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3. SEDIMENT MICROMORPHOLOGY

3.1 INTRODUCTION

Grotte des Pigeons at Taforalt, Morocco, has a long history of geoarchaeological investigation, including the use of soil micromorphology (Barton et al., 2013; Courty/Goldberg/Macphail 1989, 216-227). This current study involves the analysis of seven large (max 100 × 60 mm) thin sections from the 2009 excavation of the Grey and underlying Yellow Series in Sector 8. The samples were taken by Peter Ditchfield and supplied to the present author by Nick Barton, Institute of Archaeology, University of Oxford. The slides had been made at Reading University and were partly studied for an MSc dissertation (Jones 2013).

3.2 METHODS

The thin sections (tab. 3.1) were analysed using a petrological microscope under plane polarised light (PPL), crossed polarised light (XPL), oblique incident light (OIL) and using fluorescence microscopy (blue light – BL), at magnifications ranging from x1 to x200/400. Thin sections, which sample between 0-70 mm and 0-100 mm depth of sediment, were described with a relative zero at the top of each slide. Sediments were ascribed soil microfabric types (SMTs) and microfacies types (MFTs) (see tabs 3.1-3.2), and counted according to established methods (Bullock et al. 1985; Courty 2001; Courty/Goldberg/Macphail 1989; Goldberg/Macphail 2006; Karkanas/Goldberg 2018; Macphail/Goldberg 2018a; Nicosia/Stoops 2017; Stoops 2003; Stoops/Marcelino/Mees 2018). Previous studies of the lower (pre-LSA) levels at Grotte des Pigeons (Courty/Goldberg/Macphail 1989, 216-227) and relatively nearby and similarly dated Gibraltar, e. g. Vanguard Cave (Macphail/Goldberg/Barton 2012), also proved useful.

3.3 RESULTS AND INTERPRETATION

Soil micromorphology results are presented in detail in tables 3.1-3.2, and illustrated in figures 3.1-3.48. Twenty-four characteristics and micro-inclusions were identified and counted from the 9 intervals in the 7 thin sections analysed, as measured from a relative zero at the top of each slide.

Thin section	Exact Lithological Unit(s)	Relative depth	MFT	SMT	Voids	Gravel	Shell	Burnt shell
S8-10-MM2	S8-09/10-L13	0-95 mm	D1	3a, 3b	35 %	*-ff-fff	ffff	aaaa
S8-10-MM3	S8-09/10-L28 (upper)	0-100 mm	C3	3b, 3a	20 %-45 %	ff-fff	*	aaa-a*
S8-09-MM6	S8-09/10-L28 (lower)	0-70 mm	C2	3b	35 %	fff	f	aa
S8-09-MM7	S8-L29 [base of Grey Series]	0-60(70) mm	C1	3a(1c)	45 %	fff	f	
S8-09-MM7	S8-L30 [top of Yellow Series]	60(70)-80 mm	A3	1c	40 %	ffff	*	
S8-09-MM8	S8-Yell08[2-12] [equivalent to the middle part of S8-Y1]	0-75 mm	A2	1b	40 %	fff	*	
S8-09-MM9	Unit S8-Yell08[16-18] and part of Unit [12-16] [equivalent to the upper part of S8-Y2spit1]	0-25 mm	B2	FS-2a-1a	35-40 %		*	
S8-09-MM9	upper part of Unit S8-Yell08[18-23] [equivalent to the middle part of S8-Y2spit1]	25-75 mm	B1	FS,1b/1b2a,2b,FS	40 %	*	*	
S8-09-MM10	centred on S8-Yell08[33-38] [equivalent to part of S8-Y2spit2]	0-70 mm	A1	1a	35 %	ff	f	

Thin section	Root residues	Charcoal	Bone	Burnt bone	Fish bone	$CaCO_3$	Burnt chert	Wetland? clay	Coprolite (hyaena?)	CaP guano?	Poss omniv cop	Burnt soil	Burnt lime/spel
S8-10-MM2		aaaaa	a	aaaa		aaaa		a*				a*	a*
S8-10-MM3	a*	aaaaa		aaa	?	aaaaa		a*				a(aaa)	aaaaa
S8-09-MM6	a(a)	aaaaa		aaaa		aaaaa		a(burnt)				a(aaa)	aaaaa
S8-09-MM7		aaaaa	a	aaa		aaaa	a-1	aa				a	aaa
S8-09-MM7	a*	aaa	aaa	a*					aaa	?			
S8-09-MM8		aaaa	aaaaa	a	a*?				aaaaa	a*	a*	(a*)	
S8-09-MM9		a*											
S8-09-MM9		a	a*						a*				
S8-09-MM10		aaa	aaa	a			a-1			aaa		a-1	

Thin section	Matrix infills	2^{ndary} $CaCO_3$	$CaCO^3$	Neoform speleothem	Thin burrows	Broad burrows	V. thin organo-min. excr.	Thin organo-min. excr.	Broad organo-min. excr.
S8-10-MM2					aaaaa	aaaa	aaaaa	aaa	
S8-10-MM3		aa			aaaa	aaaaa	aaa	aaaaa(tot)	
S8-09-MM6		aa	a*		aaaaa	aaaaa	aaaaa	aaaa	
S8-09-MM7					aaaaa	aaa	aaaaa	aaaa	
S8-09-MM7		a-1	a-1		aaaaa	aa	aaaaa	aaa	

Thin section	Matrix infills	2ndary $CaCO_3$	$CaCO^3$	Neoform speleothem	Thin burrows	Broad burrows	V. thin organo-min. excr.	Thin organo-min. excr.	Broad organo-min. excr.
S8-09-MM8	a				aaaaa	aaaaa	aaaaa	aaaa	aaa(tot)
S8-09-MM9	(aa)	aa	a	aa	aa	a	aaa	a	
S8-09-MM9	aa	aaaa	aaa	aaa	aaaa	aaaaa	aaaaa	aa	
S8-09-MM10	aaaa	a			aaa	aaaa	a	aaa	aaaaa(tot)

Tab. 3.1 Taforalt Cave, Morocco: soil micromorphology samples and counts. – * = very few 0-5 %; f = few 5-15 %; ff = frequent 15-30 %; fff = common 30-50 %; ffff = dominant 50-70 %; fffff = very dominant >70 %; a = rare <2 % (a*1 %; a-1; single occurrence); aa = occasional 2-5 %; aaa = many 5-10 %; aaaa = abundant 10-20 %; aaaaa = very abundant >20 %.

Microfacies type (MFT)/Soil micro-fabric type (SMT)	Sample No.	Depth (relative depth) Soil Micromorphology (SM)	Summary and Comments
MFT D1/SMT 3a, 3b	S8-10-MM2	0-95 mm SM: very dominant very shell-rich calcitic grey and darkish grey ash residues (SMT 3a), with common sub-horizontally oriented shell, and frequent burrow fills of more charcoal-rich ashy sands (SMT 3b); *Microstructure*: massive with both sloping broad layering and sub-horizontal diffuse fine layering, and pellety, 35 % voids, complex packing voids, open sub-horizontal fissures; *Coarse Mineral*: as SMT 3a and 3b, with for example layers of very few gravel (30-60 mm depth), common gravel-size material (c. 60-80 mm depth; max 5 mm, burnt soil; with coarse bone, 12 mm), and frequent gravel at 15-30 mm depth (max 9 mm, limestone); *Organic and Anthropogenic*: abundant fine to coarse charcoal throughout, with bands (max 9 mm) of very abundant and associated calcitic crystals and ash *sensu lato* which is patchily abundant throughout, very abundant shell with abundant burnt shell, often showing sub-horizontal orientation, and with broken fragments, abundant mainly fine bone with coarse examples (max 13 mm), very dominantly rubefied, some of possible coprolitic origin, rare trace of clay clasts and unburnt reddish soil, fine burnt soil (max 5 mm) and burnt limestone and other minerogenic material and a possible 2 mm size chert flake(?); *Fine Fabric*: as SMT 3a and 3b; *Pedofeatures*: *Fabric*: very abundant thin and abundant broad burrows; *Excrements*: very abundant very thin and many thin organo-mineral excrements, with loose total excremental microfabric.	S8-09/10-L13 The uppermost sample of the Grey Series is made up of very dominant, very shell-rich calcitic grey and darkish grey ash residues, with common sub-horizontally oriented shell (**figs 3.43-3.46**), and frequent burrow fills of more charcoal-rich ashy sands, with for example layers within the thin section of the following materials: very few gravels at 30-60 mm depth; common gravel-size material at c. 60-80 mm depth (max 5 mm, burnt soil; with coarse bone, 12 mm); and frequent gravel at 15-30 mm depth (max 9 mm, limestone). There are abundant fine to coarse charcoals throughout, with bands (max 9 mm) of very abundant and associated calcitic crystals and ash *sensu lato* which is patchily abundant throughout, very abundant shell with abundant burnt shell, often showing sub-horizontal orientation, and with broken fragments, abundant mainly fine bone with coarse examples (max 13 mm), very dominantly rubefied but some of possible coprolitic origin, rare trace of clay clasts and unburnt reddish soil, fine burnt soil (max 5 mm) and burnt limestone and other minerogenic material, and a possible 2 mm size chert flake(?) (**figs 3.47-3.48**). Very abundant thin and abundant broad burrows, and very abundant very thin and many thin organo-mineral excrements, with loose total excremental microfabric.

Tab. 3.2 Taforalt Cave, Morocco: soil micromorphology descriptions and preliminary comments.

Microfacies type (MFT)/Soil micro-fabric type (SMT)	Sample No.	Depth (relative depth) Soil Micromorphology (SM)	Summary and Comments
MFT C2/SMT 3b, 3a	S8-10-MM3	0-100 mm SM: broadly and diffusely layered and broadly burrowed composed of dominant dark brownish grey fine charcoal-rich calcitic ash residues (SMT 3b) fine charcoal-rich dusty calcitic grey silty sands (SMT 3a); *Microstructure*: massive, with open 45 % voids (complex packing voids mainly) in broad burrows and compact 20 % voids (fine channels) throughout generally; *Coarse Mineral*: as SMT 3a and 3b, with common gravel and small stones (e. g. burnt limestone – max 19 mm) in broad burrowed areas, and frequent gravel (max 6 mm) in compact deposits; *Organic and Anthropogenic*: abundant fine and coarse charcoal (max 7 mm), many rubefied bone (max >11 mm), very abundant burnt limestone and speleothem and abundant ash residues in broad burrows, and generally very abundant fine and coarse charcoal (max 9 mm), abundant rubefied fine bone (max c. 2 mm), many burnt soil and fine minerogenic inclusions, very abundant burnt limestone and speleothem and very abundant ash and semi-cemented ash, with embedded very fine charcoal, rare shell (max 5 mm) and many burnt shell including bivalve material (max 5 mm), often with charcoal sometimes showing sub-horizontal orientation, and with 5 mm example of clay, with trace of very fine fibrous roots; *Fine Fabric*: *Pedofeatures*: *Depletion*: examples of included partially decalcified speleothem; *Crystalline*: occasional recalcifications and example of partial micritisation of burnt bone; *Fabric*: abundant thin and very abundant broad burrows; *Excrements*: many very thin and very abundant thin organo-mineral excrements, with compacted total excremental microfabric.	S8-09/10-L28 (upper) This upper part of L28 is broadly and diffusely layered and broadly burrowed (**fig. 3.36**). It is composed of dominant dark brownish grey fine charcoal-rich calcitic ash residues fine charcoal-rich dusty calcitic grey silty sands. Common gravel and small stones (e. g. burnt limestone, max 19 mm) in broad burrowed areas, and frequent gravel (max 6 mm) in compact deposits. Abundant fine and coarse charcoal (max 7 mm), many rubefied bone (max >11 mm), very abundant burnt limestone and speleothem and abundant ash residues were found in broad burrows, while generally very abundant fine and coarse charcoal (max 9 mm), abundant rubefied fine bone (max c. 2 mm), many burnt soil and fine minerogenic inclusions, very abundant burnt limestone and speleothem and very abundant ash and semi-cemented ash, with embedded very fine charcoal, rare shell (max 5 mm) and many burnt shell including bivalve material (max 5 mm), often with charcoal sometimes showing sub-horizontal orientation, and with 5 mm example of clay, with trace of very fine fibrous roots (**figs 3.36-3.42**). Occasional recalcifications and an example of partial micritisation of burnt bone, abundant thin and very abundant broad burrows, and many very thin and very abundant thin organo-mineral excrements, with compacted total excremental microfabric.

