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Appendix II Laboratory data

1 Heating experiments

Table 1A Broekpolder (BP02): Magnetic susceptibility (MS) measurements before heating.

sample	depth	top sample	weight x 10^{-3} kg	weight container x 10^{-3} kg	weight sample x 10^{-3} kg	volume x 10^{-6} m^3	MS ms1[1]	weight corrected ms1	calibrated ms1 x 10^{-8} m^3/kg
A80	5-20	5	12.39	2.81	9.58	9.7	2.1	10.96	14.52
A80	40-50	40	13.35	2.81	10.54	9	0.5	2.37	3.14
A80	85-90	85	15.9	2.81	13.09	10.5	0.6	2.29	3.04
A100	20-30	20	13.43	2.81	10.62	9.5	0.8	3.77	4.96
A140	25-35	25	16.09	2.81	13.28	11.5	1	3.77	4.96
A160	25-35	25	14.49	2.81	11.68	10	1.3	5.57	7.34
A180	15-45	15	14.07	2.81	11.26	9.5	1.1	4.88	6.47
B20	5-15	5	12.42	2.81	9.61	9.5	2.5	13.01	17.23
B40	30-40	30	14.69	2.81	11.88	9.7	1.1	4.63	6.13

[1] ms1: measurement 1

Table 1A continued

sample	depth	MS ms2[2]	weight corrected ms2	calibrated ms2 x 10^{-8} m^3/kg	mean MS value x 10^{-8} m^3/kg
A80	5-20	2.2	11.48	15.11	14.81
A80	40-50	0.6	2.85	3.75	3.44
A80	85-90	0.4	1.53	2.01	2.52
A100	20-30	0.9	4.24	5.58	5.27
A140	25-35	0.8	3.01	3.96	4.46
A160	25-35	1.5	6.42	8.45	7.89
A180	15-45	1.3	5.77	7.60	7.03
B20	5-15	2.3	11.97	15.75	16.49
B40	30-40	1.1	4.63	6.09	6.11

[2] ms2: measurement 2

Table 1B Broekpolder (BP02): Magnetic susceptibility (MS) measurements after heating.

sample	depth	weight x 10^{-3} kg	weight container	volume x 10^{-6} m^3	MS ms1[1]	weight corrected ms1	calibrated ms1 x 10^{-8} m^3/kg	weight sample x 10^{-3} kg
A80	5-20	11.22	2.805	8.5	58.5	347.59	465.520	8.415
A80	40-50	12.97	2.805	8.2	102.1	502.21	673.298	10.165
A80	85-90	15.57	2.805	10	23.2	90.87	120.539	12.765
A100	20-30	12.78	2.805	9	145.8	730.83	978.64	9.975
A140	25-35	15.21	2.805	10.5	194.8	785.17	1051.52	12.405
A160	25-35	13.16	2.805	8.7	137.2	662.48	886.97	10.355
A180	15-45	12.66	2.805	8	102.4	519.53	696.572	9.855
B20	5-15	11.4	2.805	8	64.3	374.05	501.078	8.595
B40	30-40	14.08	2.805	9.5	166.7	739.25	991.822	11.275

[1] ms1: measurement 1

Table 1B continued

sample	depth	MS ms2[2]	weight corrected ms2	calibrated ms2	MS ms3[3]	weight corrected ms3	calibrated ms3 x 10^{-8} m^3/kg
A80	5-20	56.4	335.12	447.96	57.6	342.25	457.42
A80	40-50	102.1	502.21	672.02	101.6	499.75	668.72
A80	85-90	23.3	91.27	120.98	22.3	87.35	115.47
A100	20-30	146.3	733.33	982.00	148.1	742.36	994.10
A140	25-35	191.7	772.67	1034.76	199	802.10	1074.22
A160	25-35	140.6	678.90	908.99	134.8	650.89	871.43
A180	15-45	97.7	495.69	663.27	99.8	506.34	677.55
B20	5-15	65	378.13	505.63	63	366.49	489.94
B40	30-40	167	740.58	991.64	164.9	731.26	979.29

[2] ms2: measurement 2; [3] ms3: measurement 3

Table 1B continued

sample	depth	mean MS value after heating x 10^{-8} m^3/kg	mean MS value before heating x 10^{-8} m^3/kg	fractional conversion
A80	5-20	456.96	14.81	3.24
A80	40-50	671.34	3.44	0.51
A80	85-90	119.00	2.52	2.12
A100	20-30	984.91	5.27	0.54
A140	25-35	1053.50	4.46	0.42
A160	25-35	889.13	7.89	0.89
A180	15-45	679.13	7.03	1.04
B20	5-15	498.88	16.49	3.31
B40	30-40	987.58	6.11	0.62

Table 2A Harnaschpolder (HP02): Magnetic susceptibility (MS) measurements before heating.

sample	depth	top sample	weight x 10^{-3} kg	weight container x 10^{-3} kg	weight sample x 10^{-3} kg	volume x 10^{-6} m^3	MS ms1[1]	weight corrected ms1	calibrated ms1 x 10^{-8} m^3/kg
A120	25-45	25	13	2.81	10.20	10	2.1	10.30	13.64
A120	25-45	25	14	2.81	11.20	10	1.9	8.49	11.20
A140	25-35	25	14.96	2.81	12.16	10	1.7	6.99	9.22
A180	5-15	5	13.11	2.81	10.31	10	2	9.70	12.85
A180	35-40	35	13.4	2.81	10.60	9.5	1.9	8.97	11.88
A180	50-60	50	15.75	2.81	12.95	11	1.2	4.63	6.14
A180	50-60	50	14.53	2.81	11.73	10	1.2	5.12	6.76
A300	45-50	45	11.68	2.81	8.88	8.5	0.6	3.38	4.48
A40	30-35	30	9.07	2.81	6.27	5.5	0.9	7.18	9.47
A60	5-15	5	13.03	2.81	10.23	10	2.1	10.27	13.56
A60	30-40	30	11.92	2.81	9.12	8	1.1	6.03	7.95
A80	30-40	30	13.89	2.81	11.09	9.5	1.7	7.67	10.16
A80	30-40	30	13.65	2.81	10.85	9.5	1.4	6.45	8.52
B20	99-102	99	4.36	2.81	1.56	1.5	0	0.00	0.00
B40	40-45	40	15.09	2.81	12.29	11	1.5	6.11	8.06
B40	40-45	40	11.44	2.81	8.64	9.5	1	5.79	7.63

[1] ms1: measurement 1

Table 2A continued

sample	depth	MS ms2[2]	weight corrected ms2	calibrated ms2 x 10^{-8} m^3/kg	mean MS value x 10^{-8} m^3/kg
A120	25-45	2.1	10.30	13.64	13.64
A120	25-45	2.1	9.38	12.34	11.77
A140	25-35	1.7	6.99	9.20	9.21
A180	5-15	2.2	10.67	14.14	13.50
A180	35-40	1.8	8.49	11.25	11.56
A180	50-60	1.4	5.41	7.16	6.65
A180	50-60	1.3	5.54	7.30	7.03
A300	45-50	0.6	3.38	4.48	4.48
A40	30-35	0.9	7.18	9.45	9.46
A60	5-15	2.3	11.25	14.80	14.18
A60	30-40	1.1	6.03	7.94	7.95
A80	30-40	1.7	7.67	10.16	10.16
A80	30-40	1.4	6.45	8.49	8.51
B20	99-102	0	0.00	0.00	0.00
B40	40-45	1.4	5.70	7.50	7.78
B40	40-45	1	5.79	7.62	7.63

[2] ms2: measurement 2

Table 2B Harnaschpolder (HP02): Magnetic susceptibility (MS) measurements after heating.

