Soil micromorphology at the Viking-Age ring-fortress of Borgring, Denmark

Analysis of samples from the East, North and South Gateways
Report from the Department of Geoscience

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DEPARTMENT OF GEOSCIENCE
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Report

Data

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Contents

Introduction

This report presents the results of soil micromorphological analysis of samples from archaeological deposits uncovered by excavations at Viking-age site of Borgring, on the island of Zealand in eastern Denmark. Here, recent research has uncovered the remains of a ring-type of fortress (Goodchild et al. 2017), which has been linked to a number of similar structures established around the 10th century AD across southern Scandinavia (Fig. 1).

In this report, the focus is on the parts of the Borgring excavation conducted at the East, North and South Gateways. The findings here have to be seen in connection with the results of other analyses that are presented in other reports and papers, including those on the non-destructive investigations (Stott et al., in prep.), the fires at the gateways and records from the rampart's turfs.

The broad stratigraphic sequence recorded consists of a levelling layer associated with the building of the rampart structure, the ramparts turfs, a layer capturing the destruction of the fortress by fire inside the gateways, a subsequent use-phase with a road in the north gateway, and last the overlying accumulation fill likely related to the destruction/erosion of the rampart.

The micromorphological sampling and analysis aimed at elucidating site formation and post-depositional processes of deposits investigated at the East, North and South Gateways of the fortress. In particular, samples were taken from deposits associated with the burning of the structure with the hope of gaining new insights into the collapse of wooden structures at the gateways, conditions after the fire, and at identifying markers of activities, use of space and traffic in general.

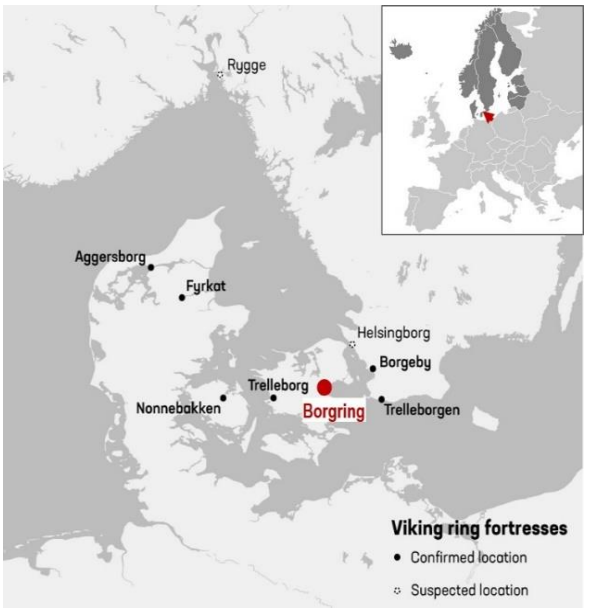

Figure 1. Map collage showing the location of Borgring Fortress in relation to known Trelleborg-type ring-fortresses (Map outlines: Wiki Commons).

1.0 Contexts of the samples

1.1/ East Gateway

One micromorphological (Kubiena-size) sample was taken from Profile 20 of a trench excavated just outside the East Gateway. The sample (P95/97) was taken across layer L519-L520 and consists of grey-brown clay with charcoal fragments. It might correspond to the same layer where a toolbox and a fireplace were recorded inside the East Gateway. The micromorphological analysis focused on establishing the nature of the material and identifying anthropogenic inclusions and features, including any potential traces of trampling (Table 1).

1.2/ North Gateway

At the North Gateway, Profile 53 exposed a sequence of sandy clay layers associated with variable quantities of charcoal and bunt clay fragments. A monolith sample (P124) was taken at the contact zone between the destruction layer, characterised by large charcoal fragments, and the underlying clay deposit. From field records, it has been postulated that the clay had been brought in. A Kubiena sample (P125) was taken from this clay deposit.

1.3/ South Gateway: levelling layer and rampart

At the South Gateway, Profile 36 exposed the sequence of fill, rampart and destruction level, and fill seen in the other two gateways. Here, a Kubina sample was taken at the contact zone between the rampart's turfs and the levelling layer beneath. The focus of the micromorphological analysis was to establish if this levelling fill might have developed *in situ* over long time, or it was brought in and used as a foundation fill. In the latter case, the analysis also aimed at gaining insights on the origin of the foundation material might have came from.

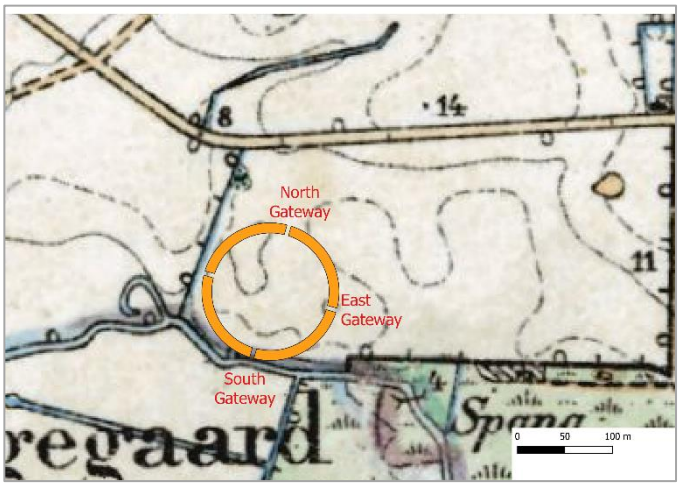

Figure 2 View of the Borgring area with the ring inserted and showing the position of the gateways. The background is a1880s cadastral map (source: Højkantkort, HistoriskAtlas.dk).

2.0 Materials and methods

2.1/ Soil micromorphology

Soil micromorphology is the study of undisturbed samples of soil/sediment under a petrographic (polarizing) microscope. First developed within soil sciences, this method has been employed in archaeology since the 1950s. Today, soil micromorphology is applied to an increasingly wide range of contexts as it allows for characterising archaeological soils and sediments and acquiring cultural and palaeoenvironmental information across different periods and environments (Nicosia and Stoops 2017: 1–5).