Microfacies type (MFT)/Soil micro-fabric type (SMT)	Sample No.	Depth (relative depth) Soil Micromorphology (SM)	Summary and Comments
MFT C2/SMT 3b	S8-09-MM6	SM: very dominant dark brownish grey calcitic ash residues (SMT 3b) with patches and broad burrow fills of fine charcoal-rich dusty calcitic grey silty sands (SMT 3a); *Microstructure*: massive, pellety and channel, 35 % voids, complex packing voids, chambers and channels; *Coarse Mineral*: C:F=65:35, moderately poorly sorted with quartz and feldspar sand, and with sand-size probably burnt limestone, speleothem and fused calcitic ash clasts; also present are common gravel-size clasts of limestone, burnt limestone and speleothem variants (max 8 mm); *Organic and Anthropogenic*: very abundant fine to coarse charcoal (max 9 mm), including several examples of sub-horizontally oriented material, very abundant ash residues (examples of plant tissue remains) and blackened and fissured burnt limestone and speleothem throughout, many shell (including much burnt shell, many bivalve and gastropod examples), abundant bone, mainly weakly to strongly rubefied burnt bone (max 15 mm), rare burnt red silt loam soil (max 3.5 mm) and possible 'wetland clay' (max 6 mm), occasional very fine to fine root remains, some fibrous (max 1.5 mm), some earlier calcitic pseudomorphs; *Fine Fabric*: SMT 3b: cloudy dark brownish grey (PPL), moderately high to high interference colours (compact intergrain aggregate to loose open porphyric, crystallitic b-fabric, XPL), pale brownish grey (OIL), with weak iron stained amorphous organic matter staining and occasional very fine charcoal; *Pedofeatures*: *Depletion*: many areas of partial decalcification of microfabric, with many partially decalcified inclusions (speleothem fragments); *Crystalline*: occasional micritic calcite infilling and void coatings, and root pseudomorphs, with possible layer cementation; *Fabric*: very abundant thin and broad burrows; *Excrements*: very abundant very thin and abundant thin organo-mineral excrements.	S8-09/10-L28 (lower) Very dominant dark brownish grey calcitic ash residues with patches and broad burrow fills of fine charcoal-rich dusty calcitic grey silty sands, with common gravel-size clasts of limestone, burnt limestone and speleothem variants (max 8 mm) (**figs 3.32-3.35**). Very abundant fine to coarse charcoal (max 9 mm), including several examples of sub-horizontally oriented material, very abundant ash residues (examples of plant tissue remains) and blackened and fissured burnt limestone and speleothem throughout, many shell fragments, including much burnt shell, and many bivalve and gastropod examples (**figs 3.32-3.35**). As found below, there is abundant bone, which is mainly weakly to strongly rubefied burnt bone (max 15 mm), rare burnt red silt loam soil (max 3.5 mm) and possible 'wetland clay' (max 6 mm). Occasional very fine to fine root remains (some fibrous. max 1.5 mm) and some earlier-formed calcitic pseudomorphs. Occasional micritic calcite infilling and void coatings, and root pseudomorphs, with possible layer cementation, very abundant thin and broad burrows, and very abundant very thin and abundant thin organo-mineral excrements.

Tab. 3.2 (continued)

Microfacies type (MFT)/Soil micro-fabric type (SMT)	Sample No.	Depth (relative depth) Soil Micromorphology (SM)	Summary and Comments
MFT C1/SMT 3a (1c)	S8-09-MM7	0-60(70) mm SM: Very dominant fine charcoal-rich dusty calcitic grey silty sands (SMT 3a), with few patches of greyish reddish brown weakly calcitic clay loam (SMT 1c); *Microstructure*: massive, diffusely layered, with occasional sub-horizontal orientation of coarse inclusions, 45 % voids, channels, chambers and complex packing voids; *Coarse Mineral*: C:F=70:30, poorly sorted with silt, fine sand (quartz, feldspars, calcite), with medium and coarse sand (limestone, sandstone, speleothem), and common gravel to stone size clasts (shell, speleothem, limestone: max >25 mm); *Organic and Anthropogenic*: example of possible fire-cracked siliceous rock (9 mm), occasional fine clay clasts with example of 8 mm long flattish pale brown and very weakly humic clay fragment (phytoliths and spore/pollen and fine channel microstructure present – wetland clay?), with associated very fine red-burnt(?) mineral material, with rare examples of burnt(?) 'clay' (max 3.5 mm: soil clasts with relict root channels), many likely burnt(?) limestone with attached speleothem (cracked and blackened), very abundant bone, including many burnt bone (max 13 mm – both strongly rubefied to weakly calcined), very abundant fine to coarse charcoal, including 10 mm long sub-horizontally oriented material, with abundant ash residues throughout and a rare trace of isotropic (hyaena?) coprolite (at the very base of this mixed layer); *Fine Fabric*: SMT 3a: dusty and dotted cloudy grey (PPL), patchy high interference colours (intergrain aggregate, linked grain and porphyric, crystallitic b-fabric, XPL), very pale brownish grey (OIL), abundant very fine charcoal and charred organic matter, with phytoliths and probable calcitic ash present; *Pedofeatures*: *Depletion*: probable many areas of partial decalcification of microfabric, with partially decalcified inclusions (speleothem fragments); *Fabric*: very abundant thin and many broad burrows; *Excrements*: very abundant very thin and abundant thin organo-mineral excrements.	*S8-L29 [base of Grey Series]* The upper part of this slide (L29) shows a marked change to very dominant fine charcoal-rich dusty calcitic grey silty sands, with a few patches of greyish reddish brown weakly calcitic clay loam, diffusely layered, with occasional sub-horizontal orientation of coarse inclusions (**fig. 3.20**). Common gravel to stone-size clasts (shell, speleothem, limestone: max >25 mm), an example of possible fire-cracked siliceous rock (9 mm), occasional fine clay clasts with an example of an 8 mm long flattish pale brown and very weakly humic clay fragment. The clay embeds phytoliths and spores/pollen and has a fine channel microstructure, which together suggest that it is wetland clay sediment. The deposit also includes very fine red-burnt(?) mineral material, with rare examples of burnt(?) 'clay', some examples (max 3.5 mm) being soil clasts with relict root channels. In addition, many likely burnt(?) limestone clasts with attached speleothem that are cracked and blackened, very abundant bone, including many burnt strongly rubefied to weakly calcined bone (max 13 mm), and very abundant fine to coarse charcoal, including 10 mm long sub-horizontally oriented material. There are abundant ash residues throughout but only a rare trace of isotropic (hyaena?) coprolite was identified at the very base of this mixed unit) (**figs 3.24-3.31**). Many areas of partial probable decalcification of microfabric, with partially decalcified inclusions (speleothem fragments), very abundant thin and many broad burrows, and very abundant very thin and abundant thin organo-mineral excrements. There is a diffuse boundary to L30 below.

Microfacies type (MFT)/Soil micro-fabric type (SMT)	Sample No.	Depth (relative depth) Soil Micromorphology (SM)	Summary and Comments
MFT A3/SMT 1c	S8-09-MM7	Diffuse boundary 60(70)-80 mm SM: Very dominant pale greyish reddish brown weakly calcitic gravelly clay loam (SMT 1c); *Microstructure*: massive, pellety, 40 % voids, complex packing voids and channels; *Coarse Mineral*: as SMT 1a, with dominant gravel and small stone-size clasts (max 12 mm, mainly partially decalcified speleothem and attached limestone, with (hyaena?) coprolites; *Organic and Anthropogenic*: many fine charcoal (max 1 mm), fine bone (max 1 mm, with heated bone examples) and (hyaena?) coprolites (max c. 2.5 mm), with probable recent root material within 5 mm wide rhizolith – calcitic void hypocoating; *Fine Fabric*: SMT 1c: cloudy pale greyish reddish brown (PPL), moderate interference colours (intergrain aggregate and porphyric, crystallitic b-fabric, XPL), pale greyish orange (OIL), occasional very fine amorphous organic matter and charred OM; *Pedofeatures*: *Depletion*: very abundant partially decalcified inclusions (speleothem fragments); *Crystalline*: example of 5 mm-size calcitic root channel hypocoating; *Fabric*: very abundant thin and occasional broad burrows; *Excrements*: very abundant very thin and many thin organo-mineral excrements, with partial total excremental microfabric.	S8-L30 [top of Yellow Series] The lower part (L30) of this thin section sample is composed of a very dominant pale greyish reddish brown weakly calcitic gravelly clay loam, with dominant gravel and small stone-size clasts (max 12 mm, mainly partially decalcified speleothem and attached limestone, with (hyaena?) coprolites (**figs 3.20-3.23**)). Present are: many fine charcoal (max 1 mm), fine bone (max 1 mm with heated bone examples) and (hyaena?) coprolites (max c. 2.5 mm), with probable recent root material within 5 mm wide rhizoliths (calcitic void hypocoating). The interval is characterised by very abundant partially decalcified inclusions (speleothem fragments), an example of a 5 mm-size calcitic root channel hypocoating (**figs 3.21-3.23**), very abundant thin and occasional broad burrows and very abundant very thin and many thin organo-mineral excrements, with partial total excremental microfabric.

Tab. 3.2 (continued)

Microfacies type (MFT)/Soil micro-fabric type (SMT)	Sample No.	Depth (relative depth) Soil Micromorphology (SM)	Summary and Comments
MFT A2/SMT 1b	S8-09-MM8	0-75 mm SM: homogeneous poorly to moderately calcitic darkish reddish brown clay loam and sandy loam variants (SMT 1b); *Microstructure*: massive, pellety, channel, 40 % voids, channels, chambers and complex packing voids; *Coarse Mineral*: as SMT 1a, poorly sorted silts and fine sands, with medium and coarse sands, and common gravel size clasts of speleothem (max 7 mm) and limestone, with bone and coprolites for example; *Organic and Anthropogenic*: very abundant grey, isotropic BL autofluorescent coprolites (max 4 mm; likely hyena with embedded silt, and examples with channel pseudomorphs of hair/fur), < 1 mm size orange brown coprolites – one with embedded charred organic matter and red-burnt(?) mineral matter (possibly omnivore – possibly human??), very abundant fine to coarse bone (max 7.5 mm; including very poorly preserved examples [coprolitic – example embedded in phosphatised sediment], rare probably burnt bone, possible bird and fish bones material), abundant fine to coarse wood charcoal (max 8 mm), and rare trace of guano and very fine red-burnt(?) mineral matter; *Fine Fabric*: as SMT 1a, darkish cloudy and finely speckled reddish brown (PPL), XPL as SMT 1a, orange to darkish orange (OIL), abundant very fine organic traces and charred organic matter; *Pedofeatures*: *Textural*: rare matrix infills; *Depletion*: rare trace of decalcified inclusions; *Fabric*: very abundant thin and broad burrows; *Excrements*: very abundant very thin, abundant thin and many broad organo-mineral excrements, with partial total excremental microfabric.	*S8-Yell08[2-12] [equivalent to the middle part of S8-Y1]* Homogeneous poorly to moderately calcitic darkish reddish brown clay loam and sandy loam variants, composed of poorly sorted silts and fine sands, with medium and coarse sands, and common gravel size clasts of speleothem (max 7 mm) and limestone, together with coarse bone and coprolites (**fig. 3.13**). The last include very abundant grey, isotropic BL autofluorescent coprolites (max 4 mm; likely hyena with embedded silt. Other < 1 mm size orange brown coprolites were observed, one with embedded charred organic matter and red-burnt(?) mineral matter, which is possibly from an omnivore (human?), and which is moderately to moderately strongly autofluorescent under BL and contains fine spores/pollen (<~50 µm). Also, very abundant fine to coarse bone (max 7.5 mm; including very poorly preserved examples (coprolitic – example embedded in phosphatised sediment), rare probably burnt bone, possible bird and fish bones material), abundant fine to coarse wood charcoal (max 8 mm), and rare traces of guano and very fine red-burnt(?) mineral matter (**figs 3.13-3.19**). Rare matrix infills, a rare trace of decalcified inclusions, very abundant thin and broad burrows, and very abundant very thin, abundant thin and many broad organo-mineral excrements, with partial total excremental microfabric.

Microfacies type (MFT)/Soil micro-fabric type (SMT)	Sample No.	Depth (relative depth) Soil Micromorphology (SM)	Summary and Comments
MFT B2/SMT FS over 2a over 1a	S8-09-MM9	0-25 mm Somewhat fragmented, but with: SM: layers of fine to medium sands (SMT FS) over strongly calcareous grey fine sandy loam (SMT 2a), and over laminated moderately calcitic reddish brown clay loam and loamy sand types (SMT 1a); *Microstructure*: massive, layered, 35-40 % voids, channels, simple packing voids upwards; *Coarse Mineral*: silts and fine sands, with upper layer of moderately well sorted fine to medium sands; *Organic and Anthropogenic*: trace of fine charcoal; *Fine Fabric*: as SMT 1a, 2a and FS; *Pedofeatures*: *Textural*: very abundant essentially decalcified clayey laminae (panning) at c. 16-22 mm depth with occasional matrix intercalations; *Depletion*: nothing evident; *Crystalline*: occasional mainly micritic microlaminated speleothem growths and rare root channel hypocoatings and rare root pseudomorphs; *Fabric*: occasional thin and rare broad burrows; *Excrements*: many very thin and rare thin organo-mineral excrements at c. 12-16 mm.	*Unit S8-Yell08[16-18] and part of Unit [12-16] [equivalent to the upper part of S8-Y2spit1]* Somewhat fragmented in this upper part of the slide, but with clear layers of fine to medium sands over strongly calcareous grey fine sandy loam; below these are laminated moderately calcitic reddish brown clay loam and loamy sand types (**figs 3.6, 3.11-3.12**). A trace of fine charcoal. Very abundant essentially decalcified clayey laminae (panning) at c. 16-22 mm depth with occasional matrix intercalations, occasional mainly micritic microlaminated speleothem growths and rare root channel hypocoatings and rare root pseudomorphs, occasional thin and rare broad burrows, and many very thin and rare thin organo-mineral excrements at c. 12-16 mm.

