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SOIL REPORT ON THREE WAYS WHARF, OXFORD RD, UXBRIDGE, MIDDX.

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Summary

Areas of the Late Upper Palaeolithic and Early Mesolithic artefact scatters in the soil/sedimentary sequence at Uxbridge were studied through soil micromorphology and bulk analyses at three locations. Some inferences on the nature of late last glacial sediment ripening and biological activity are discussed, and some details of the alluvial gley soil contemporary with Early Mesolithic occupation are described. Late Upper Palaeolithic material underwent some one to two thousand years of biological reworking, whereas most of the Early Mesolithic artefacts were little affected by biological turbation before being buried by alluvium. Alluviation, seems to have coincided with abundant fine charcoal input, perhaps associated with Early Mesolithic burning of the Boreal pine forest. Neolithic to Medieval influences on the site are also discussed. The report is supported by 22 colour plates, 2 tables and 1 figure.

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Introduction

In the spring of 1988 Palaeolithic and Mesolithic flint scatters and associated fossil fauna at Uxbridge were excavated by the Department of Greater London Archaeology of the Museum of London (site director, John Lewis). At this site in the valley of the river Colne, fine alluvial sediments that overlie late Last Glacial/earliest Postglacial fluvial gravels (Colcutt, unpub. rep.) contain several flint scatters (Appendix 1, figure 1) and associated mammal bones. Molluscan remains may also occur. Flint scatter A, which has been dated (radiocarbon) by associated horse bone to 10,270 +/- 100 years BP (uncalib. OXA 1778) and to 10,010 years BP +/- 120 (uncalib. OXA 1902) is Late Upper Palaeolithic in character, whereas flint scatter C, dated by thermoluminescence on a burned flint to 8000 +/- 800 years BP (OXTL 772F), is Early Mesolithic in typology (Lewis 1989; Lewis et al. in press). This fossil and artefact bearing mineralogenic sediment is capped by a 4 cm thick black humic clay which, although as yet undated, contains a pollen assemblage which can be best fitted to the Boreal period, around 8500-8000 years BP (Wiltshire AMLR 18/89). Reworked tufa occurs just above the black humic clay, at the base of Neolithic levels which are themselves capped by an overburden of Medieval deposits. Similar black humic clays overlie early prehistoric flint scatters elsewhere on the calcareous alluvial gley soils (Frome Association: Jarvis et al. 1983) in the local river valleys (Lewis pers. comm.; I. Stewart, unpub.).

Dr Simon Colcutt has produced a report (unpub.) based on the field characteristics of the sediments of the site, and this present soil and micromorphological study was carried out in order to better understand a) the nature of the fine alluvial sedimentatation on the site, b) the pedological and sedimentary environment of the human occupations and its variation betweeen scatters A and C, c) the possibility of local reworking of artefacts and faunal remains (flint refitting and dating and environmental indicators) by pedoturbation, d) the character and sedimentary environment of the black humic clay, e) the origins of the tufa and f) the nature of the Neolithic soil.

Methods

Undisturbed soil samples were taken from a 50 cm long monolith located at scatter A (Late Upper Palaeolithic) (thin sections A, B, C [each approximately 7x4.5 cm in size]) through layers 4 (sterile fine alluvium; context 334), 3 (artefact layer; "orange-grey clay" over "ferruginous orange clay", context 333), and 2 (black humic clay; context 332) (figure 1; appendix 1, figures 1 and 2). Layers 3 and 2 were similarly sampled at scatter C (Early Mesolithic) (thin sections D, E: plate 1). Layers 1 and 2 from the centre of the site were sampled (thin section F) to investigate the tufa and the overlying later prehistoric levels (plate 2). Complementary samples for the bulk analysis of grain size, loss on ignition, calcium carbonate and organic carbon (Avery and Bascomb 1974) were also taken. Undisturbed samples were air dried, impregnated with polyester resin (Murphy 1986), made into thin sections (Guilloré 1985), described according to Bullock _et al_. (1985) and interpreted using the guidelines of Courty _et al_. 1989). A sample of the thickest area of the humic clay, where the pollen column was located, was also taken. Unfortunately, no thin section of this sample could be made because of problems with impregnation, although two attempts were made (Muriel Macleod, Stirling University, pers. comm.).

Results

Analytical data is presented in table 1, site details are located in appendix 1 and soil micromorphological descriptions and preliminary interpretations are presented in Appendix 2. Supportive colour plates are in Appendix 3.

Discussion

a) Late Last Glacial/early Postglacial alluvial sedimentation and weathering: The upward fining sequence of alluvium (Table 2) over the gravels comprises some 30 cms of moderately calcareous coarsely mottled yellowish brown (10YR5/6) clay loam (table 1, samples 2, 3), containing chalk clasts and mollusc fragments, with some 6 cms of finely mottled light yellowish brown (2.5Y6/4) mainly non-calcareous clay loam (table 1, sample 5) sediment above. These are layers 4 and 3, respectively, and flint artefacts have been found ranging through layer 3 into the top of layer 4.

Colcutt (unpub. rep.) suggests that the gravel body (appendix 1, figure 1), by dissecting an otherwise flat river valley, may have allowed the low energy deposition of silts (40% silt in the clay loam), and possibly as this stream migrated southeastwards this sediment was abandoned by the active stream. The sediment (thin section C) contains evidence of both calcium carbonate depletion (weathered chalk fragments, fine fabric depleted of calcium carbonate), and flushing by calcium carbonate enriched water (micritic pseudomorphic impregnation of roots; plates 3 and 4). These features which are typical of late glacial sediments (Macphail 1986, AMLR 4942), could relate to the rapid decalcification of sediments under cool and high water flow conditions (Catt 1979). The sediment was also homogenised by biological activity and no microfabrics relating to sedimentary structures or cryogenic processes, that may have developed, remain. Thus during the period of Upper Palaeolithic occupation, the site was damp but vegetated and biologically active. The upper part of the soil retains only poor microfabric evidence of later pedological activity that produced a finely prismatic and channel microstructure, which is quite comparable to the soil fabrics extant during the Early Mesolithic activity at scatter C. In any case, biological activity (perhaps over a period of at least a thousand years) is assumed to have continued up to and until increased site wetness caused a valley "swamp" to form during the Early Mesolithic. This conjecture is supported by the "micro-debitage sort assessment" (G R Holman unpub.) which shows the Upper Palaeolithic material to be mixed throughout the artefact bearing zone, whereas the Early Mesolithic material (scatter C) has been found dominantly in the top two 5 cm thick spits of the artefact bearing zone (see below).

b) Early Holocene (Flandrian Chronozone 1) pedogenesis: In the field, layer 3 was divided into the archaeological sub-layers of an upper "grey clay" and a lower "ferruginous clay" at scatter C. Here at this area of Early Mesolithic occupation, evidence of pedological activity (Table 2) in an otherwise iron and clay depleted microfabric, is patchily preserved. This preservation results from strong iron and manganese impregnation of features caused by later hydromorphism (Bouma et al 1990), and some artefacts in the "ferruginous orange clay" reportedly had iron concretions on them (Lewis, pers. comm.). It is an accident that this part of the site has information preserved in this way, because the area of scatter A probably developed a similar soil microfabric but later inundation caused total depletion of the fine fabric, removing all evidence of soil formation on this part of the site. Loss of soil microfabric features through alluvial inundation has been argued elsewhere

(Goldberg and Macphail 1990; Macphail AMLR 39/90).

At scatter C (thin section E), iron and manganese impregnation has preserved a soil with a fine subangular and channel microstructure, that was perforated by medium to coarse roots (plates 5, 6, 7), and well worked by earthworms (plates 8, 9). This biological activity, which suggests the lowering of the water table in this typical alluvial gley soil (Avery 1980) site, was present throughout the artefact bearing zone, and must have had an impact on the present distribution of bone and artefacts, especially those dating to the earlier Late Upper Palaeolithic occupation. Even though near to the stream, this site can be considered fully terrestrial at this time and may well have had a cover of vegetation could root successfully in shallow ripened sediments (Bal 1982), without necessarily leaving much evidence of this after later soil depletion caused by increased soil wetness (Macphail and Goldberg 1990; Macphail AMLR 39/90). The soil itself contains rare fine charcoal, that is believed not to be contamination from the overlying charcoal-rich layer 2, but is possibly of Early Mesolithic or earlier origin. In addition, some of the clay coatings and infills that affect the biological porosity, may possibly relate to surface soil disturbance brought about by the trampling of humans on the site (Courty et al. 1989:124-125, fig. 17.d), whereas the pale dusty clay inwash into the soil is more likely to increased wetness on the site (see section c).

The micro-debitage sort assessment (G R Holman, unpub.) at scatter C shows that the majority of artefacts are present in the top two 5 cm spits of the artefact bearing zone, with some actually resting on the top of the "orange-grey clay" of layer 3, being stained black on their top surface by the overlying humic clay (layer 2)(Lewis, pers. comm.). This may be accounted for by assuming occupation(s) possibly up to the time of alluvial inundation, which only permited biological activity, as demonstrated above, to rework a small portion of the bone and flint down profile. In the biological soil fabric at scatter C, a small fragment of possible laminated alluvial clay was present, that was earthworm-worked into the soil, but this is assumed to be a natural (wind, animal hoof) or accidental (eg. human trampling; Macphail, 3587) localised importation onto the site perhaps from the nearbye river, and is not considered to relate to the flood event.

c) Increased site wetness and the deposition of the black humic clay: A rise in water table led to gleying and caused the mottling on site, for example, pseudomorphically replacing relic roots with iron and manganese (Kemp 1985), whereas soil fabrics in general across the site became depleted of iron and lost their structure. The uppermost few (6 cm) centimetres were most strongly affected by hydromorphic (Bouma et al. 1990) iron and clay depletion and loss of structure on slaking. The deflocculated or dispersed soil (peds fall apart) caused fine soil material to be washed down profile and this clay and fine silt probably forms the pale dusty clay coatings that affect the relic biological structures below (plates 8, 9, 10). Such effects on soils caused by flood inundation have been recorded from Neolithic palaeosols in Essex (Macphail, AMLR 39/90). After this episode, the structureless "topsoil" (layer 3) now comprises in the field, a leached "orange-grey clay" layer overlying the "ferruginous orange clay" layer (Lewis, pers. comm.) because of these post-depositional transformations. In addition, the uppermost one to two centimetres of the Mesolithic soil contain iron replaced organic matter laminae (plates 11, 12), that are considered to relate, not to in situ sedimentary features, but to wetting-front phenomena; i.e. when organic-rich flood water infiltrated into the structureless topsoil. Again, similar features are recorded in Essex (Macphail, AMLR, 39/90), and comparable features called "fibers" similarly occur in the structureless horizons of podzols (Mokma and Buurman, 1982). Later, aquatic plants growing on the site of Uxbridge possibly produced tangential rooting systems (Kooistra 1978). These when replaced by iron may appear similar to the organic laminae produced by infiltration, but differ by having a central main root from which the tangential ones project.

At the time of increased wetness, the site could have been occupying the slopes of a low lying gravel island (appendix 1, figure 1) associated with a channel cut-off that was occasionally reactivated or just flooded by overbank flow. The sediment (layer 2) sequence noted in thin section, comprises an initial phase of silty and organic clay deposition, followed by the main deposit of organic clay containing abundant to very abundant detrital fine charcoal, and lastly renewed (similar but less organic) silty clay sedimentation (upper layer 2). (The ironpan, unit 5a, at Boxgrove has a similar sequence; Goldberg and Macphail 1990). Even the main deposit of organic matter and clay (table 1, sample 1) which contains microscopic size charred material (plate 13) appears to be laminated. In the area of scatter C, layer 2 (thin section D) is essentially a weakly banded, moderately organic (1.60% organic carbon) clay (47%)(table 1, sample 4). As at scatter A (thin section A), layer 2 contains so much fine charred organic matter that it is almost opaque (plates 14, 15, 16) in some laminae, because of the vertical variation in the concentration of this material. This was also recorded by Wiltshire (AMLR 18/89) in pollen preparations from her site (E29/N03), the only part of the site where there was pollen preservation (appendix 1, figure 2).

The micromorphological features together with pollen analysis (Wiltshire, AMLR 18/89; Lewis et al. in press) indicate that increased wetness at the site caused a swamp to form which possibly very slowly (series of radiocarbon dates awaited) developed a laminated humic clay deposit, with occasional silt incursions. The last could reflect ephemeral surface water flow, perhaps concentrated where layer 2 is thickest and where pollen was found (E29/N03). The "swamp" clays are rich in fine charcoal and with the pollen assemblages present, suggest both local fires and the burning of the pine forests by Mesolithic peoples in late Boreal times (Wiltshire AMLR 18/89).

Wiltshire (Lewis _et al_. in press) considers the humic clay to be a telescoped organic clay sequence that may cover possibly hundreds of years, but the microfabric does not obviously reflect this. On the other hand there are no direct analogues for comparison. It is also worth noting here, however, that from experiments it has been found that, when clay is deposited onto a similar clay surface, the number of depositional episodes will not be observable (only depositional episodes of strongly contrasting clay complexes are observed)(Theocharopoulos and Dalrymple 1987), and so a large number of observable clay laminae at Uxbridge to fill the timespan suggested by Wiltshire (AMLR 18/89) is not strictly necessary. A number of radiocarbon dates through the humic clay layer are expected to answer this interpretational problem (Lewis and Rackam, pers. comm.). Locally and along other tributaries of the River Thames similarly dated increases in valley bottom wetness are recorded (Lewis _et al_. in press), whereas elsewhere in southern England (Sussex), major alluviation possibly associated with Mesolithic valley side activity in the Boreal period has been mooted by Scaife (1987:133).

d) Later events and occupation: It is very difficult to know exactly what occurred after the alluvial deposition of the black humic clay, because of biological mixing (plates 17, 18) of layers 1, 2 and 3. Earthworms, in the more calcareous soil above the rather acid, and therefore less attractive, clay, have particularly homogenised the boundary between layers 1 and 2, in the area of the tufa (thin section F). As a consequence the nature of the tufa deposition is also not clear. Firstly, the tufa (plates 19, 20) that seems to have resulted from algal growth in waters charged with calcium carbonate, is not in situ, but occurs as poorly rounded transported fragments. In fact, none of the calcium carbonate recorded in layers 2 and 3 is tufa, but is thought to be only secondary micritic impregnation and nodular formation, that is the result of decalcification of the tufa-rich layer 1 above. Colcutt (unpub. rep.) suggested that the tufa had arrived from a local calcareous spring, but as the soil containing the tufa has been so strongly reworked both biologically (abundant earthworm excrements and arionid (slug) granules) and by downwash from a disturbed (trampled ? ; plates 21, 22) surface at or within the Neolithic levels, its origin on-site remains enigmatic (natural or anthropogenic ?) for the moment.

