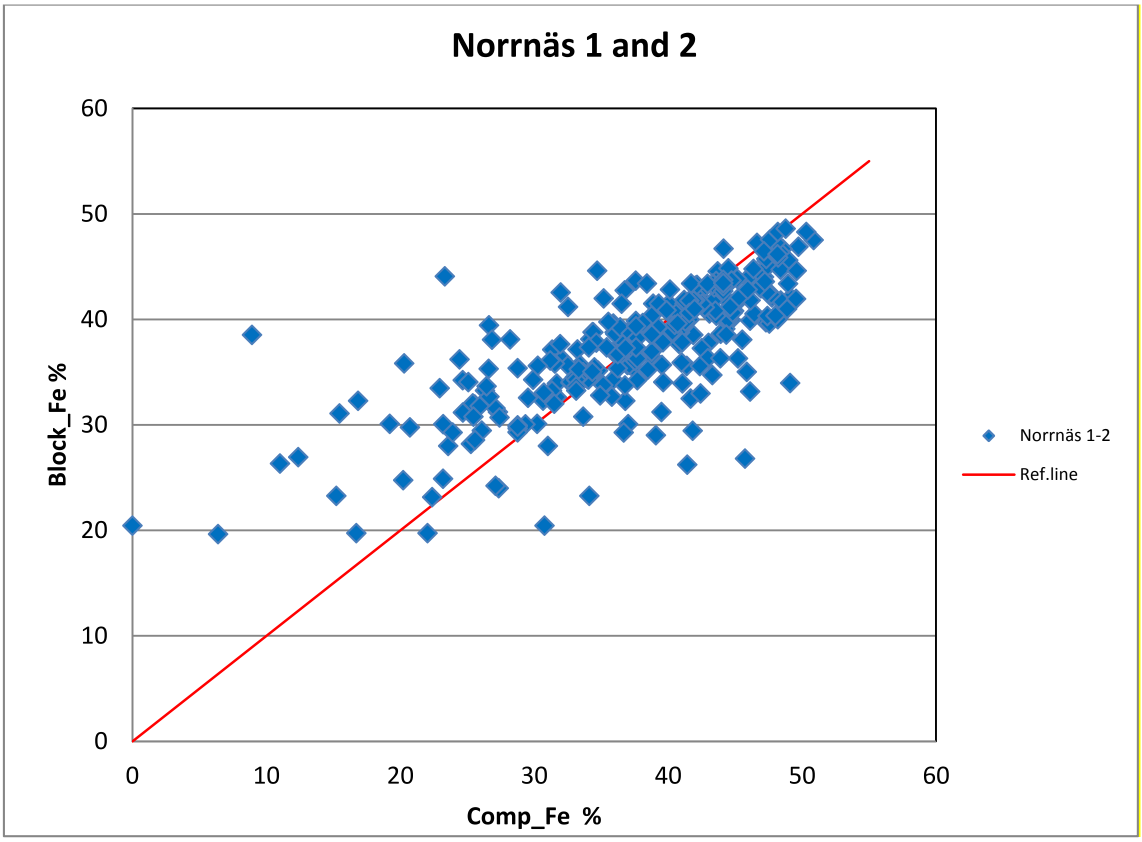
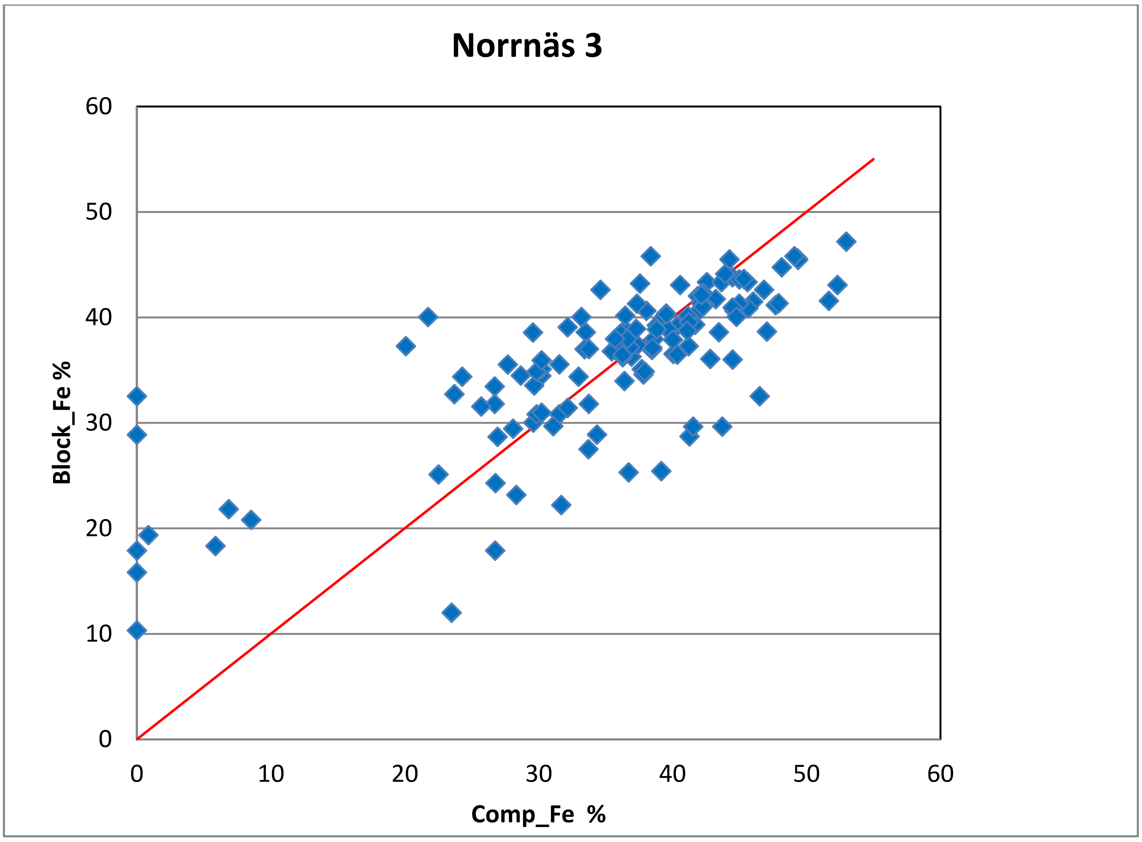
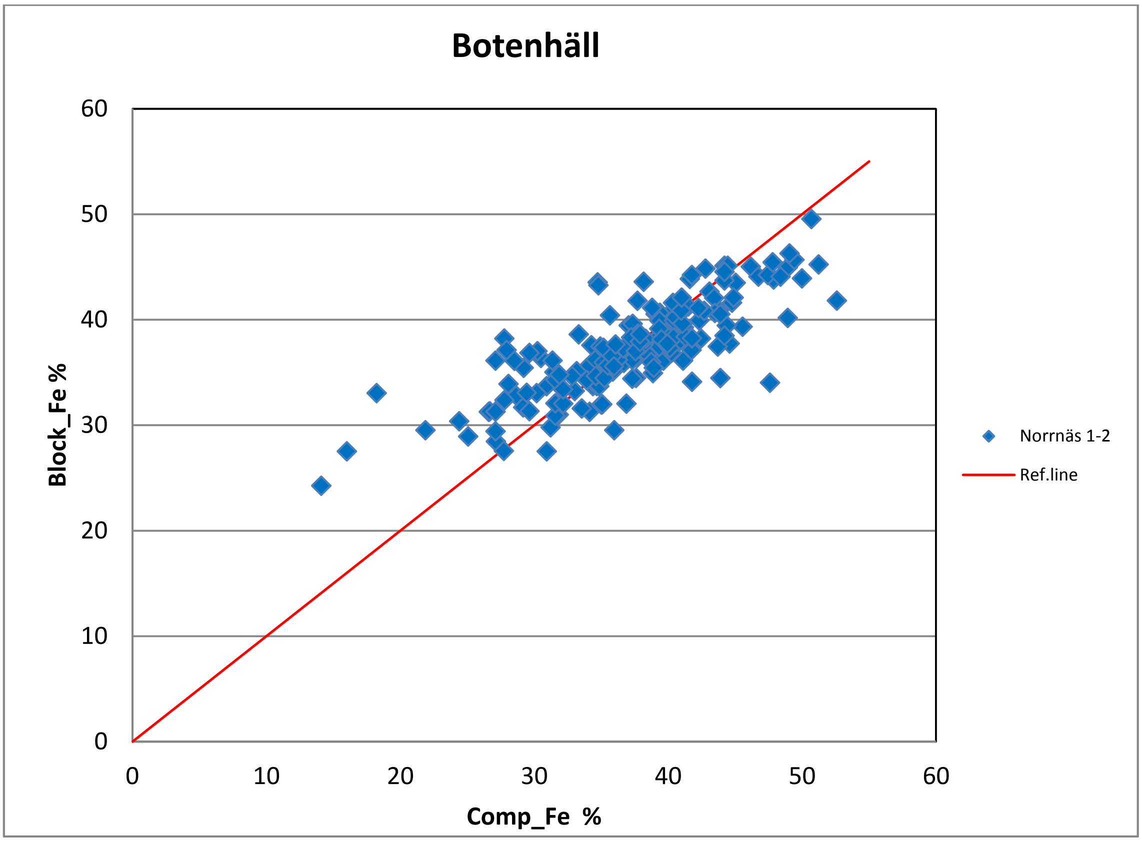
Appendix 1

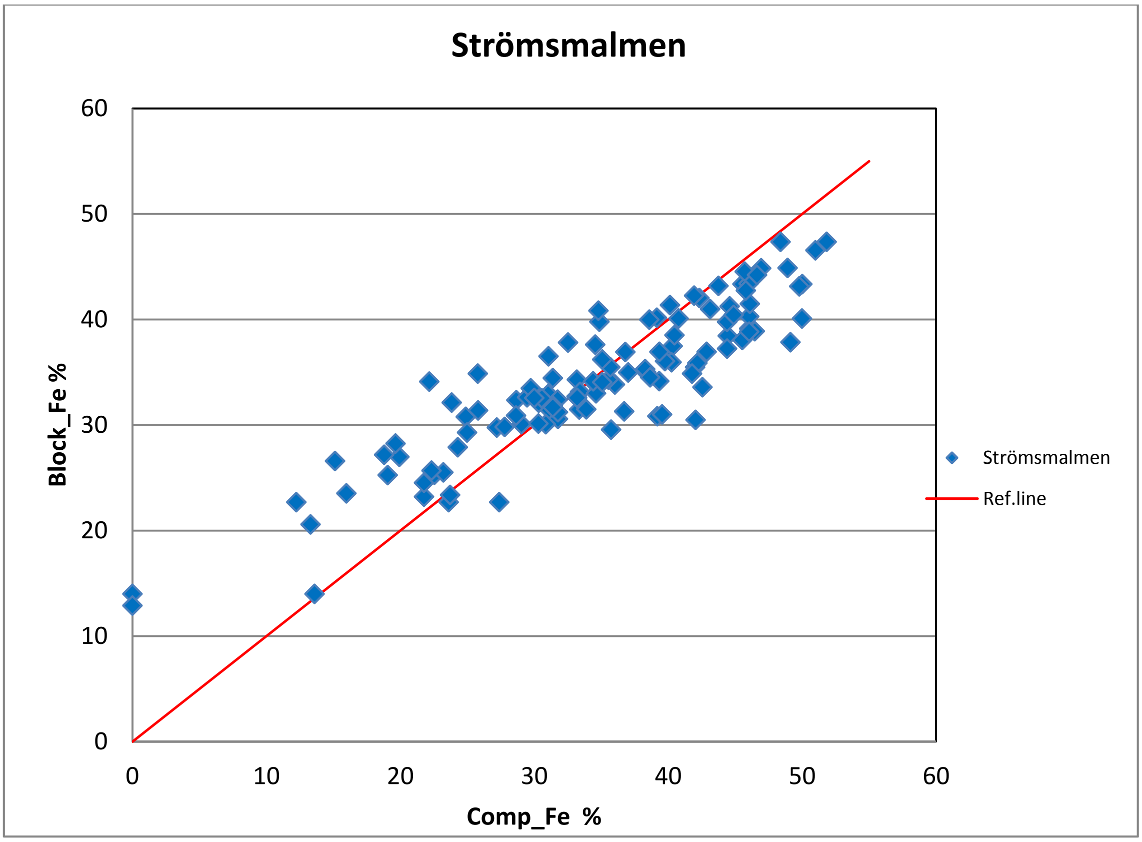
De-clustering plots for Fe, Mn and S where composites and block values are separated <3 m



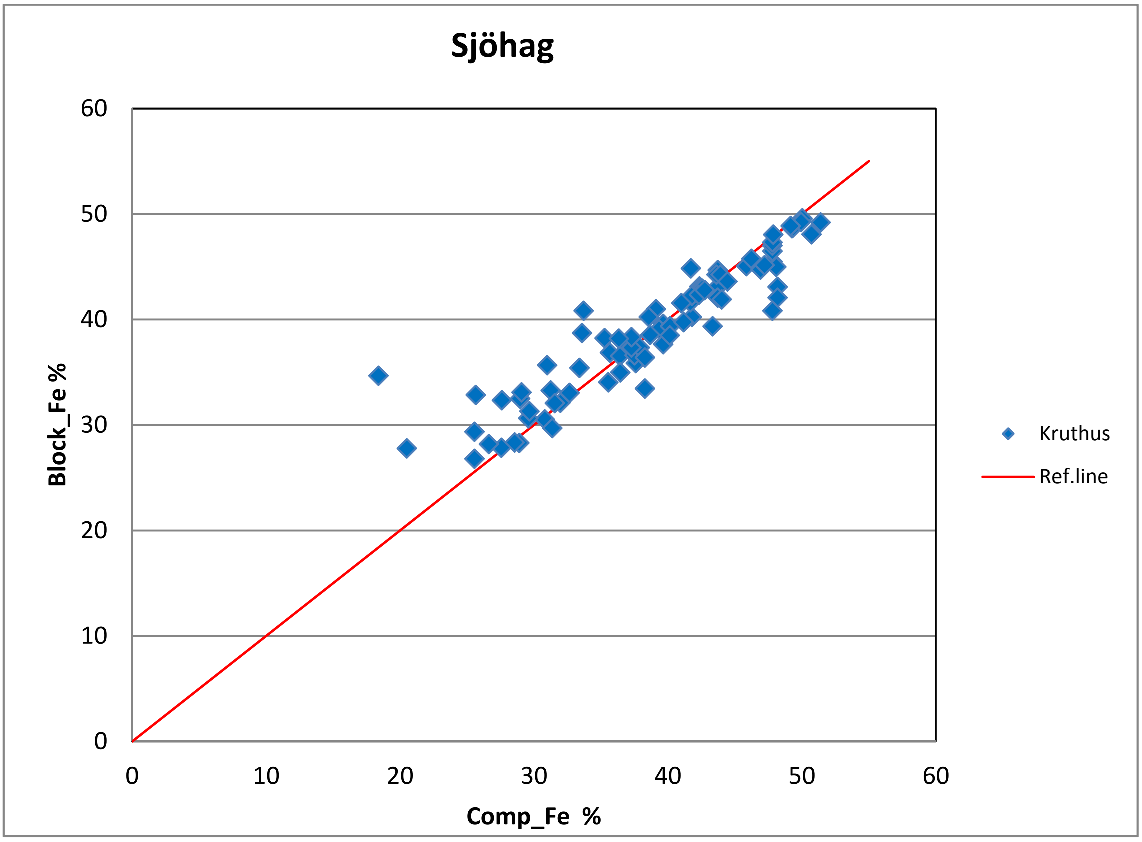


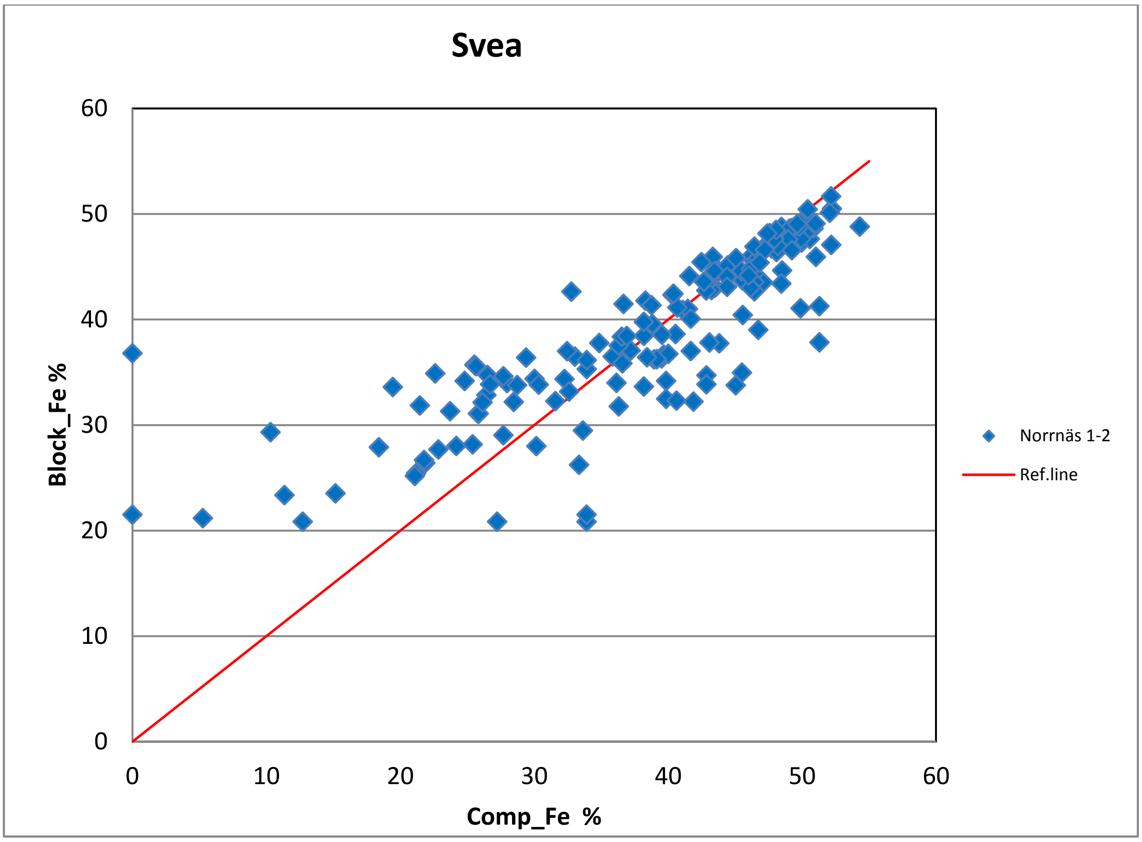


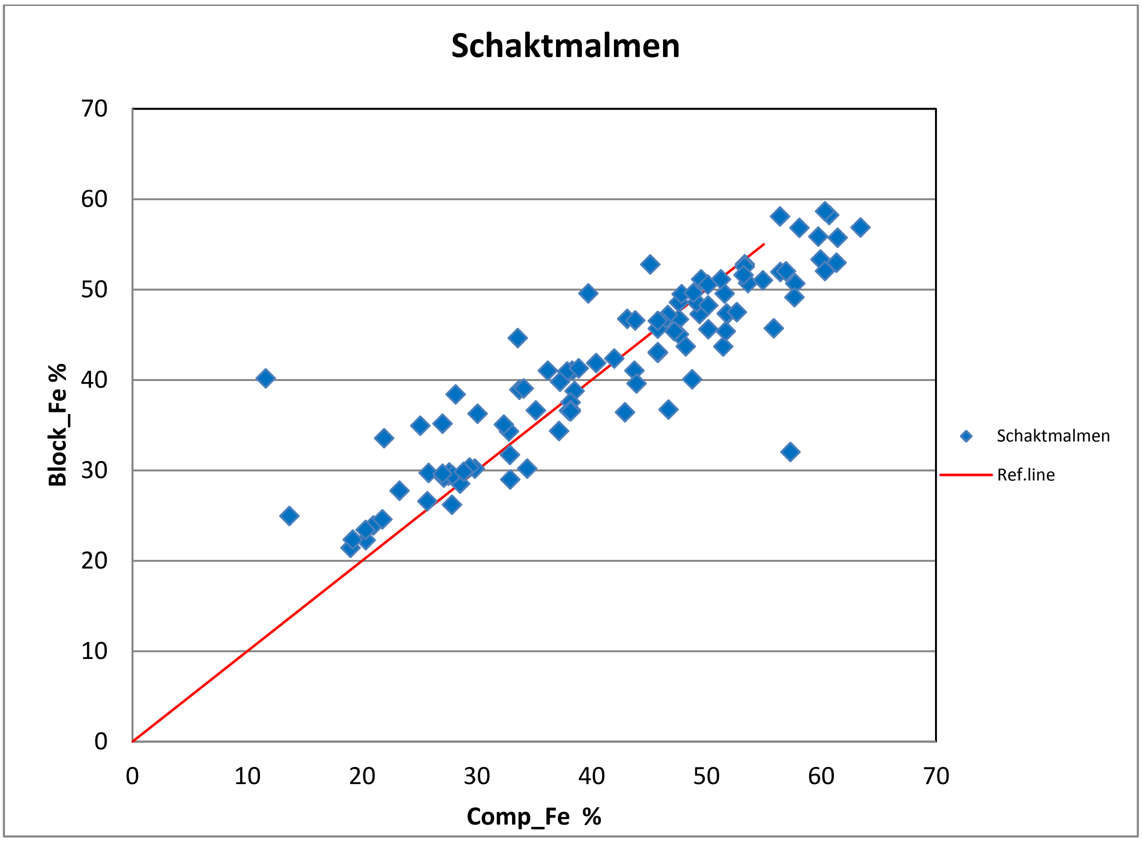
Botenhäll
Block_Fe %
Comp_Fe %
0
10
20
30
40
50
60
Norrnäs 1-2
Ref.line