sample	depth	weight x 10^{-3} kg	weight container	volume x 10^{-6} m^3	MS ms1[1]	weight corrected ms1	calibrated ms1 x 10^{-8} m^3/kg	weight sample 10^{-3} kg
A120	25-45	11.14	2.805	8.7	27.9	167.37	223.43	8.335
A120	25-45	12	2.805	9	29.1	158.24	211.17	9.195
A140	25-35	13.29	2.805	8.8	60	286.12	382.20	10.485
A180	5-15	10.49	2.805	8.1	43.9	285.62	382.31	7.685
A180	35-40	12	2.805	8.4	62.6	340.40	455.91	9.195
A180	50-60	14.77	2.805	10.5	20.9	87.34	115.91	11.965
A180	50-60	13.54	2.805	9	21.3	99.21	131.86	10.735
A300	45-50	9.77	2.805	7.2	87	624.55	837.66	6.965
A40	30-35	8.24	2.805	5.3	16	147.19	195.87	5.435
A60	5-15	11	2.805	8.5	34.6	211.10	282.19	8.195
A60	30-40	10.85	2.805	7.4	27.7	172.16	229.35	8.045
A80	30-40	12.4	2.805	8.5	37	192.81	257.61	9.595
A80	30-40	12.38	2.805	8.5	44.9	234.46	313.58	9.575
B20	99-102	4.42	2.805	1.2	59.7	1848.30	2481.76	1.615
B40	40-45	12.49	2.805	9.5	367	1894.68	2544.08	9.685
B40	40-45	9.47	2.805	6.5	227	1702.93	2282.41	6.665

[1] ms1: measurement 1

Table 2B continued

sample	depth	MS ms2[2]	weight corrected ms2	calibrated ms2	MS ms3[3]	weight corrected ms3	calibrated ms3 x 10^{-8} m^3/kg
A120	25-45	28	167.97	224.24	28.2	169.17	225.85
A120	25-45	28.6	155.52	207.52	28.9	157.15	209.71
A140	25-35	58.3	278.02	371.33	59.1	281.83	376.44
A180	5-15	42.5	276.51	370.07	43.4	282.37	377.94
A180	35-40	62.3	338.77	453.71	62.1	337.68	452.25
A180	50-60	20.6	86.08	114.23	20.3	84.83	112.55
A180	50-60	21.6	100.61	133.74	21.4	99.67	132.49
A300	45-50	85	610.19	818.37	84.9	609.48	817.41
A40	30-35	15.8	145.35	193.40	15.9	146.27	194.63
A60	5-15	35.1	214.15	286.29	36.3	221.48	296.13
A60	30-40	26.6	165.32	220.18	26	161.59	215.18
A80	30-40	36.3	189.16	252.71	36.7	191.25	255.51
A80	30-40	45.5	237.60	317.79	45.4	237.08	317.09
B20	99-102	60.8	1882.35	2527.52	65.6	2030.96	2727.17
B40	40-45	364	1879.19	2523.27	368	1899.85	2551.02
B40	40-45	235	1762.94	2362.91	246	1845.46	2473.58

[2] ms2: measurement 2; [3] ms3: measurement 3

Table 2B continued

sample	depth	mean MS value after heating x 10^{-8} m^3/kg	mean MS value before heating x 10^{-8} m^3/kg	fractional conversion
A120	25-45	224.51	13.64	6.08
A120	25-45	209.46	11.77	5.62
A140	25-35	376.66	9.21	2.45
A180	5-15	376.77	13.50	3.58
A180	35-40	453.96	11.56	2.55
A180	50-60	114.23	6.65	5.82
A180	50-60	132.70	7.03	5.29
A300	45-50	824.48	4.48	0.54
A40	30-35	194.63	9.46	4.86
A60	5-15	288.21	14.18	4.92
A60	30-40	221.57	7.95	3.59
A80	30-40	255.28	10.16	3.98
A80	30-40	316.15	8.51	2.69
B20	99-102	2578.82	0.00	0.00
B40	40-45	2539.46	7.78	0.31
B40	40-45	2372.97	7.63	0.32

2 Curie Balance measurements

2.1 Introduction

The characterization of a certain type of magnetic anomalies of a geological origin in the estuarine environment

During a study into the application of magnetic methods for archaeological prospection in The Netherlands, magnetometer surveys in the western part of the Netherlands showed some unexpected results. Large scale, strongly magnetic anomalies with a creek like appearance dominated the magnetic map of some of the archaeological sites under investigation. Low frequency magnetic susceptibility measurements of soil samples obtained by hand augering, showed that the high magnetic susceptibility sediment was waterlogged, and the magnetic susceptibility decreased strongly upon oxidation. Black staining, associated with the presence of pyrite, occurred frequently in the high susceptibility layers or just above or below it. It is postulated that the magnetic anomalies are caused by the presence of bodies of iron sulphides in the subsoil.

After the presentation of the preliminary data of the results of this project on the Archaeological Prospection conference in Krakow (2003), some of the other research groups and commercial companies working in archaeological prospection in the UK and Ireland, recognized the type of anomalies that were mapped in The Netherlands from their own surveys on estuarine deposits. No characterization of these anomalies has been made, however, and it is likely that often these natural anomalies have been interpreted as archaeological features. In order to understand the formation and preservation of these magnetic anomalies in the estuarine environment, an investigation of the iron mineralogy of some of the soil samples is carried out. In order to investigate whether it is the same phenomena causing the magnetic anomalies in the Netherlands as it is in the UK, some samples from Spalding, UK, are included in the research.

The lack of magnetic contrast between archaeological features and the undisturbed matrix in the estuarine environment

Magnetometry is a technique that is widely used to map archaeological features. In many instances the fill of for example ditch and pit features has a higher magnetic susceptibility than the undisturbed matrix. A number of processes can cause this magnetic contrast;

- The feature is filled with a different material than it is cut into, the magnetic susceptibility of the feature can be either higher or lower than the magnetic susceptibility of the undisturbed matrix.
- The feature is filled with topsoil material, topsoil generally has a higher magnetic susceptibility than the subsoil.
- The feature is filled with settlement material which generally has a higher magnetic susceptibility due to the magnetic material caused by burning.

The magnetometer surveys that have been carried out in the estuarine areas of The Netherlands seem to lack this sort of magnetic contrast. Measurements of the low frequency magnetic susceptibility of soil samples collected at excavations and from cores show that the magnetic susceptibility of the sediments is generally very low (approx. 5 to 10 $x10^{-8}$ m^3/kg), and the magnetic susceptibility of the fills of archaeological features seem to fall in the same range. Modern features (filled in ditches of the 20^{th} century) dug in the same material have however obtained a magnetic contrast.
All the sites that have been investigated in the estuarine area of The Netherlands have had marine transgressions after the abandonment of the archaeological site. It is proposed that these marine transgressions have changed the iron mineralogy of the soils and by doing so have deleted the magnetic contrast between the archaeological features and the undisturbed matrix. A magnetic investigation of the iron mineralogy of a number of soil samples is needed to investigate these processes further.

2.2 Sample selection

The characterization of a certain type of magnetic anomalies of a geological origin in the estuarine environment

The Netherlands *Harnaschpolder*

Core PYR	depth 5-15	mag sus 17 x 10^{-8} m^3/kg	topsoil	O
Core PYR	depth 30-35	mag sus 11 x 10^{-8} m^3/kg	Duinkerke	O
Core PYR	depth 372-374	mag sus 9 x 10^{-8} m^3/kg	Calais	R
Core PYR	depth 374-376	mag sus 15 x 10^{-8} m^3/kg	Calais	R
Core PYR	depth 376-378	mag sus 114 x 10^{-8} m^3/kg	Calais	R
Core PYR	depth 378-380	mag sus 135 x 10^{-8} m^3/kg	Calais	R
Core PYR	depth 395-400	mag sus 64 x 10^{-8} m^3/kg	Calais	R

Sample treatment: Samples were frozen immediately after sampling and freeze dried within two weeks, after freeze drying samples were kept in the freezer under silica gel.

