and **4**: top to bottom (1min, 1h, 2h 3h, 4h).

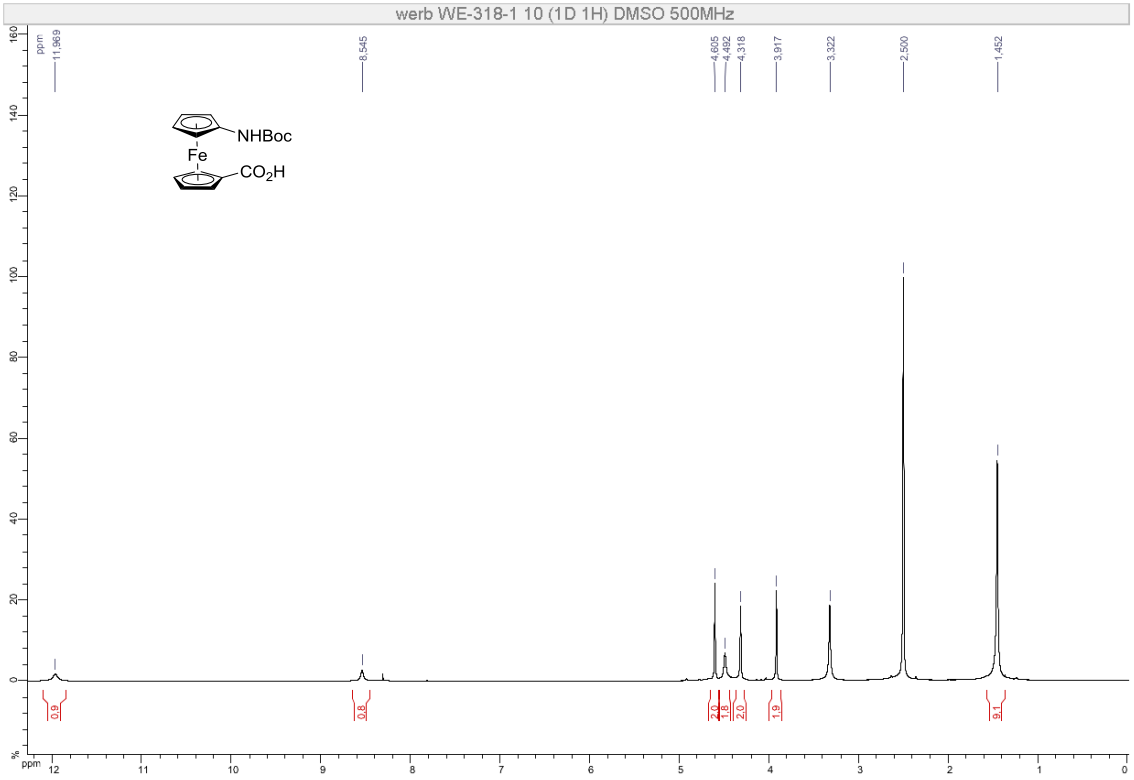


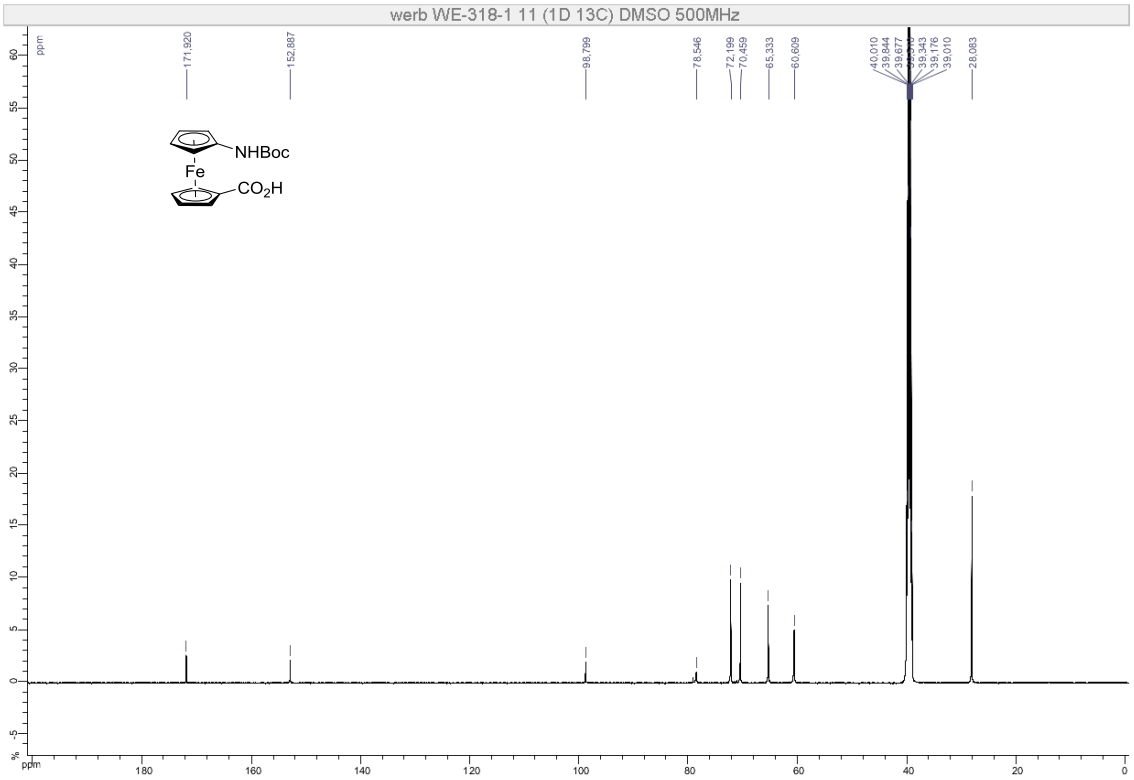
Formation of isocyanate from **4**: top to bottom (1 min, 10 min, 20 min, 40 min, 60 min).

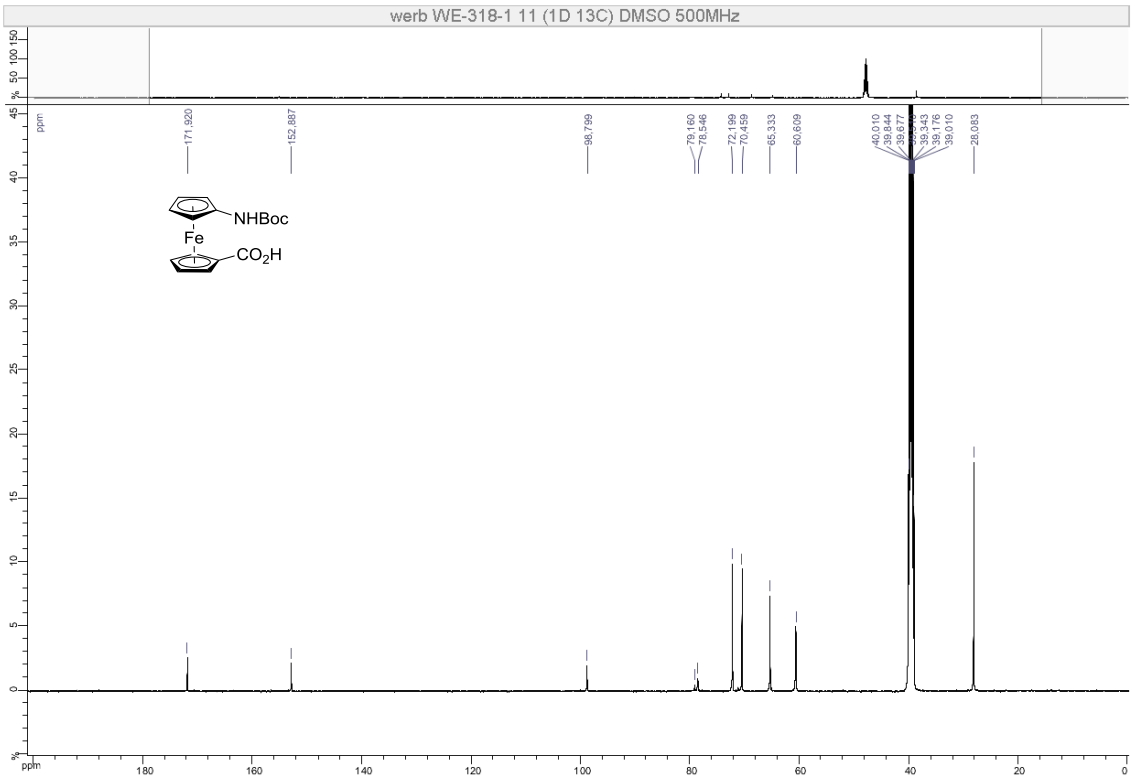


NMR spectra for compounds 1 – 15 and SI1-4

1'-((*tert*-Butoxycarbonyl)amino)ferrocene-1-carboxylic acid - 1



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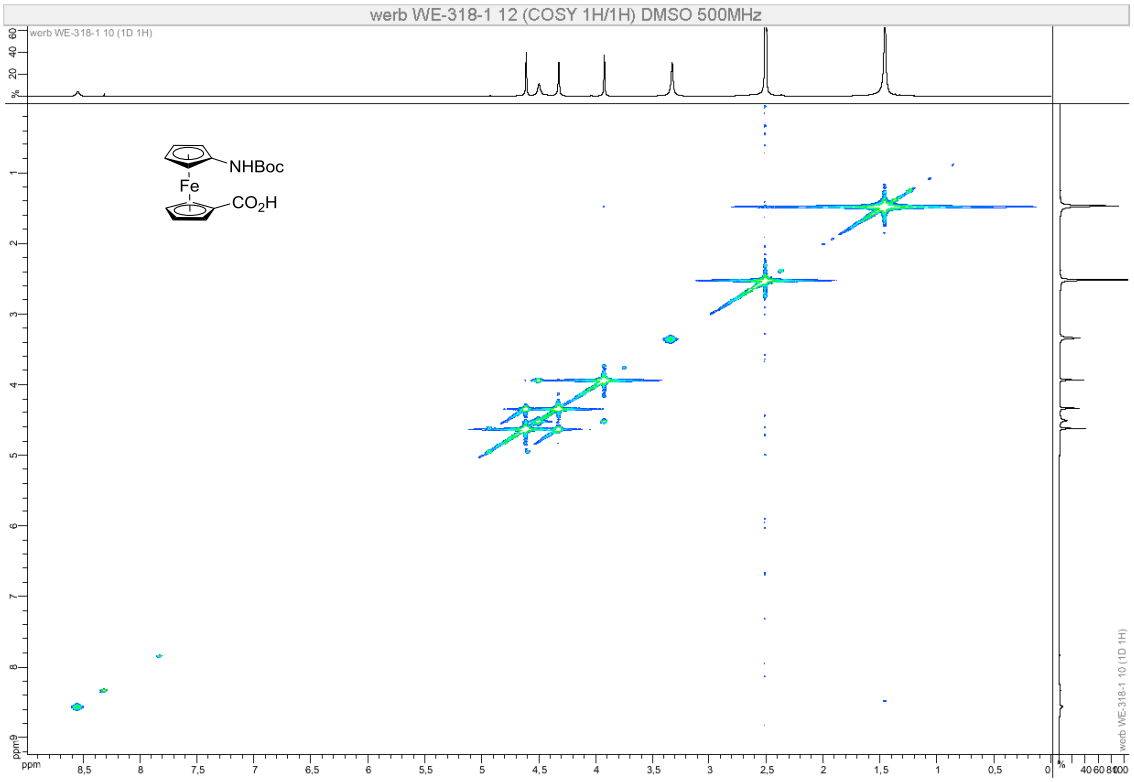
NHBoc
Fe
CO2H
ppm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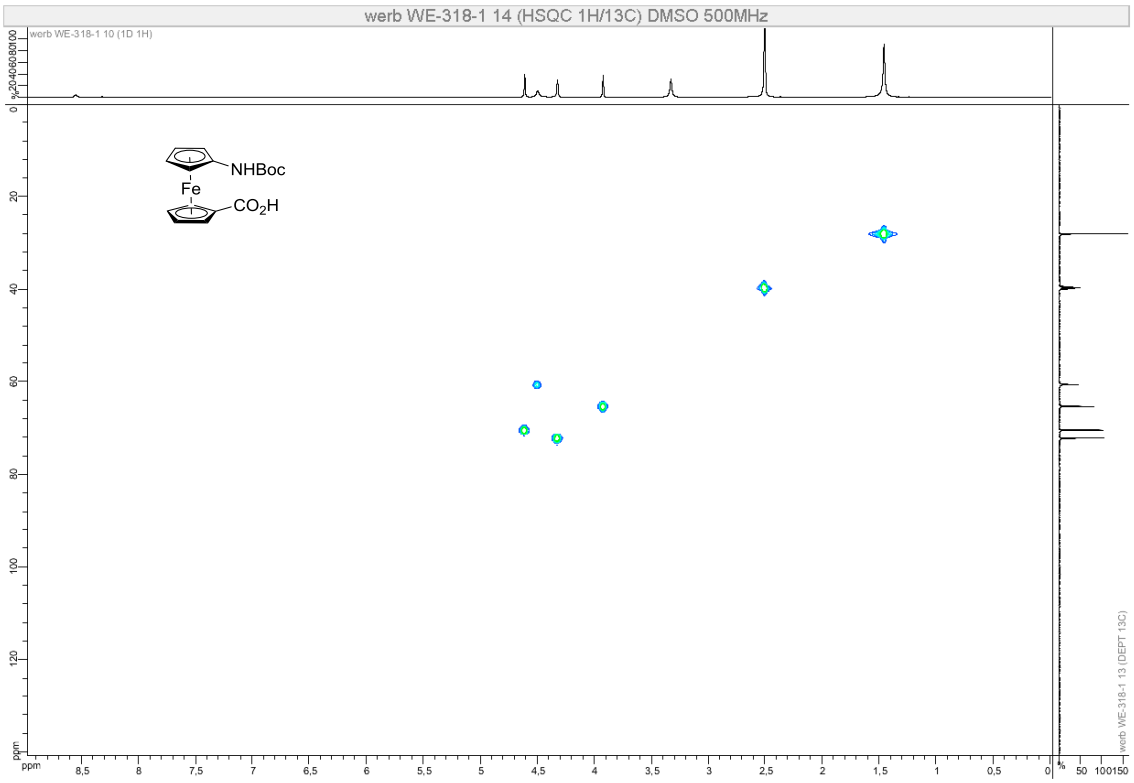
CO2H
ppm
ppm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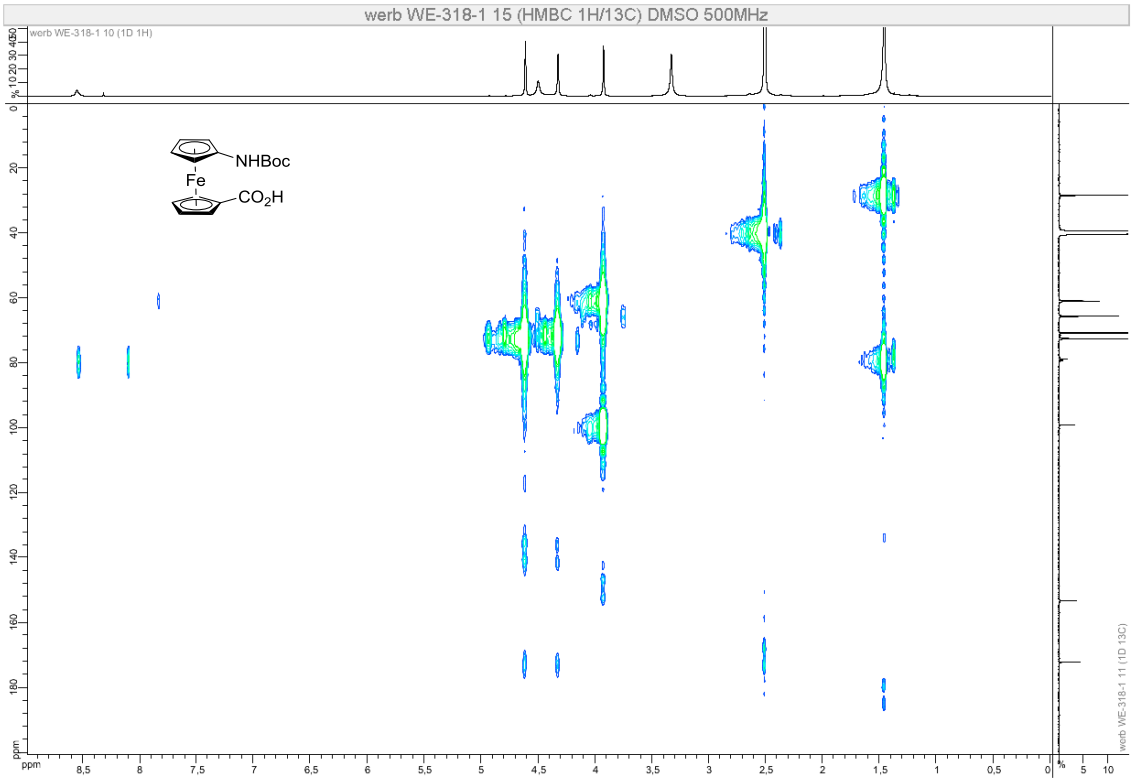
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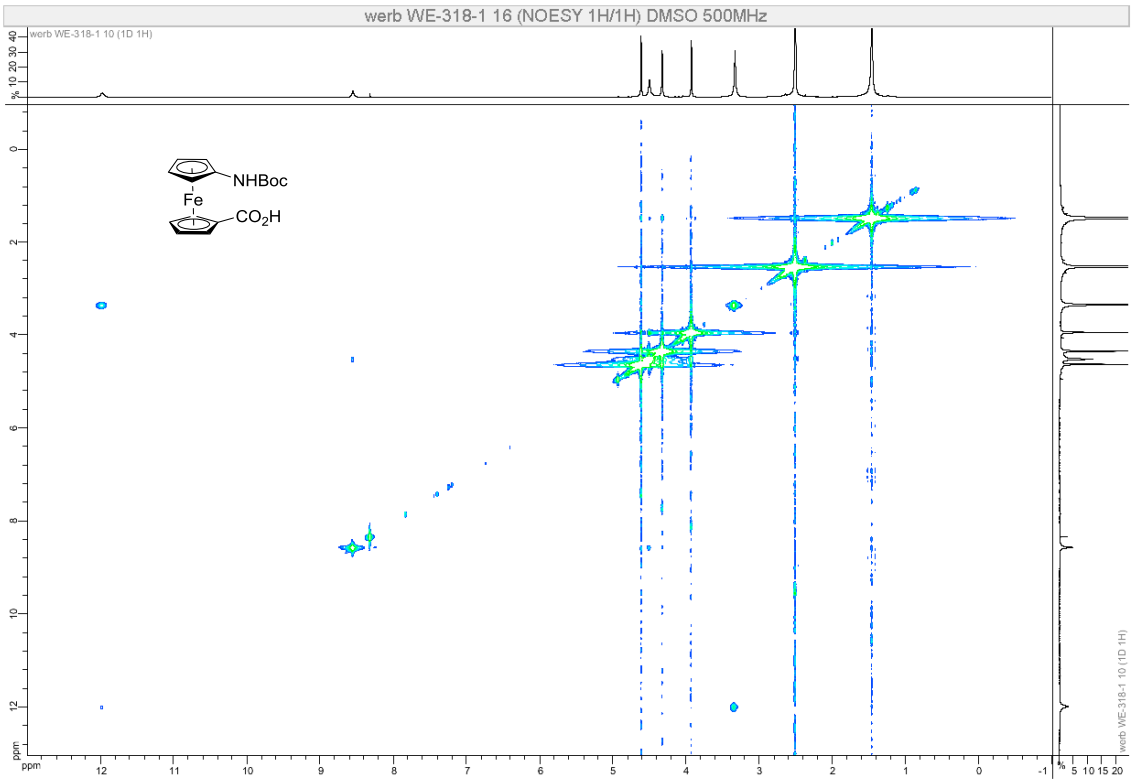
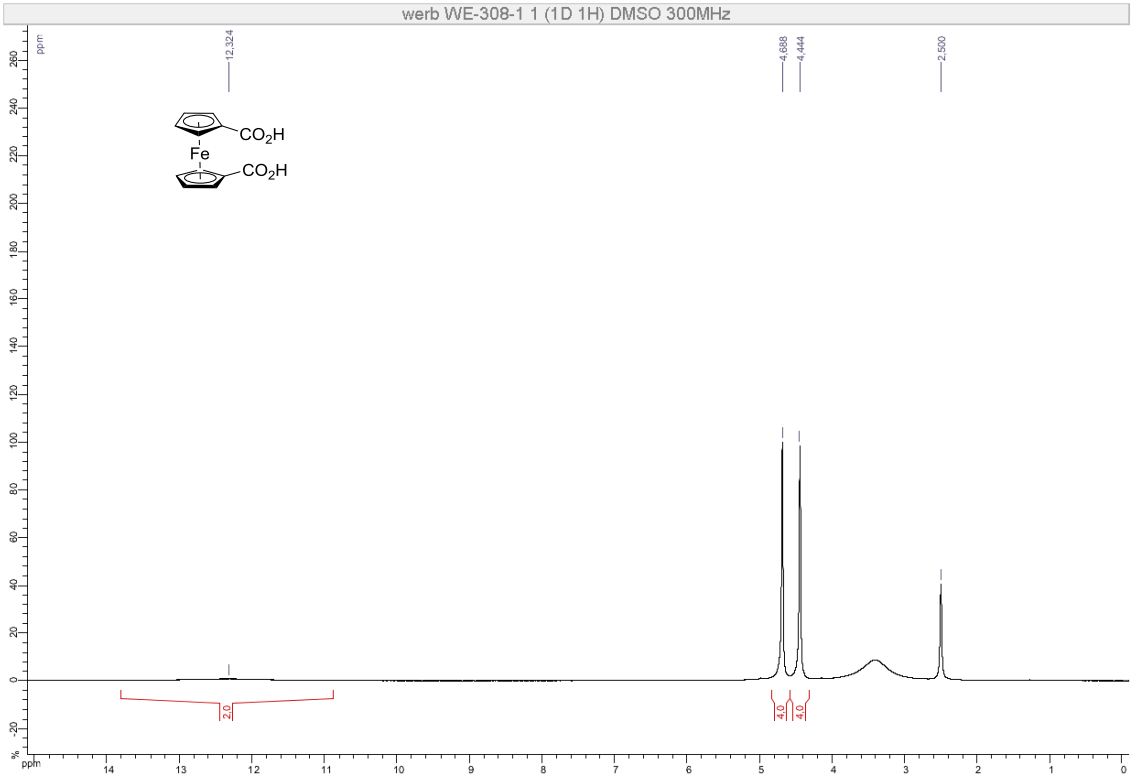
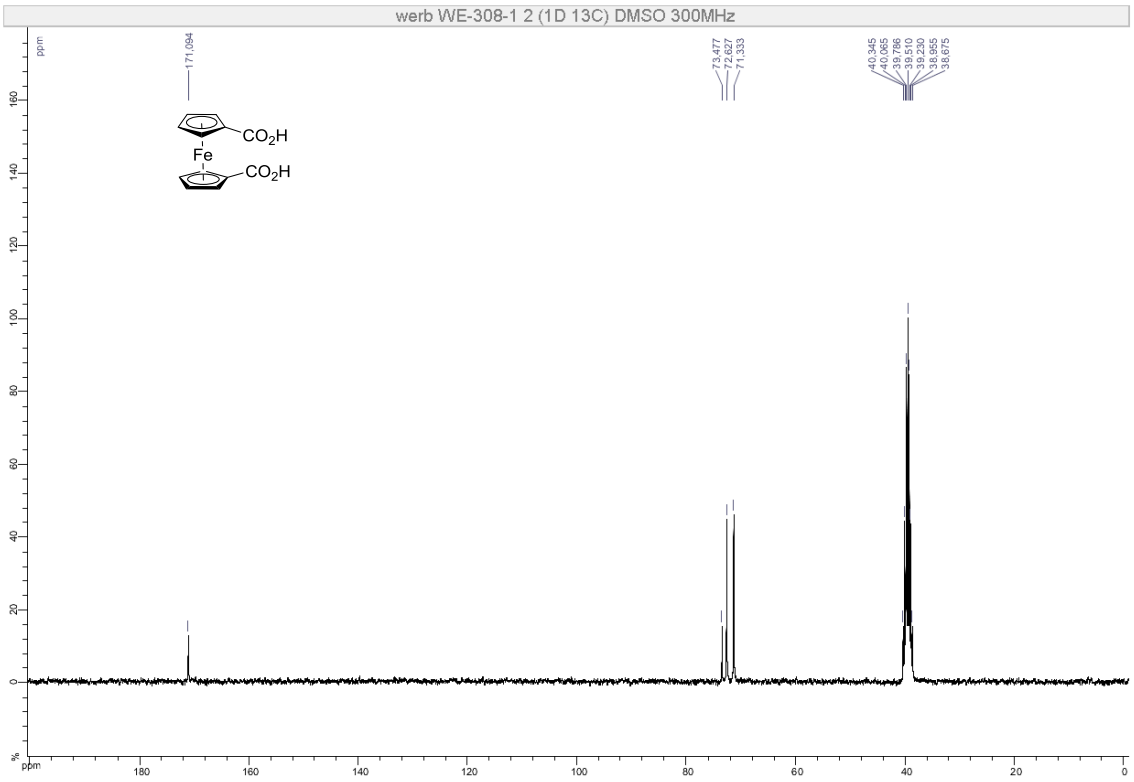


Ferrocene-1,1'-dicarboxylic acid - 2

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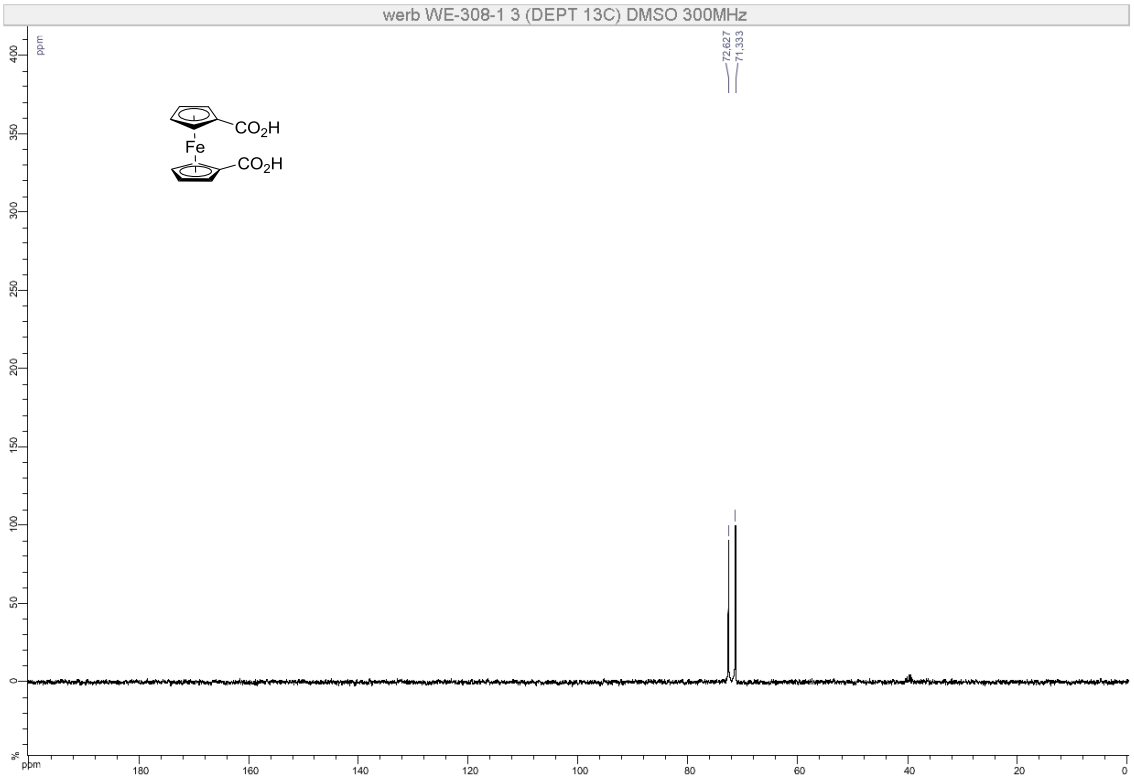
CO2H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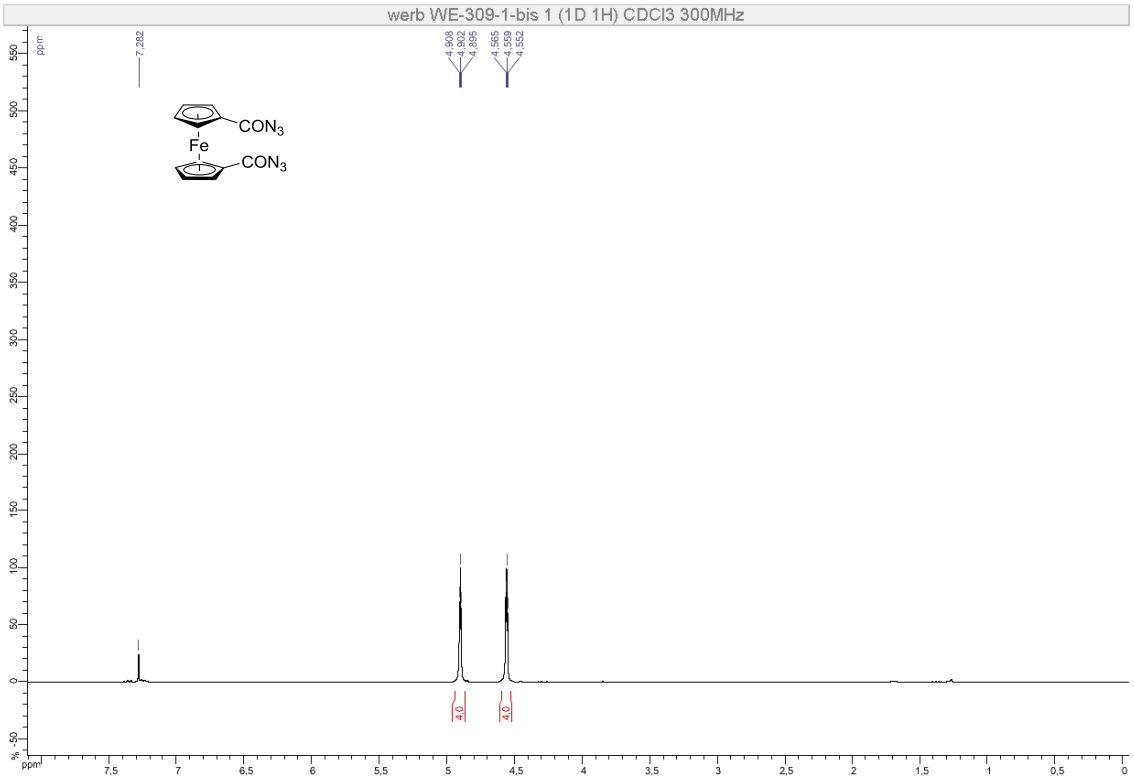
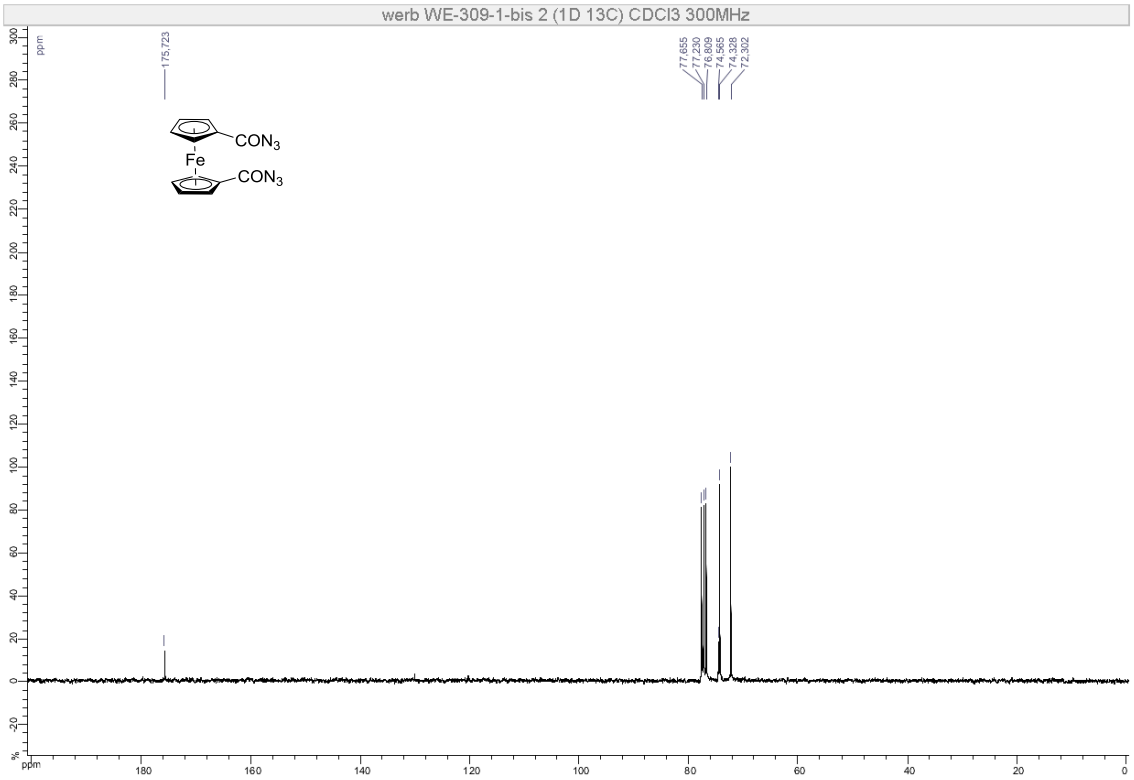
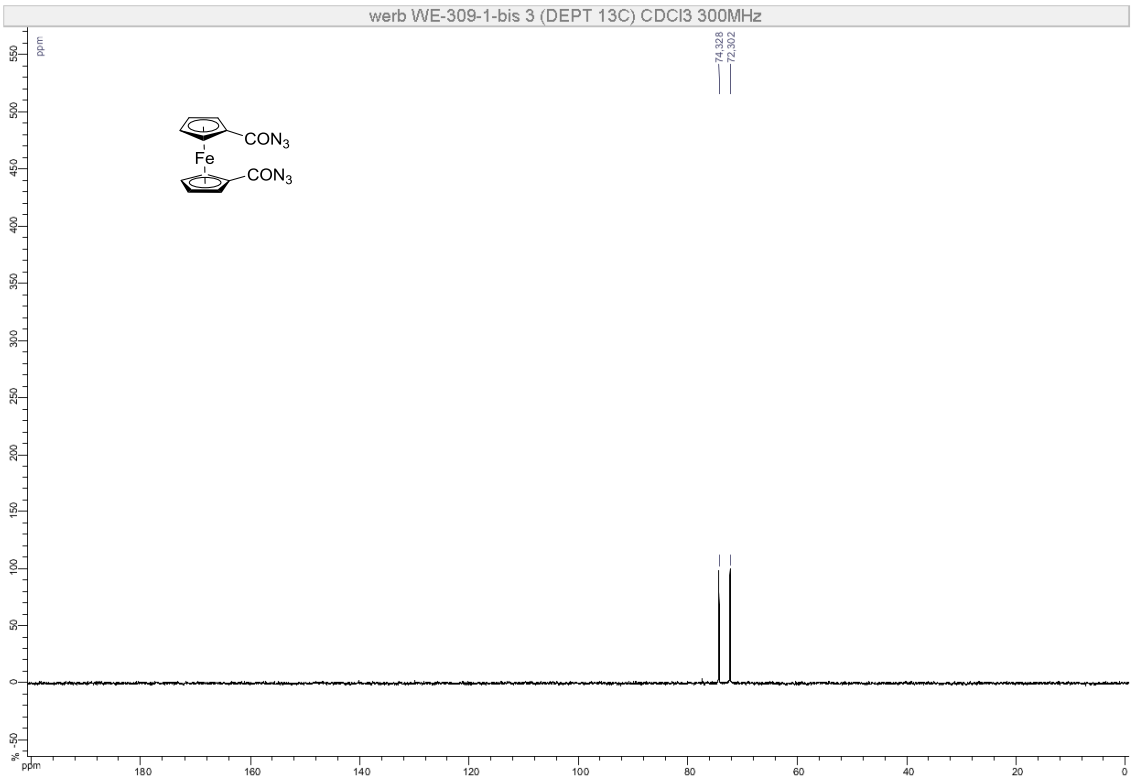
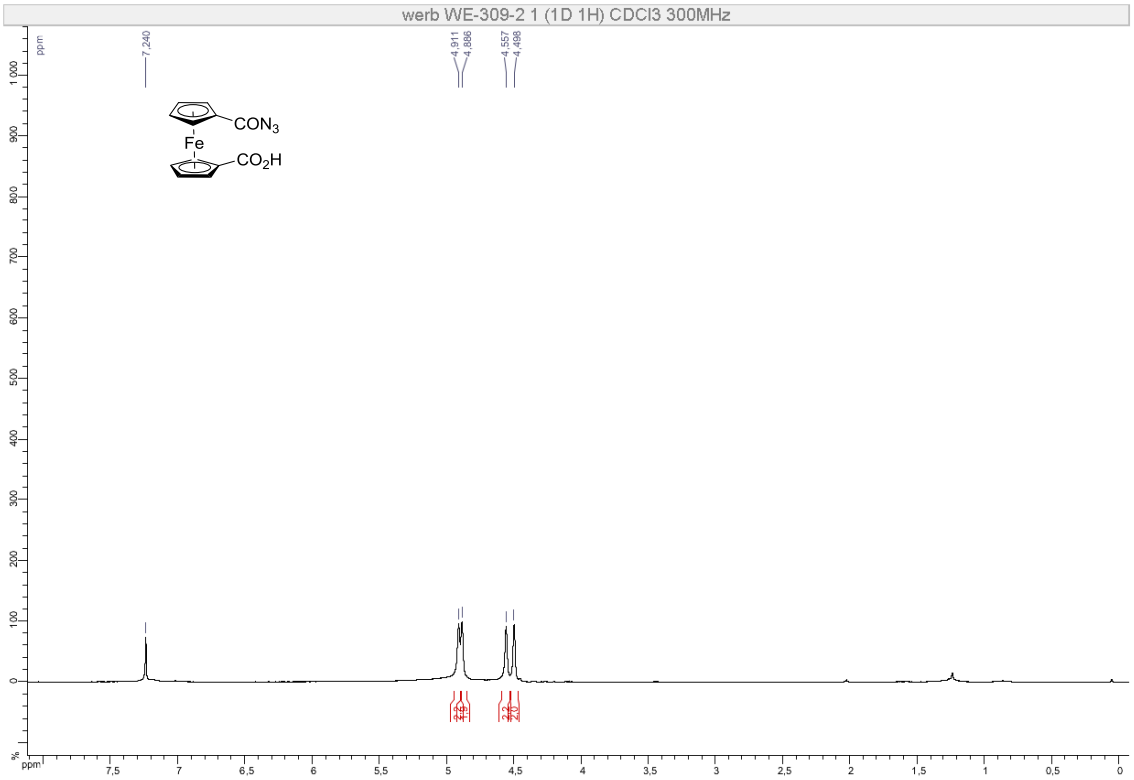
1,1'-Diazidocarbonylferrocene - 3