2.2/ Sample processing and analytical protocols

A total of 6 samples were taken from key deposits by the excavation team and processed for micromorphological analysis (Table 1). These include 3 Kubiena samples and 1 monolith sample. Micromorphology samples were handed over to Søren M. Kristiansen, then inspected for integrity and processed into thin sections at the University of Ghent (2 samples) and the McBurney Laboratory for Geoarchaeology, University of Cambridge (4 samples).[1] The procedure consists of a variably long process that turns the blocks into hard imprints on glass slides for study using optical microscopy. After collection, the samples are left to dry at room temperature or in a ventilated over at low temperature. Once dried, the samples are impregnated using crystic polyester resin, mixed with acetone and a catalyst. The impregnated blocks are then put under vacuum to enhance the capillary penetration of the mixture into the material, so that each pore is filled, and all the particles are fixed. The blocks are left to cure for a variable amount of time, depending on the nature of the material. Once fully hardened, the blocks are cut into thin slices, which are mounted onto glass slides and grinded down to reach a thickness of about 30 microns.[2] The glass slides (thin sections) are covered with a thin slip for protection and are ready for study using optical microscopy.

Thin sections are studied under a polarizing microscope equipped with two polarising filters (nichols) and objectives for different magnification views. The analysis is performed using three main types of light: plane polarized light (PPL), crossed polarized light (XPL), and oblique incident light (OIL). The description follows international standards for terminology and concepts (Stoops 2003). Identification and interpretation follow guidelines from reference textbooks (Stoops et al. 2010; Nicosia and Stoops 2017; Macphail and Goldberg 2018) and case studies relevant to the context under examination (see References). The thin sections from Borgring Fortress were described and analysed by Federica Sulas.

[1] The full procedure is available at:
https://www.arch.cam.ac.uk/research/laboratories/mcburney/cmb_docs/guide_soil_thin_sections
[2] 1 micron (μm) = 1 x 10^{-3} millimetres.

Area	*Profile*	*Samples**	*Excavation layers*	*Key questions*
EAST GATE	Profile 20	P97/P5[3]	L519-L520 clay fill/levelling layer with charcoal and artefacts	Trampling; fire intensity, accumulation rate
NORTH GATE	Profile 53	P124.1-3	L1098 humus sandy clay L1090 fired clay L1089 compact burnt clay L1094 compact sandy clay, stripes L1123 compact sandy clay, mottles	Nature of the deposit; fire intensity; trampling
		P125	L1094 compact sandy clay, stripes L1123 compact sandy clay, mottles	Accumulation rate
SOUTH GATE	Profile 36	P88	Contact zone between the rampart turfs and clayey levelling/fill layer below	Nature of the deposit in the levelling layer, accumulation rate (if any), possible trampling

*Table 1 List of micromorphological samples and related contexts. *Monolith sample from which 3 thin sections were obtained.*

[3] The sample was labelled P97 in the field and maintained this code during micromorphological analysis. However, in the field archaeological record and the section of Profile 20, the sample is labelled as P95 (email communication J. Kristensen, November 2018). For clarity, the thin section discussed here is labelled 'P97/95'

3.0 Results

3.1/ Characterising the micro-contexts

The main aims of the analysis were to identify accumulation rates and activity markers within the deposits sampled. In thin sections, three main categories of materials and processes were identified, and they are suggestive of different accumulation patterns and post-depositional processes. In most thin sections, two to three sub-units were identified based on differences in composition and these are labelled using small case letters from bottom to top.

At sub-unit level, the following materials and processes were recorded across the areas investigated: general anthropic waste, burnt material and indicators of land use (Table 2). In some instances, the same material is observed in different deposits, suggesting potential associations between different parts of the site.

In some cases, the properties of specific micromorphological features provide indication of the nature and pace of processes (Table 3). For example, horizontal orientation of components (e.g. sand, plant residues) can be the result of compaction and compression by trampling. Whether the trampling is by people or animals cannot be ascertained via soil micromorphology. However, where traces of animal excrements were detected alongside features deriving from trampling, the presence of animal browsing is very likely.

Materials /Processes	*Key micromorphological characteristics*
Anthropic waste	Fine, comminute charcoal and microcharcoal; rarely, ceramic fragments and metalworking debris
Burnt material	Large fragments of wood charcoal and burnt soil material.
Compression	Parallel orientation of components (sand grains) and charcoal fragments; massive microstructure and porosity. Rarely, compaction features

Table 2 Summary list of key materials and processes identified in the thin sections from Borgring Fortress. Identification based on: Angelucci 2017: 223–230; Canti 2017: 141–142, 2017: 181–188.

3.2/ East Gateway (P97/95)

One micromorphological (Kubiena-size) sample was taken from Profile 20 during the excavation of a trench just outside the East Gate but still within the gateway. The sample (P95/97) was taken across layer L519-L520 (Fig. 3). This consists of grey-brownish loam with metal artefacts and charcoal fragments, and it might correspond to the layer where a toolbox and a fireplace were recorded inside the East gateway. The micromorphological analysis focused on establishing the nature of the material and identifying anthropogenic inclusions and features, including traces of trampling.

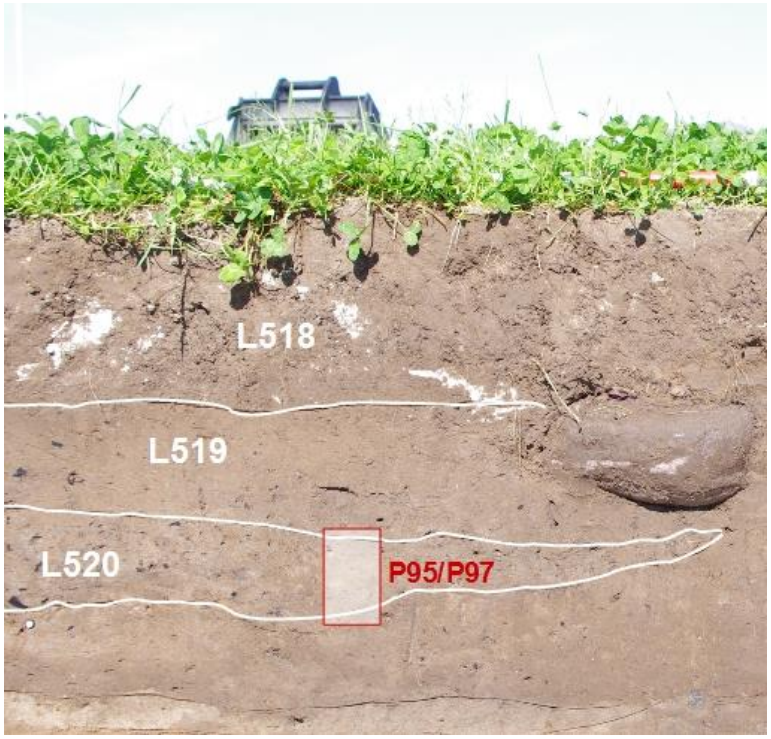

Figure 3 View of Profile 20 at the East Gateway, indicating main layers (white lines) and showing the approximate position of sample P95/P97 (Picture: Museum Sydøstdanmark).