United Kingdom *Spalding*

Core A6	depth 30	mag sus 21 x 10^{-8} m^3/kg	silt (topsoil)	O
Core A6	depth 170	mag sus 92 x 10^{-8} m^3/kg	silt with black stains / jarosite	R
Core A6	depth 300	mag sus 281 x 10^{-8} m^3/kg	silt with black stains	R
Core A6	depth 440	mag sus 76 x 10^{-8} m^3/kg	silt with black stains	R

Sample treatment: Samples were frozen immediately after sampling and freeze dried within three months, after freeze drying samples were kept in the freezer under silica gel.

The lack of magnetic contrast between archaeological features and the undisturbed matrix in the estuarine environment

The Netherlands *Harnaschpolder-South*

G3-9	mag sus 18.69 x 10^{-8} m^3/kg	topsoil over ditch
G3-10	mag sus 12.69 x 10^{-8} m^3/kg	upper fill
G3-11	mag sus 12.89 x 10^{-8} m^3/kg	lower fill
G3-12	mag sus 11.03 x 10^{-8} m^3/kg	C next to ditch

2.3 Methodology

Soil samples were obtained either by hand-augering (Harnaschpolder and Spalding) or from the sections of archeological excavations (Harnaschpolder-South and Limmen) or from a freshly cut ditch (Broekpolder). Samples were stored in lidded plastic sample tubes, and were either freeze dried (Harnaschpolder and Spalding) or air dried (Broekpolder, Harnaschpolder-South and Limmen). The magnetic susceptibility of all samples has been measured using a AGICO KLY-2 susceptibility bridge in the Palaeomagnetic Laboratory 'Fort Hoofddijk' of the Universiteit van Utrecht.
Thermomagnetic measurements were carried out with a modified horizontal-translation-type Curie Balance (Mullender *et al*. 1993) with a sensitivity of approximately 5 x 10^{-9} Am^2 in the Palaeomagnetic Laboratory 'Fort Hoofddijk' of the Universiteit van Utrecht.

Samples were placed in a quartz glass sample holder and kept in place with quartz glass wool, and heated and cooled in air in 16 runs of 15-150, 150-50, 50-250, 250-150, 150-300, 300-200, 200-350, 350-250, 250-400, 400-300, 300-500, 500-400, 400-600, 600-500, 500-650, 650-15 °C, at a heating rate of 10 °C and a cooling rate of 15 °C per minute. The alternating field varied from 150-300 mT.

2.4 Results

The characterization of a certain type of magnetic anomalies of a geological origin in the estuarine environment

Netherlands *Harnaschpolder*

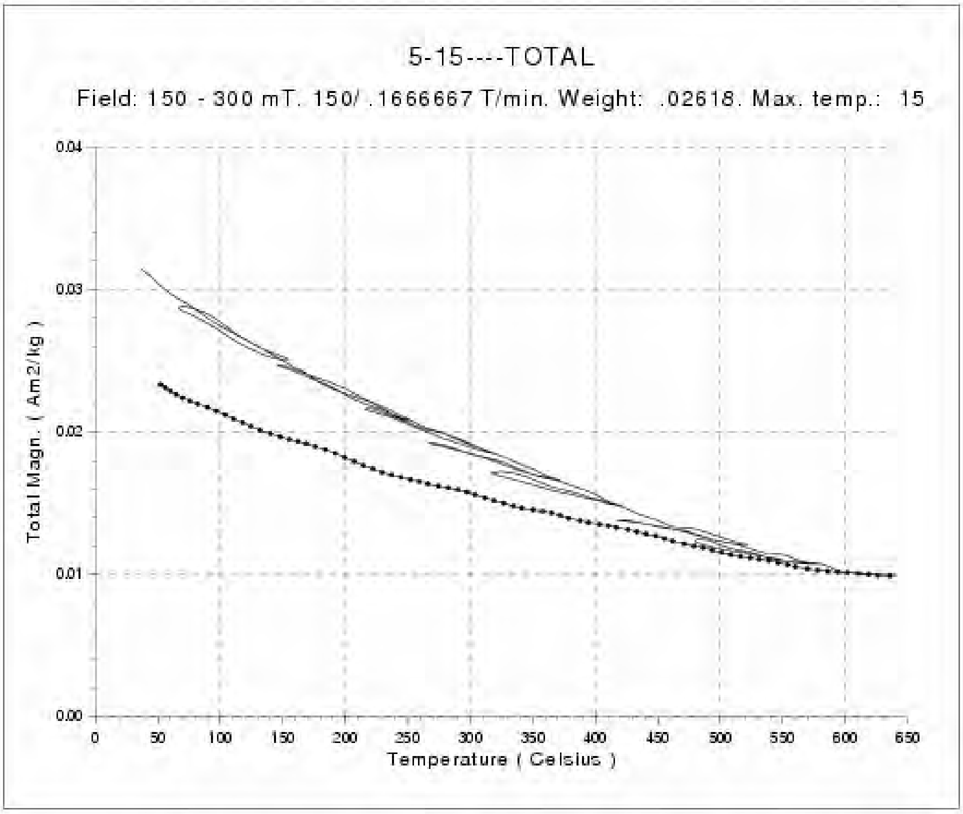

Figure 1 The results of the Curie balance measurement of sample core PYR, depth 5-15 cm, magnetic susceptibility 17 x 10^{-8} m^3/kg.

Low magnetic susceptibility – oxidizing (5-15 and 30-35 cm)

Two samples from the oxidizing part of the soil section were measured on the Curie balance. The magnetic susceptibility of these samples was low at 17 and 11 x 10^{-8} m^3/kg. In the Curie plots there is no evidence for the presence of a certain type of ferrimagnetic iron compound, the hyperbolic shape of the plot is caused by paramagnetic material, most likely the clastic material that forms the bulk of the samples. The total magnetization of both samples decreases after being heated to 650 °C, which indicates that there is some ferrimagnetic material present in the samples.

Low magnetic susceptibility – reducing (372-374 cm and 374-376 cm)

Two samples from the top of the reducing part of the soil section were submitted to a series of thermomagnetic runs. In the lower temperature part of the graphs there is an irreversible decrease of the total magnetisation up to a temperature of respectively 320 or 350 °C. This decrease is clearer in the 374-376 cm plot than it is in the 372-374 cm plot.

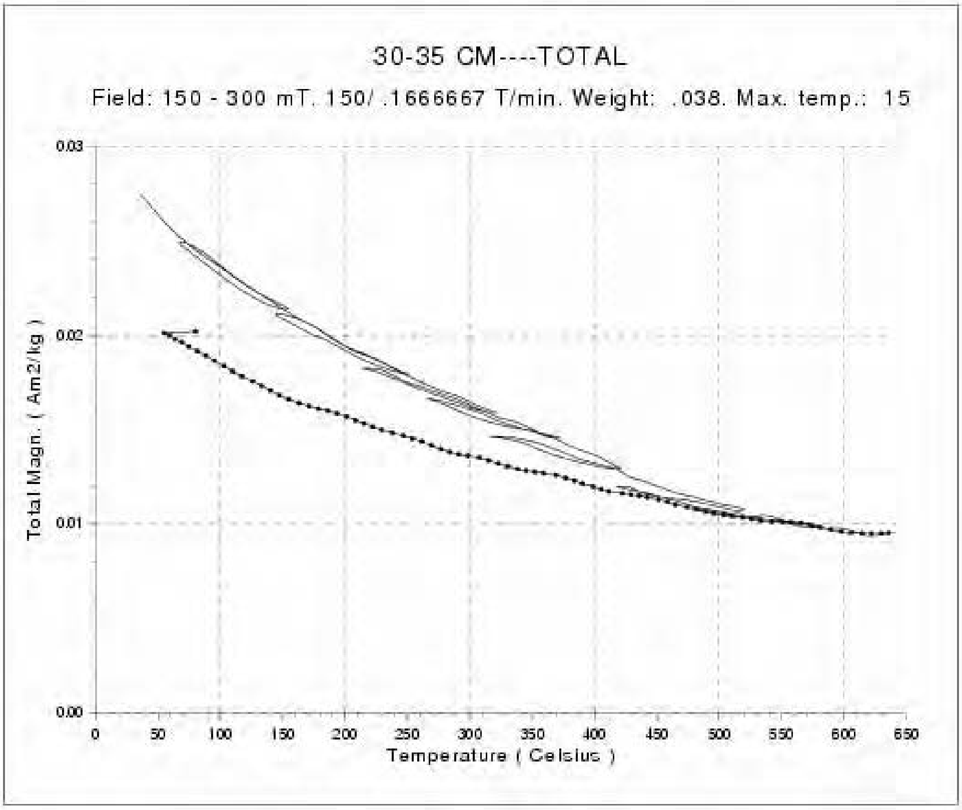

Figure 2 The results of the Curie balance measurement of sample core PYR, depth 30-35 cm, magnetic susceptibility 11 x 10^{-8} m^3/kg.