Coarse physical mixing of archaeological levels on the site by roots and earthworms (see plates 17, 18) were also noted, as well as the inwash of amorphous yellowish brown organic matter that is associated with vivianite (see plates 13, 14, 17, 18). The latter can be best interpreted as evidence of cess (Courty et al. 1989), and as it most affects the site (thin section A) away from the broken modern sewage pipe (in the southern corner of the excavated site) it may in all probability relate to the medieval occupation of the area.

Conclusions

1. Late last glacial/early postglacial fluvial activity deposited a calcareous clay loam as a result of gravel deposition and stream

migration. This sediment, which as a damp but vegetated and biologically active substrate was occupied by Upper Palaeolithic people, underwent decalcification.

2. An earthworm-worked and well structured typical alluvial gley soil had developed by the early Holocene (Flandrian Chronozone 1), and this probably had a fully terrestrial vegetation rooted in it, including woodland. Earlier Palaeolithic artefacts at scatter A were reworked thoroughly, whereas Early Mesolithic material was only partially disturbed by biological activity because increasing site wetness occurred moderately soon/immediately after occupation(s).

3. The whole site became wet, and humic clay muds containing varying amounts of very abundant microscopic charred organic matter became deposited in a swamp at a time when there was associated Mesolithic induced conifer forest burning. The timespan for this period has yet to be accurately measured.

4. The origin of tufa on site cannot be satisfactorily explained because it occurs in a Neolithic terrestrial soil that has been strongly reworked by earthworms in association with anthropogenic activity.

5. Some of the stratigraphy has been mixed by biological activity, whereas secondary calcium carbonate (from the weathered tufa) and probable cess (from the Medieval layers ?) have contaminated parts of the site sequence.

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Figure 1

Layer No.		Relative depths	Archaeological Layers	
Scatter A				
		97 cm		
layer 2	A		humic clay	
		104 cm		
layer 3			orange-grey clay ferruginous orange clay	artefacts
		107 cm		
layer 4	B	114 cm		sterile
		117 cm		
	C	124.5 cm		

Layer No.		Relative depths	Archaeological Layers	
Scatter C				
		17 cm		
layer 2	D		humic clay	
	flint core	24.5 cm 25 cm		
layer 3	E		orange-grey clay ferruginous orange clay	artefacts
layer 4		33 cm		sterile

Layer No.		Relative depths	Archaeological Layers
Scatter C			
		12 cm	
layer 1	F		tufa/Neolithic
layer 2		19 cm	humic clay

Table 1: Uxbridge soil analytical data

Sample No	Layer	%Calcium carbonate	%Organic carbon	%Loss on ignition	Thin section
Scatter A					
1	layers 2 and 3 97-104 cm	1.5	0.70	9.6	A
2	layers 3 and 4 107-114 cm	1.7	0.77	7.2	B
3	layer 4 117-124 cm	8.2	0.7	11.5	C
Scatter C					
4	layer 2	0.08	1.6	15.7	D
5	layer 3	0.12	0.53	7.9	E

Sample No	% Clay	% FZ	% MZ	% CZ	% Silt	% VFS	% FS	% MS	% CS	% VCS	% Sand	Texture	Thin section
Scatter A													
1	22	29	14	12	55	7	9	5	<1	<1	23	Clay loam	A
2	27	11	11	19	41	24	4	1	2	1	32	Clay loam	B
3	25	10	10	19	39	28	4	1	2	1	36	Clay loam	C
Scatter C													
4	47	11	6	10	27	17	4	2	1	2	26	Clay	D
5	27	11	12	17	40	20	7	3	1	2	33	Clay loam	E

Table 2: Approximate sequence of events and processes at Three Ways Wharf, Uxbridge based on sedimentary and soil micromorphological data.

Depth cm	Period/ Sediment	Layer	Microfabric	Pedofeatures	Interpretation
-	Medieval	-	-	-	Occupation activities led "cess" (l) affecting layer 2 at scatter A.
-	Neolithic	-	Charcoal-rich calcareous microfabric; abundant tufa fragments.	k) Total biological fabric with earthworm excrements and Arionid granules. Soil mixing with layer 2. Some decalcification of tufa (j).	Soil formation with biological activity extending into layer 2 (k). Secondary calcium carbonate also deposited in layer 2 (j).
0-4	Boreal Black humic clay (sterile)	2	Very dark brown laminated clay, with silt and very abundant fine charcoal (i).	j) secondary calcite; k) fabric mixing; l) amorphous infills and vivianite	h) Increased wetness; swamp affected by ephemeral stream and intensive local burning activity (fires)(i).
4-6	Early Flandrian grey clay (concentration of Mesolithic and scatter of Upper Palaeolithic artefacts)	3 upper	Structureless grey silt.	f) Loss of iron and clay; g) thin ferruginous laminae; j) secondary calcite; k) fabric mixing; l) amorphous infills and vivianite	Mesolithic old ground surface affected by soil slaking (f) and gleying (g) and organic matter (iron replaced) infiltration from swamp (h).
6-10	Early Flandrian ferruginous orange clay (Mesolithic and Upper Palaeolithic artefacts)	3 lower	Fine subangular blocky clay loam, with coarse channels and chambers.	e) rooting and faunal mixing; f) dusty clay infills; g) iron and manganese impregantion of roots, biological fabric and clay coatings;	Calcareous alluvial gley soil formation, with biological activity (e) totally reworking Upper Palaeolithic artefacts; Mesolithic material only partially worked. Rise in water table caused upper soil to slake (f) probably coeval with hydromorphic (g) iron and manganese impregnation.

10-30 Late Glacial upward fining yellowish brown calcareous clay loam (**b**) (mainly sterile)	**4**	Massive/ coarse prismatic clay loam with chalk, and flint gravel	**c**) decalcified fabric; **d**) calcite pore infills and (**e**) pseudomorphic root replacement; **g**) iron impregnation of fabric and iron micropans.	**b**) Alluviation of diminishing energy. Decalcification (**c**) and weathering of sediment; **d**) flushing by calcareous water; Pedogenesis (**e**); rise in water table in Early Flandrian causes hydromorphism (**g**).
30+ Late Glacial fluvial gravels (**a**)		-	-	**a**) Deposition of high energy alluvial deposit.

NB: letters **a-l**; hierarchy of features (and events/processes).

Appendix 1

Uxbridge: soil thin section description and preliminary interpretation

NB: PPL - plane polarised light, XPL - crossed polarised light, OIL - oblique incident light.

Scatter A (Section 1)

Thin section C: 117-124 cm (layer 4)

Structure: weakly massive, with poorly developed coarse prismatic. Heterogeneous (pale yellowish brown with common distinct coarse dark brown mottles). Porosity: 40%; very dominant poorly accomodated planes and fissures; few fine channels and vughs; in places packing porosity (infilling by $CaCO_3$ impregnation). Mineral: C:F (limit 40 µm) 40:60. Coarse moderately sorted; very dominant silt and very fine sand, generally subangular quartz; few medium sand and flint gravel; rare chalk coarse sand; fossils. Fine a) dominant pale brown or grey (PPL), moderately high to high birefringence, brown or orange (OIL) (weakly impregnated by calcium carbonate); b) common very dark brown (PPL), almost non-birefringent, bright orange (OIL). Organic Coarse absent, but rare $CaCO_3$ pseudomorphs of roots. Fine rare amorphous fragments. Groundmass a) close porphyric, crystallitic; b) porphyric, mainly undifferentiated. Pedofeatures Textural rare impure clay and impure calcitic clay infills and coatings. Depletion dark areas mainly depleted of calcium carbonate; weathering chalk fragments; pale areas depleted of iron. Crystalline very abundant, generaly weak impregnation by micritic calcium carbonate; common fine pores in (b) coated in microsparite; rare impure micrite pseudomorphs of roots cutting original sediment. Amorphous very abundant strong ferruginous impregnation of fine fabric and near channel patchy hypocoatings. At least five thin (80 µm) subhorizontal micropans, 3-5 mm apart.

Interpretation: Alluvial calcareous clay loam deposit, with probable high water table was ripened by biological activity (rooting) and sub-aerial weathering, leading to partial decalcification. Plant metabolism lead to roots becoming impregnated by calcium carbonate. Such features are common from early weathering of Late Last Glacial sediments. Fluctuations in the water table, especially the one resulting from the alluvial deposition of the organic clay (layer 2), increased anaerobic activity and decalcification, etching chalk and producing ferruginous cementation. Possibly the micro-ironpans relate to surface inundation and are wetting-front phenomena. Subsequently the sediment underwent partial recalcification as local groundwater was at times calcareous, or from weathering of non-*in situ* tufa deposits which are found in some places above layer 2.

Thin section B: 107-114 cm (layers 3 and 4)

Structure massive with relic fine prismatic?. Porosity 15-20%; 30% in vertical very coarse burrow. Dominant medium vughs, few fine channels, occasional root channels; moderately smooth walled, whereas internal vughs are rough walled. In coarse burrow, coarse packing porosity, vughs, smooth walled cracks and medium channels. Mineral C:F 50:50 Coarse coarse burrow contains very dominant gravel size flint, and coarse and medium sand size quartz and flint; rare weathered biogenic calcite: finer coarse mineral as elsewhere ie. very dominant silt and very fine sand size quartz; very few weathered mica, glauconite, feldspar. Fine dirty, darkish brown and highly speckled (PPL), moderate birefringence; pale yellow (OIL). Organic Coarse rare fragments Fine rare phytoliths, rare amorphous fragments; abundant amorphous organic complexes (see Amorphous) Groundmass close porphyric, speckled b-fabric. Pedofeatures Textural a) very abundant weakly formed small intercalations within matrix of dirty grey fine silt and clay (primary inundation?). b) abundant void coatings and infills of strongly humic very dark brown, fine charcoal rich soil - often associated with amorphous organic (/iron) impregnations but appears to pre-date in many locations. Depletion matrix generally depleted of calcium carbonate and iron (washed/leached out during inundation) Crystalline lowest third of slide has many weak micritic impregnations and void hypocoatings, some reflecting relic structures and channels. Amorphous very abundant ferruginous hypocoatings of channel porosity; with probably later many amorphous complexes, probably of iron, organic matter and possible phosphorus - some associated possible coprolitic fragments. Fabric coarse vertical burrow feature seems to post date inundation but predates organo-phophorus features. Excrements probable but rare evidence of earthworm burrowing, except for coarse burrow.

Interpretation Possibly the original calcareous clay loam sediment was affected by late glacial decalcification and biological activity which led to micritic void and channel hypocoating formation. Subsequently decalcification continued and a mainly decalcified soil formed with prisms and a channel microstructure, indicating that the water table had dropped. Inundation resulted in the general leaching of iron from the sediment and the movement of fines - ie. as indicated by the intercalations. Saturation of the soil led to some oxygenation through the relic porosity and hence the ferruginous hypocoatings. Probable aquatic rooting produced the typical iron coated root channels. Much later, Neolithic/ B. A. occupation above produced charcoal-rich humic soils and fragments were occasionally washed or biologically moved downprofile; also from the humic layer 2. Subsequently, strongly coprolitic solutions (cess) washed down into the soil, rarely with possible coprolitic fragments, producing amorphous features.

Thin section A: 97-101 cm (layer 2); 101-104 cm (layer 3)

Layer 3: Structure massive with weak prismatic. Porosity 15-20%, very dominant moderately rough walled medium to coarse channels and vughs; common fine smooth walled vesicles. 40% in coarse burrow (see B), packing porosity. Mineral C:F Coarse (burrow area - very dominant gravel and coarse sand, flint and quartz - mortar) very dominant silt and few sand. Fine pale greyish brown, speckled (PPL), moderate birefringence; colourless (OIL), with frequent mixing-in of very dark brown to blackish, speckled and dotted (PPL), poor birefringence, dark brown, blackish (OIL) (peaty clay from above - layer 2). Organic Coarse occasional charcoal associated with layer 2 and burrow material, and occasional very fine charcoal and charred fragments. Groundmass close porphyric, speckled with weakly developed unistrial b-fabric. Pedofeatures Textural abundant charcoal-rich dusty clay, and sometimes silt inwash. Depletion this zone appears to be depleted of iron and was mainly decalcified. Crystalline rare blue green vivianite infilling of many amorphous iron nodules. Fragments of weathered micrite have been brought in by bioturbation. Rare relic weathered micro-sparitic calcite

- somewhat pseudomorphic of root cells. Rare (much more recent?) poorly developed sparite infillings. Amorphous very abundant yellowish brown amorphous organic (iron and phosphorus ?) coatings to most void space. These are non-birefringent and non-fluorescent. Fabric Strong fabric mixing of layer 2 into layer 3; also occupation soils and tufa of layer 1(?) also brought down. Top of layer 3 has merging boundary of micro-laminations with layer 2.

