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SOIL REPORT ON CANON GREENWELL'S PIT, GRIMES GRAVES, NORFOLK.

R I Macphail October 1985

Summary

A soil and hearth dating to the beginning of the 2nd Millenium BC which were buried by flint mining spoil at Grimes Graves, Norfolk, were investigated both chemically and in thin section. The buried soil had been deeply truncated, but essentially had features of a brown soil, possibly weakly affected by podozolisation. The truncated soil in which a new A horizon had begun to develop was also apparently truncated, probably at the time of occupation. At the hearth, quantities of calcitic wood ash and charcoal were present. Minor post-burial working by earthworms produced calcite "excrements". These and other features noted above are illustrated by 10 colour plates.

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During the summer of 1985 the Norfolk Archaeological Unit carried out limited excavations (Director, Frances Healey) around the edge of Canon Greenwell's Pit, Grimes Graves, Norfolk, prior to the construction over it of a concrete cap by the Historic Buildings and Monuments Commission. The working of the pit is dated by a series of twelve radiocarbon determinations, ranging from 3974 ± 45 yrs bp (BM-1047) to 3784 ± 50 yrs bp (BM-1068) (Burleigh, etal 1979). Spoil from it and from at least one adjacent pit buried a number of soil contexts, dated as follows: hearth charcoal, 4060 ± 90 yrs BP (BM-2377), various hearth charcoal (cutting 19) 4150 ± 90 yrs BP (BM-2379) and collagen from antler on the old land surface (cutting 19), 3810 ± 60 yrs BP (BM-2380).

Methods

The hearth at Cut 19 and the soils at Cuts 29 and 20 were examined (Hodgson, 1974.) Analyses of pH, loss on ignition, and organic carbon (Avery and Bascomb, 1974) and microfabric analysis (Bullock, et al 1985; Murphy, et al 1985) of the hearth and levels 51 and 52 at Cut 20 suggested tests for pyrophosphate extractable C, Fe and Al, and dithionite extractable Fe were also essential. The latter were carried out by the Soil Survey of England and Wales, Rothamsted Experimental Station.

Results

The flint mining spoil buried only poorly preserved soils. These are truncated typical brown sands (Newport 4 Association; Hodge, et al 1983) developed on glaciofluvial drift. In the case of Cuts 20 and 29 (Profile Description) this comprises ferruginous sands over sands and gravels typical of the Breckland (Corbett, 1973). The buried soils have at present alkaline pH's (Table 1), similar to the overburden (sands, context 37) of sand and chalk. The "surface" horizons at Cut 20 (Plate 1) are weakly humic, whereas the hearth at Cut 19 is dark (Plate 2) by virtue of the large quantity of charcoal and charred organic matter present.

Detailed micromorphological (Micromorphology) and chemical (Table 1b) analysis of levels 51 and 52 at Cut 20 suggest that here surface soil formation has taken place in a ferruginous subsoil horizon. The latter is dominated by residual dithionite iron in the form of sesquioxidic coatings (Plates 3,4 and 5). The microfabric and chemistry clearly suggest it is a truncated Bw horizon of a brown sand soil with in addition possible podzolic (Bs) characteristics. Amorphous organic matter in this horizon is generally of an acid Ah type, which developed after soil truncation - forming a poorly developed fine subangular blocky structure. No surface organic matter horizons (ie L. F or H) are now present indicating a second truncation, probably associated with human occupation and the incorporation of small amounts of charcoal and ash (see later) into the soil. Minor post-burial probable earthworm burrowing occurred.

At Cut 19, the hearth (Plate 2) was examined. Here evidence of burning in the form of high quantities of probable wood ash (calcite crystals, Wattez and Courty in press - see Micromorphology) and fine charcoal (Plates 6,7 and 8) - giving high loss on ignition is present. The absence of red colours (se Plate 8) and the presence of charcoal within the calcitic ash suggests only moderate temperatures at this level - the highest temperatures at the top of the fire giving rise to pure ash and red soil fabrics (Courty, 1984; Page and Courty, in press).

Again this area of the buried soil was visited by probable earthworms, which had burrowed through the chalky overburden (see Plate 2), and deposited lines of well formed coarse (Bal, 1982) calcium carbonate crystals (Plates 9 and 10).

Discussion and Conclusions

It is quite clear that a brown sandy soil had formed at Grimes Graves by the Neolithic. The evidence suggests that, as elsewhere in England on ferruginous sands, the soils were decalcified (Macphail, in press) and possibly even affected by podzolisation (Scaife and Macphail, 1983). In the latter case, there is data based on C14 dates of Bh horizons (Mean Residence Time dates) that may associate Neolithic activity in the Brecklands with podzolisation (Perrin, et al, 1964: Guillet, 1982).

The soils were also deeply truncated, but it is uncertain whether by design or by windblow (Corbett, 1973; Macphail, in press) after soil disturbance. Ah horizon formation took place in the truncated subsoil, but a further phase of disturbance removed the actual topmost Ah horizon. This latter phase was probably associated with use of the site, involving the incorporation of charcoal and calcite ash into the soil. At the hearth, the uppermost part of the burned area was possibly removed prior to burial.

The buried soils were affected by minor washing in of calcite materials from the chalky overburden, and minor earthworm burrowing.

Acknowledgements

Thin section manufacture (Aberdeen University) and analyses for Fe and Al (Soil Survey of England and Wales) are acknowledged.

