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Ancient Monuments Laboratory
Report 88/91

REPORT ON THE ORIGIN OF SOIL MATERIAL IN THE LAWNS OF BRODSWORTH HALL, SOUTH YORK.

Matthew Canti

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Summary

Soil material from the lawns of Brodsworth Hall has been compared mechnically and mineralogically with samples from local fields. No significant spatial variations were found and the lawn soils' origin cannot be further delineated by current analytical techniques.

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REPORT ON THE ORIGIN OF SOIL MATERIAL IN THE LAWNS OF BRODSWORTH HALL, SOUTH YORKS.

1. Introduction

Brodsworth Hall, Brodsworth, South Yorkshire was built in the 1860's and occupied by the Williams family until its donation to English Heritage in 1990. The house is now undergoing considerable restoration.

Technical Services Group have undertaken an ecological survey of the gardens, led by Andrew Wimble of the Landscape Branch. It has emerged from this study that the lawns are florally rich in the extreme, somewhat resembling the now-scarce pastures once typical of the local limestone. From this observation, there arose a question of whether the lawns were created from local grassland (by turfing) or seeded on in-situ soil. This report details an attempt at providing the answer through scientific study.

2.Site Information

The Hall itself is situated on a gentle slope, falling towards the North and East. The slope is formed of inclined beds of the Lower Magnesian Limestone (B.G.S 1976). Outcrops of Basal Permian Sand and various Coal Measures materials occur within 2km of the site. Drift materials have not been recorded, but deposits less than 1 metre deep are ignored in geological mapping.

3. Sampling Details

9 holes were dug, 5 in the lawns and 4 in the fields to the South and East of the Hall. Their positions are shown on Figure 1. The turf line was morphologically indistinct and biological reworking made the chances of finding differences through micro-morphology extremely unlikely. It was therefore decided to sample the turf-layer and subsoil at each of the lawn-holes and compare them analytically with the subsoils from the field sites.