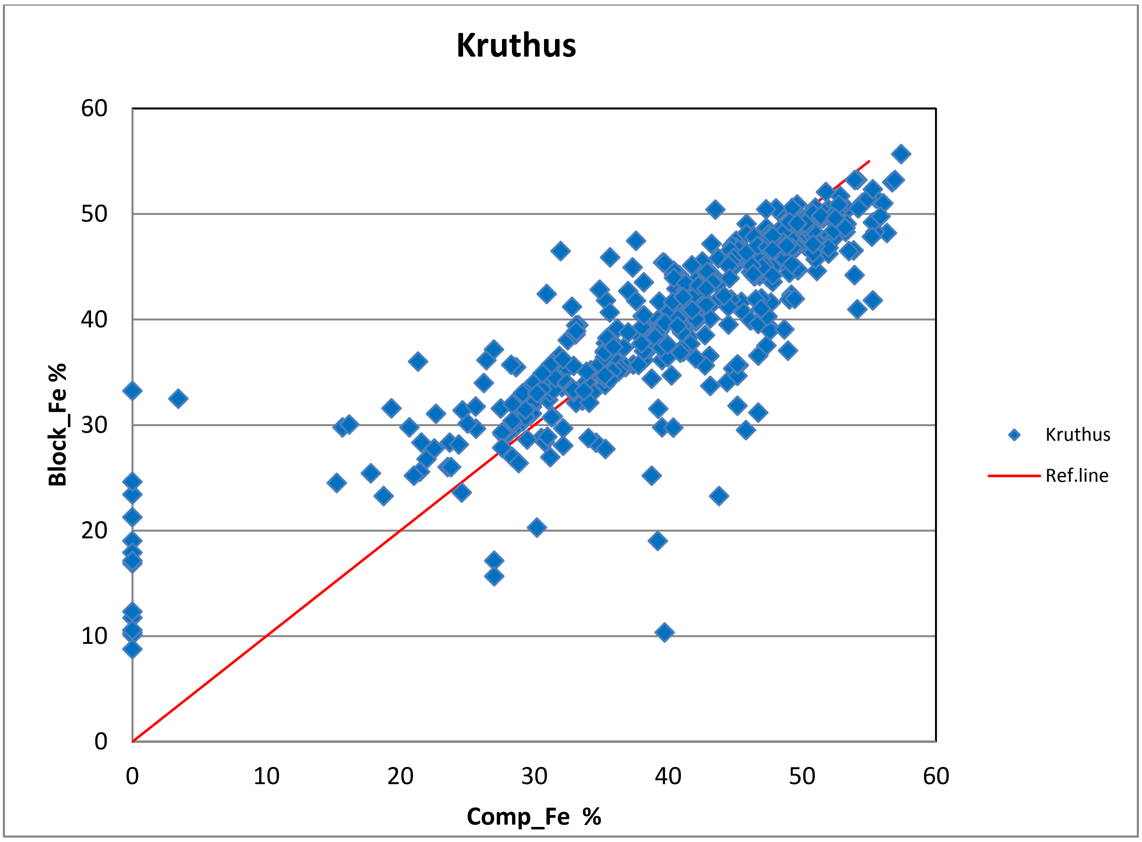


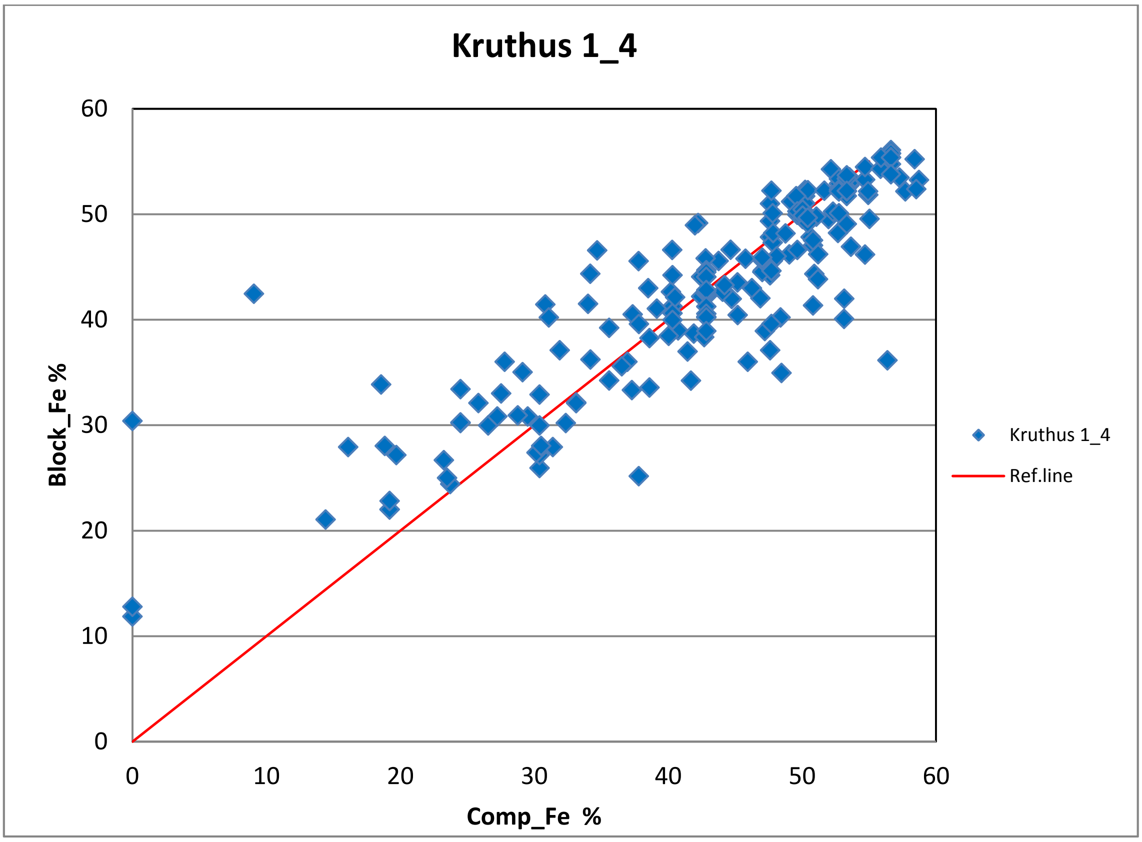
Strömsmalmen
Block_Fe %
Comp_Fe %
0
10
20
30
40
50
60
Strömsmalmen
Ref.line

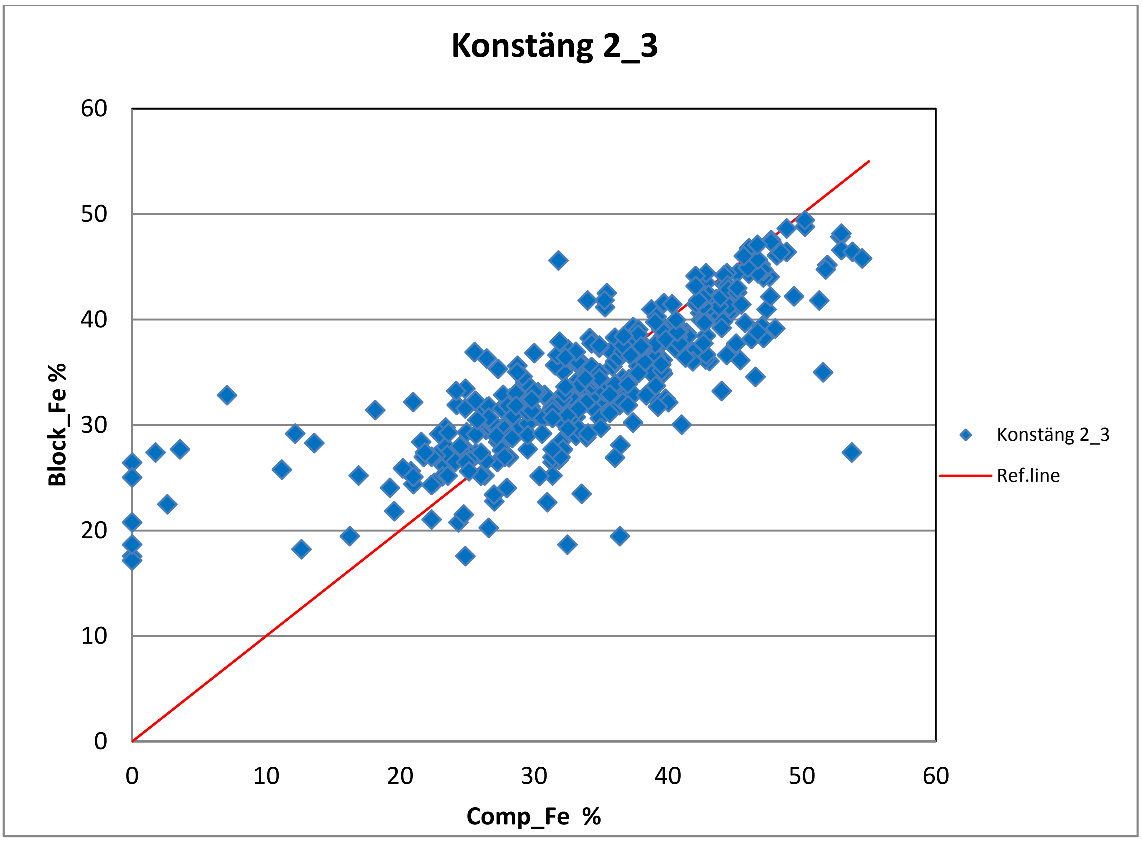

Sjöhag
60
50
40
30
20
10
0
0
10
20
30
40
50
60
Block_Fe %
Comp_Fe %
Kruthus
Ref.line


Svea
60
50
40
30
20
10
0
0
10
20
30
40
50
60
Block_Fe %
Comp_Fe %
Norrnäs 1-2
Ref.line

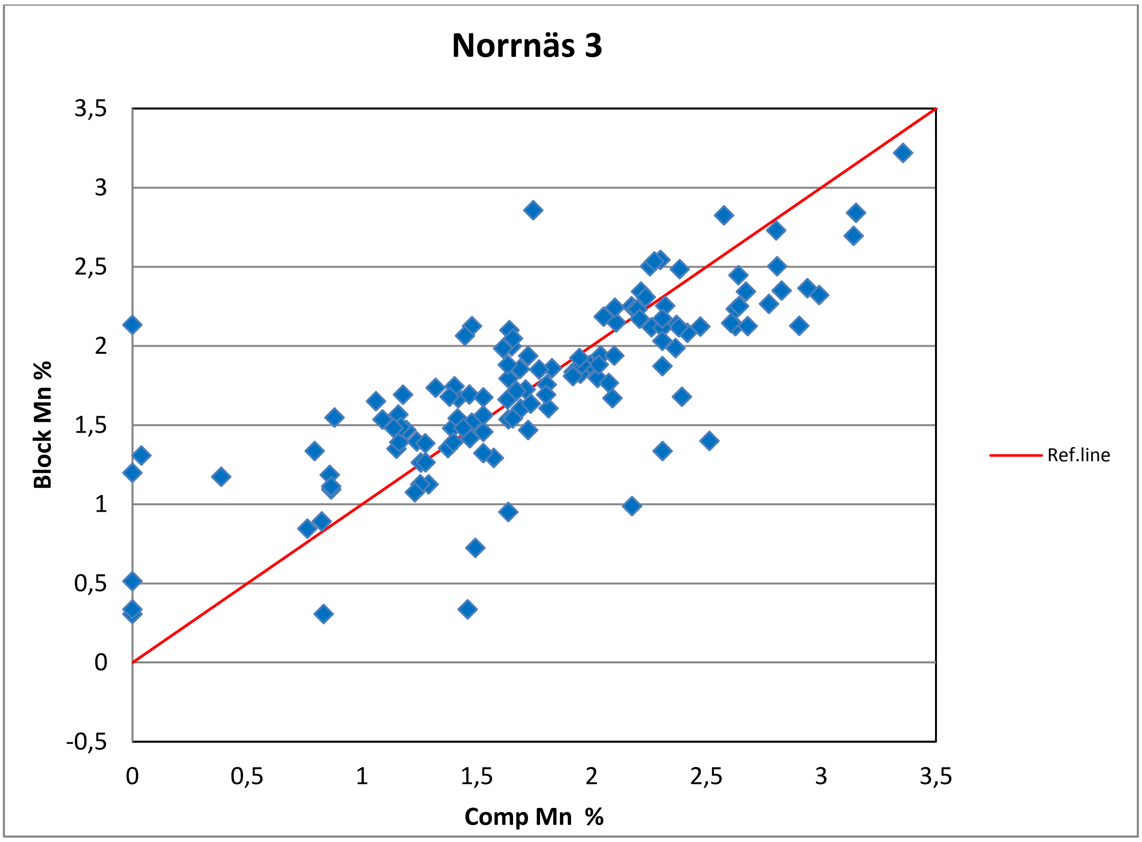

Schaktmalmen
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
Block_Fe %
Comp_Fe %
Schaktmalmen
Ref.line

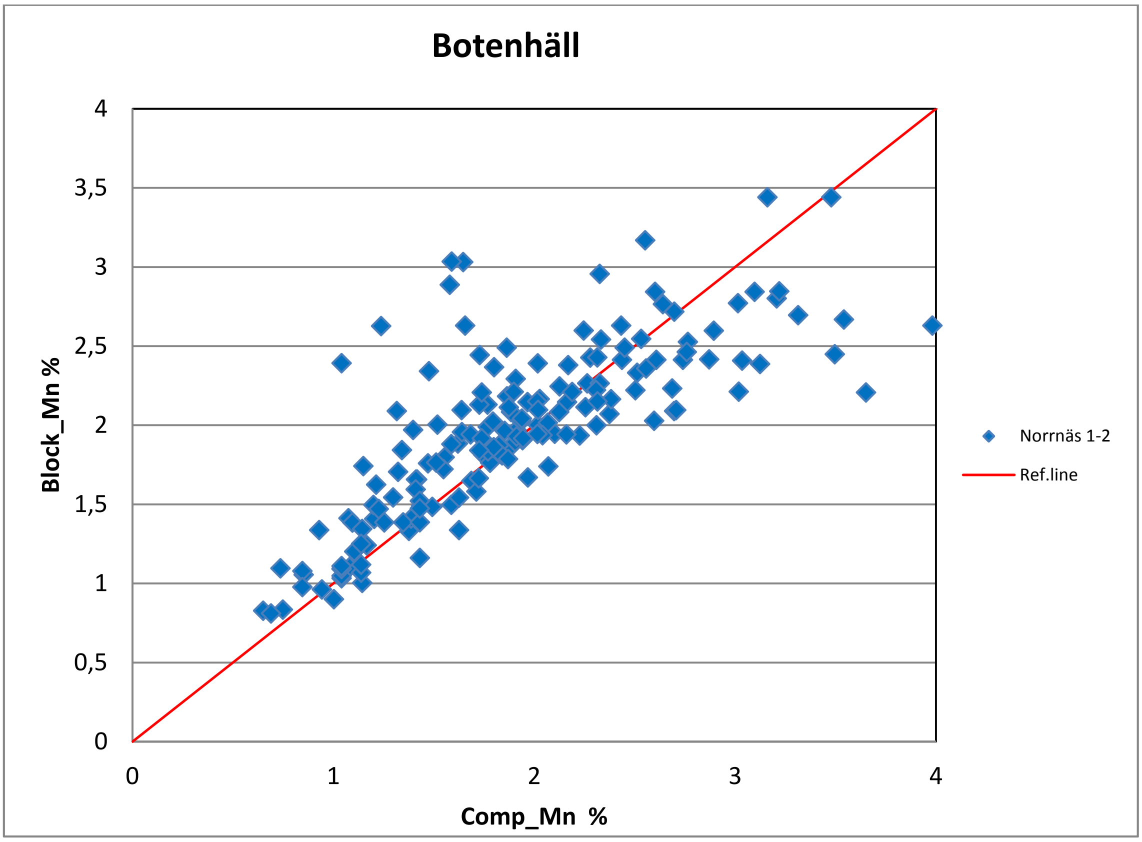

Kruthus
60
50
40
30
20
10
0
0
10
20
30
40
50
60
Block_Fe %
Comp_Fe %
Kruthus
Ref.line