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SOIL PROFILE DESCRIPTION: GRIMES GRAVES

Canon Greenwell's Pit

Cut 29

horizon, depth cms.

Overburden of Chalk spoil (33) over dump of strong brown (7.5YR5/8) sands.

i (39)	Reddish brown to dark reddish brown.
0-11(16) B (Bs)	(5YR 4/3-3/2) very weak sand, with (40%) reddish yellow (7.5YR 6/6) mottles of inwashed (?) loose sand; structureless; few charcoal flecks, clear, smooth boundary.
ii (39) 16-22 B	Discontinuous reddish brown (5YR 4/4) very weak structureless sand with (30%) reddish yellow (7.5YR 6/6) mottles of loose sand; clear wavy boundary.
iii (39) 11(22)-36+ B/C	Reddish yellow (7.5 YR 7/6-6/6) loose sand; structureless, increasing (few) stones (flints) to sands and gravels.

Cut 20 (Plate 1)

43cms of strong brown sandy overburden, beneath chalk spoil.

(51) 0-5 Ah/B(s?)	Dark reddish brown to reddish brown (5YR 3/2-4/3) very weak fine sand (see Micromorphology); very poorly developed fine subangular blocky; weakly humose; fine charcoal present; clear; smooth boundary.
(52) 5-15	Reddish brown (5YR 4/4) very weak fine sand; poorly developed fine to medium.

Ah/B	Subangular blocky; few small flints; very weakly humose; few charcoal present; clear, wavy boundary.
(53) 15-30+ B	Strong brown (7.5 YR 6/4) loose, weakly massive to structureless fine sand; becoming loose and moderately stony.

Table Chemistry

1a.	Cut	Sample	pH	%Org C.	%Loss on Ignition
	29	37	8.3	-	
	"	39(i)	8.4	-	
	"	39(ii)	8.7	-	
	"	39(iii)	8.8	-	
	20	51	8.5	0.1	
	"	52	8.7	0.02	
	"	53	8.7	-	
	19	hearth	8.5	0.43	4.4

1b*	Section	Sample	Pyrophosphate		ext.	dithionite ext.
			C	Fe	Al	Fe
	20	51	0.5	0.09	0.0	2.75
	"	52	0.02	0.12	0.01	3.06

*Analyses by Soil Survey of England and Wales, Rothamsted Exp. Station.

MICROMORPHOLOGICAL DESCRIPTION: GRIMES GRAVES

51/52 (Plates 1,3,4 and 5)

0-7cms.

Structure: weakly massive to subangular fine blocky. Porosity: 35-40%; very dominant compound packing voids; frequent medium (400um) open walled channels, and inter-aggregate (poorly accomodated) planes, especially in 52; Mineral Coarse/Fine limit 10cm. C/F, 90:10 (51), less finer material in 52; Coarse; very dominant very fine, fine and medium size sub-rounded quartz; very few flint, feldspar; few opaques (limonite for eg.); Fine; as few darkish brown (PPL), pale orange (RL), non-birefringent sesquioxidic coatings (see Amorphous) and rare groundmass; b) very few pale brown/dirty grey (PPL), very pale yellow/white (RL), moderately to highly birefringent calcitic coatings and rare groundmass (see Crystalline); pale brown material throughout fabric, especially at top of 51; whereas grey fabric only present in channels etc: c) rare colourless (PPL, RL), highly birefringent earthworm gut calcium, carbonate crystals, c.50cm in size, grouped into 250um cluster. 2% Organic, Coarse; few lignified root; charcoal Fine very dominant blackish (PPL) or brownish when associated with fine mineral; amorphous organic matter associated with mineral matter; fine charcoal present - character of both weak Ah and also some spodic-polymorphic material. Groundmass: single grain (monic), mainly uncoated to very thinly coated; few intergrain agregates; undifferentiated b-fabric (a), crystallitic (b). Pedofeatures; excrements, rare faunal calcite crystals (Bal, 1982). Crystalline occasional (especially in upper 1-2 cms) areas of yellowish brown fine fabric (b); both fine and coarse crystals, suggest it is calcareous material from the chalky overburden; more rare, and greyish coatings may be solution features of more pure $CaCO^3$ being translocated. Some dirty calcitic material which is rather intimately mixed with the fine and organic fabric may be ash (see 19, hearth). Amorphous Much of fine fabric included many (but thin) sesquioxidic coatings and minor cementation of intergrain material. It is closely associated with the fine organic matter and may be weakly spodic in character.

Interpretation. The soil is primarily composed of moderately well sorted quartz sand, which are loosely held together by (mainly ferruginous) sesquioxidic coatings (Table 1b) and associated amorphous organic matter (Plates 3,4 5). The latter has the character of Ah horizon material, rather than Bh horizon (spodic materials) material whereas the sesquioxodic coatings and infills are more suggestive of a subsoil Bs horizon fabric. In addition, the soil has a recognisable fine subangular blocky structure. Both organic matter and structural characteristics decline from level 51 to 52. Experience of these types of fabric (Macphail 1979; 1983) suggest that the sesquioxidic fabric and chemistry relate to B(Bs?) horizon formation (Avery, 1980) in a brown podzolic soil (podzol?). Truncation of possibly 50cms of soil exposed this subsoil horizon to renewed soil formation, but this time as an Ah horizon - hence the fine structures and amorphous organic matter. Soil conditions were still essentially acid at this time. Occupation probably removed some further soil and any surface litter, as little plant material was present other than lignified roots.