Layer 2 Structure massive (with laminae). Porosity 10%; fine and medium smooth wall vughs and vesicles (sometimes within infilled coarser channels and vughs) Mineral C:F varied; but generally at the base 40:60, whereas above 0:100 (silt or clay dominated). Coarse very dominant silt Fine a) moderately pale dusty brown b) dark brown, heavily speckled and dotted (PPL); c) dark reddish brown to black, heavily speckled and dotted (PPL): a) moderate to moderately low birefringence; b) moderately low birefringence; c) isotic; a) dark grey, few black specks; b) dark greyish brown, with numerous black specks; c) black (OIL). Organic Coarse few fine charcoal. Fine a) very abundant fine charred organic organic matter; ditto, but 40% fine charred organic matter with strong amorphous humic staining of clay; c) 60% fine charred organic matter with very strong amorphous humic staining Groundmass a) open porphyric, speckled b-fabric; b) open porphyric, weakly uni-strial b-fabric; c) open porphyric, undifferentiated b-fabric. Pedofeatures Textural occasional void infill and coatings of humic silt and clay (generally predates amorphous infills) Fabric very abundant mixing of layers; channel (pore) perforations - by rooting probably. Amorphous very abundant yellow amorphous organic matter (cess-like) void infills and coatings. Crystalline many post-biological mixing infills by impure micrite, rarely sparite. Rare vivianite associated with amorphous features.

Interpretation Upper part of mineral sediment of layer 3 has become increasingly influenced and mixed with fine charcoal-rich clay. The junction with the charcoal-rich clay of layer 2 was partially homogenised by post-depositional bioturbation. As some Mesolithic flints were found at the top of layer 3 at scatter C, layer 3, may be regarded as the top of the buried soil. Its character as a structureless and iron depleted layer apparently relates to post-depositional slaking and depletion after alluvial inundation, rather than to its being an initial mineralogenic alluvial sediment, as was first thought. In fact, initial sedimentation here now seems to have been purely in the form of an organic clay (layer 2) containing different concentrations of very abundant fine charred organic matter. Later the sediment was coarsely bioturbated as already noted, and fine roots penetrated producing "pressure orientation" of the clay. Growth of secondary calcium carbonate followed infilling some of the coarse mineral porosity. Lastly, the sediment was strongly influenced by mobile organic matter (cess) which infills much of the fine porosity in the clay, and is present downprofile associated with vivianite. Rarely has secondary calcium carbonate affected the organic clay, perhaps because this is more acid than the more mineral soil/sediment beneath.

Thin section E: 25-26 cm (layer 3), 26-33 cm (layer 4) (merging boundary)

Structure massive with channel microstructure (relic fine subangular blocks) Porosity 35% (more dense in upper slaked part), very dominant, very coarse and coarse channels and chambers, generally not smooth walled; few vughy areas, sometimes with smooth walls; rare horizontal root channels. Mineral C:F, 50:50 Coarse very dominant angular silt, few fine and medium. Very dominant quartz, very few mica. Fine a) very dominant, very pale brown, lightly speckled (PPL), moderate birefringence, very pale yellowish brown (OIL) (many areas stained areas; see Amorphous), b) very few darkish brown, heavily speckled (PPL). Organic Coarse rare weakly ferruginised root remains in channel porosity. Abundant iron and manganese replaced root material in medium channels (350-400 µm) (see Amorphous). Fine a) rare amorphous material; rare pollen/spore preserved by ferruginisation. b) abundant fine charred material, some humified. Groundmass generally close porphyric, weakly grano-striate/weakly parallel-striate b-fabric (typical of slaked/collapsed fabrics). Pedofeatures Textural many charcoal-rich (like fine fabric b) infills and coatings of very dusty clay. Occasional non-charcoal-rich clay inwash (now strongly ferruginised) containing fragments of clay fabric. Depletion Very abundant depletion of iron in places. Rare examples of strongly etched/decalcified mollusc shell. Crystalline occasional micritic, microsparitic and rare sparitic growth of calcite. Possible pseudomorphic replacement of grub by calcite. Amorphous very abundant iron and manganese (poorly pseudomorphic) replacement of roots; very abundant ferruginisation of groundmass, especially fine infills. Fabric rather heterogeneous with upper part having lost much of its original structure, whereas there are abundant areas of channel and blocky structure, and zones of probable earthworm activity - producing excremental fabrics, opening up the soil and bringing-in fragments of layered clay. Excrements patches of probable earthworm worked soil.

Interpretation The soil is complex. As elsewhere the late Glacial silt/very fine sand-rich alluvium became weathered and strongly depleted of calcium carbonate, for example, affecting original mollusc shell. The sediment was homogenised by earthworm and plant activity, producing a channel and blocky structure. Layered "alluvial clay" fragments may have been brought down into the soil by earthworms. The origin of this material is probably not from in situ alluviation, but was probably brought in or arrived acidentally. Coarse plant roots also perforate the soil. Earthworm structures themselves are coated by non-charcoal-rich clay, possibly originating from the slaking of topsoil after alluvial inundation. During full inundation and water saturation, much of the upper soil lost its structure, except where iron and manganese cementation preserved fabrics. This suggests that water table fluctuations to produce this mottling were common prior to full inundation. Once flooded, aquatic plants sent down roots, some obvious tangential ones running parallel to the surface were noted. Later in the site's history, inwash of charcoal-rich clay and mixing of layers 2 and 3 took place.

Thin section D: 17-24.5 cm (layer 3; 20-24 cm: layer 2; 17-20 cm)

Layer 3: Structure massive, with evidence of lamina structure upwards towards layer 2. Porosity 10-15%, fine channels and vughs, rough walled. Mineral (Coarse as E) Fine greyish brown, speckled becoming (upwards) dark greyish brown, heavily speckled (PPL), moderately low birefringence, grey black speckled brown (OIL). Organic Coarse rare charcoal. Many ferruginised root remains. Fine abundant and areas of very abundant charred organic matter, patchily mixed with few areas of many or occasional amorphous organic matter. Occasional sub-horizontal, very thin (20-30 µm) ferruginous "organic" pans, giving lamina appearance at the top of layer 3. Occasional dusty reddish brown amorphous organic matter infills of fine pores. Groundmass close porphyric, weakly grano- and parallel striate b-fabric. Pedofeatures Textural rare dusty clay, abundant loose infillings of dusty charcoal-rich layer 2 material. Depletion much of groundmass depleted of iron. Amorphous weak ferruginisation of organic matter and channel margins (roots) throughout; including "pans" of "peaty" lenses. Fabric moderate heterogeneity - biological mixing of various components of layer 2 with layer 3.

Interpretation It was very difficult to identify the upper soil/supposed alluvial loam boundary, because the upper soil has lost its structure. The inundation phase was thought to be very mineralogenic initially and only thin (now ferruginised) organic lenses (some 33 distinguished) separated by this supposed silty sediment, occur, before charcoal-rich clays arrive on the scene. It was thought that, alternatively, these fine laminae could relate to infiltration of the slaked/structureless topsoil by fine organic matter from the overlying flood waters, forming wetting-front pans (like fibre formation in podzols). Now that John Lewis has confirmed that some E Mesolithic flints occur right on the surface of layer 3, and are stained black on top (by layer 2 material), it seems more likely that the structureless layer 3 is in fact the top of the buried Mesolithic soil that was depleted of iron and clay (hydromorphism and slaking effect) by alluvial flooding. The thin organic lenses that appear as laminae being in fact wetting-front phenomena.

Layer 2. Structure massive with laminae. Porosity 10%, very dominant medium smooth wall vughs, few channels. Mineral, Organic and Groundmass as layer 2, thin section A. Pedofeatures Textural rare silty void coatings. Amorphous many iron hydroxide stains and infillings of very fine cracks in organic clay (presumably after clay had dried out). Rare amorphous organo-iron infills and coatings (unlike thin section A which has abundant ones). Crystalline rare poorly preserved vivianite. Rare to occasional poorly preserved micritic calcite void infills. Fabric abundant mixing and turbation producing fragments in whole layer.

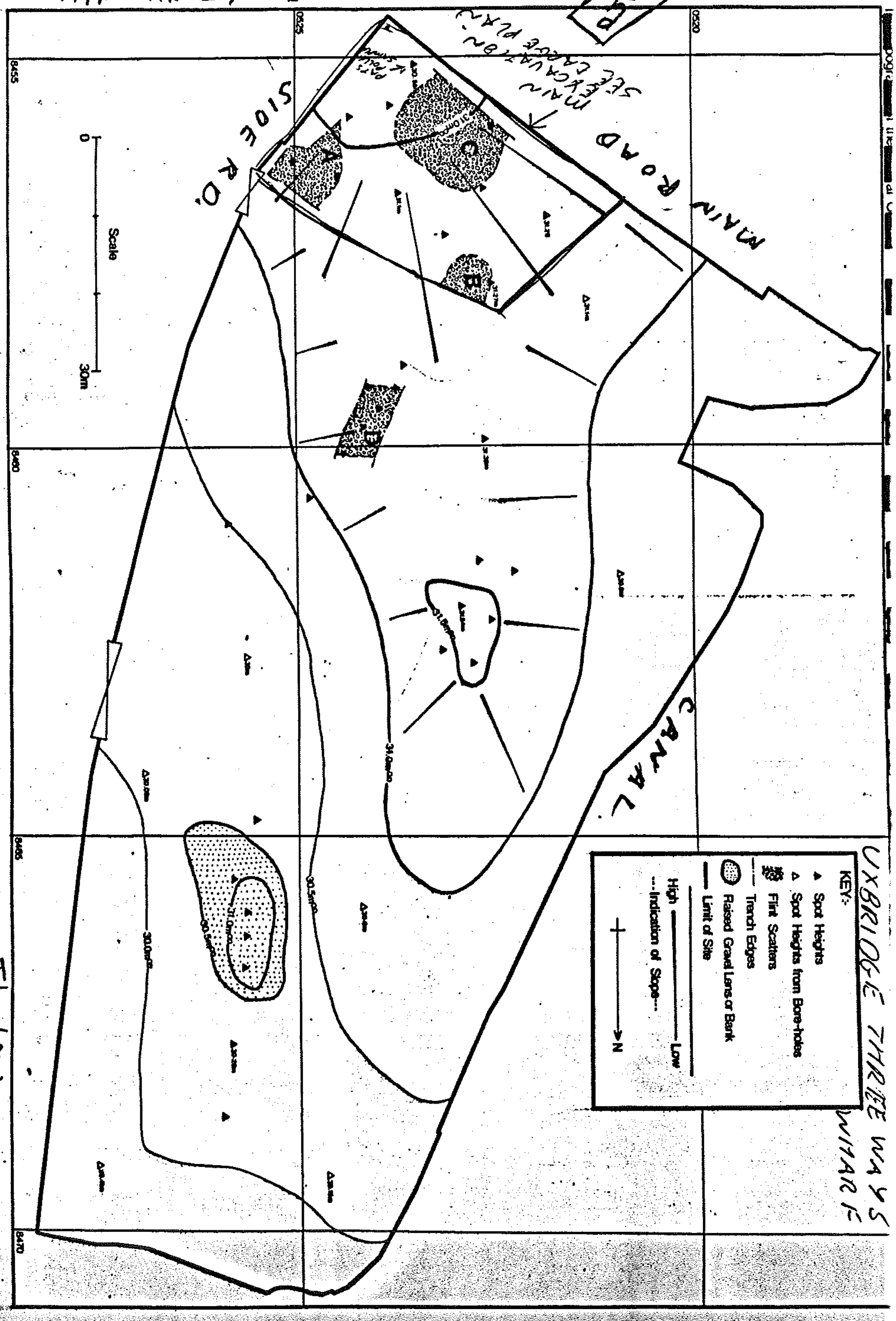
Interpretation In essence, layer 2 at this part of the site, is very similar in character to layer 2 in Area VIII (thin section A) in the way it was deposited, ie. a low energy deposition of fine charcoal-rich organic clay. Post-depositional characteristics are quite different, in that this site was far less influenced by cess, and by experiencing calcium carbonate deposition. In short, this part of the site remained more acid and was at the margins of the cess source. Thus, although nearer a modern sewage pipe than Area VIII (Scatter A), it was much less affected by cess. The source of the cess must therefore be archaeological.

Thin section F 0-4.5 cm (layer 1), 4.5-7 cm (layer 2)

Structure Coarse subangular blocky Porosity 30%; common coarse moderately poorly accomodated planes; common fine channels and vughs. Mineral layer 1, C:F, 70:30. Coarse dominant stone size (2 cm) to sand size tufa (from algal growth in calcium carbonate charged water?) fragments. Very few stone size pottery. Few sand size flint. Common silt size with medium sand size quartz. Mollusc shell and Arionid (slug) granules. Unsorted coarse mineral. Fine darkish brown, highly speckled (PPL), moderately high birefringence, greyish brown (OIL). Layer 2 - as thin section A - occurs as very coarse fragments. Organic Coarse few charcoal. Fine abundant fine charred material (helps mask birefringence). Groundmass close porphyric, weakly crystallitic b-fabric. Pedofeatures Textural rare areas of intercalations. Crystalline occasional sparitic infills. Very abundant calcitic impregnation of groundmass. Poorly pseudomorphic root replacement. Depletion abundant calcium carbonate depletion of tufa. Amorphous rare yellowish amorphous organo-iron (cess ?) infills and coatings. Fabric strongly heterogeneous material, strongly homogenised; with disruption of layer 1/layer 2 junction. Excrements occasional Arionid (slug) granules, rare possible earthworm gut calcite crystals. Very abundant strongly calcitic mammilated excrements, and strongly excremental fabric.