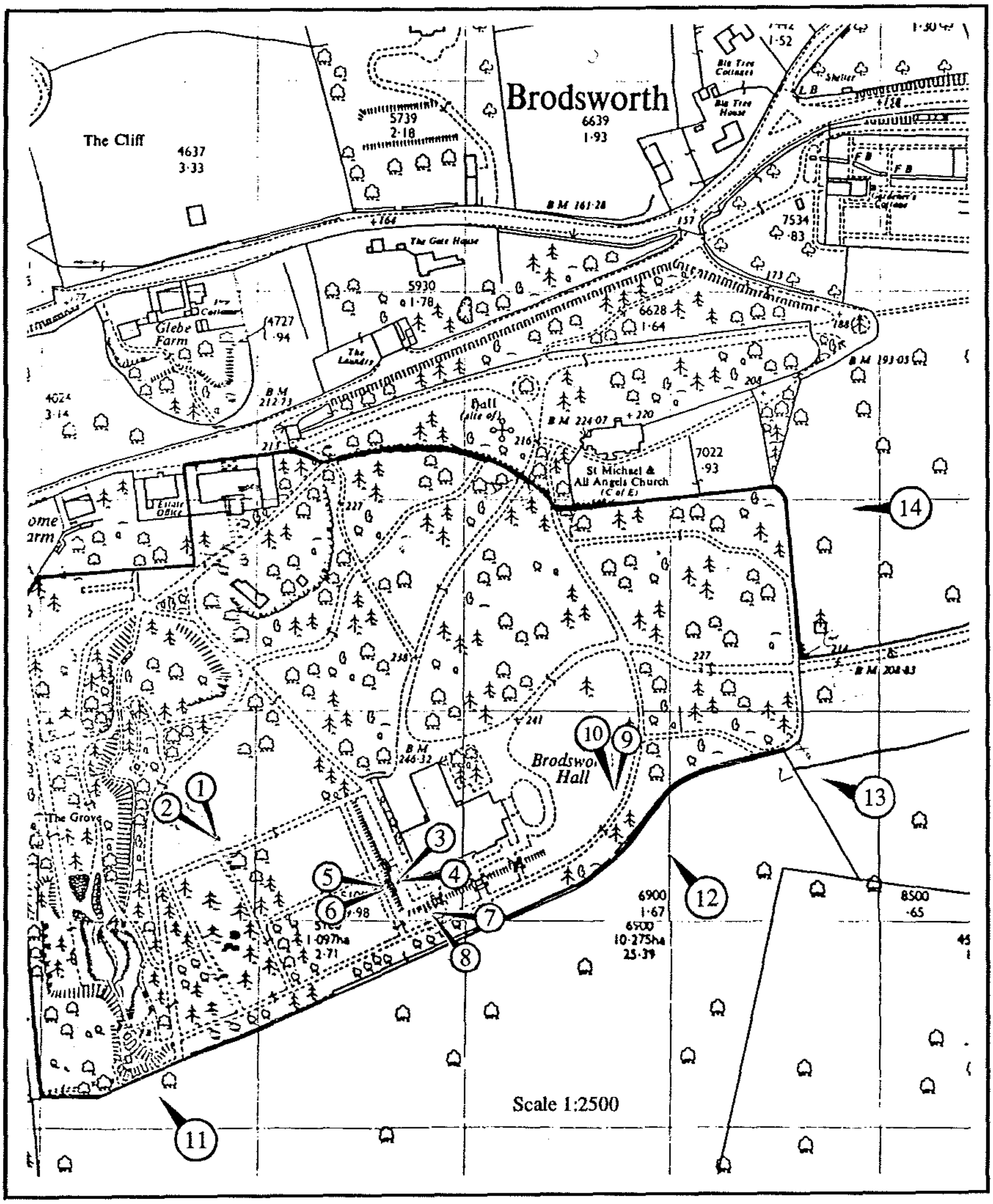


Figure 1
Map of Brodsworth Hall grounds showing sampling points.

The details of the samples are as follows:-

Sample	Depth cm	Remarks
Brod 1	0 - 5	Turf layer
Brod 2	15 - 25	Subsoil
Brod 3	0 - 5	Turf layer
Brod 4	15 - 21	Subsoil (made-up layer)
Brod 5	0 - 5	Turf layer
Brod 6	15 - 25	Subsoil (?natural)
Brod 7	0 - 4	Turf layer
Brod 8	14 - 21	Subsoil (charcoal and brick fragments)
Brod 9	0 - 3	Turf layer
Brod 10	3 - 22	Subsoil
Brod 11	15 - 25	Subsoil
Brod 12	15 - 25	Subsoil
Brod 13	15 - 25	Subsoil
Brod 14	15 - 25	Subsoil

4. Laboratory Work

4.1 Particle size analyses

All the samples were analysed for particle size using sieves for the coarse fraction and a Sedigraph 5000ET for the fine sediment. The graphical results are shown in bunch form on Figure 2. These curves are a standard representation of the mechanical analyses and a discussion of interpretation methods can be found in Canti (1991). The full data set appears in Appendix 1.

The curves are strongly shape-similar and show no systematic differences associated with source position. The two oddities at the coarse end of the scale (Brod 4 and Brod 13) contain some unusual stone. In the former case, it was building waste incorporated into the lawn soil, while in the latter it was a single large stone, perhaps introduced by humans. Certainly, neither of these erratic values argues for a heterogeneous interpretation of this soil group.

The variation (up to 20%) found at the fine end of the curves is harder to explain, chiefly because it is not obvious by what process the soil material actually arrived at this location. It is definitely too coarse to be Lower Magnesian Limestone dissolution residue (see Appendix 3). If it is glacial material, then the overall sorting would have to be inherited from the source sediment. It may be partially windblown, but is not well-sorted enough to be entirely transported in this manner. Either of these transport systems would allow some variation due to incomplete mixing of heterogeneous source components.

4.2 Heavy mineral analyses

As a check on the apparent similarity suggested by the particle size analyses, a heavy mineral count was carried out on selected samples. All soils and sediments contain a small proportion of minerals other than common quartz. Many of these are significantly