The thermomagnetic behaviour of greigite (Fe_3S_4) has been described by Dekkers *et al.* (2000), who state that greigite shows a typical decrease of magnetization between ~250 °C and ~350 °C, depending on the grain size of the material. A Curie temperature for greigite is difficult to assess because of the thermal decomposition of the compound that occurs at low temperatures.
Both plots are dominated by the neo-formation of a ferrimagnetic compound above the temperature of 400 °C. The irreversible decrease of the total magnetization from respectively 480 and 500 °C up to 580 °C may identify the newly formed compound as magnetite (T_c = 580 °C), although apparent chemical chances may influence the total magnetization and apparent Curie temperature as well. Greigite that is heated under air will form magnetite starting from 400 °C in natural samples (Dekkers *et al.* 2000), but the oxidation of pyrite to magnetite starts at approximately 420 °C (Van Velzen & Zijderveld 1992).
Given the low magnetic susceptibility of these two samples (respectively 9 and 15 x 10^{-8} m^3/kg) only a very limited amount of greigite is expected to be present. The neoformation of magnetite may in this case mainly be caused by the oxidation of pyrite rather than by the oxidative alteration of greigite.

High magnetic susceptibility – reducing (376-378 cm, 378-380 cm and 395-400 cm)
Three samples with a high magnetic susceptibility (respectively 114, 135 and 64 x 10^{-8} m^3/kg) from the lower reducing part of the soil section were thermomagnetically investigated. This series of Curie plots is dominated by the irreversible drop in magnetization at lower temperature ranges, from room temperature to 320 °C for the upper two samples (376-378 cm and 378-380 cm) and to 370 °C for the lowest sample (395-400 cm), the former may well indicate the presence of greigite in the sample, the latter temperature, on the other hand, is higher than temperatures that generally have been observed for synthetic and natural greigite samples, and may indicate the presence of (newly formed?) phyrrhotite (Tc = 420 °C) in this sample.

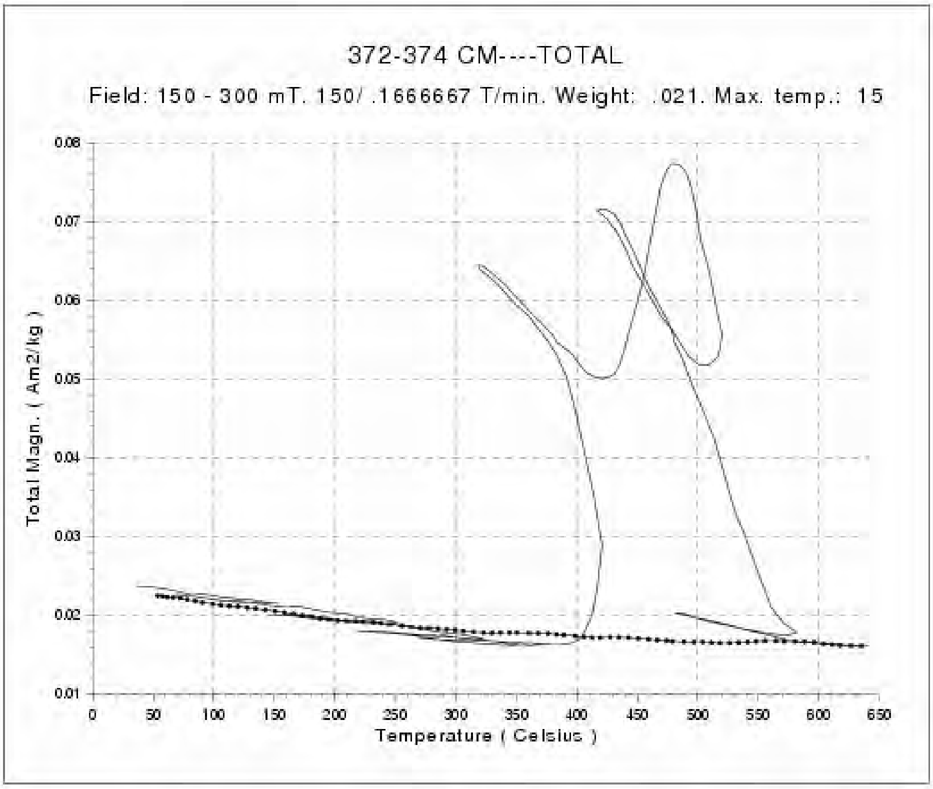

Figure 3 The results of the Curie balance measurement of sample core PYR, depth 372-374 cm, magnetic susceptibility 9 x 10^{-8} m^3/kg.

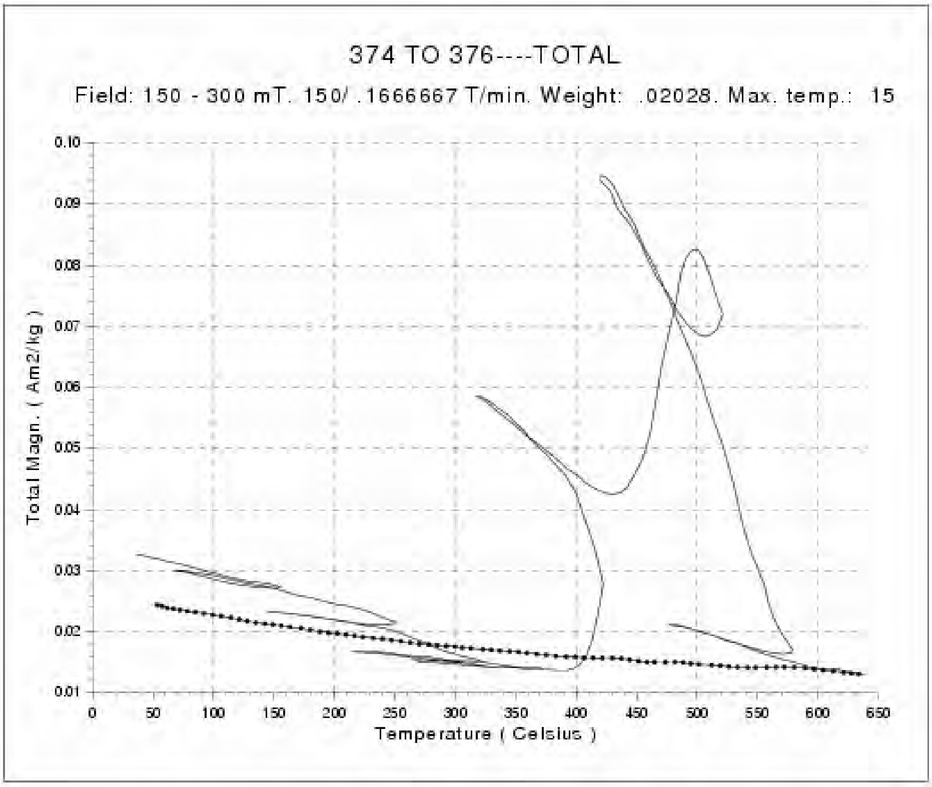

Figure 4 The results of the Curie balance measurement of sample core PYR, depth 374-376 cm, magnetic susceptibility 15 x $10^{-8}$$m^3$/kg.

