Ancient Monuments Laboratory
Report 9/93

COURAGE BREWERY SITES, SOUTHWARK: DETAILED ASSESSMENT OF SOILS

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Summary

Detailed assessment of the dark earth and associated soils and sediments at COSE 84 and 28 Park St were carried by the study of 22 thin sections and the chemical and grain size analysis of 11 bulk samples. Dark earth and Roman building and refuse materials were characterised. Much of the dark earth and dark earth-like deposits were shown to be formed through the pedological reworking of urban stratigraphy A significant part of this reworking seems to have occurred during the Roman period itself, and was not just a result of post-Roman abandonment. The report is supported by three tables and one figure.

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1. Introduction

In 1984 the sites of Courage Brewery (COSE84) and 28 Park St (28PS84), Southwark, were excavated (director, Robin Densem) by the Southwark Archaeological Unit (now MOLAS). A detailed sampling and study programme was initiated because of research interest in the site formation processes of dark earth (Macphail 1981, 1983). Dark earth also posed many interpretational problems for London (Sheldon, pers. comm.) at this time. As the Courage Brewery sites have only recently come under archaeological study for their assessment (Cowan, pers. comm.), earlier pedological results on the formation of the dark earth at these sites have had to be generalised (Macphail and Courty 1985; Courty *et al*. 1989; Macphail in press). The present assessment, however, has had the unusual benefit of a thorough soil micromorphological and bulk analytical study, which is organised within a well understood archaeological and research framework (Yule 1990; Macphail in press). The assessment is therefore a detailed one.

2. Methods

Many techniques have been applied to the study of urban sediments and dark earth (Macphail 1981; Courty *et al* . 1989), but the only one to bring consistently useful results is soil micromorphology. Undisturbed samples of features of interest and dark earth were impregnated with crystic resin under vacuum, at the Institute of Archaeology, and manufactured into thin sections at the Institut National Agronomique, Paris-Grignon (Guilloré 1985), generally following the guidelines of Murphy (1986). Thin sections were systematically described according to Bullock *et*

al. (1985), and interpretations made on the basis of current literature, collaboration and experience (Courty et al. 1989; Courty, pers. comm.). Micromorphological data were complemented by grain size, organic carbon, and calcium carbonate analyses (Avery and Bascomb 1974).

3. Archaeology, investigative approach and samples

At Courages Brewery, a sandy parent material/occupation "ploughsoil" underlay a series of 1st/2nd century brickearth clay and timber buildings and industrial structures (Dillon et al. 1991; Cowan, pers. comm.). Other features of later Roman date include 2nd century dumps, 3rd century substantial structures and 4th century inhumations, the last seemingly sealed by dark earth (Dillon et al. 1991; Densem (1985), Cowan (1992) pers. comm.). At 28 Park St, northwards towards the river Thames, supposed waterlain silts were buried by a series of, as yet, undated building debris dumps, hard standing and "weathered dumps" and dark earth (Densem (1985), Cowan (1992) pers. comm.).

The main questions posed by the dark earth at this site are;

a) what is the dark earth made up of and what does it represent, as far as the landuse history of Roman and post Roman Southwark, is concerned?

b) does it relate purely to the natural reworking of dumps or does it represent Roman stratigraphy transformed by human and biological activity (Yule 1990; Macphail in press)?

c) were dark earth-like deposits forming during the Roman period (as at Winchester Palace; Macphail in Yule archive)?

d) what were the human mechanisms and landuse patterns, and associated environmental factors, which produced dark earth?, and

e) finally, can data from the Courage Brewery site help to

understand better dark earth elswhere in London and in the UK as a whole?

The research approach, based on previous work (Macphail and Courty 1985, Macphail 1991, Macphail 1992, Brown and Macphail in prep), was to first characterise the dark earth in relationship to its parent materials. These are natural (local sands and recent alluvial silts), those derived from buildings (brickearth clay floors and walls, brickearth based daub, mortar/opus signinum/plaster), industrial (ashes, charcoal and slags) and domestic (plant and food residues, ashes, coprolites) in character. Secondly, the dark earth was investigated according to its pedological nature, so that the factors of weathering and biological transformations could be assessed. The factor time was more difficult to tackle, because the dark earth is so poorly dated, and in places may well be a palimpsest, reflecting a whole series of unknown human activities on the sites. At the Courage Brewery sites, however, some controls over dating are already available even at this assessment stage.