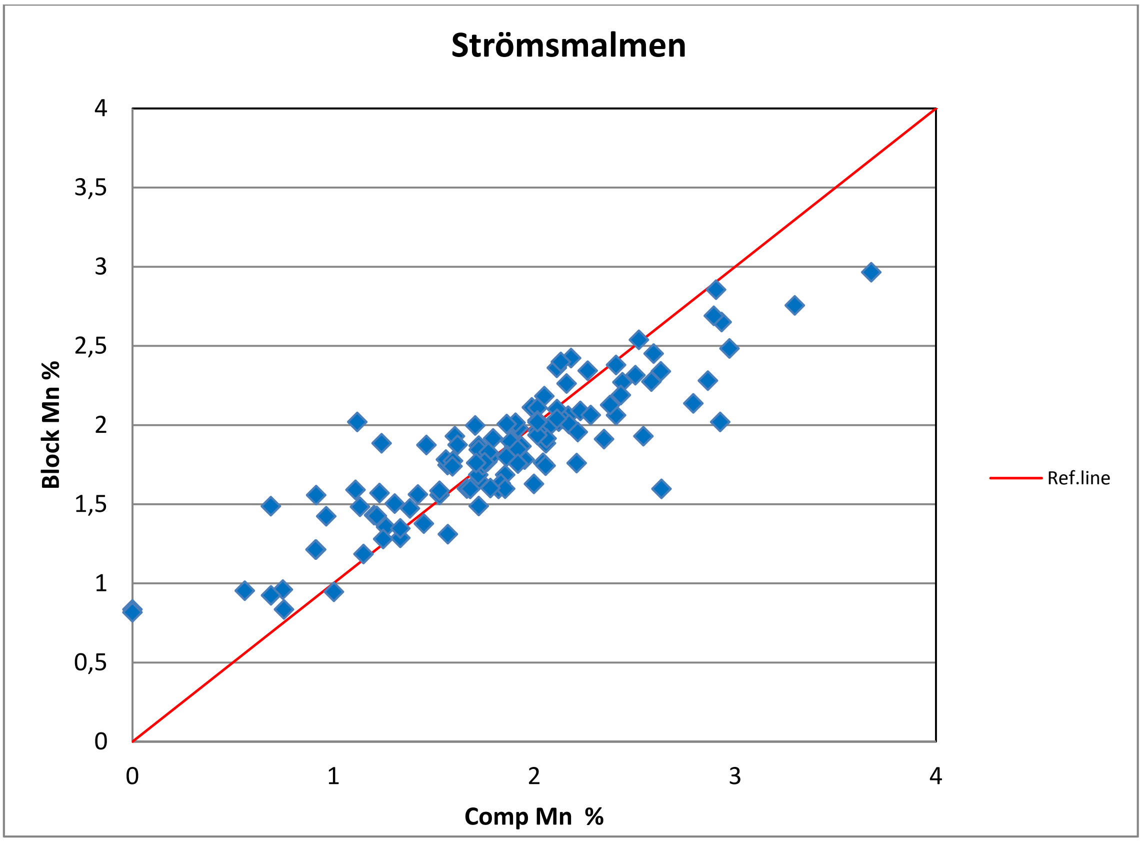

Kruthus 1_4
Block_Fe %
Comp_Fe %
Kruthus 1_4
Ref.line
0
10
20
30
40
50
60

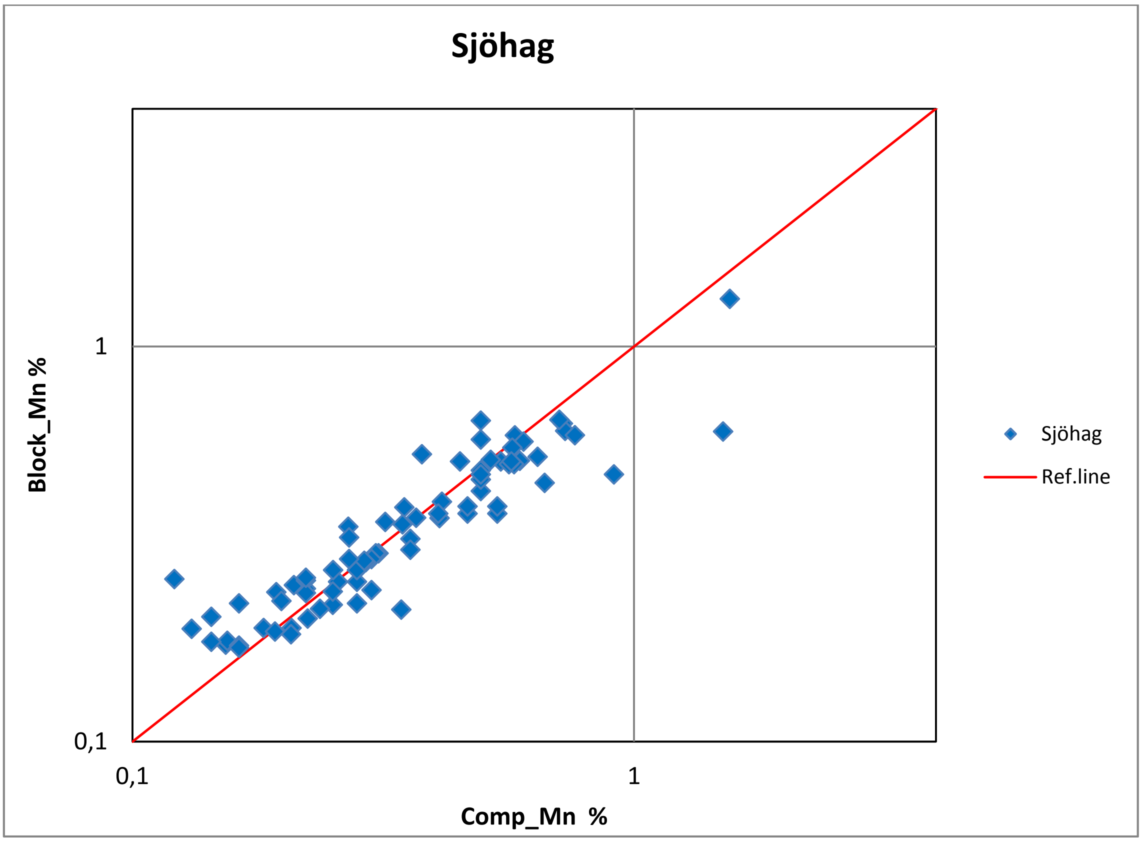

Konstäng 2_3
Block_Fe %
Comp_Fe %
Konstäng 2_3
Ref.line
0
10
20
30
40
50
60

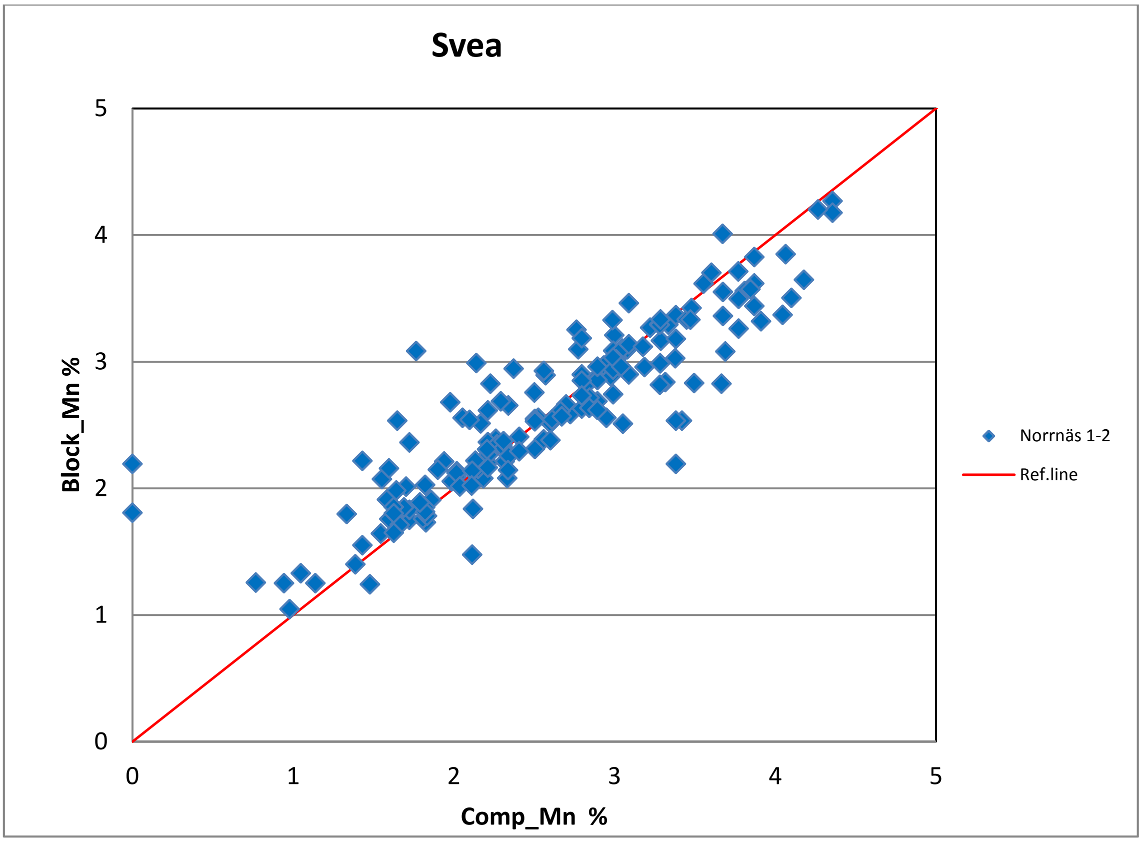
De-clustering plots Mn

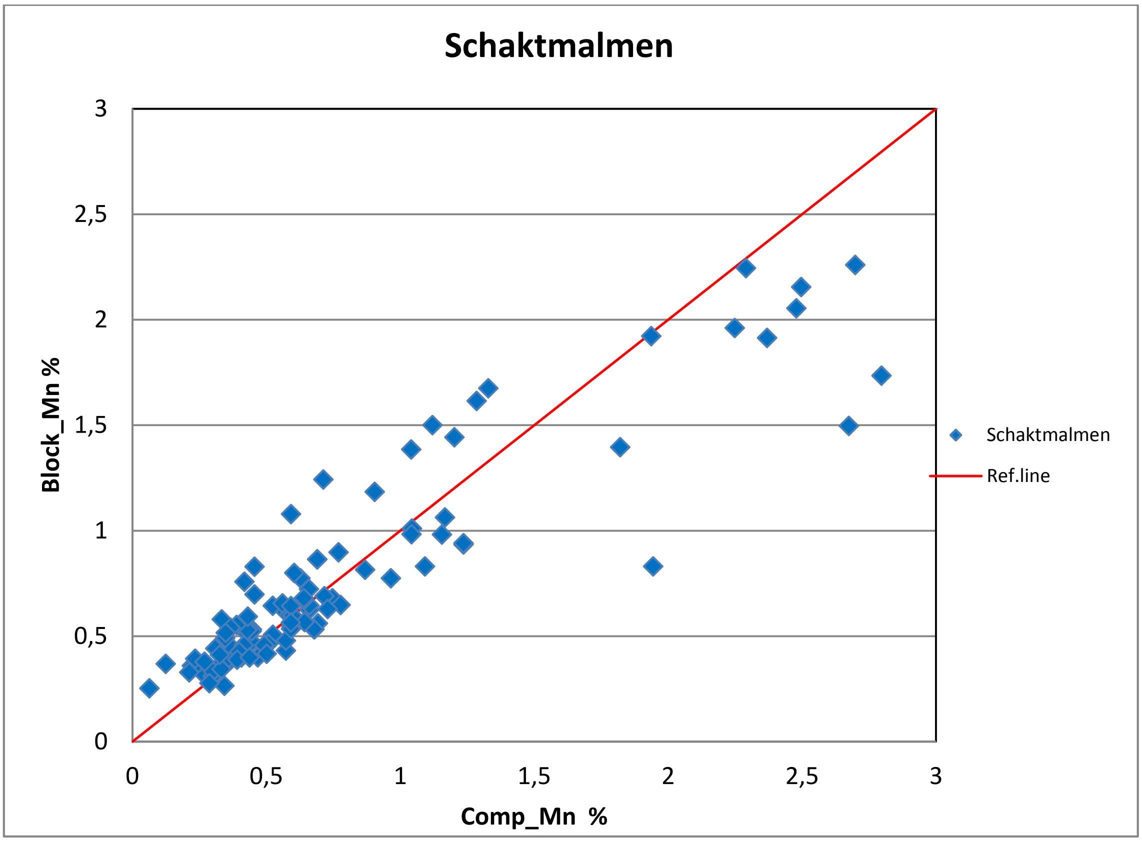


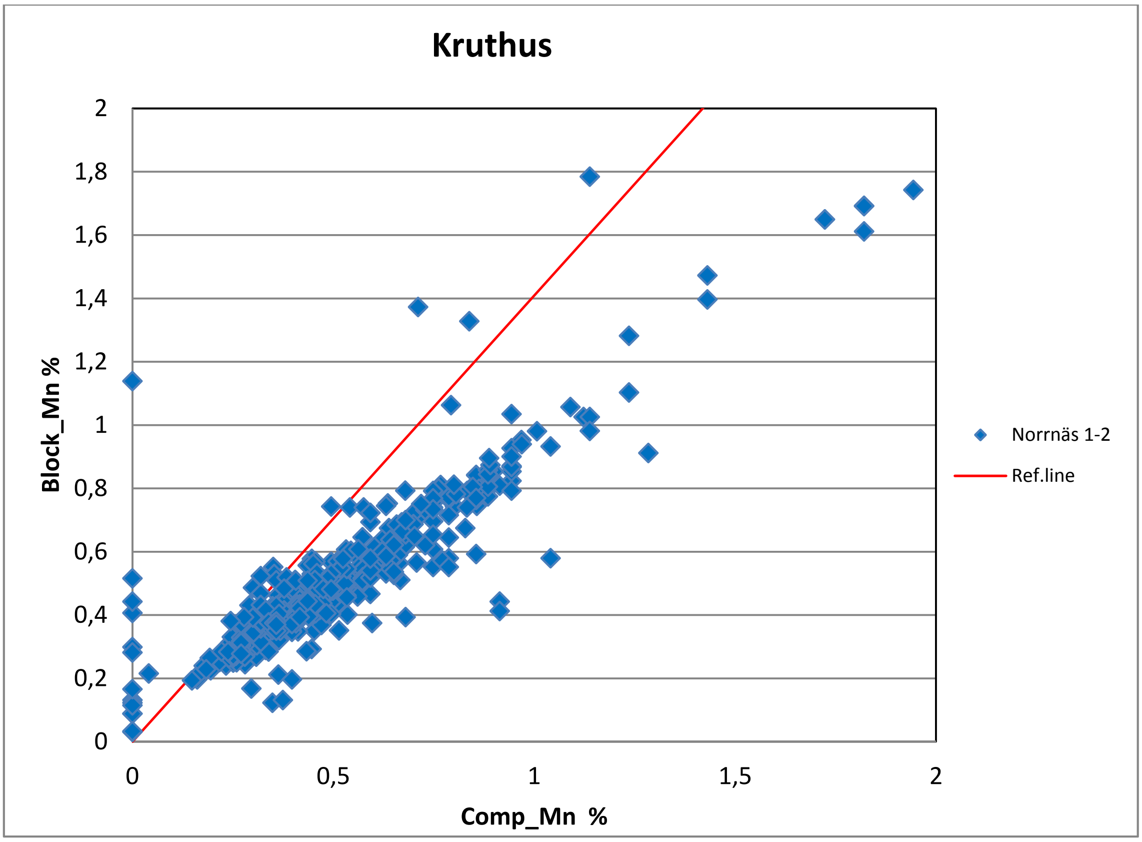

Botenhäll
4
3,5
3
2,5
2
1,5
1
0,5
0
0
1
2
3
4
Block_Mn %
Comp_Mn %
Norrnäs 1-2
Ref.line

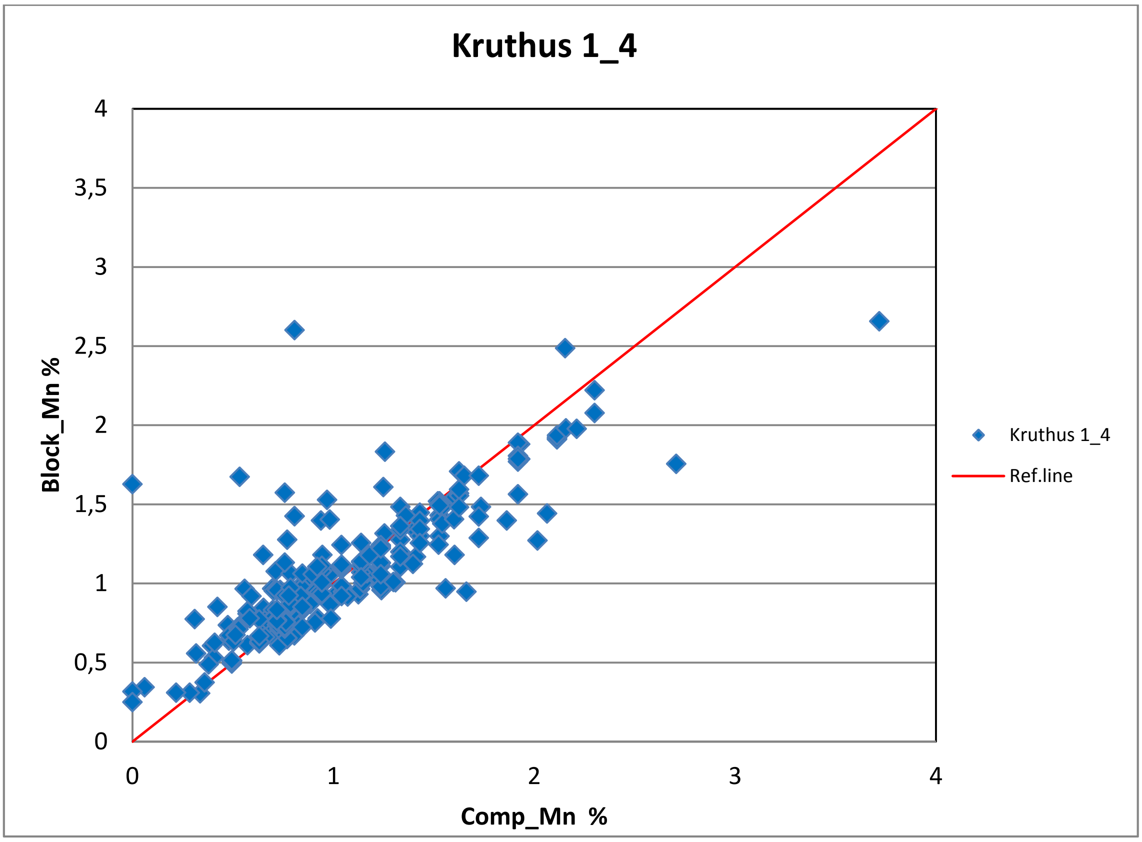

Strömsmalmen
4
3,5
3
2,5
2
1,5
1
0,5
0
0
1
2
3
4
Block Mn %
Comp Mn %
Ref.line

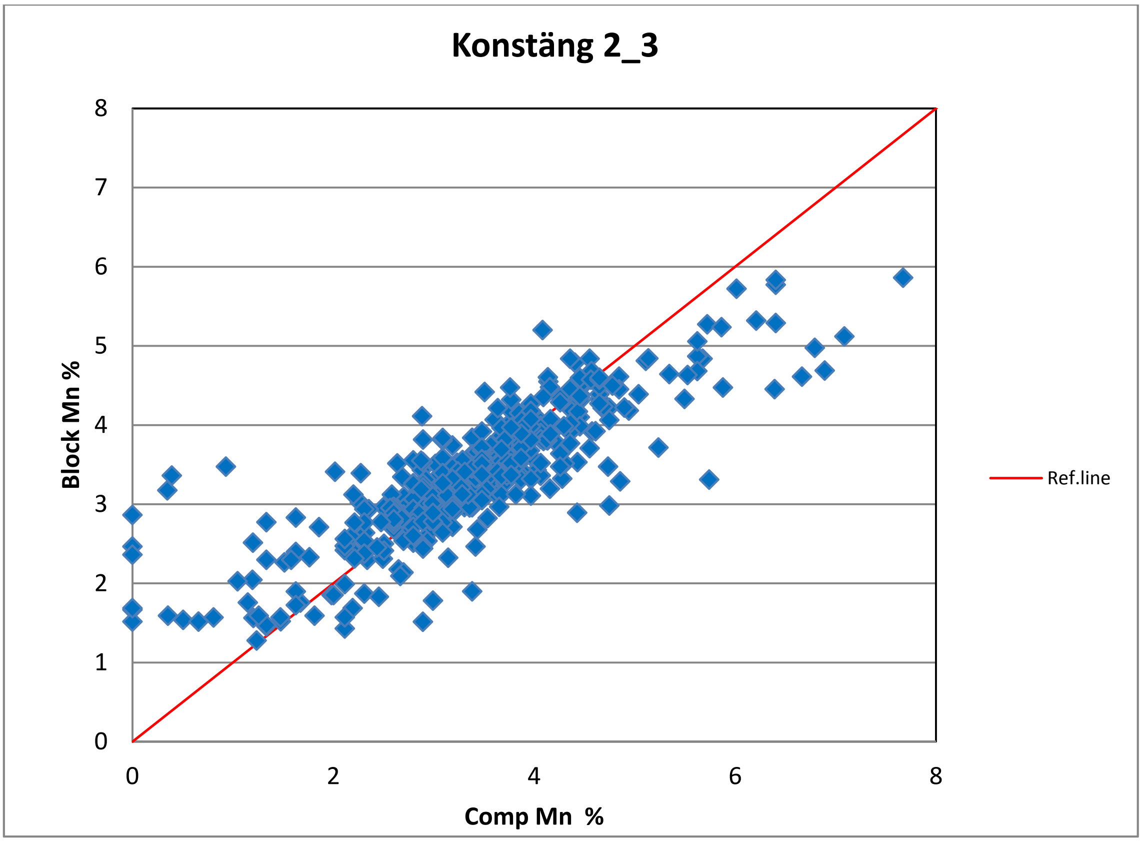

Sjöhag
Block_Mn %
1
0,1
0,1
1
Comp_Mn %
Sjöhag
Ref.line


Svea
Block_Mn %
5
4
3
2
1
0
0
1
2
3
4
5
Comp_Mn %
Norrnäs 1-2
Ref.line

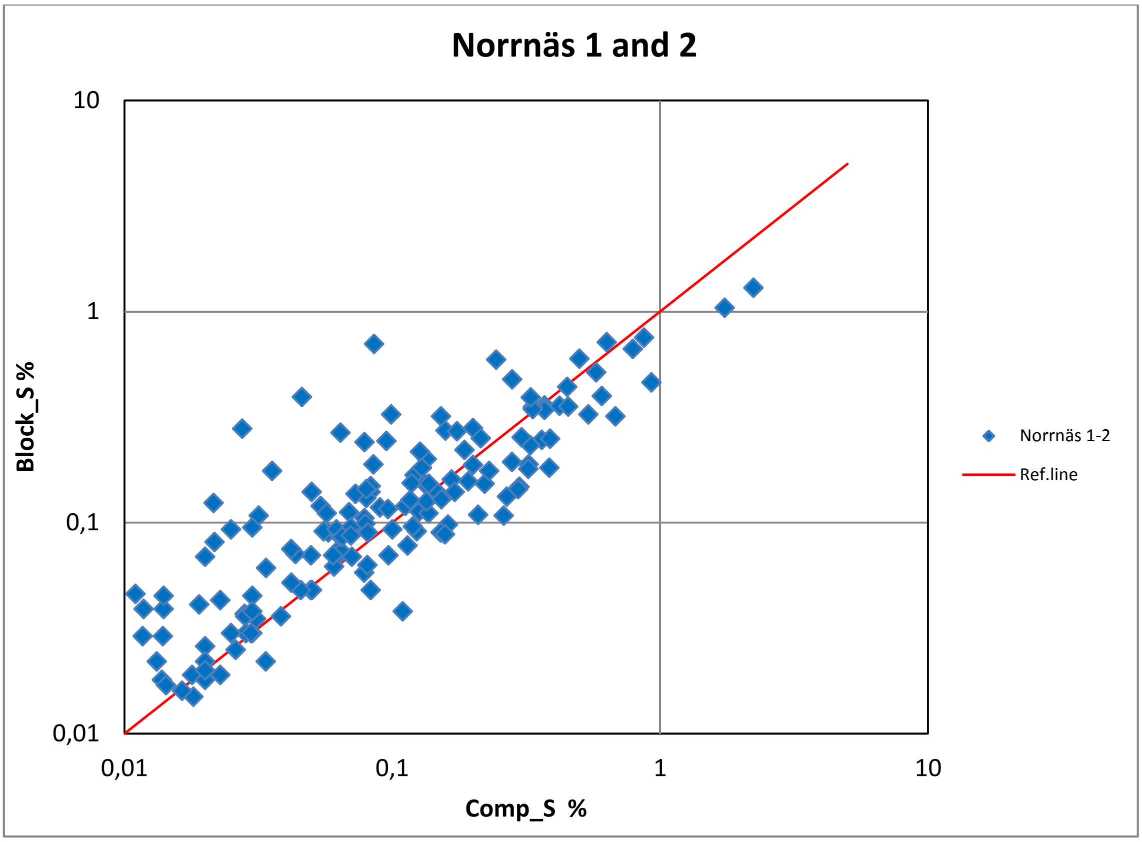

Schaktmalmen
Block_Mn %
Comp_Mn %
0
0,5
1
1,5
2
2,5
3
Schaktmalmen
Ref.line

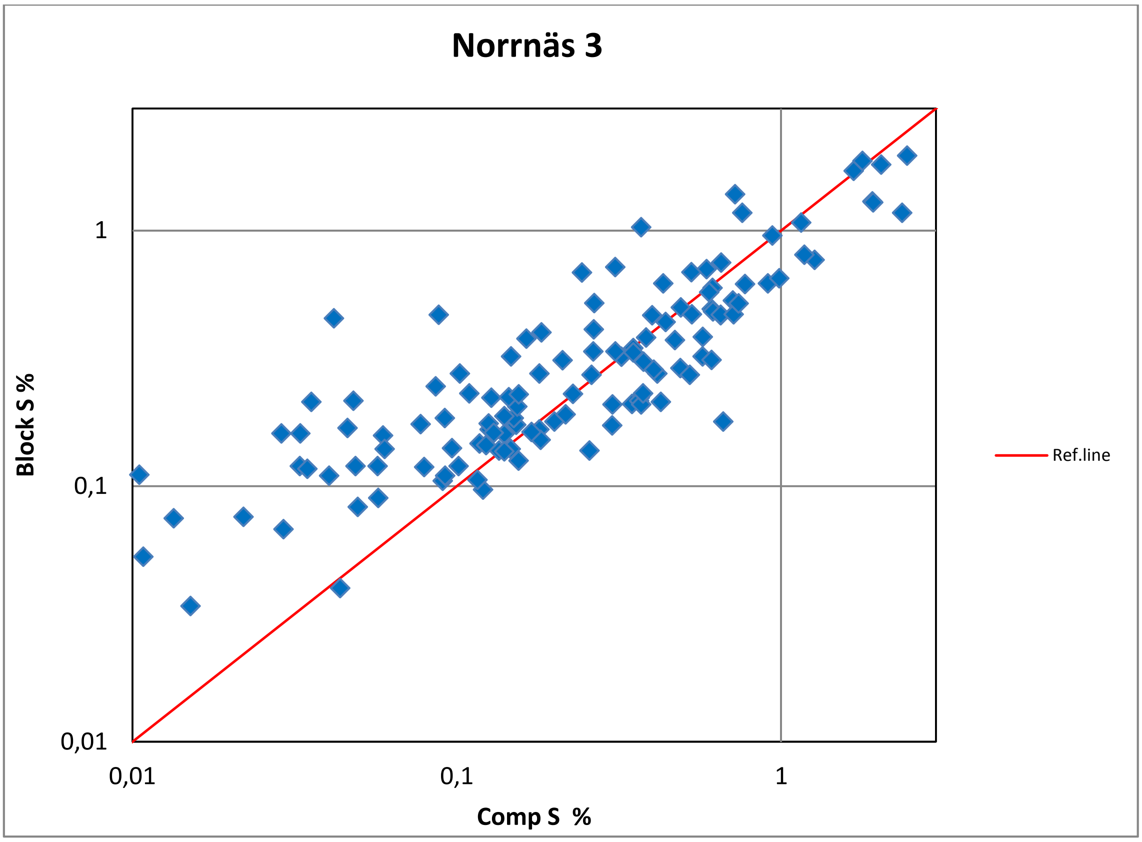

Kruthus
Block_Mn %
Comp_Mn %
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
1,8
2
0,5
1,5
Norrnäs 1-2
Ref.line

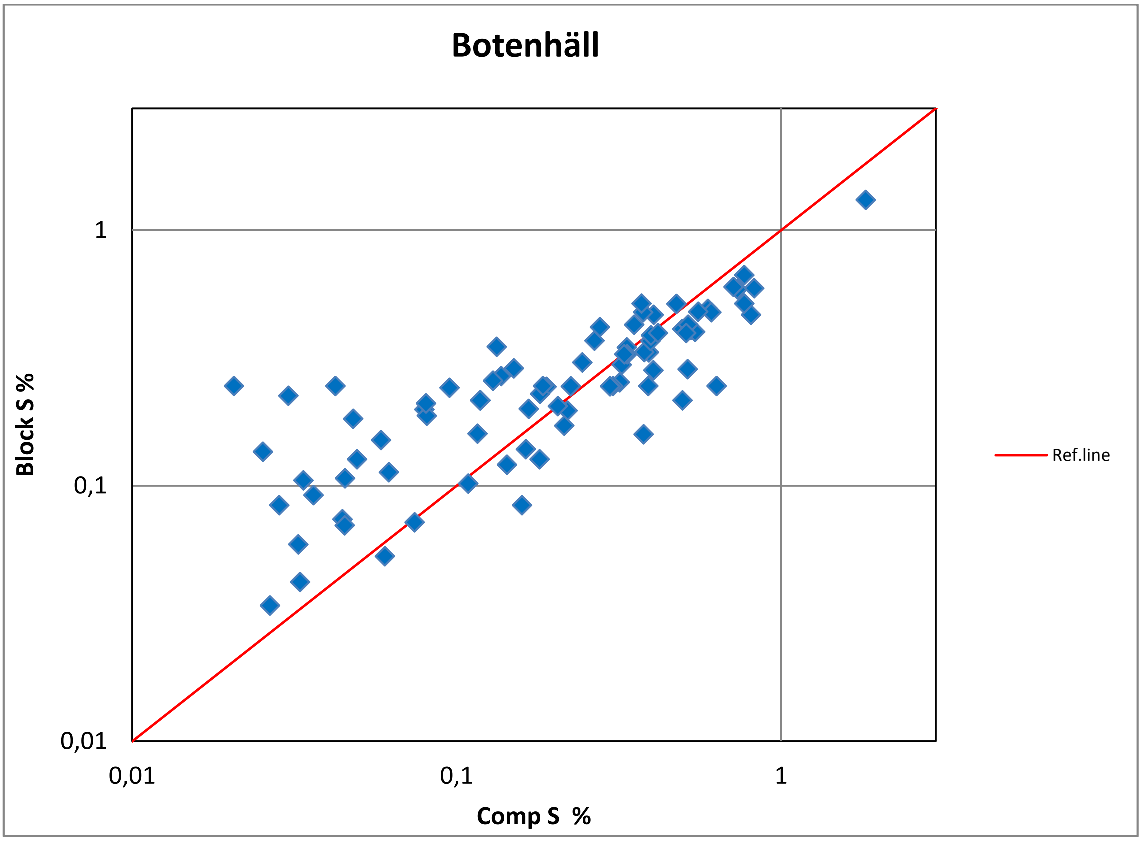

Kruthus 1_4
Block_Mn %
Comp_Mn %
0
0,5
1
1,5
2
2,5
3
3,5
4
0
1
2
3
4
Kruthus 1_4
Ref.line