Human occupation, including burning in the overall area (see Hearth) led to the deposition of fine charcoal and (calcite rich), probable wood ash (Courty, 1984; Page and Courty in press; Wattez and Courty; in press) leading to minor alkalisation (ie. a rise in pH from acid to neutral) of the soil.

Burial by spoil from the flint mine also led to further fabric features. The spoil is composed of both sands and chalk. Fauna (probably earthworms) have burrowed through the spoil and made a few channels in the underlying soil (level 51). Here they have deposited lines of well developed, high birefringent rounded calcite crystals noted elsewhere in base rich soils (Bal, 1982) and in prehistoric (decalcified) soils beneath Iron Age chalk ramparts at Balksbury Camp (Macphail, 1985, AMLR 4621).

Some calcitic features lining the soil posity may also relate to "chalky" material and calcium carbonate in solution being washed into the buried soil from the overlying chalky spoil. Similar features were noted under the Avebury (Wiltshire) Neolithic bank (Macphail, in Keeley 1984, AMLR 4490).

Cut 19; hearth (0.6.5cm) (Plates 2,6,7,8,9 and 10)

Structure: structureless, very weakly massive; inter-aggregate microstructure. Porosity 30%; very dominant compound and complex packing voids; few medium open-walled channels at depth. Mineral (95%) Coarese/Fine 85:15; Coarse; As 53/53; included coarse chalk, pottery. Fine dominant (a) very dark brownish/black (PPL), black speckled dark orange (Rl), non-birefringenet: common (b) very dark grey (PPL), brownish grey (RL) moderately high birefringence. A few (c) pale greyish (secondary calcitic coatings) Organic (5%). Coarse; few charcoal - charred wood: Fine frequent charcoal, charred organic material, eg as associated with clacitic fine fabric (b), well mixed: Groundmass; loose bridged and coated grain (chitonic-gefuric); (a) undifferentiated b-fabric, (b) crystallitic. Pedofeatures; occasional faunal (earthworm?) highly birefringent calcite crystals, sub-rounded and often joined together; loose in open walled channels. Crystalline: fine fabric (b) intimate mixture of calcitic (ash crystals) material and charred organic matter. Poorly crystallised material, differs from large earthworm cystals, and pure grey void coating calcitic material related to post-burial in-wash. Amorphous: very abundant, rather thin sesquioxodic coatings (see fine fabric (a)), and minor cementation. Spodic fabric (?) with possibly fine charcoal mixed in; possibly also polymorphic organic matter? but un-affected by burning?

Interpretation The hearth has the same underlying fabric as levels 51 and 52, in that it includes sesquioxodic coatings and associated amorphous organic matter; and is similarly interpreted as a truncated subsoil horizon. Howeever, it differs strongly by having a much greater infill of fine material cxomprising various sized charcoal and (probable) wood ash (Plates 6,7,8). Similar fabrics have been noted elsewhere experimentally and at prehistoric sites (Courty, 1984; Page and Courty, in press; Wattez and Courty, in press). The ash is made up of poorly formed, moderately birefringent, fine calcite crystals mixed with fine charcoal. Rather reddened(?) pottery, fragments also occur but ferruginous coatings are only orange.

As at section 20, soil fauna (probably earthworms) have buried through the overlying chalk and sand spoil to investigate the hearth. In fact, the hearth features more burrows exhibiting calcite crystals (Plates 9 and 10) than at section 20, possibly because od the higher organic content of the hearth area. It should be noted however that wood ash, by virtue of all the alkali material present is at first toxic to earthworms (Romans, pers comm), but this situation lasts a very short time (Page and Courty, in press).

CAPTIONS

Plate 1. Grimes Graves, Cut 20. Chalk and sand overburden over buried soil (levels 51 and 52).

Plate 2. Grimes Graves, Cut 19; Buried Hearth sample.

Plate 3. Photomicrograph; Level 51; fine sand-size quartz grains; mainly ssquioxidic opaque fine fabric; minor amorphous organic matter; few fine charcoal. Plane polarised light (PPL); frame length 1.348mm.

Plate 4. As Plate 3; Crossed polarised light (XPL).

Plate 5. As Plate 3; Oblique incident light (OIL).

Plate 6. Photomicrograph; Hearth; fine sand-size quartz grains; opaque, mainly sesquioxidic fine fabric and in top centre very dark grey ash and fine charcoal. PPL; frame length 1.348mm.

Plate 7. As Plate 6; area of calcitic ash is moderately birefringent. XPL.

Plate 8. As Plate 6; common black flecks of fine charcoal, sesquioxidic coatings are orange; calcitic ash is whitish. OIL.

Plate 9. Photomicrograph; Hearth; fine sand-size quartz grains; common fine charcoal and opaque sesquioxodic fine fabric; small areas of dark greyish calcitic ash and fine charcoal; one horizontal and one vertical double line of clear calcite crystals of faunal (probable earthworm) origin. PPL; frame length 5.225mm.

Plate 10. As Plate 9; note lines of highly birefringent faunal (excremental) calcite crystals. XPL.