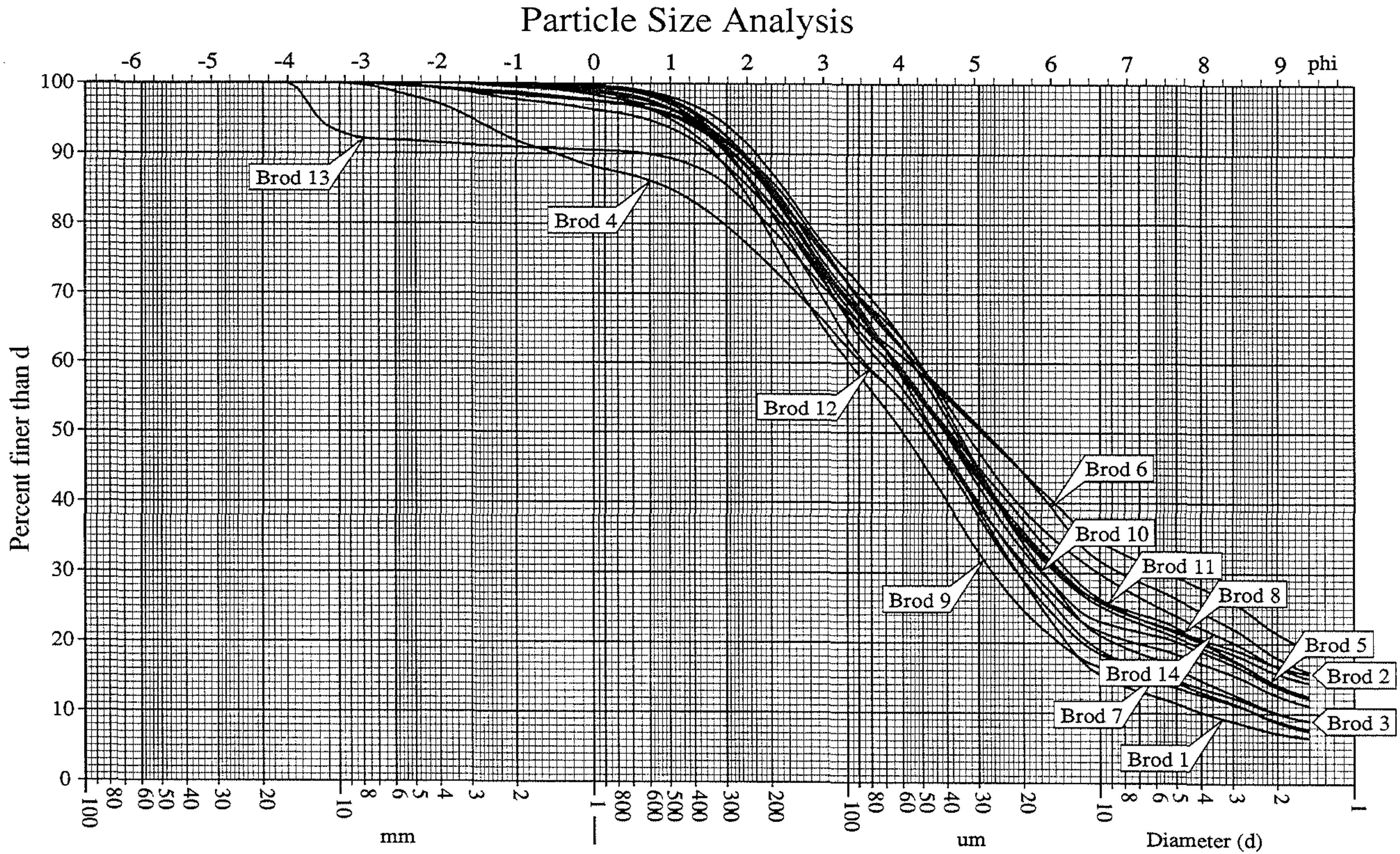


Figure 2.

Particle size analyses of all 14 samples.

heavier than quartz and can therefore be extracted by floating the lighter fraction off in a high density liquid. The "heavy fraction" thus obtained (sp.gr.> 2.95g/cc) comprises around 20 optically identifiable groupings or individual species.

Eight subsoil samples, four from the lawns and four from the fields, were extracted using this technique to obtain a concentrate of the minerals in the 180-63um fraction. Approximately 200 grains were identified and counted in each sample. The full results are shown on Table 1 and then represented as histograms on Figures 3 (lawns) and 4 (fields).

Mineral	Brod 1	Brod 5	Brod 7	Brod 9
Zircon	26.6	27.7	27.5	28.1
Rutile	12.8	9.9	8.6	12.4
Anatase	0.0	1.9	0.0	0.0
Brookite	0.9	1.4	0.9	1.4
Titanite	0.9	0.0	1.3	0.0
Tourmaline	22.0	23.5	22.3	20.0
Apatite	2.8	1.4	1.7	5.7
Garnet	19.3	16.4	18.9	17.6
Staurolite	0.0	0.0	1.7	0.0
Orthopyroxenes	0.0	1.4	0.0	0.0
Clinopyroxenes	0.9	1.4	1.7	2.4
Green Amphiboles	0.0	1.4	0.9	0.5
Clinozoisite	5.5	4.2	3.4	4.3
Epidote	0.0	0.0	0.0	0.0
Chlorite	2.8	1.9	5.2	1.0
Chloritoid	0.0	0.0	0.0	0.0
Monazite	0.0	1.4	0.0	0.5
Unidentified	5.5	6.1	6.0	6.2
	Brod 11	Brod 12	Brod 13	Brod 14
Zircon	27.5	27.5	27.3	35.1
Rutile	10.9	10.4	7.6	10.0
Anatase	0.0	0.5	0.0	0.0
Brookite	0.0	0.9	0.0	0.5
Titanite	0.0	0.0	0.0	0.0
Tourmaline	19.7	23.0	26.5	24.2
Apatite	1.3	3.6	5.3	5.2
Garnet	22.3	21.2	19.3	10.9
Staurolite	0.4	0.5	0.8	0.5
Orthopyroxenes	0.0	0.5	0.0	0.0
Clinopyroxenes	2.6	1.8	1.9	0.0
Green Amphiboles	0.0	0.0	1.1	0.5
Clinozoisite	1.3	1.8	1.9	0.9
Epidote	0.0	0.0	0.0	0.5
Chlorite	6.1	1.4	1.9	3.8
Chloritoid	0.4	0.5	0.0	0.0
Monazite	1.7	0.0	0.4	2.4
Unidentified	5.7	6.8	6.1	5.7

Table 1

Full heavy mineral analyses of the selected samples from the lawns and fields.