Tab. 3.2 (continued)

Microfacies type (MFT)/Soil micro-fabric type (SMT)	Sample No.	Depth (relative depth) Soil Micromorphology (SM)	Summary and Comments
MFT B1/SMT FS, 1b over SMT 1b, 2a, 2b, FS	S8-09-MM9	35-75 mm SM: heterogeneous with dominant (broad and thin burrow-mixed) reddish grey moderately calcareous fine sandy clay loam (SMT 1b), strongly calcareous grey fine sandy loam (SMT 2a) and loamy fine sands (SMT 2b), with increasingly common fine sand concentrations (SMT FS) upwards (c. 25-40 mm); *Microstructure*: massive, with relict layering, pellety and channel, 40 % voids, simple and complex packing voids, chambers and channels; *Coarse Mineral*: C:F – 2a=70:30, 2b=90:10, moderately well sorted silts and fine sands, with very few medium, and coarse sands, and gravel (max 8 mm – speleothem/limestone clast); mineralogy as below with only examples of shell; *Organic and Anthropogenic*: rare wood charcoal (max 4 mm), an example of CaP coprolite (1.5 mm; fine channels possibly pseudomorphic of hair – hyaena?) and trace of fine bone (< 1 mm; possible hollow bird bone example), and example of eggshell (c. 1 mm); *Fine Fabric*: SMT 1b: grey red (PPL), moderately high interference colours (XPL as SMT 1a), pale orange (OIL), rare very fine charcoal; SMT 2a and 2b: pale reddish grey (PPL), high interference colours (XPL as SMT 1a), grey (OIL), minerogenic; *Pedofeatures*: *Textural*: occasional clayey infills (panning); *Depletion*: nothing evident; *Crystalline*: many mainly micritic microlaminated speleothem growths and many root channel hypocoatings and rare root pseudomorphs; *Fabric*: abundant thin and very abundant broad burrows (including mixing reddish clay downwards); *Excrements*: very abundant very thin, and occasional organo-mineral excrements.	*Upper part of Unit S8-Yell08[18-23] [equivalent to the middle part of S8-Y2spit1]* Heterogeneous with dominant (including a mix of broad and thin burrows) reddish grey moderately calcareous fine sandy clay loam, strongly calcareous grey fine sandy loam and loamy fine sands, with increasingly common fine sand concentrations upwards (c. 35-40 mm; **figs 3.6-3.8**). Moderately well sorted silts and fine sands, with very few medium and coarse sands, and gravel (max 8 mm – speleothem/limestone clast) (cf. Vanguard Cave: Macphail/Goldberg/Barton 2012). Rare wood charcoal (max 4 mm), examples of CaP coprolites (max 1.5 mm; vesicles formed by 'trapped gas' and fine channels possibly pseudomorphic of hair – hyaena?; see MM8, **figs 3.13-3.14**) (Horwitz/Goldberg 1989; Karkanas/Goldberg 2018, 68-71; Larkin/Alexander/Lewis 2000; Macphail/Goldberg 2012). Trace amounts of fine bone (< 1 mm; including possible hollow bird bone example) and example of eggshell (c. 1 mm). Cave soil is characterised by occasional clayey infills (panning), no evident decalcification, many mainly micritic microlaminated speleothem growths and many root channel hypocoatings and rare root pseudomorphs (**figs 3.9-3.10**) (Durand/Monger/Canti 2010; Gillieson 1996), abundant thin and very abundant broad burrows (including mixing of reddish clay downwards), very abundant very thin, and occasional thin organo-mineral excrements.

Microfacies type (MFT)/Soil micro-fabric type (SMT)	Sample No.	Depth (relative depth) Soil Micromorphology (SM)	Summary and Comments
MFT A1/SMT 1a	S8-09-MM10	0-70 mm SM: essentially homogeneous moderately to strongly calcitic reddish brown clay loam and sandy loam variants (SMT 1a); *Microstructure*: massive, with areas of diffuse layering, and with current channel and chamber, 35 % voids, channels, chambers, and with relict fine vughs; *Coarse Mineral*: C:F (Coarse:Fine ratio limit at ~10 µm) – 70:30 to 85:15; unsorted coarse silts and fine sands, and with medium and coarse sands (quartz, feldspar, calcite, shell, limestone), and frequent gravel to small stones (max 17 mm; shell, speleothem, examples of cave soil clasts, bone, coprolite and flint – see below); *Organic and Anthropogenic*: many fine and coarse wood charcoal (max 6 mm), probable example of 13 mm-size angular fire cracked flint, many fine bone, including variously preserved/coprolitic and with heated to burnt examples (rubefied to strongly blackened; max 3.5 mm), according to PPL colour and autofluorescence under BL; occasional fine shell (max 4 mm), and many phosphatic nodules (~CaP), some of diffusely layered probable guano origin; and possible example of blackened (burnt/) humic cave soil clast (1.5 mm); *Fine Fabric*: SMT 1a: dusty and cloudy reddish brown (PPL), moderate to moderately high interference colours (open to close porphyric, crystallitic b-fabric, XPL), orange (OIL), many to abundant very fine blackened and sometimes charred organic matter; *Pedofeatures*: *Textural*: abundant relict diffuse layering (panning), and broad void infills of matrix material (decalcified clay); *Depletion*: partial decalcification has affected calcite and speleothem clasts; *Crystalline*: rare sparitic calcite void infills; *Fabric*: many thin and abundant broad burrows; *Excrements*: rare very thin, many thin and very abundant broad organo-mineral excrements and areas of total excremental fabric.	*Centred on S8-Yell08[33-38] [equivalent to part of S8-Y2spit2]* Essentially homogeneous moderately to strongly calcitic reddish brown clay loam and sandy loam variants, composed of unsorted coarse silts and fine sands, and with medium and coarse sands (quartz, feldspar, calcite, shell), and frequent gravel to small stones (max 17 mm; shell, speleothem, examples of cave soil clasts, bone, coprolite and flint – see below) (**fig. 3.1**). There are many fine and coarse wood charcoal (max 6 mm), probable example of 13 mm-size angular fire cracked chert (**figs 3.1-3.2**), many fine bone, including variously preserved/coprolitic and with heated to burnt examples (rubefied to strongly blackened; max 3.5 mm; **fig. 3.3**); this is according to PPL colour and autofluorescence under BL. Occasional fine shell (max 4 mm), and many phosphatic nodules (~CaP), some being of probable hyaena coprolite origin (see main text), some of diffusely layered probable guano origin (Karkanas/Goldberg 2018, 68-71; Karkanas et al. 2002; Shahack-Gross/Berna/Karkanas/Weiner 2004) (cf. Vanguard Cave: Macphail/Goldberg/Barton 2012) (**fig. 3.4**); and possible example of blackened (burnt/) humic cave soil clast (1.5 mm), probably linked to a combustion zone, where cave soil had become incorporated. Abundant relict diffuse layering (panning), and broad void infills of matrix material (decalcified clay; **fig. 3.5**)), partial decalcification affecting some calcite and speleothem clasts, rare sparitic calcite void infills, many thin and abundant broad to very broad (1-5 mm) burrows; and rare very thin, many thin and very abundant broad organo-mineral excrements and areas of total excremental fabric.

Tab. 3.2 (continued)

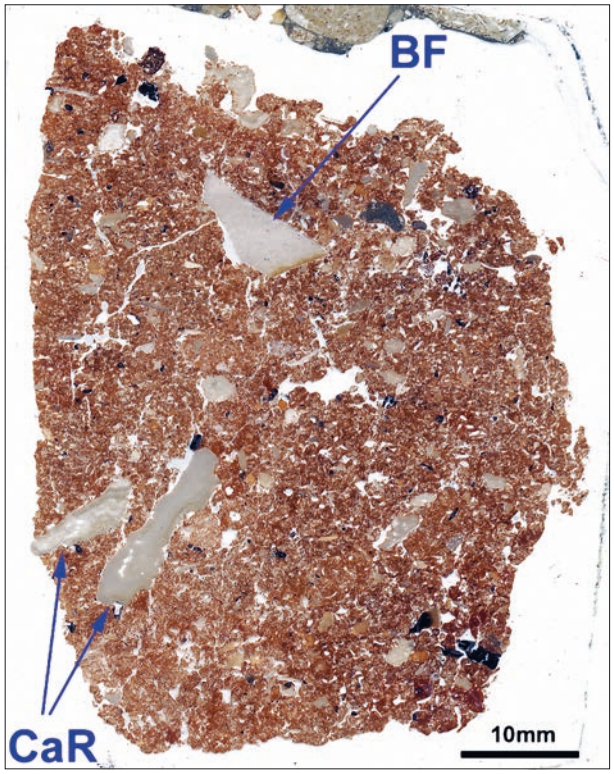


Fig. 3.1 Scan of S8-09-MM10 (centred on S8-Yell08[33-38]; equivalent to part of S8-Y2spit2); calcitic reddish brown clay loam and sandy clay loam variants, with coarse calcareous rock (**CaR**), an example of possibly burnt siliceous chert-like material (**BF**; cf. **fig. 3.2**) and charcoal. – Scale bar 10 mm.

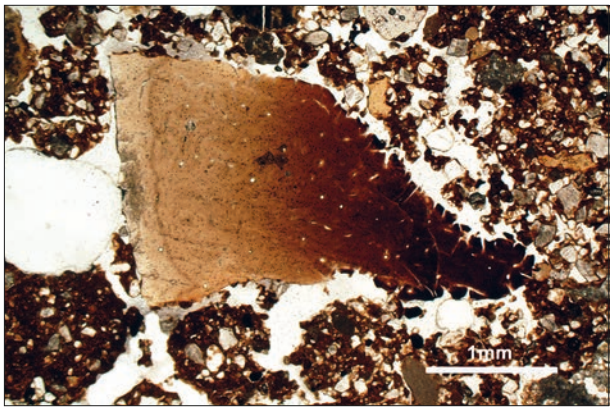


Fig. 3.3 MM10 (as **fig. 3.2**), moderately strongly to weakly burnt bone showing degrees of blackening to weak rubefication; plane polarised light (PPL). – Scale bar 1 mm.

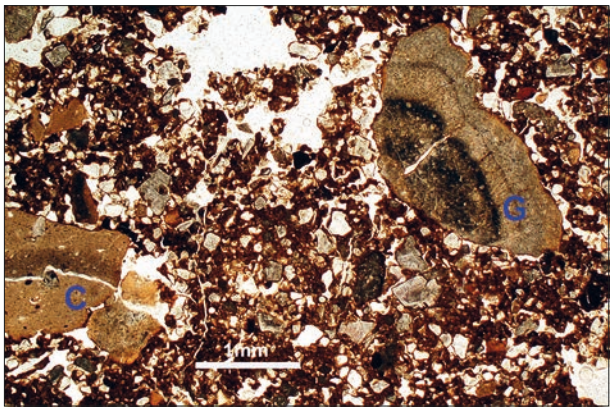


Fig. 3.4 MM10 (as **fig. 3.2**), coarse phosphatic fragments (isotropic under crossed polarised light, and autofluorescent under blue light); coprolite (**C**) and layered example of probable mineralised guano (**G**); PPL. – Scale bar 1 mm.

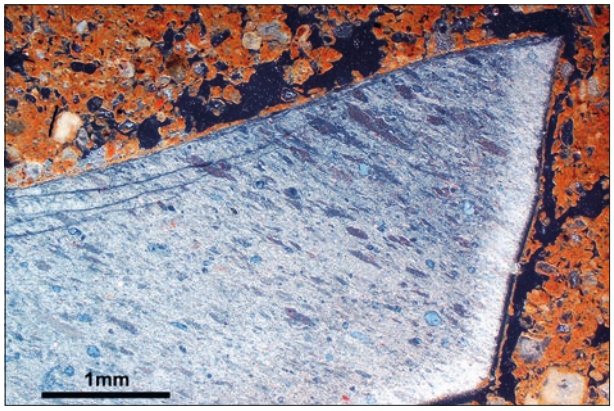


Fig. 3.2 Photomicrograph of S8-09-MM10 (centred on S8-Yell08 [33-38]; equivalent to part of S8-Y2spit2); reddish cave earth embeds possible fire cracked rock (cf. **fig. 3.1**); oblique incident light (OIL). – Scale bar 1 mm.

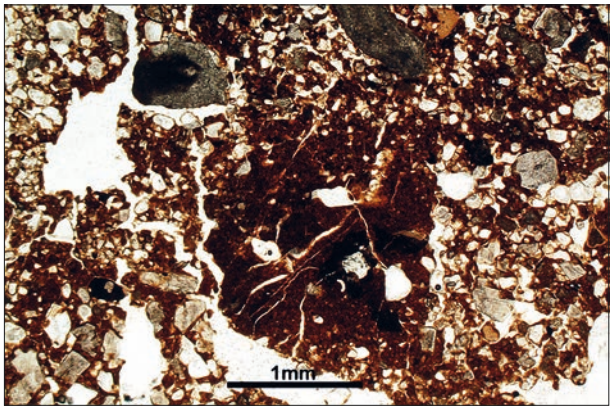


Fig. 3.5 MM10 (as **fig. 3.2**), decalcified reddish clay inwash from accumulating and overlying colluvial deposition; PPL. – Scale bar 1 mm.

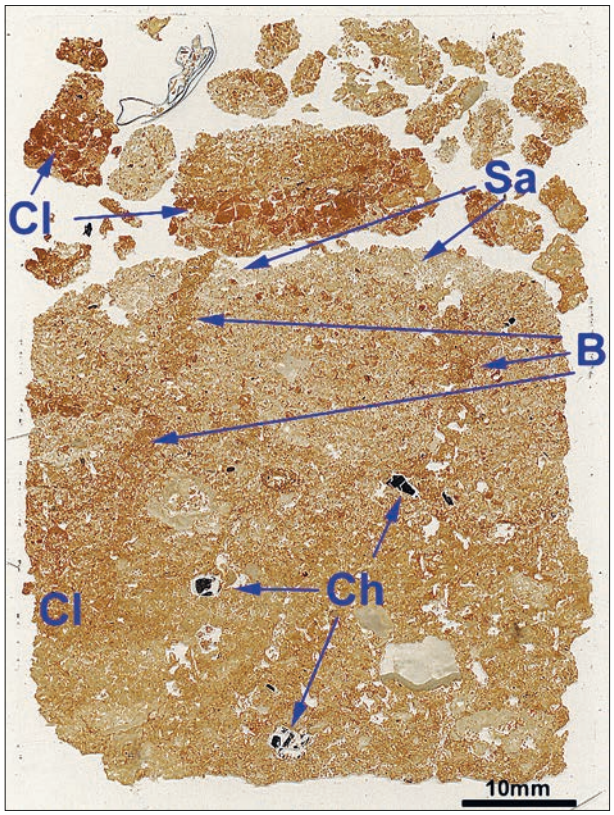


Fig. 3.6 Scan of S8-09-MM9 (Units S8-Yell08[16-23] and part of [12-16]; equivalent to the middle and upper parts of S8-Y2spit1)); calcareous fine sandy loam with burrow fills and areas of reddish grey calcareous sandy loam/clay loam (**Cl**), with upper interval of semi-intact fragments with major decalcified clay layers and pans (**Cl**); the lower interval, which includes charcoal (**Ch**) is markedly affected by burrowing (**B**); upwards, there is a fine sand layer (**Sa**) with burrows through it (**B**; cf. **figs 3.7-3.8**). – Scale bar 10 mm.