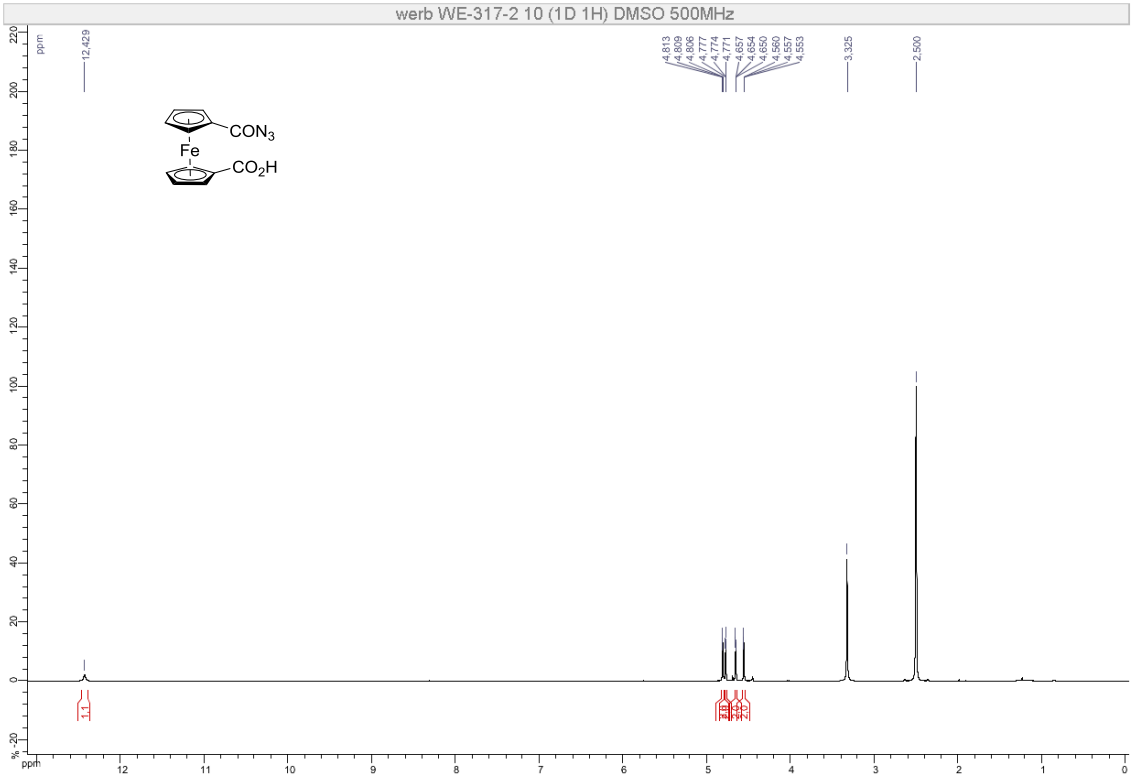






1’-Azidocarbonylferrocene-1-carboxylic acid - 4

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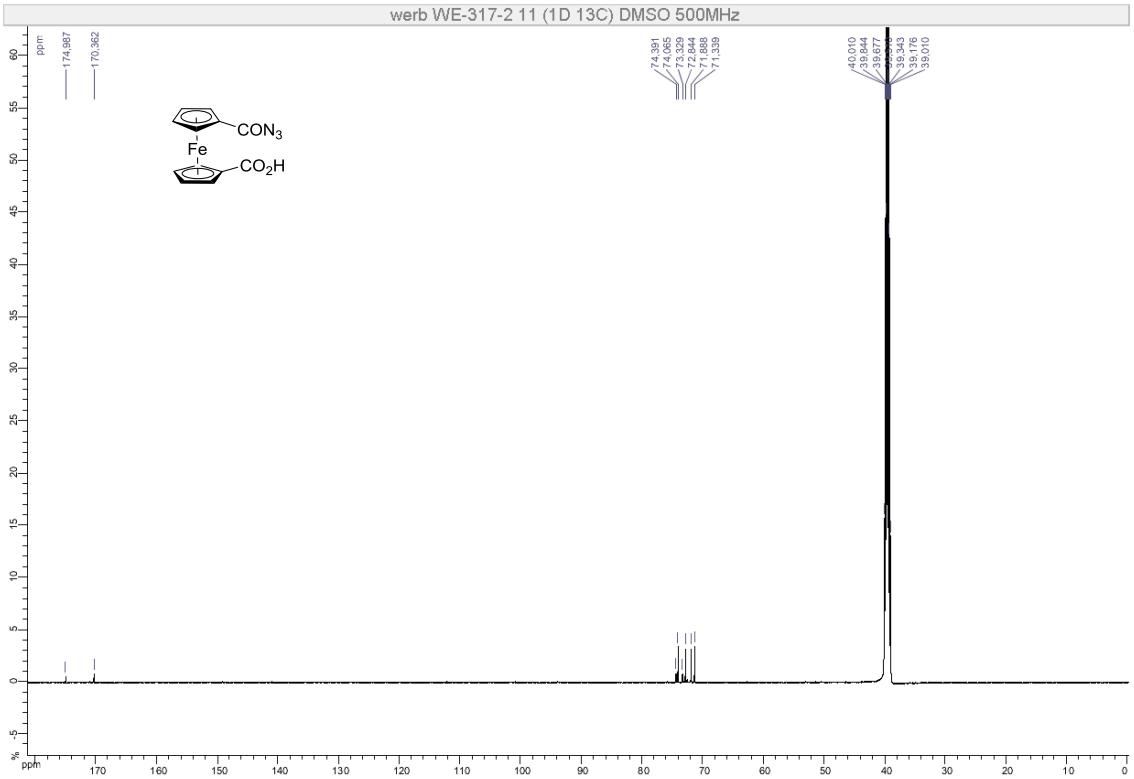
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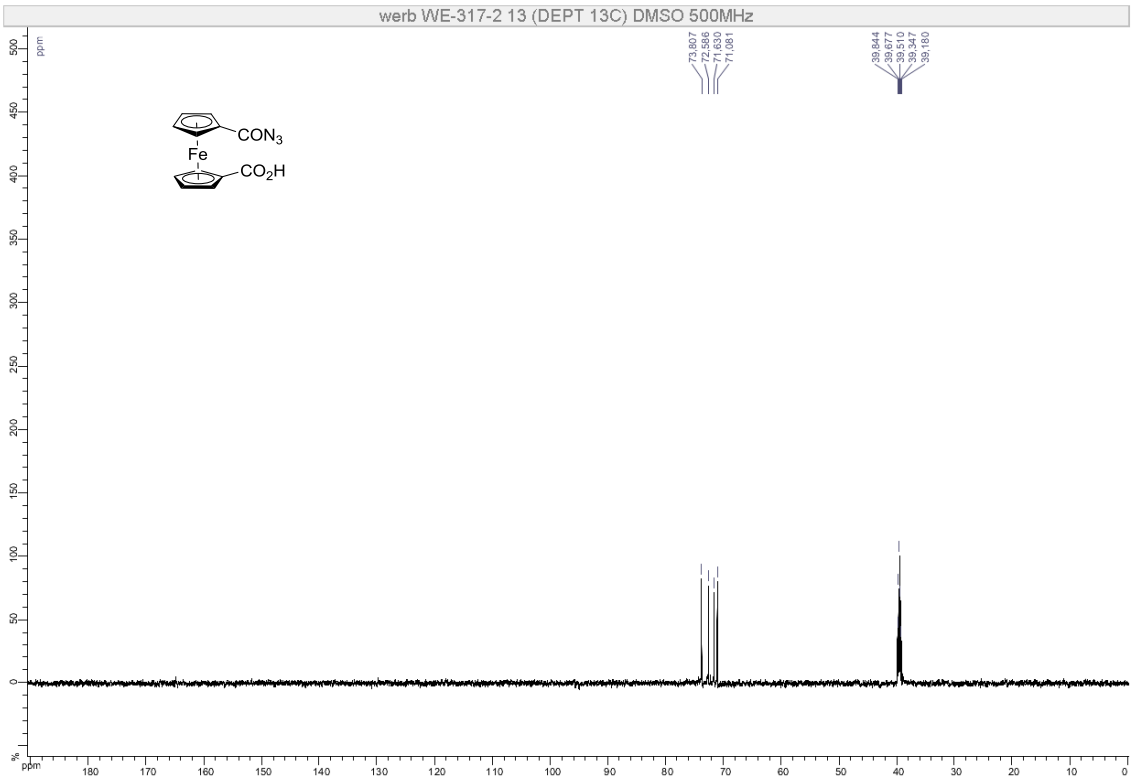
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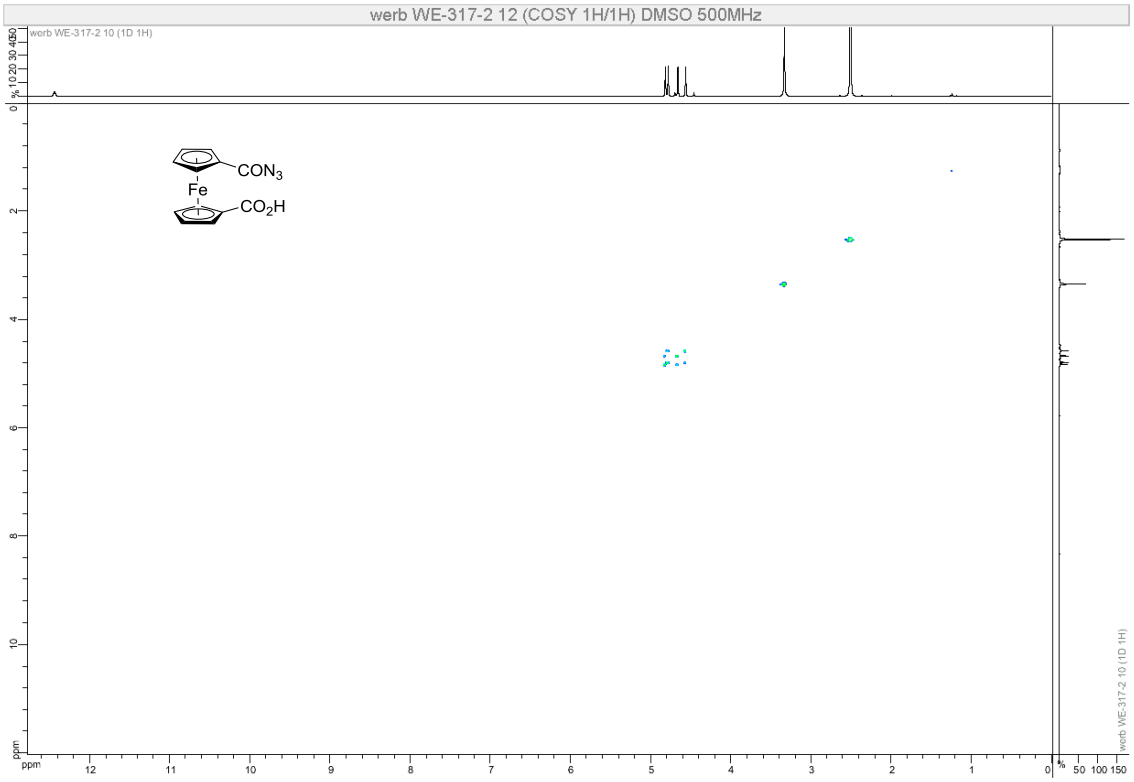
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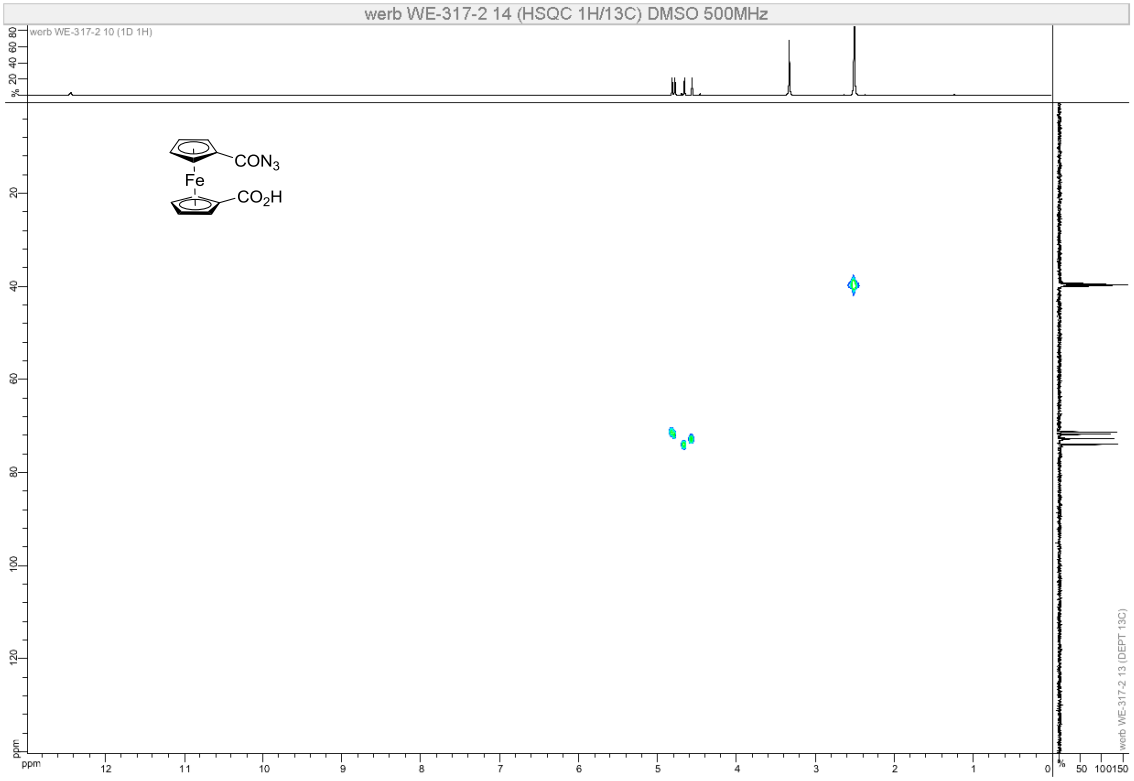
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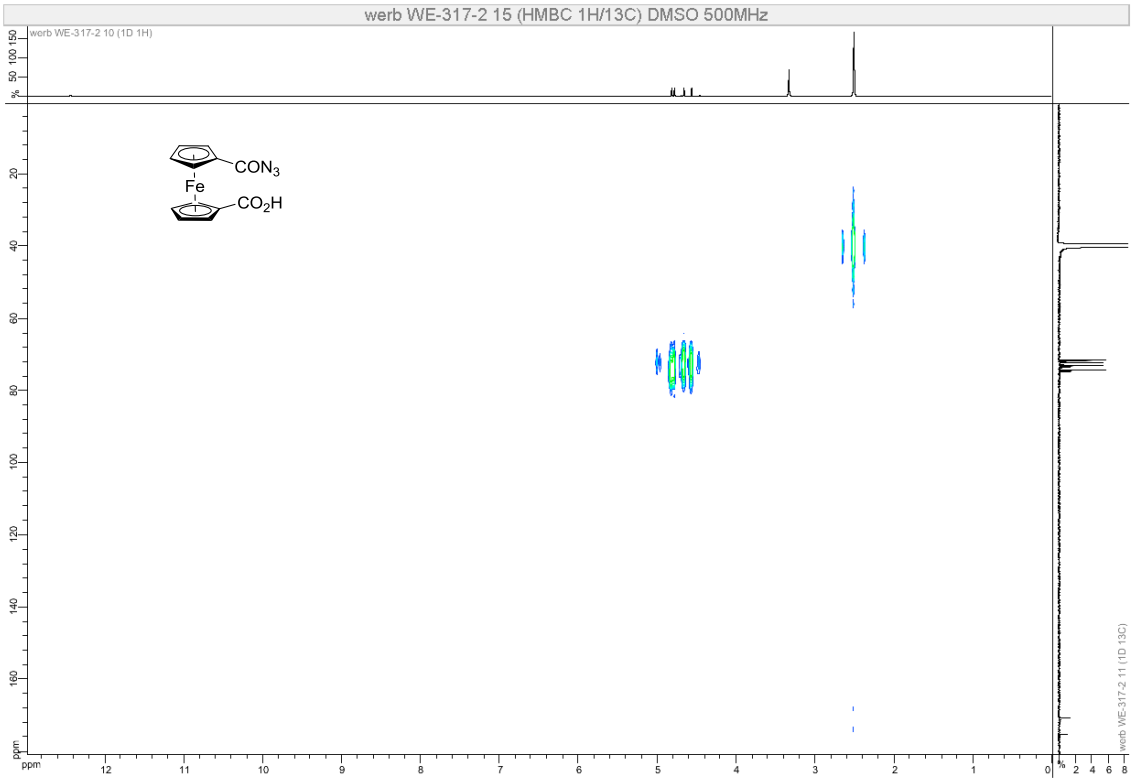
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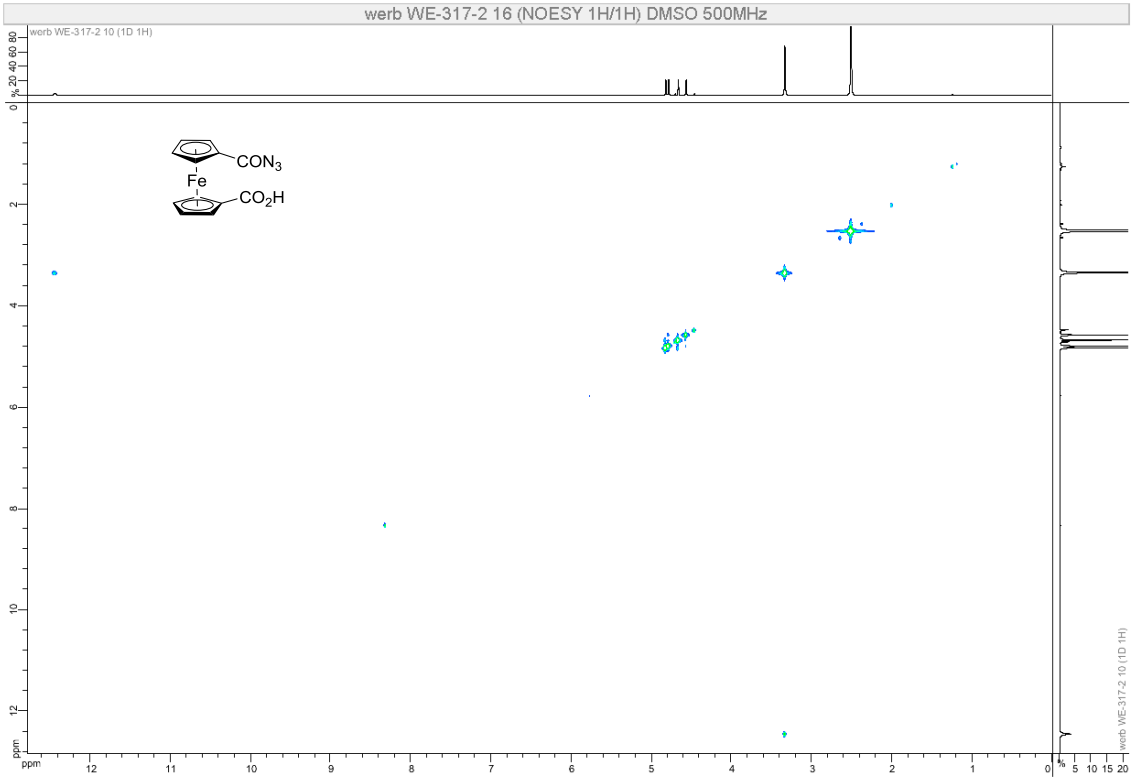
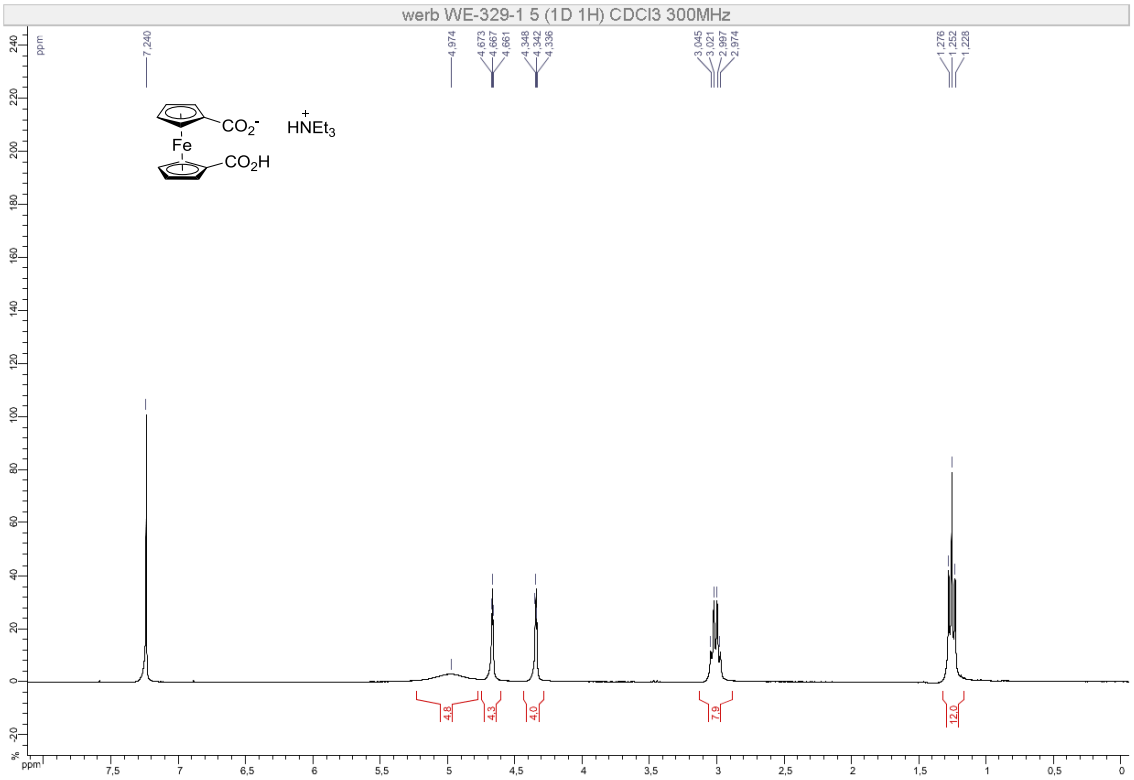
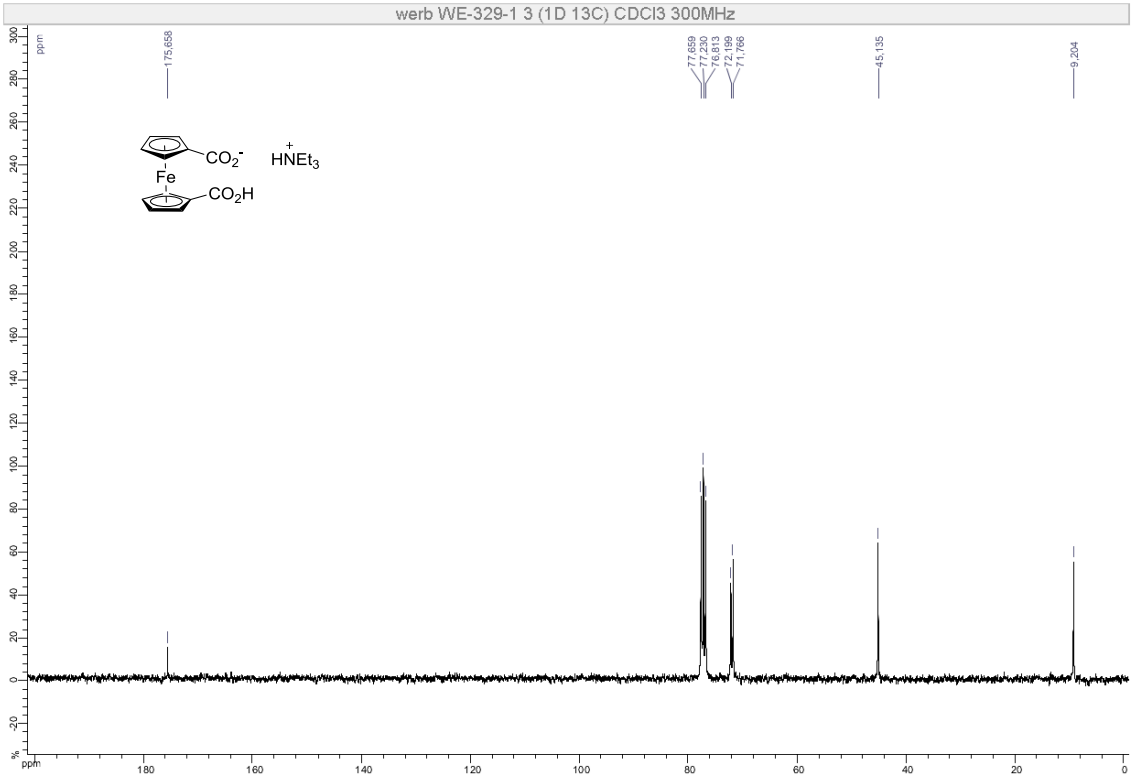


Triethylammonium 1'-carboxyferrocene-1-carboxylate - 5

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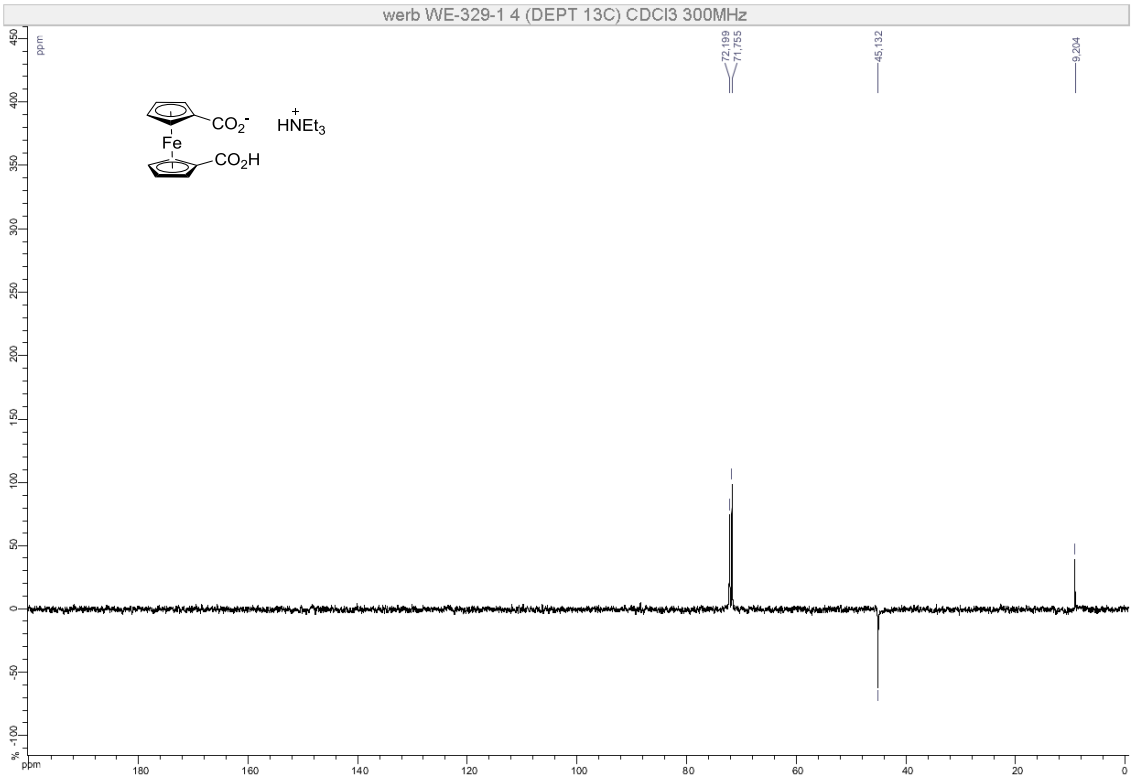
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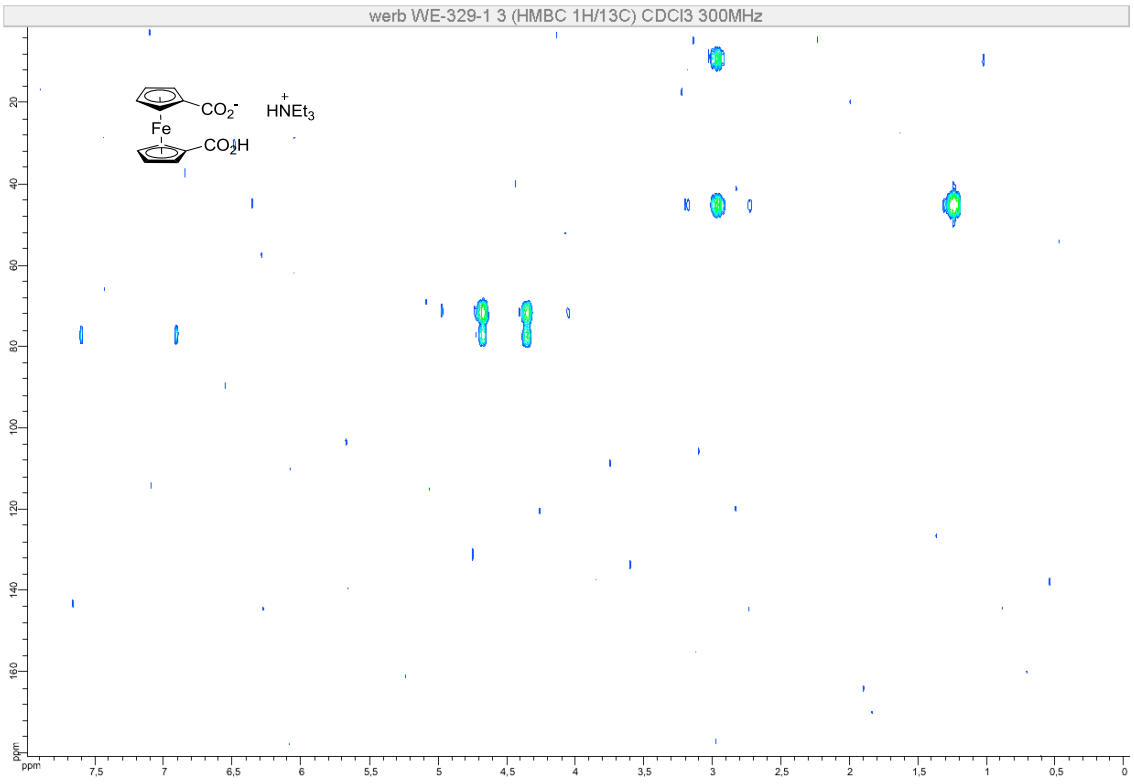
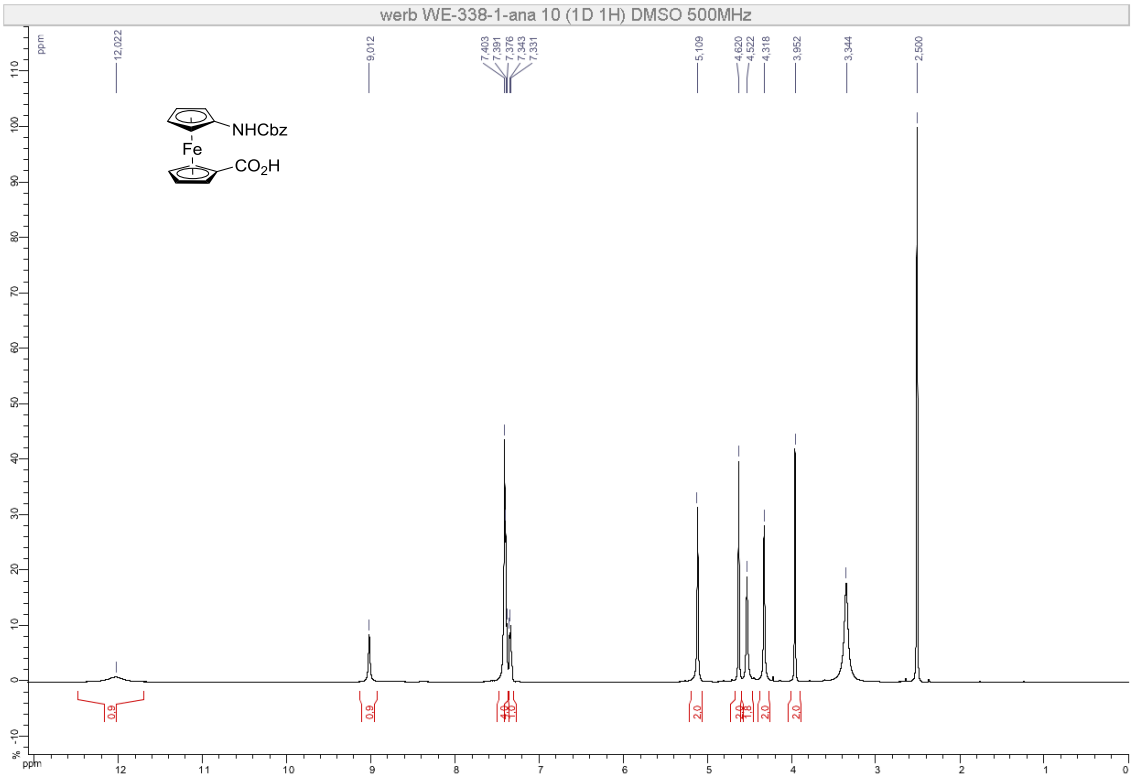
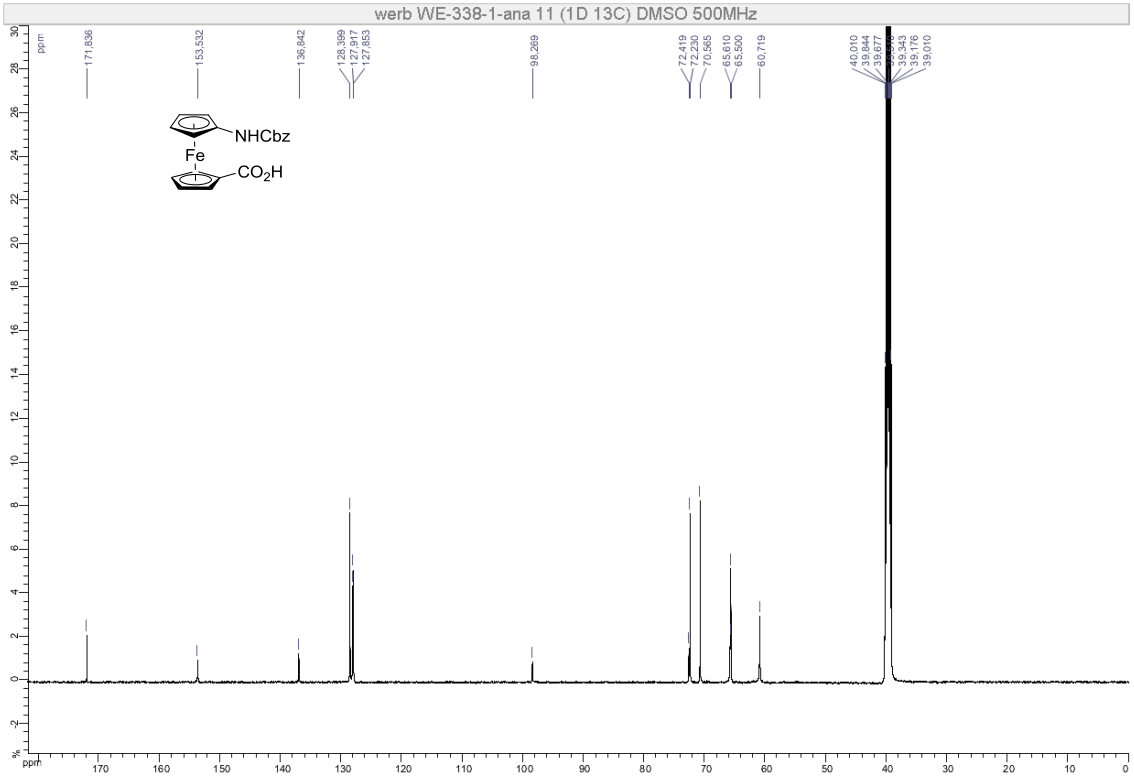