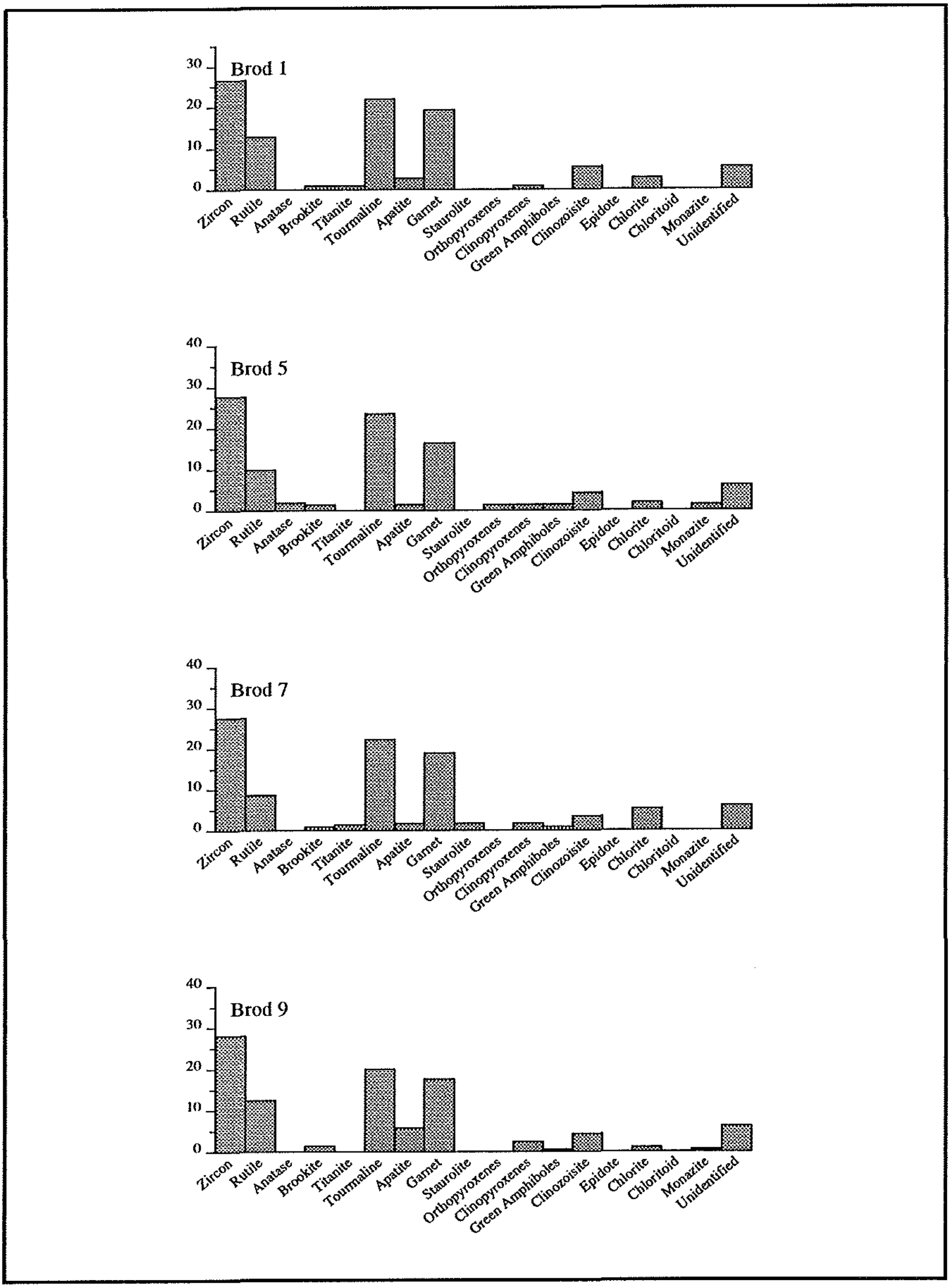


Figure 3

Full heavy mineral analyses of the 63-180um fraction from 4 of the lawn samples.