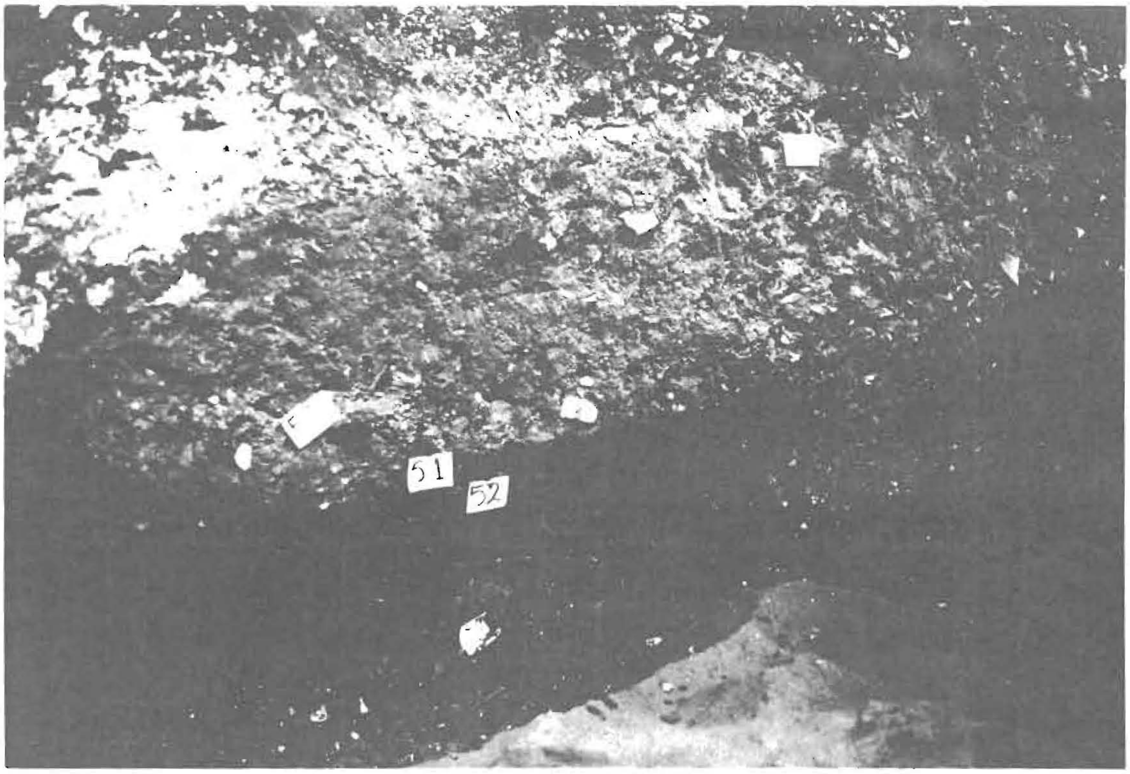

Plate 1. Grimes Graves, Cut 20. Chalk and sand overburden over buried soil (levels 51 and 52).

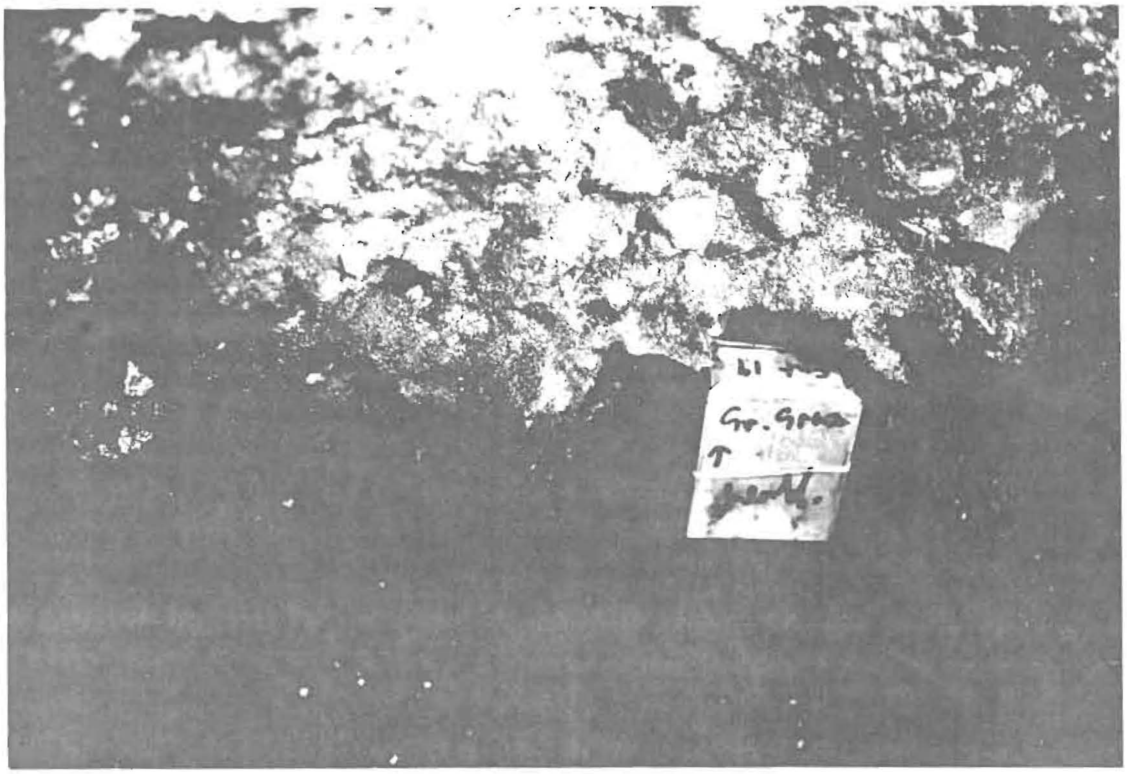

Plate 2. Grimes Graves, Cut 19; Buried Hearth sample.