Two microstratigraphic sub-units were identified in the thin section (Fig. 4)

Figure 4 Thin section of P97, East Gateway, showing sub-unit divisions.

- Sub-unit **(a)** consists of fine to very fine loamy material (of colluvial origin) (Fig. 5). The presence of limpid clay points to material originating from a B(t) horizon, with leaching occurring under natural vegetation cover. At some point, disturbance of this soil material ensued and was likely associated with landscape opening up (farming?) as indicated by dusty clay and redox-related features (iron nodules). Anthropic presence is indicated by the presence of few charcoal fragments and microcharcoal. No clear traces of compaction by trampling were noted.

- Sub-unit **(b)** is a burnt surface characterised by dominant charcoal fragments (Fig. 6) and appears almost sandwiched between two deposits of fine clayey, (colluvial) material. The parallel orientation and porous distribution of the wood charcoal fragments might be indicative of rapid accumulation. The present of clay coating within the charcoal pores is associated with a landscape with some vegetation cover and low-intensive land use after the fire.

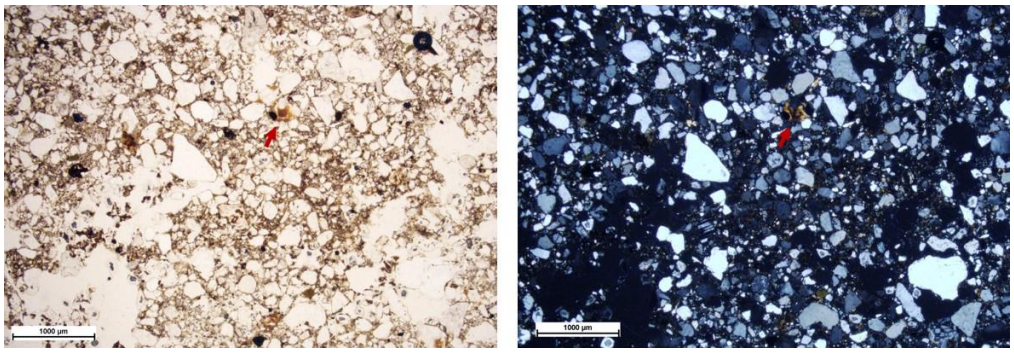

Fig. 5 Sub-unit (a) in thin section P97, East Gateway. Very fine loamy matrix and weakly developed subangular blocky microstructure with channel voids and occasional microlaminated clay coating (red arrow). PPL and XPL.

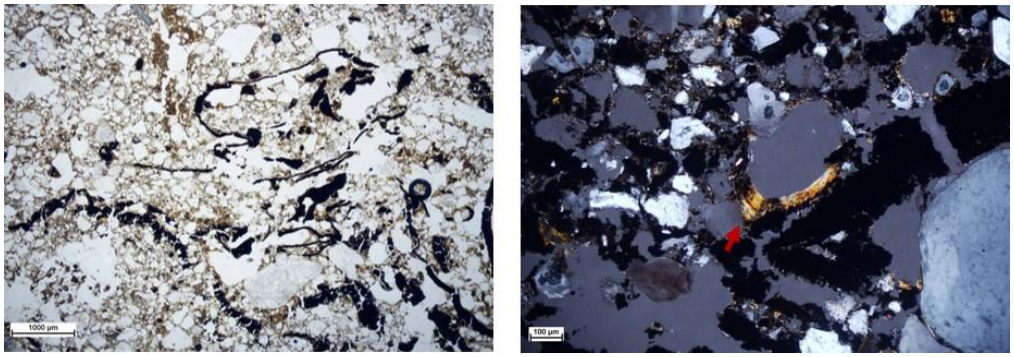

Fig. 6 Sub-unit (b) in thin section P97, East Gateway. Left: large wood charcoal fragments, note the convoluted and parallel orientation, PPL; right: microlaminated clay coating within charcoal pore (red arrow), XPL.

3.3/ North Gateway (P124 and P125)

At the North Gateway, a monolith sample and a Kubiena sample were taken from Profile 53 (Fig. 7).

Figure 7 View of the trench excavation at the East Gateway and Profile 53 showing the position of the monolith (P124) and Kubiena (P125) samples (Pictures: Museum Sydøstdanmark).

The thin sections show three main microstratigraphic units, from bottom to top (Fig. 8):

1. At the bottom, a relatively thick deposit of heterogeneous, fine loamy material mixed with anthropic waste is observed in thin section BOR 2.3 and BOR 1 (Fig. 9). The presence of several clay coatings and infillings suggests that this material might originate from a B(t) horizon. The texture and degree of compaction point to re-deposited (colluvial) material dumped here and compressed (trampling?) (Fig. 10). A few fine iron nodules indicate change in redox conditions. Anthropogenic elements include burnt soil fragments and small pieces of burnt clay/ceramic material.

2. Next, a relatively thick deposit of finely comminute organic-rich loamy material is observed in sub-unit **(a)** of BOR 2.1 and BOR 2.2.

3. Embedded within sub-unit (a), concentrations of large wood charcoal are observed in sub-unit **(b)** of BOR 2.1 and BOR 2.2. Fragments of charcoal from ring- and diffuse-porous hardwood and softwood are observed (Fig. 11). The presence of clay infilling, also seen within the charcoal pores, is related to post-depositional processes. The size, condition, and organisation of coarse components (charcoal, sand) might be indicative of rapid burning and accumulation.