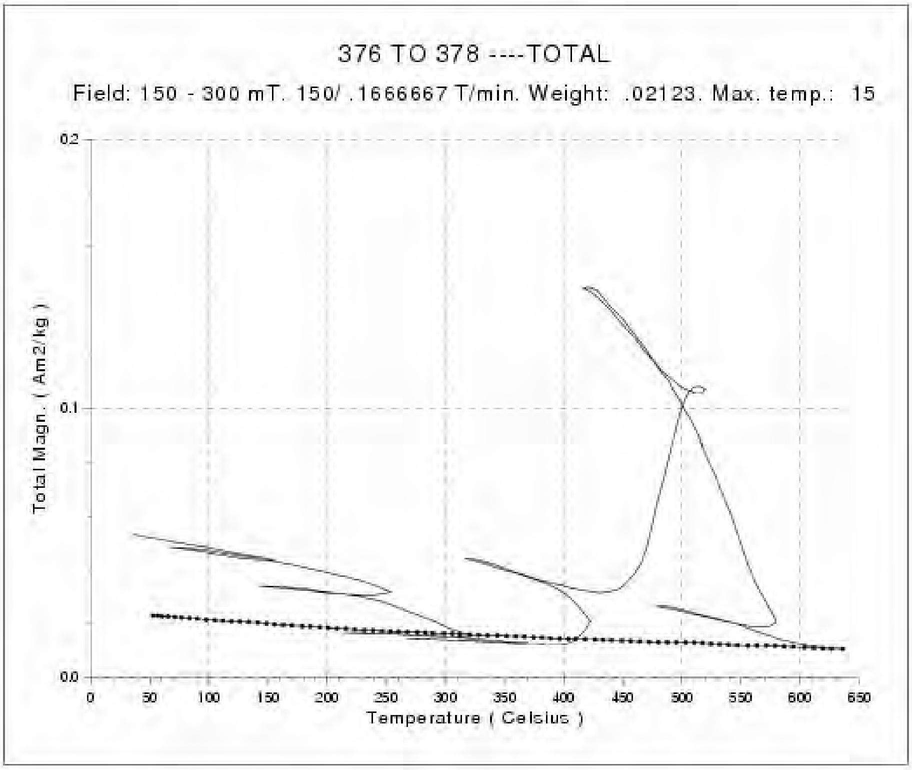

Figure 5 The results of the Curie balance measurement of sample core PYR, depth 376-378 cm, magnetic susceptibility 114 x $10^{-8}m^3$/kg.

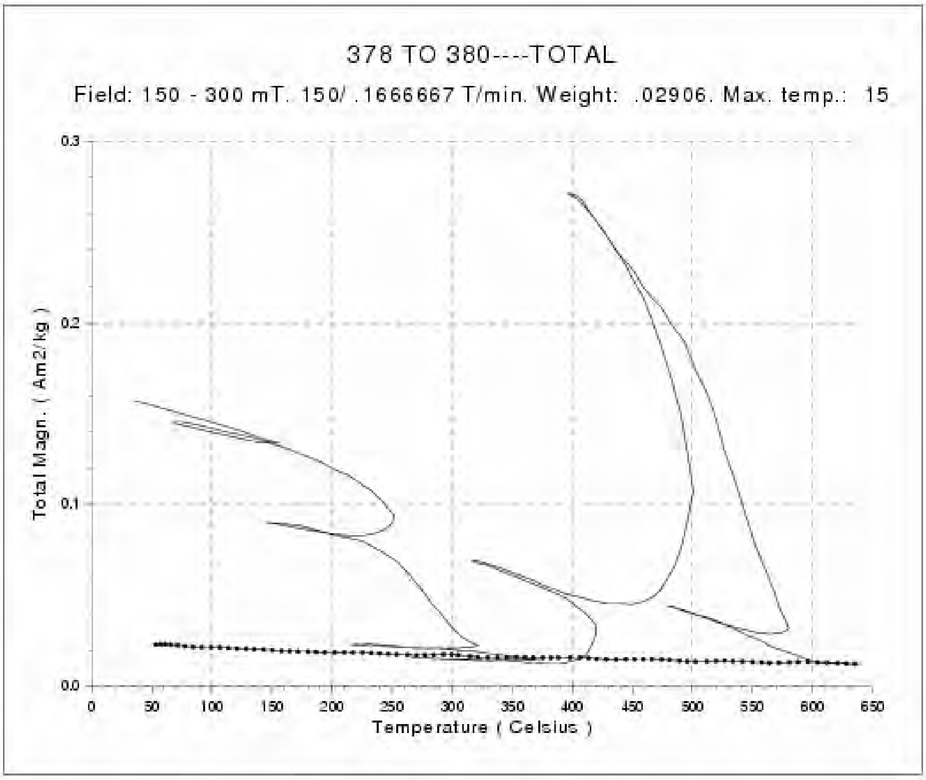

Figure 6 The results of the Curie balance measurement of sample core PYR, depth 374-376 cm, magnetic susceptibility 135 x 10^{-8} m^3/kg.

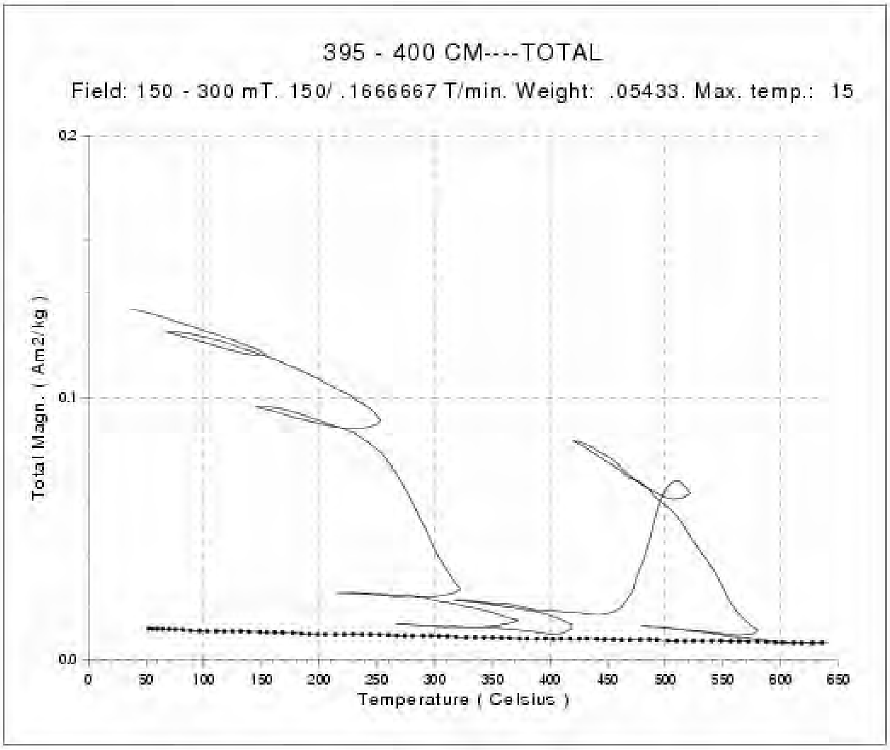

Figure 7 The results of the Curie balance measurement of sample core PYR, depth 395-400 cm, magnetic susceptibility 64 x 10^{-8} m^3/kg.

Neo-formation of a ferrimagnetic compound starts at approximately 410 °C. The total magnetization decreases irreversibly to approximately 600 °C to 620 °C, these temperatures suggest that maghemite (Tc ~ 600-675 °C) rather than magnetite (Tc = 580 °C) may be the final ferrimagnetic product of the thermomagnetic run. Because of the obvious chemical alterations in the sample during the thermomagnetic investigations, this remains highly speculative. The contributions of greigite and/or pyrite to the newly formed compound cannot be separated. High magnetic susceptibility values for these three samples suggest the presence of a considerable amount of greigite in the samples.