1'-((Benzyloxycarbonyl)amino)ferrocene-1-carboxylic acid - 7

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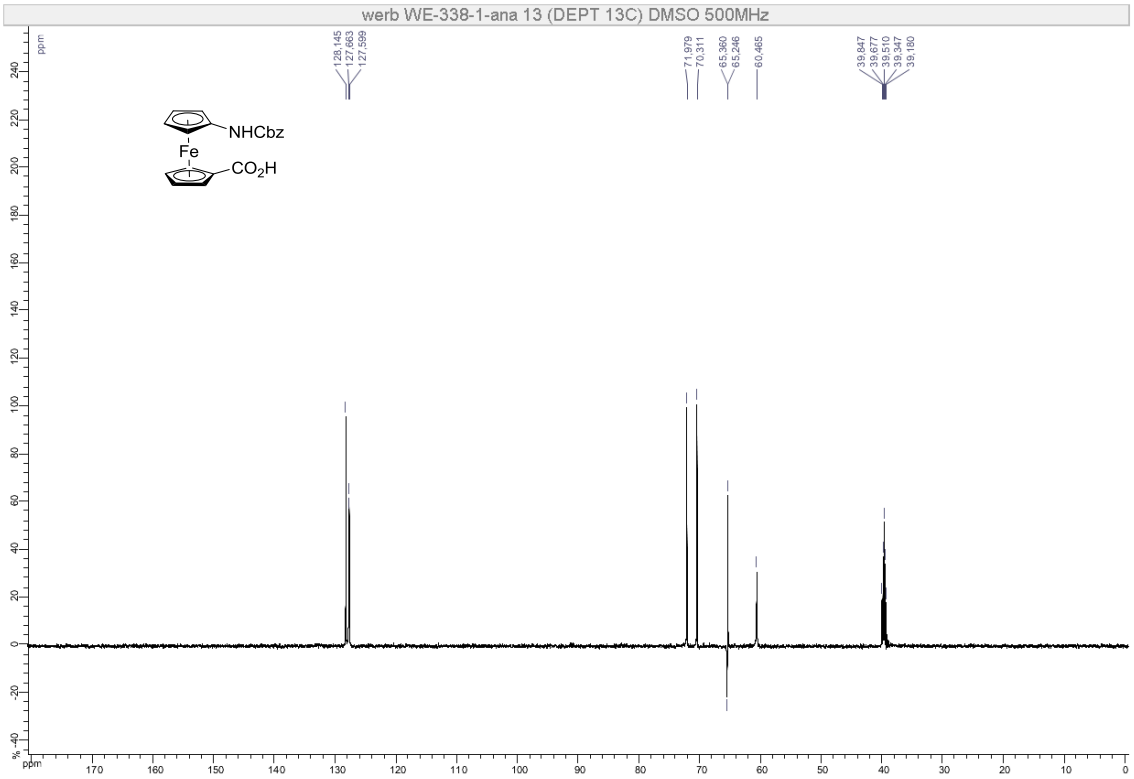
NHCbz
Fe
CO2H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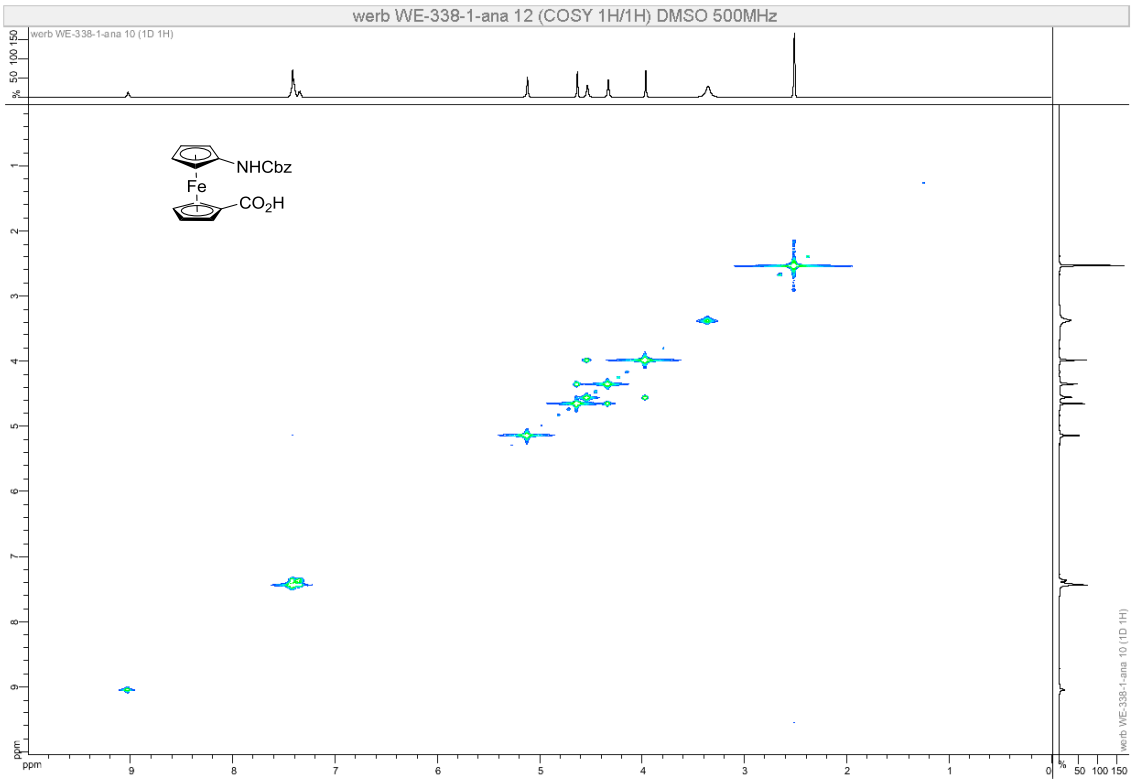
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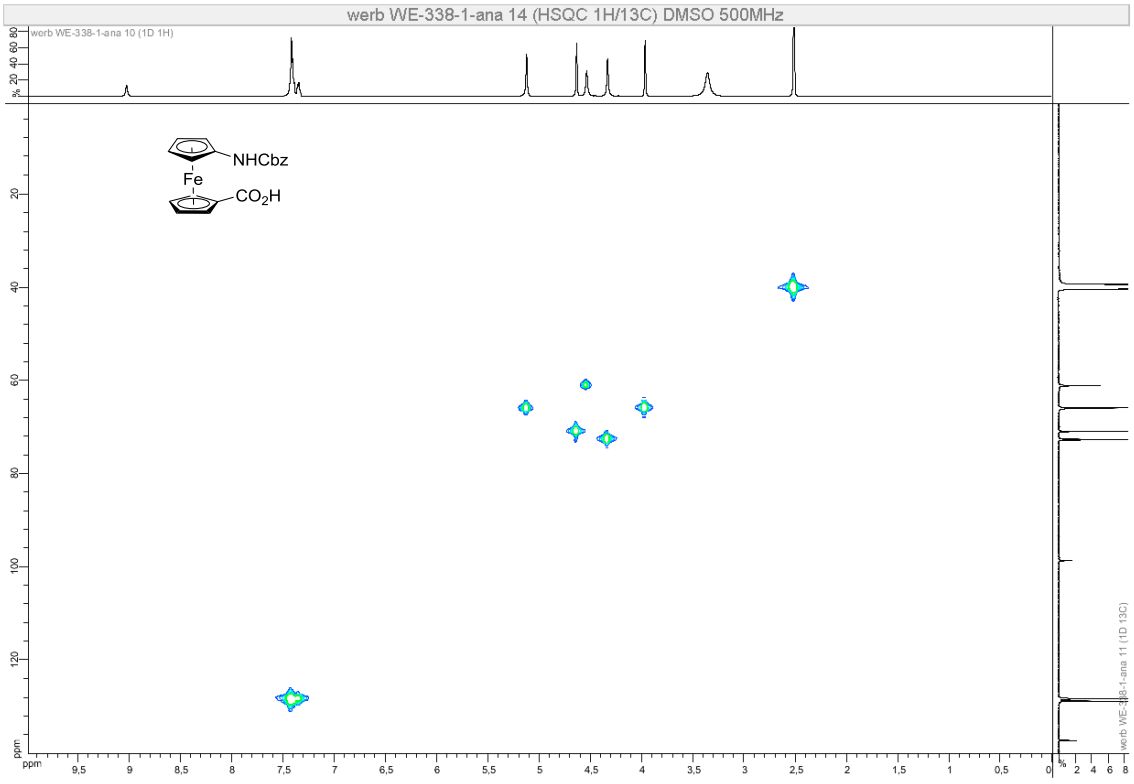
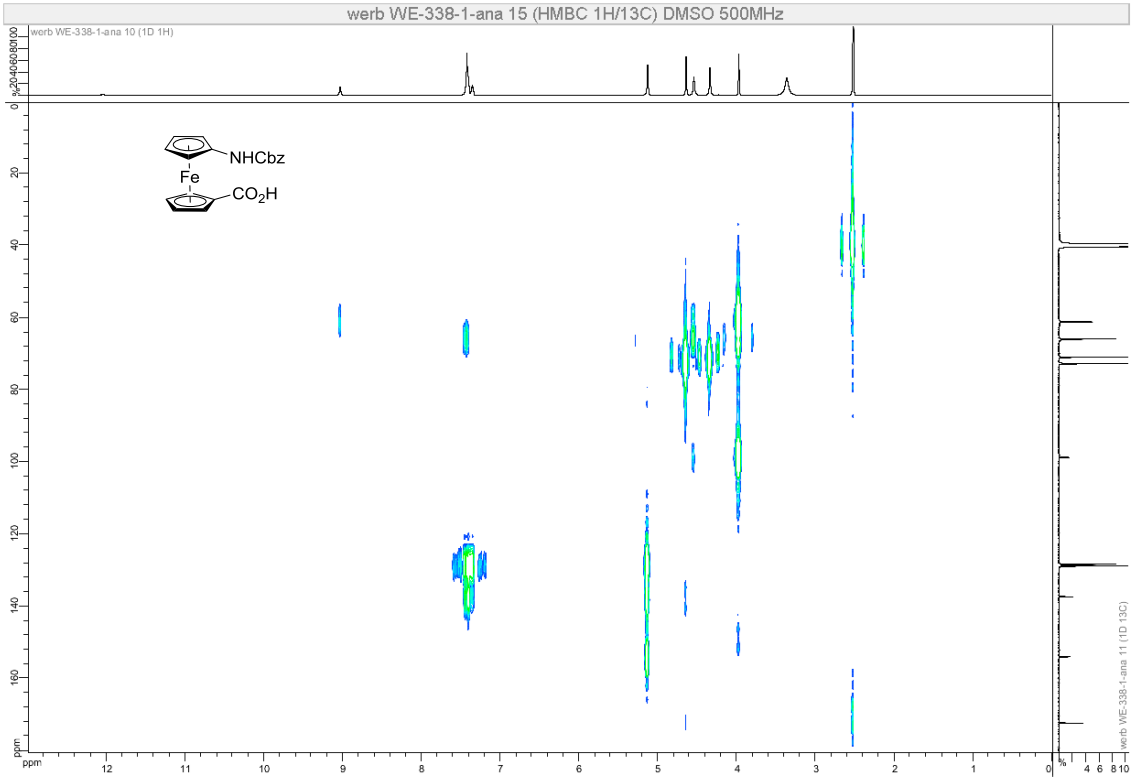
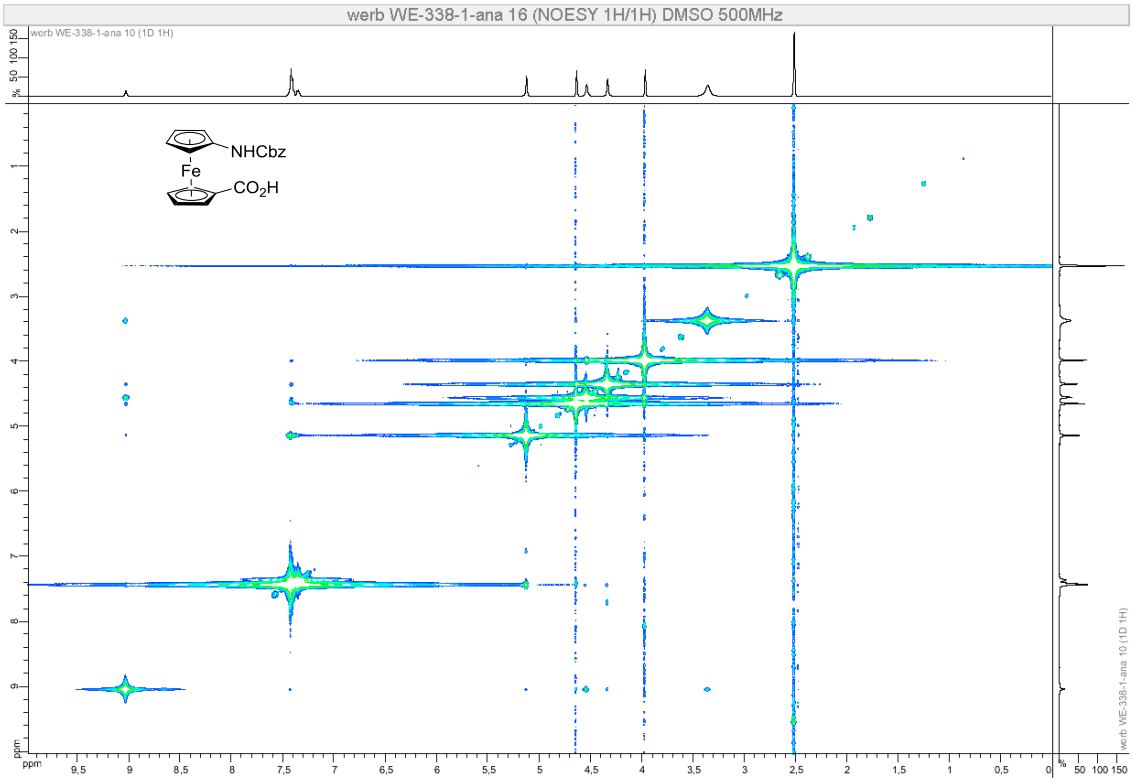
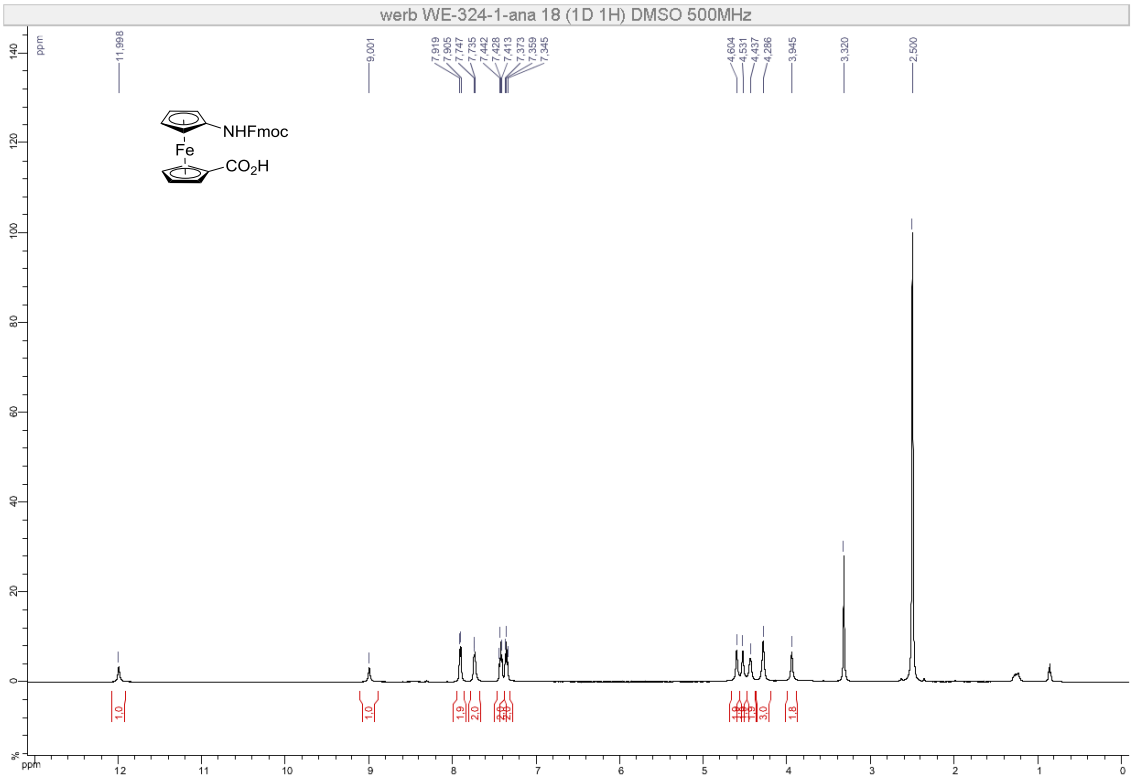
ppm
werb WE-338-1-ana 10 (1D 1H)

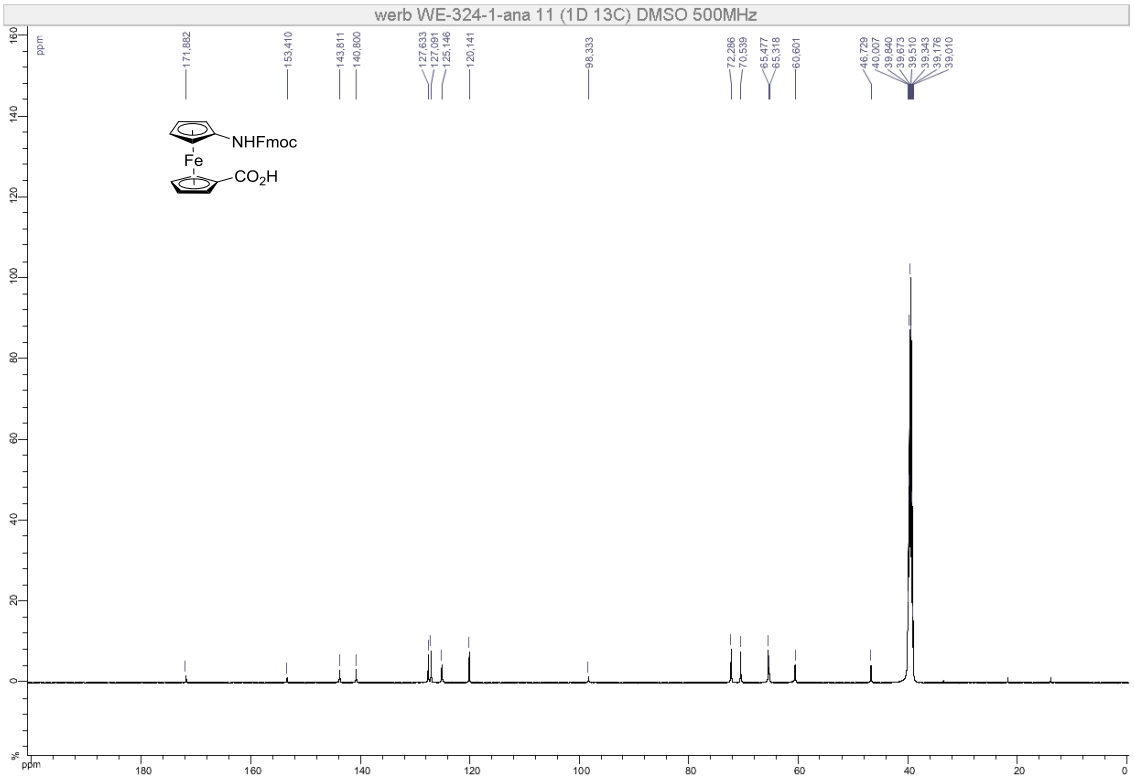

werb WE-338-1-ana 14 (HSQC 1H/13C) DMSO 500MHz
werb WE-338-1-ana 10 (1D 1H)
NHCbz
Fe
CO2H
ppm
werb WE-338-1-ana 11 (1D 13C)

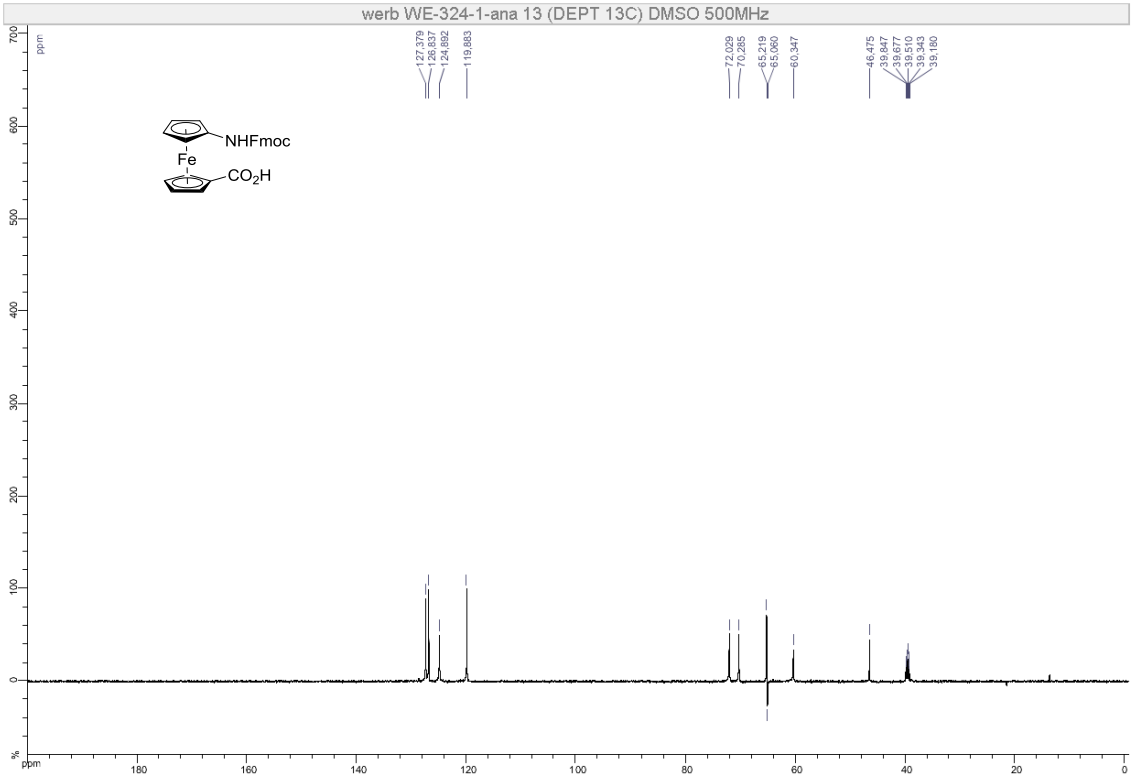

werb WE-338-1-ana 15 (HMBC 1H/13C) DMSO 500MHz
werb WE-338-1-ana 10 (1D 1H)
NHCbz
Fe
CO2H
ppm
werb WE-338-1-ana 11 (1D 13C)

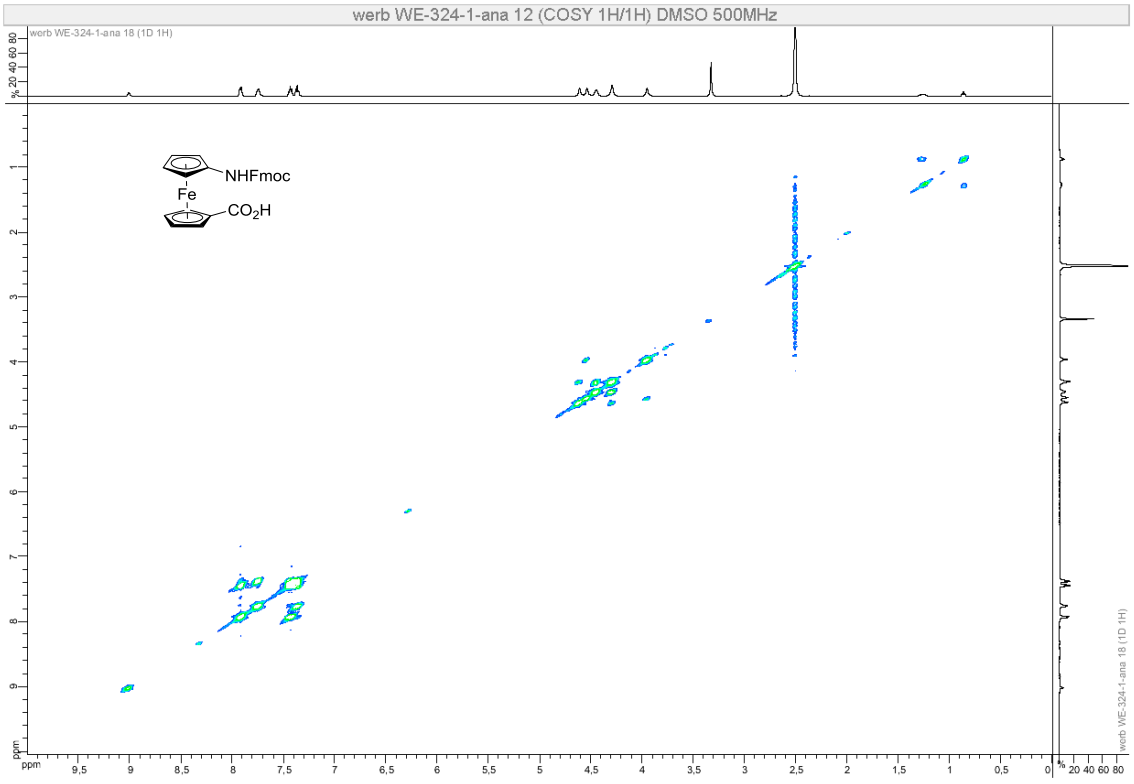

werb WE-338-1-ana 16 (NOESY 1H/1H) DMSO 500MHz
werb WE-338-1-ana 10 (1D 1H)
NHCbz
Fe
CO2H
ppm
werb WE-338-1-ana 10 (1D 1H)

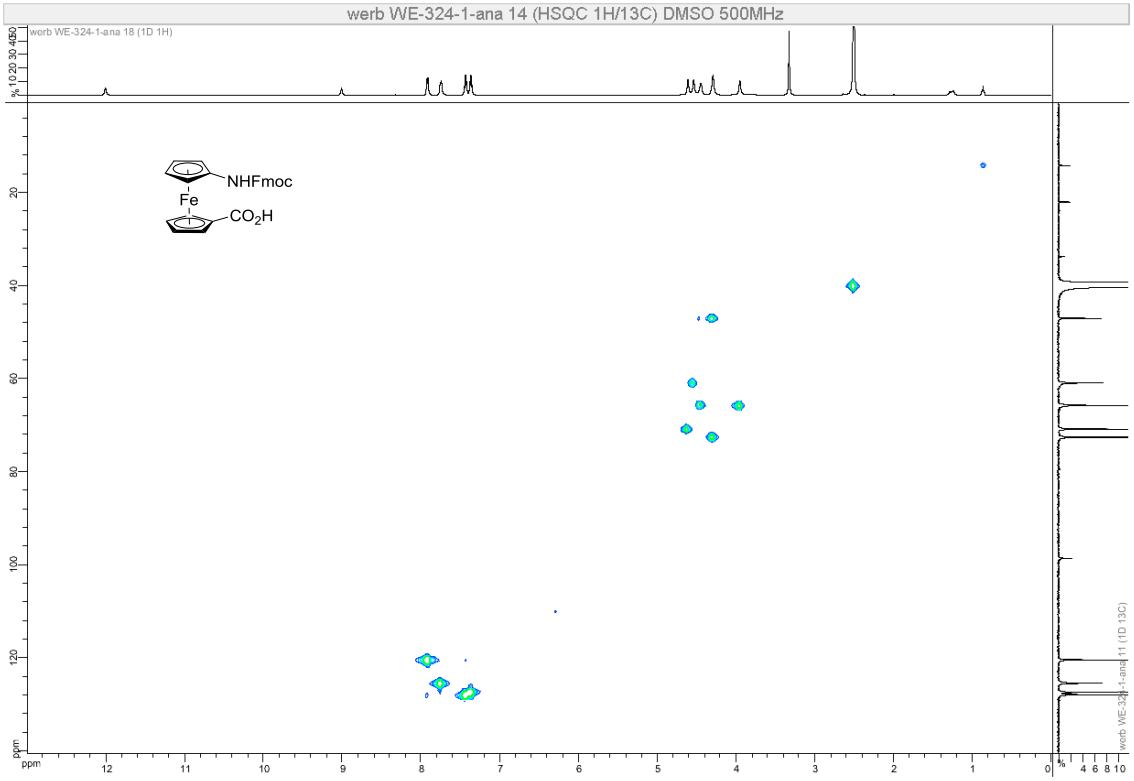
1’-[((Fluoren-9-yl)methoxycarbonyl)amino]ferrocene-1-carboxylic acid - 8

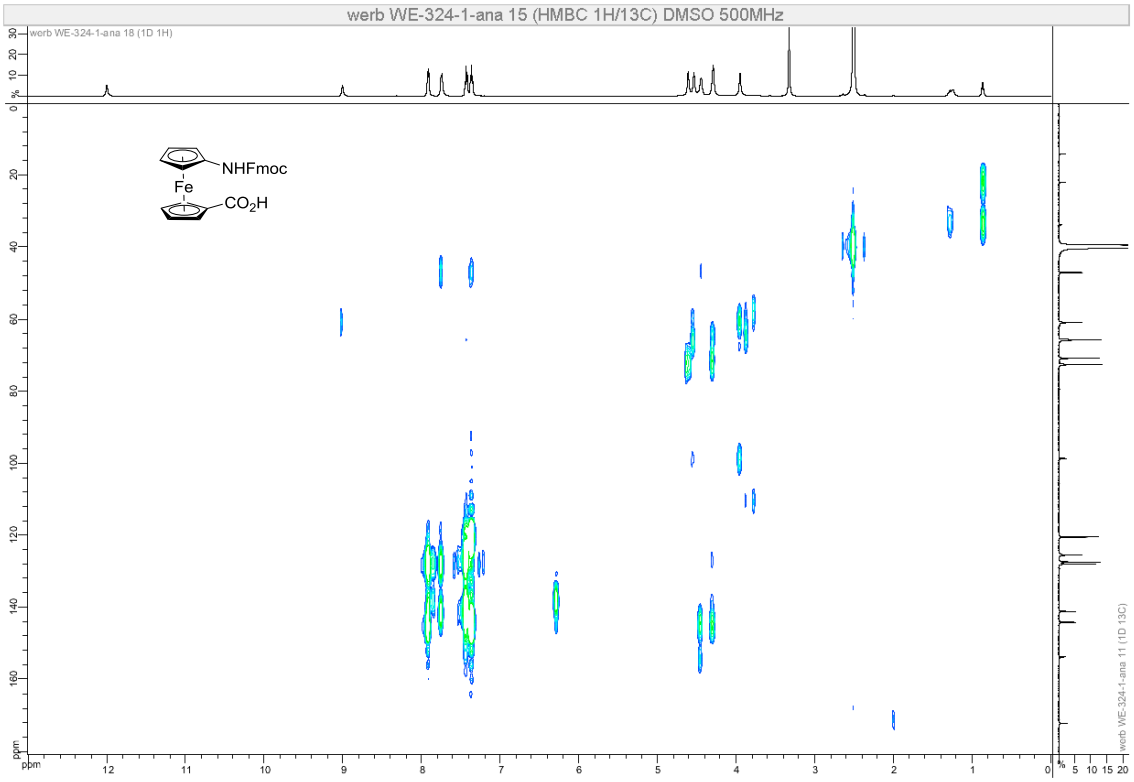


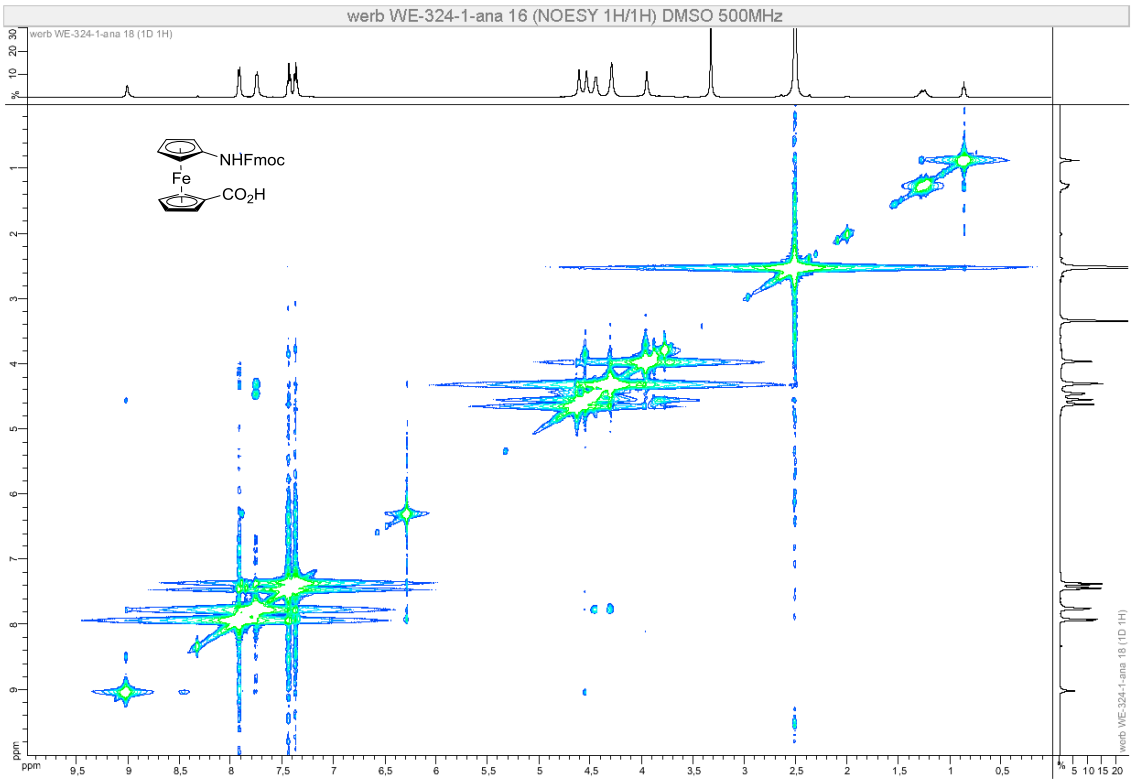



werb WE-324-1-ana 13 (DEPT 13C) DMSO 500MHz
ppm
127,379
126,837
124,892
119,883
72,029
70,285
65,219
65,060
60,347
46,475
39,847
39,677
39,510
39,343
39,180
NHFmoc
Fe
CO2H
%
ppm
180
160
140
120
100
80
60
40
20
0