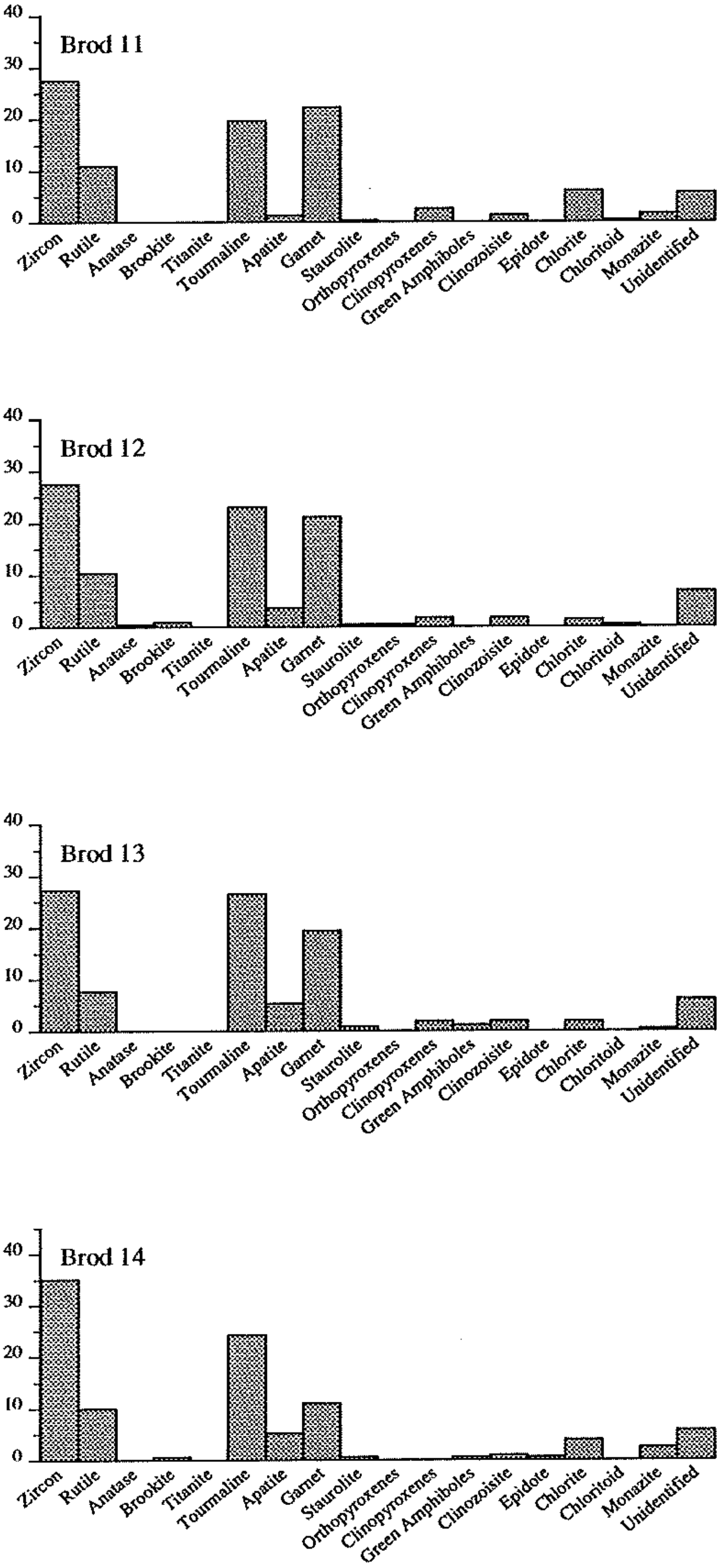


Figure 4
Full heavy mineral analyses of the 63-180um fraction from the 4 field samples.

These results show no significant variation between the lawn and field samples. The slight differences in Zircon (26-35%), Tourmaline (20-26%), Garnet (10-22%) and Rutile (8-12%) must be set against the regularity of the peak patterns in Figures 3 and 4, as well as the 5 - 7% regularly unidentifiable minerals which represent a constant error in the technique.

5. Discussion

There can be no doubt that the soils of the lawns and the local fields are formed from the same parent materials. In addition, the subsoils and turf layers of the lawn samples appear to be identical. Since there are no significant spatial trends, it cannot be stated that the lawn turf did or did not come from the fields. It seems most likely that in-situ material would be used for the garden construction, and that any extra requirements might have come from the surface of the quarry, or the visible depression in the fields near sample 11.

REFERENCES

B.G.S. (1976) Barnsley Sheet 87.

Canti M.G. (1991) "Particle size analysis - a revised inter - pretative guide for excavators". Ancient Monuments Laboratory Report 1/91.

APPENDIX 1

Particle Size Analyses.
Values are weight% finer than diameter in left hand column.