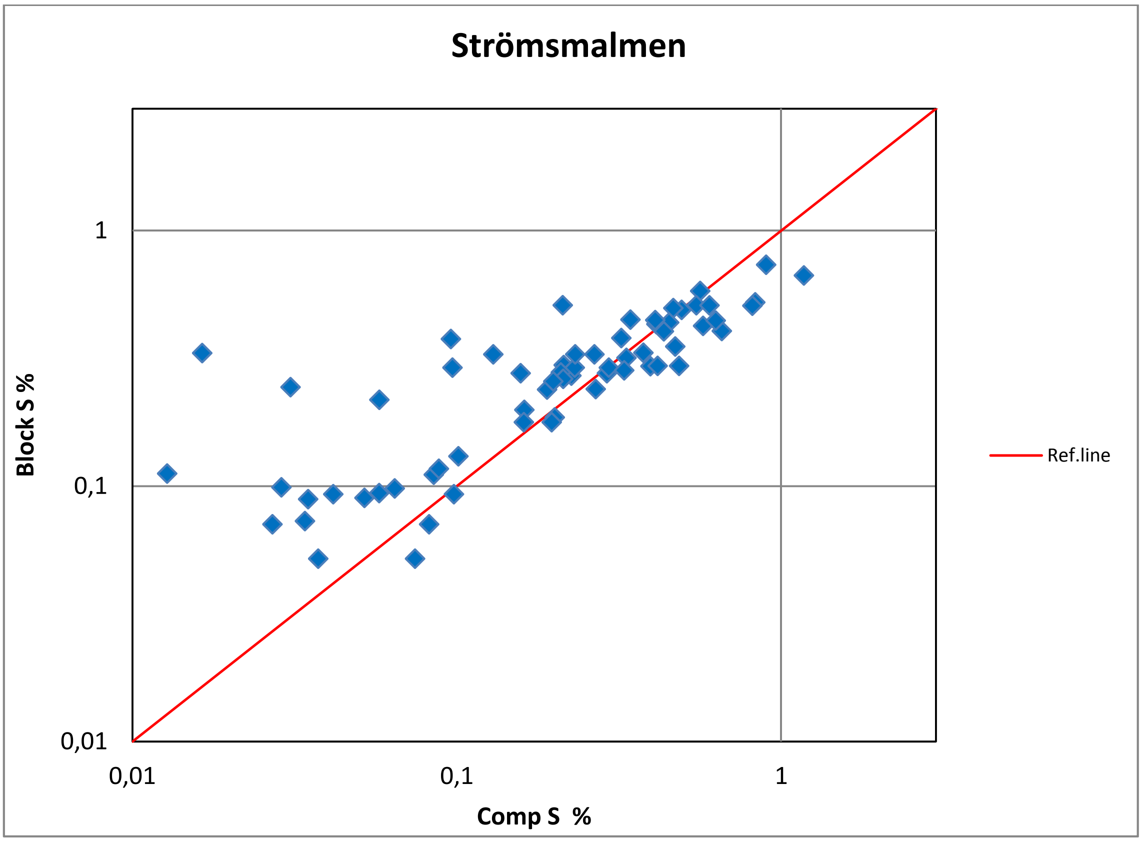

Konstäng 2_3
Block Mn %
Comp Mn %
0
1
2
3
4
5
6
7
8
0
2
4
6
8
Ref.line

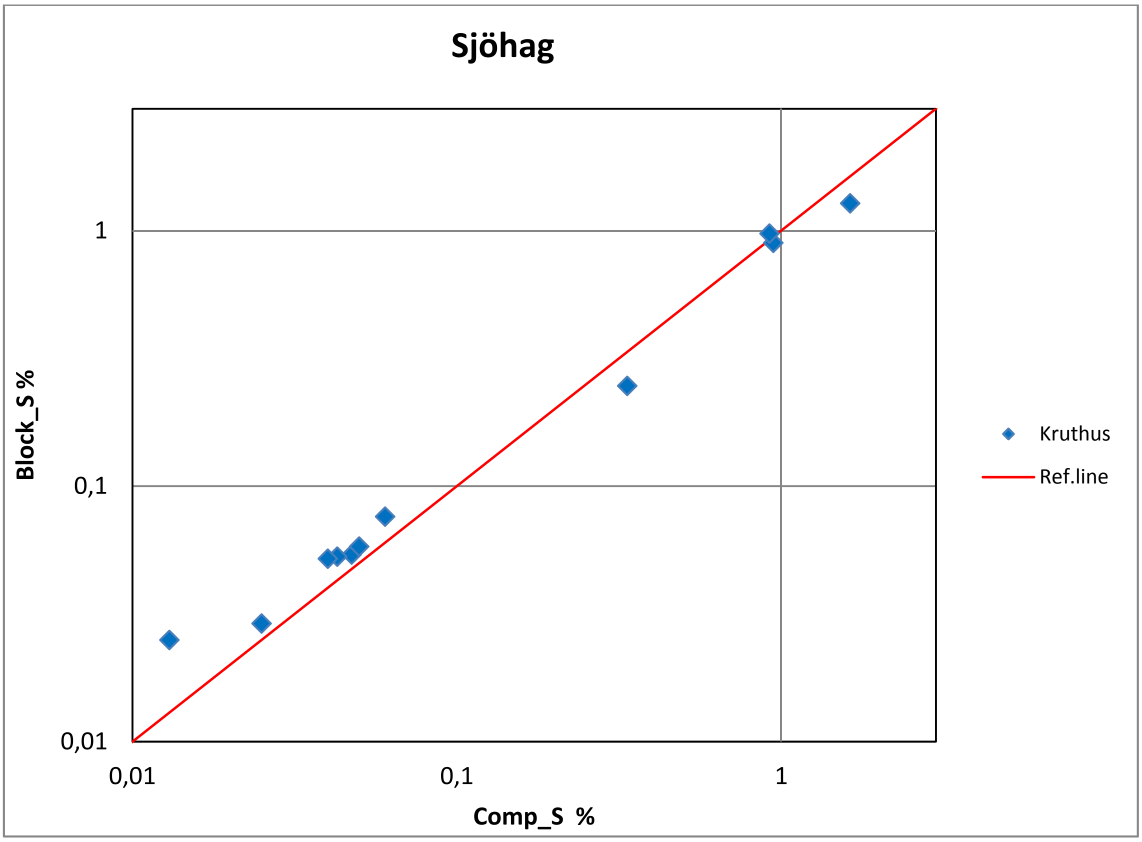
De-clustering plots S

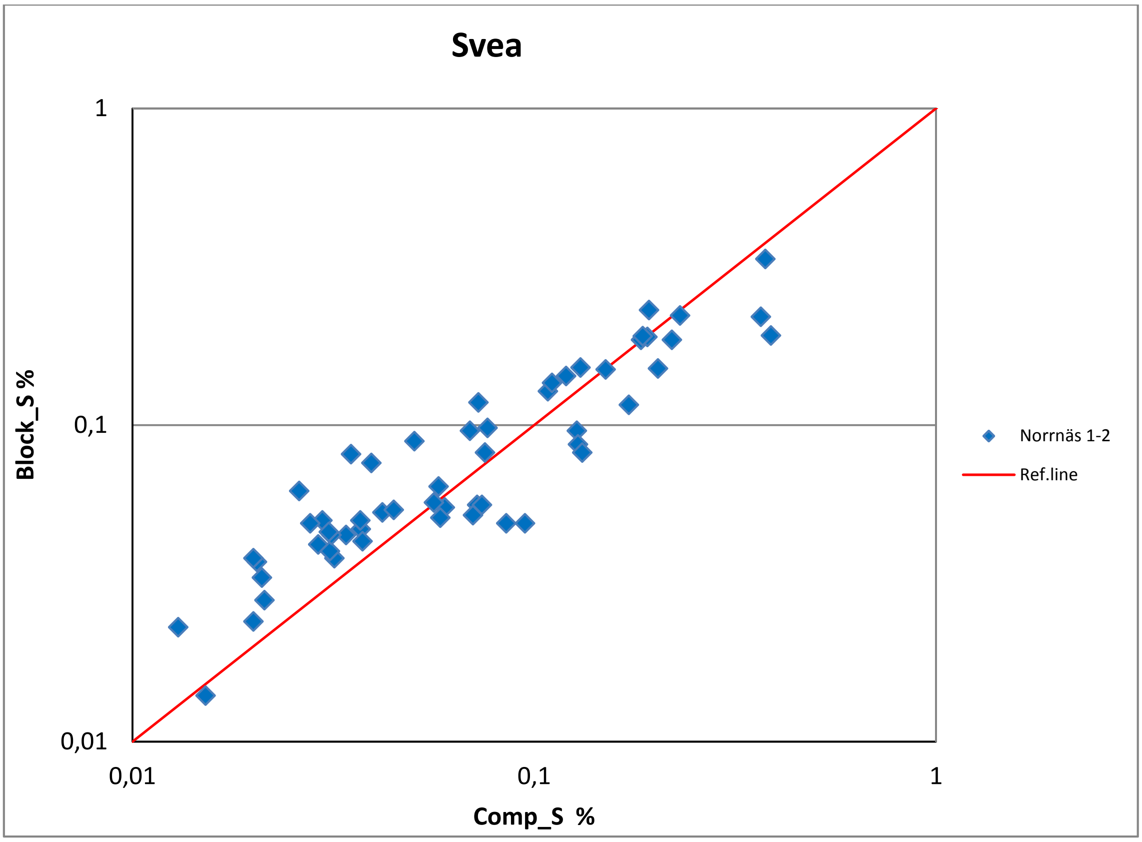


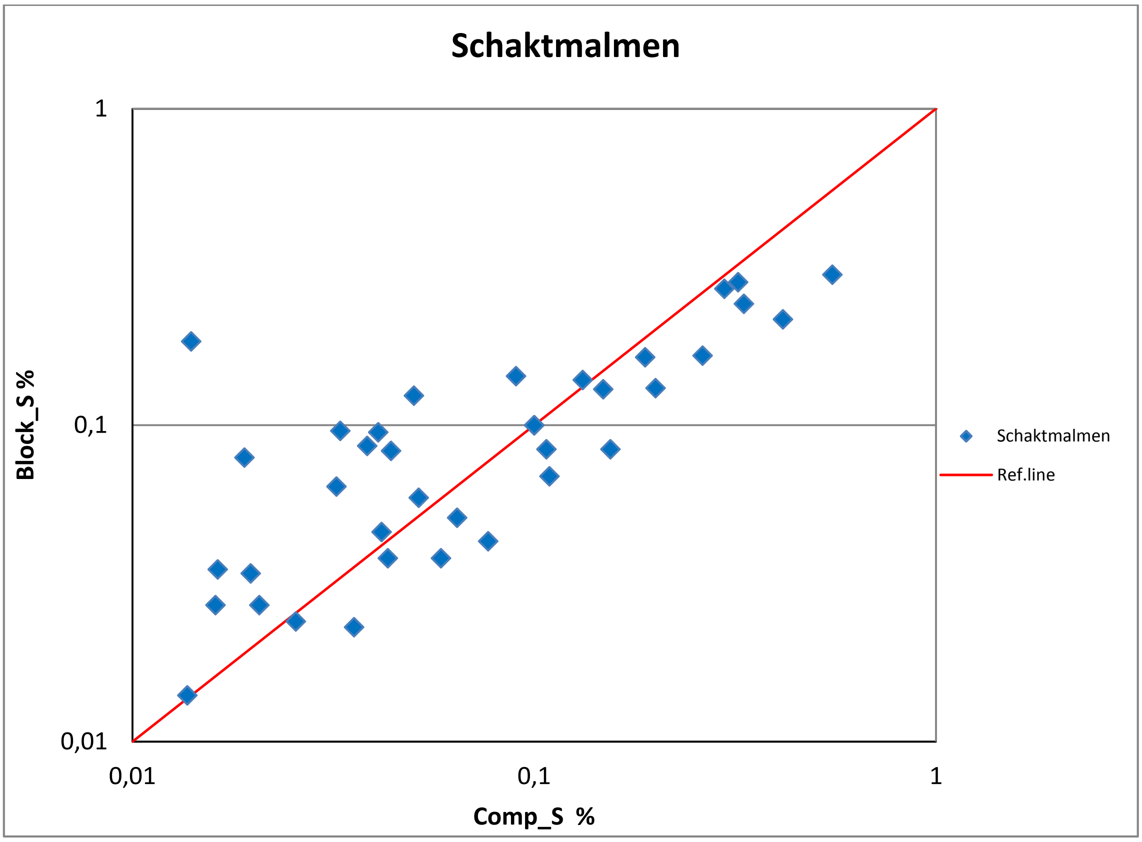



Botenhäll
Block S %
Comp S %
1
0,1
0,01
0,01
0,1
1
Ref.line

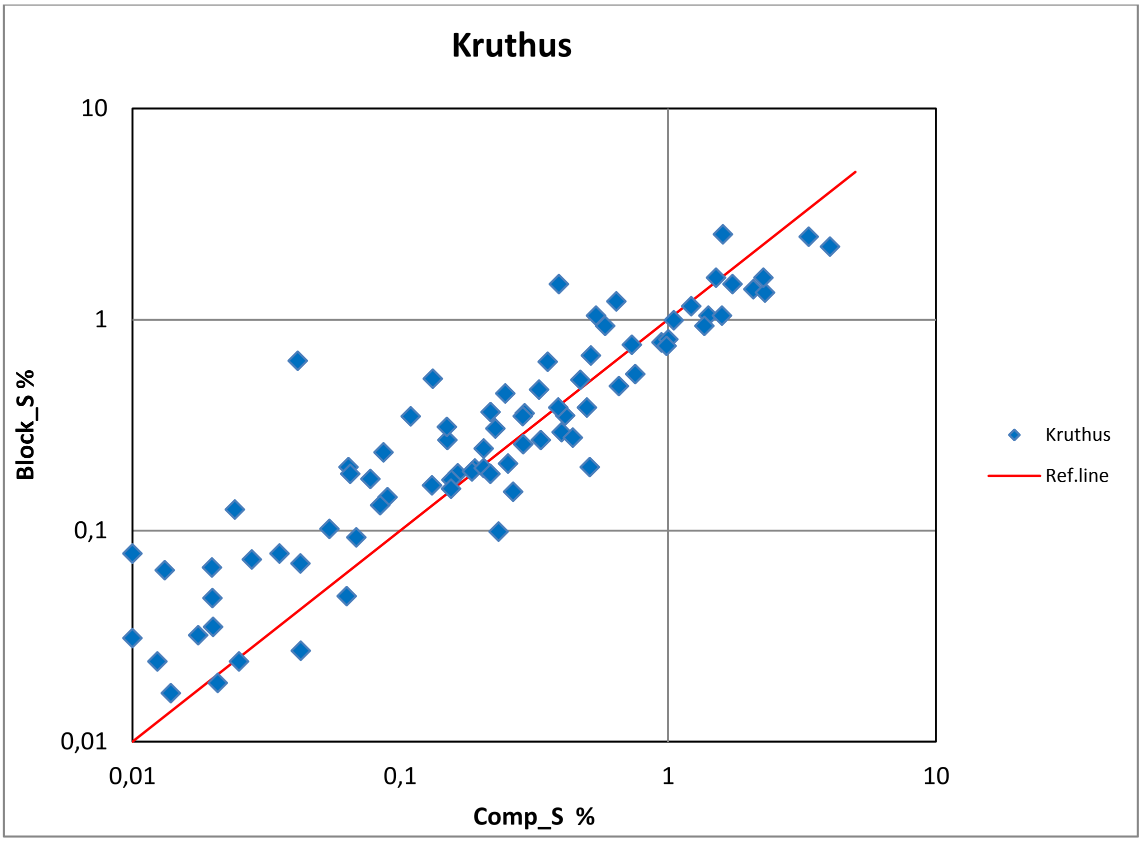

Strömsmalmen
Block S %
Comp S %
1
0,1
0,01
0,01
0,1
1
Ref.line


Sjöhag
Block_S %
Comp_S %
1
0,1
0,01
0,01
0,1
1
Kruthus
Ref.line

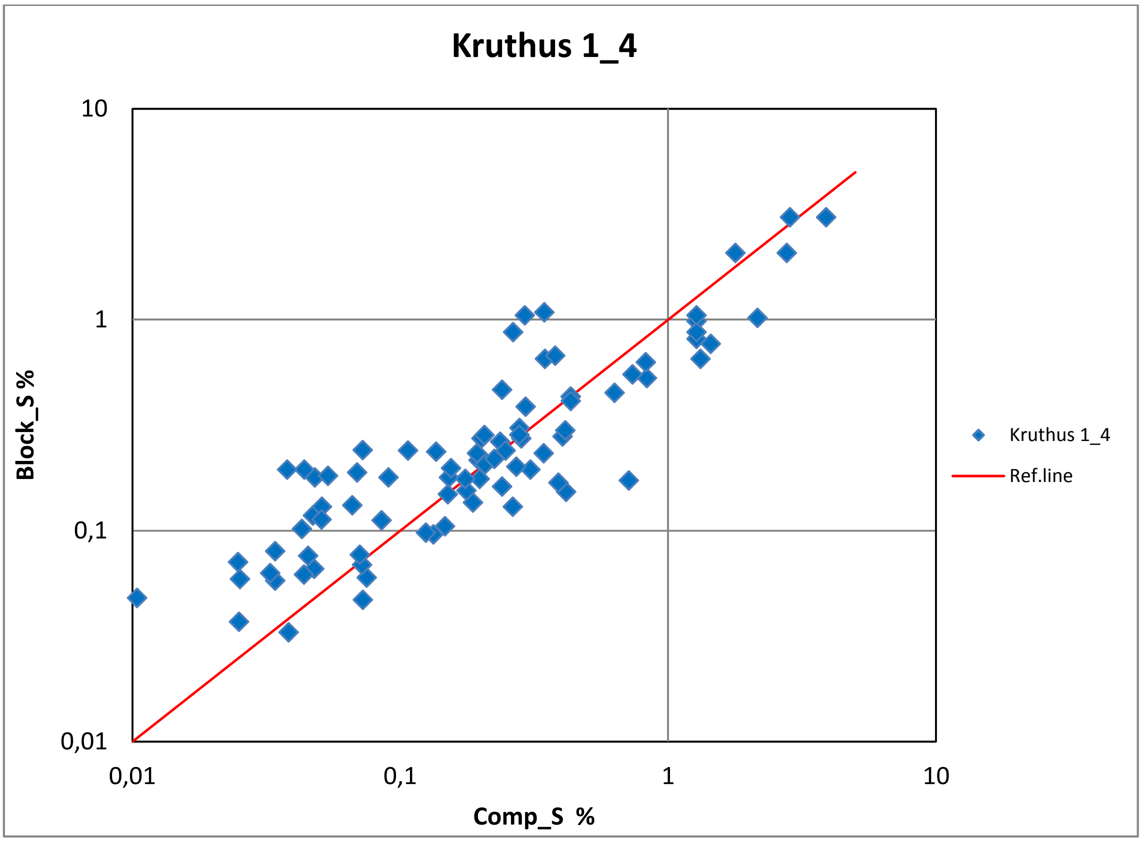

Svea
Block_S %
Comp_S %
1
0,1
0,01
0,01
0,1
1
Norrnäs 1-2
Ref.line



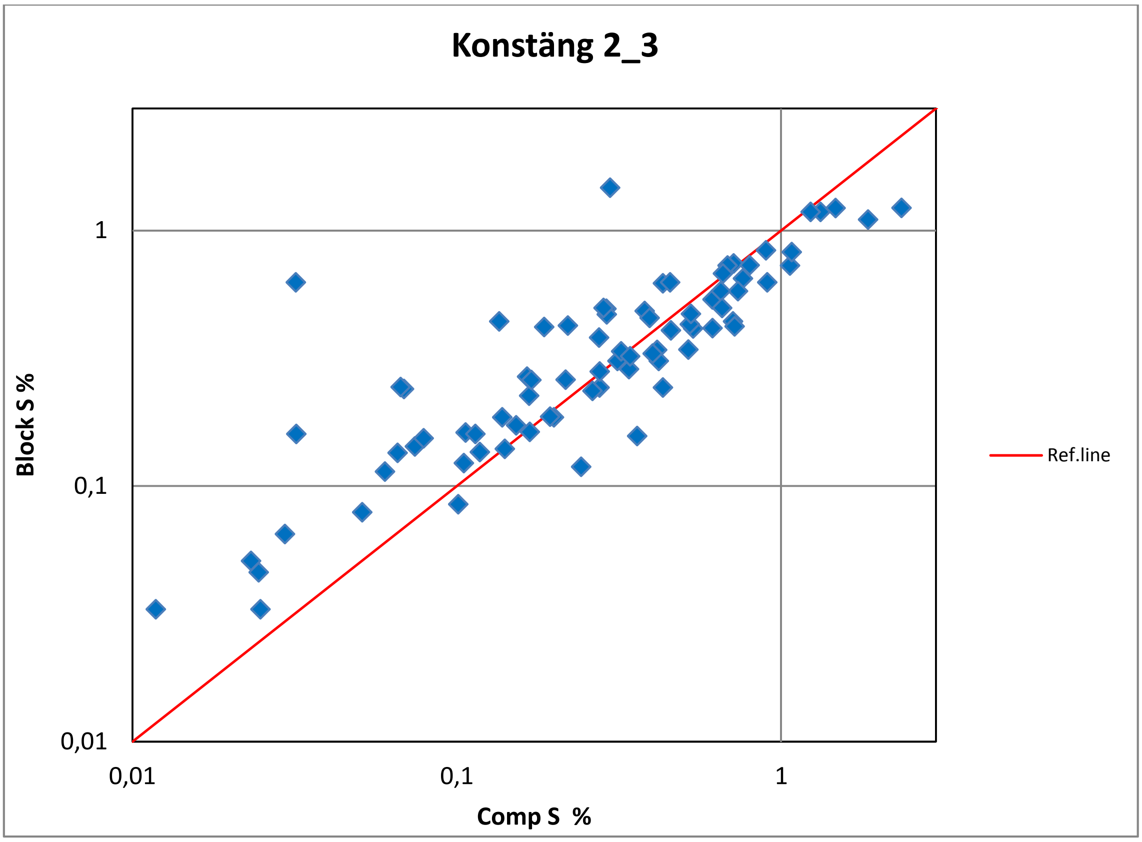
Schaktmalmen
1
0,1
0,01
Block_S %
0,01
0,1
1
Comp_S %
Schaktmalmen
Ref.line



Kruthus
10
1
0,1
0,01
Block_S %
0,01
0,1
1
10
Comp_S %
Kruthus
Ref.line



Kruthus 1_4
10
1
0,1
0,01
0,01
0,1
1
10
Block_S %
Comp_S %
Kruthus 1_4
Ref.line



Konstäng 2_3
1
0,1
0,01
0,01
0,1
1
Block S %
Comp S %
Ref.line

Appendix 2 - Comparisons of the general statistics between the composite Fe- and block Fe-values

Botenhäll

String range	1	All
Variable	D1	D1
Number of samples	163	89758
Minimum value	1.4810	25.334
Maximum value	53.4495	51.269
	Ungrouped Data	Ungrouped Data
Mean	37.6504	38.236
Median	38.3138	38.477
Geometric Mean	36.4368	37.992
Variance	55.7174	18.249
Standard Deviation	7.4644	4.272
Coefficient of variation	0.1983	0.112
Moment 1 About Arithmetic Mean	0.0000	0.000
Moment 2 About Arithmetic Mean	55.7174	18.249
Moment 3 About Arithmetic Mean	-407.1337	-9.894
Moment 4 About Arithmetic Mean	17784.3004	866.719
Skewness	-0.9789	-0.127
Kurtosis	5.7287	2.602
Natural Log Mean	3.5956	3.637
Log Variance	0.1039	0.013
10.0 Percentile	28.2675	32.604
20.0 Percentile	31.6479	34.361
30.0 Percentile	35.0429	35.722
40.0 Percentile	36.2064	37.104
50.0 Percentile (median)	38.3138	38.477
60.0 Percentile	40.0633	39.752
70.0 Percentile	41.6574	40.876
80.0 Percentile	43.9322	42.190
90.0 Percentile	46.8456	43.375
100.0 Percentile	53.4495	51.269
Trimean	38.2261	38.378
Biweight	38.3045	38.335
MAD	4.6863	3.180
Alpha	-1.4662	-25.081
Sichel-t	38.3668	38.240