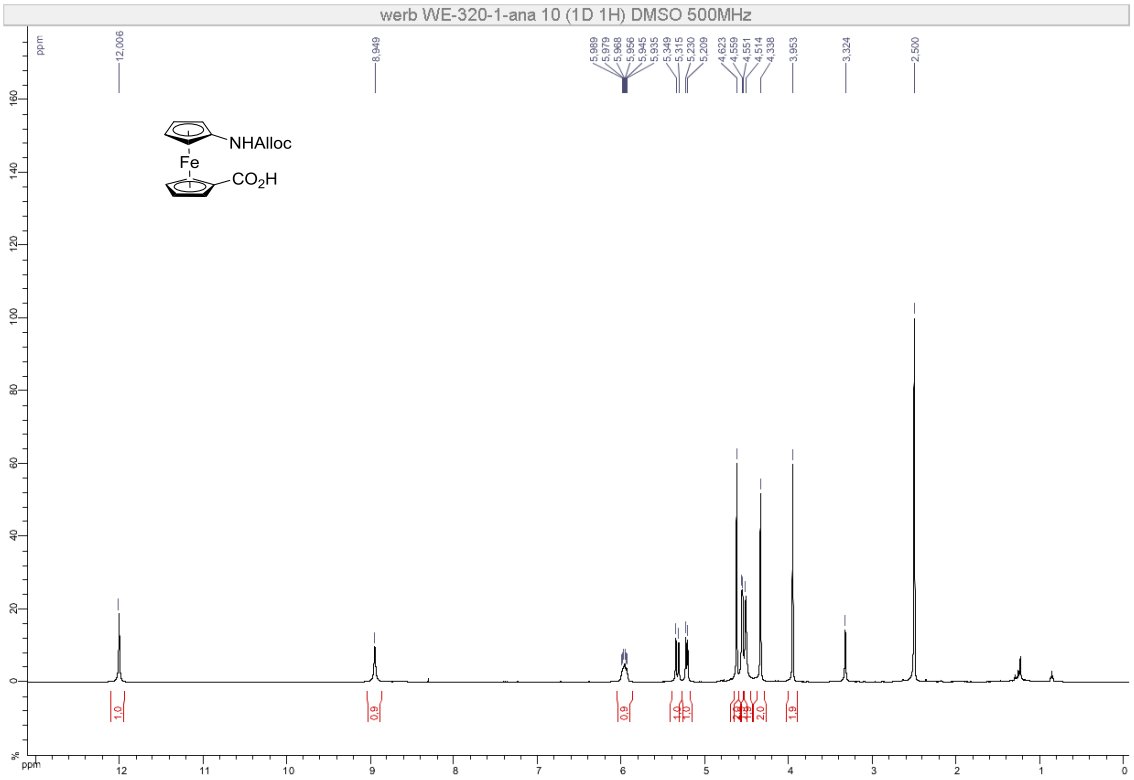

werb WE-324-1-ana 12 (COSY 1H/1H) DMSO 500MHz
werb WE-324-1-ana 18 (1D 1H)
NHFmoc
Fe
CO2H
ppm
9,5
9
8,5
8
7,5
7
6,5
6
5,5
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
werb WE-324-1-ana 18 (1D 1H)

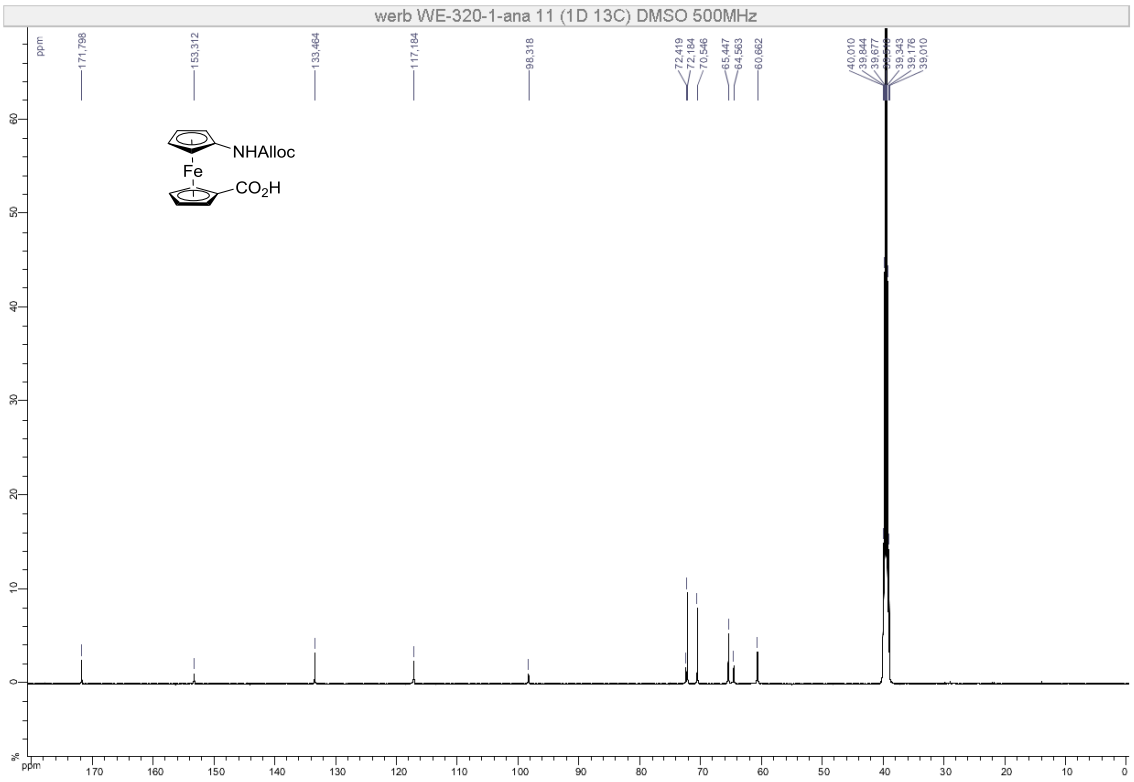

werb WE-324-1-ana 14 (HSQC 1H/13C) DMSO 500MHz
werb WE-324-1-ana 18 (1D 1H)
NHFmoc
Fe
CO2H
ppm
werb WE-324-1-ana 11 (1D 13C)

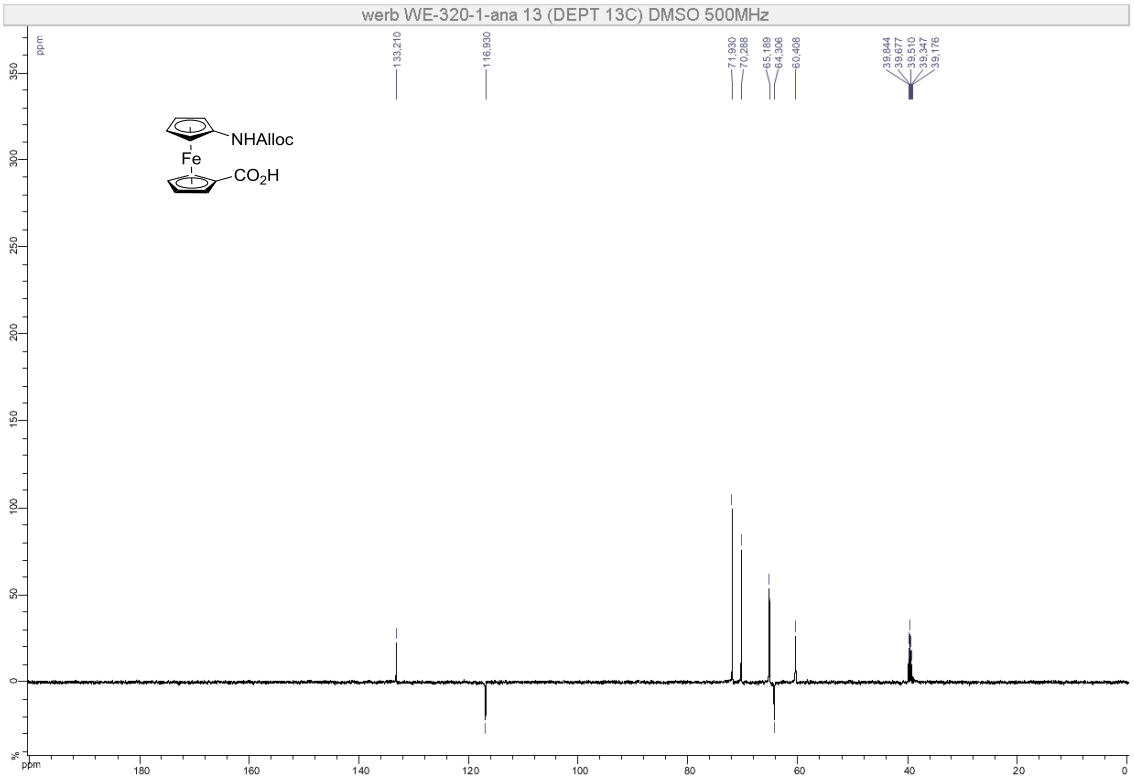

werb WE-324-1-ana 15 (HMBC 1H/13C) DMSO 500MHz
werb WE-324-1-ana 18 (1D 1H)
NHFmoc
Fe
CO2H
ppm
werb WE-324-1-ana 11 (1D 13C)

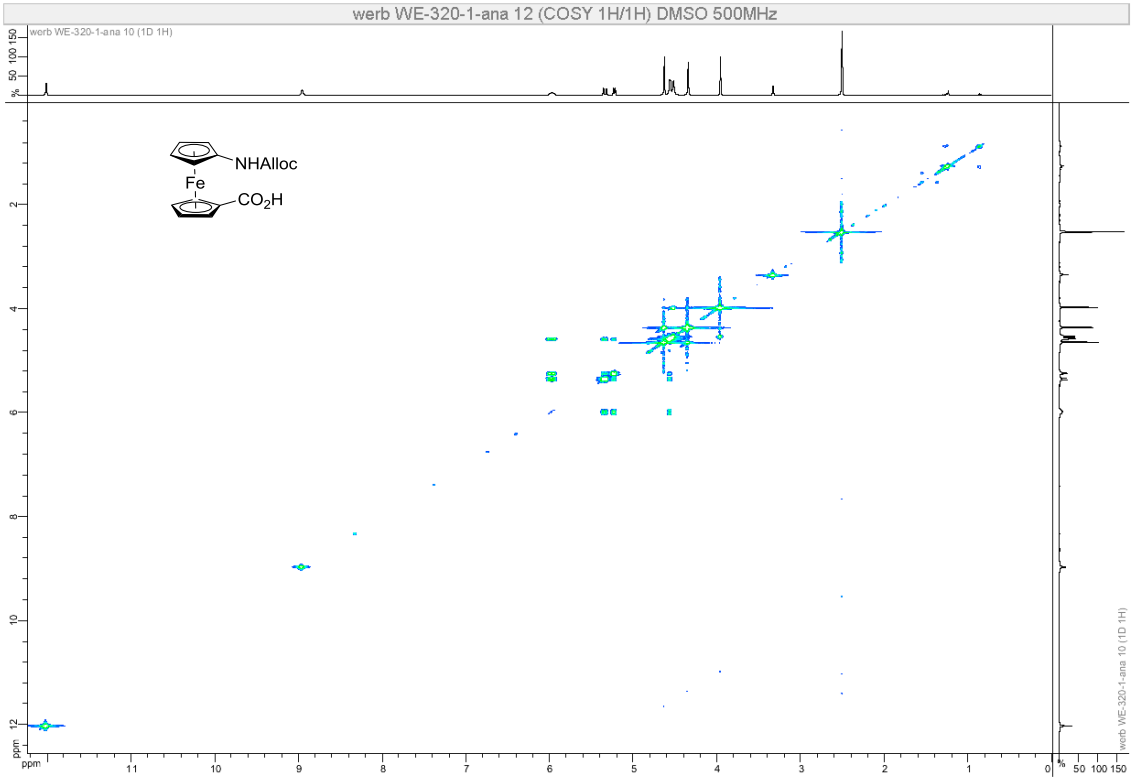


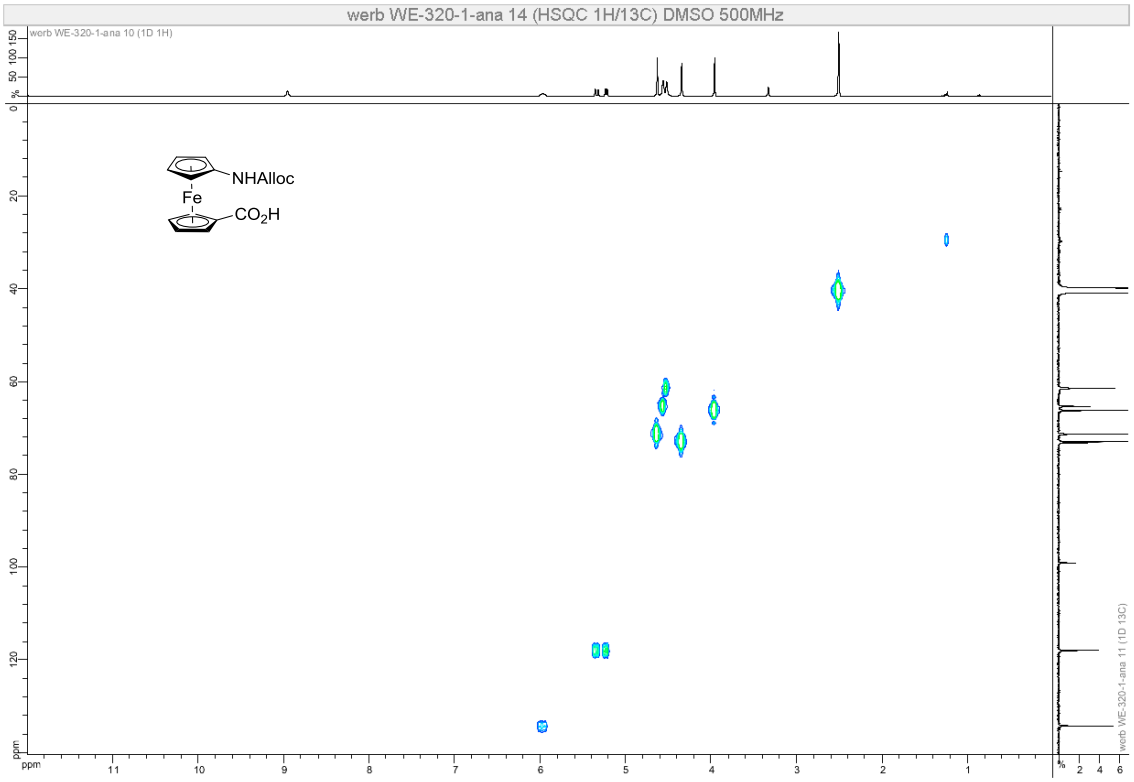
1'-((Allyloxycarbonyl)amino)ferrocene-1-carboxylic acid - 9

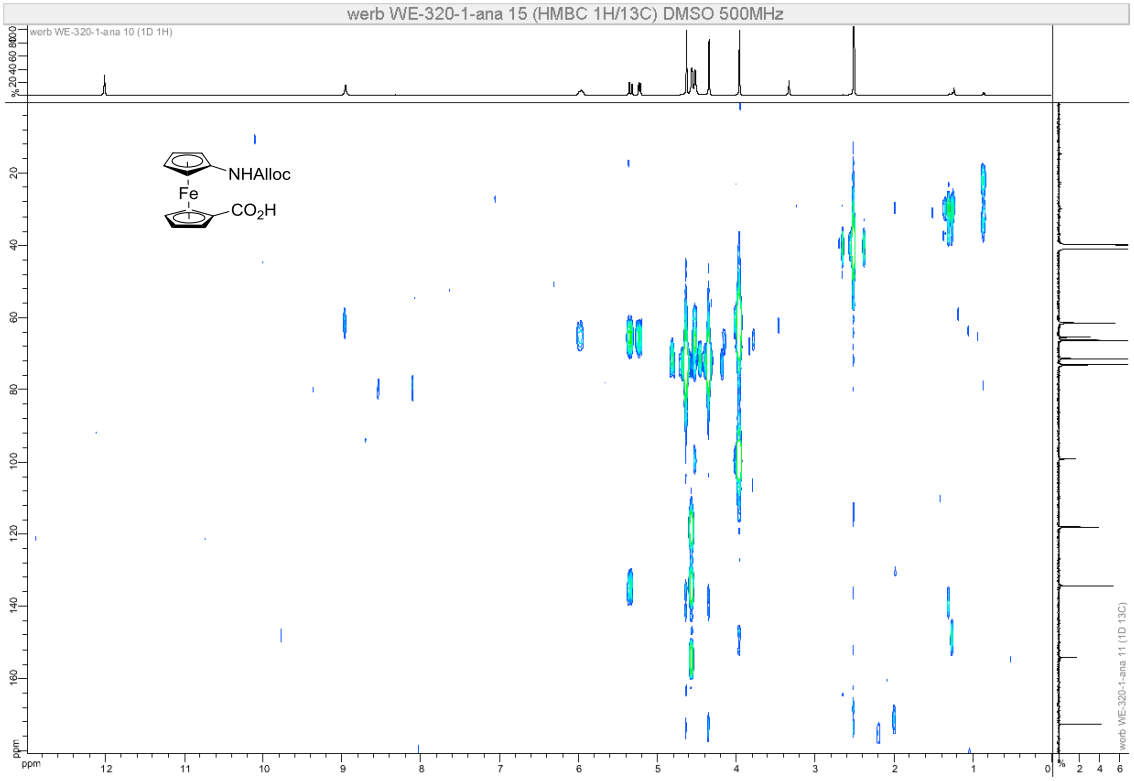


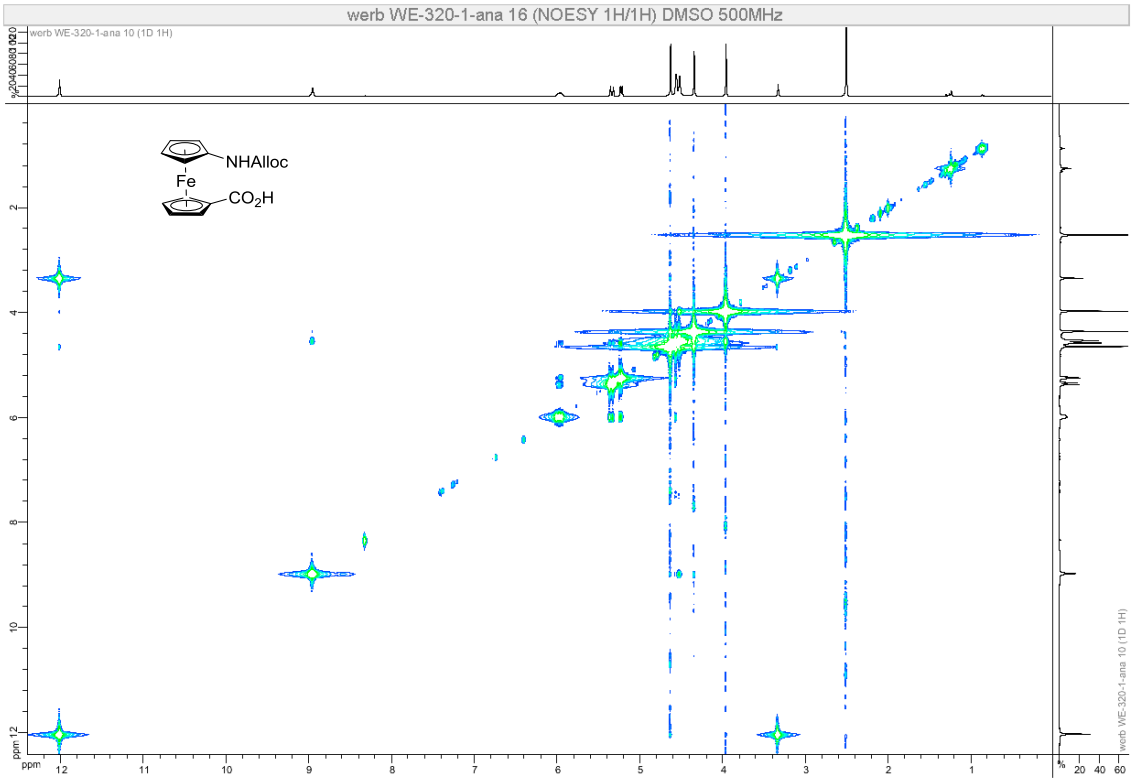

werb WE-320-1-ana 11 (1D 13C) DMSO 500MHz
ppm
171,798
153,312
133,464
117,184
98,318
72,419
72,184
70,546
65,447
64,563
60,662
40,010
39,844
39,677
39,343
39,176
39,010
NHAlloc
Fe
CO2H
%
ppm


werb WE-320-1-ana 13 (DEPT 13C) DMSO 500MHz
ppm
133,210
116,930
71,930
70,288
65,189
64,306
60,408
39,844
39,677
39,510
39,343
39,176
NHAlloc
Fe
CO2H
%
ppm

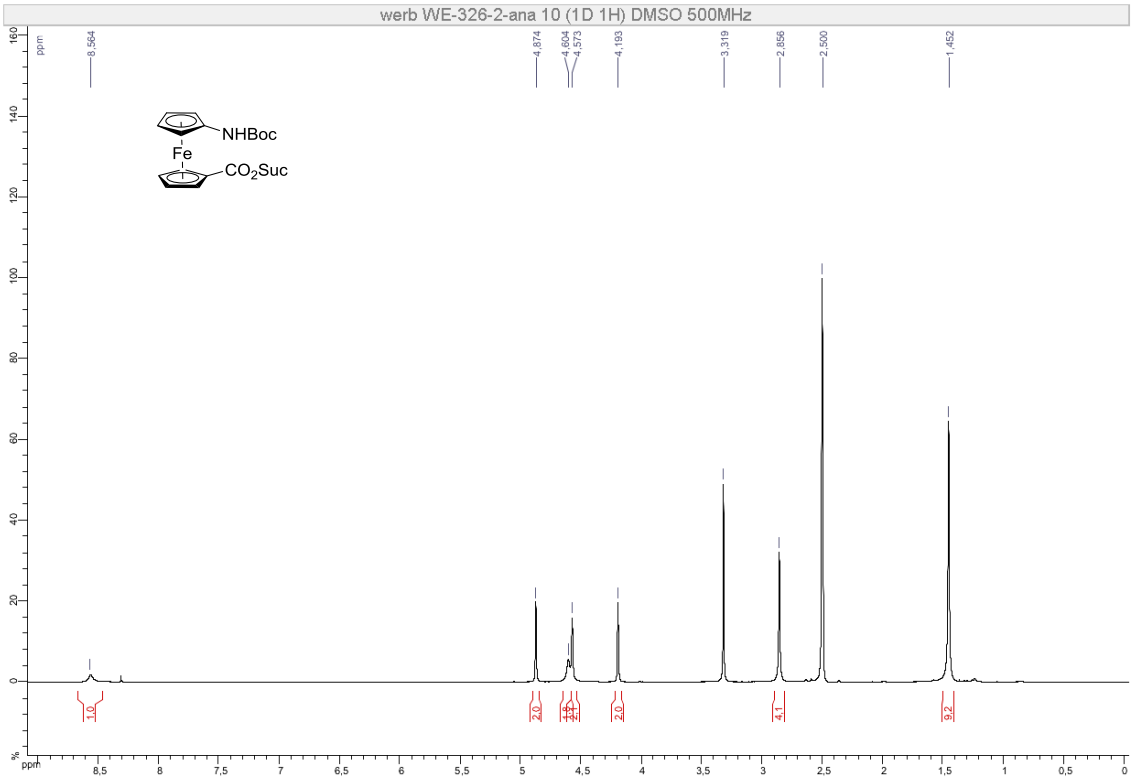

werb WE-320-1-ana 12 (COSY 1H/1H) DMSO 500MHz
NHAlloc
Fe
CO2H
ppm

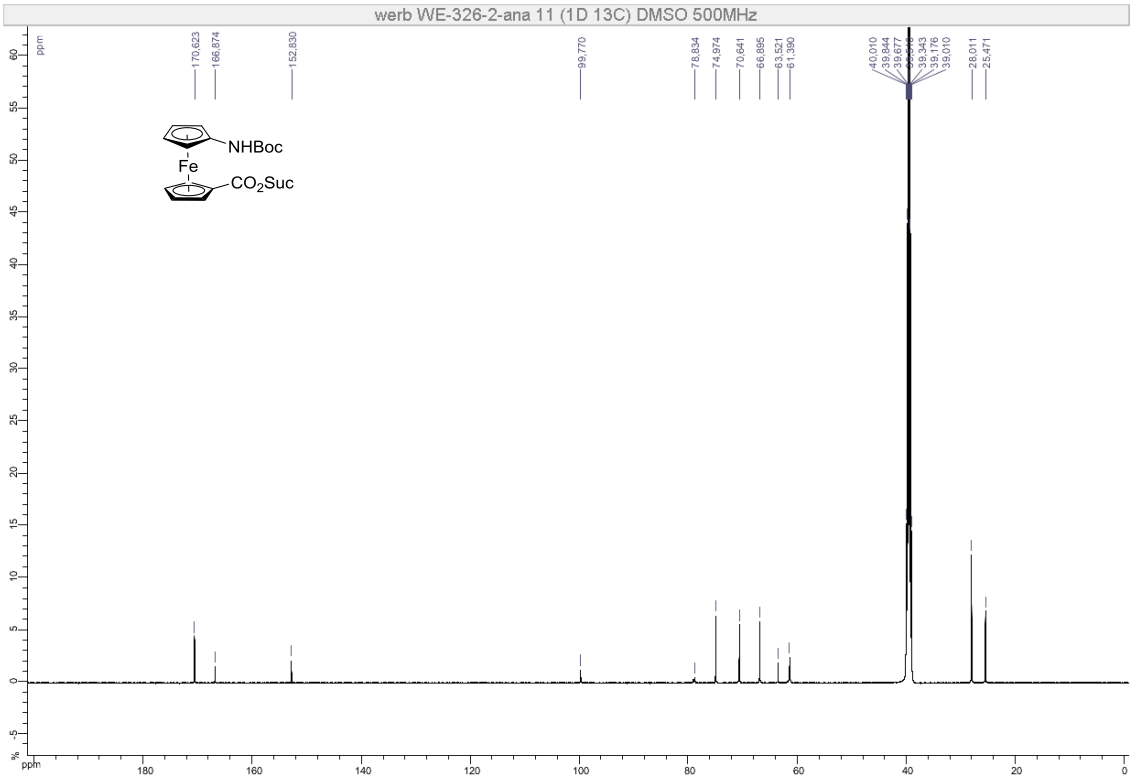

werb WE-320-1-ana 14 (HSQC 1H/13C) DMSO 500MHz
NHAlloc
Fe
CO2H
ppm

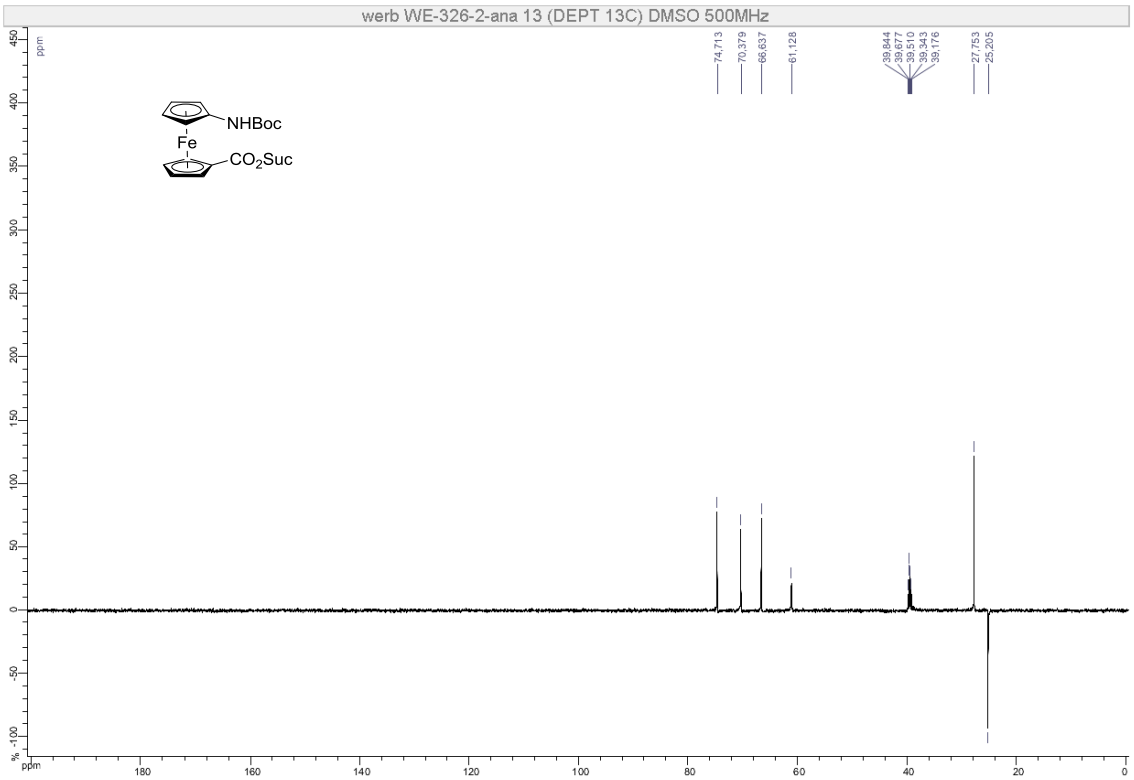

werb WE-320-1-ana 15 (HMBC 1H/13C) DMSO 500MHz
werb WE-320-1-ana 10 (1D 1H)
NHAlloc
Fe
CO2H
ppm
werb WE-320-1-ana 11 (1D 13C)

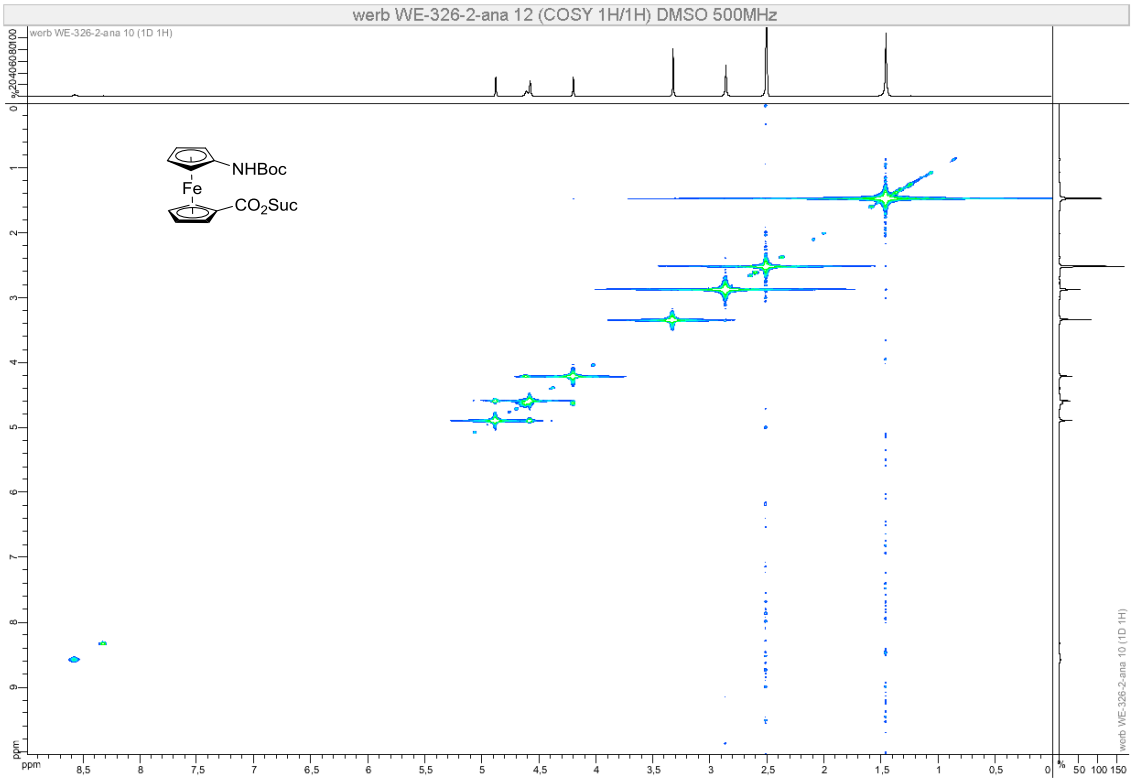

werb WE-320-1-ana 16 (NOESY 1H/1H) DMSO 500MHz
werb WE-320-1-ana 10 (1D 1H)
NHAlloc
Fe
CO2H
ppm
werb WE-320-1-ana 10 (1D 1H)