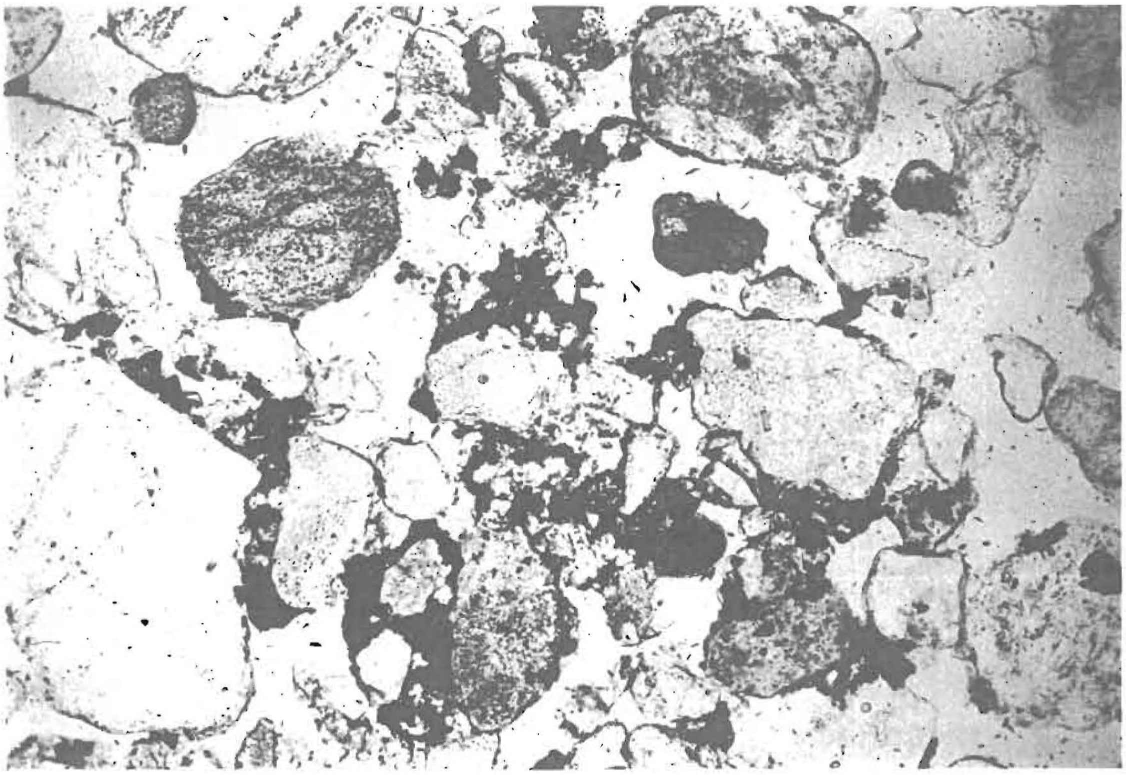

Plate 3. Photomicrograph; Level 51; fine sand-size quartz grains; mainly sesquioxidic opaque fine fabric; minor amorphous organic matter; few fine charcoal. Plane polarised light (PPL); frame length 1.348mm.

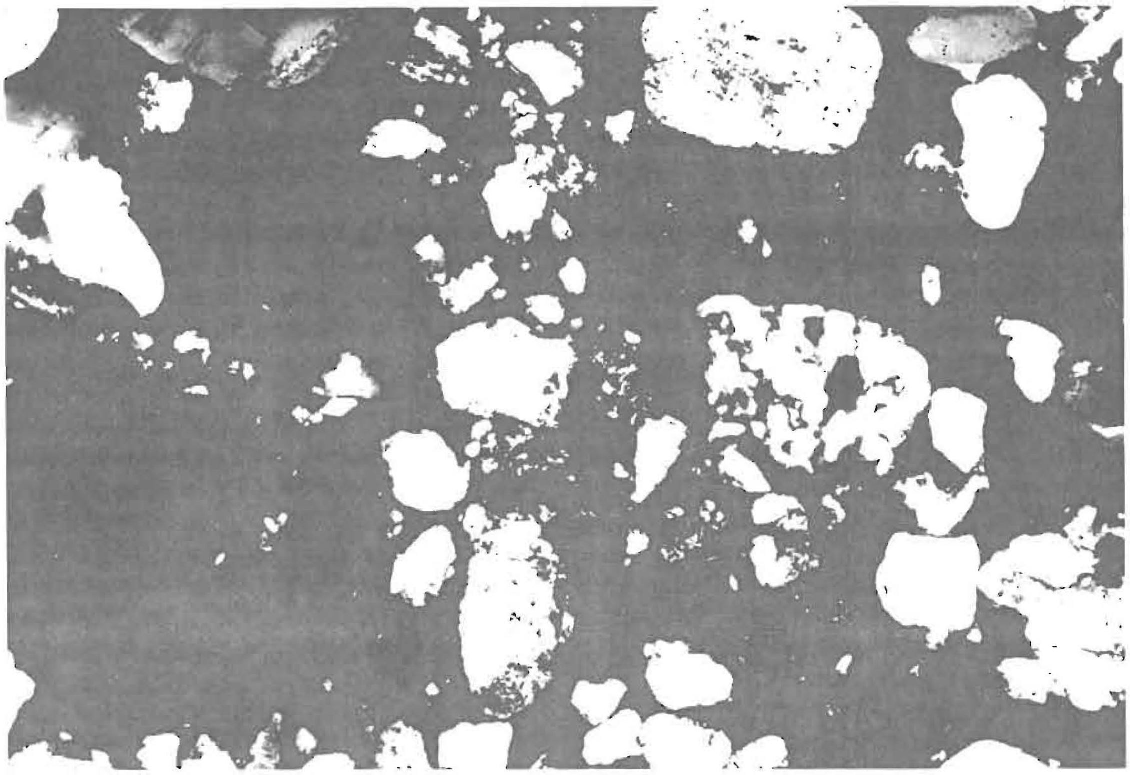

Plate 4. As Plate 3; Crossed polarised light (XPL).