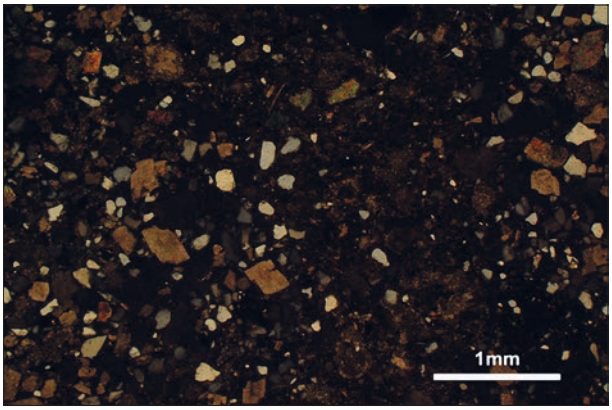


Fig. 3.8 MM9 (as **fig. 3.7**), under crossed polarised light (XPL), showing quartz-feldspar fine sands and fine sand size calcite. – Scale bar 1 mm.

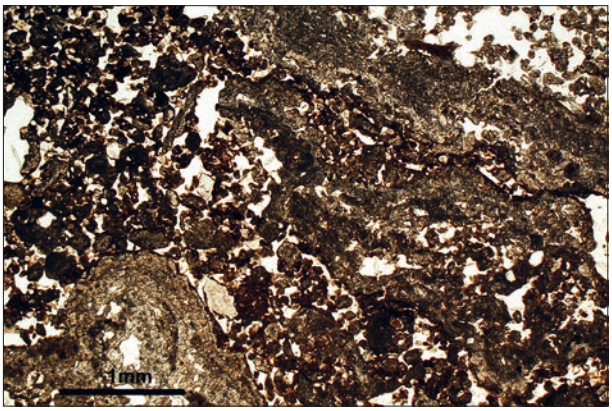


Fig. 3.9 MM9 (as **fig. 3.7**), calcitic fine sands and micritic calcite speleothem growths; PPL. – Scale bar 1 mm.

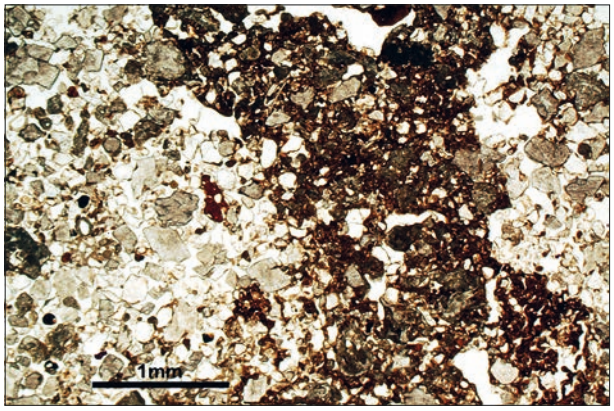


Fig. 3.7 Photomicrograph of S8-09-MM9 (Units S8-Yell08[16-23] and part of [12-16]; equivalent to the middle and upper parts of S8-Y2spit1); clayey burrow fill through fine sandy layer; PPL. – Scale bar 1 mm.

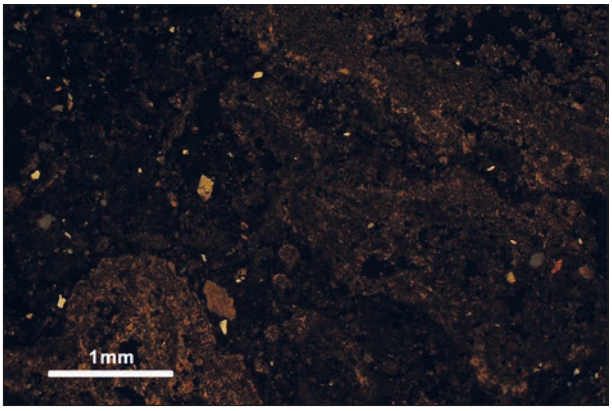


Fig. 3.10 MM9 (as **fig. 3.9**), under XPL. – Scale bar 1 mm.

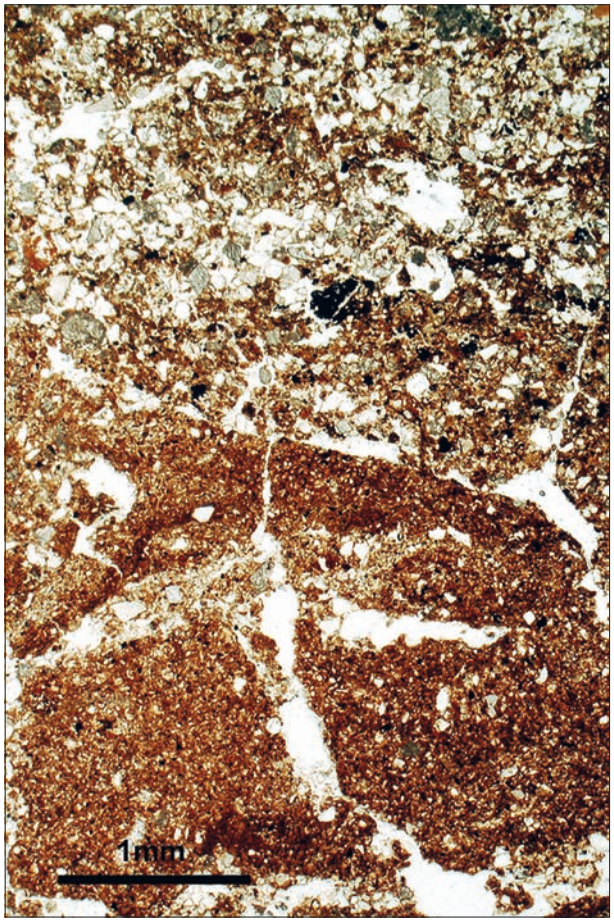


Fig. 3.11 Photomicrograph of S8-09-MM9 (Unit S8-Yell08[16-18] and part of Unit [12-16]; equivalent to the upper part of S8-Y2spit1); Upper unit in **fig. 3.6**; muddy clay layer below more fine sandy loamy fine sand; PPL. – Scale bar 1 mm.

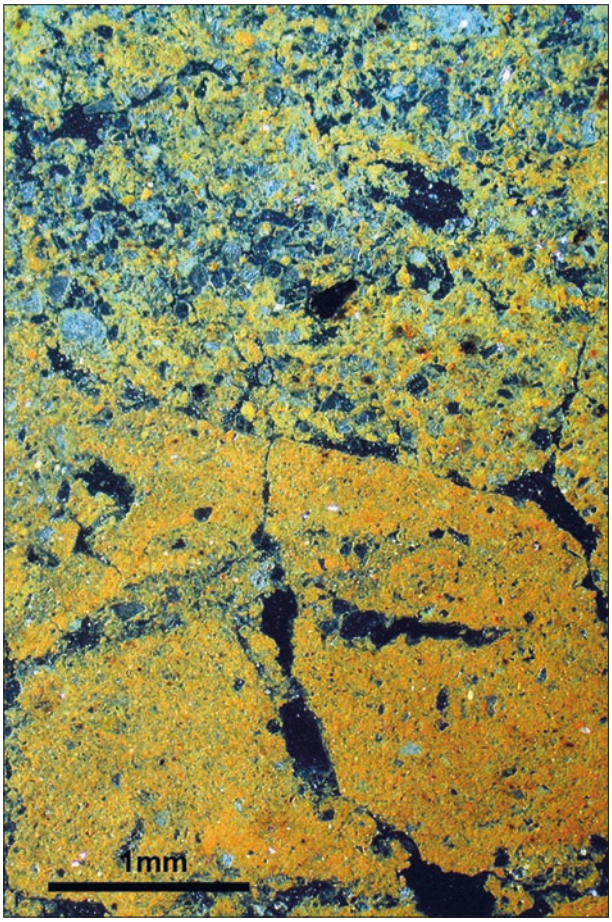


Fig. 3.12 MM9 (as **fig. 3.11**), under OIL; muddy colluvial clayey wash occurs below fine sands of windblown origin; note thin burrow mixing of the two microfacies. – Scale bar 1 mm.

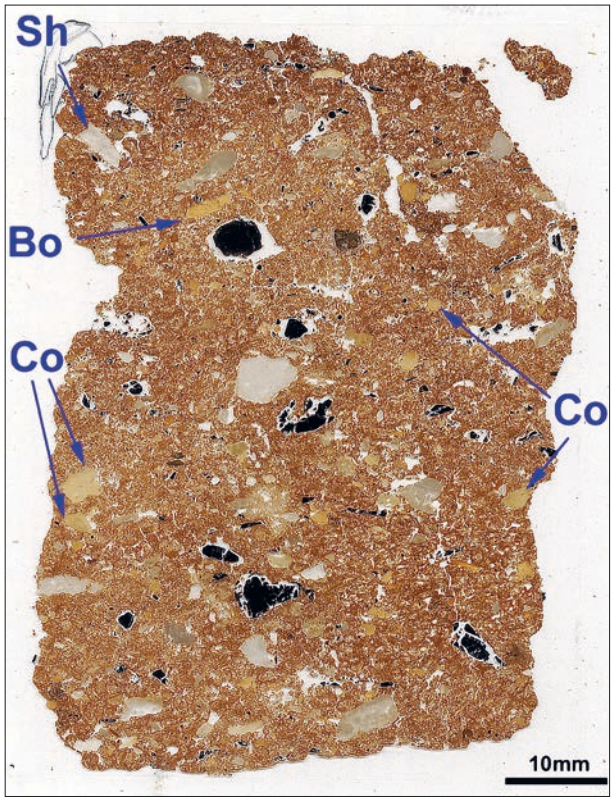


Fig. 3.13 Scan of S8-09-MM8 (S8-Yell08[2-12]; equivalent to the middle part of S8-Y1); reddish cave earth loam, with whitish calcareous rock inclusions, black fine and coarse charcoal, bone (**Bo**), shell (**Sh**) and very abundant coprolite fragments (**Co**; cf. **figs 3.14-3.15**). – Scale bar 10 mm.

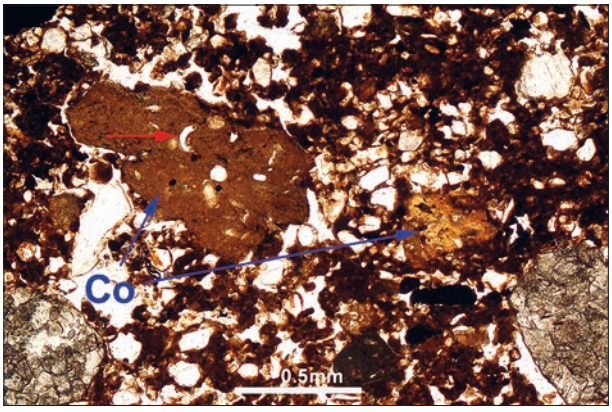


Fig. 3.14 MM8 (as **fig. 3.13**), reddish grey calcareous clay loam, with coprolitic inclusions, which are isotropic under XPL and autofluorescent under BL (blue light); note vesicles (from 'trapped gas') and fine channel probably pseudomorphic of ingested hair/fur by a carnivore such as a hyaena; PPL. – Scale bar 0.5 mm.

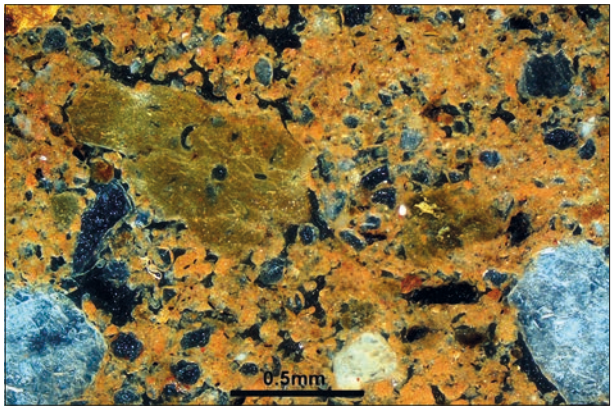


Fig. 3.15 MM8 (as **fig. 3.14**), under OIL; the cave earth is typically orange while the coprolites are a dull yellow. – Scale bar 0.5 mm.