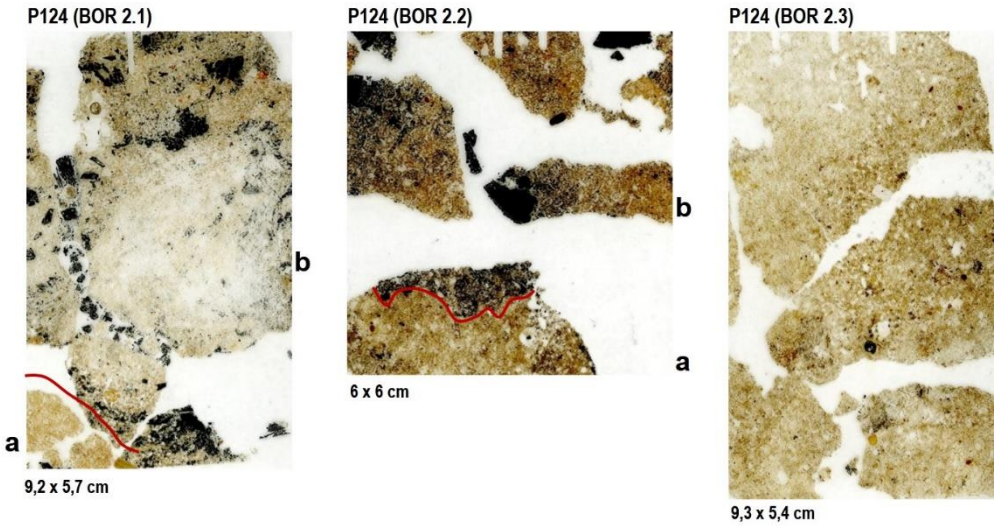

Figure 8 Thin sections obtained from monolith sample P124, showing the sub-unit divisions, North Gateway..

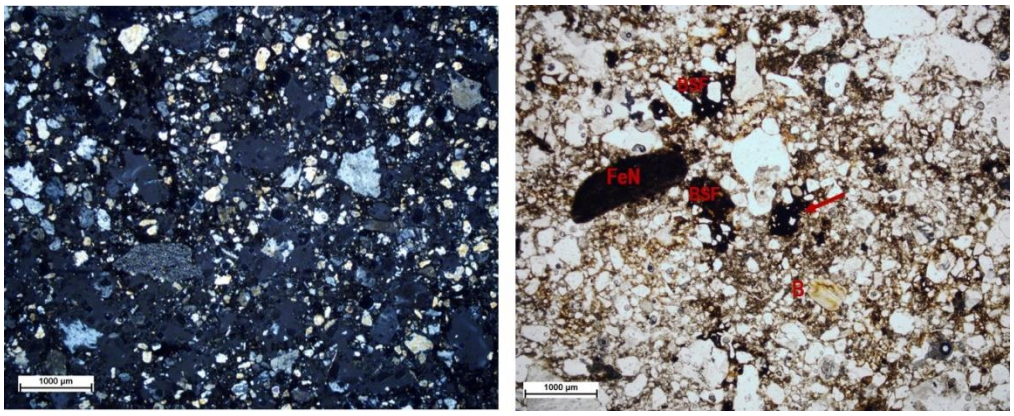

Figure 9 Sub-unit (a) in the thin sections from the North Gateway: right, fine loamy matrix, porous and chaotic organisation, thin section P124, XPL; right: anthropic inclusions of burnt soil/daub material (BSF), burnt bone fragment (B), and iron nodule (FeN), an iron aggregate possibly associated with metalworking debris (red arrow) (REF), P124, XPL.

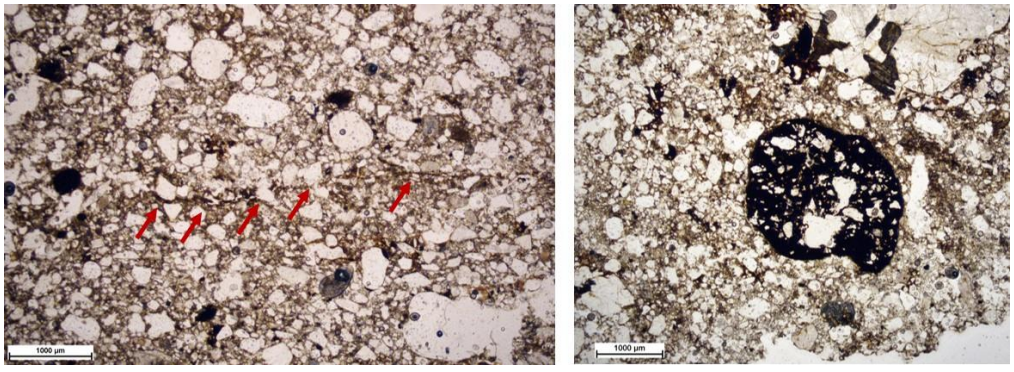

Figure 10 Sub-unit (a) in the thin sections from the North Gateway: right compaction features (red arrows), P125, PPL; right: iron aggregate with vesicular porosity reminiscent of metalworking debris features (Angelini et al. 2017), P124, XPL.

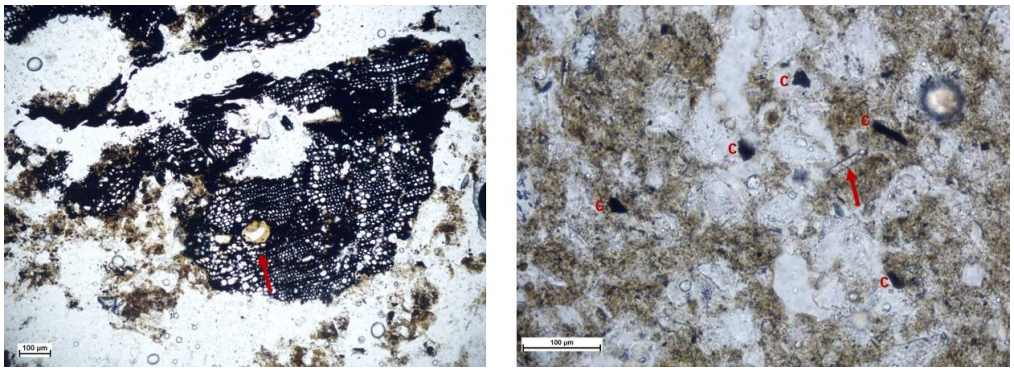

Figure 11 Sub-unit (b) in the thin section P124.2, the North Gateway: right fragment of wood charcoal (ring-porous hardwood?) and clay coating inside a pore (red arrow); left organic-rich groundmass with very fine charcoal (c) and phytoliths, including non-smooth elongate types (red arrow), PPL.

3.4/ South Gateway (P88)

At the South Gate, thin section P88 from Profile 36 shows capture a deposit of loamy clayey (colluvial) material mixed with anthropic waste (Fig. 12).