Twenty-two thin sections were made in all (table 1). These include samples of weathered natural/primary occupation (No. 15/45), building materials (Nos. 16/47, 16a, 21), brickearth clay floor and sealed occupation soil (No. 6/94; fig. 1c), Roman "weathered dumps" (Nos. 14/46, 19/64, 20/66), dark earth (Nos. 1, 2, 3, 4/44, 5/43, 7/38, 8/40, 9/39, 10/37, 12/90, 13/41, 18/65; figs. 1a, 1b) and post medieval earth (No. 11/91). At the Courage site the dark earth that was sampled occurred over remnants of demolished clay and timber buildings dating to around AD70-100, with dumps over them of around AD120-200.

4. Results

4.1. Grain size and chemistry Organic carbon and calcium

carbonate, and grain size data are given in tables 2 and 3, respectively. These results immediately show that, for example, the dark earth (Nos. 1, 2, 3, 4/44, 5/43) is a moderately calcareous, humic sandy loam, whereas brickearth clay wall (No. 7/38), as one of its parent materials, is a non-humic, weakly calcareous, fine sandy silt loam. In some contrast, an occupation soil (No. 6/94) can be seen to be a little more humic, but this may relate to different burial conditions. It can be noted that the Roman "weathered dump" material (Nos. 9/39 and 10/37) at 28, Park St, has a grain size (sandy loam) and organic matter content similar to dark earth at the Courage site, but is much less calcareous. On the other hand, the dark earth (No. 8/40) at 28 Park St is again humic, but has a totally different grain size character, being a much finer clay loam deposit. The calcareous and strongly humic silts (clay loam with 51% silt) at the base of sequence at 28 Park St (No. 11/91), are so well sorted that they can be determined as being waterlain. Other than the last, the detail of the similarities and differences between the deposits was much more clearly defined through soil micromorphological analysis.

4.2. Soil micromorphology At the Courage Brewery site the natural alluvial sandy (Macphail and Courty 1985; Macphail in press) parent material (15/45) has had little influence on the formation of the dark earth, which has mainly formed from anthropogenic parent materials (see below). Evidence of human activities affecting the natural brown sandy soil is in the form of general mixing of fine charcoal-rich soil, through biological agencies (roots, earthworms, Enchytraeids etc.), and occasionally through washing down-profile. The soil coatings that the latter

has produced could be interpreted as originating from surface soil disturbance during occupation, one mechanism being cultivation of an overlying occupation soil. The weathered dump (14/46) that overlies this "ploughsoil", has similar characteristics of the dark earth in general (see below and Park St "weathered dumps" for details), and can be interpreted as a domestic ash residue dump.

As regards the dark earth at the Courage site, there are examples of a simple stratigraphic separation of dark earth, as identified previously in London. Firstly, there are the commonly debris-rich, heterogeneous and little weathered (intact mortar and plaster) basal layers, termed "pale" dark earth (table 1, No. 2, probably represents a dump or collapse). Above, are the more homogeneous, more humic "dark" dark earth layers, which have more "free" fine calcium carbonate. The last is from the weathering and dissolution of calcium carbonate "cements" and fragmentation of mortar (gravel size clasts in a micritic cement containing silt) and plaster (dense porphyritic fabric of sands in micritic cement containing silt), processes which release silt, sand, gravel and fragments of the calcium carbonate cement itself (Nos. 16a, 21). This same sequence has been found at St Thomas St and Southwark St, Southwark (Macphail and Courty 1985) and Jubilee Hall, Covent Garden (here over a Middle Saxon floor)(Macphail 1987; Whytehead in press). These microfabric characteristics of dark earth have already been illustrated (Macphail 1983; Macphail and Courty 1985; Courty et al. 1989).