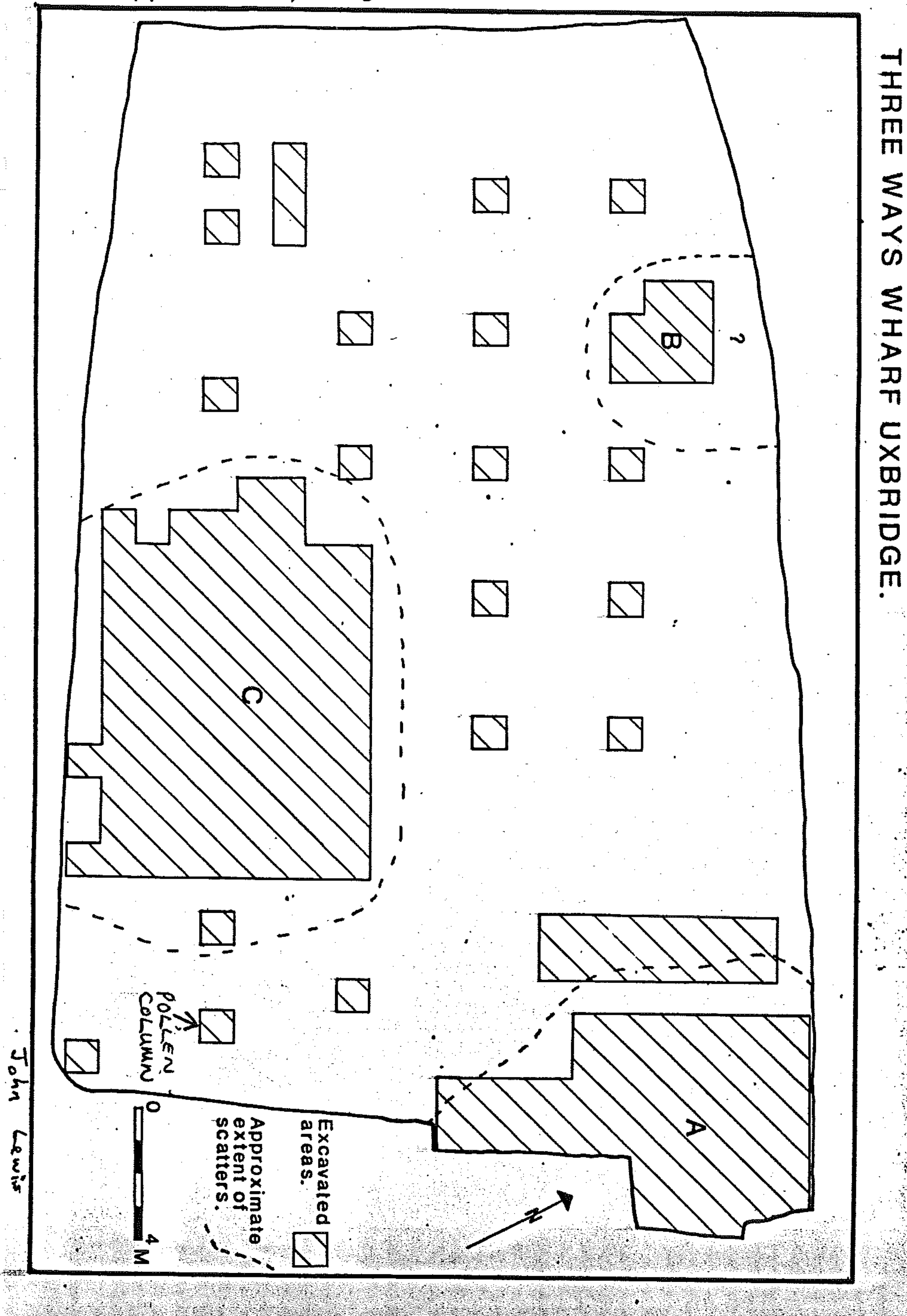
Interpretation Both soil and sediment have been highly reworked by earthworms (and slugs), and so the exact nature of the boundary between layers 1 and 2 is difficult to determine. It is possible to suggest that after the deposition of the organic clay of layer 2, sedimentation became more mineralogenic. The origin of the tufa fragments, because they are only moderately rounded, either has to be 1) erosion from a very nearbye calcareous spring, or 2) their importation on to the site by humans (flooring ?, constructional/manufacturing use of "lime"? Certainly at Area VIII secondary calcium carbonate deposition has occurred, but not as tufa. It would be interesting to have calcareous depostion of tufa locally and its erosion onto the centre of the site, but this idea must be viewed carefully, because this tufa is strongly mixed with charcoal rich soil, that has indications (ie. the intercalations) of trampling. Earthworm activity has been strong, but although often penetrating through layers 2, 3 and 4 (bringing up fragments of silt) these fauna have concentrated in the calcareous soil zone of layer 1. Some of the cess-like deposition appears to post date much of the earthworm activity.

Appendix 1, Figure 1.



John Lewis

Appendix 1, Figure 2.



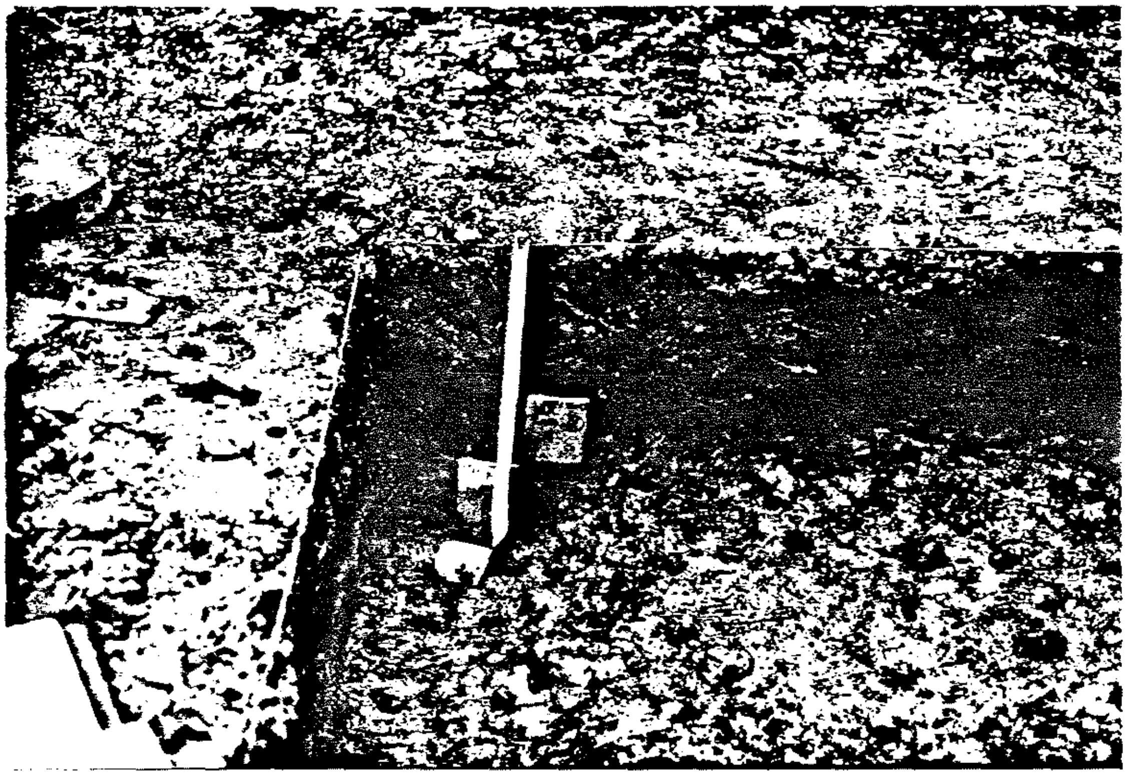


Plate 1: Field photograph of the sampling of monoliths D(A) and E(C) through layers 2 (humic clay) and 3 (artefact layer) of the sediments present at scatter C (Early Mesolithic) at Uxbridge.

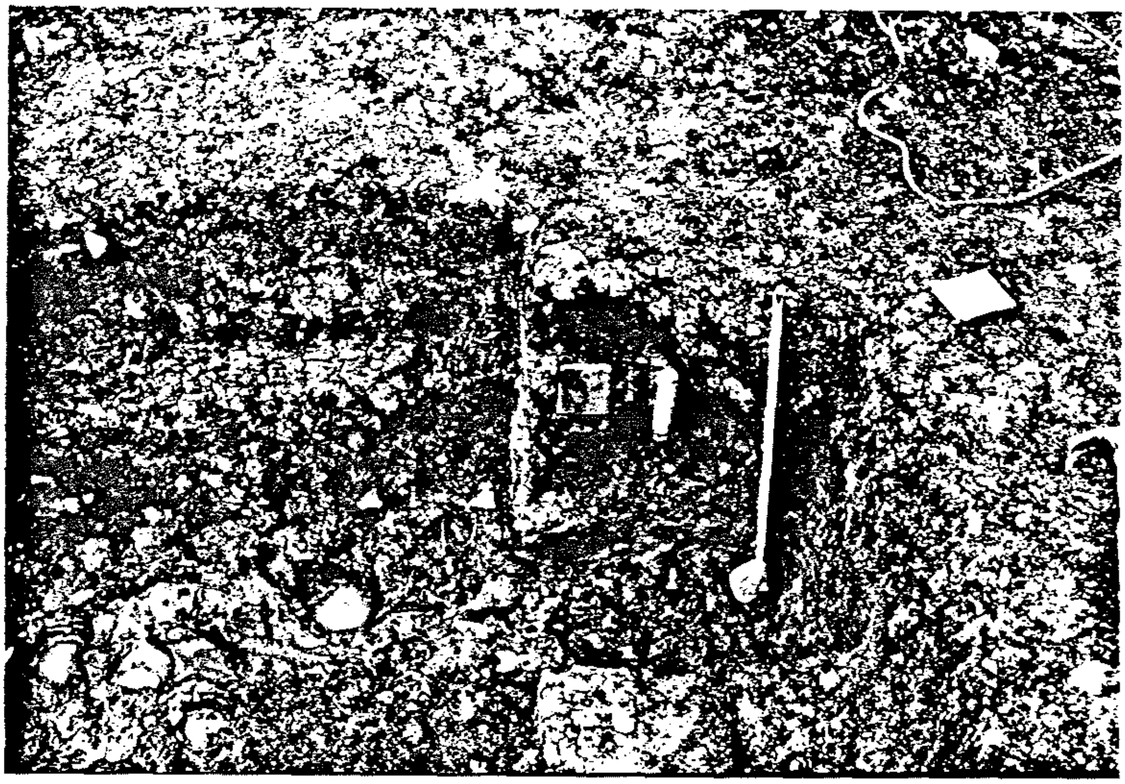


Plate 2: Field photograph of monolith F(C) through layer 2 (humic clay) into the tufa bearing Neolithic layer above (layer 1).

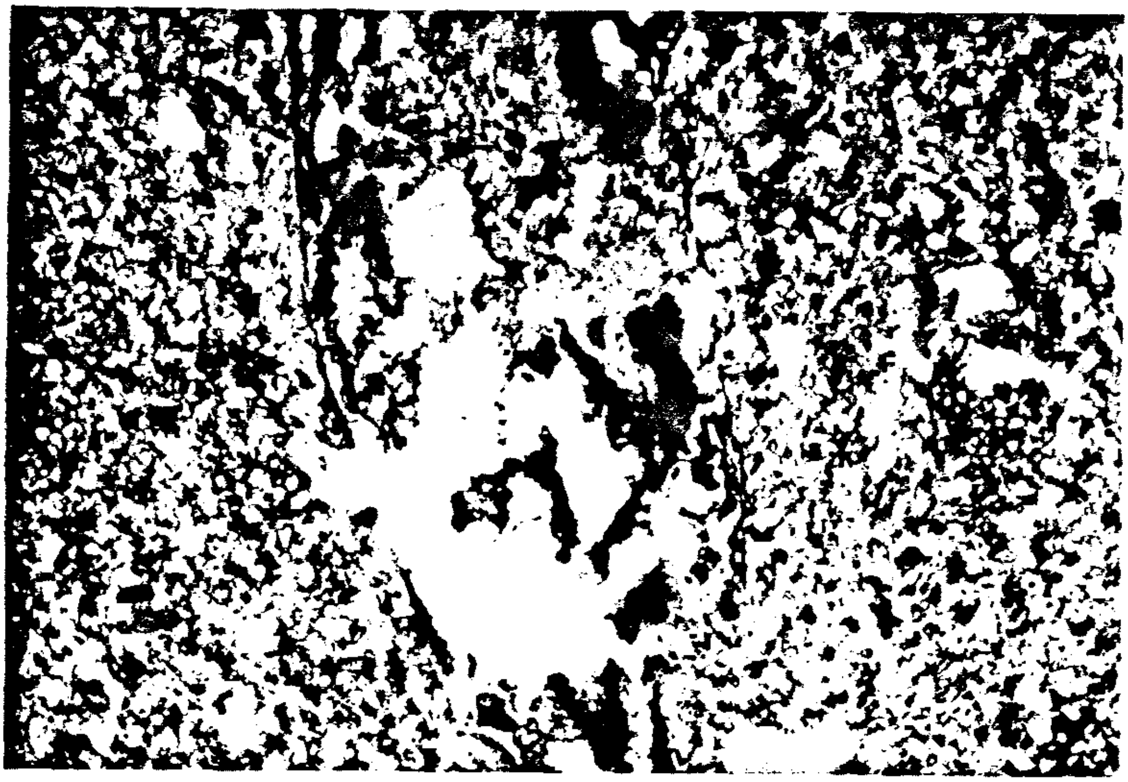


Plate 3: Photomicrograph; scatter A, thin section C; root replaced pseudomorphically by calcium carbonate (a possible relic feature of late lastglacial decalcification) in layer 4, a homogenised and partially decalcified subsoil. Plane polarised light (PPL), frame is 5.56 mm.