Diameter	Brod 1	Brod 2	Brod 3	Brod 4	Brod 5
16.00mm	100.00	100.00	100.00	100.00	100.00
11.30mm	100.00	100.00	100.00	100.00	100.00
8.00mm	100.00	99.96	100.00	99.68	100.00
5.70mm	100.00	99.76	100.00	98.48	100.00
4.00mm	100.00	99.35	100.00	96.98	100.00
2.80mm	100.00	98.77	100.00	94.39	100.00
2.00mm	99.99	98.38	100.00	91.81	99.93
1.40mm	99.68	97.95	99.57	89.99	99.79
1.00mm	99.41	97.51	99.01	88.23	99.47
707.10um	99.14	96.88	98.37	86.94	99.02
500.00um	97.46	95.40	96.47	85.00	97.71
353.60um	94.46	92.62	93.24	81.73	94.62
250.00um	89.57	88.43	89.23	77.17	89.67
176.80um	83.04	81.48	82.75	71.85	83.95
125.00um	74.60	73.41	75.82	66.18	76.36
88.40um	67.73	66.59	69.38	60.17	69.43
62.50um	58.83	59.75	62.92	55.21	64.17
44.20um	49.51	52.34	54.58	47.77	55.80
31.30um	40.08	44.76	45.39	39.08	45.89
22.10um	31.23	37.73	36.57	30.94	36.97
15.60um	23.16	31.67	28.71	24.46	30.78
11.00um	16.43	26.69	22.08	19.30	26.18
7.80um	13.68	24.12	19.24	16.85	23.54
5.50um	11.92	22.29	17.18	15.17	21.46
3.90um	10.05	20.49	14.53	13.49	19.23
2.80um	8.58	18.81	12.28	11.92	16.99
2.00um	7.22	16.76	10.09	10.02	14.06
1.40um	6.49	15.58	8.89	8.92	12.31

Textural Details
These values are the normal weight percent in each of the class groups. See Appendix 2 class details.

Coarse Sand	1.45	2.11	2.36	6.19	1.38
Medium Sand	12.97	12.35	12.45	13.43	12.40
Fine Sand	27.81	25.66	23.17	21.06	22.81
Total Sand (S)	42.23	40.12	37.97	40.68	36.60
Coarse Silt	28.84	23.34	27.72	27.75	28.40
Medium Silt	16.53	13.40	16.52	14.57	12.97
Fine Silt	5.18	6.10	7.70	6.08	7.97
Total Silt (Z)	50.55	42.84	51.94	48.40	49.33
Total Clay (C)	7.22	17.04	10.09	10.92	14.07
Texture	SZL	SZL	SZL	SZL	SZL

APPENDIX 1 contd.

Particle Size Analyses.
Values are weight% finer than diameter in left hand column.

Diameter	Brod 6	Brod 7	Brod 8	Brod 9	Brod 10
16.00mm	100.00	100.00	100.00	100.00	100.00
11.30mm	100.00	100.00	100.00	100.00	100.00
8.00mm	99.91	100.00	99.93	100.00	100.00
5.70mm	99.58	100.00	99.63	100.00	100.00
4.00mm	99.30	100.00	99.25	100.00	100.00
2.80mm	99.05	100.00	98.52	100.00	100.00
2.00mm	98.76	99.74	97.72	99.73	99.84
1.40mm	98.23	99.48	97.12	99.13	99.61
1.00mm	97.66	99.18	96.32	98.38	99.40
707.10um	97.04	97.51	95.44	97.32	98.82
500.00um	95.70	96.33	93.67	94.93	97.11
353.60um	92.94	92.60	90.48	91.04	93.29
250.00um	88.21	86.83	85.57	84.20	86.97
176.80um	82.30	80.37	79.47	74.38	80.21
125.00um	76.53	72.16	71.89	65.11	72.80
88.40um	68.86	63.50	64.40	57.96	65.62
62.50um	62.67	57.07	58.79	50.89	59.90
44.20um	57.01	49.27	51.74	42.60	52.06
31.30um	51.58	40.91	44.12	33.91	43.28
22.10um	45.96	32.95	37.08	26.38	35.19
15.60um	39.41	25.92	31.32	21.02	28.72
11.00um	32.83	19.97	26.72	17.13	23.72
7.80um	29.59	16.99	24.72	15.34	22.01
5.50um	27.14	14.92	22.99	14.03	20.74
3.90um	24.32	12.91	19.98	12.51	18.65
2.80um	21.52	11.04	17.12	10.97	16.47
2.00um	17.94	8.76	14.09	8.93	13.73
1.40um	15.81	7.44	12.38	7.71	12.10

Textural Details
These values are the normal weight percent in each of the class groups. See Appendix 2 class details.

Coarse Sand	2.27	2.75	3.06	3.37	1.65
Medium Sand	12.24	14.21	13.24	18.47	15.53
Fine Sand	22.74	26.68	24.32	28.03	23.64
Total Sand (S)	37.25	43.63	40.62	49.87	40.82
Coarse Silt	17.93	25.38	23.20	25.38	25.86
Medium Silt	16.65	15.49	12.06	10.31	12.11
Fine Silt	10.01	6.71	9.70	5.48	7.45
Total Silt (Z)	44.59	47.58	44.96	41.17	45.43
Total Clay (C)	18.16	8.79	14.42	8.96	13.75
Texture	CL	SZL	SZL	SZL	SZL

APPENDIX 1 contd.