In particular, at section I/52 at Courage Brewery, dark earth immediately over the fallen wall of re-used tegulae (Figure 1b, No. 5/43) is coarsely and strongly heterogeneous, with a poor amount of fine fabric. It contains charcoal and a dominant amount

of coarse, weakly decalcifying mortar. Immediately above (No. 4/44), the dark earth is much more fine, humic (see table 2) and small fragments of decalcifying mortar are common. Biological activity, including the reworking by earthworms and Enchytraeids is strongly in evidence. At this area of the site the dark earth can easily be recognised as a calcareous brown earth soil (Macphail, in press).

At section II/13, thin section 7/38 shows the basal part of the dark earth to be characterised by large amounts of included slags and amorphous yellow, non-birefringent materials, previously observed in Roman roadside gully deposits at Deansway, Worcester (Macphail 1990, plates 22-24). These slags and amorphous materials in the dark earth over a hard standing layer, may reflect the Roman industrial use of this part of the site (Cowan, 1992, pers comm).

At section I/44, the basal sample (no. 10/37) of the dark earth taken just above a brickearth floor, seems to retain evidence of the initial weathering and soil formation at this part of the site. The whole sample is dominated by silt, sand and abundant gravel, but the finer fraction shows a pedological sequence. The basal 1-2 cm is a weakly calcareous Ah horizon, containing amorphous organic matter, high amounts of dusty charcoal and possible evidence of earthworm activity. The next 3 cm above are in contrast an "acidic", decalcified H-like horizon, made up of amorphous organic matter, with partially decalcified Arionid (slug) granules, and very little charcoal. The top of the slide comprises a highly organic Ah horizon, again with much charcoal. The overlying sample (No. 9/39), has a more typical dark earth character, with high biological activity integrating

charcoal-rich soil around mortar and brickearth clay relic material.

The sequence here seems to show evidence of initial soil formation on an abandoned urban site. The soil can be possibly classified as a lithosol (Avery 1990, p.116-118, fig. 4.2), trending towards a pararendzina (Avery 1990, p 142-143), the type of soil recorded on Berlin's bomb sites (Blume and Runge 1978; Sukopp et al. 1979). It seems that collapse or dumping of mortar and brickearth clay, aided the accretion of dark earth further up the sequence (No. 9/39) and the formation of a brown calcareous earth (Avery 1990, p 181) over the initial calcaric lithosol. Lastly, this part of the site was affected by probable post medieval dumps rich in slag and (decalcified) ash residues (No. 8/40). At section I/41 too, the upper part of the dark earth can be recognised as a post medieval ash and slag dump (No. 11/91), that contaminates the underlying post Roman deposits (No. 12/90). Only the basal sample (No. 13/41) is uncontaminated, and although a biologically worked calcareous brown earth, it still retains some relic elements of being originally stratified by increments of dumped or collapsed material. For example, the basal layer is sandy and "capped" by a charcoal-rich horizon, whereas above far more brickearth clay is present. Such stratigraphies, however, could also relate to periods of robbing disturbance, even after the dark earth had began to form.

At section I/64 sample 6/94 records the short-lived formation of a weathering surface over a clay floor after abandonment. Here this episode was preserved by wall collapse. The sample preserves a whole catalogue of features that may help identify mechanisms in the formation of dark earth. For example, biological homogenisation is very strong in what must have been a

short-lived soil, but it has not been extensive enough to finely fragment the abundant charcoal that is present. Coprolitic remains from possible bird and human agencies occur, alongside frequent bone fragments and possible bird shell. It is also interesting to note that part of the clay floor layer appears to have been phosphatised, as further evidence of guano accumulation. What is most noteworthy, however, in this assessment, is how quickly biological homogenising agencies were on the scene. This is important when studying the formation of dark earth-like deposits that are of Roman date, such as at 28 Park St.