United Kingdom: *Spalding, Lincolnshire*

Low magnetic susceptibility – oxidizing (30 cm)

One sample from the oxidizing part of the soil section was measured on the Curie balance. The magnetic susceptibility of this samples was low at 21 x 10^{-8} m^3/kg. The Curie plot shows a mainly reversible decrease in total magnetization up to about 570 °C. This could indicate a small amount of substituted magnetite to be present in the sample. This substitution would cause the Curie temperature to be slightly lower than for pure magnetite.

High magnetic susceptibility – oxidizing / reducing (170 cm)

A sample with a high magnetic susceptibility (92 x 10^{-8} m^3/kg) from the interface of the reducing and oxidizing environment (both jarosite and black staining present) was thermomagnetically investigated. This Curie plot resembles the high magnetic susceptibility plots of Harnaschpolder. An irreverible drop in magnetization starts at room temperature and ends at approximately 320 °C. This may indicate the presence of greigite in the sample, although a fixed Curie temperature for greigite cannot be established.

Neo-formation of a ferrimagnetic compound starts at approximately 410 °C, and has a peak around 500 °C. After that the total magnetization decreases irreversibly to approximately 580 °C. This process is not reversible, and chemical changes obviously occur. It is likely, however, that in this second part of the thermomagnetic run magnetite was formed. On cooling no anomalies were recorded.

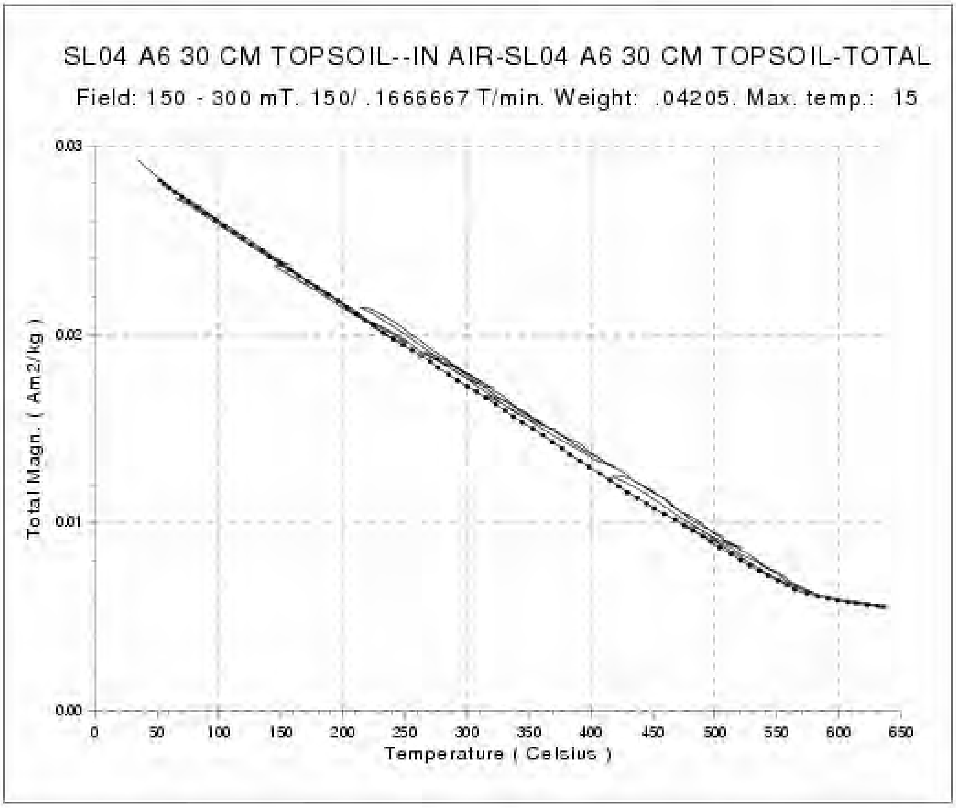

Figure 8 The results of the Curie balance measurement of sample core A6, depth 30 cm, magnetic susceptibility 21 x 10^{-8} m^3/kg.

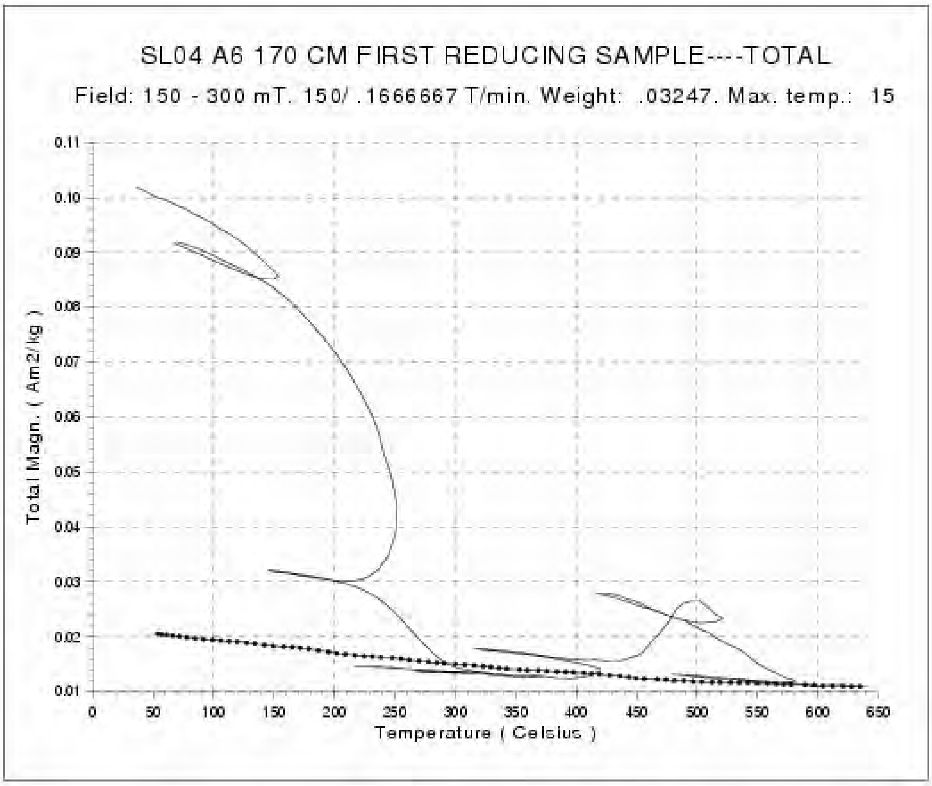

Figure 9 The results of the Curie balance measurement of sample core A6, depth 170 cm, magnetic susceptibility 92 x 10^{-8} m^3/kg.

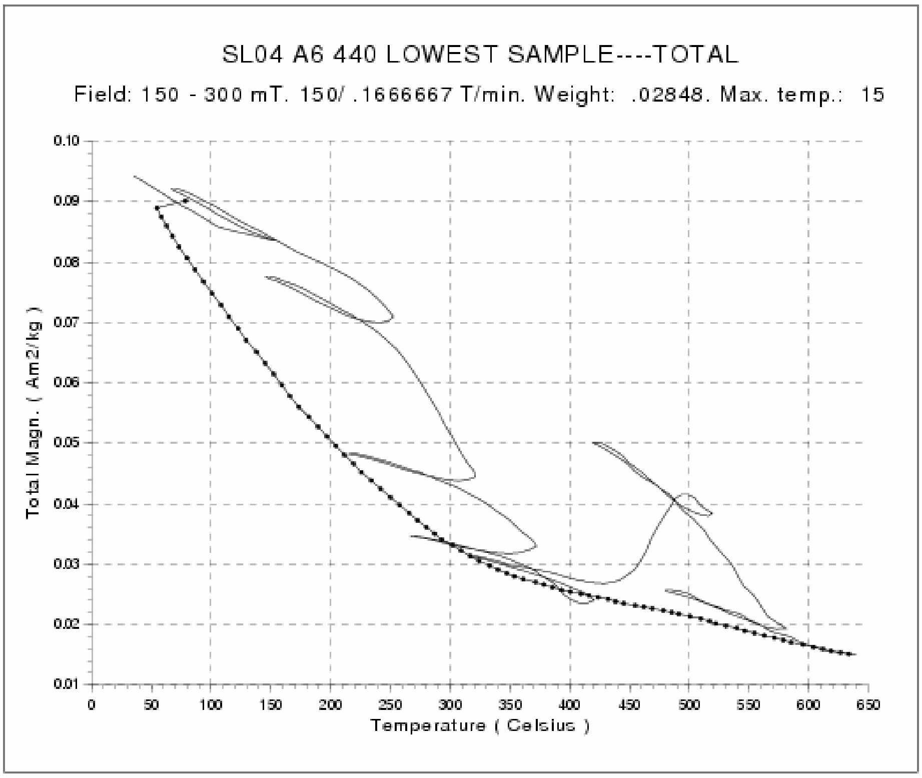

Figure 10 The results of the Curie balance measurement of sample core A6, depth 300 cm, magnetic susceptibility 281 x 10^{-8} m^3/kg.