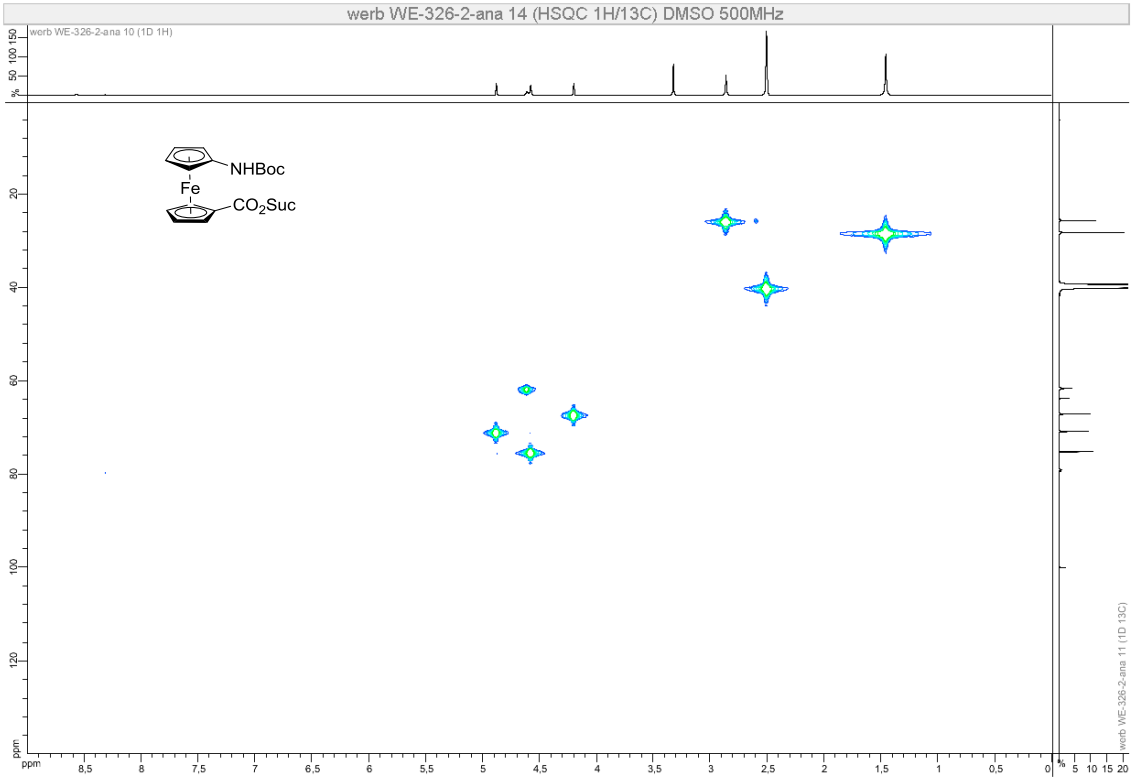
2,5-Dioxopyrrolidin-1-yl 1'-(*tert*-butylcarbonylamino)ferrocene-1-carboxylate - 10

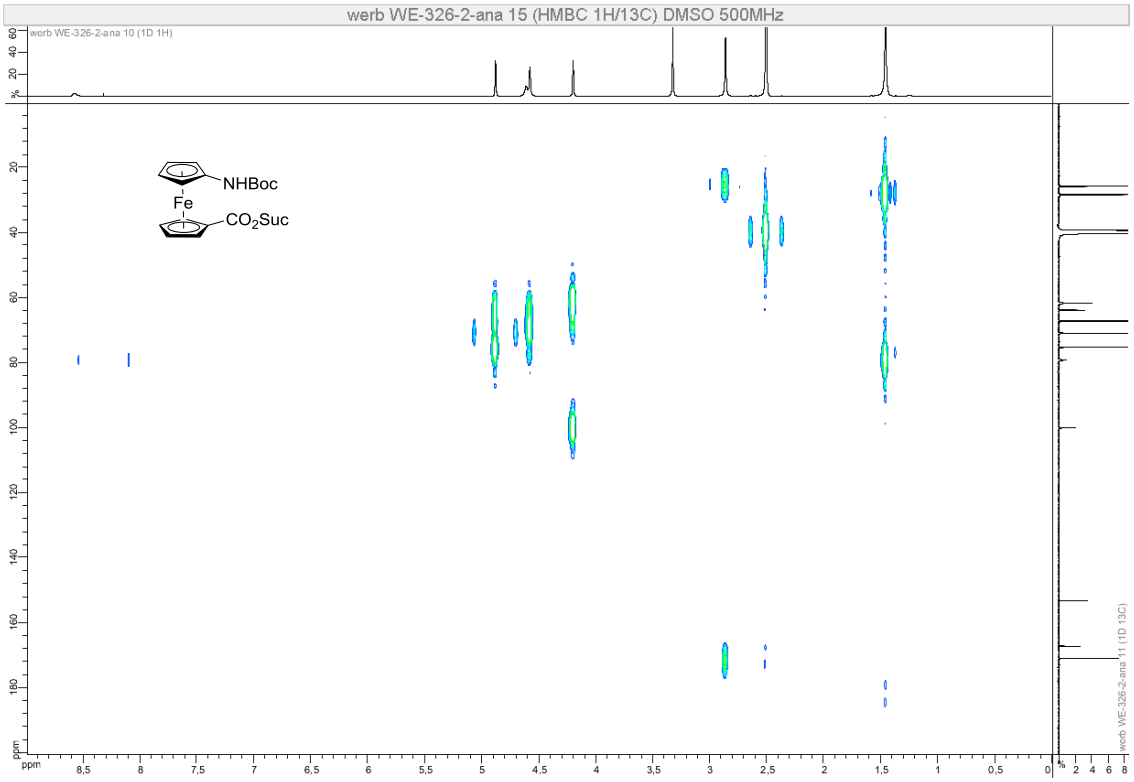


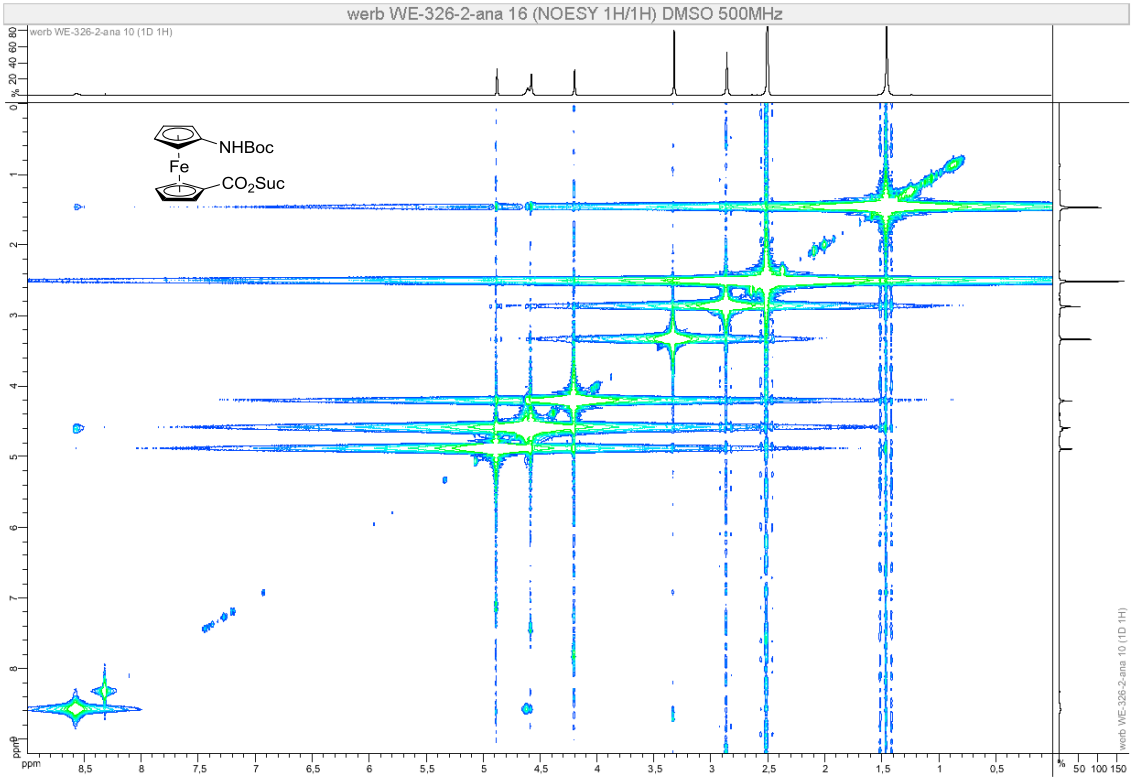



werb WE-326-2-ana 13 (DEPT 13C) DMSO 500MHz
74,713
70,379
66,637
61,128
39,844
39,677
39,510
39,343
39,176
27,753
25,205
NHBoc
Fe
CO2Suc
ppm

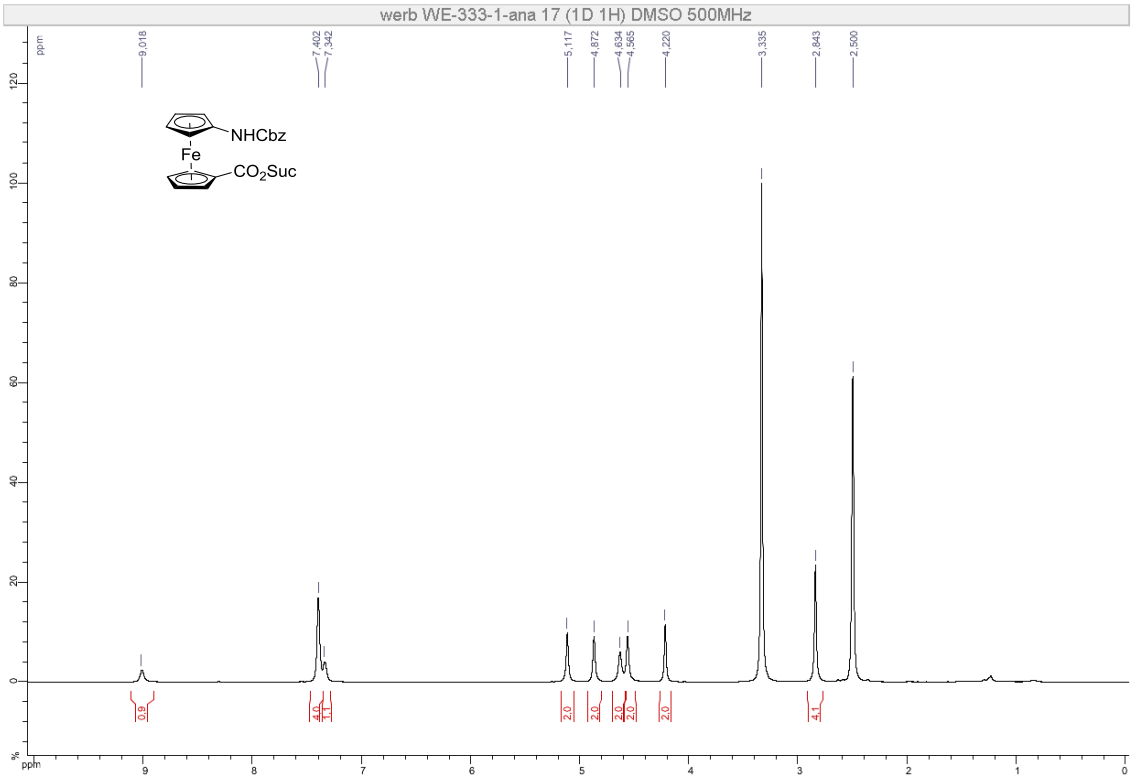

werb WE-326-2-ana 12 (COSY 1H/1H) DMSO 500MHz
werb WE-326-2-ana 10 (1D 1H)
NHBoc
Fe
CO2Suc
ppm

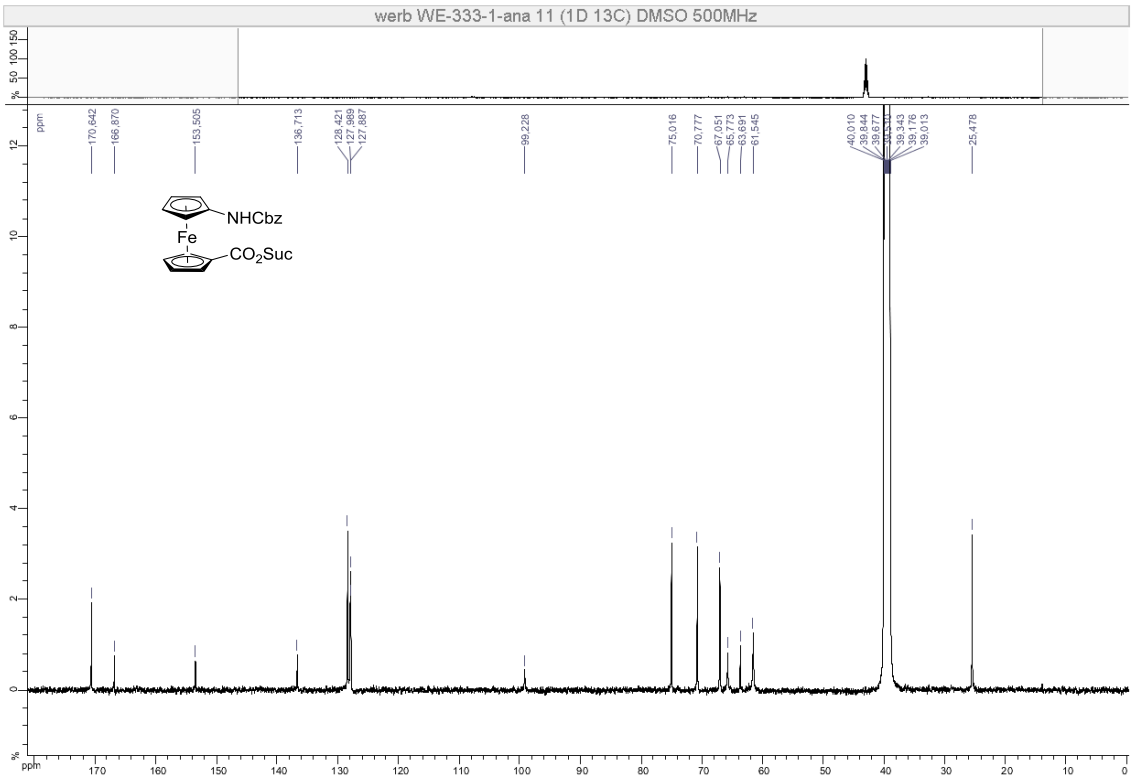

werb WE-326-2-ana 14 (HSQC 1H/13C) DMSO 500MHz
werb WE-326-2-ana 10 (1D 1H)
NHBoc
Fe
CO2Suc
ppm
werb WE-326-2-ana 11 (1D 13C)

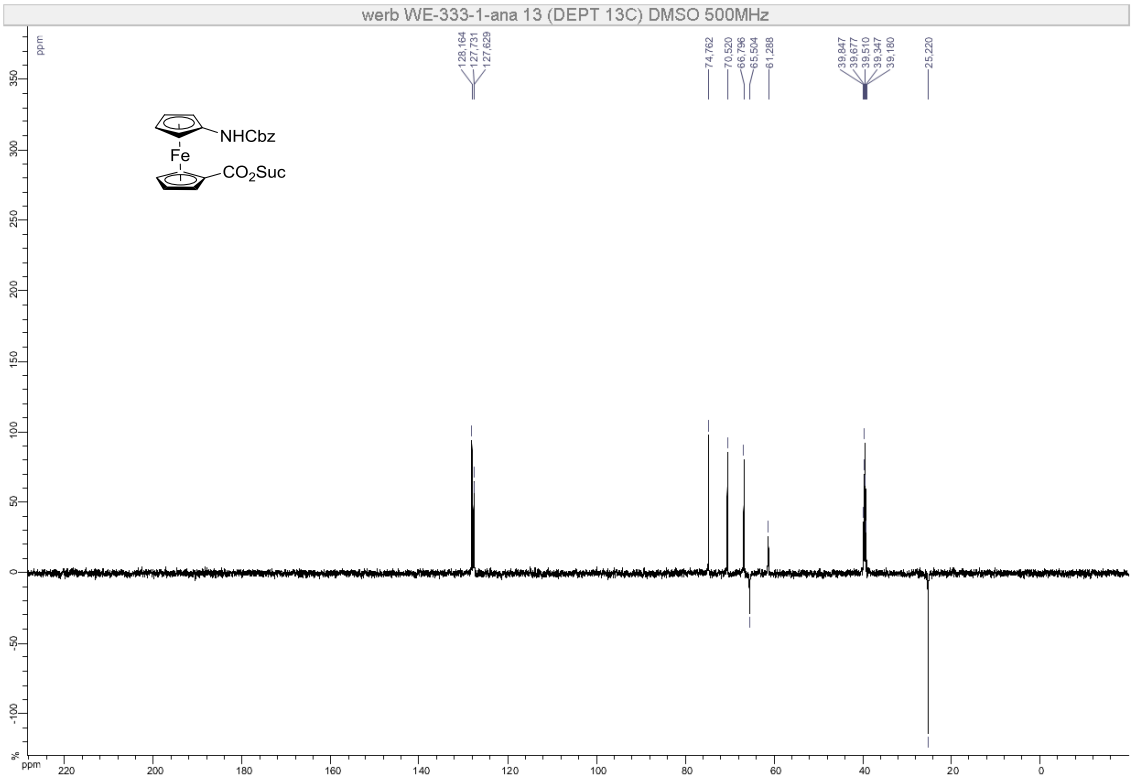

werb WE-326-2-ana 15 (HMBC 1H/13C) DMSO 500MHz
werb WE-326-2-ana 10 (1D 1H)
NHBoc
Fe
CO2Suc
ppm
werb WE-326-2-ana 11 (1D 13C)

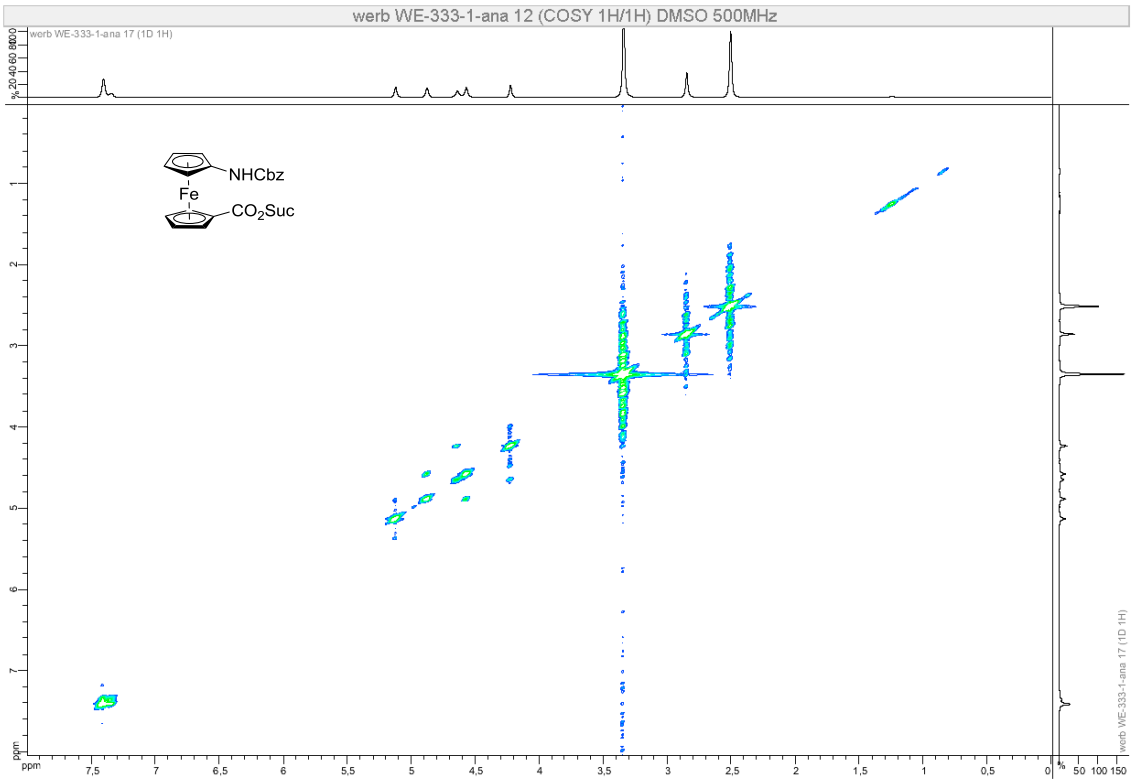


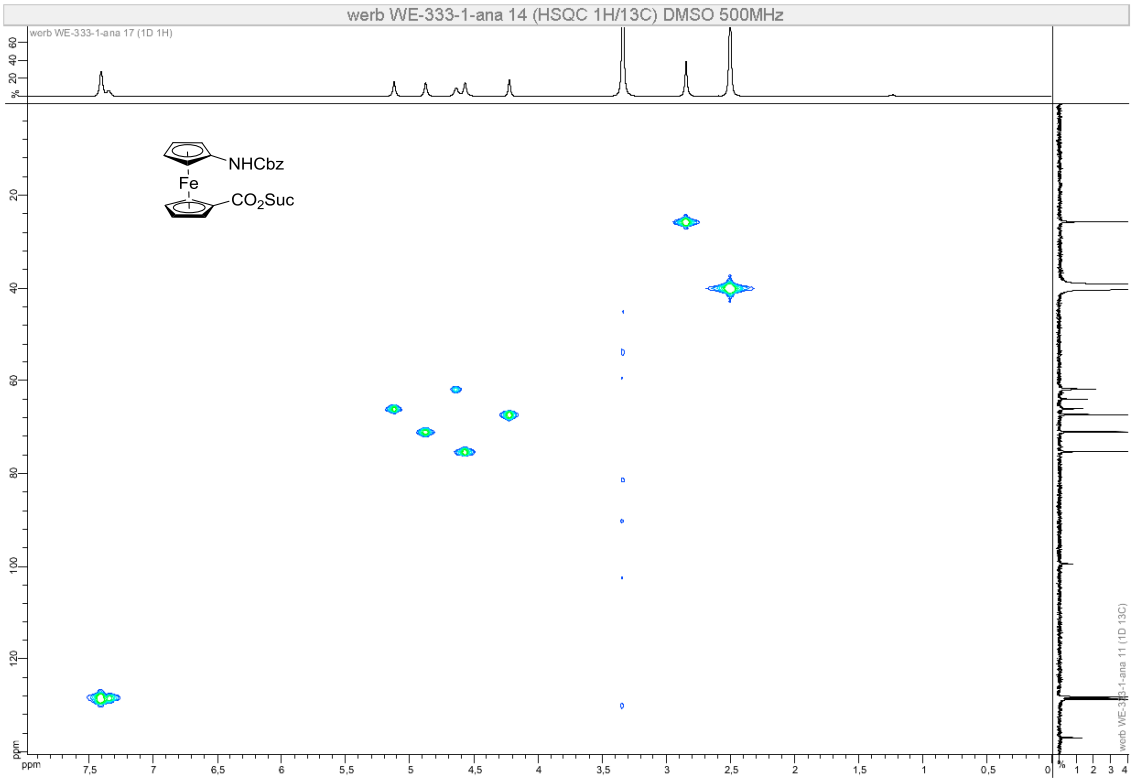
2,5-Dioxopyrrolidin-1-yl 1'-((benzyloxycarbonyl)amino)ferrocene-1-carboxylate - 11

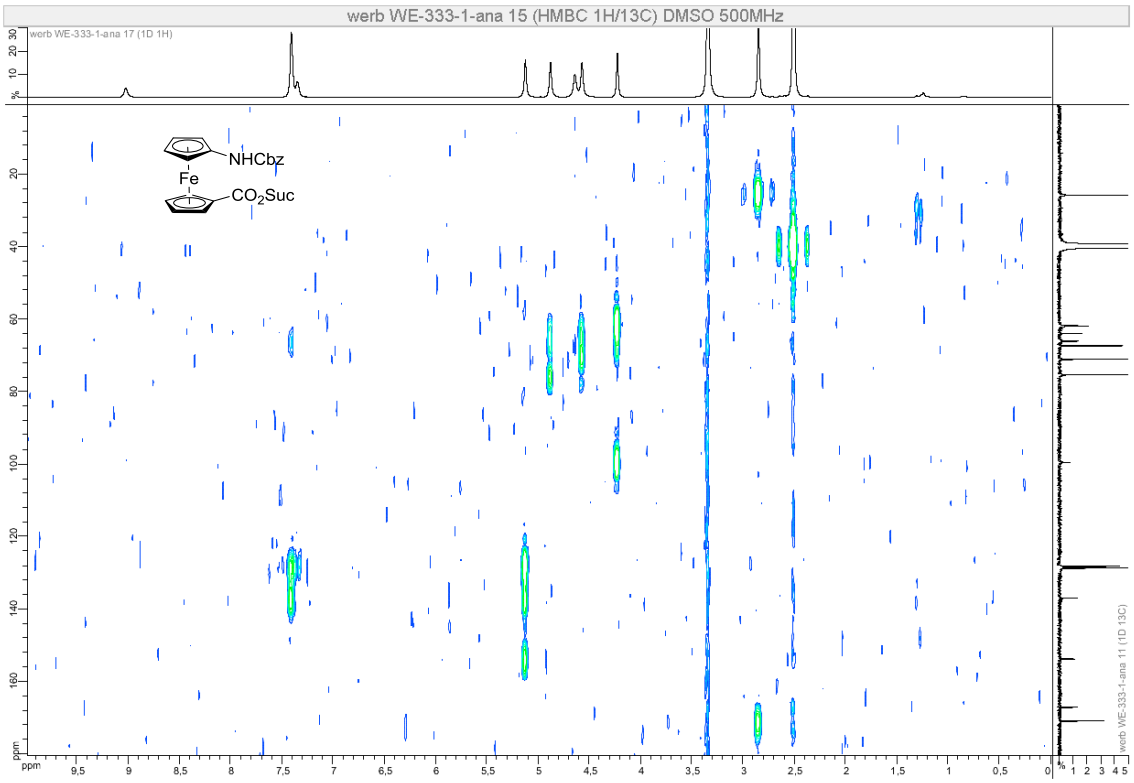


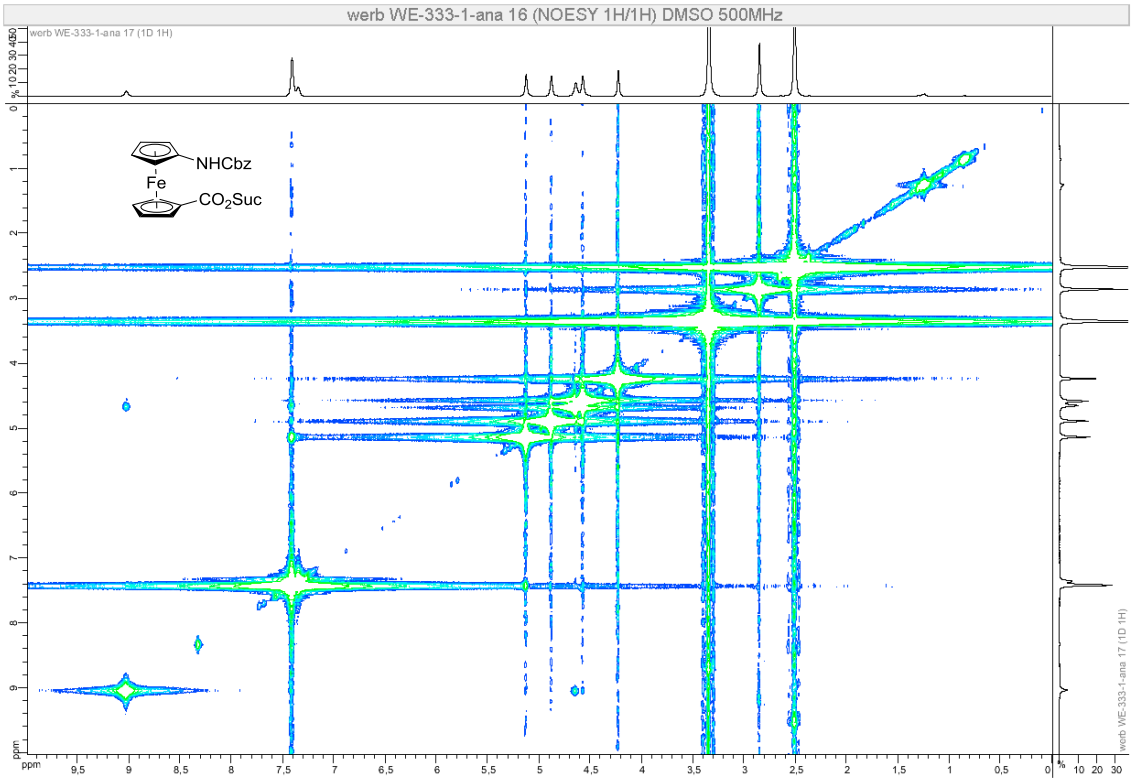

werb WE-333-1-ana 11 (1D 13C) DMSO 500MHz
ppm
170.642
166.870
153.505
136.713
128.421
127.989
127.387
99.228
75.016
70.777
67.051
65.773
63.691
61.545
40.010
39.844
39.677
39.510
39.343
39.176
39.013
25.478
NHCbz
Fe
CO2Suc


werb WE-333-1-ana 13 (DEPT 13C) DMSO 500MHz
ppm
128.164
127.731
127.629
74.762
70.520
66.796
65.504
61.288
39.847
39.677
39.510
39.347
39.180
25.220
NHCbz
Fe
CO2Suc