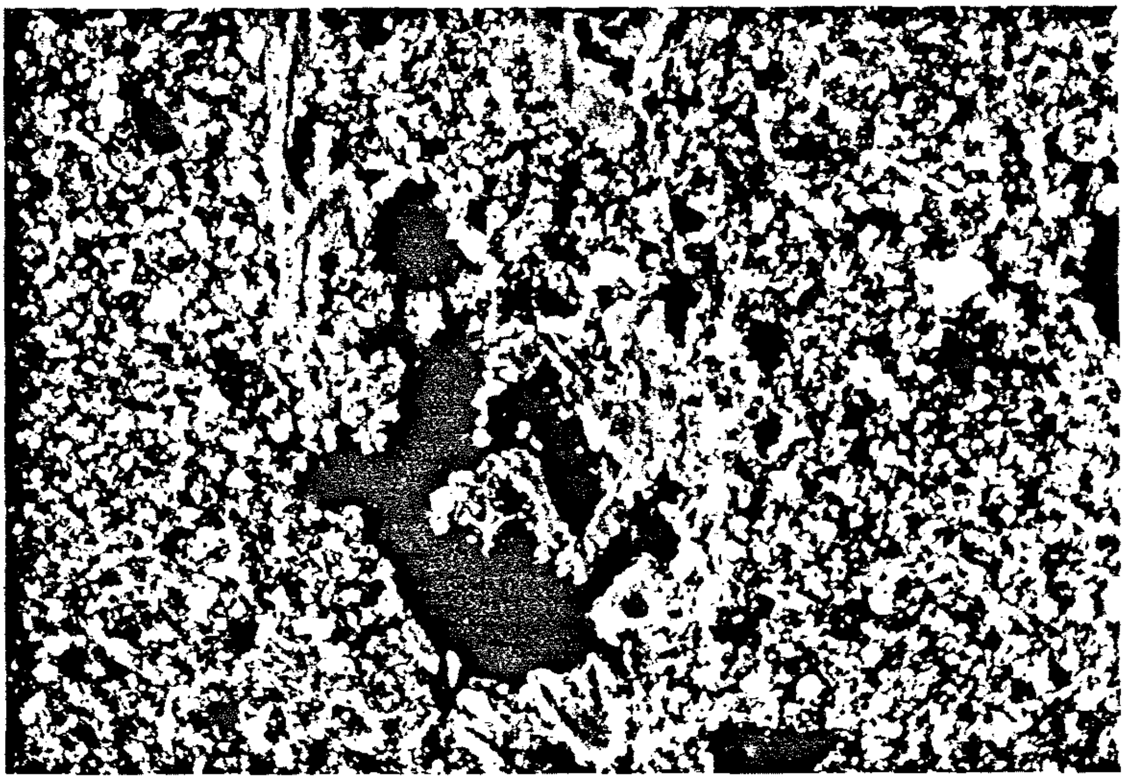


Plate 4: As plate 3, crossed polarised light (XPL) showing high birefringence of calcitic features.

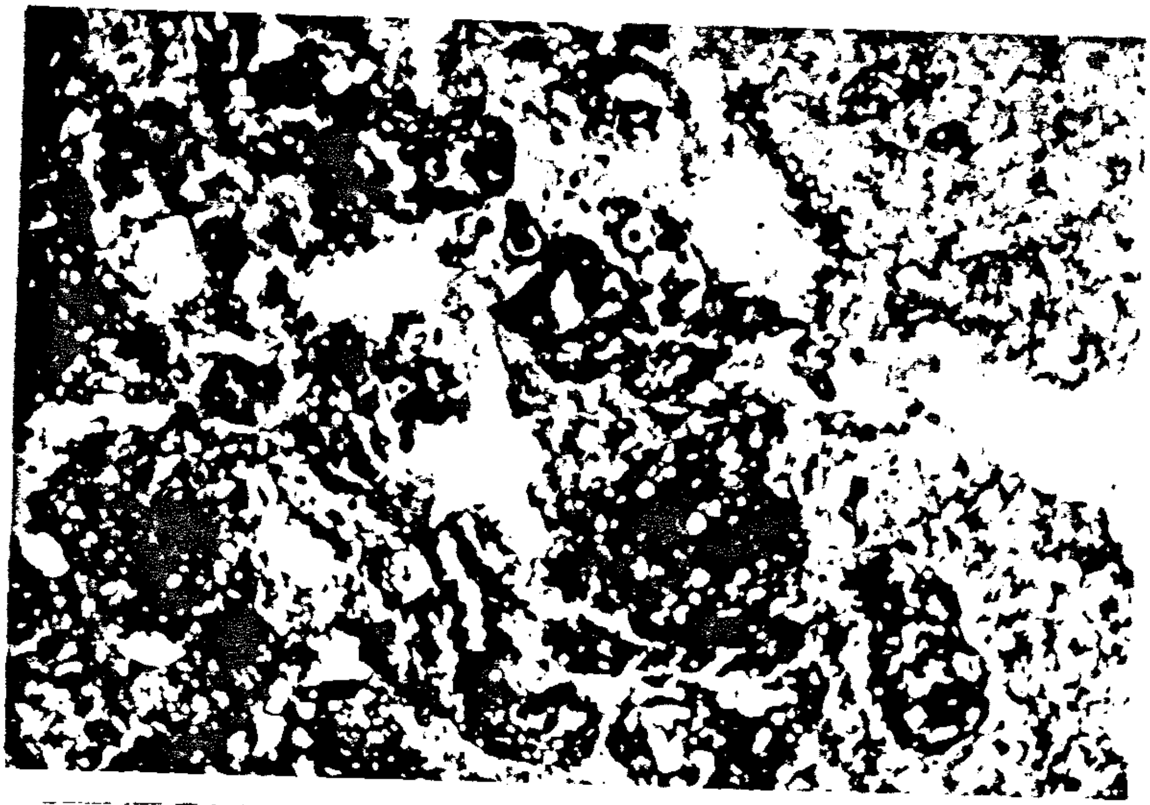


Plate 5: Scatter C, thin section E, layer 3; near surface soil roots (black features), probably contemporary with the Mesolithic occupation, have been replaced pseudomorphically by iron and manganese as a result of gleying probably brought about by a rise in water table associated with the floodin of the site. Ferruginised clay infills of the coarse biological porosity probably also relate to flood inundation and alluvial sedimentation, but possibly could also have resulted earlier from surface soil disturbance (trampling) by the Early Mesolithic people occupying the site (see plates 8 9, 10). PPL, frame length is 5.56 mm.

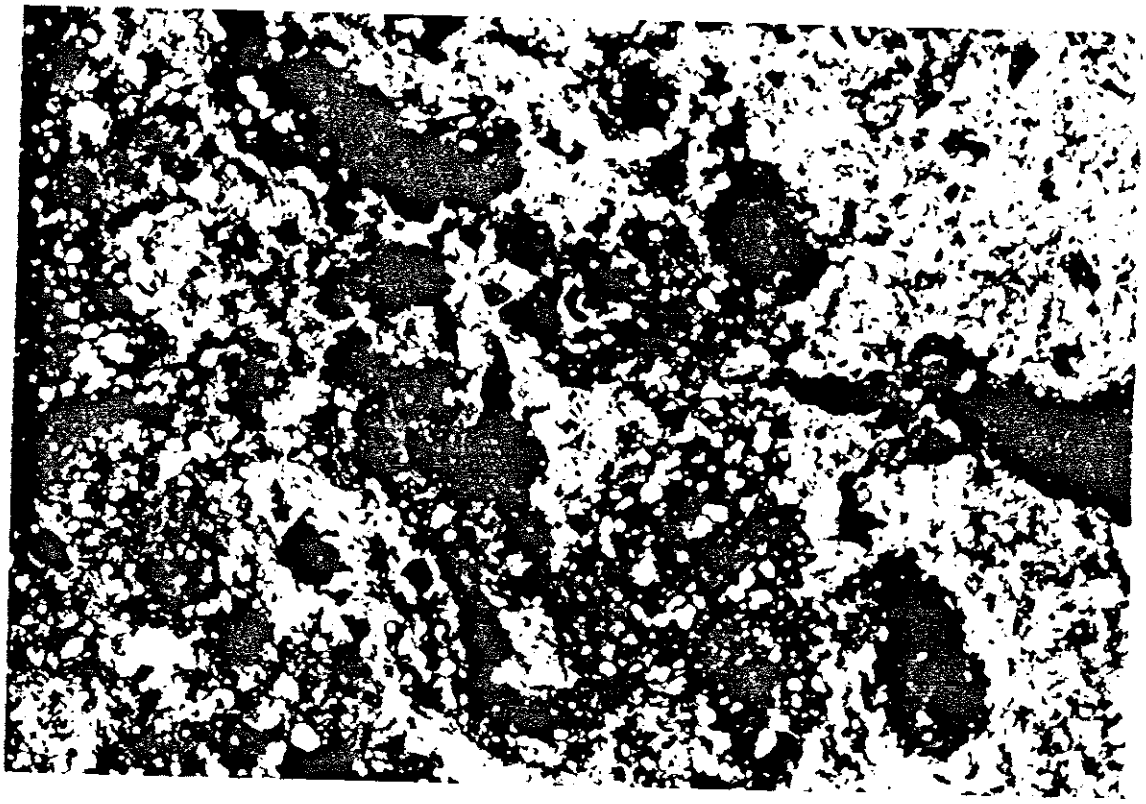


Plate 6: As plate 5, XPL illustrating the silty nature of the soil in comparison to the non-birefringent ferruginised clay infills and iron and manganese replaced roots.

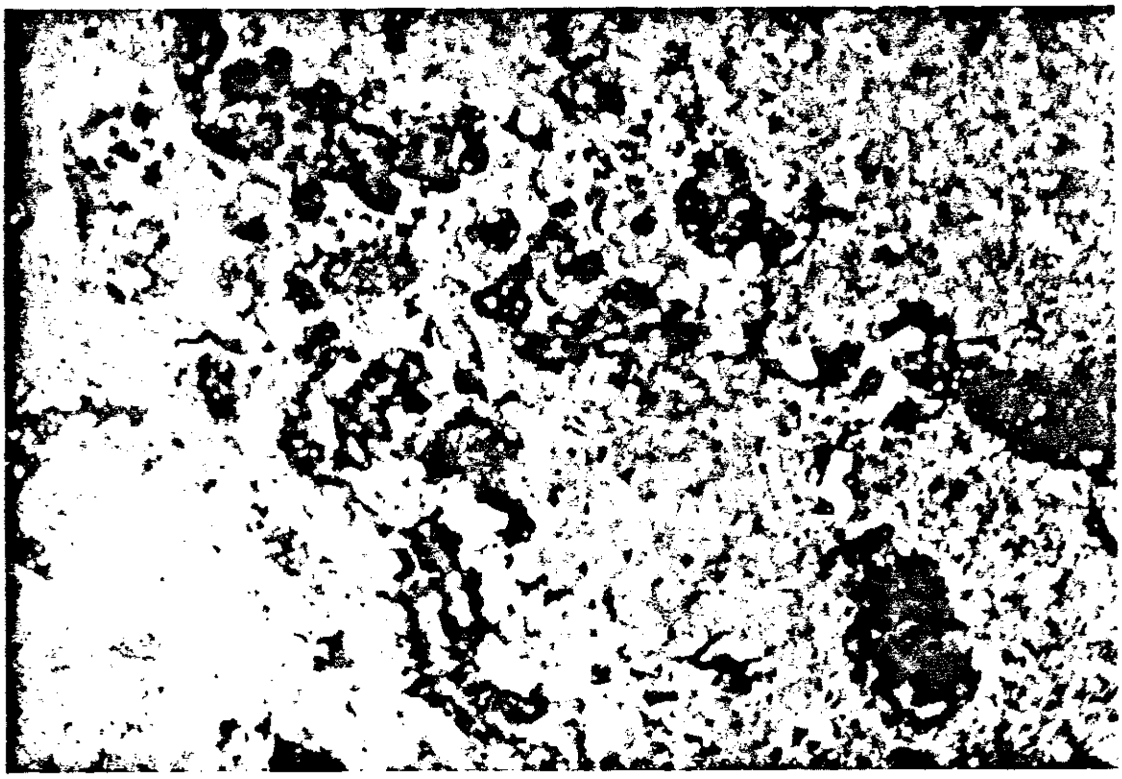


Plate 7: As plates 5 and 6, but under oblique incident light (OIL), further demonstrating the iron and manganese features that produce more obvious mottling in the field.