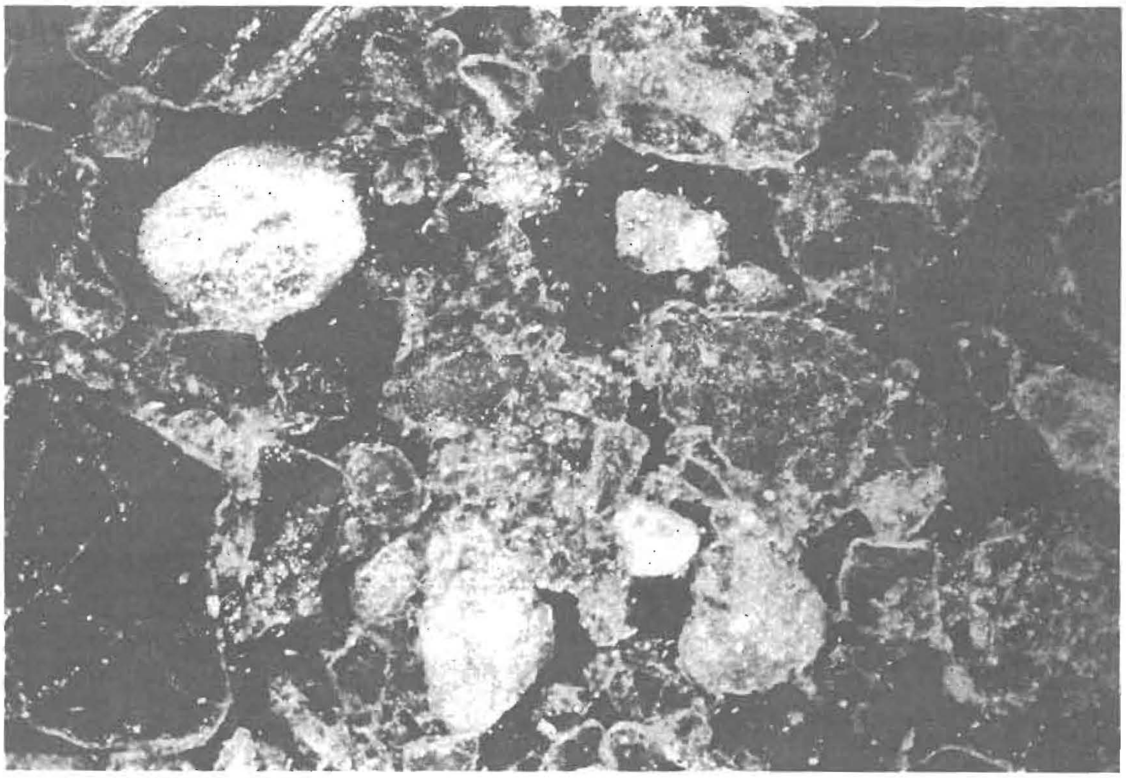

Plate 5. As Plate 3; Oblique incident light (OIL).