Konstäng1_4

String range	1	All
Variable	D1	D1
Number of samples	268	98080
Minimum value	0.0000	7.731
Maximum value	60.3000	56.972
	Ungrouped Data	Ungrouped Data
Mean	43.3961	42.514
Median	46.5683	43.844
Geometric Mean	Not Calculated	41.633
Variance	128.4483	64.105
Standard Deviation	11.3335	8.007
Coefficient of variation	0.2612	0.188
Moment 1 About Arithmetic Mean	0.0000	0.000
Moment 2 About Arithmetic Mean	128.4483	64.105
Moment 3 About Arithmetic Mean	-1854.7123	-390.668
Moment 4 About Arithmetic Mean	82137.1662	13010.073
Skewness	-1.2740	-0.761
Kurtosis	4.9783	3.166
Natural Log Mean	Not Calculated	3.729
Log Variance	Not Calculated	0.046
10.0 Percentile	28.3748	30.845
20.0 Percentile	35.5933	36.396
30.0 Percentile	40.1827	39.255
40.0 Percentile	42.8472	41.598
50.0 Percentile (median)	46.5683	43.844
60.0 Percentile	48.3142	45.675
70.0 Percentile	50.8118	47.816
80.0 Percentile	53.2401	49.790
90.0 Percentile	54.9080	51.918
100.0 Percentile	60.3000	56.972
Trimean	45.9647	43.628
Biweight	45.3234	43.454
MAD	7.4304	5.376
Alpha	-0.0000	-7.654
Sichel-t	0.0000	42.603

Konstäng2_3

String range	1	All
Variable	D1	D1
Number of samples	617	144593
Minimum value	0.0000	14.646
Maximum value	54.5028	49.977
	Ungrouped Data	Ungrouped Data
Mean	35.0593	35.935
Median	35.4653	35.726
Geometric Mean	Not Calculated	35.419
Variance	83.6209	35.709
Standard Deviation	9.1444	5.976
Coefficient of variation	0.2608	0.166
Moment 1 About Arithmetic Mean	0.0000	0.000
Moment 2 About Arithmetic Mean	83.6209	35.709
Moment 3 About Arithmetic Mean	-702.6777	-8.157
Moment 4 About Arithmetic Mean	35330.0938	3313.196
Skewness	-0.9189	-0.038
Kurtosis	5.0526	2.598
Natural Log Mean	Not Calculated	3.567
Log Variance	Not Calculated	0.030
10.0 Percentile	24.8781	28.624
20.0 Percentile	28.1437	30.870
30.0 Percentile	31.5761	32.521
40.0 Percentile	33.3284	34.193
50.0 Percentile (median)	35.4653	35.726
60.0 Percentile	37.7964	37.283
70.0 Percentile	39.6419	39.095
80.0 Percentile	43.1146	41.539
90.0 Percentile	46.2915	44.340
100.0 Percentile	54.5028	49.977
Trimean	35.6338	35.848
Biweight	35.7686	35.899
MAD	6.0638	4.230
Alpha	444.3090	4.735
Sichel-t	0.0000	35.951

Kruthus

String range	1	All
Variable	D1	D1
Number of samples	869	197174
Minimum value	0.0000	6.704
Maximum value	61.2227	55.827
	Ungrouped Data	Ungrouped Data
Mean	39.2269	39.216
Median	42.0701	40.090
Geometric Mean	Not Calculated	38.333
Variance	148.4300	57.754
Standard Deviation	12.1832	7.600
Coefficient of variation	0.3106	0.194
Moment 1 About Arithmetic Mean	0.0000	0.000
Moment 2 About Arithmetic Mean	148.4300	57.754
Moment 3 About Arithmetic Mean	-2489.9861	-331.089
Moment 4 About Arithmetic Mean	111945.7979	12222.857
Skewness	-1.3769	-0.754
Kurtosis	5.0812	3.664
Natural Log Mean	Not Calculated	3.646
Log Variance	Not Calculated	0.051
10.0 Percentile	23.7512	29.396
20.0 Percentile	31.0857	33.448
30.0 Percentile	35.6498	35.970
40.0 Percentile	39.2533	38.181
50.0 Percentile (median)	42.0701	40.090
60.0 Percentile	44.6926	41.839
70.0 Percentile	47.2180	43.765
80.0 Percentile	49.0635	45.874
90.0 Percentile	51.0531	48.048
100.0 Percentile	61.2227	55.827
Trimean	41.3106	39.959
Biweight	41.5492	39.984
MAD	7.1189	4.953
Alpha	-0.0000	-6.637
Sichel-t	0.0000	39.328

Norrnäs 1 and 2

String range	1	All
Variable	D1	D1
Number of samples	235	194183
Minimum value	0.0484	20.798
Maximum value	50.1432	48.637
	Ungrouped Data	Ungrouped Data
Mean	36.6679	37.329
Median	37.7113	37.541
Geometric Mean	34.7531	37.121
Variance	67.9073	14.867
Standard Deviation	8.2406	3.856
Coefficient of variation	0.2247	0.103
Moment 1 About Arithmetic Mean	0.0000	0.000
Moment 2 About Arithmetic Mean	67.9073	14.867
Moment 3 About Arithmetic Mean	-587.2456	-20.361
Moment 4 About Arithmetic Mean	21394.7318	863.652
Skewness	-1.0494	-0.355
Kurtosis	4.6395	3.907
Natural Log Mean	3.5483	3.614
Log Variance	0.2553	0.012
10.0 Percentile	25.4609	32.406
20.0 Percentile	30.5950	34.553
30.0 Percentile	33.9491	35.908
40.0 Percentile	36.2288	36.701
50.0 Percentile (median)	37.7113	37.541
60.0 Percentile	39.9042	38.232
70.0 Percentile	41.7979	39.143
80.0 Percentile	43.4453	40.338
90.0 Percentile	46.2062	41.784
100.0 Percentile	50.1432	48.637
Trimean	37.6144	37.507
Biweight	37.7224	37.542
MAD	5.0178	2.171
Alpha	-0.0479	-20.590
Sichel-t	39.4601	37.335

Norrnäs 3

String range	1	All
Variable	D1	D1
Number of samples	154	71106
Minimum value	0.0000	9.506
Maximum value	52.9750	47.750
	Ungrouped Data	Ungrouped Data
Mean	35.9238	37.181
Median	38.3037	38.395
Geometric Mean	Not Calculated	36.640
Variance	119.0138	32.116
Standard Deviation	10.9093	5.667
Coefficient of variation	0.3037	0.152
Moment 1 About Arithmetic Mean	0.0000	0.000
Moment 2 About Arithmetic Mean	119.0138	32.116
Moment 3 About Arithmetic Mean	-2063.2264	-249.516
Moment 4 About Arithmetic Mean	84330.6388	5850.371
Skewness	-1.5891	-1.371
Kurtosis	5.9537	5.672
Natural Log Mean	Not Calculated	3.601
Log Variance	Not Calculated	0.034
10.0 Percentile	23.6077	29.687
20.0 Percentile	29.7548	33.246
30.0 Percentile	33.4778	35.686
40.0 Percentile	36.4846	37.320
50.0 Percentile (median)	38.3037	38.395
60.0 Percentile	39.8619	39.406
70.0 Percentile	41.9729	40.419
80.0 Percentile	44.0846	41.696
90.0 Percentile	46.4819	43.064
100.0 Percentile	52.9750	47.750
Trimean	37.6765	38.078
Biweight	38.2697	38.187
MAD	5.4098	3.202
Alpha	-0.0000	-9.411
Sichel-t	0.0000	37.262

Schaktmalmen

String range	1	All
Variable	D1	D1
Number of samples	161	104656
Minimum value	0.0000	7.728
Maximum value	63.4279	59.530
	Ungrouped Data	Ungrouped Data
Mean	39.2659	38.932
Median	38.9620	39.141
Geometric Mean	Not Calculated	37.715
Variance	206.4415	83.662
Standard Deviation	14.3681	9.147
Coefficient of variation	0.3659	0.235
Moment 1 About Arithmetic Mean	0.0000	0.000
Moment 2 About Arithmetic Mean	206.4415	83.662
Moment 3 About Arithmetic Mean	-843.4183	-153.919
Moment 4 About Arithmetic Mean	97834.2289	19714.674
Skewness	-0.2843	-0.201
Kurtosis	2.2956	2.817
Natural Log Mean	Not Calculated	3.630
Log Variance	Not Calculated	0.070
10.0 Percentile	20.8235	28.043
20.0 Percentile	27.0150	31.145
30.0 Percentile	29.9344	33.735
40.0 Percentile	33.6132	36.255
50.0 Percentile (median)	38.9620	39.141
60.0 Percentile	45.7610	41.522
70.0 Percentile	49.1996	44.470
80.0 Percentile	54.6077	47.298
90.0 Percentile	57.9994	50.709
100.0 Percentile	63.4279	59.530
Trimean	39.5096	39.098
Biweight	39.5029	39.121
MAD	11.9839	6.639
Alpha	345.1852	234.011
Sichel-t	0.0000	39.059

Sjöhag

String range	1	All
Variable	D1	D1
Number of samples	95	43688
Minimum value	18.3820	24.686
Maximum value	51.3946	49.590
	Ungrouped Data	Ungrouped Data
Mean	39.0536	38.753
Median	39.6419	38.691
Geometric Mean	38.2255	38.410
Variance	58.1820	26.083
Standard Deviation	7.6277	5.107
Coefficient of variation	0.1953	0.132
Moment 1 About Arithmetic Mean	0.0000	0.000
Moment 2 About Arithmetic Mean	58.1820	26.083
Moment 3 About Arithmetic Mean	-207.5962	-4.264
Moment 4 About Arithmetic Mean	8262.3813	1554.998
Skewness	-0.4678	-0.032
Kurtosis	2.4408	2.286
Natural Log Mean	3.6435	3.648
Log Variance	0.0458	0.018
10.0 Percentile	27.6045	32.204
20.0 Percentile	31.3077	34.201
30.0 Percentile	35.6595	35.619
40.0 Percentile	38.0854	37.064
50.0 Percentile (median)	39.6419	38.691
60.0 Percentile	42.3324	40.209
70.0 Percentile	43.7213	42.056
80.0 Percentile	47.0704	43.486
90.0 Percentile	48.1893	45.485
100.0 Percentile	51.3946	49.590
Trimean	39.2861	38.742
Biweight	39.5350	38.754
MAD	5.9861	3.957
Alpha	-18.1982	104.868
Sichel-t	39.1014	38.758

Strömsmalmen

String range	1	All
Variable	D1	D1
Number of samples	139	101318
Minimum value	0.0000	8.904
Maximum value	51.8366	47.569
	Ungrouped Data	Ungrouped Data
Mean	34.3891	33.635
Median	34.7978	33.747
Geometric Mean	Not Calculated	33.119
Variance	99.6095	30.333
Standard Deviation	9.9805	5.508
Coefficient of variation	0.2902	0.164
Moment 1 About Arithmetic Mean	0.0000	0.000
Moment 2 About Arithmetic Mean	99.6095	30.333
Moment 3 About Arithmetic Mean	-721.5757	-97.766
Moment 4 About Arithmetic Mean	36711.2183	3920.800
Skewness	-0.7258	-0.585
Kurtosis	3.7000	4.261
Natural Log Mean	Not Calculated	3.500
Log Variance	Not Calculated	0.034
10.0 Percentile	21.9642	26.796
20.0 Percentile	26.8083	30.013
30.0 Percentile	30.3271	31.548
40.0 Percentile	32.2847	32.494
50.0 Percentile (median)	34.7978	33.747
60.0 Percentile	38.1641	34.905
70.0 Percentile	40.4046	36.395
80.0 Percentile	44.0973	38.069
90.0 Percentile	46.0511	40.691
100.0 Percentile	51.8366	47.569
Trimean	35.1392	33.897
Biweight	35.1457	33.934
MAD	6.9413	3.055
Alpha	-0.0000	-8.815
Sichel-t	0.0000	33.686

Svea

String range	1	All
Variable	D1	D1
Number of samples	234	125573
Minimum value	0.0000	10.734
Maximum value	54.8913	51.649
	Ungrouped Data	Ungrouped Data
Mean	39.6037	40.180
Median	42.7986	41.944
Geometric Mean	Not Calculated	39.524
Variance	125.7754	45.769
Standard Deviation	11.2150	6.765
Coefficient of variation	0.2832	0.168
Moment 1 About Arithmetic Mean	0.0000	0.000
Moment 2 About Arithmetic Mean	125.7754	45.769
Moment 3 About Arithmetic Mean	-1847.5892	-266.856
Moment 4 About Arithmetic Mean	72894.7216	6578.225
Skewness	-1.3098	-0.862
Kurtosis	4.6079	3.140
Natural Log Mean	Not Calculated	3.677
Log Variance	Not Calculated	0.036
10.0 Percentile	25.1054	29.740
20.0 Percentile	31.4135	34.209
30.0 Percentile	36.4223	37.532
40.0 Percentile	39.6935	39.888
50.0 Percentile (median)	42.7986	41.944
60.0 Percentile	45.4289	43.430
70.0 Percentile	47.3314	44.880
80.0 Percentile	49.0149	46.160
90.0 Percentile	50.4233	47.522
100.0 Percentile	54.8913	51.649
Trimean	41.9311	41.298
Biweight	41.7664	41.091
MAD	6.6950	4.672
Alpha	-0.0000	-10.627
Sichel-t	0.0000	40.239

Diamanten 2

String range	1	All
Variable	D1	D1
Number of samples	243	128653
Minimum value	7.7075	14.375601
Maximum value	56.4453	56.339951
	Ungrouped Data	Ungrouped Data
Mean	41.1895	39.761675
Median	44.7897	41.152291
Geometric Mean	39.3276	38.736057
Variance	111.1639	69.124249
Standard Deviation	10.5434	8.314099
Coefficient of variation	0.2560	0.209098
Moment 1 About Arithmetic Mean	0.0000	0.000000
Moment 2 About Arithmetic Mean	111.1639	69.124249
Moment 3 About Arithmetic Mean	-1285.1761	-400.366491
Moment 4 About Arithmetic Mean	41702.9055	13681.213256
Skewness	-1.0965	-0.696646
Kurtosis	3.3747	2.863280
Natural Log Mean	3.6719	3.656771
Log Variance	0.1126	0.057944
10.0 Percentile	25.3239	27.693511
20.0 Percentile	32.0626	31.916478
30.0 Percentile	38.6220	36.031467
40.0 Percentile	41.0988	38.898238
50.0 Percentile (median)	44.7897	41.152291
60.0 Percentile	46.7197	43.383306
70.0 Percentile	48.6750	45.585685
80.0 Percentile	49.6463	47.438243
90.0 Percentile	50.9971	49.257700
100.0 Percentile	56.4453	56.339951
Trimean	43.6727	40.779227
Biweight	43.4234	40.562725
MAD	6.2229	5.997393
Alpha	-7.6304	-14.231845
Sichel-t	41.5943	39.874727

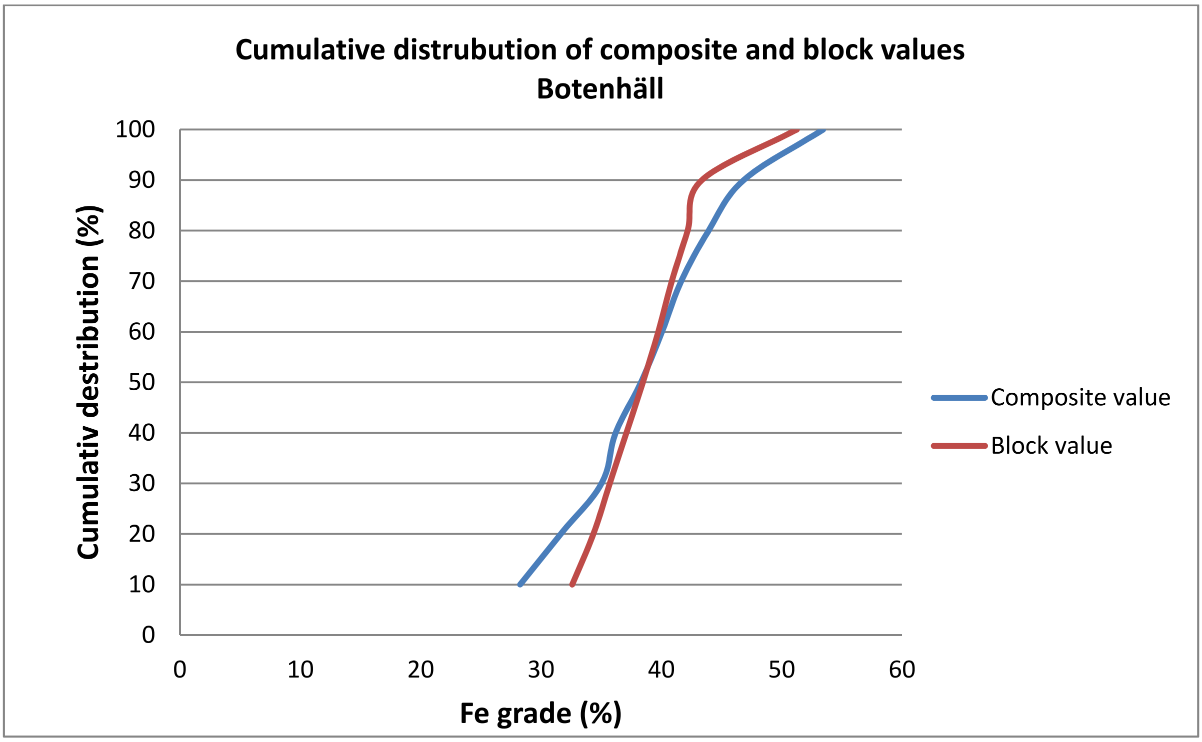
Lyndon 1

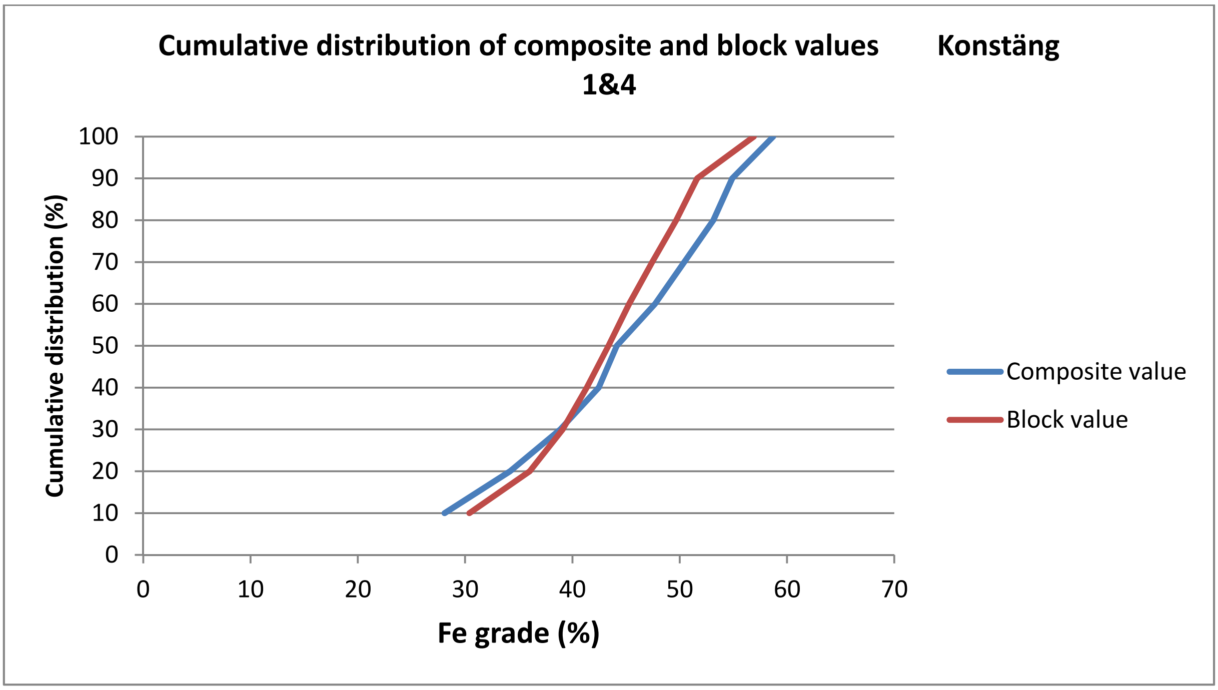
String range	1	All
Variable	D1	D1
Number of samples	544	137654
Minimum value	0.0000	4.100071
Maximum value	61.8082	59.212902
	Ungrouped Data	Ungrouped Data
Mean	40.1953	40.886386
Median	42.1539	40.858071
Geometric Mean	Not Calculated	40.162865
Variance	130.3703	51.715527
Standard Deviation	11.4180	7.191351
Coefficient of variation	0.2841	0.175886
Moment 1 About Arithmetic Mean	0.0000	0.000000
Moment 2 About Arithmetic Mean	130.3703	51.715527
Moment 3 About Arithmetic Mean	-1347.7284	-152.587684
Moment 4 About Arithmetic Mean	66637.7812	9695.844529
Skewness	-0.9054	-0.410287
Kurtosis	3.9207	3.625298
Natural Log Mean	Not Calculated	3.692943
Log Variance	Not Calculated	0.039904
10.0 Percentile	25.4269	32.034950
20.0 Percentile	31.7375	34.759865
30.0 Percentile	35.5624	37.219674
40.0 Percentile	38.7119	39.237321
50.0 Percentile (median)	42.1539	40.858071
60.0 Percentile	44.4012	43.022347
70.0 Percentile	47.5334	45.039102
80.0 Percentile	50.2520	47.544081
90.0 Percentile	53.0661	50.004755
100.0 Percentile	61.8082	59.212902
Trimean	41.8176	41.022550
Biweight	41.6096	41.079745
MAD	7.5391	5.144146
Alpha	-0.0000	208.559507
Sichel-t	0.0000	40.972244