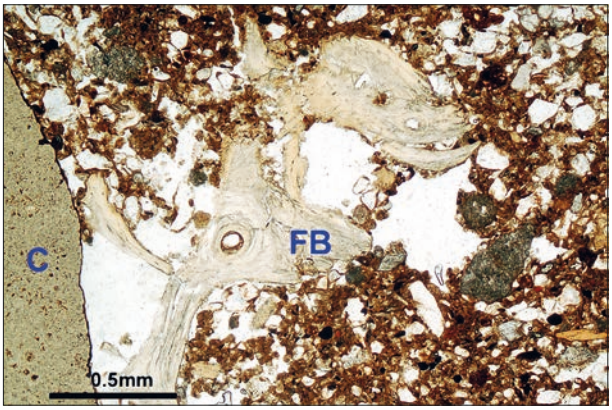


Fig. 3.16 MM8 (as **fig. 3.14**); leached white probable fish bone (**FB**) next to dusty grey (hyaena?) coprolite (**C**); PPL. – Scale bar 0.5 mm.

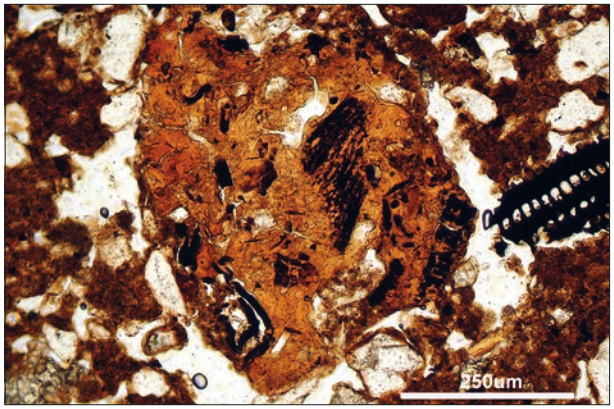


Fig. 3.17 MM8 (as **fig. 3.14**); orange brown omnivore (human?) coprolite embedding fine charcoal; PPL. – Scale bar 250 µm.

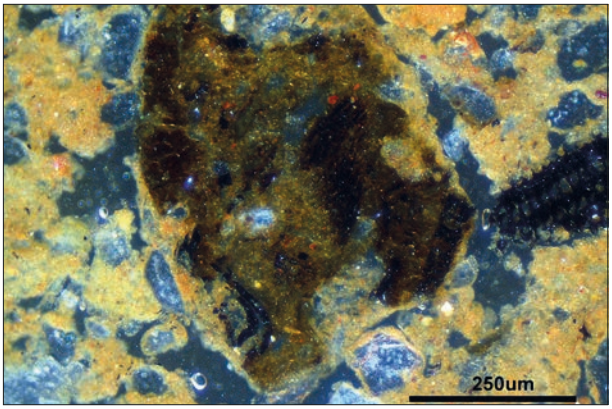


Fig. 3.18 MM8 (as **fig. 3.17**), under OIL (coprolite is isotropic under XPL, and moderately to strongly autofluorescent under BL); staining is from an organic content; note very fine red burnt minerogenic inclusions. – Scale bar 250 µm.

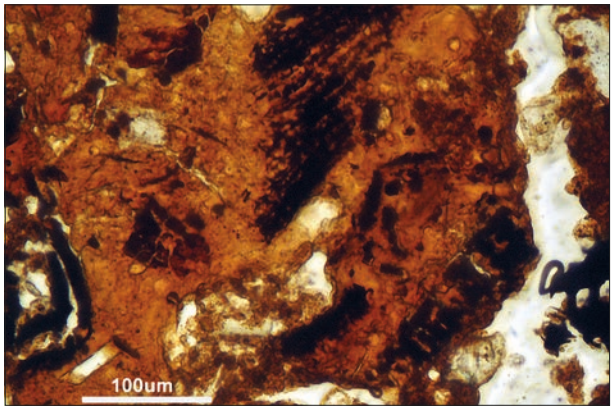


Fig. 3.19 MM8 (as **fig. 3.18**); detail of coprolite showing organic and charred organic content; spores/pollen are present (not easily visible in image); PPL. – Scale bar 100 µm.

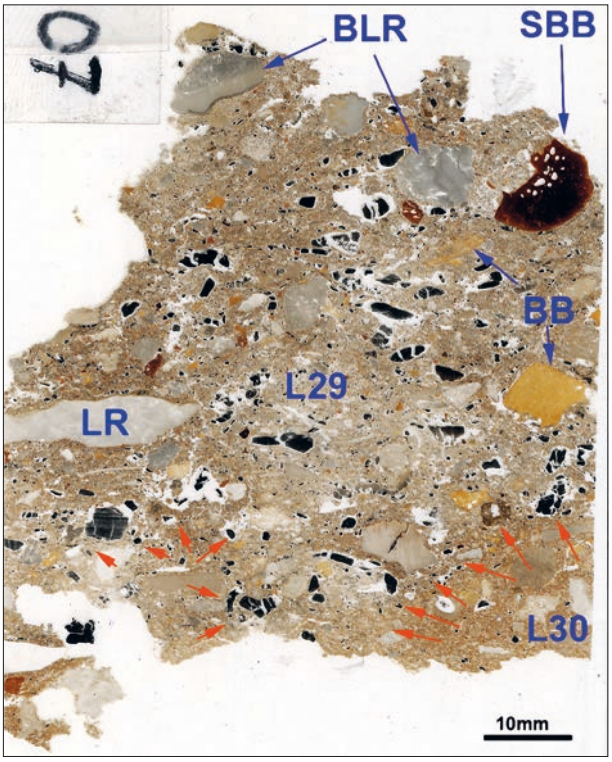


Fig. 3.20 Scan of S8-09-MM7 (crossing boundary between L29 and L30, shown by orange arrows); ashy L29 includes much charcoal, burnt calcareous rock (**BLR**), burnt bone (**BB**) and more strongly burnt bone (**SBB**), with sub-horizontally oriented travertine limestone rock (**LR**). – Scale bar 10 mm.

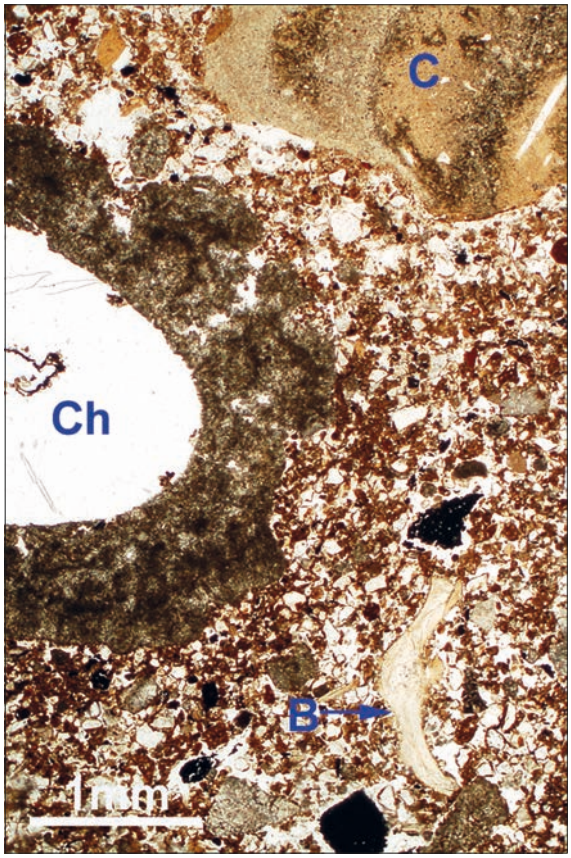


Fig. 3.21 Photomicrograph of S8-09-MM7 (L30); reddish pellety cave earth with coarse yellow (hyaena?) coprolite (**C**), bone fragment (**B**) and micritic calcite (root) channel hypocoating (**Ch**); PPL. – Scale bar 1 mm.

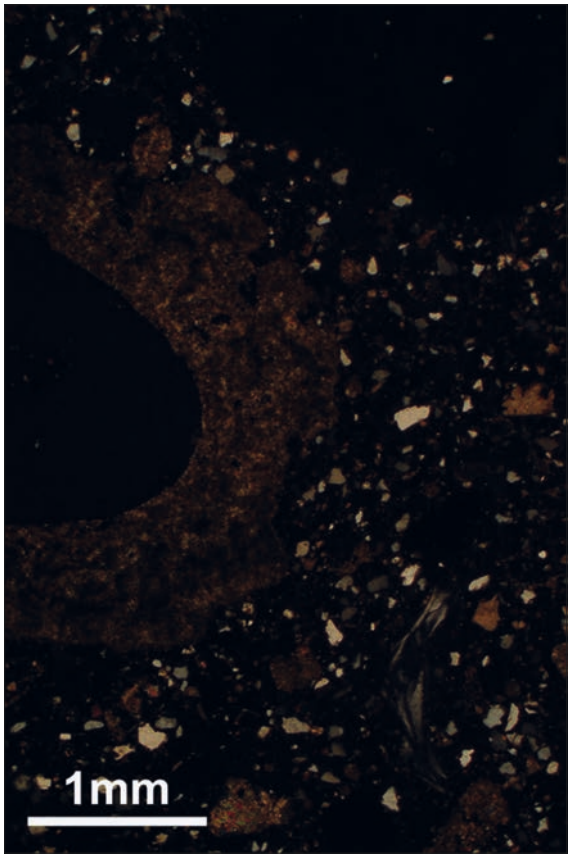


Fig. 3.22 MM7 (as **fig. 3.21**), under XPL; note silt content of cave earth, micritic calcite channel hypocoating and isotropic coprolite (calcium phosphate), whilst the bone fragment retains some birefringent properties. – Scale bar 1 mm.

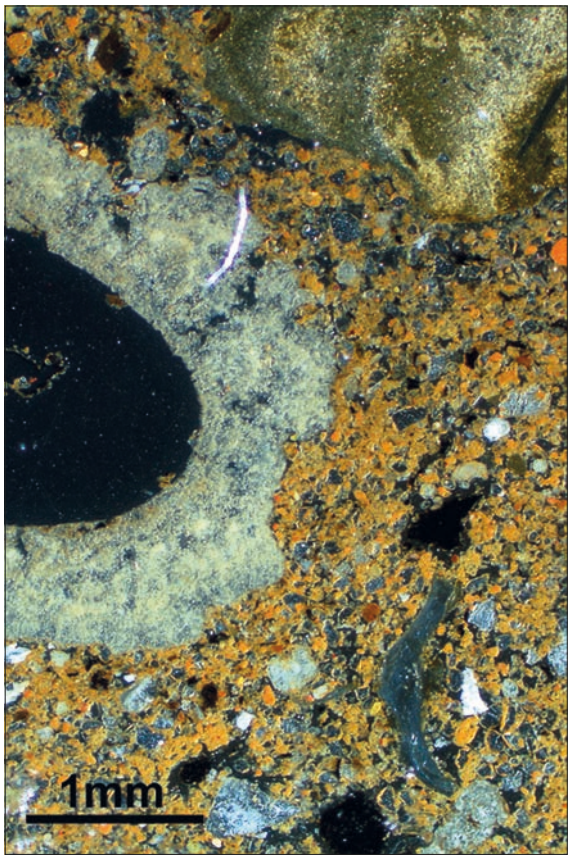


Fig. 3.23 MM7 (as **fig. 3.21**), under OIL; cave earth is typically orange; secondary calcite may have formed due to partial decalcification of ashy deposits above in L29. – Scale bar 1 mm.

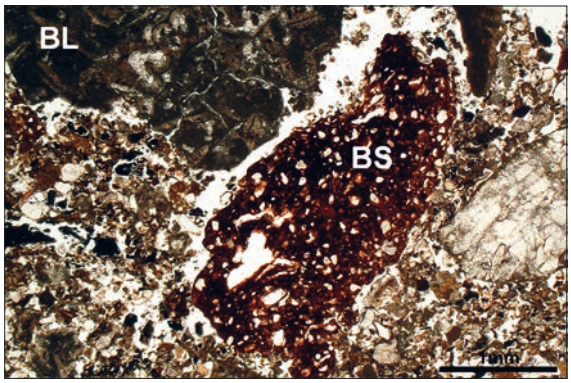


Fig. 3.24 Photomicrograph of S8-09-MM7 (L29); ashy deposits with blackened and fissured burnt limestone (**BL**) and rubefied burnt soil (**BS**) – note root channel feature; PPL. – Scale bar 1 mm.

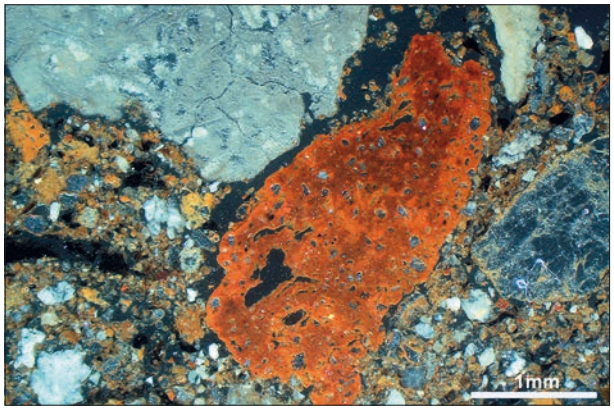


Fig. 3.25 MM7 (as **fig. 3.24**), under OIL. – Scale bar 1 mm.

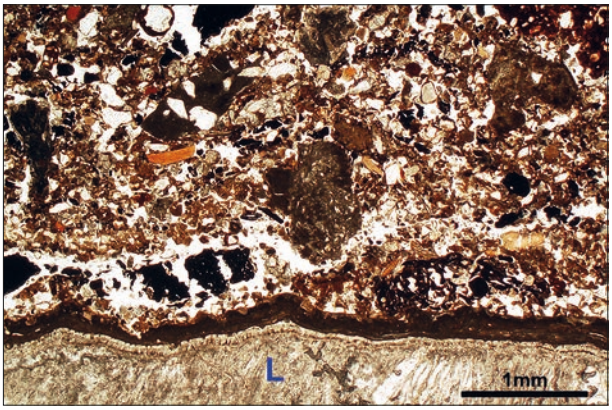


Fig. 3.26 MM7 (as **fig. 3.24**), possibly trampled ashy deposits over coarse limestone (**L**) clast (cf. **fig. 3.20**); PPL. – Scale bar 1 mm.