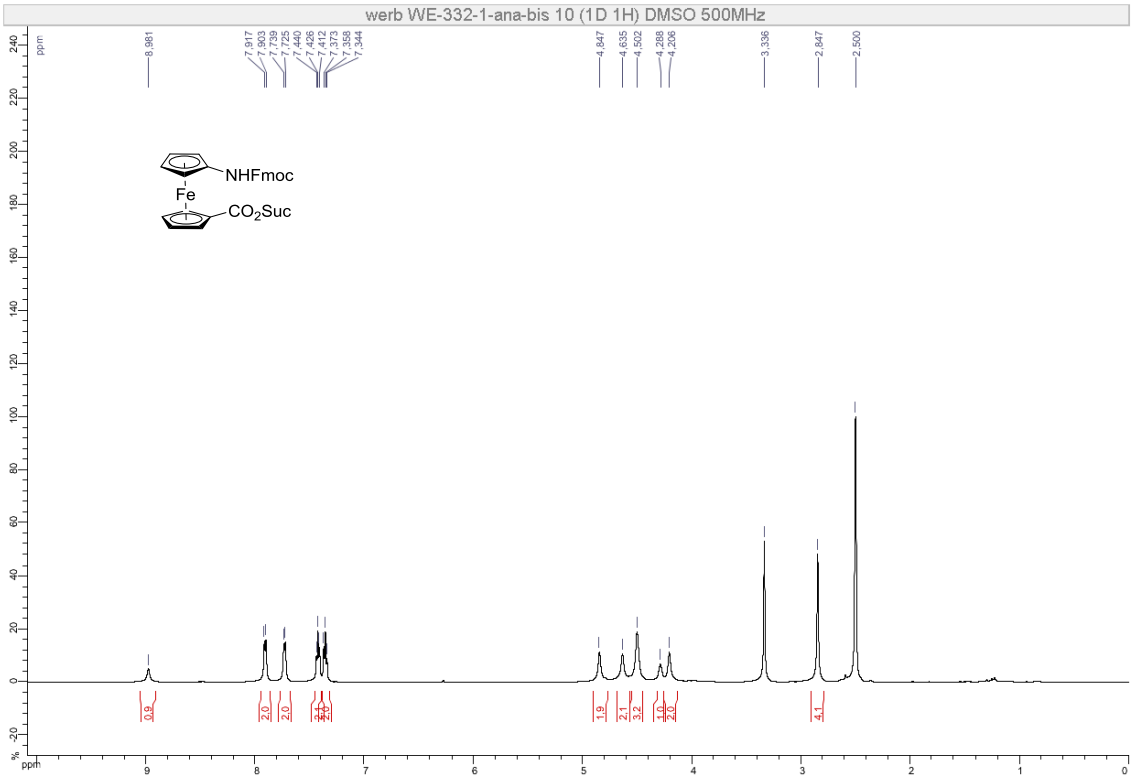

werb WE-333-1-ana 12 (COSY 1H/1H) DMSO 500MHz
NHCbz
Fe
CO2Suc
ppm

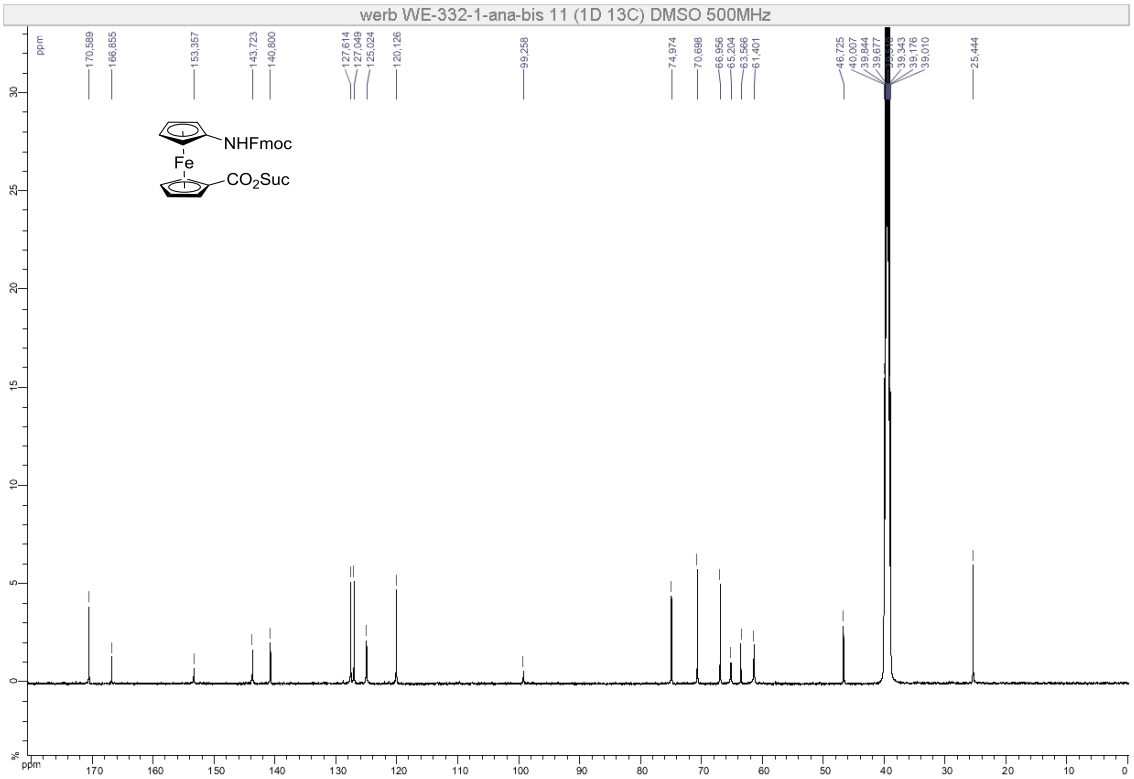

werb WE-333-1-ana 14 (HSQC 1H/13C) DMSO 500MHz
NHCbz
Fe
CO2Suc
ppm

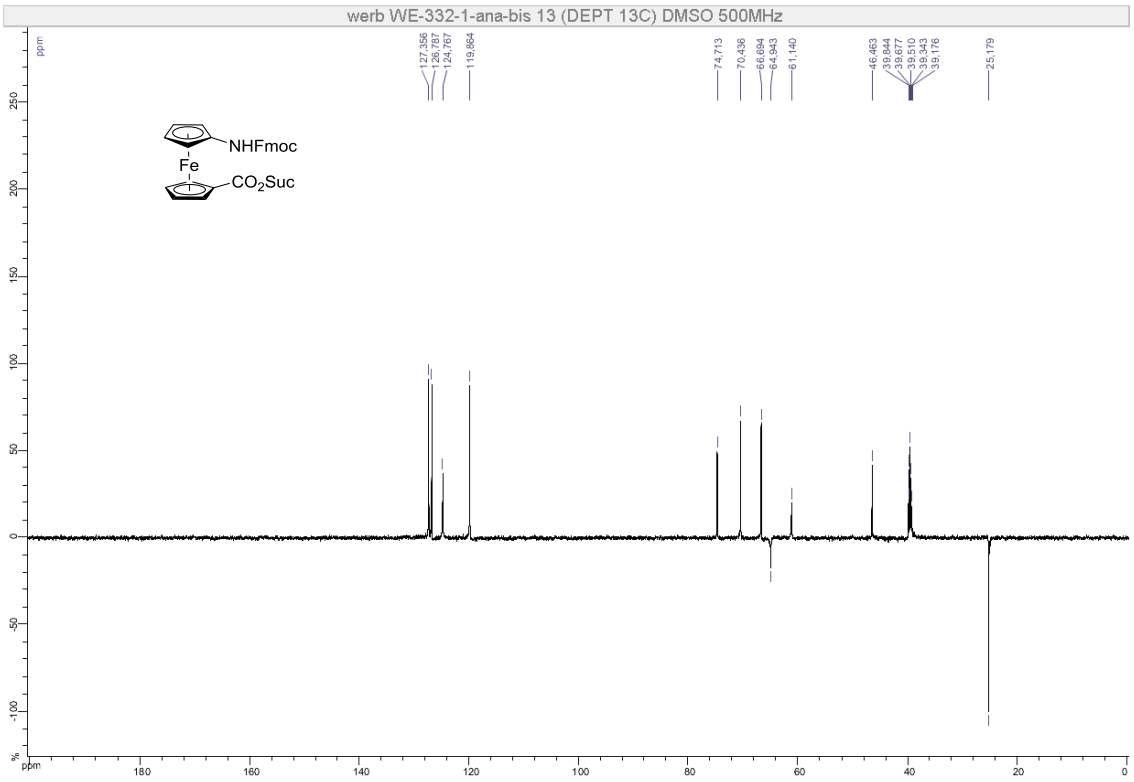

werb WE-333-1-ana 15 (HMBC 1H/13C) DMSO 500MHz
NHCbz
Fe
CO2Suc
ppm

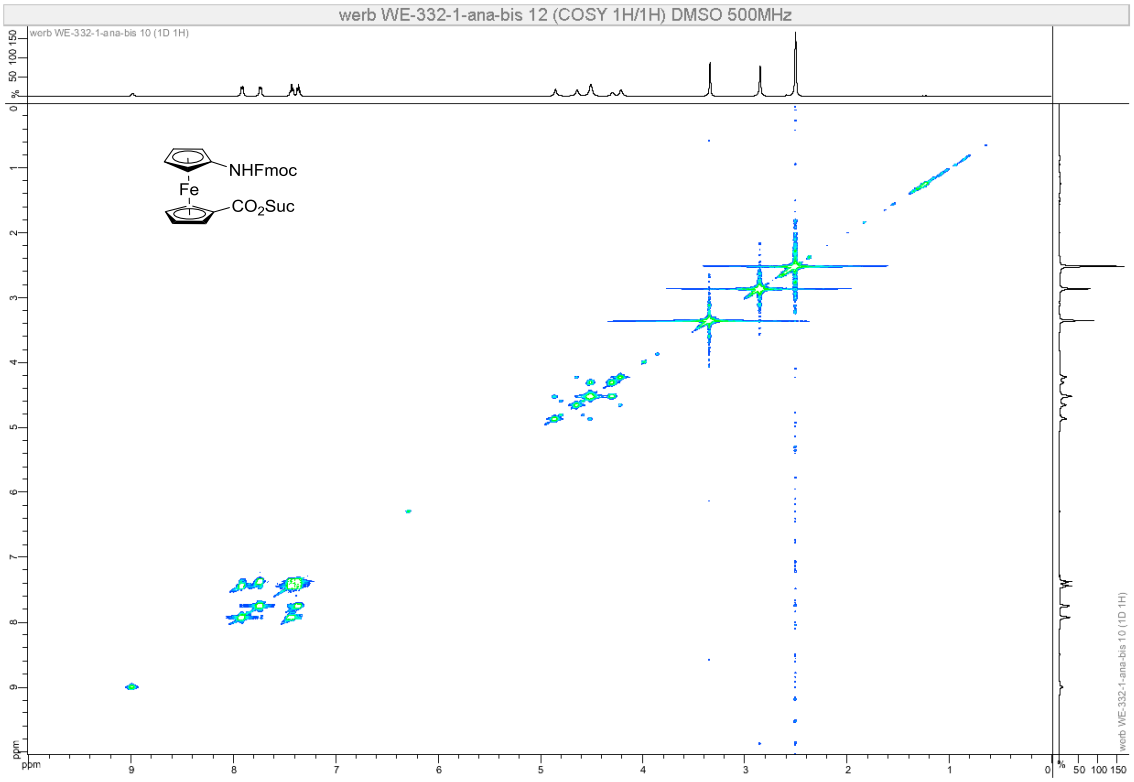

werb WE-333-1-ana 16 (NOESY 1H/1H) DMSO 500MHz
NHCbz
Fe
CO2Suc
ppm

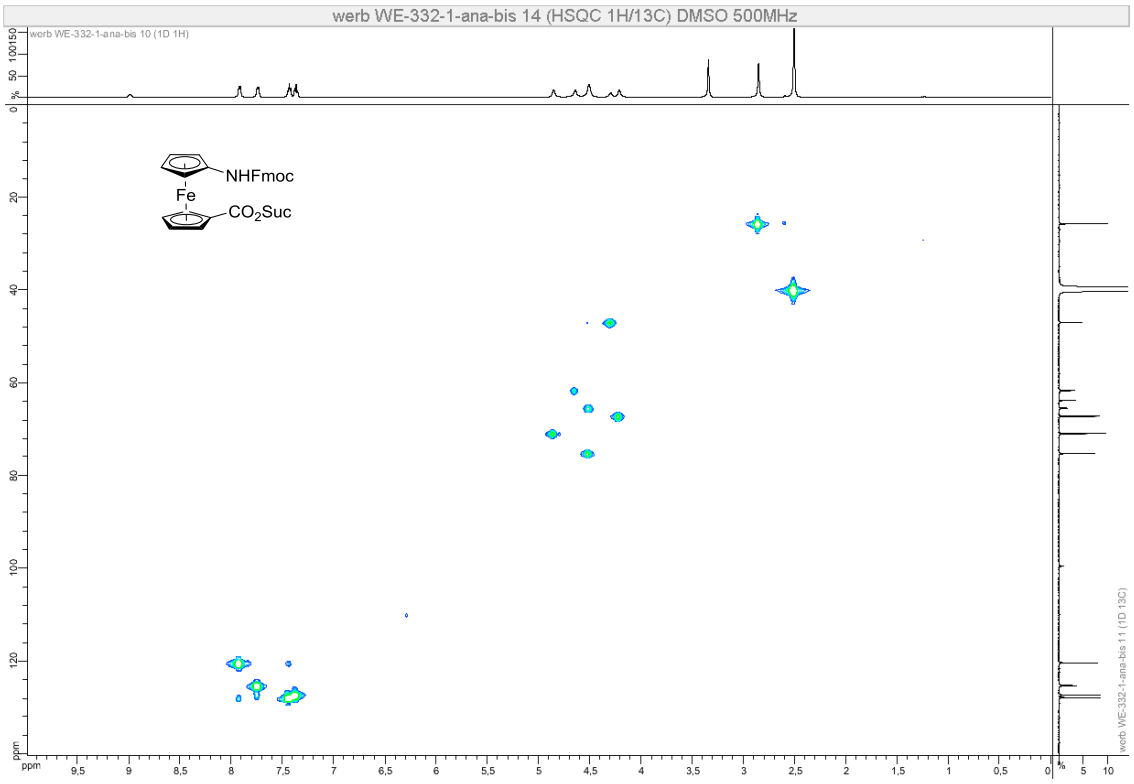
2,5-Dioxopyrrolidin-1-yl 1'-[((fluoren-9-yl)methoxycarbonyl)amino]ferrocene-1-carboxylate - 12

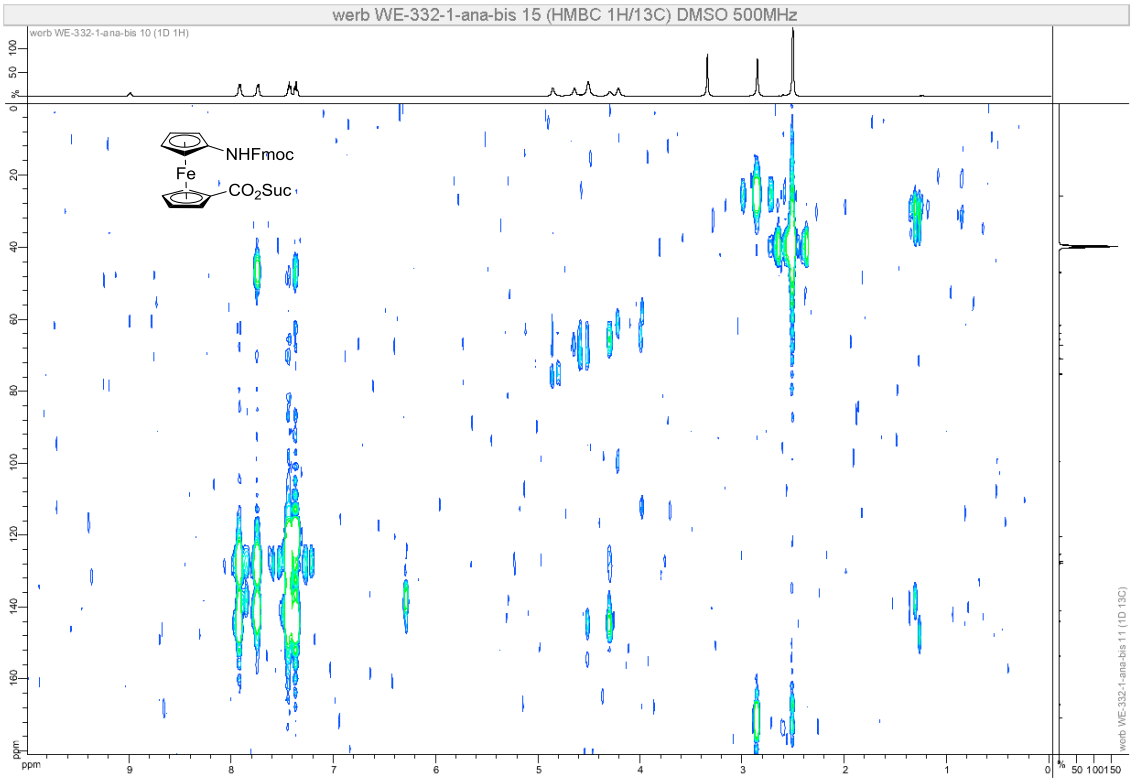


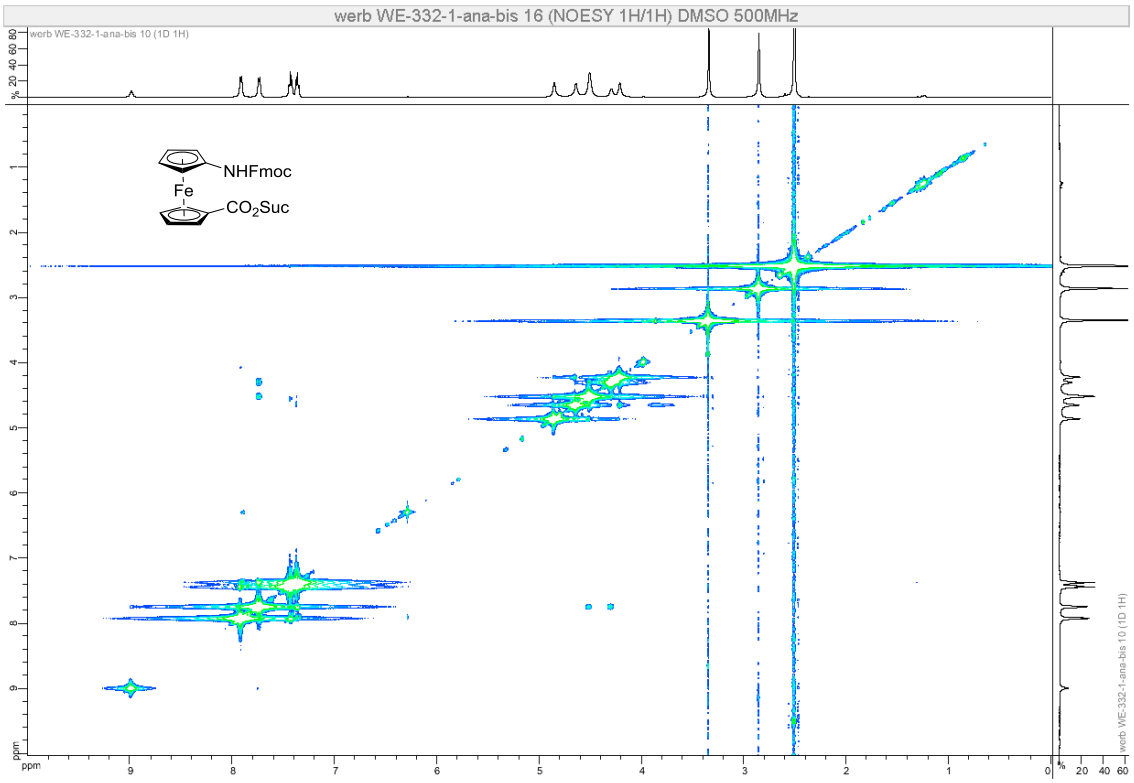



werb WE-332-1-ana-bis 13 (DEPT 13C) DMSO 500MHz
127.356
126.787
124.767
119.864
74.713
70.436
66.694
64.943
61.140
46.463
39.844
39.677
39.510
39.343
39.176
25.179
NHFmoc
Fe
CO2Suc
ppm

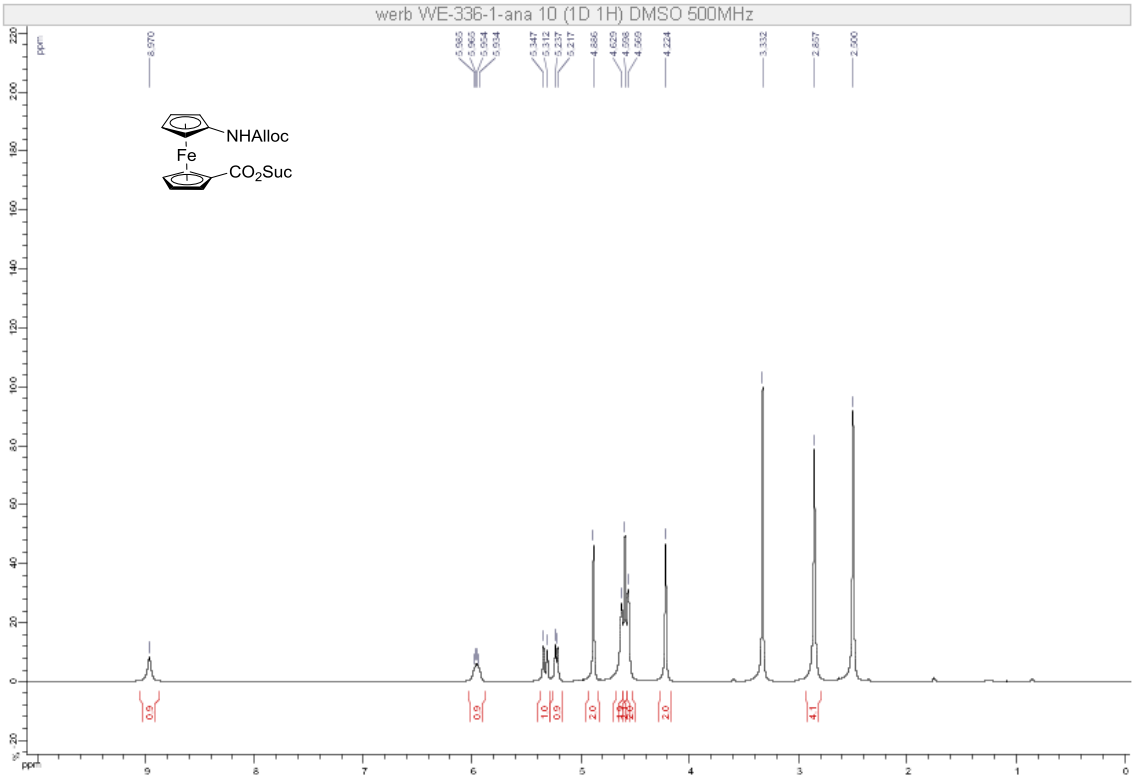

werb WE-332-1-ana-bis 12 (COSY 1H/1H) DMSO 500MHz
werb WE-332-1-ana-bis 10 (1D 1H)
NHFmoc
Fe
CO2Suc
ppm

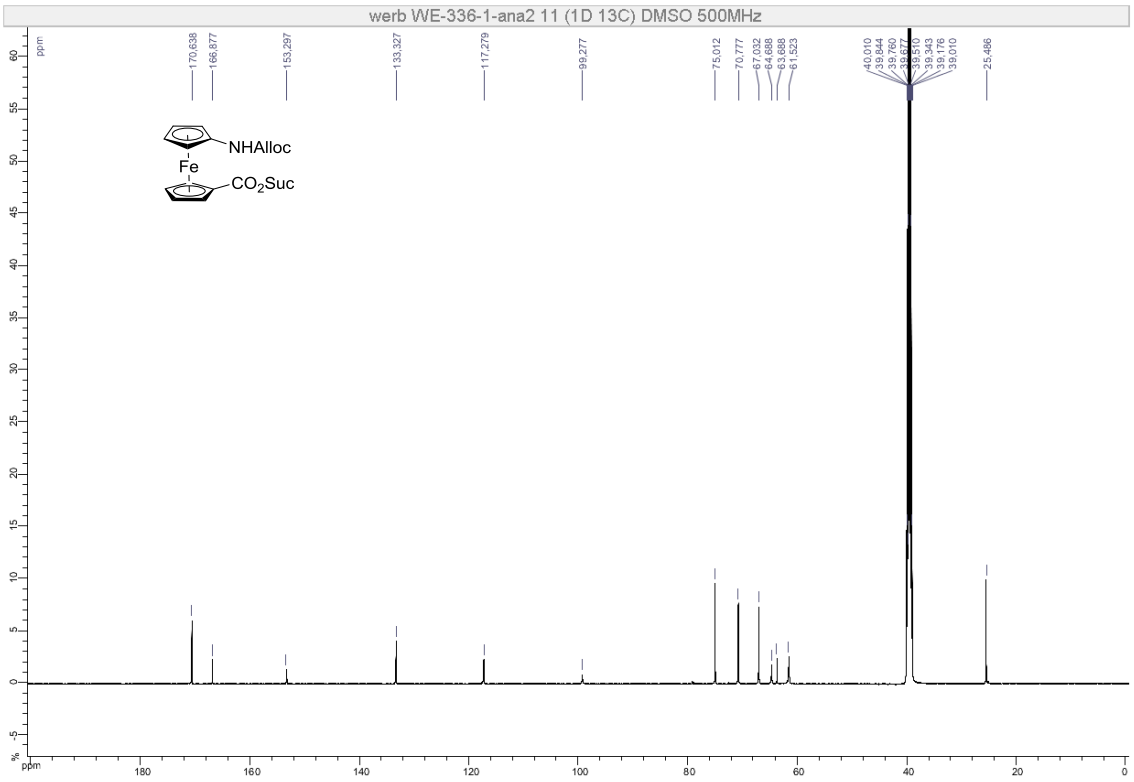

werb WE-332-1-ana-bis 14 (HSQC 1H/13C) DMSO 500MHz
werb WE-332-1-ana-bis 10 (1D 1H)
NHFmoc
Fe
CO2Suc
ppm
werb WE-332-1-ana-bis 11 (1D 13C)

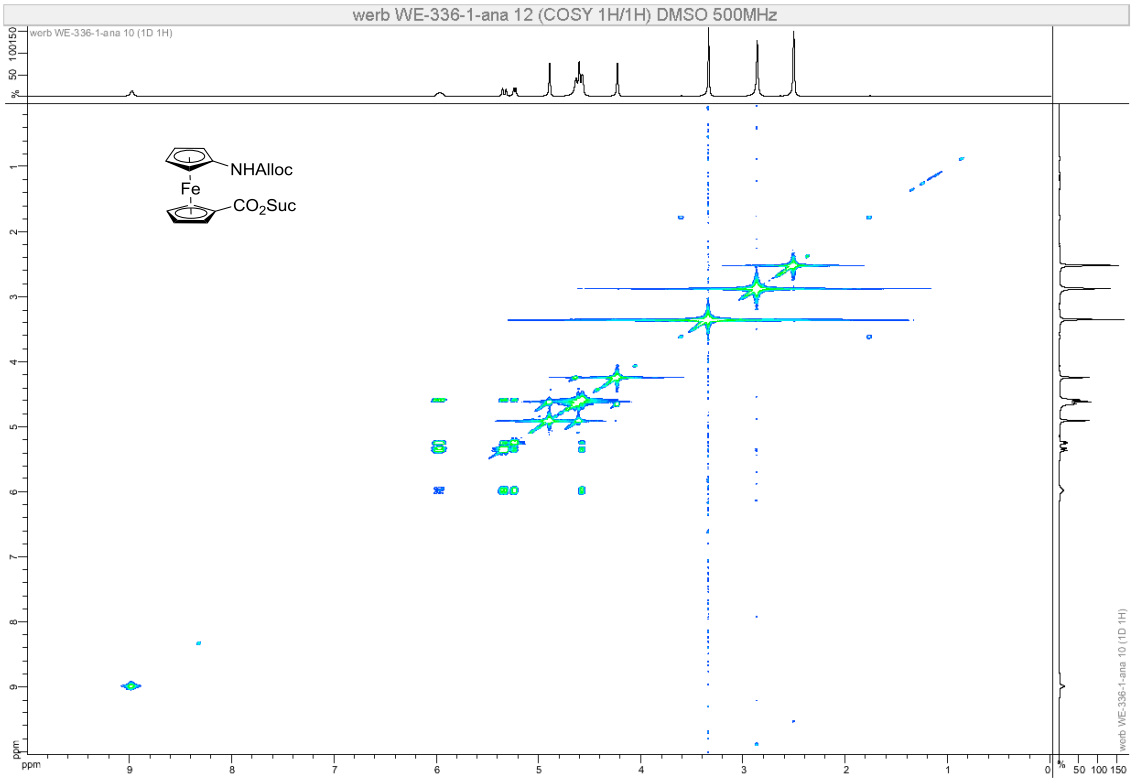

werb WE-332-1-ana-bis 15 (HMBC 1H/13C) DMSO 500MHz
werb WE-332-1-ana-bis 10 (1D 1H)
NHFmoc
Fe
CO2Suc
ppm
werb WE-332-1-ana-bis 11 (1D 13C)

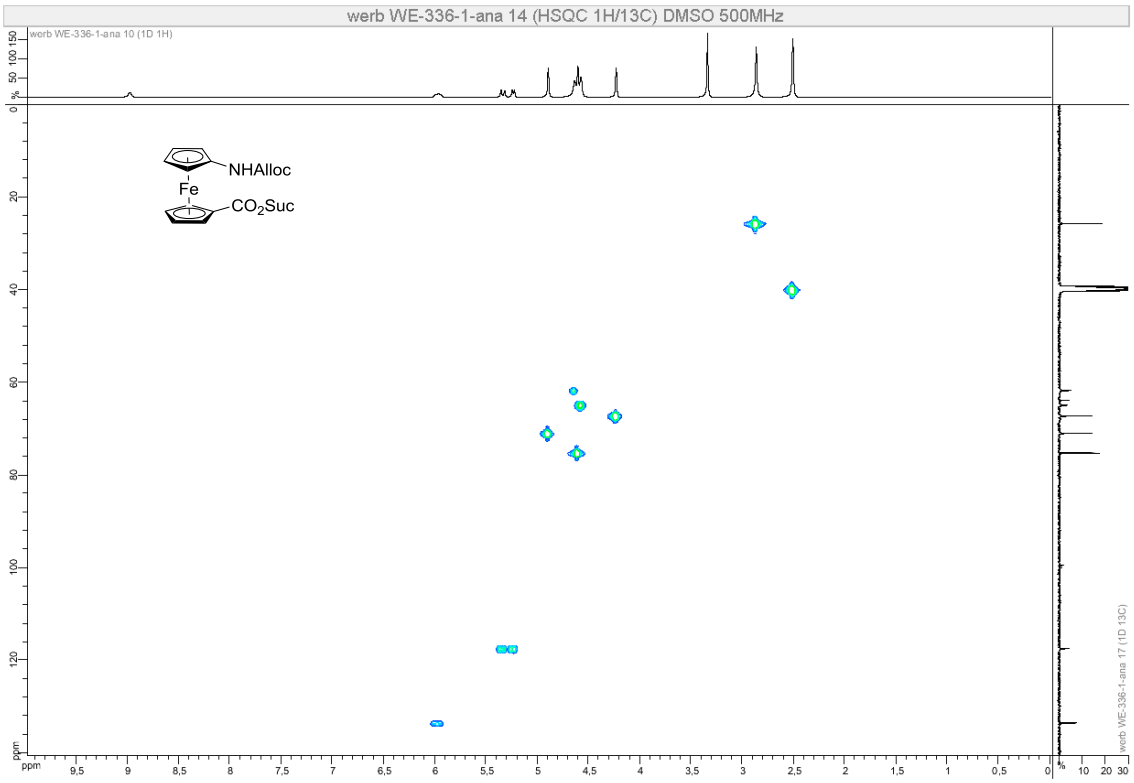


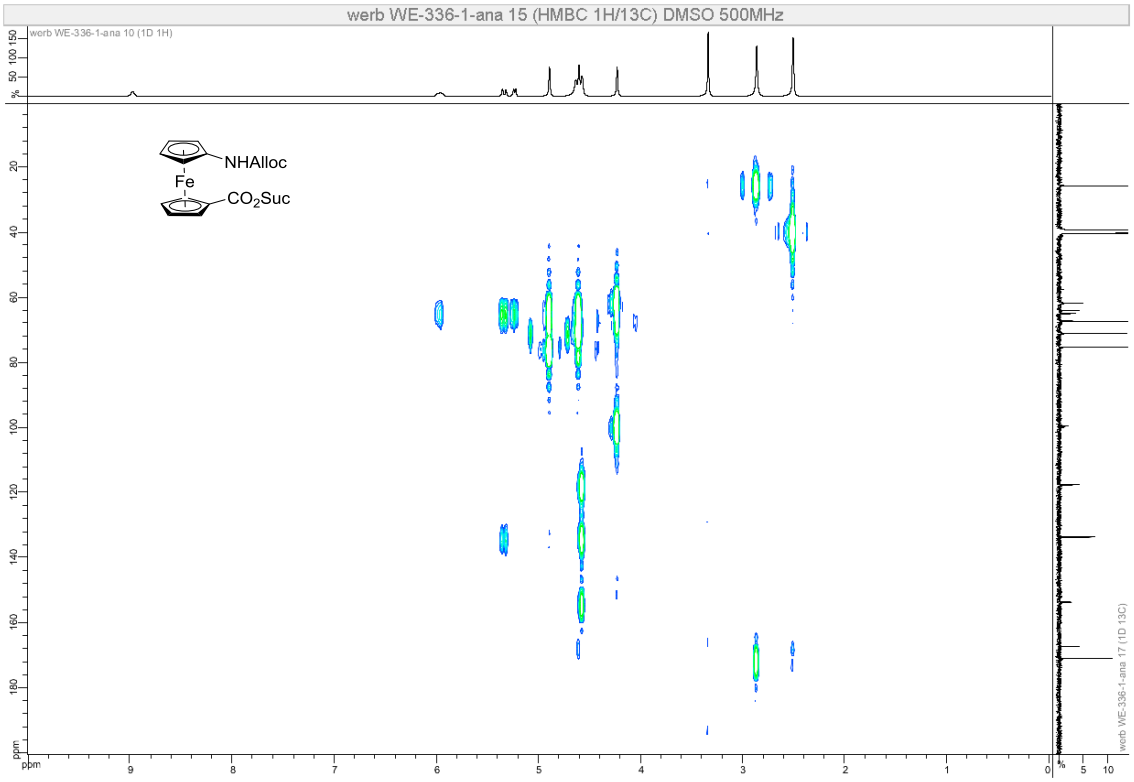
2,5-Dioxopyrrolidin-1-yl 1'-((allyloxycarbonyl)amino)ferrocene -1-carboxylate - 13

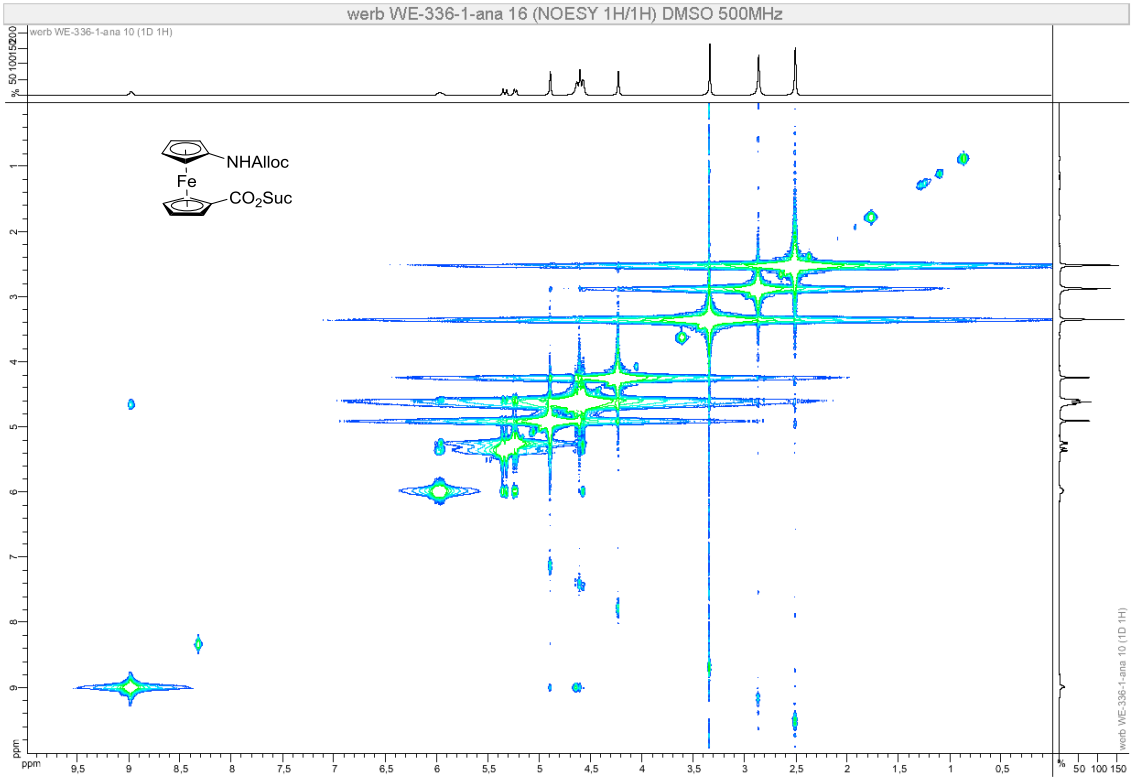



werb WE-336-1-ana2 11 (1D 13C) DMSO 500MHz
170.638
166.877
153.297
133.327
117.279
99.277
75.012
70.777
67.032
64.688
63.688
61.523
40.010
39.844
39.760
39.677
39.510
39.343
39.176
39.010
25.486
NHAlloc
Fe
CO2Suc
ppm

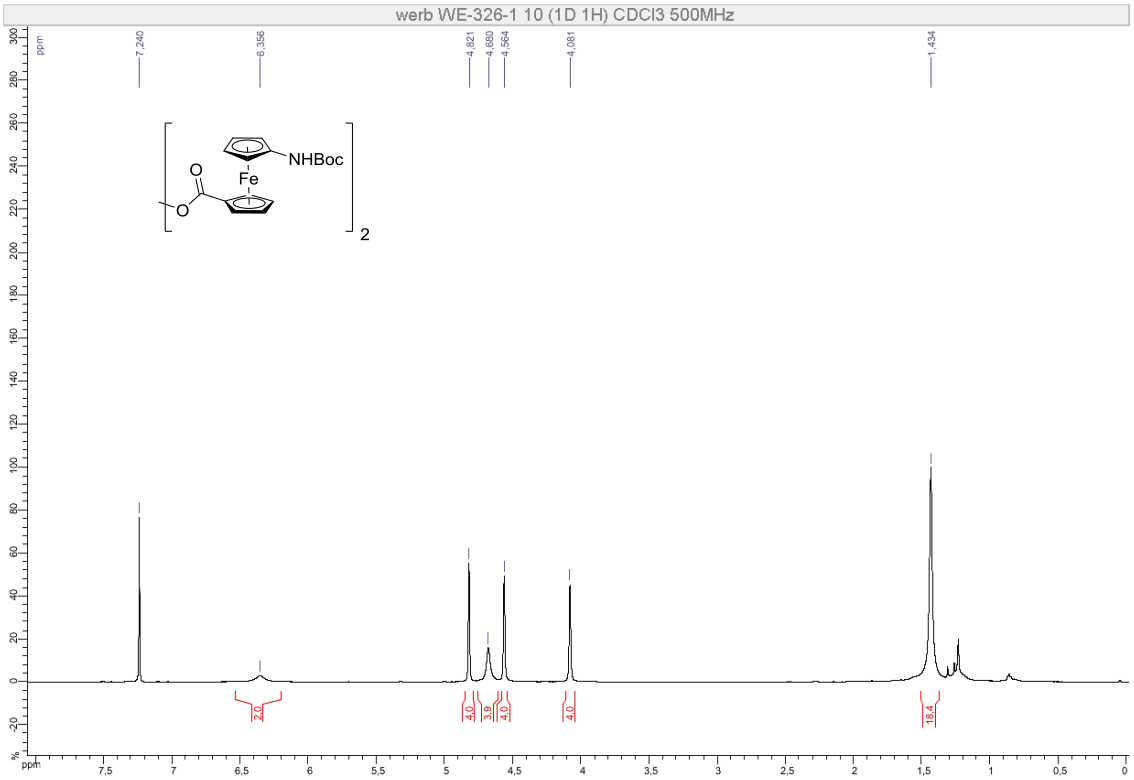

werb WE-336-1-ana 12 (COSY 1H/1H) DMSO 500MHz
werb WE-336-1-ana 10 (1D 1H)
NHAlloc
Fe
CO2Suc
ppm