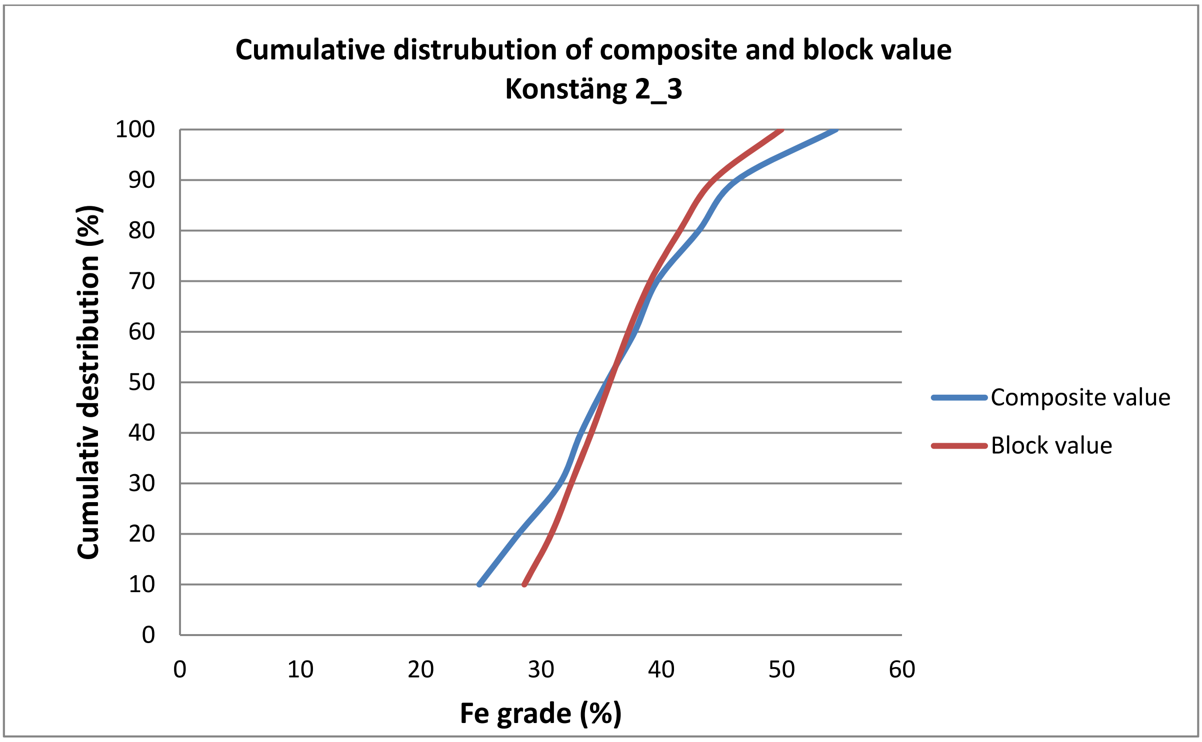
Lyndon 3

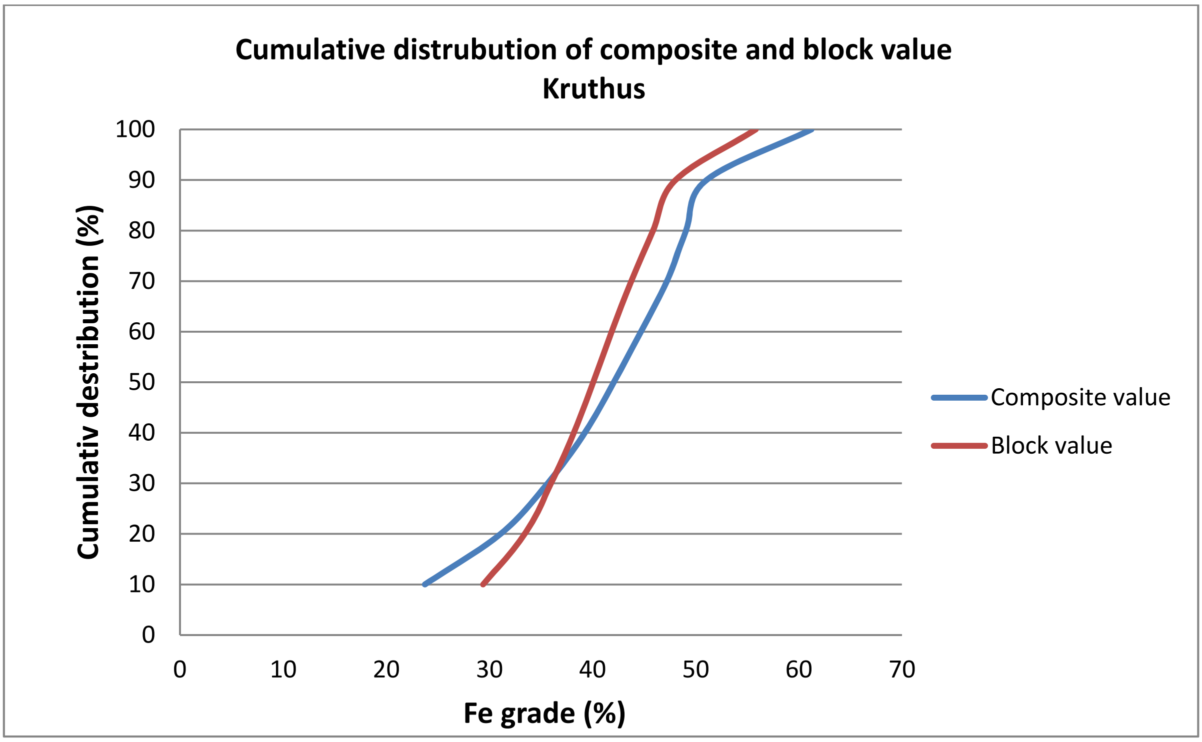
String range	1	All
Variable	D1	D1
Number of samples	42	17698
Minimum value	5.7218	17.763079
Maximum value	42.1701	39.515892
	Ungrouped Data	Ungrouped Data
Mean	28.8990	29.783257
Median	28.5722	30.361476
Geometric Mean	27.6407	29.407083
Variance	56.2927	22.065444
Standard Deviation	7.5028	4.697387
Coefficient of variation	0.2596	0.157719
Moment 1 About Arithmetic Mean	0.0000	0.000000
Moment 2 About Arithmetic Mean	56.2927	22.065444
Moment 3 About Arithmetic Mean	-133.8406	5.290601
Moment 4 About Arithmetic Mean	10799.8065	1066.060961
Skewness	-0.3169	0.051043
Kurtosis	3.4081	2.189559
Natural Log Mean	3.3193	3.381236
Log Variance	0.1104	0.025767
10.0 Percentile	21.2843	23.408707
20.0 Percentile	22.8305	24.465166
30.0 Percentile	24.1198	26.894950
40.0 Percentile	25.4167	28.576575
50.0 Percentile (median)	28.5722	30.361476
60.0 Percentile	31.0156	31.589770
70.0 Percentile	33.3508	32.442712
80.0 Percentile	35.8754	33.505371
90.0 Percentile	39.5176	35.824744
100.0 Percentile	42.1701	39.515892
Trimean	28.6383	29.689692
Biweight	28.9793	29.863970
MAD	5.6982	3.267635
Alpha	-5.6646	-17.585448
Sichel-t	29.1689	29.788375

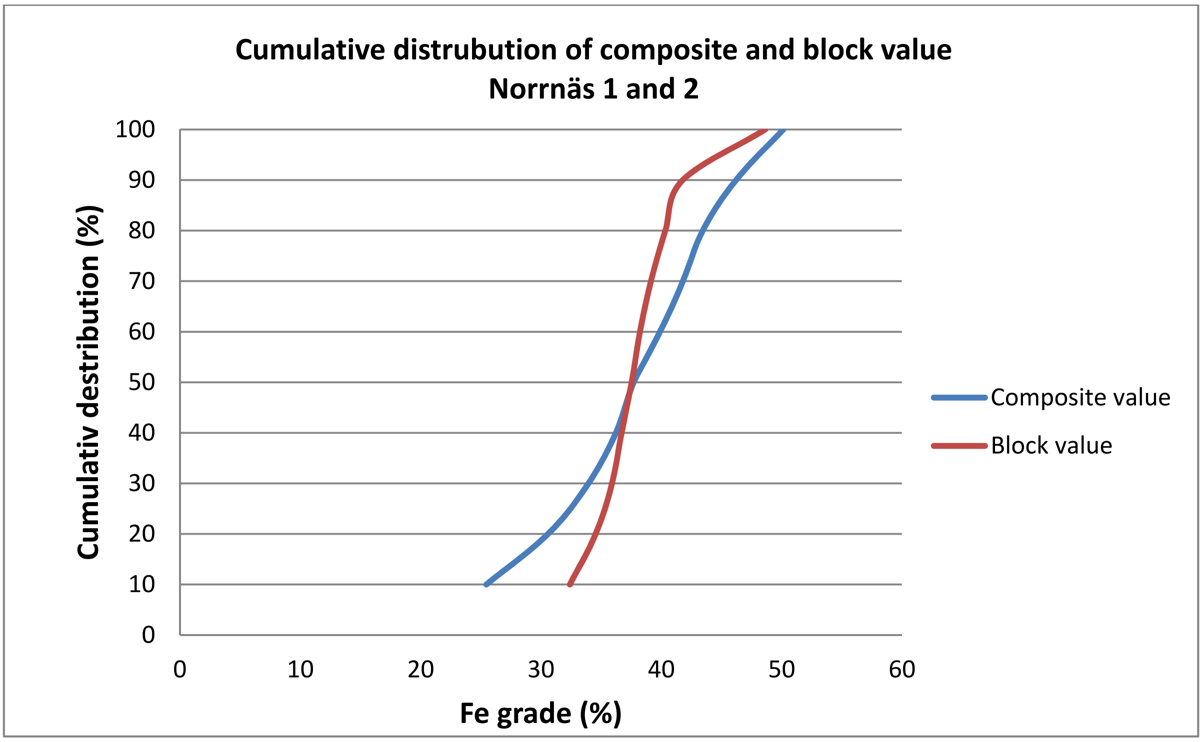
Appendix 3 – Examples of cumulative distribution plots comparing composite Fe values with raw block Fe values



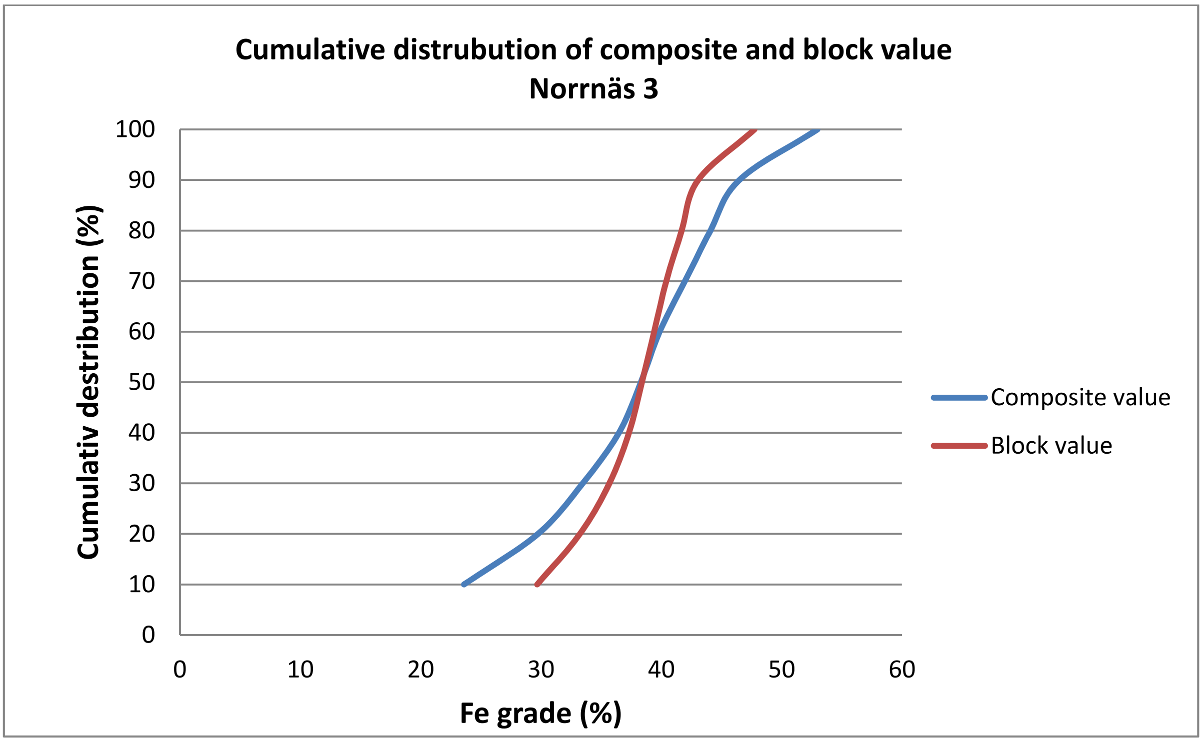



Cumulative distrubution of composite and block value
Konstäng 2_3
Cumulativ destribution (%)
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60
Fe grade (%)
Composite value
Block value

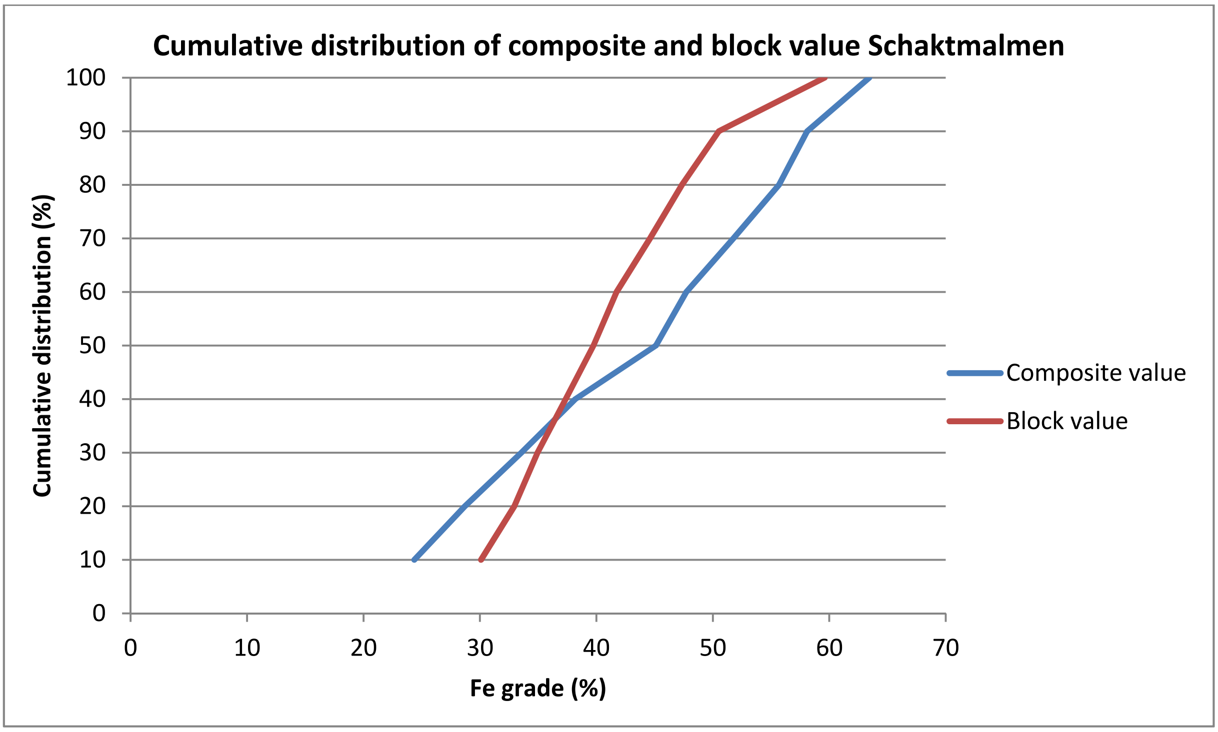

Cumulative distrubution of composite and block value
Kruthus
Cumulativ destribution (%)
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60
70
Fe grade (%)
Composite value
Block value

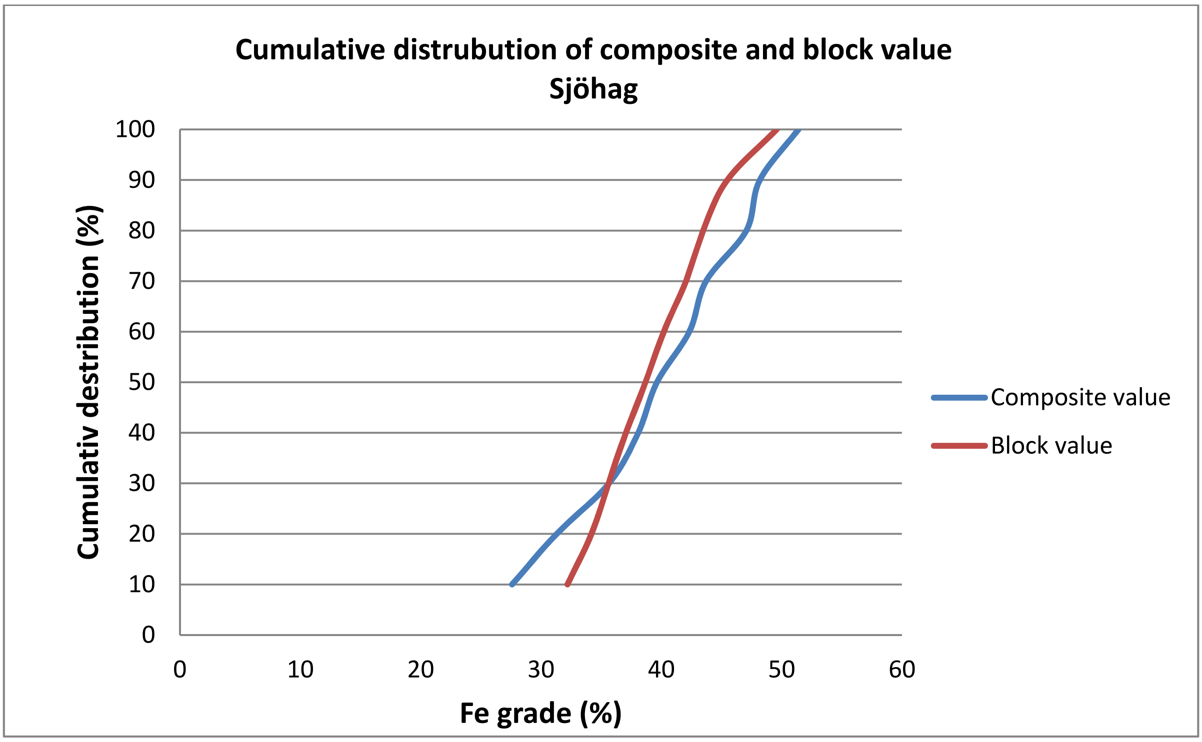


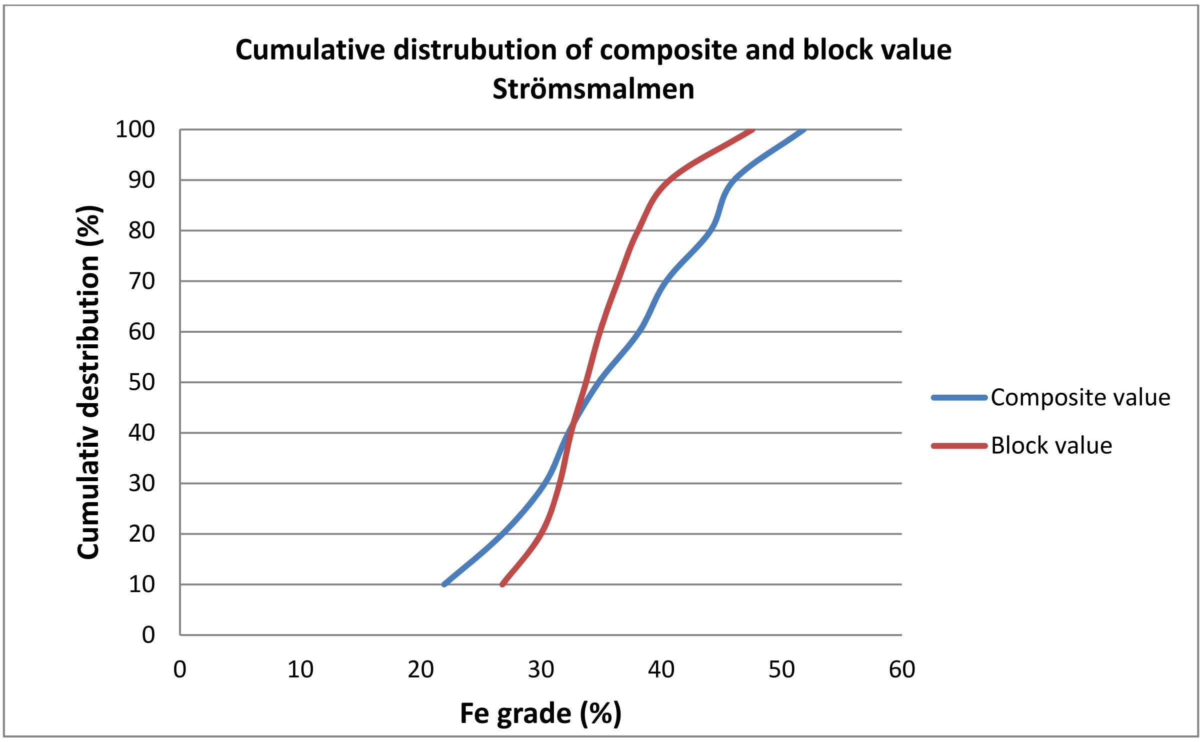
Cumulative distrubution of composite and block value
Norrnäs 1 and 2
Cumulativ destribution (%)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
Fe grade (%)
Composite value
Block value

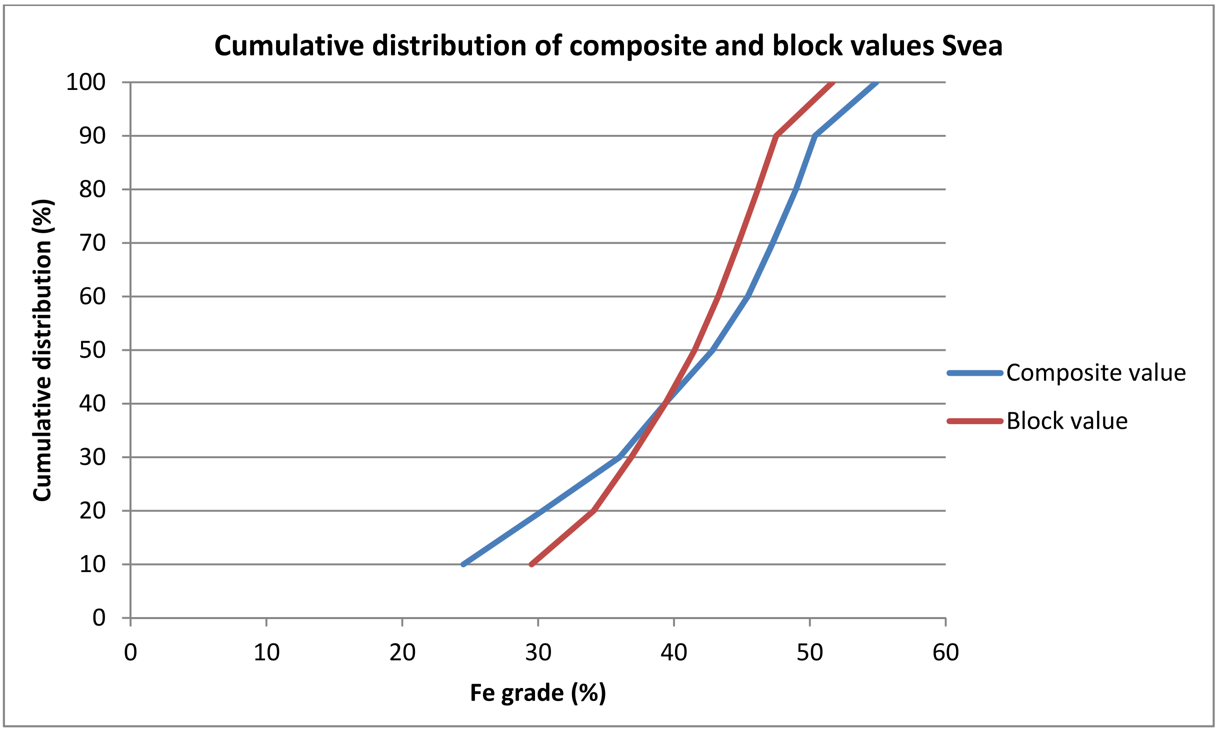


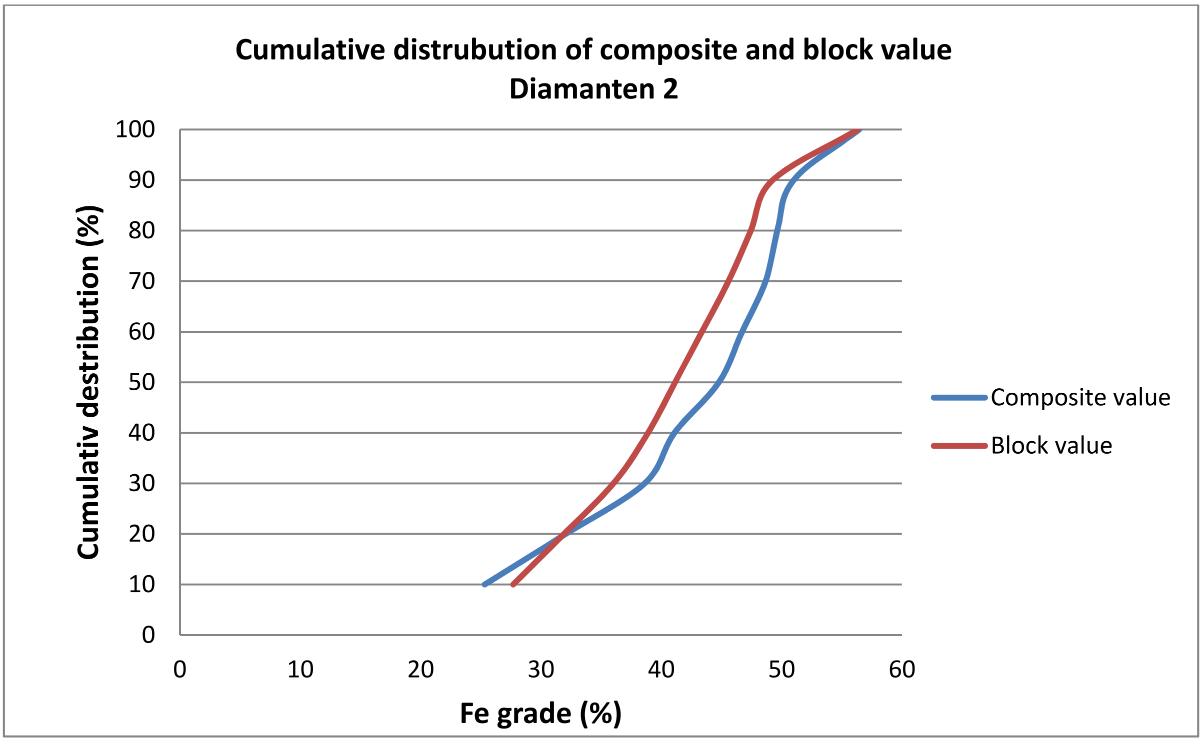
Cumulative distrubution of composite and block value
Norrnäs 3
Cumulativ destribution (%)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
Fe grade (%)
Composite value
Block value