Particle Size Analyses.
Values are weight% finer than diameter in left hand column.

Diameter	Brod 11	Brod 12	Brod 13	Brod 14
16.00mm	100.00	100.00	100.00	100.00
11.30mm	100.00	100.00	93.90	100.00
8.00mm	100.00	100.00	92.08	100.00
5.70mm	100.00	100.00	91.79	100.00
4.00mm	100.00	100.00	91.46	100.00
2.80mm	99.81	100.00	91.15	99.91
2.00mm	99.41	100.00	90.93	99.71
1.40mm	99.19	99.91	90.69	99.62
1.00mm	98.72	99.72	90.51	99.48
707.10um	97.98	99.28	90.26	99.19
500.00um	96.50	97.69	89.42	98.10
353.60um	93.69	93.79	87.37	95.83
250.00um	89.17	86.77	82.95	91.46
176.80um	81.97	78.50	77.26	84.93
125.00um	73.90	69.33	71.01	77.21
88.40um	67.13	60.77	65.65	71.17
62.50um	59.46	55.16	61.42	64.37
44.20um	52.47	48.10	56.43	56.46
31.30um	45.77	40.45	51.11	48.17
22.10um	39.34	33.30	45.77	40.75
15.60um	33.00	27.25	40.46	35.24
11.00um	27.32	22.37	35.48	30.93
7.80um	24.28	20.37	32.50	27.52
5.50um	22.10	18.92	30.15	24.65
3.90um	20.01	17.01	27.78	22.04
2.80um	18.06	15.06	25.23	19.62
2.00um	15.69	12.56	21.43	16.66
1.40um	14.31	11.06	19.07	14.95

Textural Details
These values are the normal weight percent in each of the class groups. See Appendix 2 class details.

	Brod 11	Brod 12	Brod 13	Brod 14
Coarse Sand	2.03	1.28	1.08	0.93
Medium Sand	12.75	17.16	11.63	11.39
Fine Sand	26.25	27.16	20.37	24.00
Total Sand (S)	41.03	45.60	33.07	36.31
Coarse Silt	21.19	22.88	18.21	24.58
Medium Silt	14.99	12.17	14.88	13.69
Fine Silt	7.01	6.80	10.26	8.71
Total Silt (Z)	43.19	41.85	43.36	46.97
Total Clay (C)	15.78	12.56	23.57	16.71
Texture	SZL	SZL	CL	SZL

APPENDIX 2

Particle size classes and textural assessment.

Size Classes :-

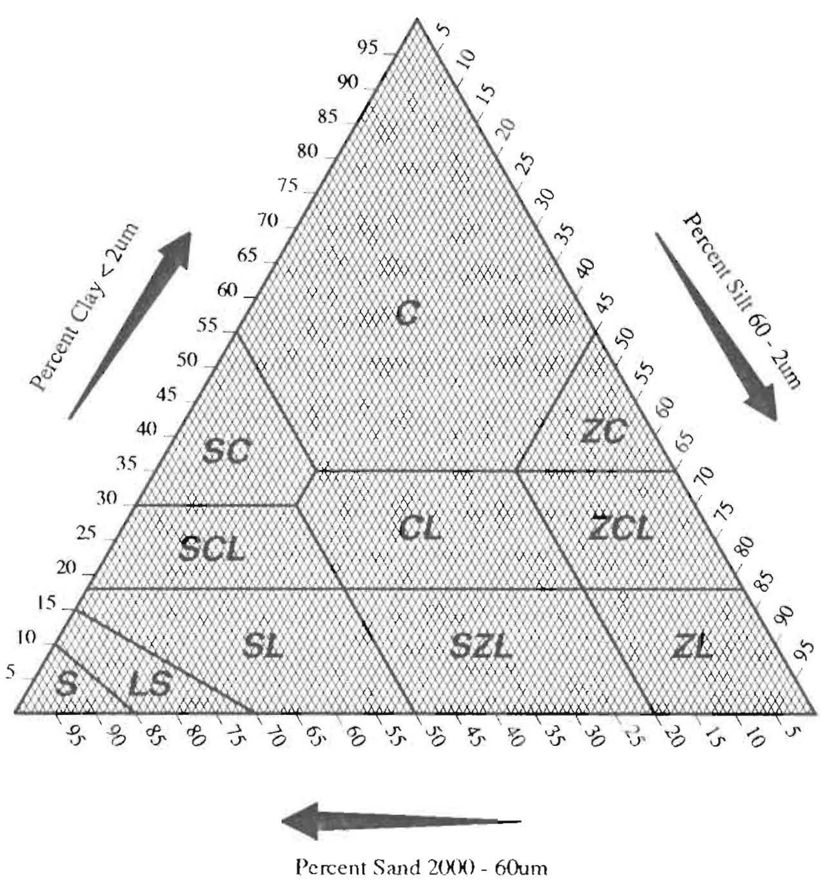
SAND (S) 2mm-60um
   Coarse (CS) 2mm-600um
   Medium (MS) 600um-200um
   Fine (FS) 200um-60um