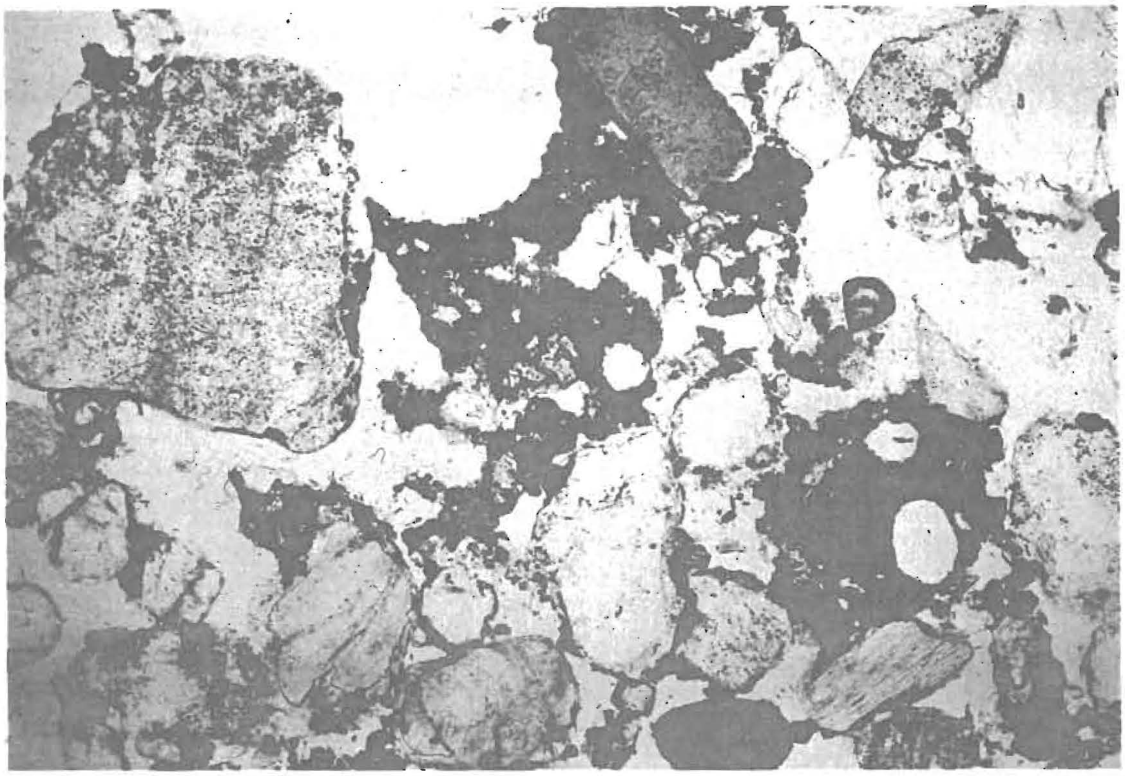

Plate 6. Photomicrograph; Hearth; fine sand-size quartz grains; opaque, mainly sesquioxidic fine fabric and in top centre very dark grey ash and fine charcoal. PPL; frame length 1.348mm.

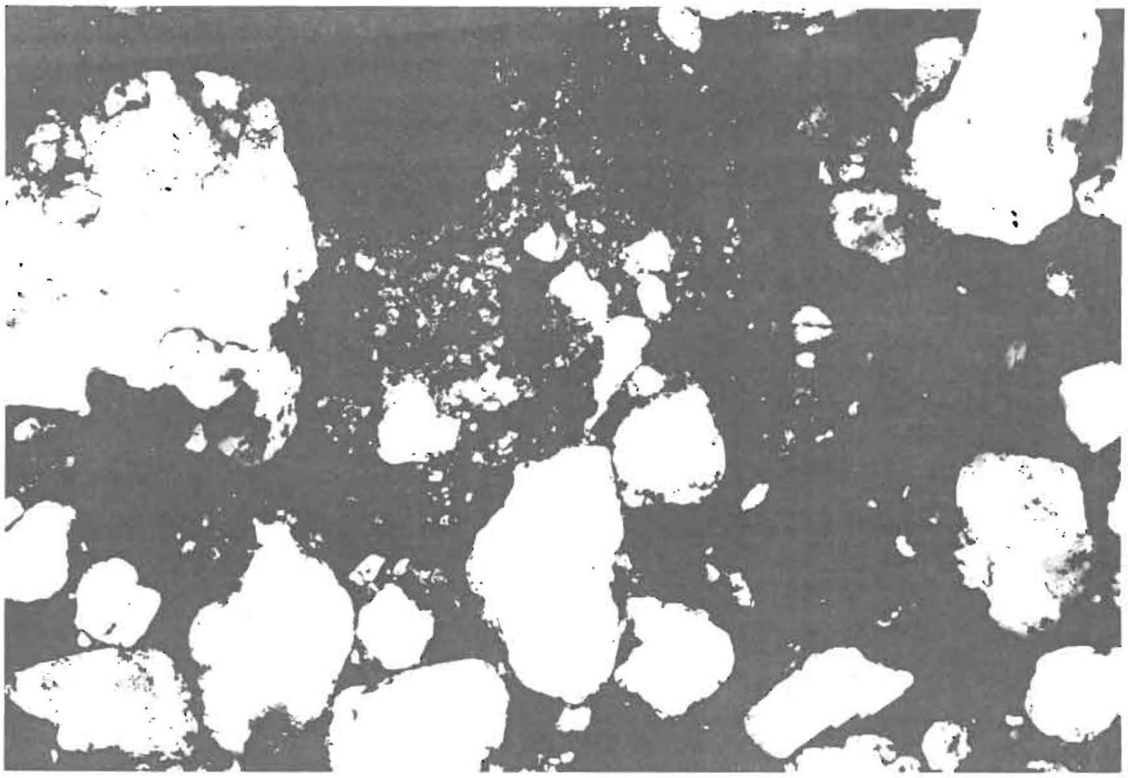

Plate 7. As Plate 6; area of calcitic ash is moderately birefringent. XPL.

Plate 8. As Plate 6; common black flecks of fine charcoal, sesquioxidic coatings are orange; calcitic ash is whitish. OIL.