At 28 Park St a Roman "weathered dump" (20/66) has a typical biologically worked dark earth character that is produced by earthworm and plant reworking of building debris, such as brickearth and calcareous mortars and plasters. Dusty clay coating features may testify to trampling of a surface, that was succeeded by the hard standing or path. The weathered dump, which also includes materials such as hammerscale shows little evidence of being waterlogged, or being influenced by the alluviation responsible for the underlying deposit (bulk sample 11), although fragments of alluvial silt containing diatoms do occur within the Park St samples.

The presumed later Roman weathered dump (No. 19/64) that overlies the path is again a poorly sorted dark earth-like soil. It has however not been totally homogenised, and although it superficially has the bulk grain size of dark earth (table 3, no. 9), its components are less dominantly of building debris, than of probable burned domestic refuse origin (hence low organic carbon and calcium carbonate, table 2, No. 9). For example, the

abundance of fine burned soil, burned brickearth, phytoliths, and charred organic matter and charcoal, may infer domestic sweepings (eg. hearth debris). There may be ashy remains and some secondary calcitic features, suggesting the exposure of these dumps to the elements. Coprolitic remains are rare in this deposit, and the ferruginous features and vivianite crystals that have formed may relate to phosphates being released from the weathered ash. The effects of local water tables have also to be considered. In addition, thick very dusty soil coatings are present, which again suggest the the deposit was open and regularly trampled. Its character overall indicates rather rapid accretion through domestic dumping. Interestingly, this material is comparable to the weathered dump analysed at the Courage site (14/46), which is again poorly calcareous and sandy, with abundant very fine charcoal-rich probable ash residues, bone, shell and rare slag and vivianite (see above). The deposit, which contains many Arionid granules has been totally homogenised by biological activity, indicating probable decades of weathering before the soil, which could have incorporated much sand of natural origin both from the underlying soil and from sweepings, was sealed by the 1st/2nd century fallen wall. Possibly the "dump" could be the result of Roman soil formation in an accumulation of refuse (as indicated by abundant slug granules) and sweepings contemporary with the 1st/2nd century structure.

The dark earth above (No. 18/65) contrasts with the dark earth so far examined, by being a well sorted, rather fine material (table 3, No. 8), which like bulk sample 9, has an untypically low calcium carbonate content (table 2). Also unlike the dark earth generally, it has a high clay content, and abundant fine charcoal, ash residue material, phytoliths and common amounts of

bone, burned bone and coprolites, some probably being of human origin. Biological activity has not been sufficiently rapid to rework the deposit, which in reality also shows some stratification. The layer has also been affected by dusty clay soil washing through, as well as the marked formation of amorphous iron nodules and vivianite crystals.

The character of this layer indicate that it has a strong domestic refuse component, such as sample 19//64 below. However, its well sorted, clay loam grain size and the inclusion of coprolitic material, also infer that it may be waste gathered from street sweepings. Once dumped, exposure to the elements allowed weathering and the washing of phosphatic and dusty soil solutions down-profile. This process formed various coatings, amorphous ferruginous features and vivianite. Some mobile material may have also penetrated into the underlying layer (No. 19/64). The lack of total biological homogenisation of the dark earth layer (18/65) indicates that this was not a deposit that was exposed throughout the post Roman period to weathering and pedological processes, and stratigraphy at this part of the site may well be truncated.

5. Discussion

The methodologies applied to this study worked well. The role of the natural and Roman anthropogenic parent materials, and their transformation by pedological processes (biological and weathering activity, etc) during the formation of weathered dumps, soils and dark earth, is now reasonably well understood. The effect of human influences and time are less well defined and will need more investigation, based upon accurate dating and detailed archaeological interpretation of particular areas.