SILT (Z) 60um-2um
   Coarse (CZ) 60um-20um
   Medium (MZ) 20um-6um
   Fine (FZ) 6um-2um

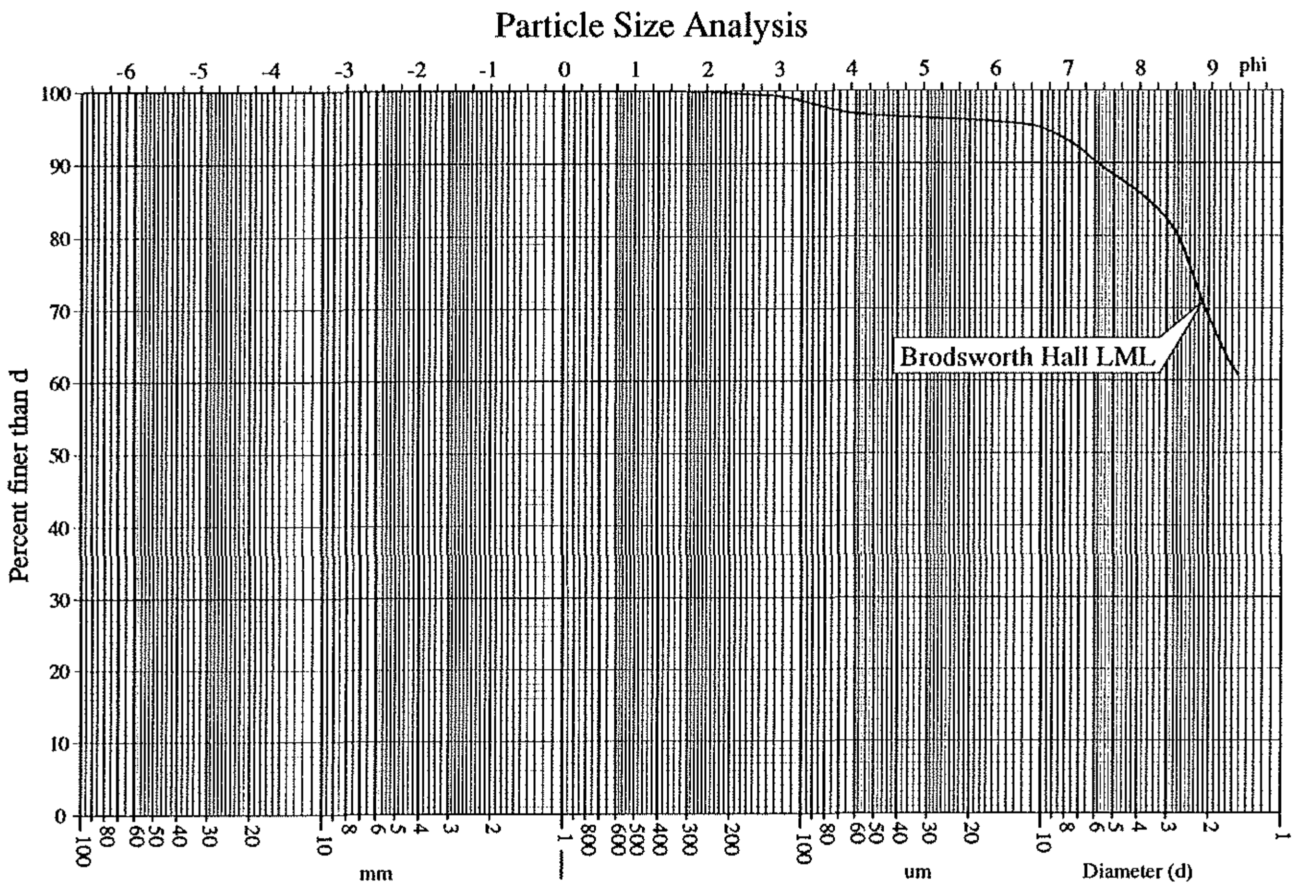
CLAY (C) <2um

Textural Assessment :-

Values for Sand, Silt and Clay are entered into the triangular diagram below.



APPENDIX 3



Lower Magnesian Limestone was collected from the quarry garden to the South West of the Hall. A cleaned dried sample was dissolved in Formic Acid. The residue after this decalcification (approximately 1% of the original weight) was subjected to particle size analysis.

The result above (compare with soils on Figure 2) shows that only small amounts of this residue can be present in the soil and its bulk must be made up of non-LML materials.