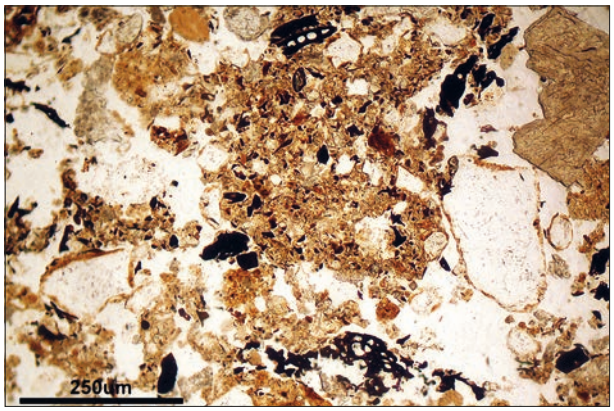


Fig. 3.27 MM7 (as **fig. 3.26**), showing very fine charcoal within ashy residues; PPL. – Scale bar 250 µm.

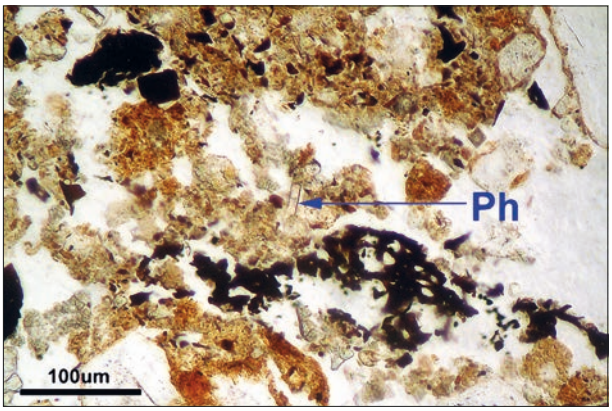


Fig. 3.28 MM7, detail of **fig. 3.27**, showing location of phytolith (**Ph**) within ash residues; PPL. – Scale bar 100 µm.

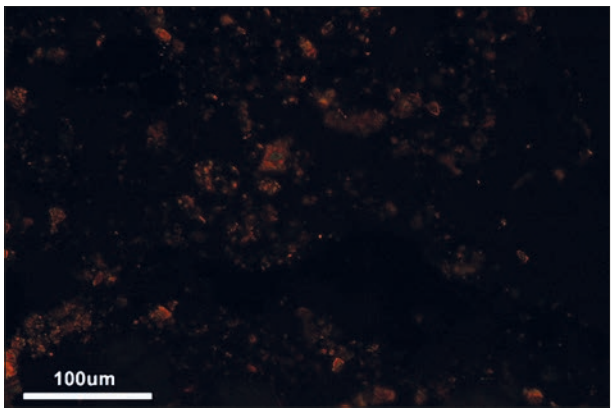


Fig. 3.29 MM7 (as **fig. 3.28**), under XPL; birefringent remains of calcitic ash crystals. – Scale bar 100 µm.

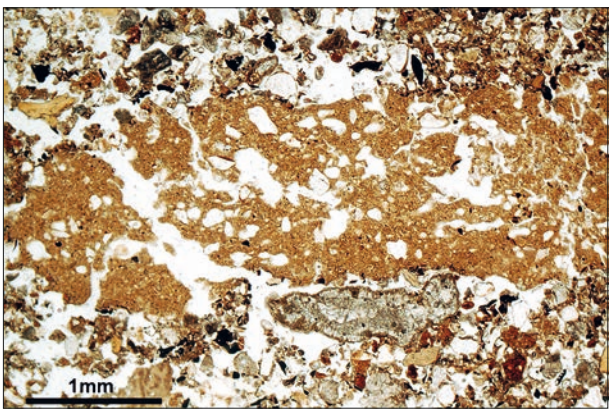


Fig. 3.30 MM7 (as **fig. 3.24**); anomalous clay clast characterised by fine channels and with microfossils, suggesting it has a wetland clay origin, and was imported into the site; PPL. – Scale bar 1 mm.

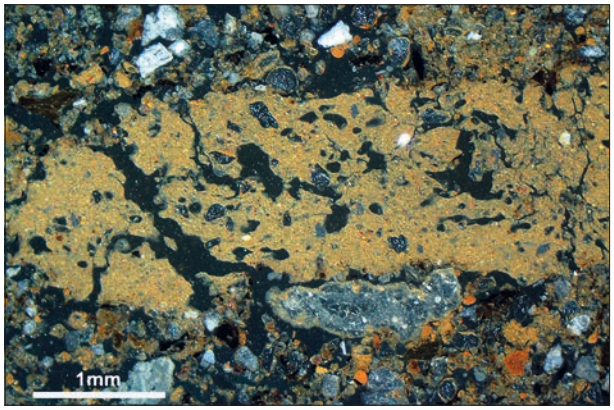


Fig. 3.31 MM7 (as fig. 3.30), under OIL. – Scale bar 1 mm.

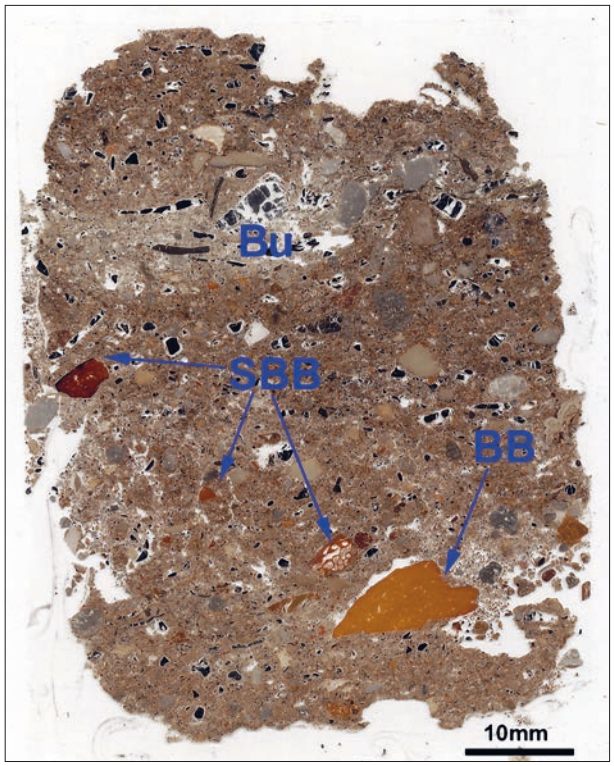
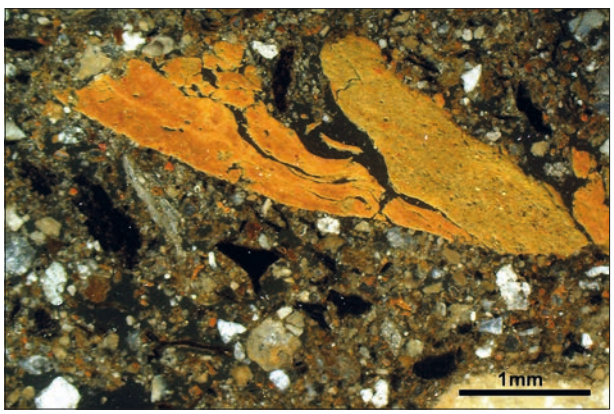


Fig. 3.32 Scan of S8-09-MM6 (L28-L29); dark brownish sometimes recemented ashy deposits with charcoal, burnt bone (**BB**), and strongly burnt bone (**SBB**), with burrow fill (**Bu**) of partially decalcified ash residues. – Scale bar 10 mm.



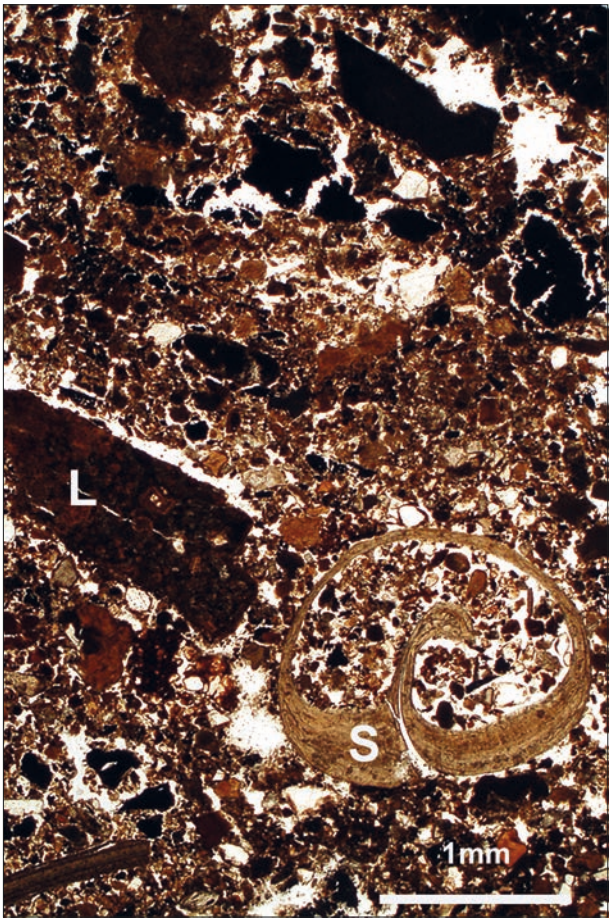


Fig. 3.33 Photomicrograph of S8-09-MM6 (L28-L29); with semi-layered darkish brown ashy remains, heated gastropod shell (**S**) and blackened limestone fragment (**L**); PPL. – Scale bar 1 mm.

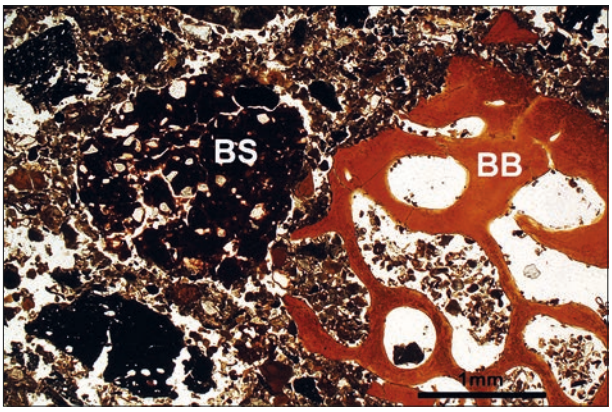


Fig. 3.34 MM6 (as fig. 3.32), rubefied burnt bone (**BB**) and blackened burnt soil clast (**BS**) in ashy remains; PPL. – Scale bar 1 mm.

Fig. 3.35 MM6 (as fig. 3.32); example of burnt imported (?) wetland clay; OIL. – Scale bar 1 mm.

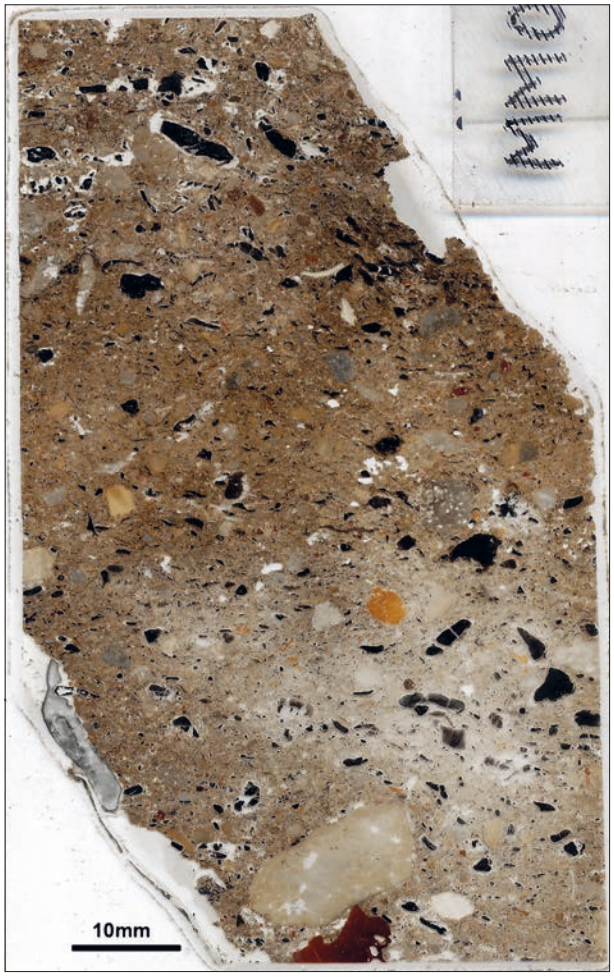


Fig. 3.36 Scan of S8-09-MM3 (L28 upper); generally dark brownish charcoal rich ashy remains, which are diffusely layered and broadly burrowed (some colour differences relate to variations in thin section thickness); burnt bone and burnt limestone occur (cf. **figs 3.37-3.38**). – Scale bar 10 mm.

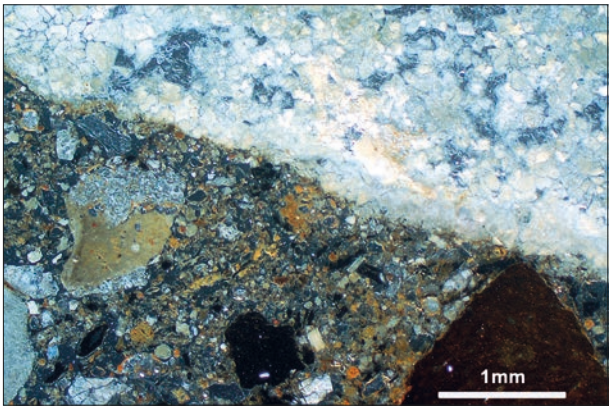


Fig. 3.38 MM3 (as **fig. 3.39**), under OIL. – Scale bar 1 mm.