Nevertheless some general ideas on the sequence of pedological events from Park St and the Courage sites can be ascertained.

a) The sandy brown soil on site was mixed and truncated by earliest Roman activity. Rather than being a "ploughsoil" with a dump on top at section I/39, it could be regarded as a truncated sandy soil contaminated by the downprofile washing and biological mixing of dumps of domestic refuse and sweepings, that were perhaps contemporary with soils in open spaces around the 1st/2nd century structures. At 28 Park St, dating should be carried out to indicate whether similar domestic dumps that occur over river silts, are contemporary with the 1st/2nd century domestic and industrial activities found elsewhere on the Courage sites.

b) Throughout the Roman period "dumps" were affected by soil formation.

c) In an abandoned 1st/2nd century structure (without a roof?), a relatively organic occupation soil formed rapidly (over 1-5yrs??) by the biological breakdown and weathering of building material (eg. plaster coated brickearth walls), charcoal, and coprolitic material including bird guano. The occupation soil over the brickearth clay floor was undoubtedly vegetated in some way.

d) Undated dark earth formed over abandoned 1st/2nd century structures. In one instance primary soil formation was in the form of a calcaric lithosol, whereas generally elsewhere, and also succeeding this particular lithosol, building debris increments, through collapse, dumping and disturbance because of robbing out etc, led to a strongly earthworm-worked calcareous brown earth soil (dark earth) to develop across the Courage site. A lithosol could have formed over a 5-20 year period (Blume and Runge 1978; Sukopp et al. 1979), whereas the calcareous dark

earth soil would have developed in long term (over decades and centuries) equilibrium with dumped and collapsed building materials.

e) As pedological activity has been shown to have been active throughout much of the Roman period in various areas, it may be suggested that dark earth formation was in places initially contemporary with other Roman urban activities. At the Courage site, areas of 1st/2nd century structures were perhaps undergoing pedological transformation into dark earth, at the same time as they were being variously robbed out and used for dumping areas. At the Park St site, dark earth formed specifically out of dumps of sorted domestic refuse and street sweepings, the origins and dates of which should be further studied from an archaeological point of view.

f) It seems reasonable to consider that areas of dark earth soils at the Courage site were probably used as graveyards during the Late Roman period, and the concept that the graves were sealed by dark earth is wrong. Rather, graves may well have been cut through a pedologically active upper stratum of dark earth, into the poorly reworked Roman layers beneath. Continuing biological activity reworked the upper part of the graves, obscuring the upper part of cut features, and thus giving the impression that graves were "sealed" by dark earth (Macphail 1991, in press).

g) The dark earth at the Courage site is generally only some 40 cm thick as a maximum. Above, the stratigraphy is made up of, or is affected by, late medieval slag and charcoal dumps. The shallow thickness indicates that dark earth may well be substantially formed from local building collapse and dumped

debris, rather than being a dumped deposit per se.

h) To conclude, the processes that led to the formation of dark earth, and possibly a significant amount of the dark earth itself, were contemporary with the Roman occupation, rather than being exclusively phenomena dating to post-Roman abandonment.

7 Future work

Archaeological feedback is necessary before more interpretative studies can be carried out. Feedback should include extra dating and analysis of the stratigraphy of specific areas investigated by soil micromorphology. Future work on this project to produce a report for publication should take only a few weeks to a month to complete, according to the type of report required. This should incur little extra expense, unless detailed soil micromorphological descriptions are needed, because all the basic analyses have been carried out.

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Table 1: Courage Brewery Sites: list of samples for soil micromorphology and bulk analysis

Report/Sample No.	Micro. Lab. No.	Bulk No.	Area	Context No.	Drawing showing sample	Description
COSE 84 (Courage Brewery)						
1/-	?	1	?	1002	?	dark earth, 0-7 cm
2/-	?	2	?	1002	?	"pale" dark earth, 15-22 cm
3/-	?	3	?	1016	?	dark earth, 23-30 cm
-	-	-	-	1014	?	1st/2nd C. clay floor
4/44	?	4	I	1509	sect. I/52	dark earth, 0-7 cm
5/43	?	5	I	1509	sect. I/52	dark earth, 8-14 cm
-	-	-	-	-		Fallen wall of re-used tegulae of large Roman stone-founded building
6/94	-	-	I	-	sect. I/64	Fallen plaster coated 1st/2nd C. wall
6/94	?	6	I	4576	sect. I/64	"occupation soil"
6/94	?	-	I	-	sect. I/64	1st/2nd C. brickearth clay floor
7/38		-	II	2038	sect. II/13	dark earth, 0-7 cm 1st/2nd C. hard core surface
8/40		-	I	-	sect. I/44	dark earth, 0-7 cm
9/39		-	I	-	sect. I/44	dark earth, 15-22 cm
10/37		-	I	-	sect. I/44	dark earth, 35-42 cm 1st/2nd C. brickearth clay floor
11/91		-	I	-	sect. I/41	post-med. earth, 0-7 cm
12/90		-	I	-	sect. I/41	dark earth, 12.5-19.5 cm
13/41		-	I	-	sect. I/41	dark earth, 51-58 cm 1st/2nd C. brickearth clay floor sealed by 1st/2nd C. fallen wall (see Sa. 4, 5)
14/46			I	4135	sect. I/39	1st/2nd C. dump/levelling
15/45			I	4165	sect. I/39	1st/2nd C. "ploughsoil"/sandy parent material?
16/47			I	1802	- -	1st/2nd C."brickearth" wall
16a (Reference material)				1116	1st/2nd C.	"brickearth" wall
17/92			I	1999&4259	plan 4259	1st/2nd C. "brickearth" wall and plaster