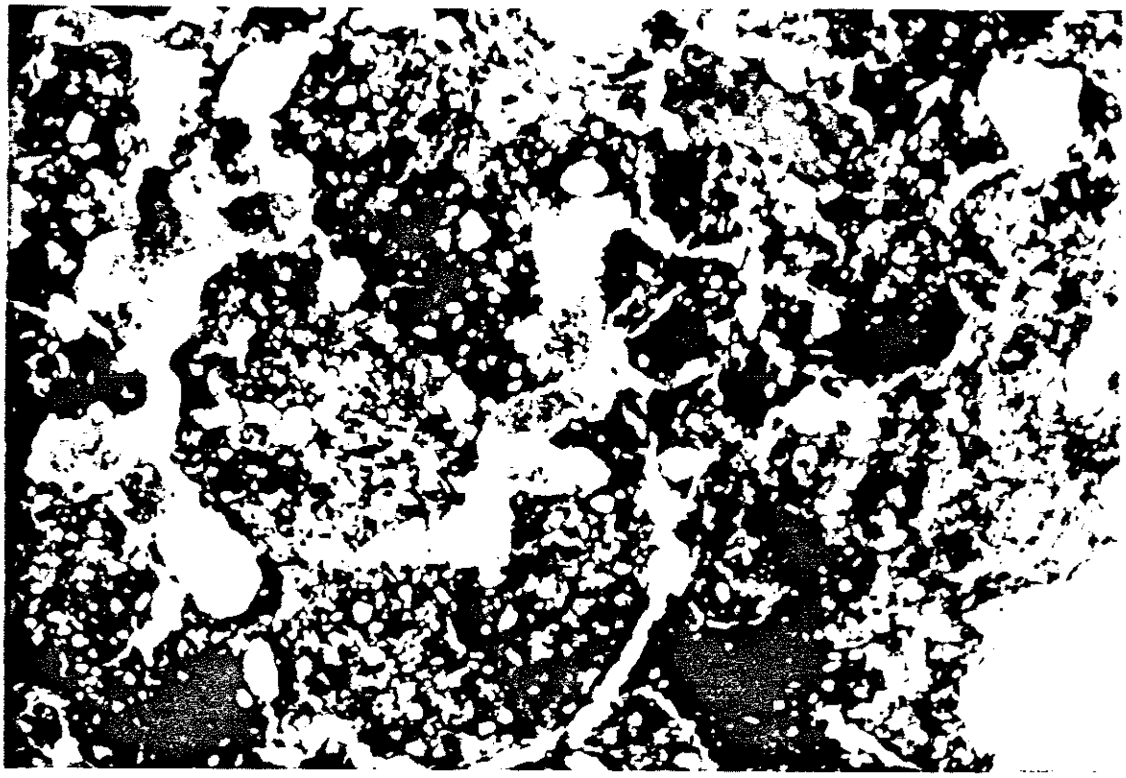


Plate 8: Same upper horizon of the soil at scatter C, showing very open, probably earthworm worked topsoil that contains rare fine charcoal, and which has been affected by various clay and silty clay inwashes infilling some of the biological porosity. In the top centre right of the photomicrograph a probable fragment of alluvial clay loam is present. Post-depositional hydromorphism has caused iron and manganese impregnation of these features. PPL, frame length is 5.56 mm.

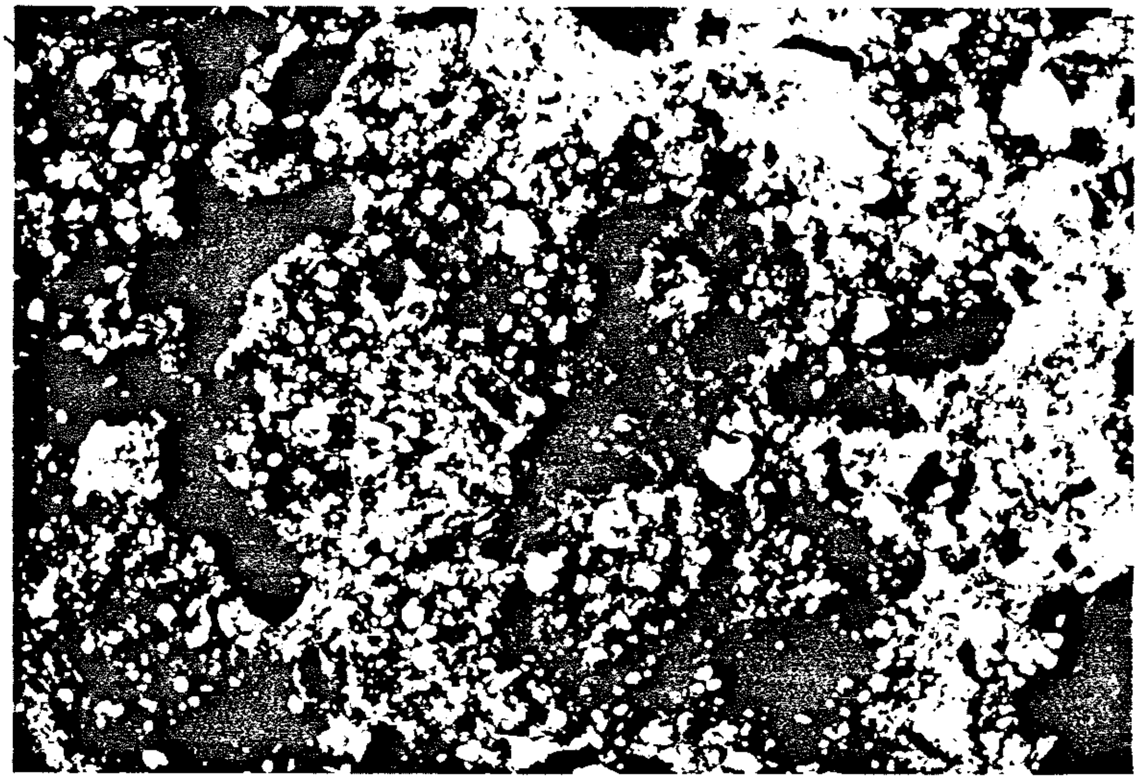


Plate 9: As plate 8, but XPL, more clearly showing the hydromorphic (amorphous) features.

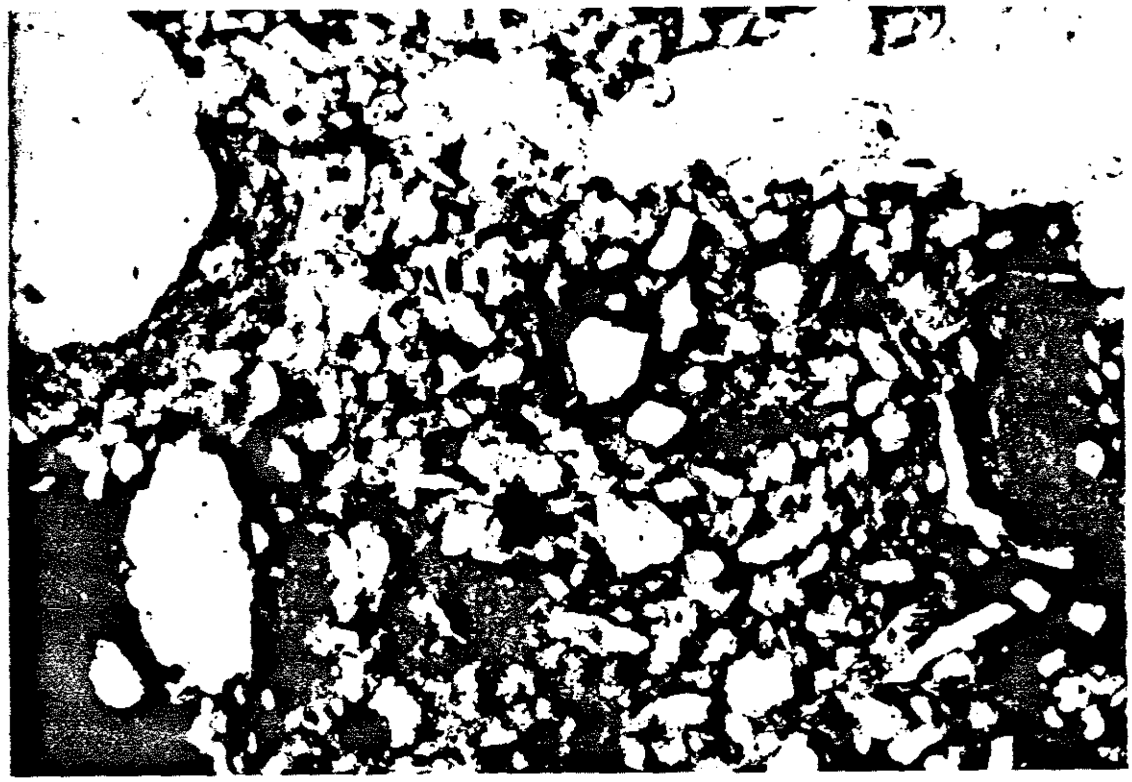


Plate 10: Detail of plate 8, illustrating two types of inwash, a strongly ferruginsed laminated clay one (right) and a more coarse fine to medium size silty one (left). It is possible that the clay coatings and infills could relate to surface soil disturbance caused by trampling during the Early Mesolithic period, whereas the more coarse silty one is a direct result of alluvial inundation. PPL, frame length is 0.33 mm.

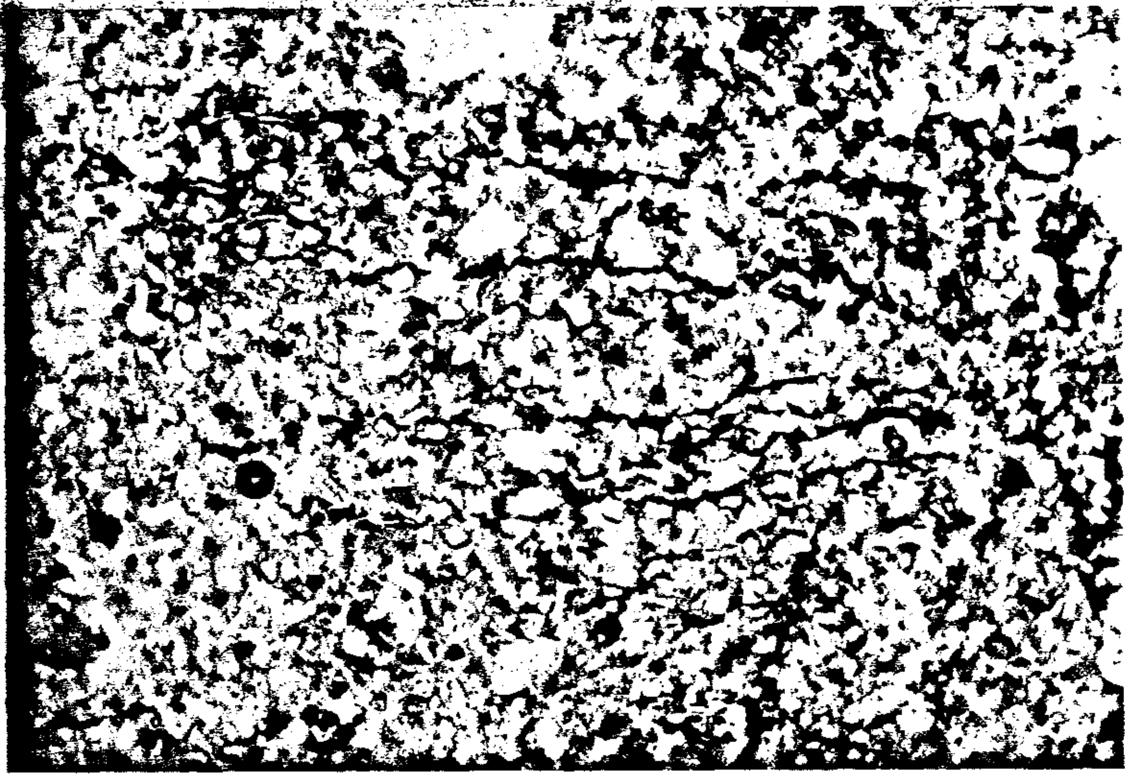


Plate 11: Scatter C, thin section D, uppermost part of layer 3: iron and clay depleted, structureless silty topsoil of the Early Mesolithic profile; with very thin organic matter laminae, now replaced by iron. These laminae are interpreted as wetting-front phenomena caused by flooding of the site with highly organic clays, like "fibre" formation in the structureless Ea horizons of podzols. PPL, frame length is 3.35 mm.

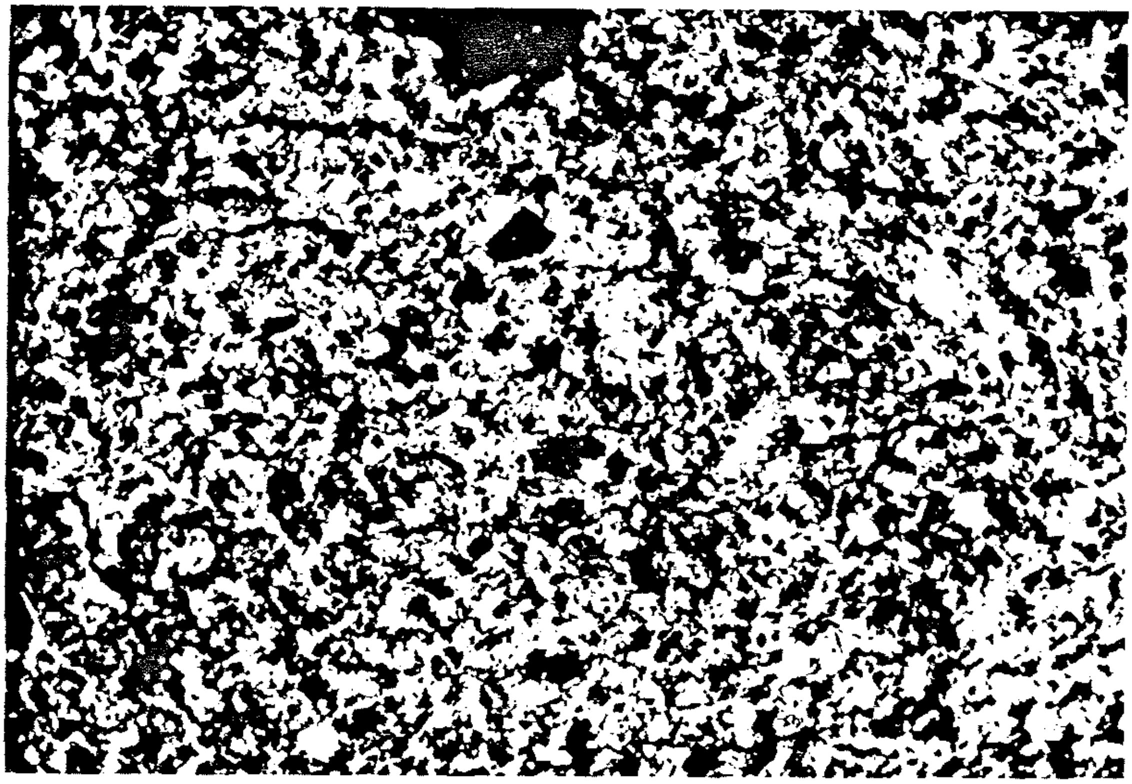


Plate 12: As plate 11, but XPL.