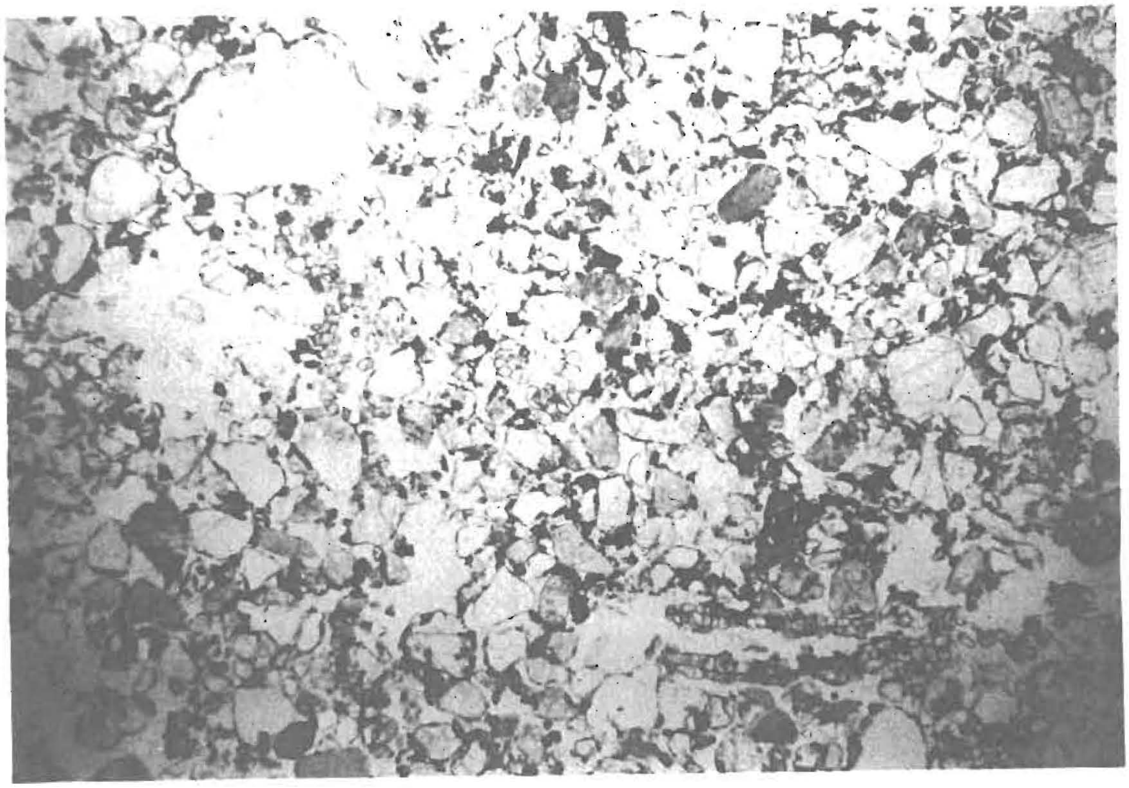

Plate 9. Photomicrograph; Hearth; fine sand-size quartz grains; common fine charcoal and opaque sesquioxodic fine fabric; small areas of dark greyish calcitic ash and fine charcoal; one horizontal and one vertical double line of clear calcite crystals of faunal (probable earthworm) origin. PPL; frame length 5.225mm.

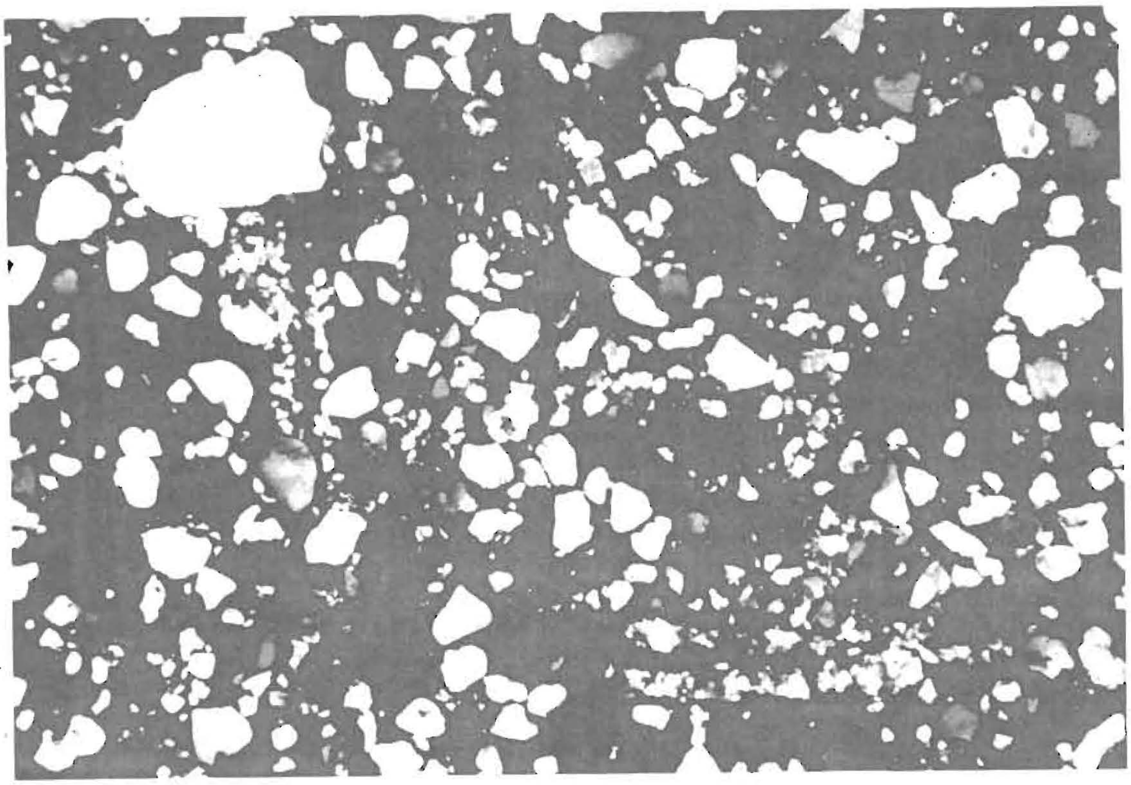

Plate 10. As Plate 9; note lines of highly birefringent faunal (excremental) calcite crystals. XPL.