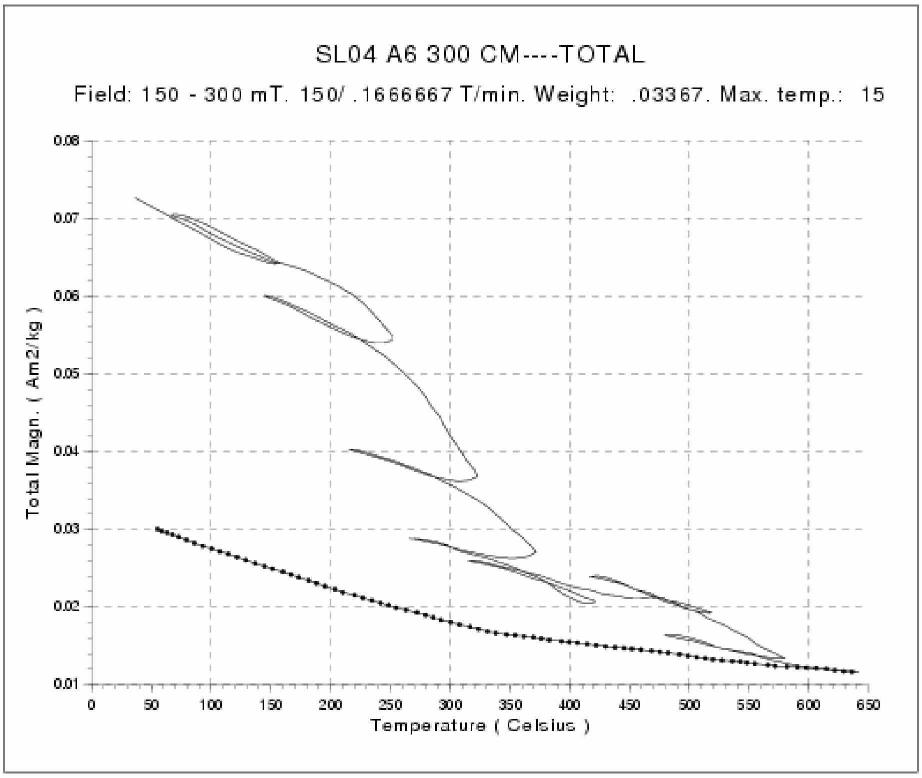

Figure 11 The results of the Curie balance measurement of sample core A6, depth 440 cm, magnetic susceptibility 76 x 10^{-8} m^3/kg.

High magnetic susceptibility – reducing (300 and 440 cm)
Two samples from reducing circumstances were selected for thermomagnetic measurements. The Curie plots of these two samples do resemble the 170 cm plot, although the total magnetization does not decrease as much up to 320 °C as it does in the former sample. Neo-formation of a ferrimagnetic compound starts at 430 °C for the 440 cm sample, in the 300 cm sample this is not as clear. Both plots show a drop in the total magnetization at 580/590 °C. On cooling the magnetisation increases down from about 350 °C. In the 300 cm plot there is a slight increase, whereas the 440 cm sample reaches a magnetization at room temperature that is comparable to the magnetization it started with. It is possible that the samples were not completely oxidized during the thermomagnetic run and that pyrrhotite (Tc = 320 °C) has formed at lower temperatures.

The lack of magnetic contrast between archaeological features and the undisturbed matrix in the estuarine environment

The Netherlands *Harnaschpolder South*

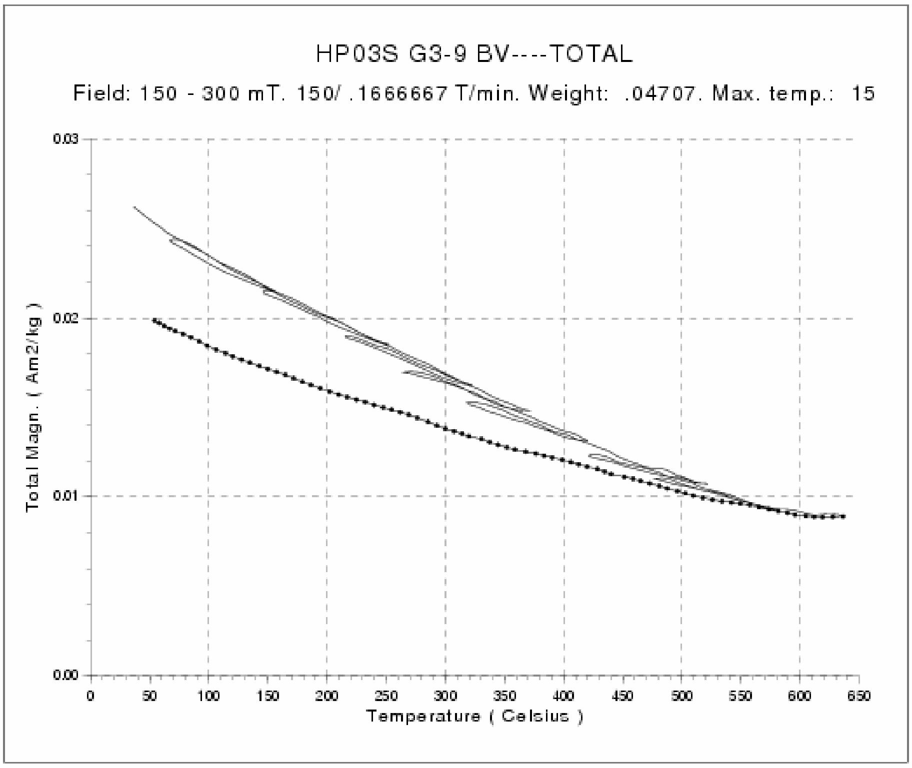

Figure 12 The results of the Curie balance measurement of sample G3-9, magnetic susceptibility 19 x 10^{-8} m^3/kg.

Four samples from an archaeological context were selected for thermomagnetic measurements. All samples show mainly paramagnetic behaviour during the thermomagnetic run. Although the individual components cannot be recognized, it can be observed that the total magnetization decreases. It is assumed that this indicates that a ferrimagnetic compound, most likely from the magnetite-maghemite series, has disappeared during the thermomagnetic run.