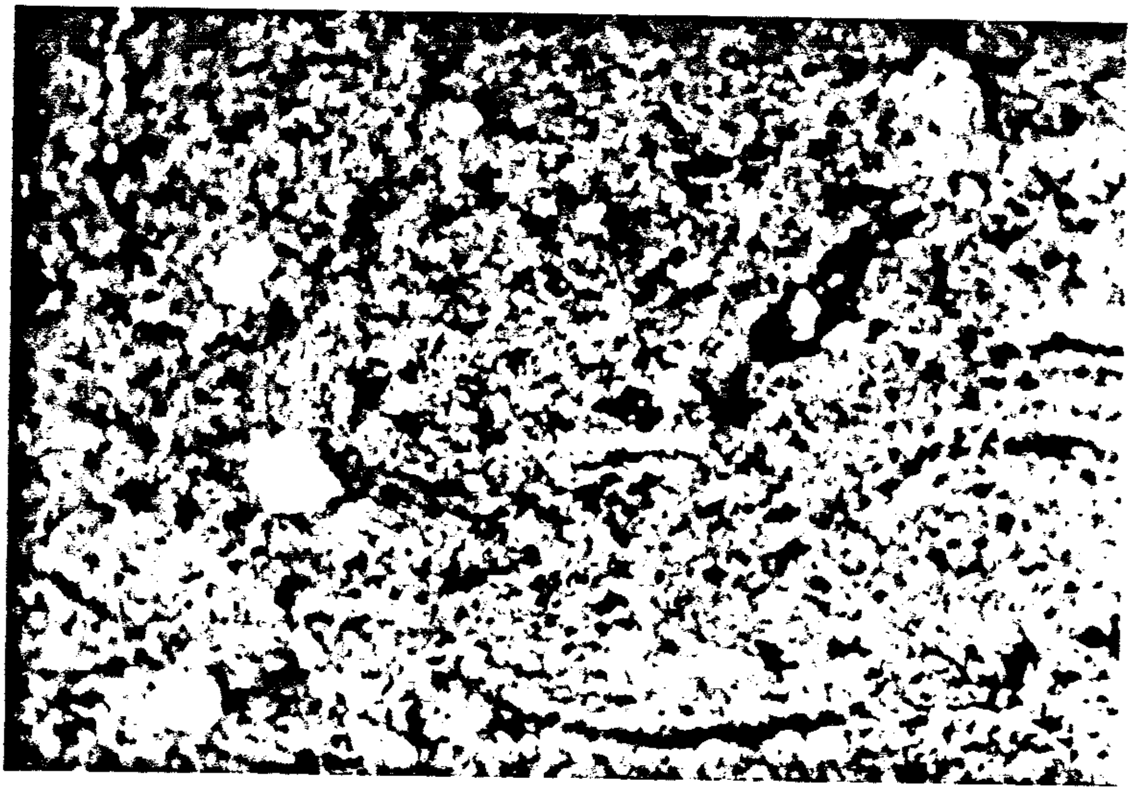


Plate 13: Scatter C, thin section D, layer 2; poorly layered fine charred organic matter, in clay matrix; centre-right, iron hypocoating surrounding probable root channel. PPL, frame length is 3.35 mm.

Plate 14: Scatter A, thin section A, layer 2; banding in humic clay relatin[g] to variations in concentration of included fine charred organic matter; bright yellow infills probably relate to post-depositional contamination by cess which produces amorphous organic/phosphorus/iron features. PPL, frame length is 5.56 mm.

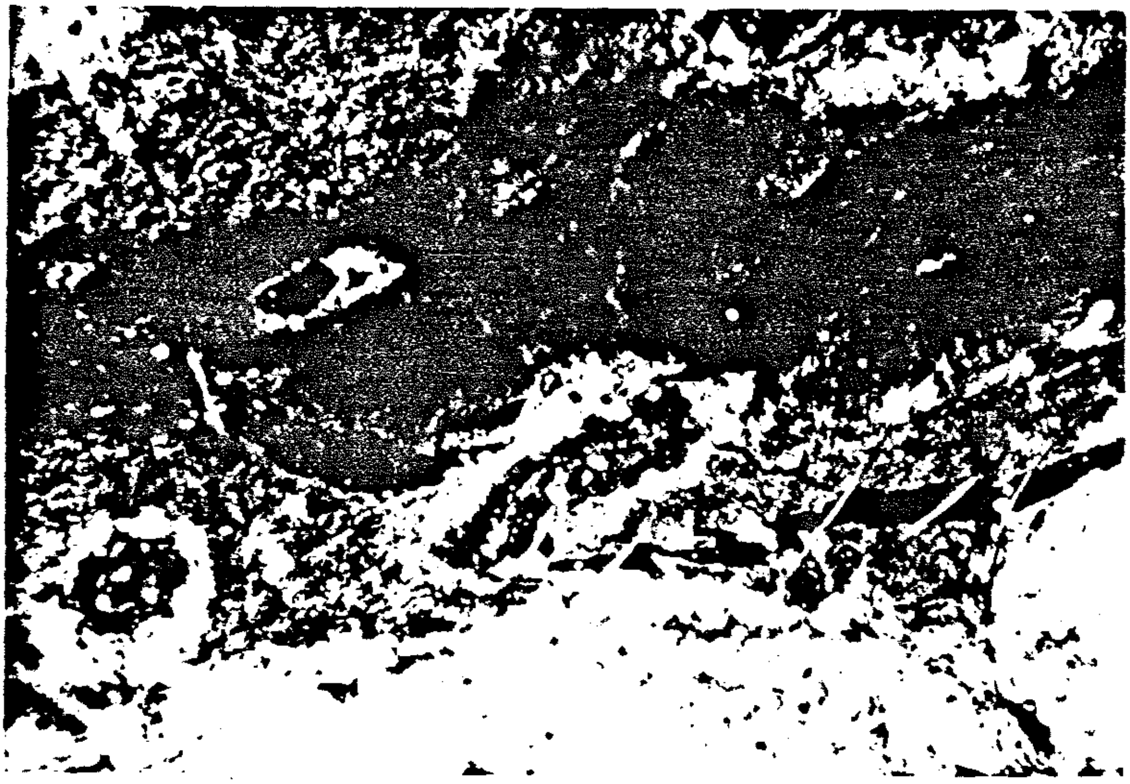


Plate 15: As plate 14, XPL; note poorly birefringent humic clay bands.

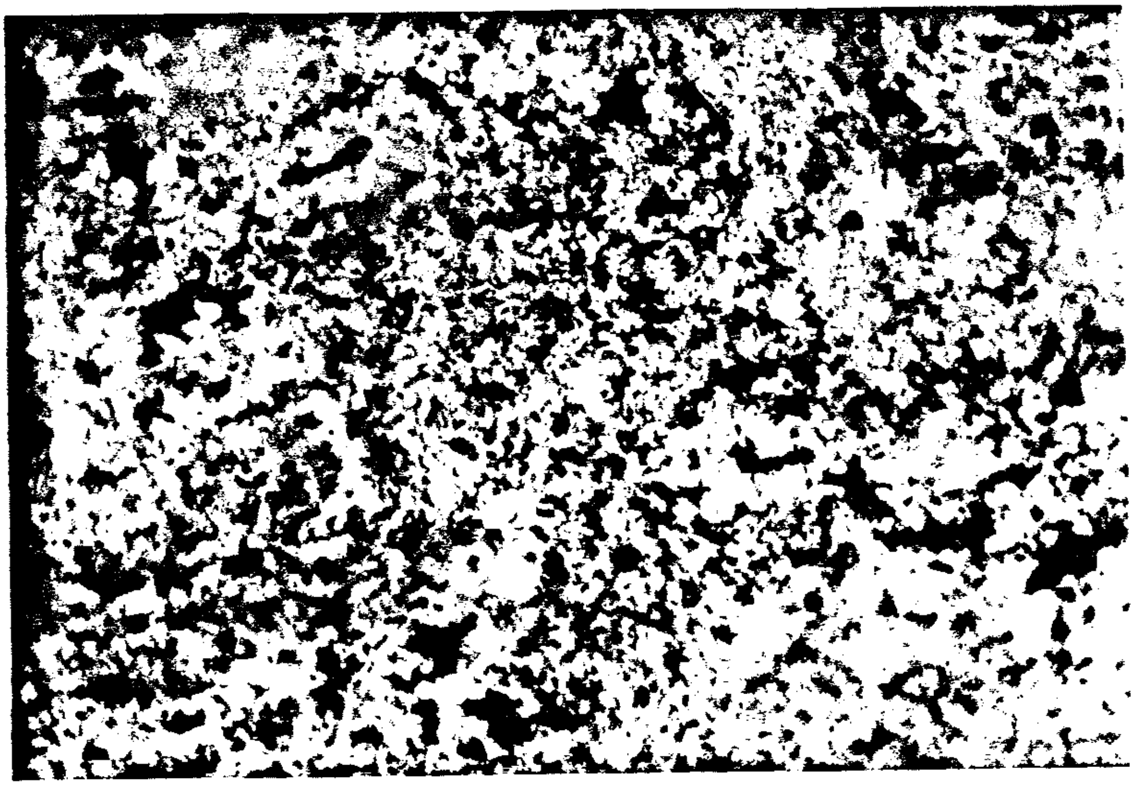


Plate 16: As plate 14; detail of fine charred organic matter fragments in the clay. PPL, frame length is 0.33 mm.

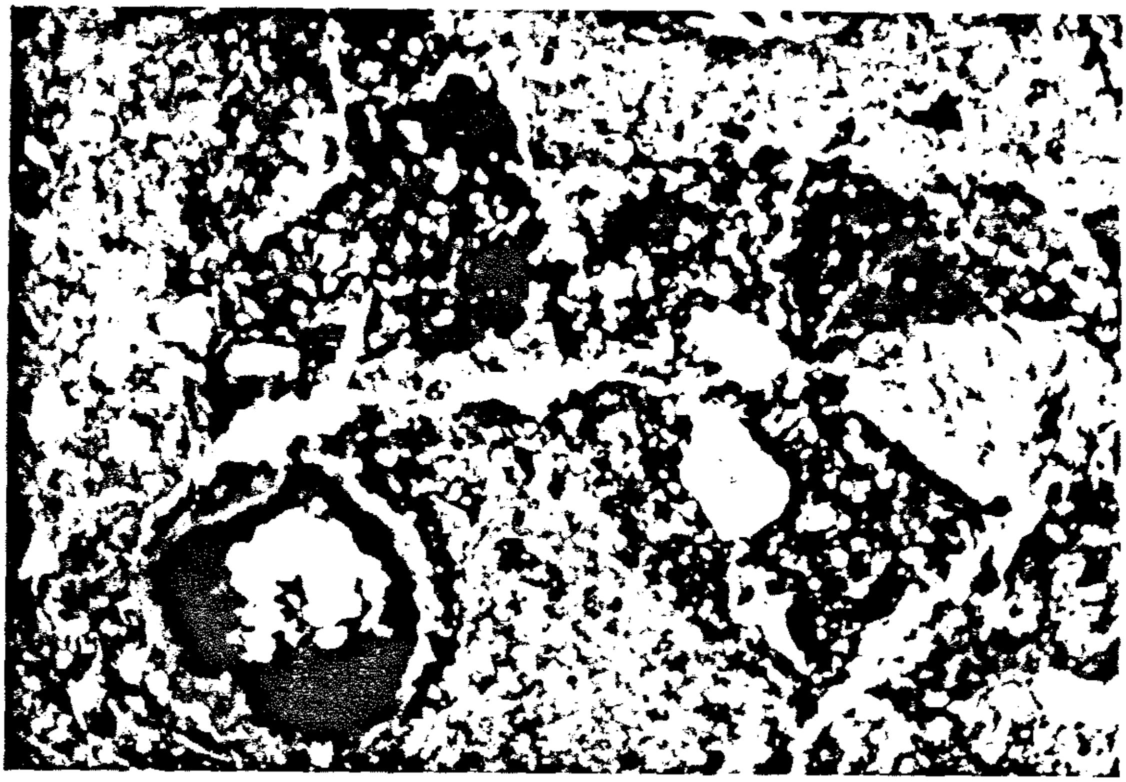


Plate 17: Scatter A; junction of layers 2 and 3, illustrating biological mixing of humic layer 2 material (which may also have been mixed with calcitic soil from layer 1) into the more mineral layer 3. Also vivianite-like material can be seen associated with the orange and very dark brown ferruginous nodule, indicative of cess input. PPL, frame length is 5.56 mm.