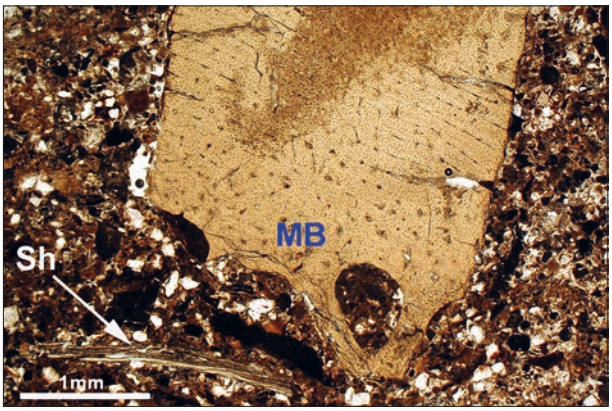


Fig. 3.39 MM3 (as **fig. 3.37**); moderately burnt bone, which has become partially micritised (**MB** – micritised bone); note compact surrounding ash residues and shell (**Sh**) remains; PPL. – Scale bar 1 mm.

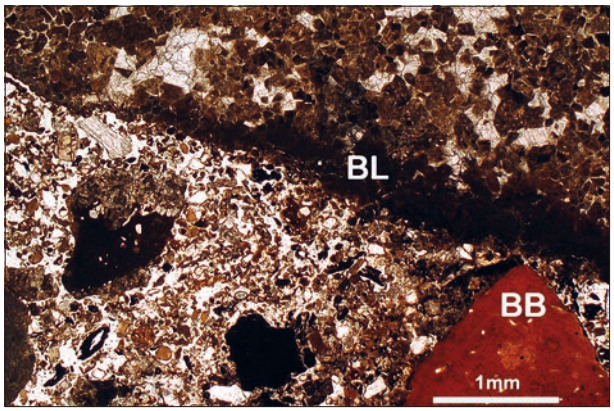


Fig. 3.37 Photomicrograph of S8-09-MM3 (L28 upper); edge of burnt limestone (**BL**) with recrystallisation, ashes and rubefied burnt bone (**BB**); PPL. – Scale bar 1 mm.

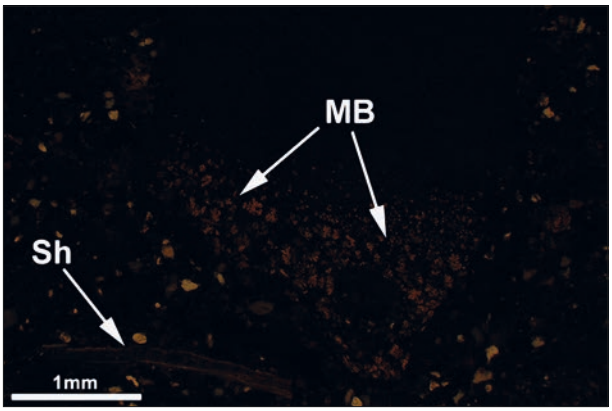


Fig. 3.40 MM3 (as **fig. 3.39**), under OIL, showing micritisation of lower part of burnt bone. – Scale bar 1 mm.

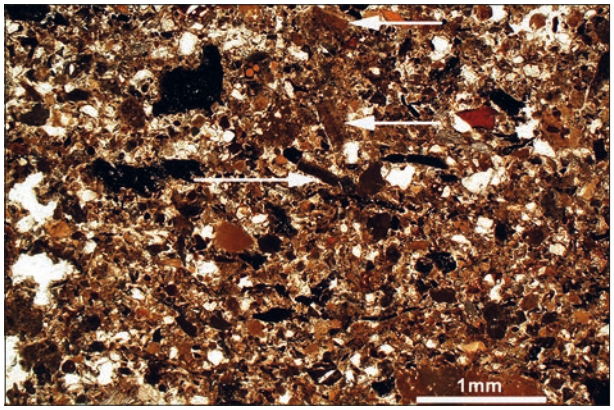


Fig. 3.41 MM3 (as **fig. 3.37**): moderately compact ash remains with traces of earlier probable sub-horizontal orientation, and including very fine to more coarse shell fragments (white arrows); PPL. – Scale bar 1 mm.

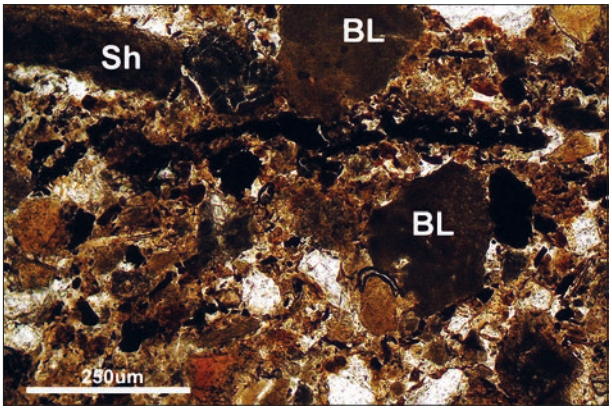


Fig. 3.42 MM3, detail of **fig. 3.41**; ash, charcoal, with fine burnt shell (**Sh**) and limestone (**BL**) material; PPL. – Scale bar 250 µm.

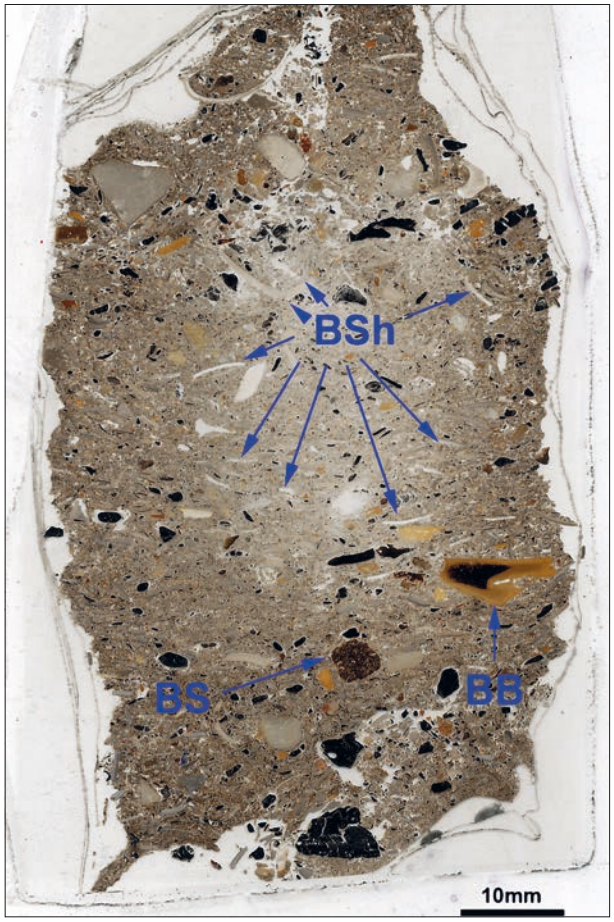


Fig. 3.43 Scan of S8-10-MM2 (L13); ash and often burnt shell (**BSh**) deposits, which are partially burrowed but with large areas of original layered composition (cf. **figs 42-44**); black burnt soil (**BS**) and burnt bone (**BB**) also occur. – Frame width is ~60 mm.

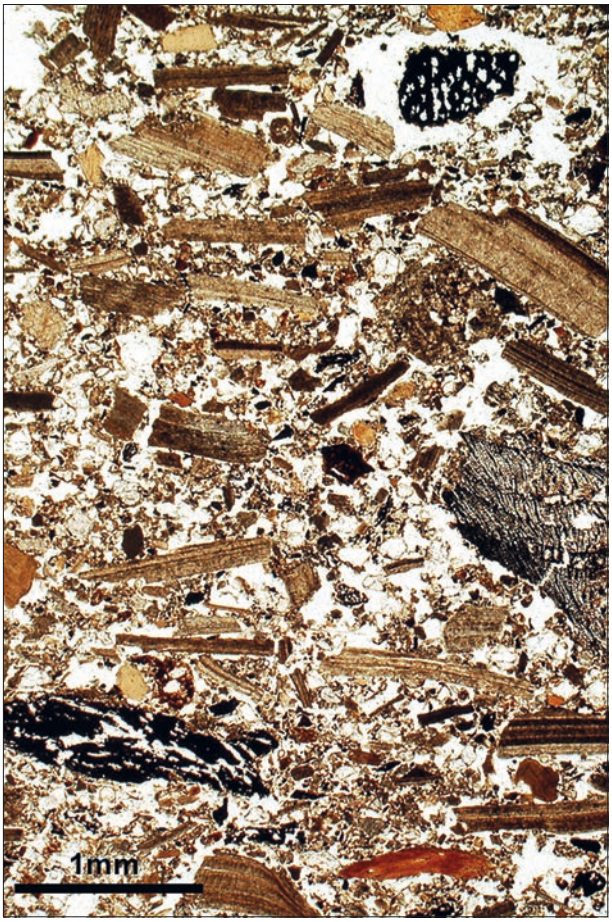


Fig. 3.44 Photomicrograph of S8-10-MM2 (L13); open ashy deposits with much semi-horizontally oriented shell and burnt shell, indicative of being a trampled occupation surface associated with a shell midden accumulation; PPL. – Scale bar 1 mm.

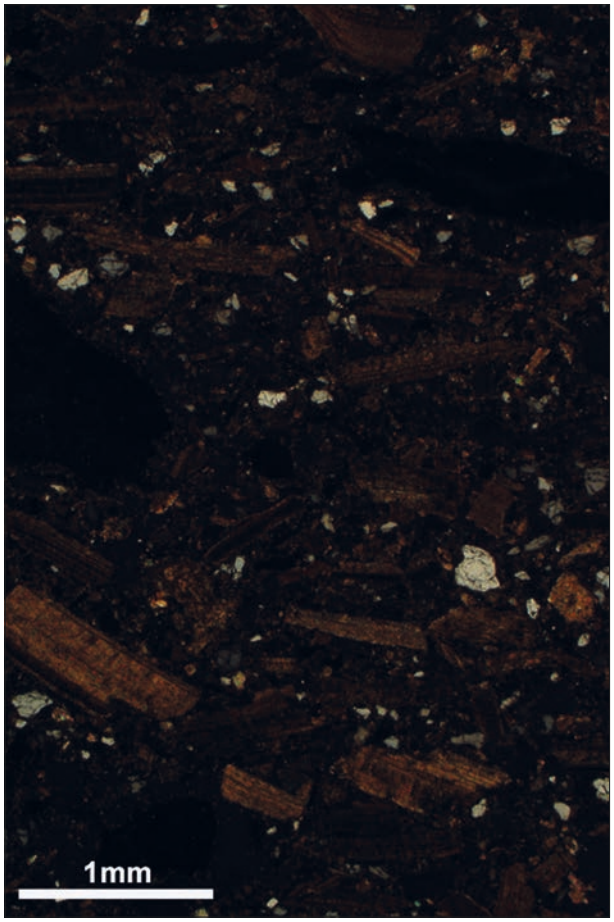


Fig. 3.45 MM2 (as **fig. 3.44**); under XPL. – Scale bar 1 mm.

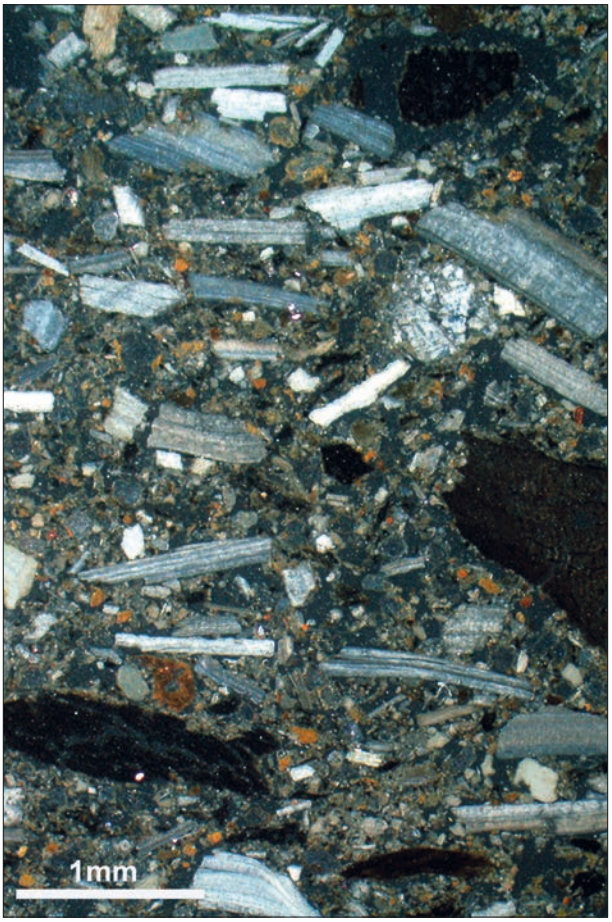


Fig. 3.46 MM2 (as **fig. 3.45**), under OIL; white shell is clearly burnt. – Scale bar 1 mm.