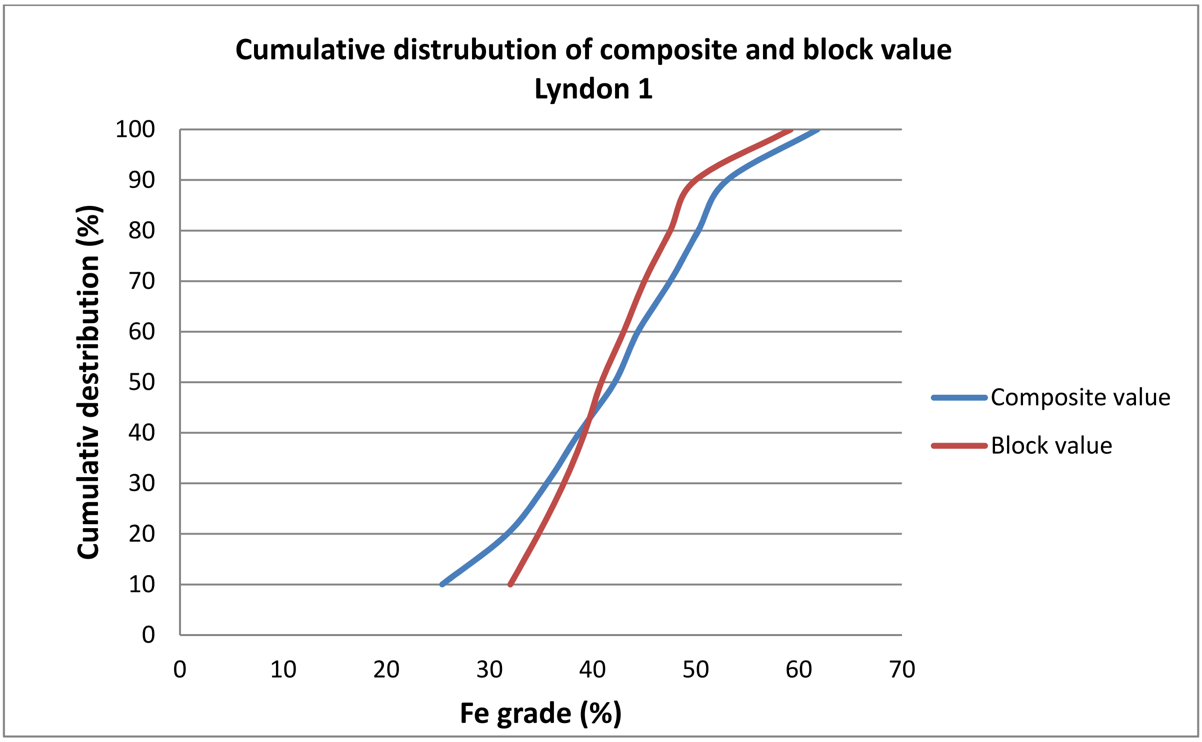

Cumulative distribution of composite and block value Schaktmalmen
Cumulative distribution (%)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
Fe grade (%)
Composite value
Block value

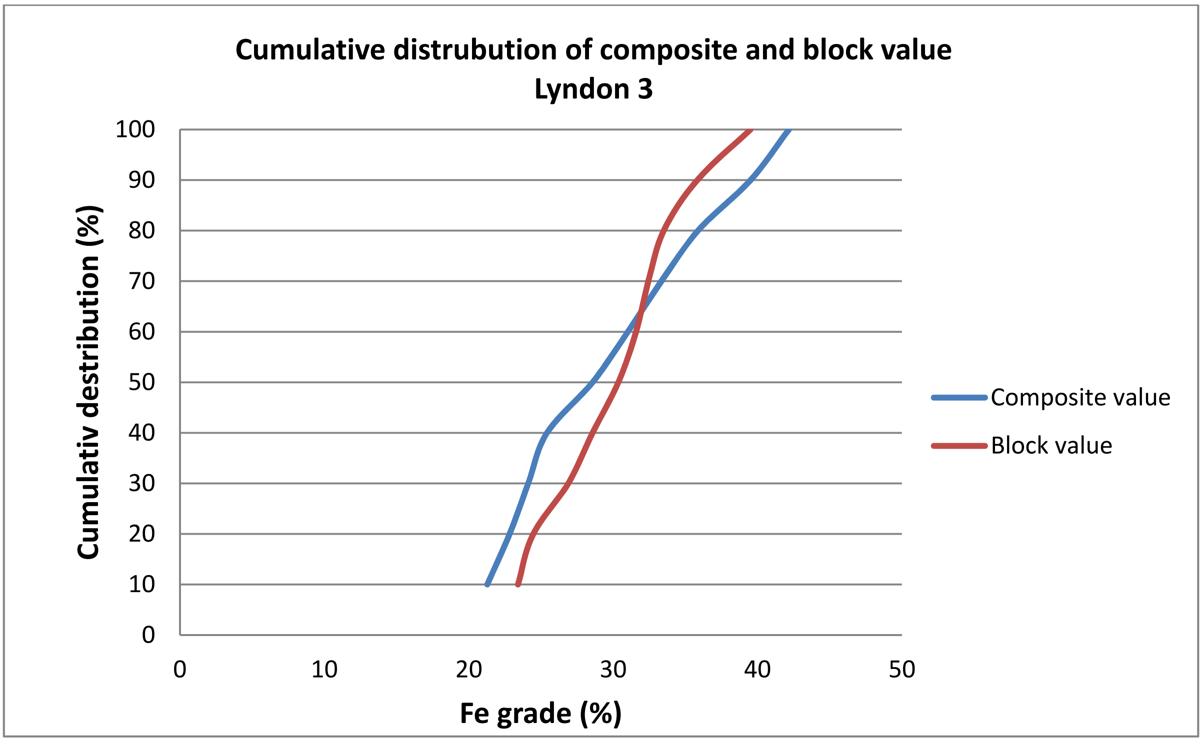

Cumulative distrubution of composite and block value Sjöhag
Cumulativ destribution (%)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
Fe grade (%)
Composite value
Block value


Cumulative distrubution of composite and block value Strömsmalmen
Cumulativ destribution (%)
Fe grade (%)
Composite value
Block value
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60

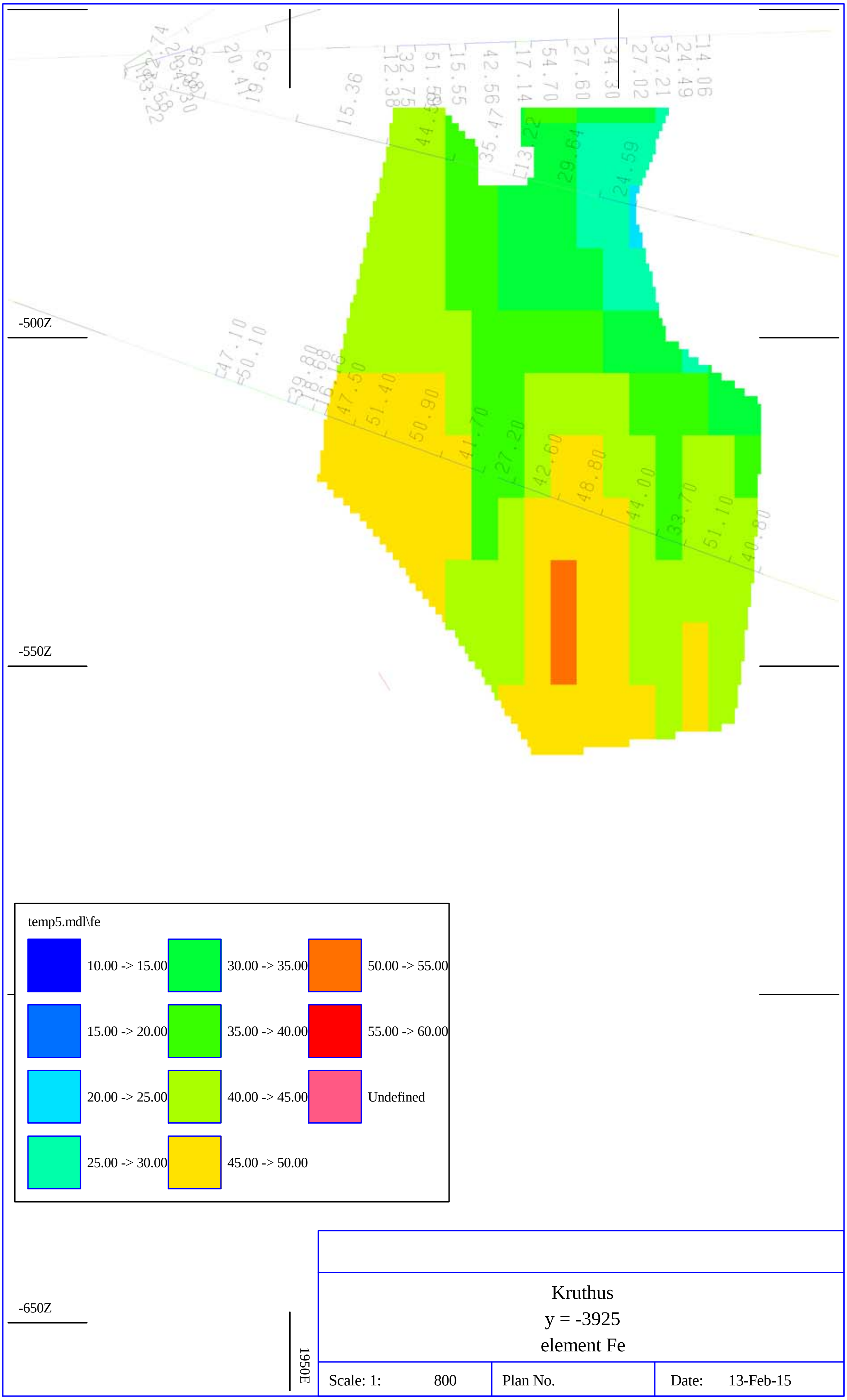

Cumulative distribution of composite and block values Svea
Cumulative distribution (%)
Fe grade (%)
Composite value
Block value
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60


Cumulative distrubution of composite and block value
Diamanten 2
Cumulativ destribution (%)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
Fe grade (%)
Composite value
Block value


Cumulative distrubution of composite and block value
Lyndon 1
Cumulativ destribution (%)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
Fe grade (%)
Composite value
Block value

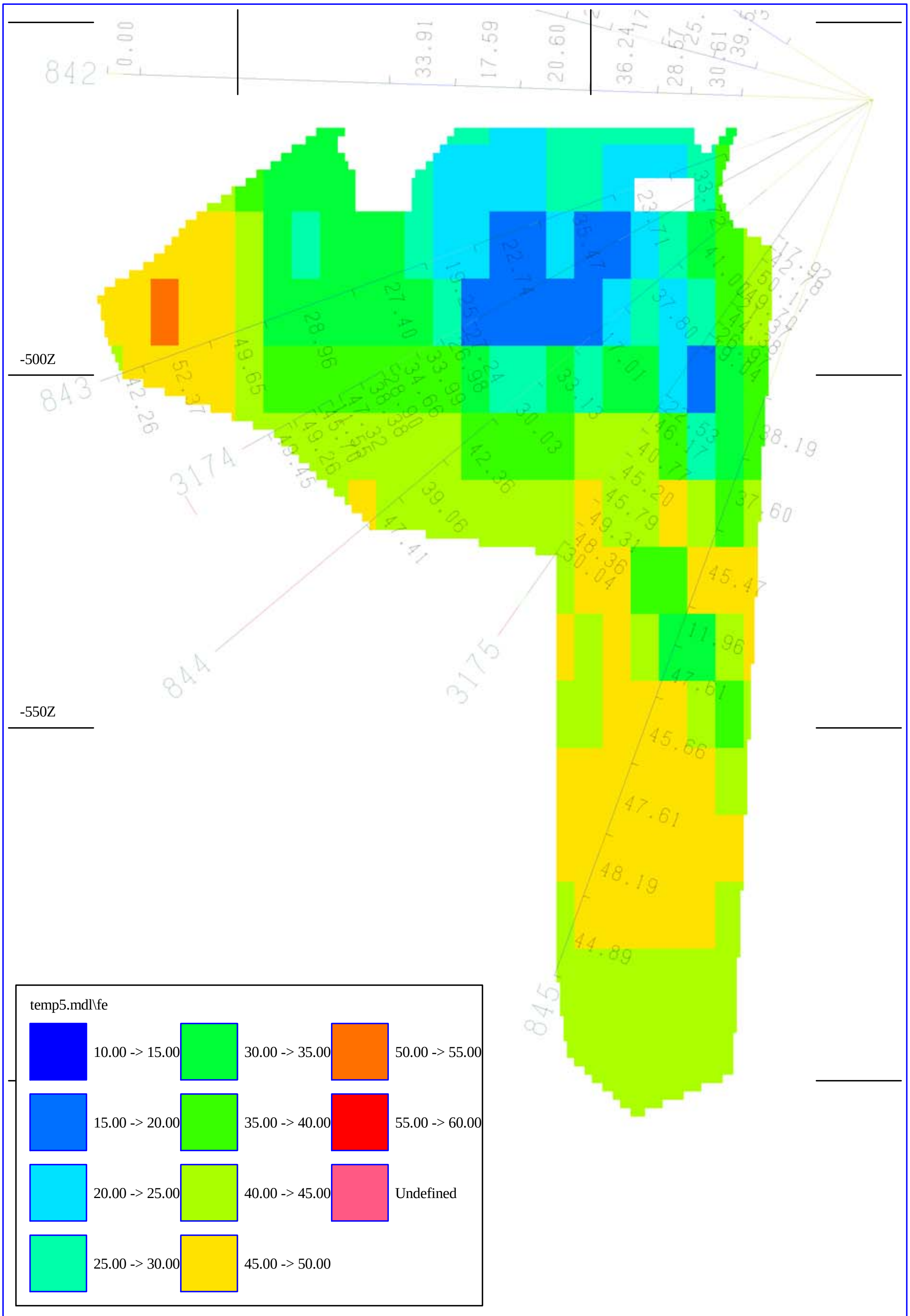


Cumulative distrubution of composite and block value
Lyndon 3
Cumulativ destribution (%)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
Fe grade (%)
Composite value
Block value



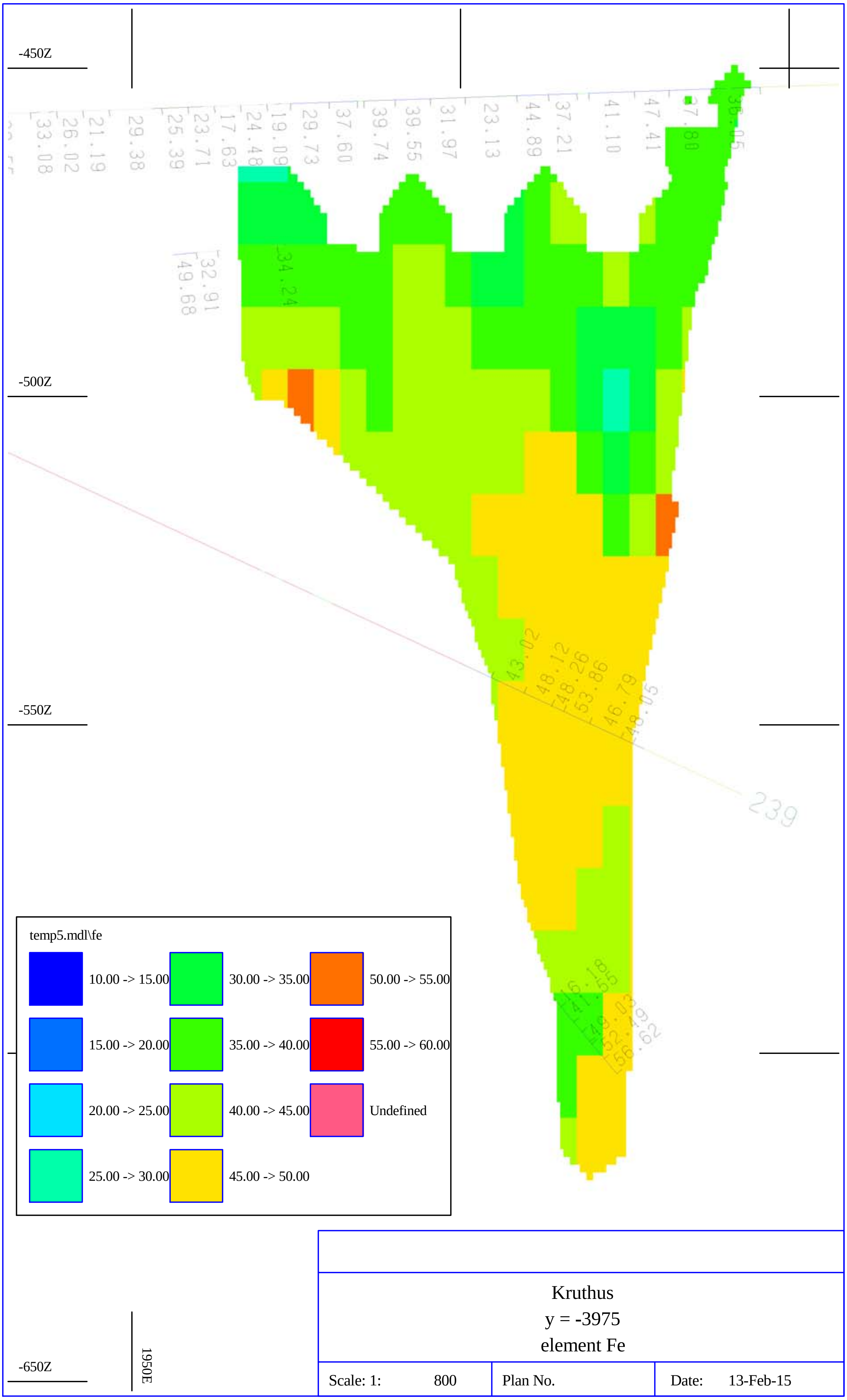
Kruthus
y = -3925
element Fe

Scale: 1: 800	Plan No.	Date: 13-Feb-15



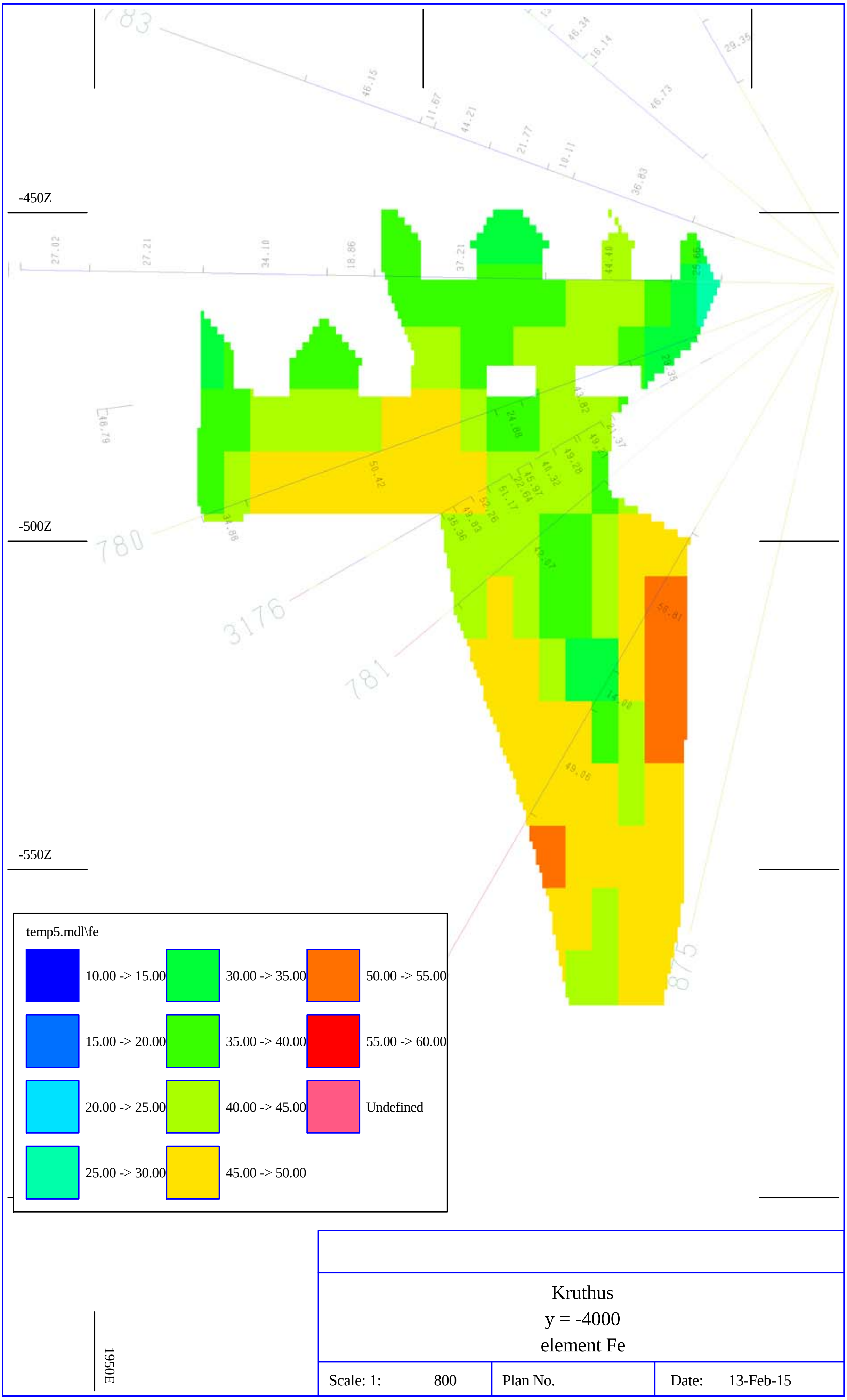
Kruthus y = -3950 element Fe

Scale: 1: 800	Plan No.	Date:



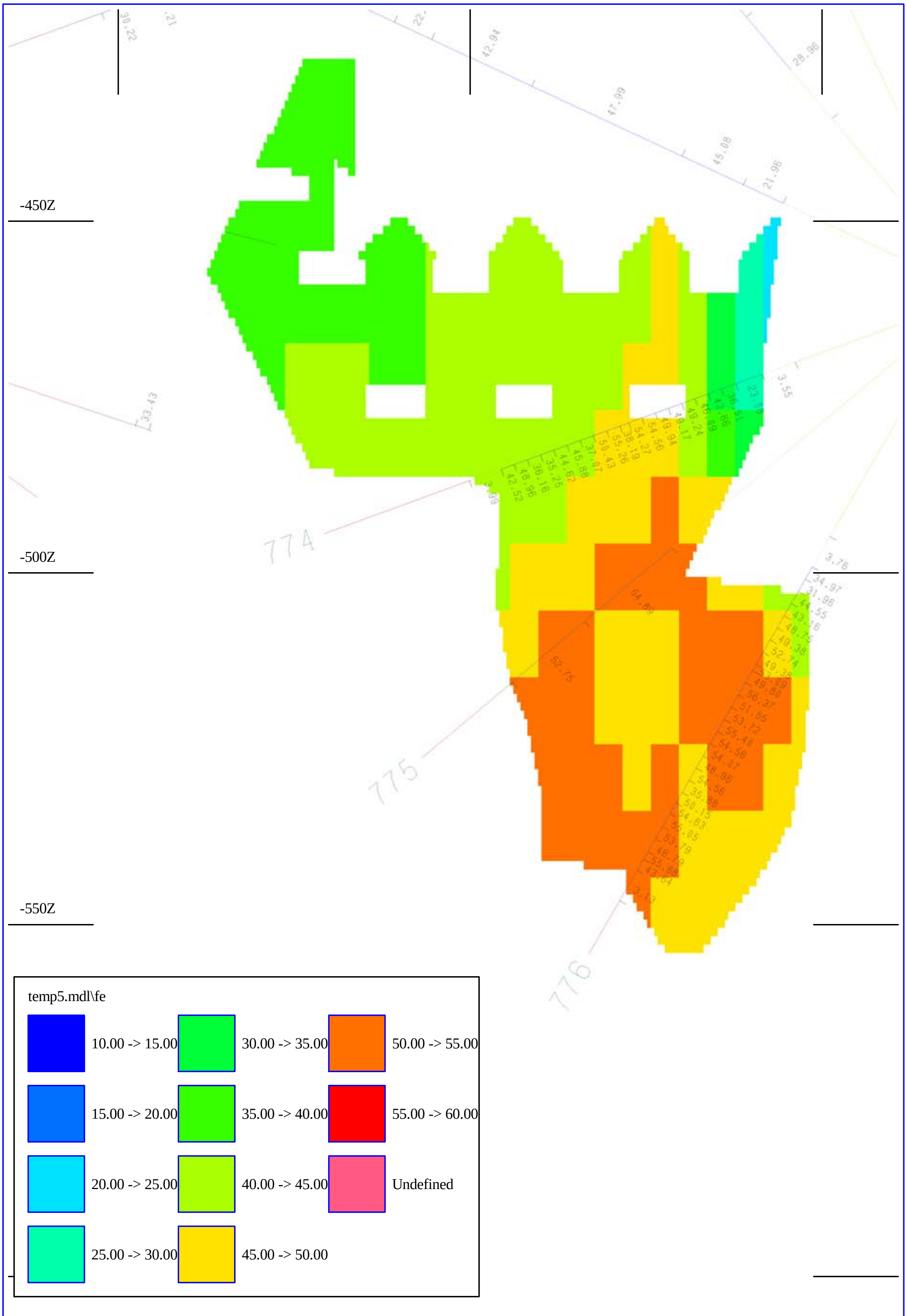
Kruthus
y = -3975
element Fe

Scale: 1: 800	Plan No.	Date: 13-Feb-15



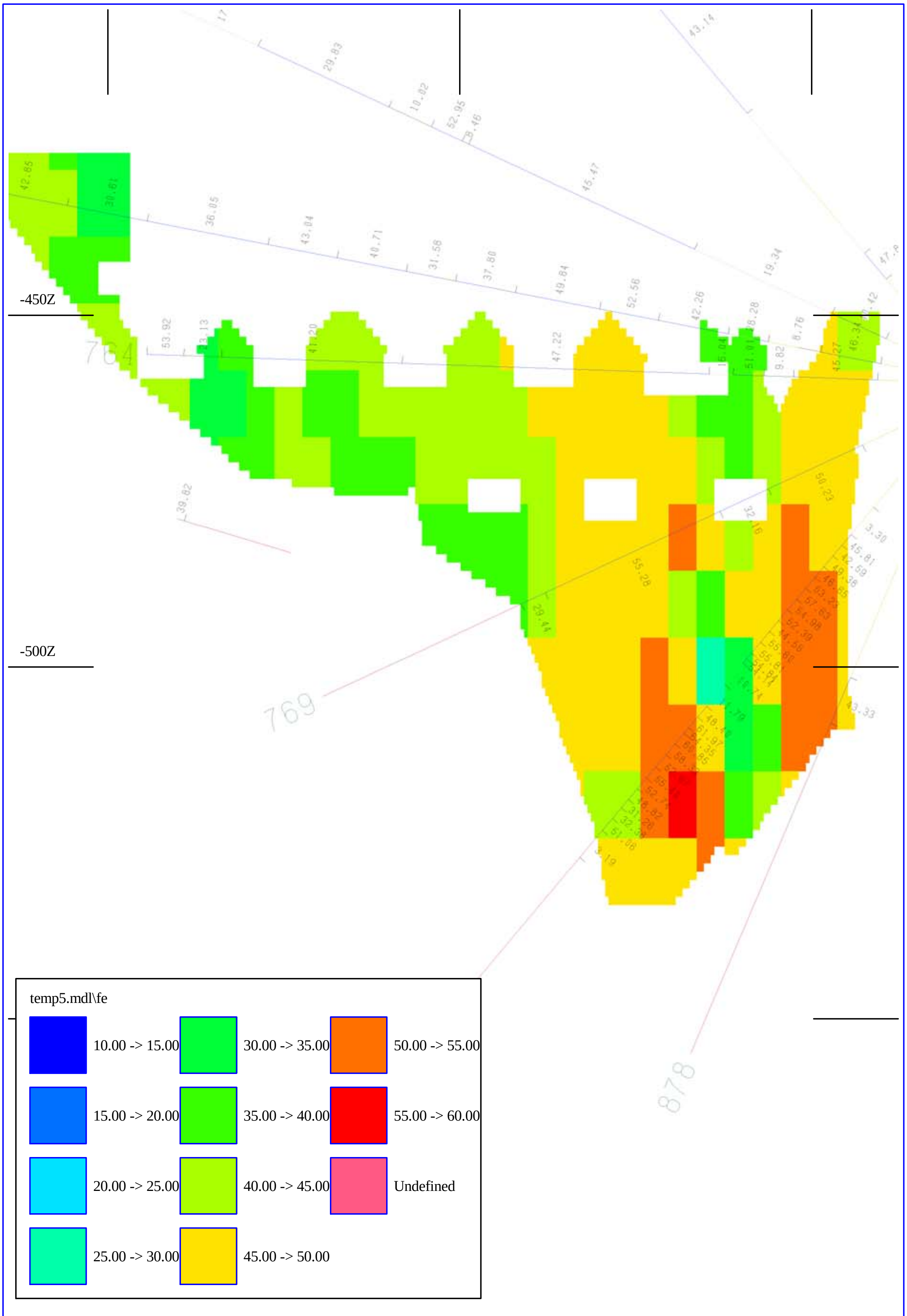
Kruthus
y = -4000
element Fe

Scale: 1: 800	Plan No.	Date: 13-Feb-15



Kruthus
y = -4025
element Fe

Scale: 1: 800	Plan No.	Date: 13-Feb-15



Kruthus
y = -4050
element Fe

Scale: 1: 800	Plan No.	Date: 13-Feb-15

Study on Retreatment Options for Backfilled Tailings, Dannemora Mine

Thomas Lindholm

Gunnar Rauséus

4 November 2014

The information in this report that relates to Mineral Resources and Exploration Targets is based on information compiled by Thomas Lindholm, who is appointed a Qualified Person for reporting on mineral resources by Svemin, as well as a Fellow of the Australasian Institute of Mining and Metallurgy. Thomas Lindholm is employed full time by GeoVista AB. Thomas Lindholm has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the 2012 Edition of the 'Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves'. Thomas Lindholm consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.

Thomas Lindholm

Thomas Lindholm

DANNEMORA
MINERAL AB

CONTENTS

1. Introduction

Since the re-opening of the Dannemora mine, tailings from the sorting plant have been deposited in the existing Kruthus and Konstäng stopes, stemming from the mining activity before 1992.

The mass yield in the sorting plant is today around 40 %. With a planned additional wet process, based on retreatment of part of the tailings from the sorting plant, it will be possible to achieve a mass yield of 56-58 %.

With the development of the new beneficiation plant, some of the backfilled tailings from the current process can be re-treated and thus considered to be a Mineral Resource.

Until now, a total of 3.7 million tonnes with an average grade of 22 % Fe have been deposited.

2. Sampling and analytical procedures

The chemical composition of the tailings produced in the current sorting process* is estimated in two ways. A calculated composition is obtained by daily estimates of mass yield based on conveyor scale tonnage combined with analyses of middlings and products for sale. Sampling is performed using automatic samplers placed at conveyor belt discharges. Each analysis is made on 12 subsamples taken during 24 hours. As a complement, the total waste is assayed. Sampling takes place in a discharge on the conveyor belt to the deposition sites in the Kruthus and Konstäng stopes. The waste product which has a grain size of minus 50 mm is sampled manually with a bucket as a momentary sample of about 20 kg/day. The two estimates of chemical composition of the tailings are in good agreement.

Sampling, preparation and analysis are performed by Dannemora personnel. Analyses are made using X-ray fluorescence spectroscopy.

3. Mineral processing and metallurgical test work

The mass yield in the existing Dannemora sorting plant is today around 40 %. With an additional upgrading step, based on the tailings from the sorting process, it is possible to increase the mass yield to 56-58 %. This is verified by various tests performed at laboratory, pilot, and large scale.

*In the current sorting process, crude ore crushed to minus 150 mm passes a first magnetic separation step removing the larger waste. After two further crushing steps and screening, the magnetite-rich material undergoes final magnetic separation for production of lump ore and sinter fines at 50 and 55 % Fe respectively. The waste from the first step is crushed to minus 50 mm and mixed with the tailings from the final separation steps.

The final step of the planned recovery process is wet grinding with wet magnetic separation. The main question in that type of process is the amount of grinding needed to liberate the magnetite particles in order to achieve the required concentrate analysis.

To secure the wet process part, GTK in Finland during November 2013 performed laboratory wet grinding and wet separation tests based on tailings from the sorting plant.

Test 1
Rod mill grinding to 40.9 % passing 75 µm and wet separation in 1 step resulted in a concentrate grade of 44.0 % Fe. Wet separation in 4 additional steps resulted in a concentrate grade of 52.0 % Fe.

Test 2
Rod mill grinding to 40.9 % passing 75 µm and wet separation in 1 step according to test 1. Grinding in ball mill to 64.0 % passing 75 µm and wet separation in 4 steps resulted in a concentrate grade of 55.6 % Fe

Test 3
Rod mill grinding to 40.9 % passing 75 µm and wet separation in 1 step according to test 1. Grinding in ball mill to 79.7 % passing 75 µm and wet separation in 4 steps resulted in a concentrate grade of 58.8 % Fe.

Total results
The tests show that a Fe content above 55 % (sinter fines specification) with high process yield can be achieved in the planned upgrading process. The results are in line with previous tests and confirm that grinding to 60 % passing 75 µm is sufficient to reach 55 % Fe in the concentrate. As expected, the Fe content in the wet tailings from the upgrading process is generally low, about 8 %, all of which is not present in magnetite. Put into a mass balance for a new beneficiation process this will result in a total process yield of 56-58 %.

3.1 Expected process yield for backfilled tailings

The chemical composition of the backfilled tailings is based on the previously described daily sampling in the sorting plant and analysed to have a Fe content of around 22 %. Upgrading of this product to a concentrate with 55 % Fe in the planned recovery process will result in a mass yield of around 25 %. The Fe content in the tailings from this process (dry + wet) will not exceed 11 %. The process yield of 25 % is calculated according to the mass balance formula:
Process yield % = $(\%Fe_{feed} - \%Fe_{Tailings}) / (\%Fe_{Conc} - \%Fe_{Tailings}) * 100$

4. Mining parameters

Since the backfilled tailings are deposited in stopes produced during earlier mining operations, all available information about historical mining methods, together with the mine maps and information from the current works, is used to make a preliminary evaluation of how to bring the material up for re-processing when the upgraded recovery process is in place.

4.1 Description of stopes

Below, the present knowledge of the shape of the stopes and the assumed levels of waste rock and backfill is presented.

4.1.1 Kruthus stope

Production in the Kruthus ore body started around 1970. Sub-level stoping was used between levels 170 and 350 m. Due to heavy wall rock caving, the mining method was changed to sub-level caving which was then used until the mine closed in 1992. Based on diamond drilling in the 1980s by the former owner, the stope was outlined on the mine map. In 1992, mining had reached the 448 m level and the top of the waste rock mass in the stope is estimated to have been located between the 260 and 300 m levels by then. Drilling by Dannemora from the surface shows that further caving has occurred. The model of the stope is adjusted in accordance to this.

During 2011-2013, two holes with a diameter of 77 cm were drilled through the roof of the stope which was then used for deposition of tailings from the current sorting plant. The Kruthus stope is now more or less filled up and the total amount of backfill is 2.9 million tonnes containing 22 % Fe.

As mining is ongoing beneath the 448 m level in Kruthus, waste rock and tailings will continue to descend towards the 350 m level.

4.1.2 Konstäng stope

Mining of the Konstäng ore body started in 1974 using sub-level stoping. In 1984, the mining method was changed to sub-level caving as from the 350 m level. This method was used until the mine was closed, when production had reached the 423 m level. When mining operations re-started in 2012, the top of the waste rock mass in the stope was below level 362 metres.

Deposition of tailings in the Konstäng stope commenced in May 2014 and is still going on. Up to October 2014, the amount is 0.8 million tonnes containing 22 % Fe. Since no suitable observation sites are accessible, it is unknown which level the backfill reaches today.

The present shape of the stope is lagely unknown. Parts of the hanging wall have most probably caved in. For an estimation of the shape, mainly information from previous mine maps is used. A minor adjustment of the roof has been made based on the intersection of the backfill hole with the top of the stope. The stope volume is probably underestimated.

As mining is ongoing also beneath the Konstäng stope, waste rock and tailings may theoretically descend towards the 400 m level, but this assumption is highly uncertain.

4.2 Characterisation of backfilled tailings

The tailings from the sorting plant consist of two different fractions. One third of the tailings is coarse material (minus 50 mm) with a low Fe content (average grade 10 % Fe), derived from the belt separator constituting the first step in the sorting plant. Two thirds of the tailings are derived from the sinter fines and lumpy production and have an average grade between 28 and 30 % Fe and a grain size of minus 16 mm.

On deposition, the tailings build a cone of material with a slope of 40°. The shallow dip is caused by the high speed with which the material falls down. The material is segregated so that the finer particles get stuck high up on the heap while the coarse particles roll downslope and come to rest against the walls of the stope. As a consequence, the deposit is water permeable and the risk for waterseal is considered minimal.

4.3 Proposals for extraction of backfilled tailings

The following calculations are based on 3D modelling and intended to give a picture of the volumes of tailings possible to extract from the Kruthus and Konstäng stopes (Fig. 1). Those volumes are, however, difficult to assess with certainty because precise knowledge of the shapes of the stopes and the character of the material is lacking.

The calculations are based on the assumption that the void produced when the possible volume of material is extracted forms a cone with a slope angle of 40° from the horizontal. Hence, the given volumes are the maximum volumes that theoretically can be extracted if no waste rock is deposited on top of and mixed with the tailings. The bulk density of the tailings is estimated at 2 tonnes per cubic metre.

The location and number of loading drifts can of course be planned in various ways, and the following example is only meant as guidance. For both Kruthus and Konstäng, the loading drifts have been located in the hanging wall, at what is supposed to be a safe vertical distance away from the waste rock filling the lower parts of the stopes. Rock stability aspects are not considered in this example.

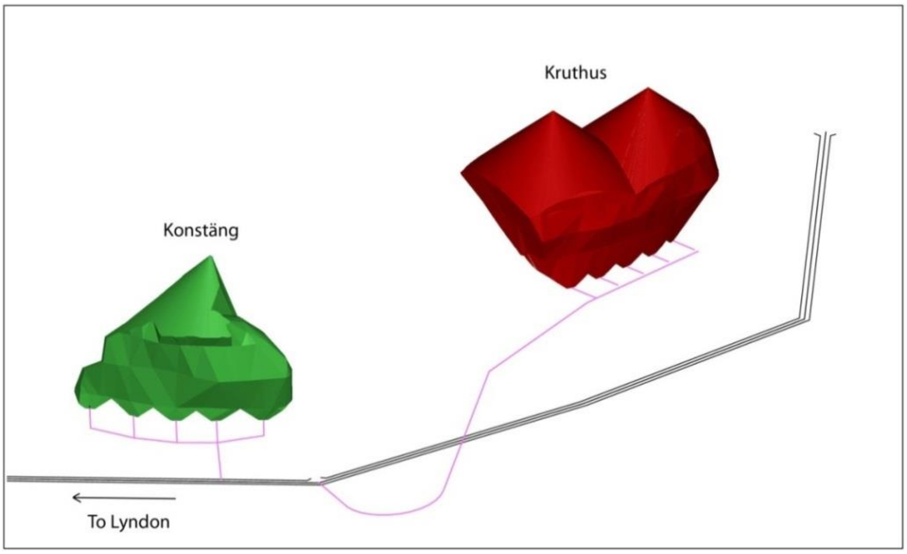


Figure 1. 3D vision of extractable tailings volumes in the stopes.

Loading of tailings from Kruthus is assumed to take place at the 260 m level. Extractable backfill is estimated at 1.3 million tonnes with a volume of 665,000 cubic metres. An estimate of 520 m of drift will be needed from the planned Lyndon drift.

Loading of tailings from Konstäng is assumed to take place at the 300 m level. This is because the top of the underlying waste rock mass is assumed to be located below the 300 m level due to mining of ore at deeper levels. Also, the choice of level is optimal for connection with the planned Lyndon drift.

Extractable backfill, from the volumes of tailings that are currently deposited, is estimated at 0.4 million tonnes with a volume of 200,000 cubic metres. If the loading drifts are located at a lower level, the possible volume to extract will of course increase. An estimate of 300 m of drift will be needed from the planned Lyndon drift.

5. Cost and revenue factors

The cost of extracting the backfill includes both capital and operating costs. Capital costs are principally related to the development of infrastructure such as drifting to the stopes and preparation of loading sites for extraction of the backfill. The capital expenditure will be different for each of the two backfilled stopes. Operating costs are fixed costs for the various moments, from extraction to loading onto cargo vessel.

5.1 Operating and capital costs

Capital costs depend primarily on the amount of drifting necessary to maximise extraction from the respective stopes. Using entrepreneurs, the general cost for drifting is estimated at 20,000 SEK/metre. This includes the whole cycle, with drilling, blasting, loading, scaling, rock supporting, as well as installation of facilities such as water supply, electricity and ventilation. If all work is carried out by Dannemora personnel, the costs will decrease. Operating costs are specified in Table 1.

Table 1. Key figures for operating costs.

	Tailings	Product
Operation	**SEK/tonne**	**SEK/tonne**
Loading	5	
Transport to crusher (2 km)	15.6	
Crushing	5.4	
Hoisting	2	
Sorting plant maintenance*	7	
Upgrading process*	9	
Transport by rail		6.2
Unloading in harbour		6.9
Loading onto cargo vessel		8.9
Fairway fee		1
Total operating cost	**44**	**23**

*Variable cost, 50 % of total cost

5.2 Assumptions on revenue factors

An assumed sale price is 60 US dollars per tonne finished product FOB (free on board). Currency conversion gives about 400 SEK/tonne (USD 60*6.75).

6. Profitability assessment

For economic retreatment of the backfilled tailings, the value of the extracted material must exceed the total capital and operating costs.

Based on estimated costs, revenues and assumptions on possible extraction volumes from the backfilled stopes, the following profitability assessment can be made (Table 2). The operating cost is set to 44 SEK/tonne for tailings, 23 SEK/tonne for product (from tailings). The capital cost is set to 20,000 SEK/metre, sale price to 400 SEK/tonne and the mass yield to 25 %.

For the Konstäng stope, extraction of 400,000 tonnes of tailings and 300 metres of drifting are assumed. For the Kruthus stope, extraction of 1.3 million tonnes of tailings and 520 metres of drifting are assumed.

Table 2. Profitability assessment for extraction of backfilled tailings.

Konstäng	SEK (thousands)
Operating cost on tailings (400 000 tonnes)	-17 600
Operating cost on product (100 000 tonnes)	-2 300
Capital cost	-6 000
Revenue	40 000
Operational margin	**14 100**
Kruthus	SEK (thousands)
Operating cost on tailings (1.3 million tonnes)	-57 200
Operating cost on product (325 000 tonnes)	-7 475
Capital cost	-10 400
Revenue	130 000
Operational margin	**54 925**

7. Mineral Resource

From the re-opening of the Dannemora mine in April 2012, until October 2014, a total of 3.7 million tonnes of tailings from the current sorting process have been deposited in the existing stopes Kruthus and Konstäng. According to the presented proposals for extraction of the backfill and the profitability assessment, 1.7 million tonnes at an average grade of 22 % Fe are considered as a

Mineral Resource (Table 3). This Resource constitutes the estimated extractable parts of the backfill, namely 1.3 million tonnes from the Kruthus stope and 0.4 million tonnes from Konstäng stope. The Resource is classified as Inferred, since the details of the extraction process are fairly uncertain and difficult to predict at the time being. All other factors are, however, well known.

Table 3. Inferred Mineral Resource of backfill, October 2014.

	Backfilled tailings, kt
Kruthus	1 300
Konstäng	400
Total	**1 700**

8. Exploration Target

The remaining part of the present backfill, ca 1900-2100 million tonnes with an average grade of 21-22 % Fe which are not included in the Mineral Resource, can be considered as an Exploration Target (Table 4). The potential quantity and grade of this target is assumed and uncertain due to lacking knowledge of, for example, the extent of wall rock caving in the stopes.

Table 4. Exploration Target of backfill, October 2014.

	Backfilled tailings, kt
Kruthus	ca 1600
Konstäng	ca 400
Total	**1 900 - 2 100**

A prerequisite for upgrading of the Exploration Target to a Mineral Resource is a detailed and realistic plan for extracting all or part of the deposited tailings. There has been insufficient studies concerning such methods to estimate a Mineral Resource and it is uncertain if further studies will result in the estimation of a Mineral Resource.

Assuming an annual production of 3 million tonnes of crude ore and a mass yield of 40 %, an additional amount of ca 2.1 million tonnes of tailings would be backfilled until the end of year 2015 (due to environmental regulations, the tailings must be deposited underground and not stored at surface, which of course would be more efficient). After deposition, these ca 2.1 million tonnes of tailings grading 21-22% Fe can, very likely, be classified as an Exploration Target.

9. Conclusions

Of the 3.7 tonnes of tailings backfilled up to October 2014, 1.7 tonnes are assumed possible to mine and retreat in the planned upgrading process. This part of the tailings is thus considered as an Inferred Mineral Resource of 1.7 million tonnes with an average grade of 22% Fe. It is classified as Inferred since the mining parameters are not fully known.

In spite of the low Fe grade and a lower mass yield, the re-treating process is assumed to give a positive operational margin. This is due to the fact that the material is mined, crushed and has already been processed once and, hence, the operation cost is lower than for crude ore.

The remaining backfilled tailings constitute an Exploration Target estimated at 1.9-2.1 million tonnes with an average grade of 21-22 % Fe.

In addition, ca 2.1 million tonnes of tailings with an average grade of 21-22 % Fe expected to be produced until December 2015 can, very likely, be classified as an Exploration Target when deposited underground.