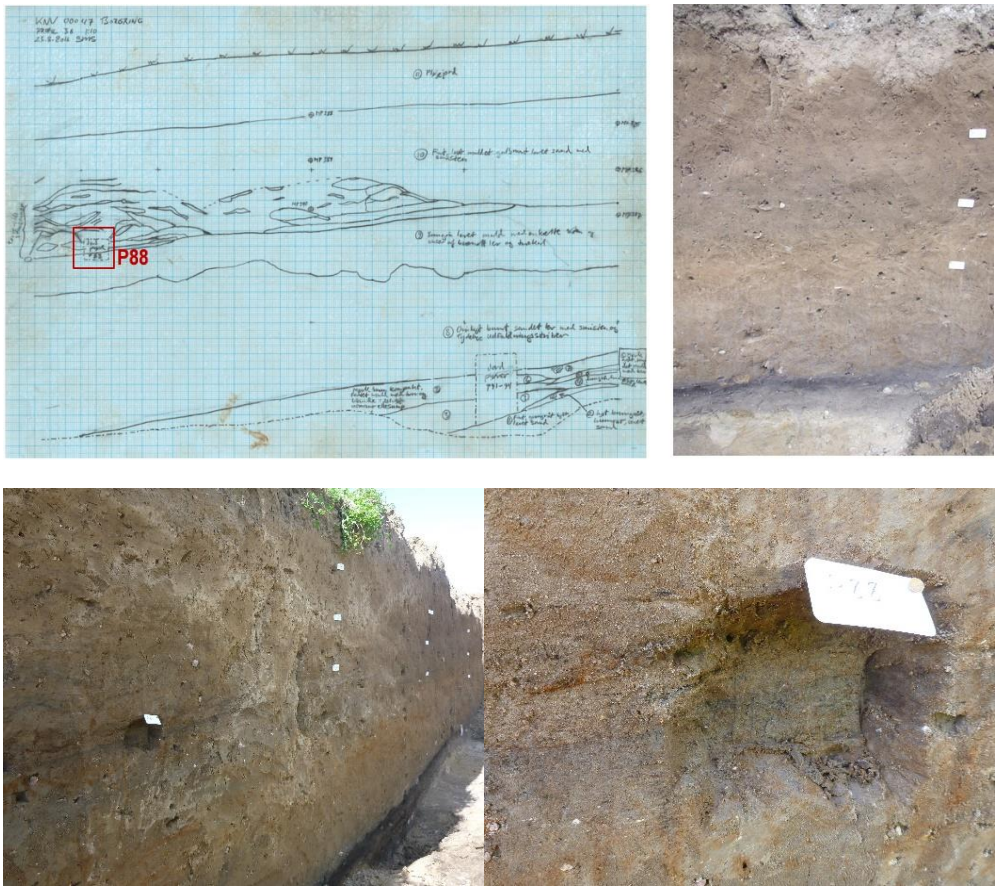

Figure 12 Section drawing and pictures of Profile 36, South Gateway. The position of the sample P88 is marked in the section drawing (courtesy of Borgring Excavation Team) and by the label on the pictures at the bottom (Pictures: Søren M. Kristiansen).

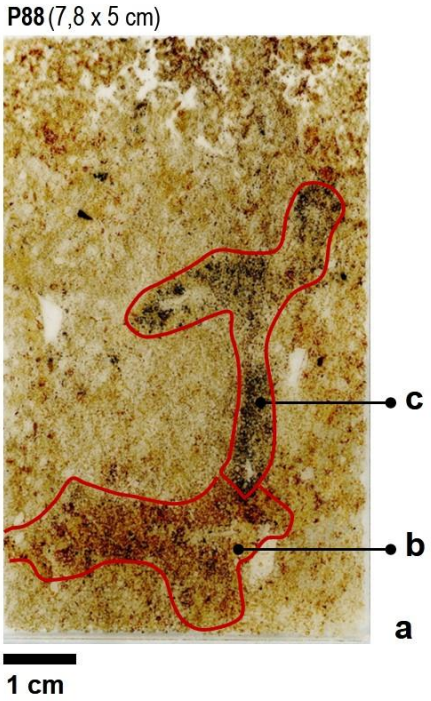

Figure 13 Thin section P88 from the South Gateway showing sub-unit divisions.

Three sub-units were identified in thin section P88, from bottom to top (Fig. 13):

- Sub-unit **(a)** consists of mixed fine loamy (colluvial) material embedded in a very fine silty matrix; the upper part of the slide appears more disturbed, where fragments of burnt soil material and charcoal are more common; no clear traces of compaction/trampling at the boundary to the overlying layer were noted;
- Sub-unit **(b)** shows fine to very fine loamy silty material as (a) but a massive, iron-rich, dark red ground mass, and microcharcoal (Fig. 14);
- Sub-unit **(c)** is associated with burning of organic (plant) material and mixed with same material from sub-unit (a); moldic pores are indicative of former plant remains (Fig. 15); the chaotic mixing with medium to fine loamy and organic-rich material might suggest rapid accumulation of burnt material together with the earth.

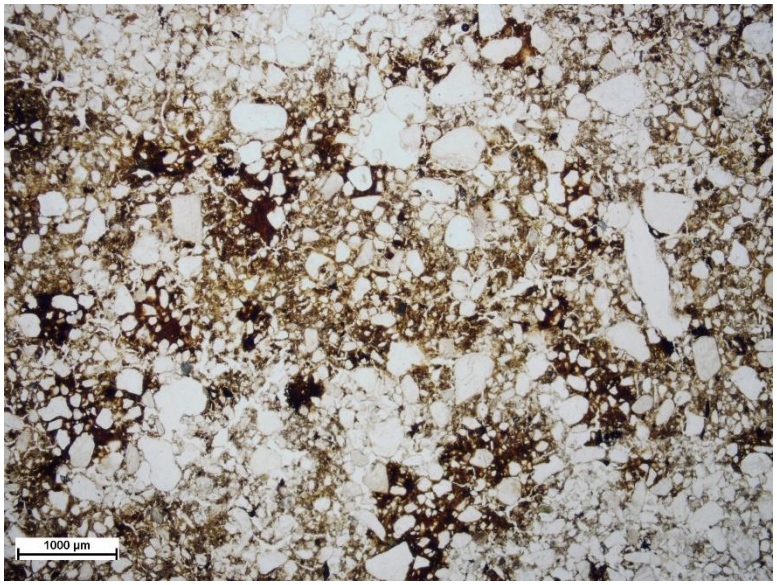

Figure 14 Sub-unit (b) in the thin section P88, South Gateway, showing very fine loamy silty material with domains of (burnt) dark red groundmass, PPL.