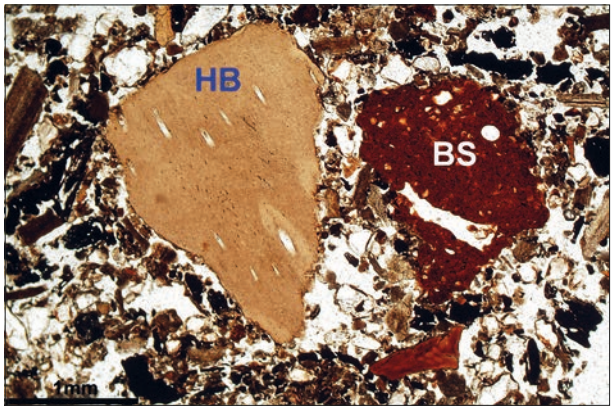


Fig. 3.47 MM2 (as **fig. 3.44**); ash remains include heated bone (**HB**) and burnt soil (**BS**; note relict root channel); PPL. – Scale bar 1 mm.

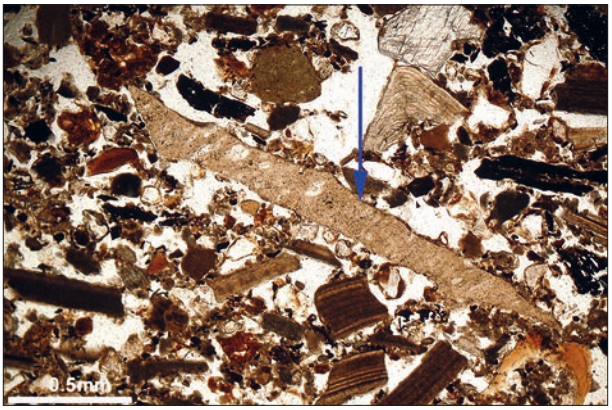


Fig. 3.48 MM2 (as **fig. 3.47**); biologically worked ash residues, with burnt shell and small chert (?) flake (arrow); PPL. – Scale bar 0.5 mm.

Yellow Series

Centred on S8-Yell08[33-38] [equivalent to part of S8-Y2spit2] (thin section S8-09-MM10; 0-70 mm)

This is a cave earth that was apparently originally deposited as a muddy colluvium and which became biomixed with washed sands (**Chapter 2**) of possibly originally windblown origin. There are also coarse inclusions of speleothem and likely hyaena coprolite and bird guano fragments from the cave environment. The colluvium includes very fine charcoal, larger charcoals, a probable fire-cracked siliceous rock (chert?), fine bone (some of which is burnt), all suggesting localised reworking of an occupation surface/combustion zone (Mallol/Mentzer/Miller 2017; Villagran et al. 2017). Reworking processes could include trampling, bioturbation and lastly local wash (Fedoroff/Courty/Guo 2018).

Upper part of Unit S8-Yell08[18-23] [equivalent to the middle part of S8-Y2spit1] (thin section S8-09-MM9 lower; 35-75 mm)

This is a complicated sediment, composed of strongly bioworked calcareous clays, with fine sands, succeeded by a layer of dominant fine sands; the sediment apparently includes no micro-inclusions evident of human activity, unlike sample MM10, for example. As the overall Unit Y2spit1 does in fact contain macro-size chert artefacts (cf. **Chapter 12**), this lack of micro-inclusions may indicate a taphonomic difference with MM10, and/or the absence of a previously existing local occupation surface. The lower part of this interval was probably first formed of colluvial cave earth, which became biomixed with blown fine sand, the whole strongly affected by rooting, biological activity and secondary calcium carbonate formation (root replacement and tufa-like formations) (Durand/Monger/Canti/Verrecchia 2018). Upwards, increasing dominance of sands occurs, some possibly being of a more or less direct windblown origin. Down-washing and burrowing down of reddish clay from above occurred later.

Unit S8-Yell08[16-18] and part of Unit [12-16] [equivalent to the upper part of S8-Y2spit1] (thin section S8-09-MM9 upper; 0-35 mm)

The thin section seems to be recording sterile natural sedimentation in the form of colluvial muddy clayey wash, with periodic originally windblown silt and fine sand sediment, which was sometimes followed by minor bioworking (seasonal activity?). A clean layer of fine and medium sand near the top could result from more or less direct wind action, perhaps forming discrete sheets within the cave.

S8-Yell08[2-12] [equivalent to the middle part of S8-Y1] (thin section S8-09-MM8; 0-75 mm)

Essentially, the middle of Unit Y1 is a poorly calcareous cave earth of possible colluvial origin, but which is now totally bioworked, and characterised by concentrated amounts of bone, coprolitic bone (burnt bone, bird and fish bone probably present) and coprolites (most being hyaena-like). Also present are concentrations of fine and coarse charcoal, likely fine red burnt mineral material, suggesting, with burnt bone, that there was mixed occupation by people and fauna such as hyaenas (Horwitz/Goldberg 1989; Karkanas/Goldberg 2018; Larkin/Alexander/Lewis 2000; Macphail/Goldberg 2012, 68-71). The possibility of

one or more omnivore coprolite(s), one of which embeds charred plant remains, pollen/spores and very fine red-burnt (?) mineral, is noteworthy, especially as it closely resembles human types.

Yellow / Grey Series

S8-L30 [top of Yellow Series] (thin section S8-09-MM7 lower; 60(70)-80 mm)

This uppermost interval of the Yellow Series has a diffusely mixed boundary with the overlying Grey Series (see above). This L30 has a similar, but finer sized, content of charcoal, bone and likely hyaena coprolites, compared to the sediment in slide MM8, and is indicative of a human and animal occupied cave earth, characterised by high amounts of biological activity. Coarse speleothem inclusions show partial decalcification, consistent with the original decalcified nature of the cave earth (weathered limestone and dust). Weak micritisation from above and rhizolith formation were additionally noted.

S8-L29 [base of Grey Series] (thin section S8-09-MM7 upper; 0-60(70) mm)

L29 is essentially a totally anthropogenic deposit, composed of fire installation (burnt soil – hearth (?), ash residues and charcoal) and likely kitchen midden (burnt bone and other bone debris) waste (Mallol/Mentzer/Miller 2017; Mentzer 2014). This is a partially trampled discard spread. Cave earth from below (L30) has become incorporated through trample-erosion of the 'natural' substrate. The presence of suggested 'wetland' clay (from the Zegzel Valley?) may indicate importation of a raw material for specialist activities/manufacture (in addition to red Mediterranean soil material) (Macphail/Goldberg 2018b). Phytoliths may come from imported plant material, for bedding, flooring, etc. (Goldberg et al. 2009). There is a marked contrast between the underlying Yellow Series (dominated by natural reddish sedimentation, and probably alternate (hypothetically seasonal at times) occupation by humans and animals) and the overlying grey and ashy anthropogenic deposits (of hearth and kitchen midden origin). A significant occupation use change is indicated.

Grey Series

S8-09/10-L28 lower (thin section S8-09-MM6; 0-70 mm)

This is a partially trampled ash spread/discard deposit, where there has been much less decalcification of the fuel ash; plant pseudomorphs occur and minor recrystallisation has taken place. Presumed kitchen midden content includes mainly burnt bone and shell. Very common burnt limestone and speleothem material (Canti 2017a), along with burnt red soil and (wetland?) clay, are involved in the hearth debris. Rare fibrous rooting has occurred recently.

S8-09/10-L28 upper (thin section S8-10-MM3; 0-100 mm)

This is probably a slightly weathered compact ash and kitchen midden deposit, with traces of trampling (Mallol/Mentzer/Miller 2017; Rentzel et al. 2017), and includes hearth material (calcitic ash, charcoal, burnt

soil and minerogenic material, burnt limestone/speleothem) and kitchen debris comprising bone and shell (Canti 2017a; 2017b). Much small invertebrate mesofauna and small animal (5-10 mm wide) burrowing has occurred. Compaction and weathering effects are probably due to post-depositional drainage through the overlying stony deposit above (**Chapter 2**).

S8-09/10-L13 (thin section S8-10-MM2; 0-95 mm)

L13 is a mainly open layered shell and burnt shell-dominated midden deposit that also includes much burnt bone; whilst, here at Taforalt, terrestrial mollusca dominate, the overall result is not unlike that seen in other, variously dated 'midden' sites with more marine shell (cf. Barton 2000; Canti 2017b; Stein 1992; Villagran/Giannini/DeBlasis 2009). The deposit has probably been trampled in possibly a drier (at least, better drained) environment compared to L28, hence its more open character and presence of finely sorted fragmented shell and charcoal (Courty/Goldberg/Macphail 1994; Gé/Courty/Matthews/Wattez 1993). This unit contains much fewer burnt limestone and speleothem clasts of larger size, in contrast to L28, and thus has much less of an obvious hearth component (but see **Chapter 2** concerning the behaviour of calc-limestone when subjected to more extreme pyrolithic processes).

3.4 DISCUSSION AND CONCLUSIONS

The Yellow Series is typically formed of a cave earth that was apparently originally deposited largely as a muddy colluvium and which became biomixed with dusts and finer sands of possible windblown origin. The supply of fine sediment was good and, in most cases, accumulation rates would have been relatively high for a dominantly natural (geogenic) context, although nothing like as fast as they would later become (cf. **Chapter 2**). As at most other cave sites (e. g. Gorham's and Vanguard Caves on Gibraltar), there are also coarse inclusions of limestone, speleothem, bone, and likely hyaena coprolite and bird guano fragments from the cave environment, along with examples of eggshell and possible fish bone (Horwitz/Goldberg 1989; Karkanas/Goldberg 2018, 68-71; Karkanas et al. 2002; Goldberg/Macphail 2012; Larkin/Alexander/Lewis 2000; Macphail/Goldberg 2012; Macphail/Goldberg/Barton 2012; Shahack-Gross/Berna/Karkanas/Weiner 2004). Certain observations concerning biological activity are relevant to the question of the persistence (or otherwise of) natural processes. Some intervals are particularly rich in bone fragments and likely hyaena coprolites (cf. Gorham's Cave). However, background bird activity was much less marked than in many dominantly natural caves (e. g. many levels at the Middle Pleistocene Westbury-Sub-Mendip Cave, Somerset: Andrews/Cook/Currant/Stringer 1999; Macphail/Goldberg 1999) or at sites with only an occasional human presence (e. g. the Mesolithic levels at Uzzo Cave, Sicily) (Macphail/Goldberg 2018a, 272-273).

In terms of human occupation evidence, the Yellow Series cave colluvium includes very fine charcoal, fine charcoals, probable fire-cracked siliceous rock (chert?), and fine bone, which is burnt, all suggesting localised reworking of occupation surfaces/combustion zones at times (Mallol/Mentzer/Miller 2017; Villagran et al. 2017). There is also the intriguing possibility of one or more omnivore coprolite(s) being present; one example embeds charred plant remains, pollen/spores and very fine red-burnt(?) mineral material, and overall closely resembles human types (Brönnimann et al. 2017; Macphail 2000; Macphail/Goldberg 2018a, 264-266 tab. 7.5). The human presence appears to have been intermittent. Between the organic

input from animal occupants, such as birds and hyaena, and from human accumulations, probably with a wide range of organic inputs but demonstrably including debris from vertebrates and mollusca, there would have been ample opportunity for the cave earth to be worked by small invertebrate mesofauna, producing alternations not dissimilar to those in the Mesolithic levels of Uzzo Cave, Sicily (Macphail 2006; Mannino et al. 2007).

The Grey Series strongly contrasts with the Yellow Series by being dominantly anthropogenic in character, with a marked burnt mineral, ash and charcoal content (**Chapter 2**). In general terms, one is more accustomed to seeing such contrasts in Mediterranean Mesolithic-Neolithic transitions and one may again cite the example of Uzzo Cave (cf. Mannino/Thomas 2007; Mannino et al. 2007; Macphail/Goldberg 2018a, 272-273. 380). As has been noted above, the GS occupation at Taforalt saw a significant change in use, in terms of both types and rhythms. The Grey Series is largely composed of waste from fire installations (burnt soil and rock, ash residues and charcoal) and kitchen middens (shell, burnt shell, burnt bone and other bone debris) (Mallol/Mentzer/Miller 2017; Mentzer 2014), and often incorporates partially trampled discard spreads. Fire installation waste included much burnt limestone and speleothem (cf. **Chapter 2**; Canti 2017a), and ash preservation was affected by how freely draining the overlying and underlying deposits were, affecting processes such as weathering. Compaction, together with fine fragmentation of semi-horizontally oriented shell and charcoal, are also effects which characterise trampled occupation surfaces.

Especially once the very rapid build-up of the Grey Series was well underway, there was little natural sedimentation in the cave. Of note, therefore, are burnt soil clasts, indicating the human introduction of red Mediterranean soil material (cf. *terra fusca*/*terra rossa*) into combustion zones. The presence of 'wetland clay', surviving both as raw and burnt examples, is even more interesting and suggests importation of this material, possibly from the wet valley bottom of the Zegzel. This was probably a raw material for specialist activities/manufacture (**Chapter 14.1**). Another category of material that may well have a component introduced by humans is phytoliths. It has previously been suggested that, at sites such as Neolithic Arene Candide, Liguria, and Middle Stone Age Sibudu Cave, KwaZulu-Natal, South Africa (Goldberg et al. 2009; Macphail/Courty/Hather/Wattez 1997), plant material was brought into the cave, possibly for bedding/floor covering. The Moroccan LSA site of Taforalt may now be added to this list, with evidence for such a possibility from the direct observation of phytoliths within the Grey Series sediment microfabric supporting the conclusions of the specific phytolith analyses at this site (cf. **Chapter 7**).

Seven large thin sections have been employed to investigate the sediment micromorphology of the Yellow and Grey Series in Sector 8 at Taforalt. Even though this must be characterised as merely a pilot study, it is clear that the application of micromorphological techniques to such a sequence provides valuable results and shows considerable potential for future studies.