93 Bulk sample only	7	II	1892?	sect. I/49	1st/2nd C. "brickearth" clay wall

Table 1 cont:

28PS84 (28, Park St)

18/65	8	4111B	"dark earth"
19/64	9	4110	undated late Roman "weathered dump"/soil
-	-	4111	hard standing/gravel layer/path
20/66	10	4254	Roman "weathered dump"/soil
-	-	-	building material dumps
Bulk sample only	11	4224	waterlain? silts

21 Reference material — Opus signinum

Table 2: Chemistry

Sample No/ Layer	%Organic Carbon	%Loss on Ignition	%CaCO3	Thin Section
COSE84; Courage Brewery				
Over Romano-British clay floor (context 1014)				
1. Dark Earth	1.6	-	5.7	1
2. Dark Earth (pale area)	1.6	-	6.5	2
3. Dark Earth	1.7	-	5.0	3
Section I/52; over later Roman fallen wall of re-used tegulae, of large stone founded building				
4. Dark Earth	1.7	-	3.8	4
5. Dark Earth	1.1	-	7.2	5
Section I/64				
6. RB Occupation Layer	2.4	-	3.1	6
Clay Wall				
7. 1116 (brickearth clay wall)	0.0	-	0.5	
28 Park St				
8. 411B	1.6	-	0.2	18
9. 4110	0.8	-	0.1	19
10. 4154	1.4	-	1.3	20

11. 4224	5.8	-	5.0	-

Table 3: Grain size analysis

Sample No/ Layer	Clay	FZ	MZ	CZ	Silt	VFS	FS	MS	CS	VCS	Sand	Texture	Thin Section
COSE84, Courage Brewery, Southwark													
2. Dark Earth (pale)	17	4	9	13	26	10	13	22	9	3	66	Sandy Loam	2
3. Dark Earth	16	6	10	13	29	12	15	19	7	3	56	Sandy Loam	3
7. Clay wall ("Brickearth")	14	3	11	27	41	17	14	12	3	<1	46	Fine Sandy Silt Loam	
28PS84, 28 Park St													
8. Dark earth (411B)	29	5	13	11	29	5	8	13	5	2	33	Clay Loam	18
9. Late? Roman "weathered dump" (4110)	16	3	9	12	24	13	14	26	5	2	60	Sandy Loam	19
10. Roman "weathered dump" (4154)	17	4	9	12	25	9	13	24	8	4	58	Sandy Loam	20
11. Silts (4224)	24	11	31	9	51	6	5	7	1	1	20	Clay Loam	

Figure 1: Schematic example of location of bulk and soil micromorphological samples at Courage Brewery, Southwark; samples 1-6

Figure 1a; Area of clay floor 1014

Sample	Sample Code	Bulk Sample	Context No	Description
				Machine removed Medieval deposits and dark earth
1 (0 cm – 7 cm)		1		Dark earth
			1002	
2 (15 cm – 22 cm)		2		Dark earth (pale)
3 (23 cm – 30 cm)		3	1016	Dark earth
			1014	1st/2nd Century brickearth clay floor