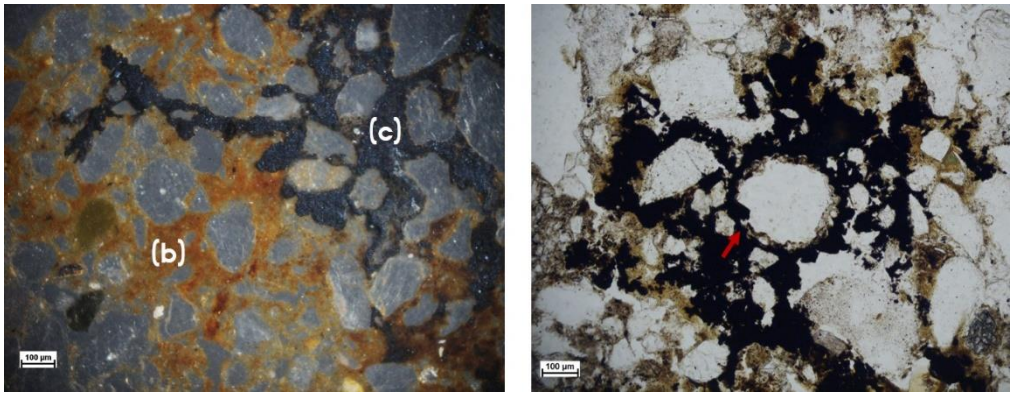

Figure 15 Sub-units (b) and (c) in the thin section P88, South Gateway: right contact zone between sub-units (b) and (c), OIL; left charred plant remains and moldic void (red arrow), PPL.

4.0 Discussion

In thin section, three main microstratigraphic units were recorded across the deposits from the three gateways, from bottom to top (Fig. 17):

[1] At the bottom, fine, loamy and clayey material (of colluvial origin) mixed with variable concentrations of anthropic waste is seen repeatedly in sub-unit (a), which was recorded at three gateways. This loamy and clayey component is likely derived from a B(t) horizon—there is no trace of a A-horizon and a structural B (likely Bw)-horizon. There is indication of changing redox conditions, which might be associated to depositional conditions or post-depositional processes (e.g. changing groundwater table levels and compaction after the construction of the rampart). Anthropogenic inclusions consist of wood charcoal, fragments of burnt clayey soil material and, rarely, burn ceramic material. These inclusions are far more common at the North Gateway than at the two others. Here, the abundance of burnt features, the presence of ash and iron nodules with vesicular porosity might be indicative of debris from metalworking. The heterogeneous nature and the mixing might suggest that this material was dumped here, or heavily reworked (removal of upper tens of cm) of the soil surface prior to the layout of the overlying layers. Subsequently, the layer was compressed as indicated by the massive to sub-angular microstructure. Whether the compression is to be associated with trampling or has to do with the weight of a (tall) overlaying rampart remains unclear, however no clear indication of (human or animal) trampling was observed.

[2] Next, there is evidence of a burnt deposit, consisting primarily of coarse wood charcoal embedded in the same loamy, clayey matrix observed in unit [a]. This deposit is recorded across all the thin sections and appears associated with *in situ* burning and rapid accumulation. The presence of clay infills within the charcoal fragments in the east and north gateways is indicative of soil disturbance across the landscape, likely associated with subsequent (plough) farming. Given its stratigraphic position, unit [2] at the South Gateway cannot be contemporary with deposits from the other two gateways, but the microstructure and composition are nevertheless relatively similar.

[3] At the top of the sequence, a fine, clayey loamy material very similar to the one observed in unit [1] is recorded only at the East Gateway. This exhibits indication of post-depositional disturbance likely associated with (plough) farming.

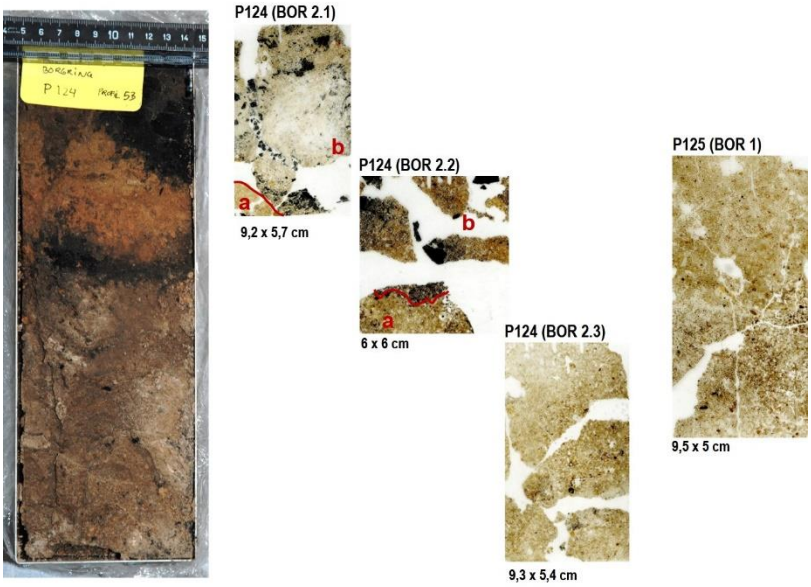

Figure 17 Monolith sample and thin sections from P124 (BOR 2) and P125 (BOR 1), Profile 53, North Gateway.

These main microstratigraphic units show a few, important, differences across the areas investigated.

At the North Gateway, traces of animal excremental matter are present in Unit [1], whose nature cannot be established. This material is sometimes seen in association with plant microfossils (phytoliths), fungal spores and fine sands, which might be indicative of animal (herbivore) dung. No distinctive indications of animal dung where noted. The preservation of distinctive dung indicators such as faecal spherulites (calcium carbonate features) might be compromised here due to dissolution (Canti 1999) or because they have been destroyed by heating (Canti and Brochier 2017).

Another important observation concerns indication of post-depositional disturbance as reflected in all the deposits. This is best expressed by the presence of different types of clay features and the spread of fine, comminute charcoal. A palimpsest of clay accumulation is seen in the microstratigraphic units. First, limpid clay coatings and infillings in unit [1] originate from land surfaces covered by well-established vegetation with no transport of humus-rich colloids. Following opening up, these surfaces become exposed to vertical leaching/relocation o fine soil material down the profile, including clay. Next, the incoming of dusty (organic rich) and silty clay illuviation seen in all the three microstratigraphic units is likely associated with a higher degree of landscape disturbance and human impact. These features are commonly found as a result of (plough or ard) farming. The fact that dusty and silty clay is found both in the loamy levelling (colluvial) deposits as well as in the burnt horizons suggests the these deposits might originate from generally consistent environmental conditions: a relatively stable landscape characterised by arable land use, including grazing both before and after the lifespan of the ring fortress.