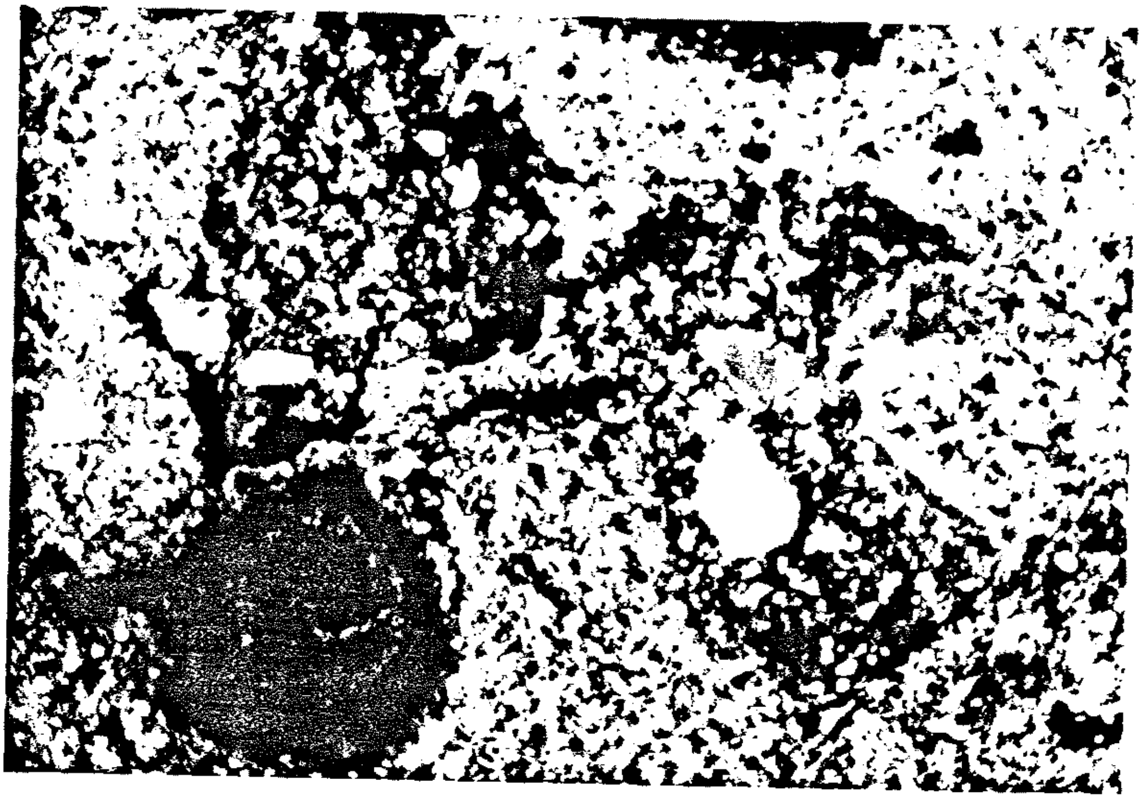


Plate 18: As plate 17, XPL; bright birefringent humic soil has been brought down from the biologically mixed layer 1 which contains non-<u>in-situ</u> tufa.

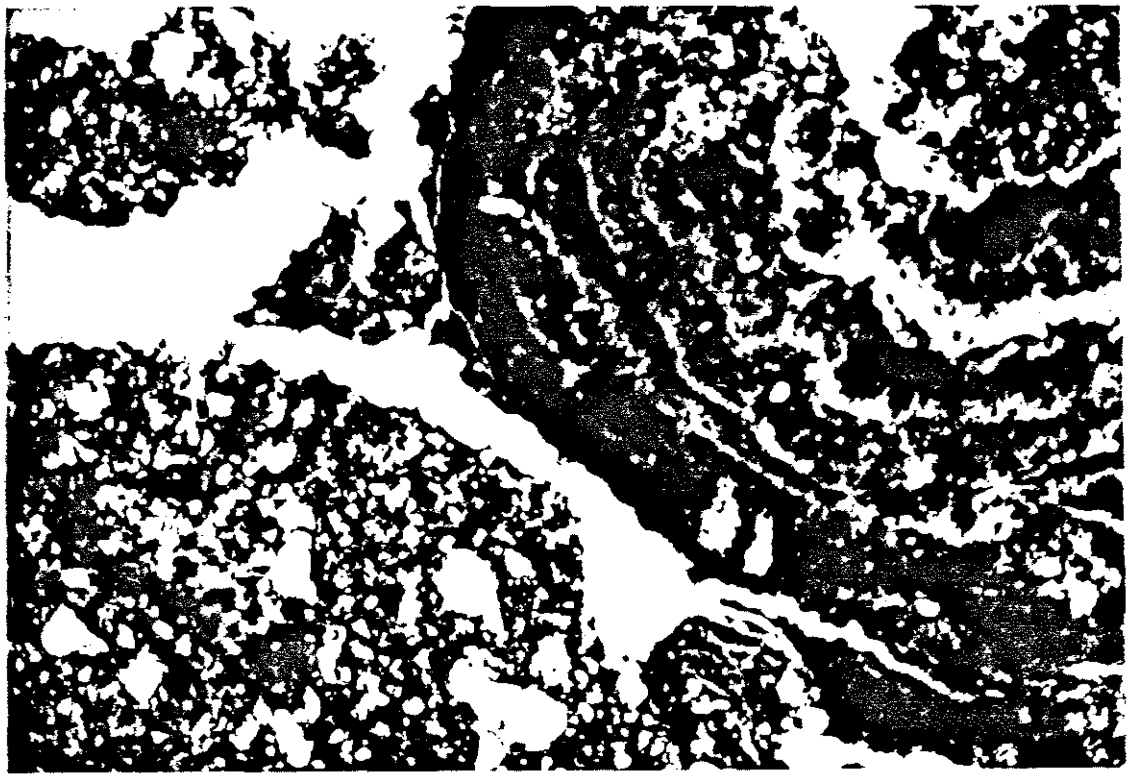


Plate 19: Layer 1, thin section F; earthworm-worked fine charcoal-rich anthropogenic soil containing rounded (transported) tufa fragments. PPL, frame length is 5.56 mm.

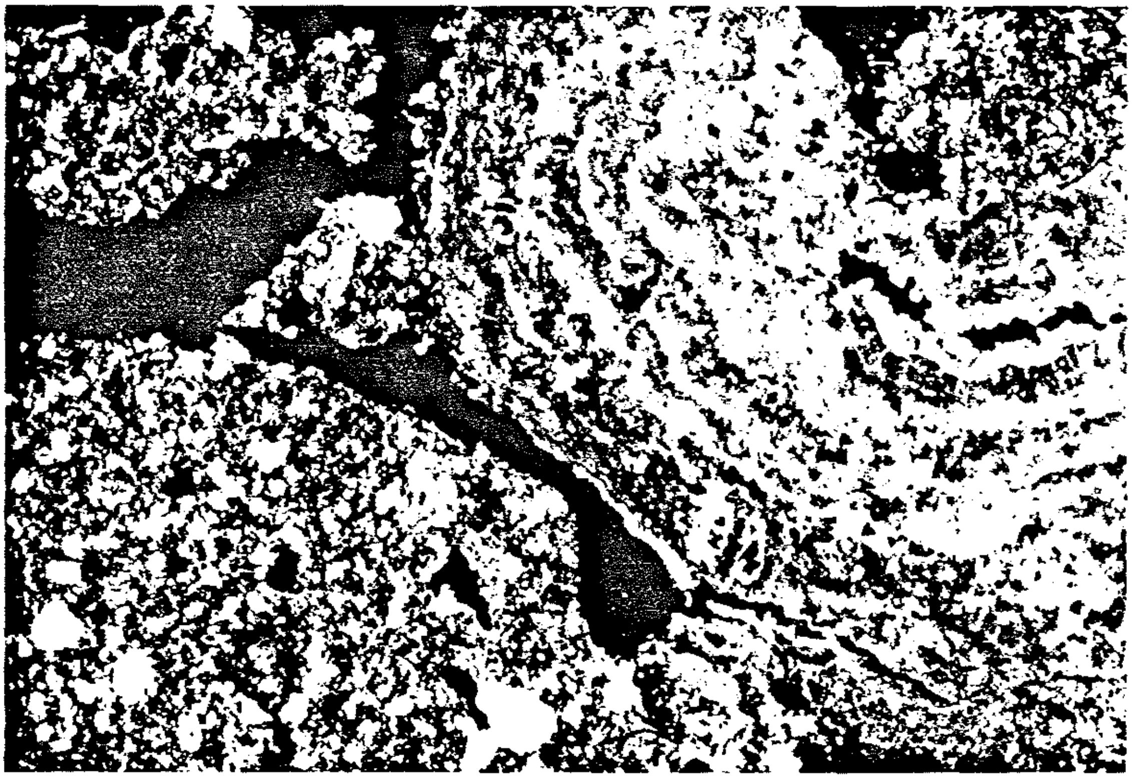


Plate 20: As plate 19, XPL; calcareous soil is moderately birefringent and edges of the tufa are less birefringent than their interiors because of moderate decalcification.

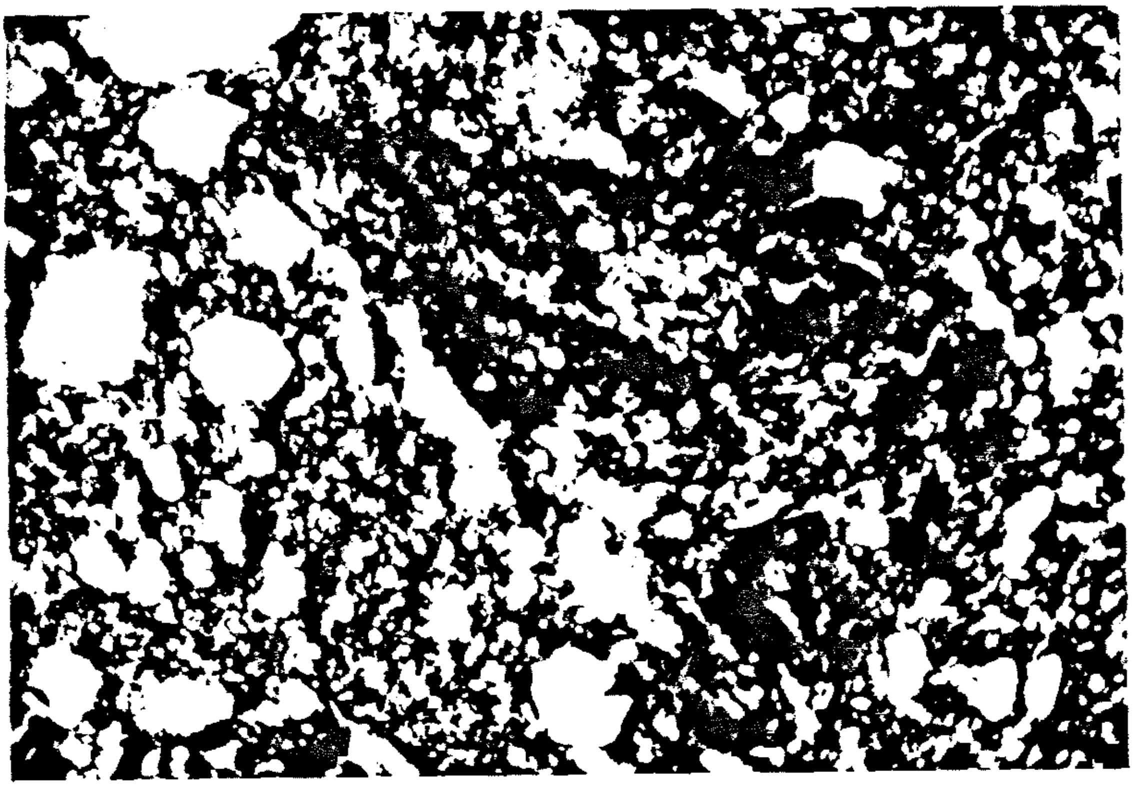


Plate 21: Layer 1, thin section F; juxtaposed variously calcareous fine charcoal-rich anthropogenic soil, earthworm-worked and containing banded infills/intercalations resulting from surface soil disturbance (trampling ?), perhaps soil infilling earthworm burrows? PPL, frame length is 5.56 mm.

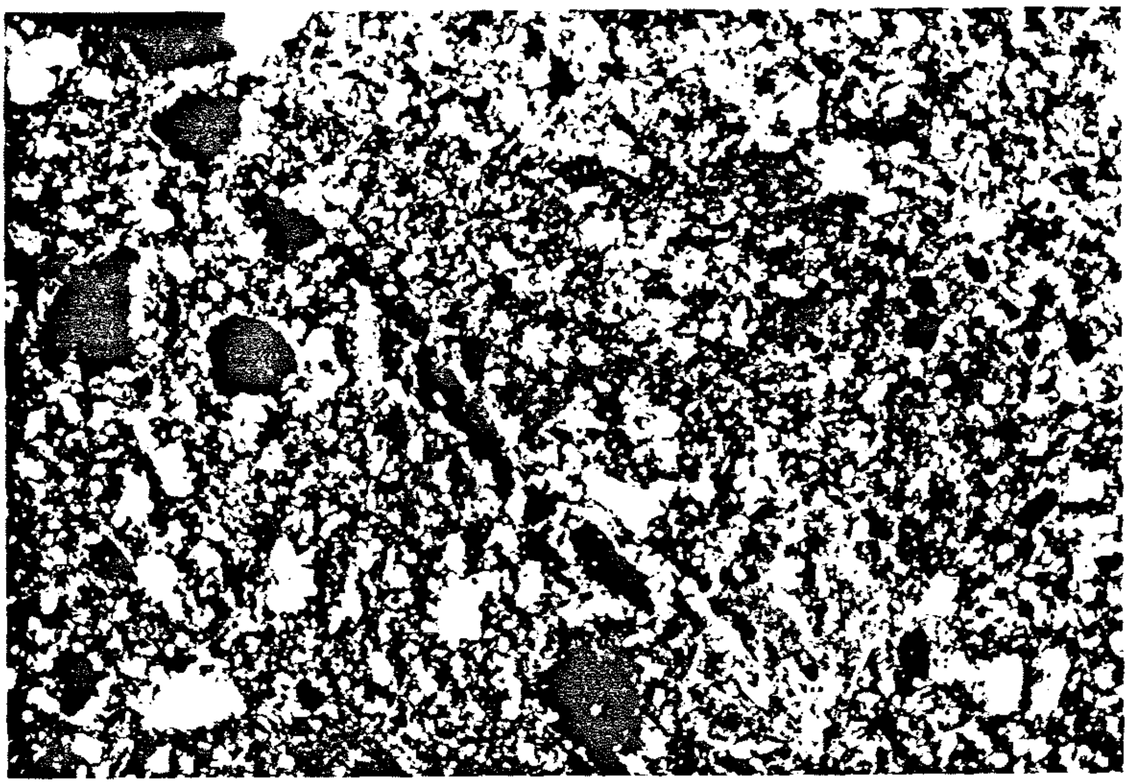


Plate 22: As plate 21, XPL.