Figure 1b; Section I/52

				Modern concrete foundation
4 (0 cm – 7 cm)	44	4		
5 (8 cm – 14 cm)	43	5	1509	Dark earth
				Fallen wall of re-used tegulae of large Roman stone founded building

Figure 1c; Section I/64

				Fallen plaster coated wall
6 (0 cm – 7 cm)	94	6	4576	Occupation "soil"
				1st/2nd Century brickearth clay floor.
				"ploughsoil"

References:

Avery, B. W. and Bascomb, C. L. 1974 Soil Survey Laboratory Methods, Soil Survey Technical Monograph No. 6, Harpenden.

Avery, B. W. 1990 Soils of the British Isles, CAB International, Wallingford.

Blume, H. P. and Runge, M. 1978. Genese und ökologie innerstädtischer Böden aus bauschutt, Z. Pflanzenernaehr, Bodenkd. 141, 727-740.

Brown, G. and Macphail, R. I. In prep. First century horticultural activities close to the Municipal boundaries of Londinium, Brittania

Bullock, P, Fedoroff, N, Jongerius, A, Stoops, G and Tursina, T, 1985 Handbook for soil thin section description, Waine Research Publications, Wolverhampton.

Courty, M A, Goldberg, P and Macphail, R I, 1989 Soils, micromorphology and archaeology, University Press, Cambridge.

Densem, R. 1986 COSE 84 archive (Courages South-East, Thrale St/Redcross Way, London SE1), Dept. Greater London Archaeology.

Dillon, J., Jackson S. and Jones H. 1991 Excavations at the Courage Brewery and Park Street 1984-90.

Guilloré, P. 1985 Méthode de Fabrication Méchanique et en Série des Lames Minces, Institut National Agronomique, Dept. des Sols.

Macphail, R. I. 1981 Soil and botanical studies of the dark earth, in (M. Jones and G. Dimbleby) eds, The environment of man : the Iron Age to the Anglo-Saxon period, BAR British Series 87, Oxford, 309-331.

Macphail, R. I. 1983 The micromorphology of dark earth from Gloucester, London and Norwich: an analysis of urban

anthropogenic deposits from the Late Roman to Early Medieval periods in England, in (P. Bullock and C. P. Murphy) eds, Soil Micromorphology vol. 1, A B Academic Publishers; Berkhamsted, 245-252.

Macphail, R. I. and Courty, M. A. 1985 Interpretation and significance of urban deposits, in (T. Edgren and H. Jungner) eds, Proceedings of the Third Nordic Conference on the Application of Scientific Methods in Archaeology, ISKOS 5, Finnish Antiquarian Soc., Helsinki, 71-84.

Macphail, R. I. 1987 Soil report on the Mid-Saxon floor and dark earth at Jubilee Hall, Covent Garden, London. AMLR 39/87.

Macphail, R. I. 1991 Soil report on the Deansway Archaeological Project, Worcester, Ancient Monument Laboratory Report, 82/91.

Macphail, R. I. 1992 Soil studies, in (P. Crummy) ed, Colchester Archaeological report 6: excavations at Culver St, the Giberd School and other sites in Colchester 1971-85, 273-275 and microfiche, Colchester Archaeological Trust.

Macphail, R. I. in press The reworking of urban stratigraphy by human and natural processes, in (A. Hall and H. Kenward) eds, The archaeology of town and country: econonmic connections and environmental contrasts, Proc. York AEA Conf. Sept. 1991, Oxbow Books.

Murphy, C P, 1986, Thin Section Preparation of Soils and Sediments, A B Academic Publishers, Berkhamsted.

Sukopp, H., Blume, H-P. and Kunick, W. 1979 The soil, flora and vegetation of Berlin's waste lands, in (I. C. Laurie) ed, Nature in cities, John Wiley, Chichester, 115-32.

Whythead, R. 1985 The Jubilee Hall site reveals new evidence of Saxon London, Rescue News, 37.

Yule, B. 1990 The "dark earth" and late Roman London, Antiquity

64, 620-28.