5.0 Conclusions

The study of thin sections has identified different microstratigraphic units in the deposits sampled at Borgring Fortress. These suggests accumulation of (colluvial) material mixed with anthropic waste before both the rampart construction and the burning of the wooden gateway structure. The burnt horizon identified in thin section is indicative of rapid and *in situ* fire.

At the top of the sequence, another deposit of (colluvial) material exhibits minimal anthropic signature. The latter is primarily reflecting natural soil and landscape conditions, rather than features caused by human occupation and is hence associated with a relatively open landscape and arable land use. In this respect, the presence of wood charcoal, clean sand, and clay infilling (inside the wood charcoal from the burned gates) point to a gradual accumulation and possibly aggradation of (A horizon) material after the fire. Excremental matter, phytoliths and fungal spores appear to be associated with animal browsing here as well. All in all, this deposit might be reflecting a low-energy, slow soil build-up associated with the presence of animals and people in this landscape after the ring fortress was abandoned.

6.0 References

ANGELINI I., ARTIOLI G., NICOSIA C. 2017. Metals and metalworking residues. In: Nicosia and Stoops (eds.), *Archaeological Soil and Sediment Micromorphology*, pp. 213–222.

ANGELUCCI D. E. 2017. Lithic Artefacts. In: Nicosia and Stoops (eds.), *Archaeological Soil and Sediment Micromorphology*, pp. 223–229.

BANERJEA R.Y, BELL M., MATTHEWS W., BROWN H. 2015, Applications of micromorphology to understanding activity areas and site formation processes in experimental hut floors. *Archaeological and Anthropological Sciences* 7: 89–112.

CANTI M. G., 1997. An investigation of microscopic calcareous spherulites from herbivore dung. *Journal of Archaeological Science* 24: 219–231.

CANTI M. G. 2003. Aspects of the chemical and microscopic characteristics of plant ashes found in archaeological soils. *Catena* 54: 339–361

CANTI M. G. 2017. Charred plant remains. In: Nicosia and Stoops (eds.), *Archaeological Soil and Sediment Micromorphology*, pp. 141–142.

CANTI M. G. 2017. Burnt carbonates. In: Nicosia and Stoops (eds.), *Archaeological Soil and Sediment Micromorphology*, pp. 181–188.

CANTI M., BROKIER J. É. 2017. Faecal spherulites. In: Nicosia and Stoops (eds.), *Archaeological Soil and Sediment Micromorphology*, pp. 51–54.

GOODCHILD H, HOLM h, SINDBÆK SM 2017. Borgring - Discovering a Viking-Age ring fortress. Antiquity 91: 1027-1042.

HAASE K., OLSEN J. 2017. Modelling time: Applying Bayesian statistics to the chronology of a medieval urban site in Denmark. Poster [presentation?]

MACPHAIL R.I., GOLDBERG P. 2018. *Applied Soils and Micromorphology in Archaeology*. Cambridge: Cambridge University Press.

NICOSIA C., STOOPS G. (eds.) 2017. *Archaeological Soil and Sediment Micromorphology*. Chichester: Wiley.

MACPHAIL R.I., COURTY M.A., GEBHARDT A. 1990, Soil micromorphological evidence of early agriculture in North-West Europe. *World Archaeology* 22: 53–69.

MILLER C.E., CONARD R.J., GOLDBERG P., BERNA F. 2010. Dumping, sweeping and trampling experimental micromorphological analysis of anthropogenically modified combustion features. *P@lethnologie* 2: 25–37.

RENTZEL P., NICOSIA C., GEBHARDT A., BRÖNNINMANN D., PÜMPIN C., ISMAIL-MEYER K. 2017. Trampling, poaching and the effect of traffic. In: Nicosia and Stoops (eds.), *Archaeological Soil and Sediment Micromorphology*, pp. 281–295.

STOOPS G., MARCELINO V., MEES F. (eds.), *Interpretation of Micromorphological Features of Soils and Regoliths*. Amsterdam: Elsevier.

STOOPS G. 2003, *Guidelines for analysis and description of soil and regolith thin sections*. Madison, WI: Soil Science Society of America.

7.0 Appendix: Thin section descriptions

7.1/ East Gateway

Sample		**East Gateway, P97 (4,89 cm)**	
Unit	*Sub-unit*	*Description*	*Interpretation*
	0-1,8 cm	**Voids**: channel, planar **Microstructure:** weakly developed subangular blocky **Mineral constituents:** loamy medium to fine silty sand – clay, rare coarse sand (quartz, plagioclase, feldspars, sedimentary rock), subangular-subrounded grains **Organic components:** amorphous plant organic matter; rare (uncharred) plant residues (100-300 µm); charcoal fragments (50 µm -1 mm), microcharcoal **Anthropogenic elements: /** **Inorganic residues of biological origin:** phytoliths (non-smooth and smooth elongate cells, non-heated); poss. shell fragments (50-100 µm) **c/f10µm -ratio**: 65/35 **c/f related distribution**: single spaced porphyric **B-fabric:** undifferentiated to stipple speckled **Pedofeatures:** Rare silty clay infillings above charcoal-rich lenses**;** limpid clay tabular fragments (50-100 µm); microlaminated dusty clay coating	Very similar to (a) but slightly coarser and more porous, it also includes soil fragments. Charcoal fragments appear concentrated in defined area (top) and burnt *in situ*. Infilling of fine loamy clay within charcoal fragments point to post-depositional disturbance. Fine silty clay infillings seen above the charcoal layer point to impede drainage and exposed soil surfaced subject to low-energy erosion and movement of fine material.
	b 3,2-1,8 cm	Layer of wood charcoal embedded in the loamy (colluvial) material as (a) but with sharp increase in limpid and dusty clay: - Microlaminated dusty to limpid clay coating along charcoal fragments - Elongate smooth phytoliths	Sub-unit associated with *in situ* burning of wood over a clay-rich (colluvial) soil material. Horizontal orientation of wood charcoal fragments might be the result of falling of the wooden structure. Open porosity embedding the wood charcoal fragments might be indicative of fast accumulation. Deposition of clay coating over charcoal fragments associated with low energy environment post-fire.