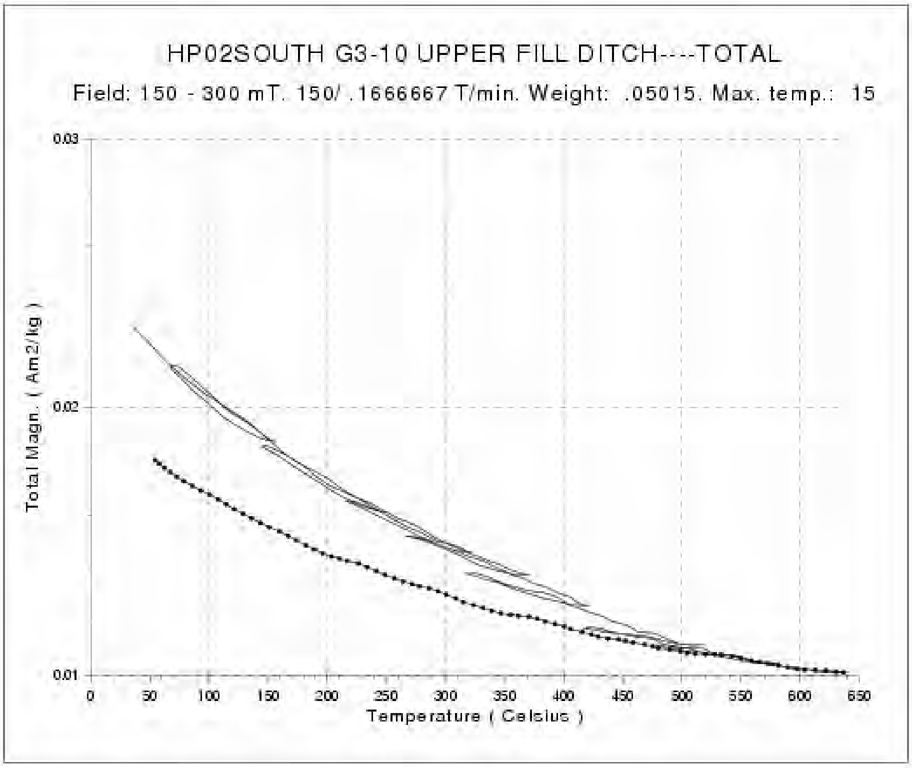

Figure 13 The results of the Curie balance measurement of sample G3-10, magnetic susceptibility 13 x 10^{-8} m^3/kg.

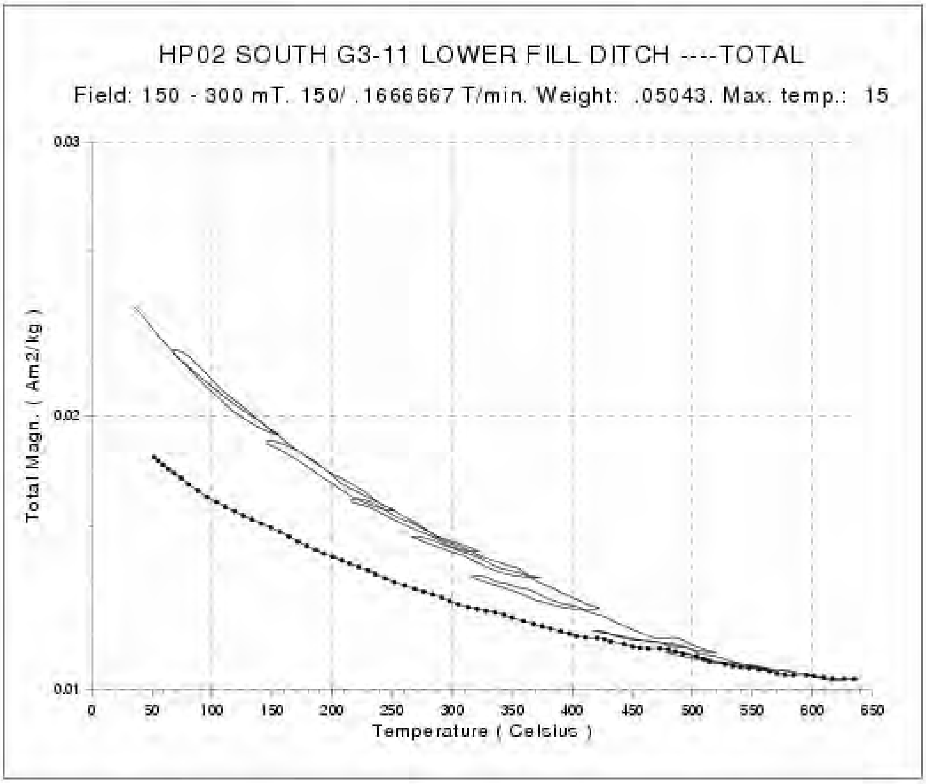

Figure 14 The results of the Curie balance measurement of sample G3-11, magnetic susceptibility 13 x 10^{-8} m^3/kg.

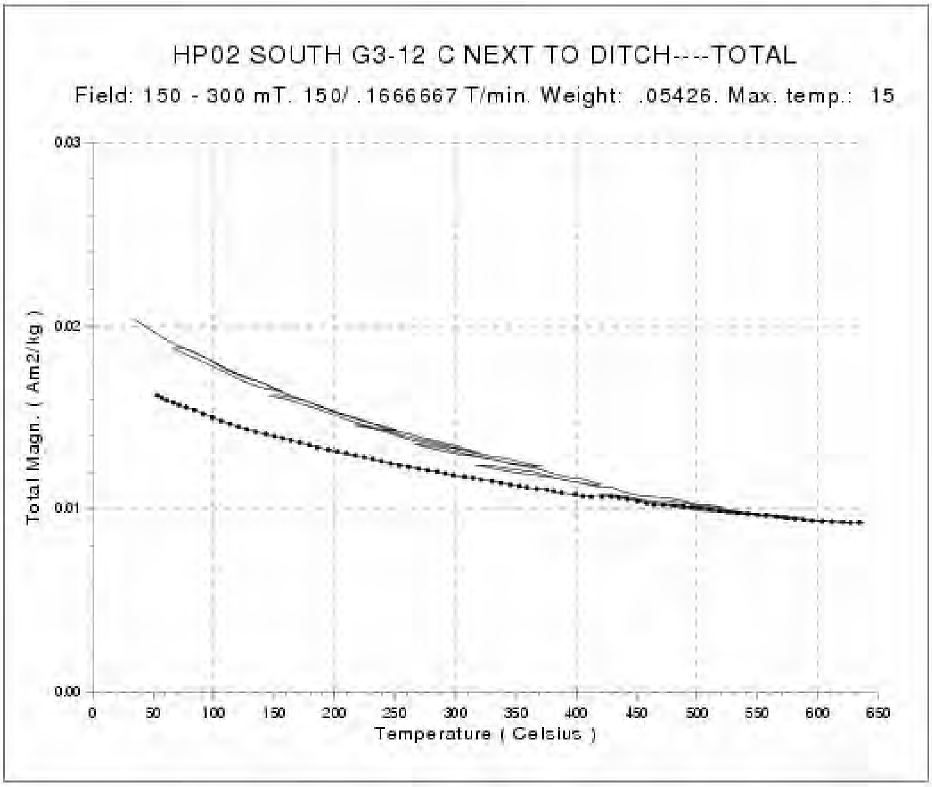

Figure 15 The results of the Curie balance measurement of sample G3-12, magnetic susceptibility 11 x 10^{-8} m^3/kg.

3 IRM component analysis

Broekpolder

sample	description	component	$B_{1/2}$ mT	SIRM (A/m)	DP
1-1	topsoil	1	41.2	52500	0.29
		2	120.2	16500	0.35
		3	1995.3	7000	0.40
1-2	undisturbed	1	56.2	13700	0.46
		2	707.9	1400	0.30
1-3	undisturbed	1	56.2	13200	0.40
		2	707.9	2200	0.37
1-4	topsoil	1	42.7	88200	0.35
		2	501.2	8500	0.47
1-5	feature	1	53.7	12400	0.42
		2	501.2	850	0.30
1-6	feature	1	52.5	10600	0.38
		2	446.7	1050	0.48
SEA	modern feature	1	41.7	55500	0.38
		2	631.0	3000	0.2

Harnaschpolder South

sample	description	component	$B_{1/2}$ mT	SIRM (A/m)	DP
G3-9	topsoil	1	38.9	95000	0.39
		2	1995.3	8900	0.43
G3-10	undisturbed	1	40.7	21800	0.44
		2	1258.9	2300	0.45
G3-11	undisturbed	1	43.7	11900	0.45
		2	501.2	800	0.40
G3-12	topsoil	1	50.1	13900	0.44
		2	794.3	1700	0.45