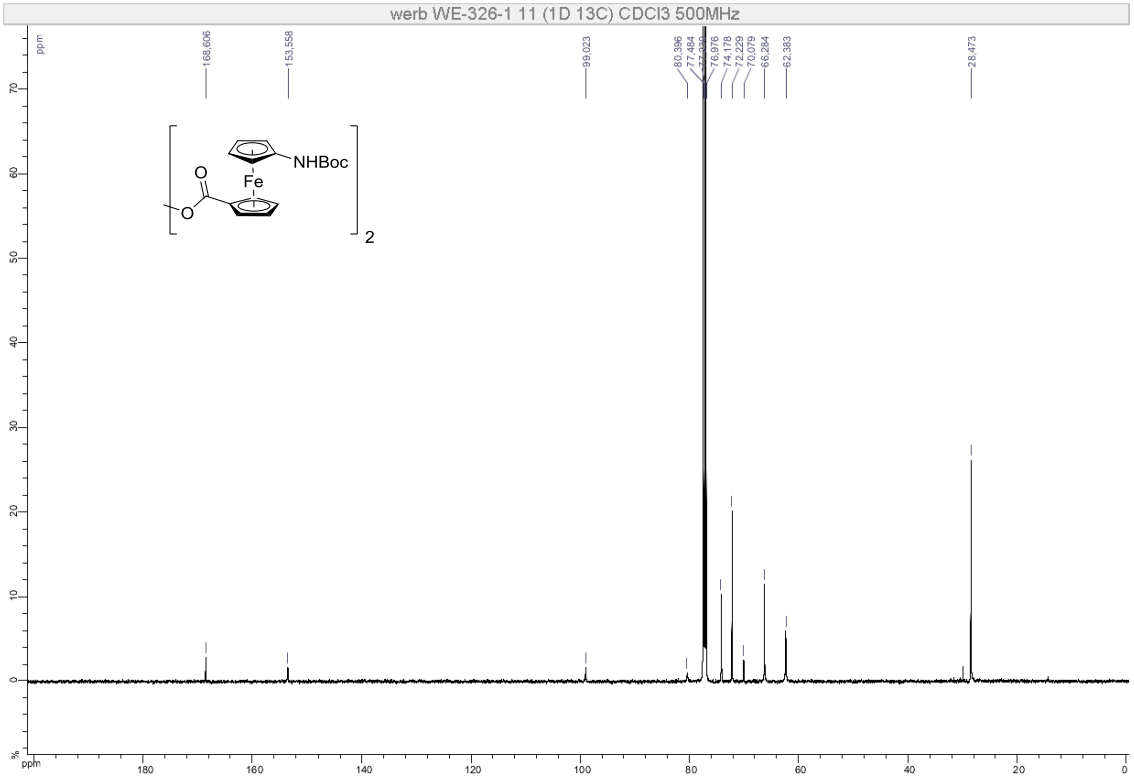

werb WE-336-1-ana 14 (HSQC 1H/13C) DMSO 500MHz
NHAlloc
Fe
CO2Suc
ppm

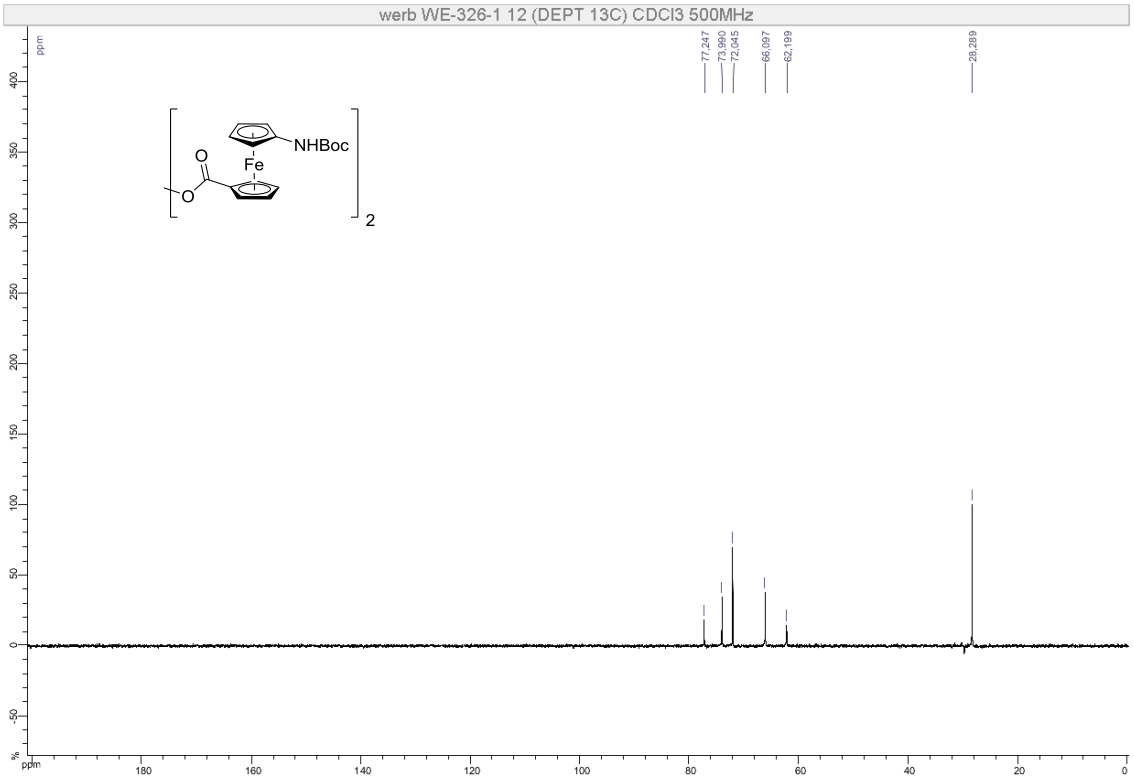

werb WE-336-1-ana 15 (HMBC 1H/13C) DMSO 500MHz
NHAlloc
Fe
CO2Suc
ppm

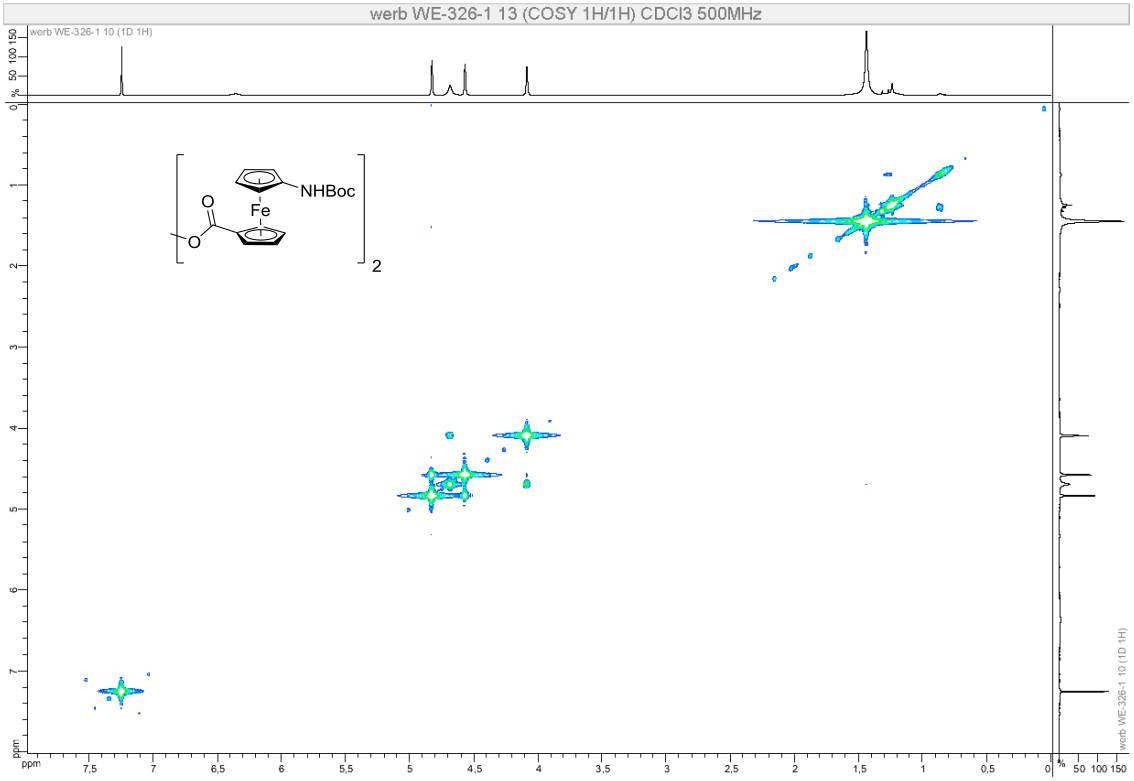


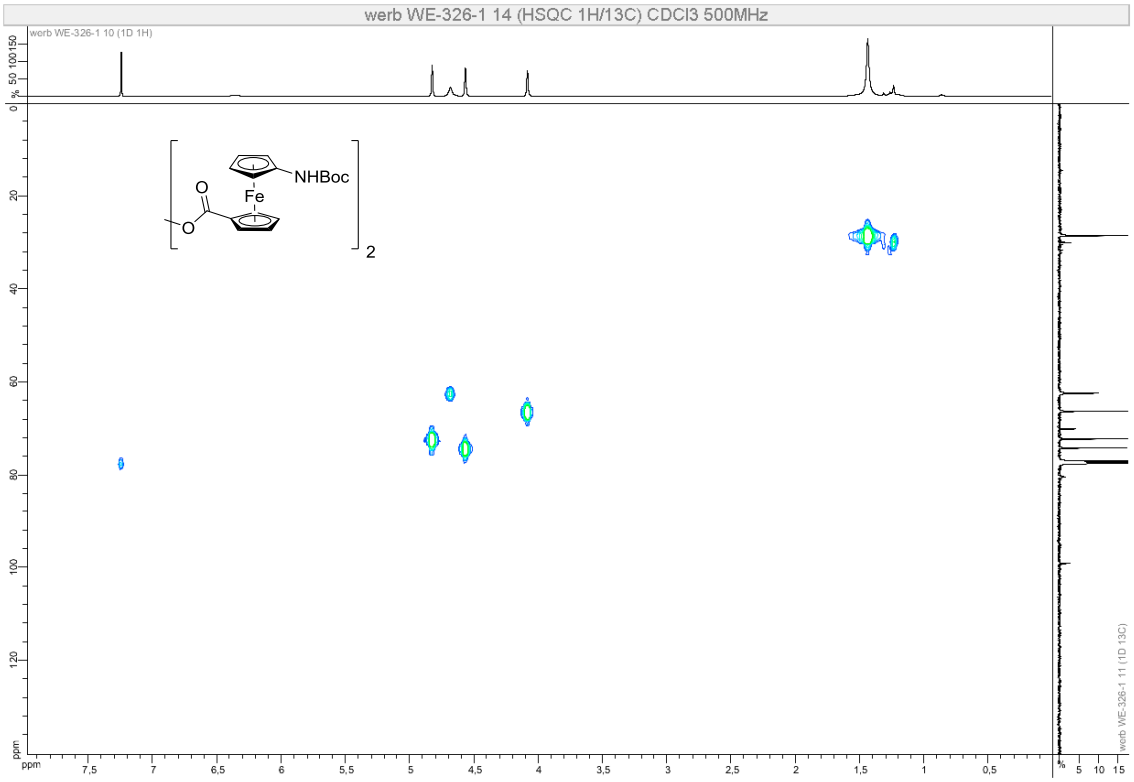
1'-((*tert*-Butoxycarbonyl)amino)ferrocene-1-carboxylic anhydride - 14



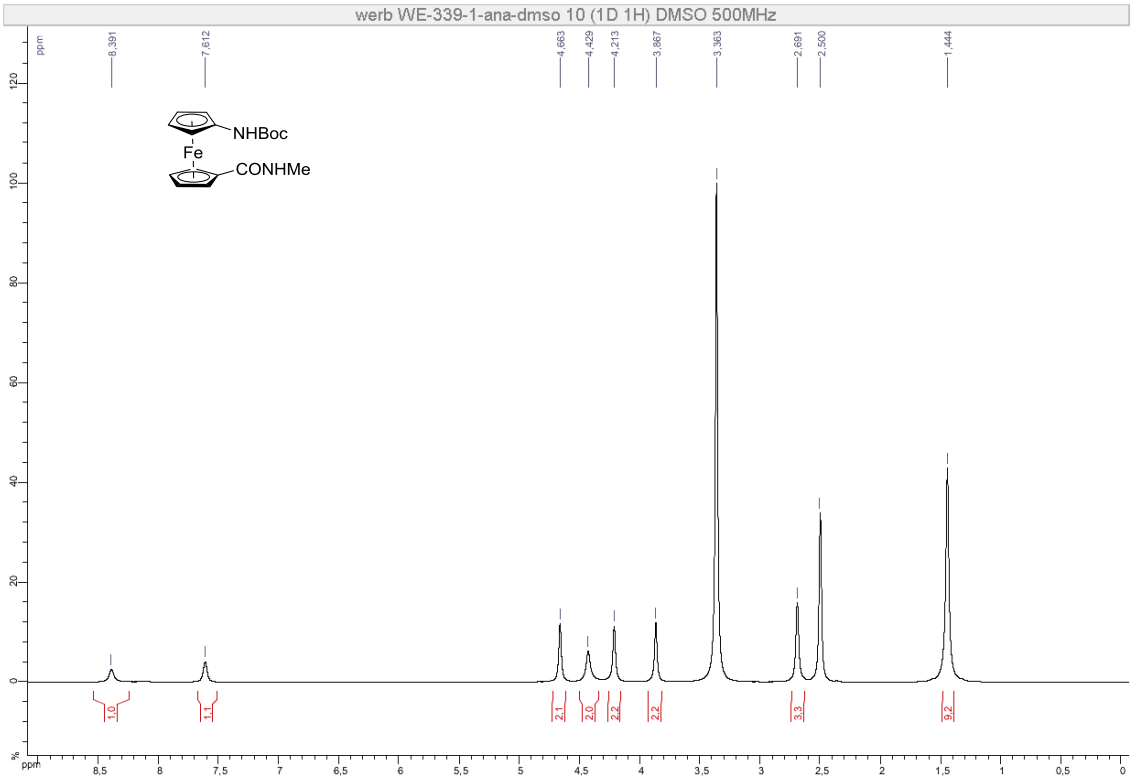

werb WE-326-1 11 (1D 13C) CDCl3 500MHz
ppm
168,606
153,558
99,023
80,396
77,484
76,976
74,228
72,079
66,284
62,383
28,473
NHBoc
Fe
O
O
2
%
ppm
180
160
140
120
100
80
60
40
20
0

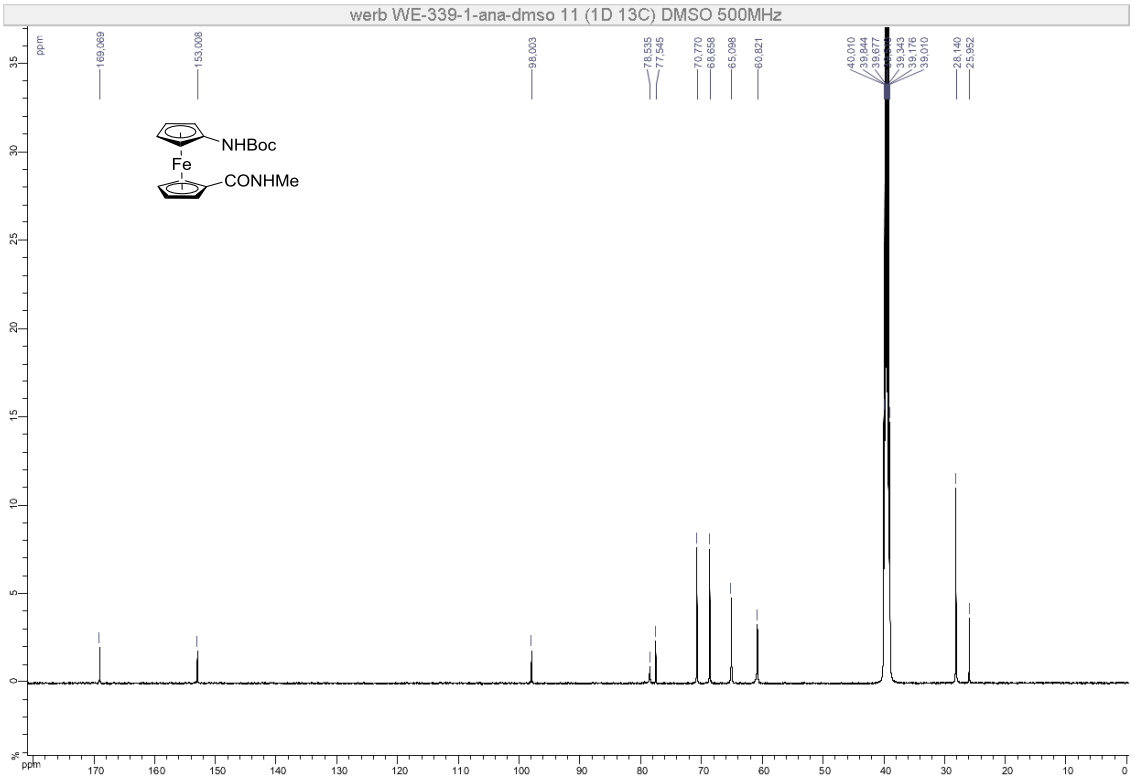

werb WE-326-1 12 (DEPT 13C) CDCl3 500MHz
ppm
77,247
73,990
72,045
66,097
62,199
28,289
NHBoc
Fe
O
O
2
%
ppm
180
160
140
120
100
80
60
40
20
0

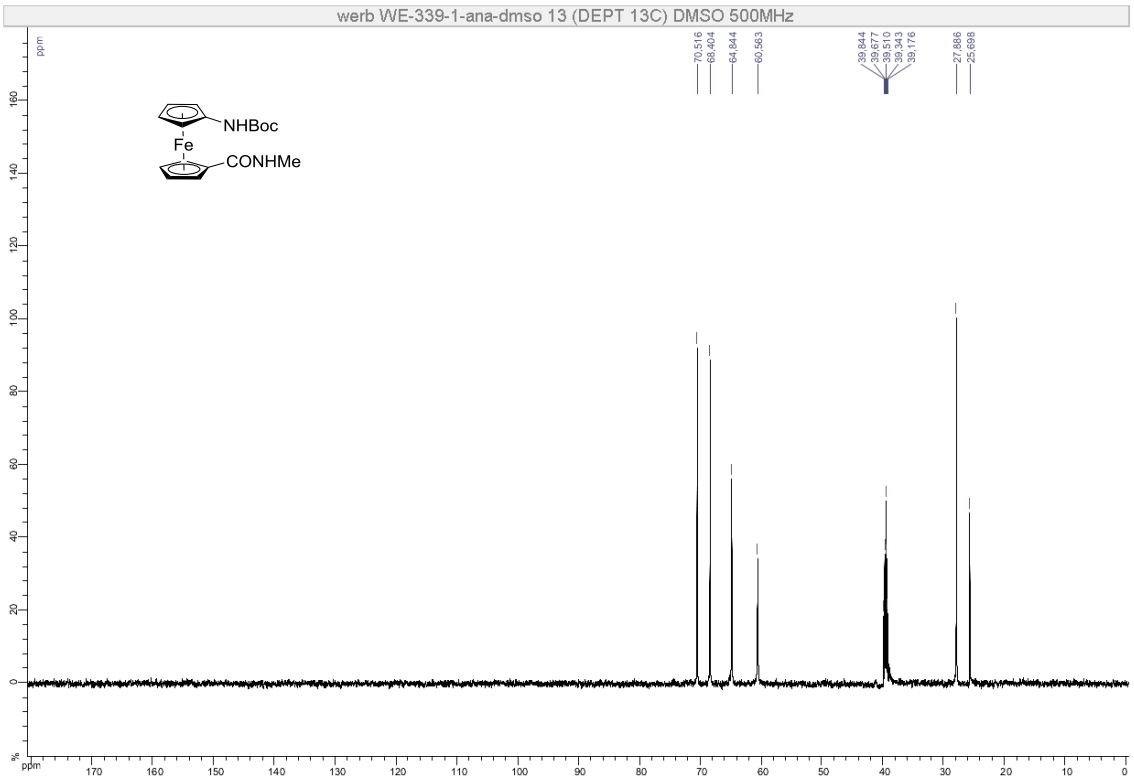

werb WE-326-1 13 (COSY 1H/1H) CDCl3 500MHz
werb WE-326-1 10 (1D 1H)
NHBoc
Fe
O
O
2
ppm
werb WE-326-1 10 (1D 1H)

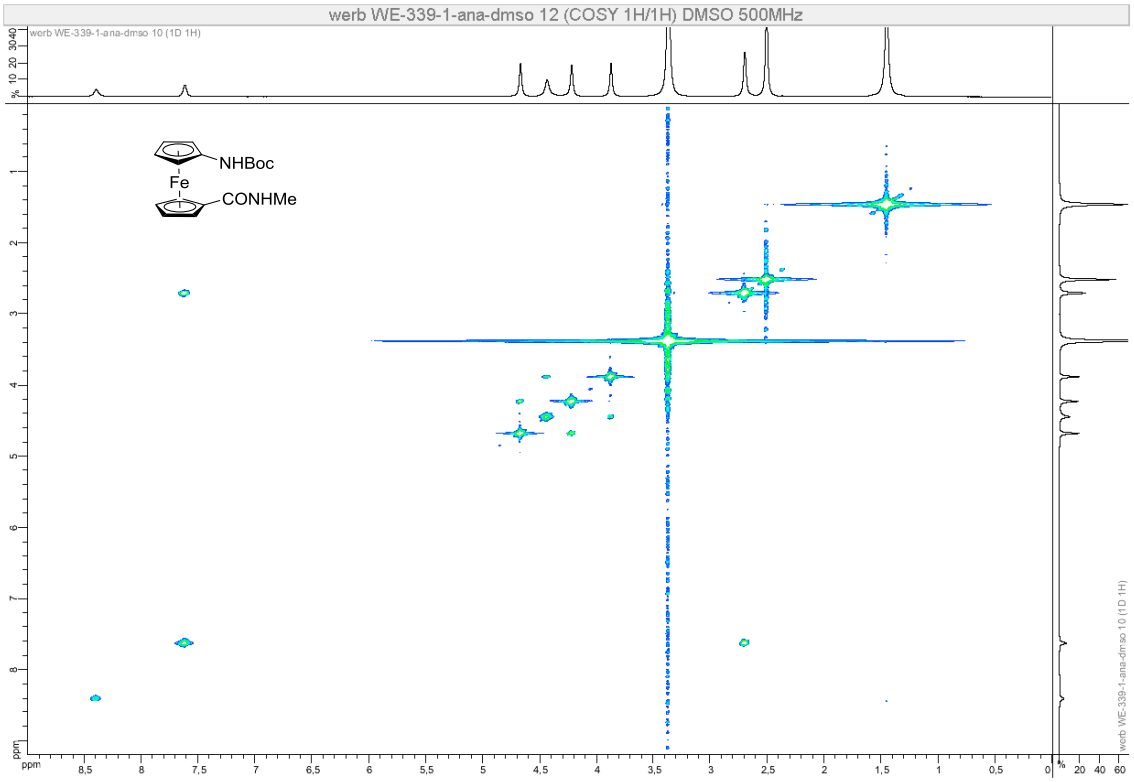

werb WE-326-1 14 (HSQC 1H/13C) CDCl3 500MHz
werb WE-326-1 10 (1D 1H)
NHBoc
Fe
O
O
2
ppm
werb WE-326-1 11 (1D 13C)

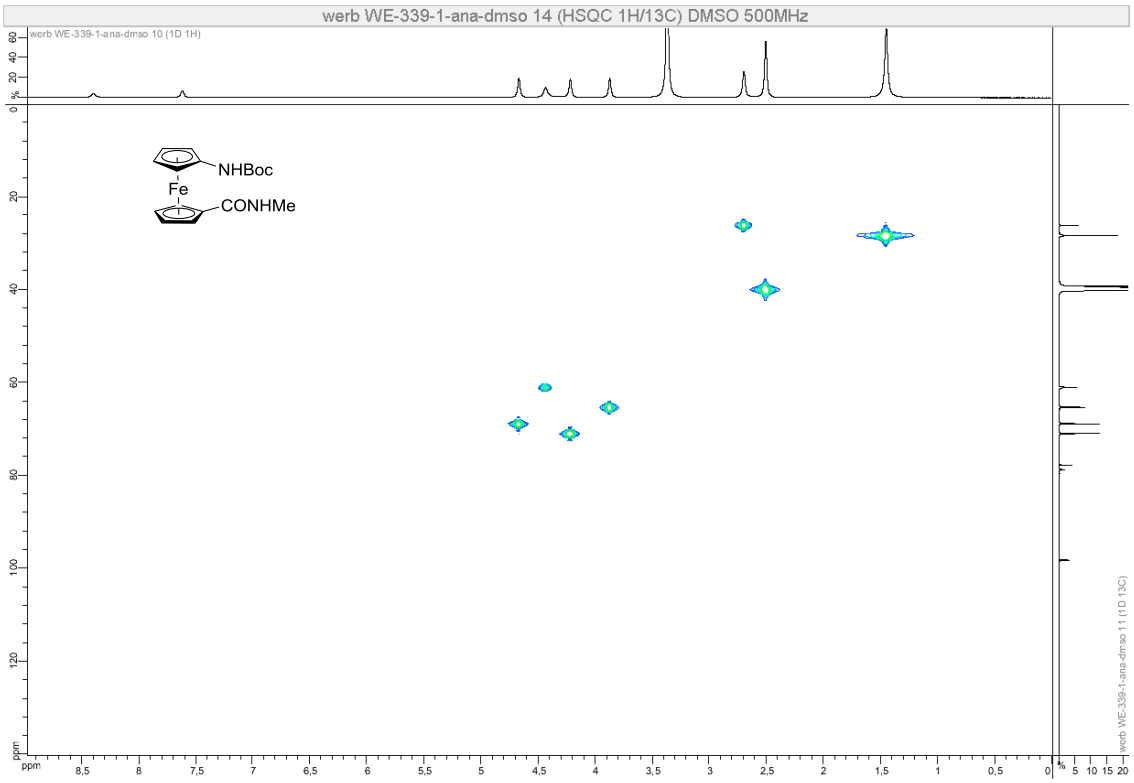
***N*-methyl 1'-((*tert*-butoxycarbonyl)amino)ferrocene-1-carboxamide - 15**

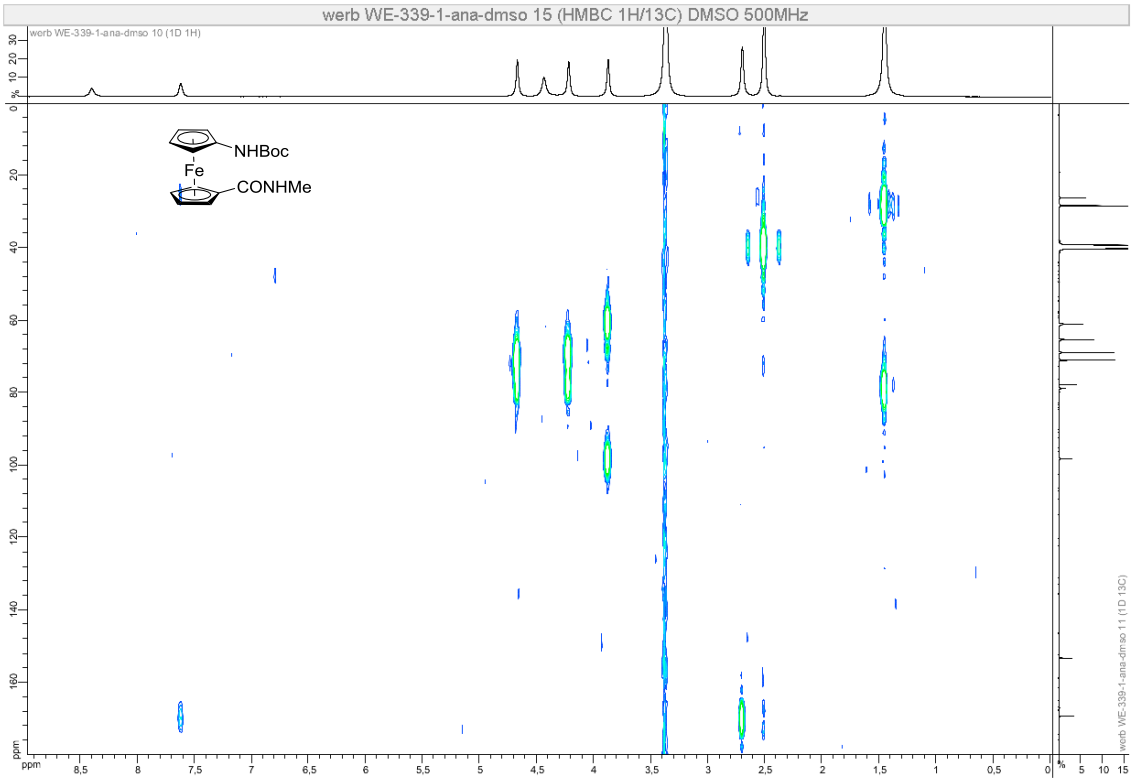


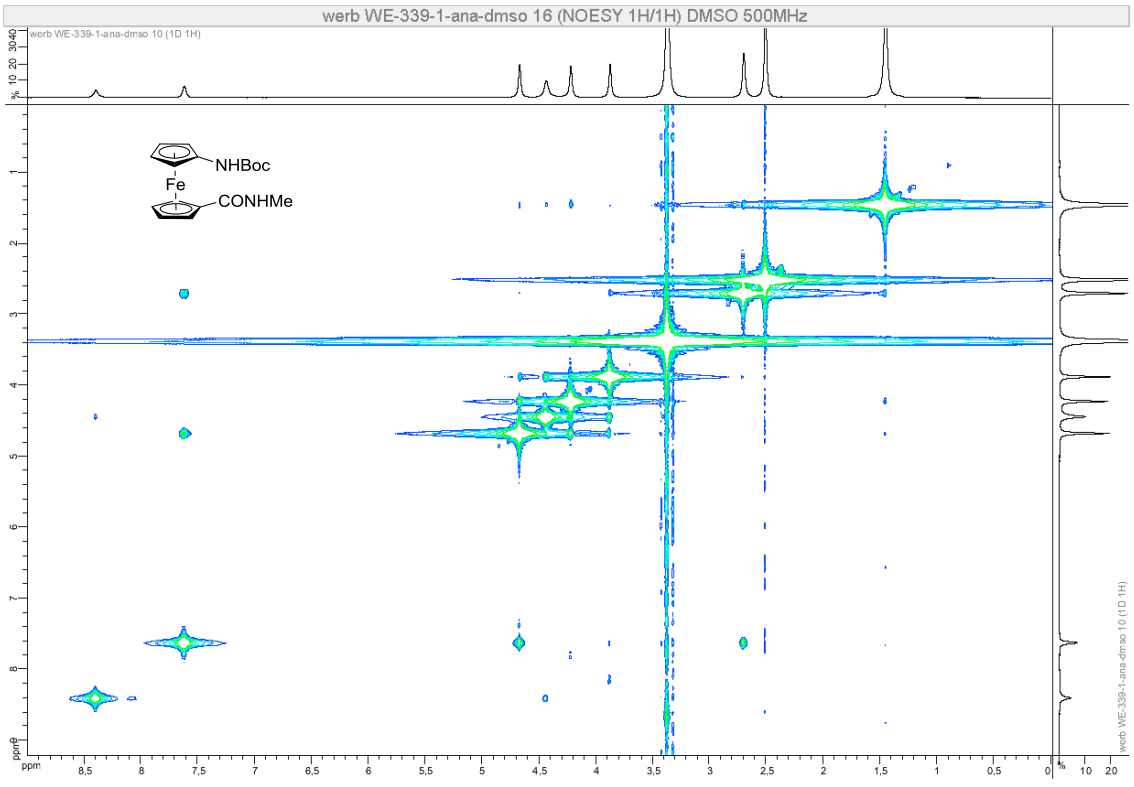



werb WE-339-1-ana-dmso 13 (DEPT 13C) DMSO 500MHz
70,516
69,404
64,844
60,563
39,844
39,677
39,510
39,343
39,176
27,886
25,698
NHBoc
Fe
CONHMe
ppm

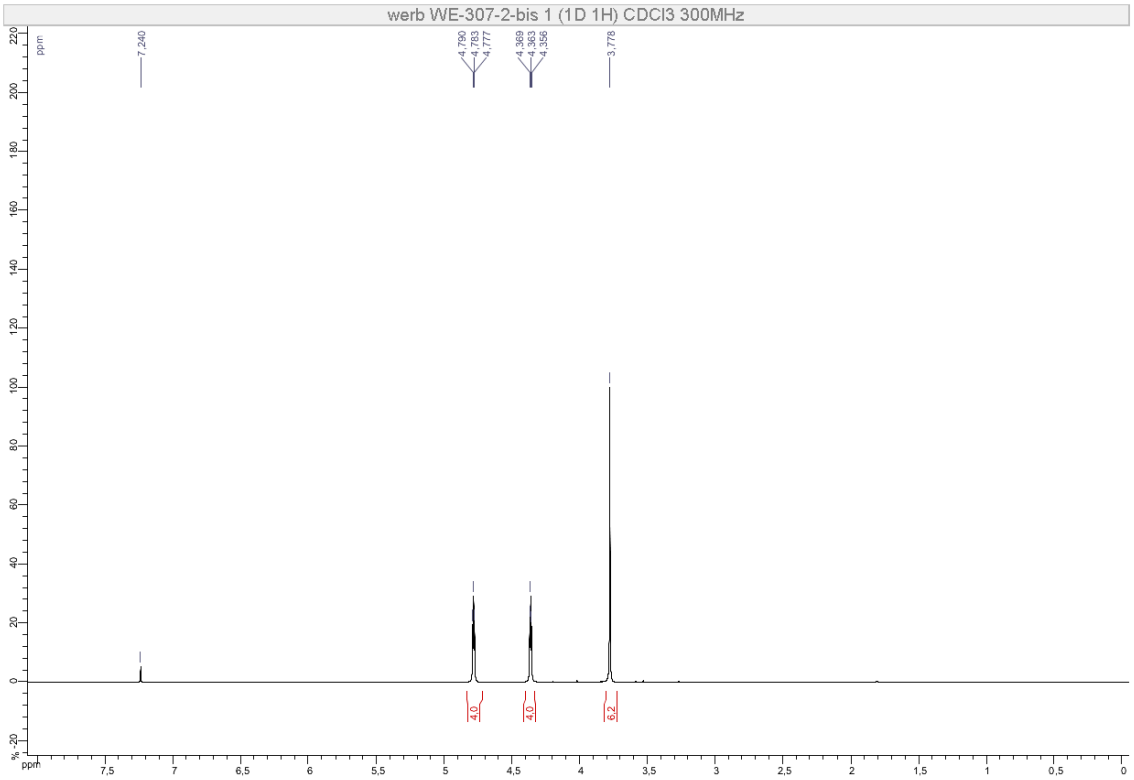

werb WE-339-1-ana-dmso 12 (COSY 1H/1H) DMSO 500MHz
werb WE-339-1-ana-dmso 10 (1D 1H)
NHBoc
Fe
CONHMe
ppm

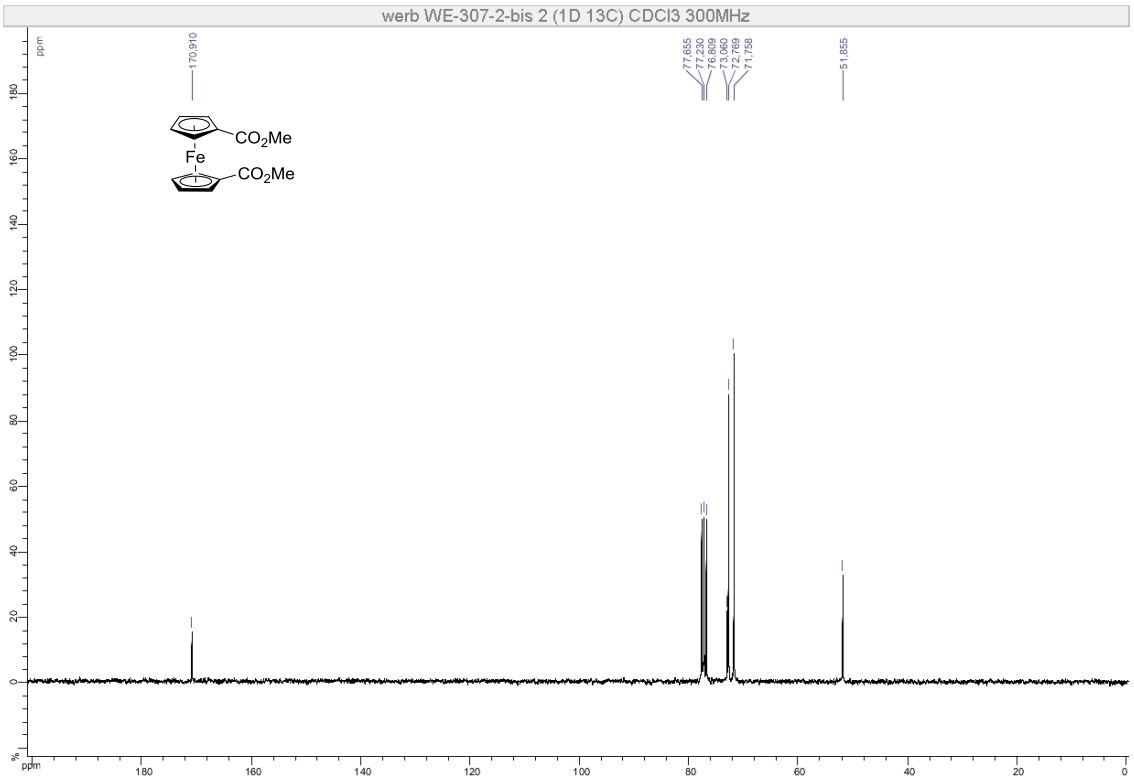

werb WE-339-1-ana-dmso 14 (HSQC 1H/13C) DMSO 500MHz
werb WE-339-1-ana-dmso 10 (1D 1H)
NHBoc
Fe
CONHMe
ppm
werb WE-339-1-ana-dmso 11 (1D 13C)

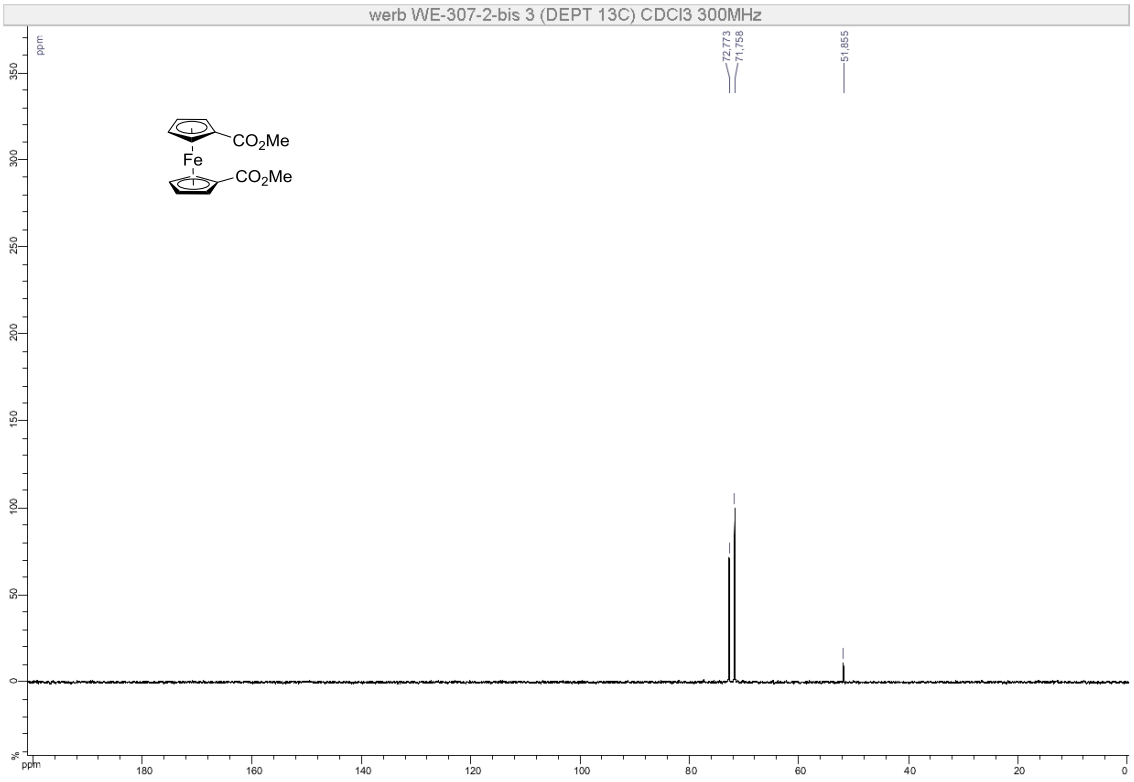

werb WE-339-1-ana-dmso 15 (HMBC 1H/13C) DMSO 500MHz
werb WE-339-1-ana-dmso 10 (1D 1H)
NHBoc
Fe
CONHMe
ppm
werb WE-339-1-ana-dmso 11 (1D 13C)



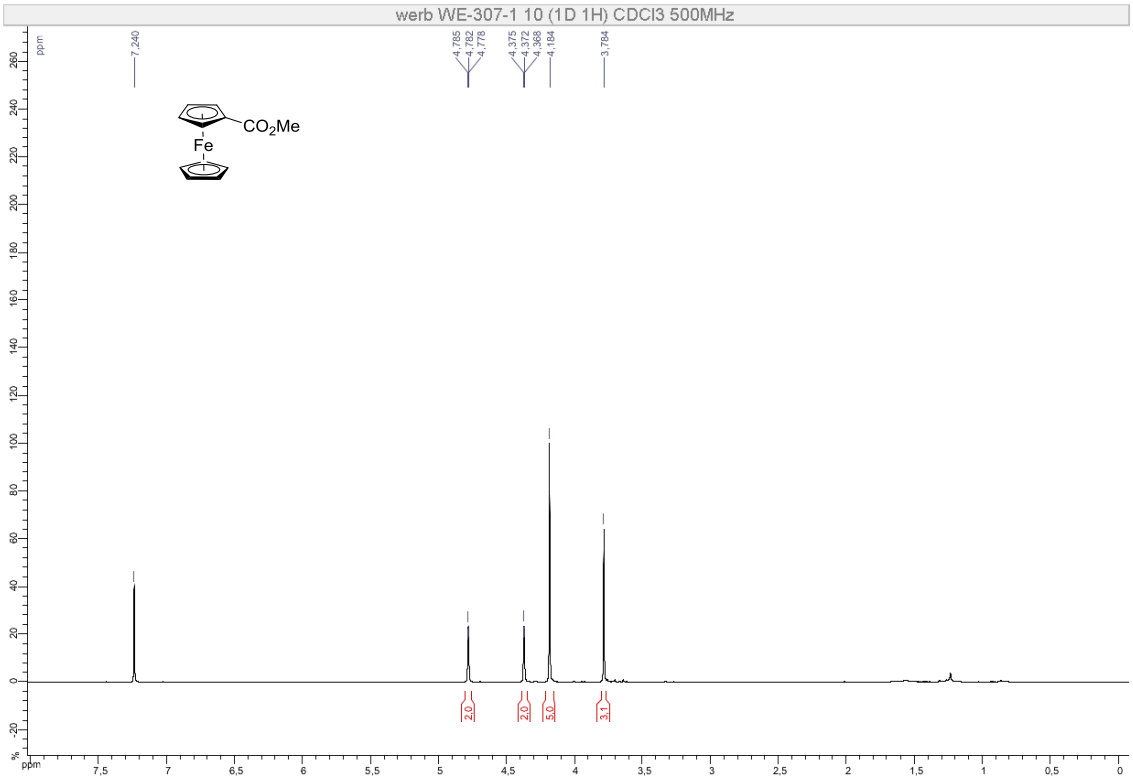
Dimethyl ferrocene-1,1'-dicarboxylate – SI1

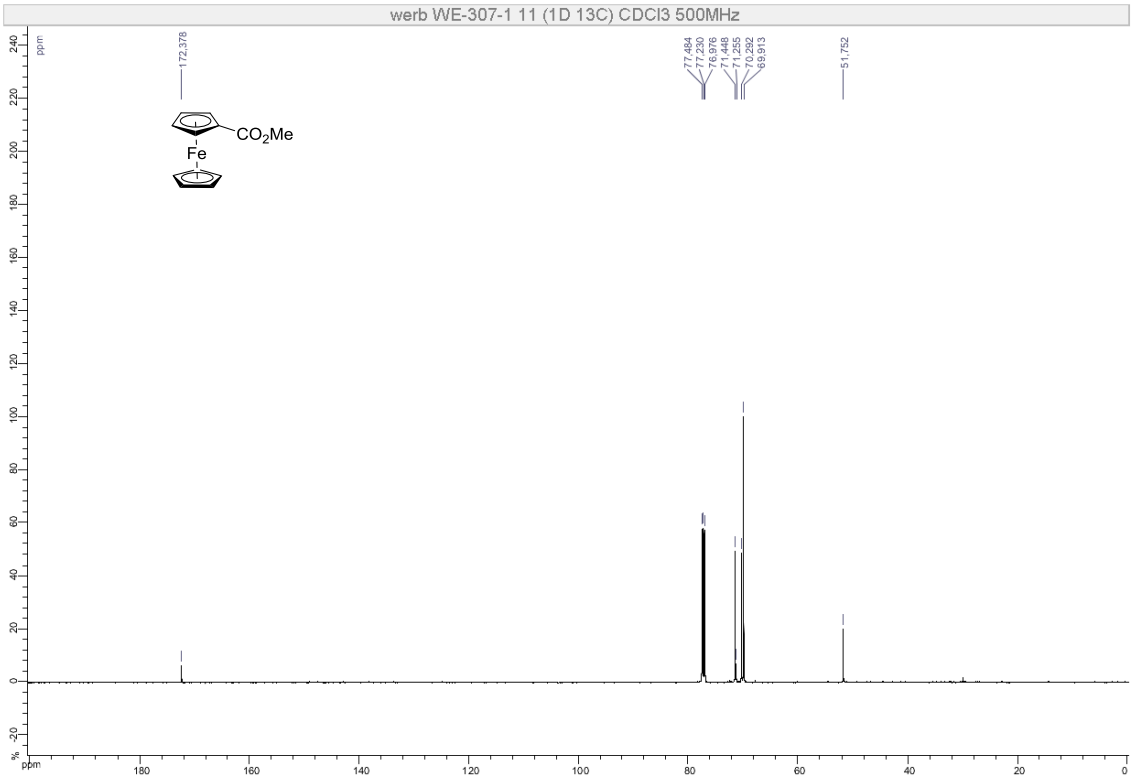


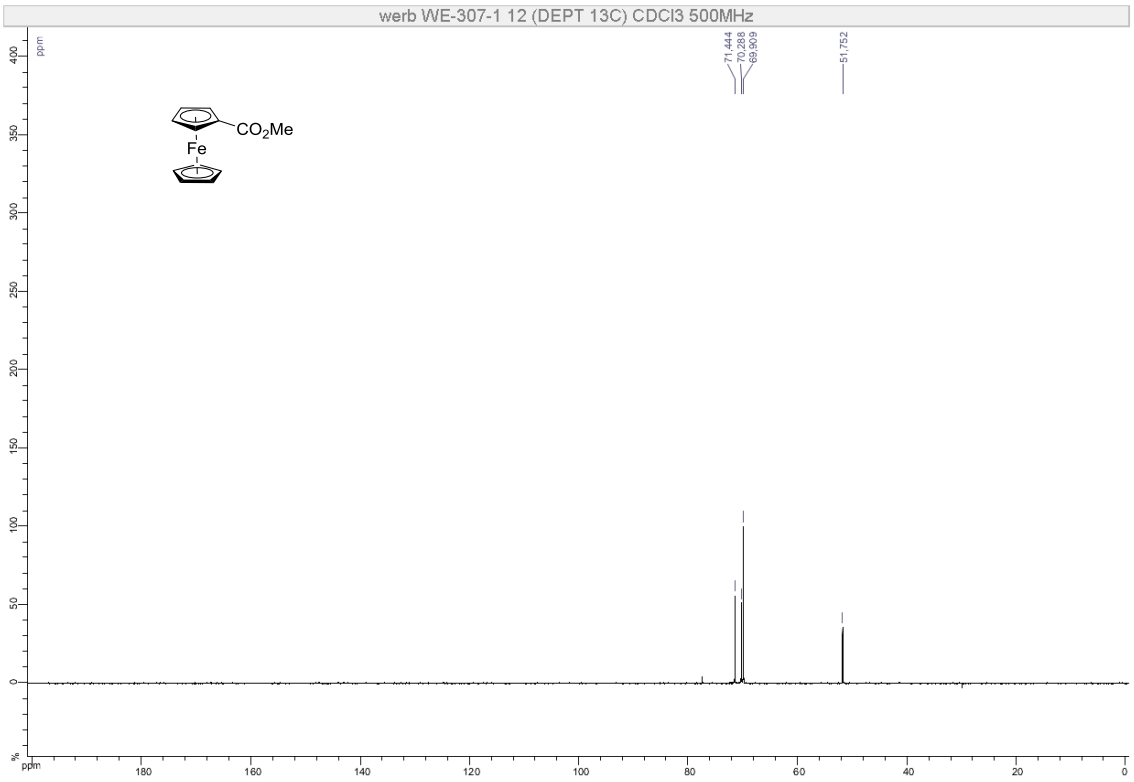

werb WE-307-2-bis 2 (1D 13C) CDCl3 300MHz
ppm
170,910
77,655
77,230
76,805
73,060
72,769
71,758
51,855
CO2Me
Fe
CO2Me
%
ppm
180
160
140
120
100
80
60
40
20
0

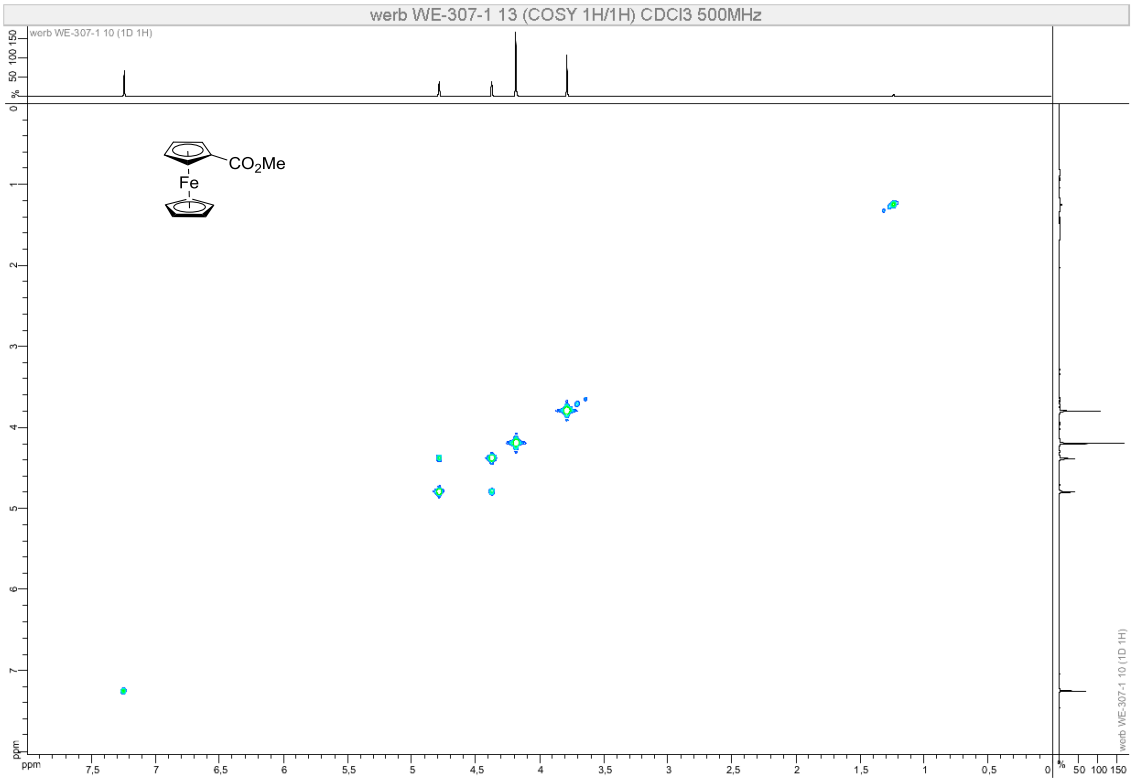

werb WE-307-2-bis 3 (DEPT 13C) CDCl3 300MHz
ppm
72,773
71,758
51,855
CO2Me
Fe
CO2Me
%
ppm
350
300
250
200
150
100
50
0
180
160
140
120
100
80
60
40
20
0

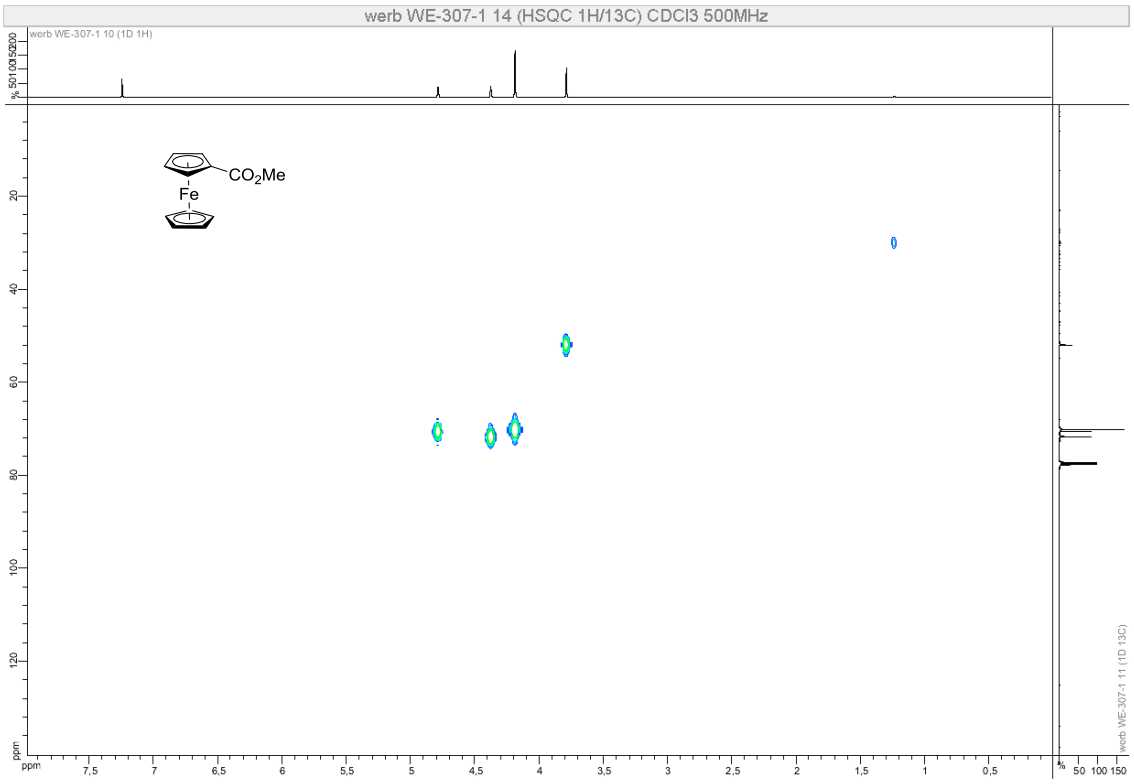
Methyl ferrocene carboxylate – SI2



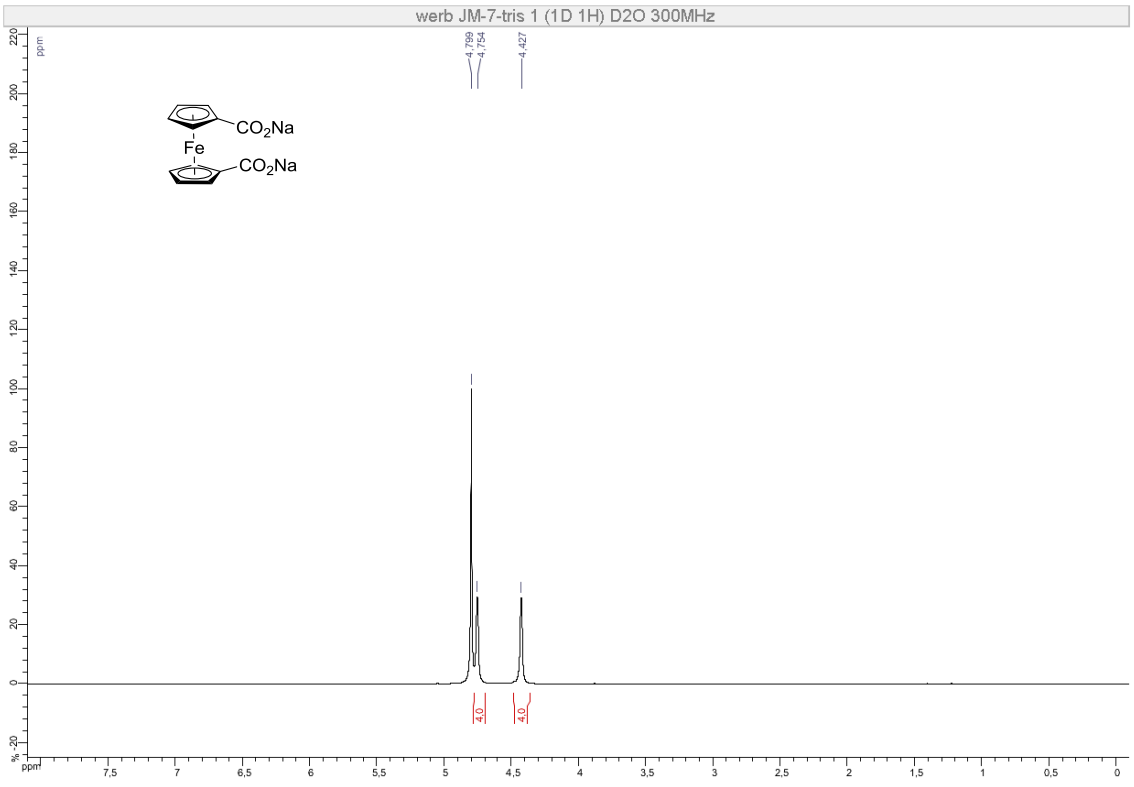


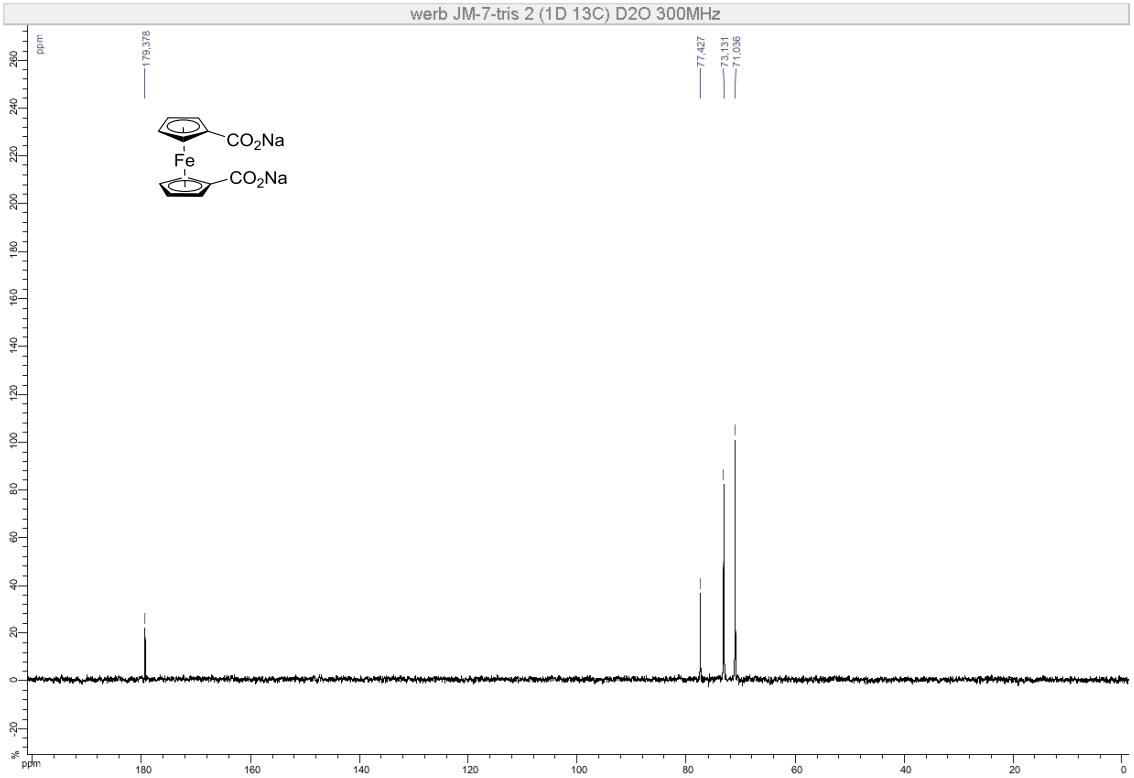

werb WE-307-1 12 (DEPT 13C) CDCl3 500MHz
71,444
70,208
69,969
51,752
CO2Me
Fe
ppm

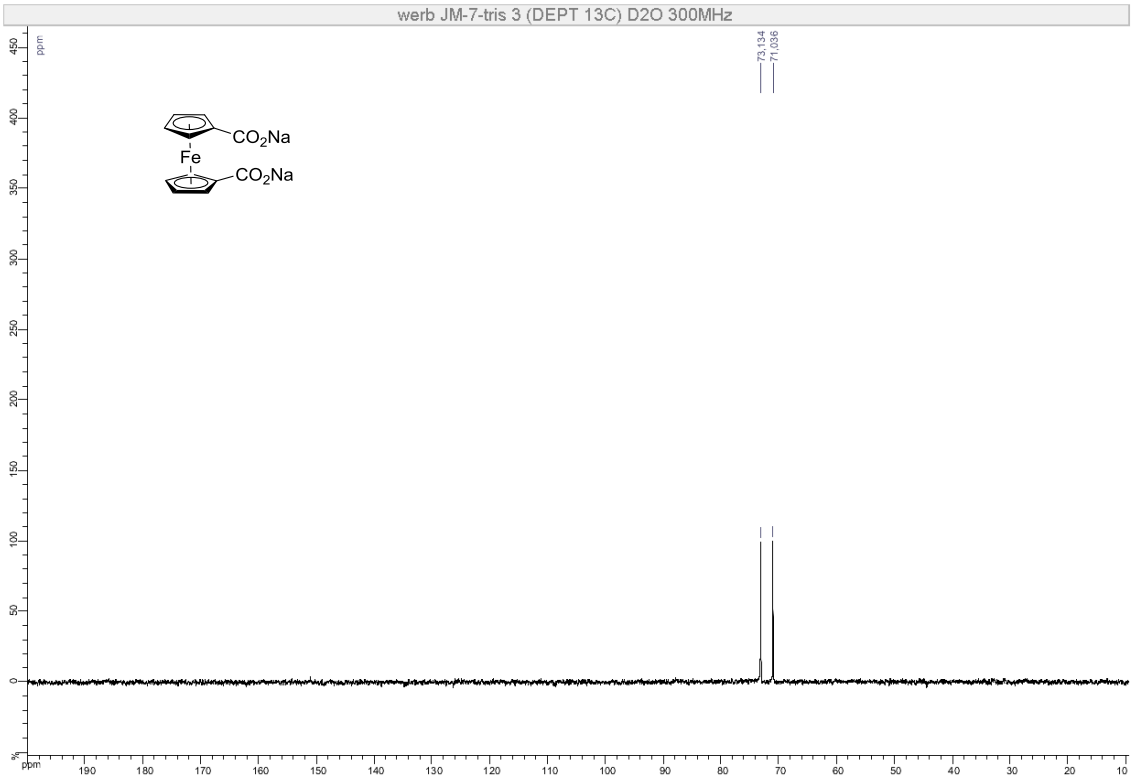

werb WE-307-1 13 (COSY 1H/1H) CDCl3 500MHz
werb WE-307-1 10 (1D 1H)
CO2Me
Fe
ppm



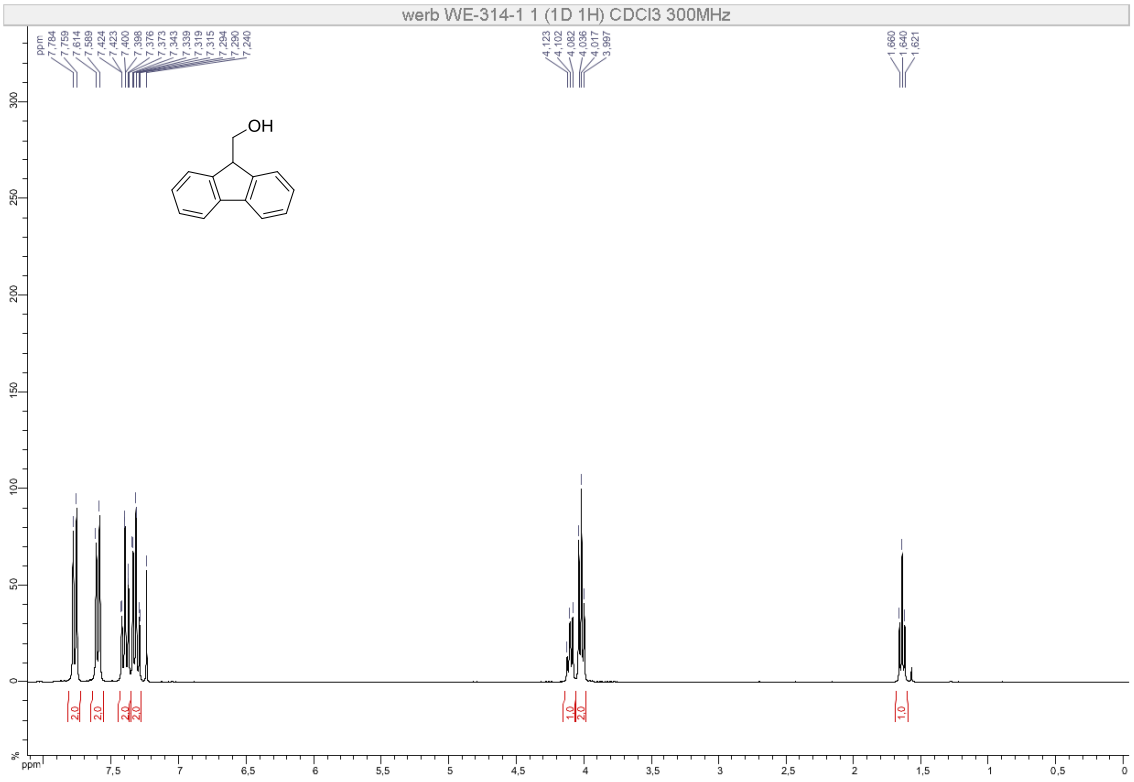
Sodium ferrocene-1,1'-dicarboxylate – SI3

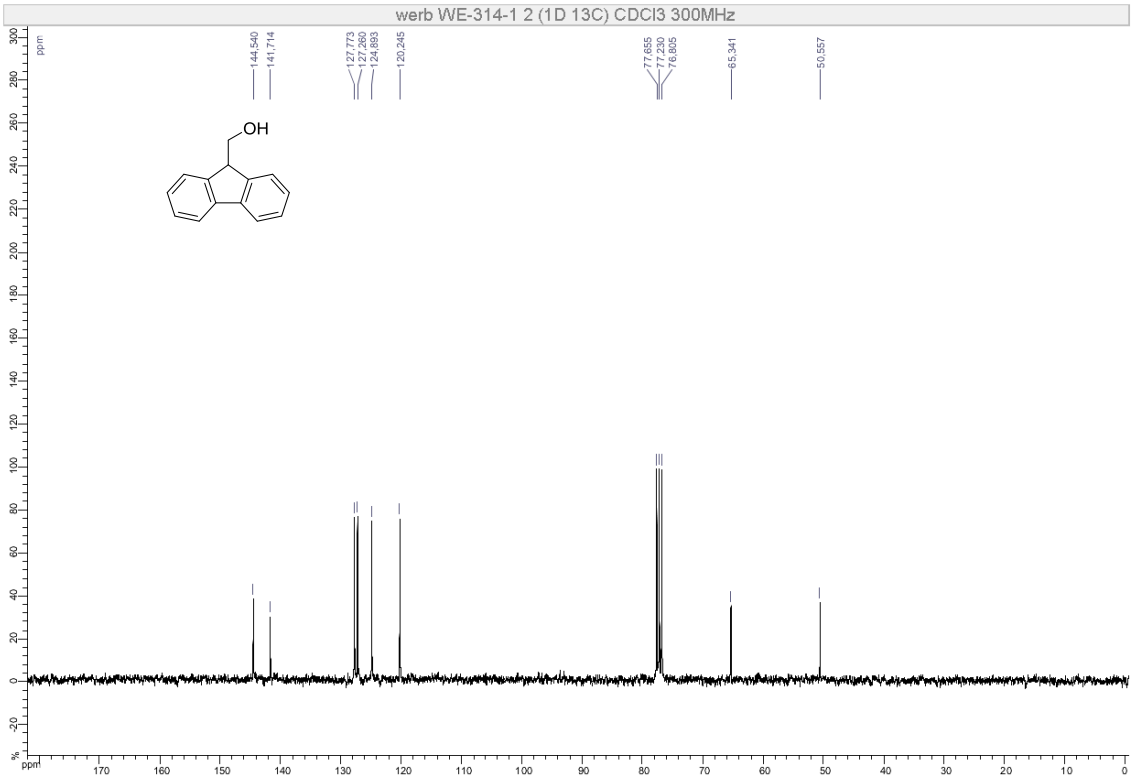


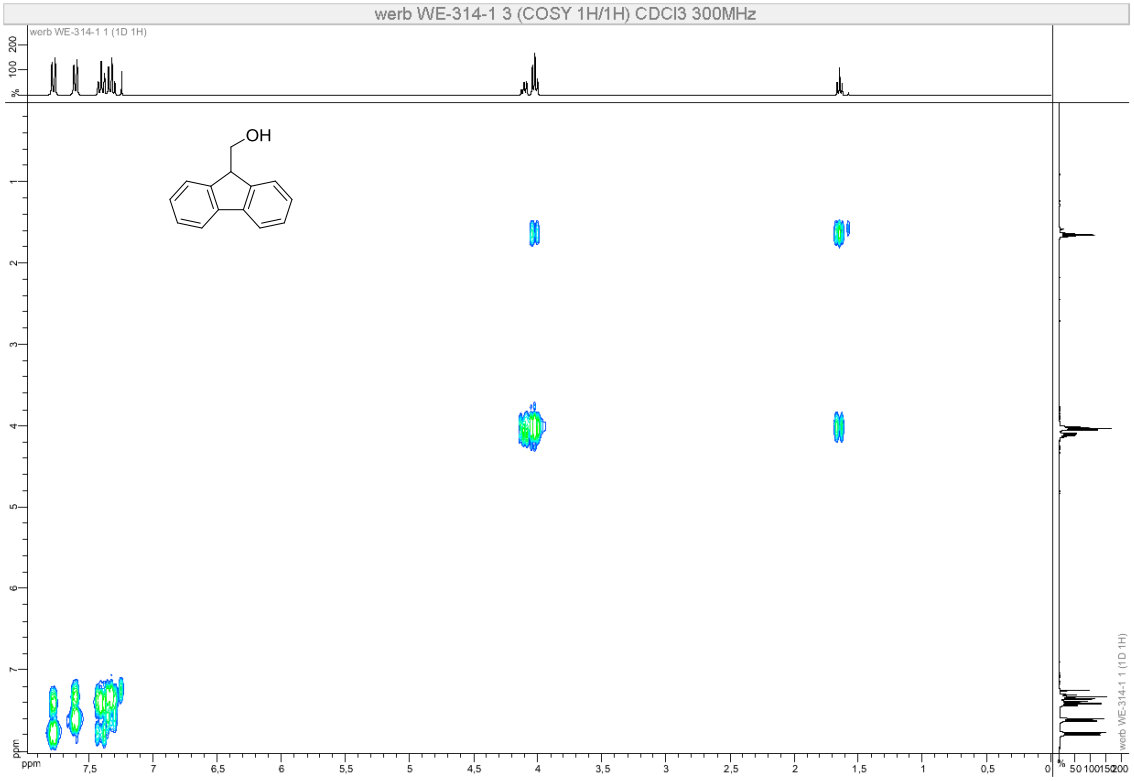

werb JM-7-tris 2 (1D 13C) D2O 300MHz
ppm
179,378
77,427
73,131
71,036
CO2Na
Fe
CO2Na
ppm


werb JM-7-tris 3 (DEPT 13C) D2O 300MHz
ppm
73,134
71,036
CO2Na
Fe
CO2Na
ppm

(9*H*-Fluoren-9-yl)methanol – SI4






werb WE-314-1 3 (COSY 1H/1H) CDCl3 300MHz
werb WE-314-1 1 (1D 1H)
OH
ppm
7,5
7
6,5
6
5,5
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
50 100 150 200
werb WE-314-1 1 (1D 1H)