Sample		**East Gateway, P97 (4,89 cm)**	
Unit	*Sub-unit*	*Description*	*Interpretation*
/	a 4,9-3,2 cm	**Voids**: channel, planar **Microstructure:** weakly developed subangular blocky **Mineral constituents:** loamy fine to very fine silty sand – clay, few medium sand, rare coarse sand (quartz, plagioclase, feldspars, sedimentary rock), subangular-subrounded grains **Organic components:** amorphous plant organic matter; rare charcoal fragments (50 µm -1 mm), microcharcoal **Anthropogenic elements:** / (poss. 1 ceramic fragment with rounded edges, 1 mm) **Inorganic residues of biological origin:** phytoliths (rare non-smooth and smooth elongate cells) **c/f10µm -ratio**: 60/40 **c/f related distribution**: close porphyric **B-fabric:** undifferentiated to poro-striated **Pedofeatures:** Common microlaminated dusty clay coatings and infillings**; l**impid clay coating, rare crescentic infillings; rare (typic) iron nodules (100-500 µm)	Fine to very fine loamy (colluvial) material with limpid clay. The latter might represent material from a B(t) horizon, with leaching occurring under vegetation cover. At some point, disturbance of this soil material ensued and was likely associated with opening up and farming, reflected in the presence of dusty clay and redox-related features (iron nodules). Anthropic signature is primarily associated with little charcoal and microcharcoal. No traces of compaction (e.g. trampling) were noted.

7.2/ Nord Gateway

Sample		**North Gateway, P124.1 (BOR 2.1) (9,2 cm)**	
Unit	*Sub-unit*	*Description*	*Interpretation*
	b	Same as (a) but characterised by higher porosity and dominant charcoal - Increased channel - Dominant charcoal fragments (10 µm -5 mm) at different degrees of burning; fragments of ring- and diffuse-porous hardwood and softwood are observed. - Common microcharcoal - Rare limpid clay coating within charcoal pore - Illuvial dusty clay infilling and coating - Few sand grains exhibit heating markers - Rare articulated phytoliths (with signs of heating)	Embedded in sub-unit (a) material, this is characterised by dominant charcoal and microcharcoal and rare potsherds. The coarse size of charcoal fragments, and coarser texture might indicate rapid burning and accumulation. Clay infilling are probably associated to post-depositional processes. No clear indication of compaction (by trampling) were noted.
	a	**Voids**: channel, compound packing void **Microstructure:** massive to crumb **Mineral constituents:** loamy very fine silt – few fine sand, rare medium sand (quartz, plagioclase, feldspars), subangular grains **Organic components:** predominant amorphous plant organic matter; rare charcoal fragments (10-50 µm); very rare plant residues (10-50 µm) **Anthropogenic elements: /** **Inorganic residues of biological origin:** common phytoliths (smooth and non-smooth elongate); rare pollen (globular), **c/f10µm -ratio**: **c/f** 60:50 **related distribution**: close porphyric **B-fabric:** undifferentiated **Pedofeatures:** Few iron typic nodules (20-50 µm)	Finely comminute organic-rich loamy material. Massive microstructure might be the result of compression.

Sample		**North Gateway, P124.2 (BOR 2.2) (6 cm)**	
Unit	*Sub-unit*	*Description*	*Interpretation*
	b (5,5-0 cm)	Rare flint fragments (300 µm – 1 mm)	Same as P124.1 (b)
	a (6-5,5 cm)	**Voids**: channel, compound packing void **Microstructure:** massive to crumb **Mineral constituents:** loamy fine to very find silt – few medium sand (quartz, plagioclase, feldspars), subangular grains **Organic components:** amorphous plant organic matter; few charcoal fragments (10-50 µm), microcharcoal; (10-50 µm) **Anthropogenic elements: /** **Inorganic residues of biological origin:** phytoliths (elongate cells) **c/f10µm -ratio**: 60: 40 **c/f related distribution**: close porphyric **B-fabric:** undifferentiated **Pedofeatures:** Amorphous excremental plant matter; few iron typic nodules (20-30 µm)	Same material P124.1 (a), more bioturbated and coarser.

Sample		**North Gateway, P124.2 (BOR 2.3) (9,3 x 5,4 cm)**	
Unit	*Sub-unit*	*Description*	*Interpretation*
		Voids: channel, planar, compound packing **Microstructure:** channel to subangular blocky **Mineral constituents:** loamy fine to very find silt – clay; common medium sand, rare coarse sand (quartz, plagioclase, feldspars, flint, sedimentary rocks), subangular grains **Organic components:** amorphous plant organic matter; few charcoal fragments (10-500 µm), microcharcoal; **Anthropogenic elements:** Fragments of burnt loamy colluvial material (2 mm) **Inorganic residues of biological origin:** phytoliths (elongate cells) **c/f10µm -ratio**: 70:30 **c/f related distribution**: porphyric **B-fabric:** undifferentiated to stipple-speckled **Pedofeatures:** Common typic iron nodule (50-300 µm)**;** rare iron nodules with vesicular porosity and loamy inclusion, poss. metal (iron) slag (200 µm - 2 mm) (see Macphail and Goldberg 2018: 241; Angelini et al. 2017); laminated clay coatings and infillings; amorphous excremental matter; poss. ash; heated rock fragments (incl. frag of chalk/limestone)	Heterogeneous, reworked (colluvial) material with anthropic inclusions (burnt soil fragments and possibly metal working debris). The presence of (illuvial) clay coatings and infilling points to material originating from a B(t) deposit. The degree of compactness might suggest that this is in fact re-deposited (colluvial) material dumped here as a fill and trampled over(?). The presence of small iron typic nodule might be related to changing redox conditions.

Sample		**North Gateway, P125 (BOR 1) (9,5 x 5 cm)**	
Unit	*Sub-unit*	*Description*	*Interpretation*
		Voids: channel, planar, compound packing **Microstructure:** channel to subangular blocky, moderately developed **Mineral constituents:** loamy fine to very find silt – clay; common medium sand, rare coarse sand (quartz, plagioclase, feldspars, flint, sedimentary rocks), subangular and subrounded grains **Organic components:** amorphous plant organic matter; few charcoal fragments (10 µm – 1 mm), microcharcoal; **Anthropogenic elements:** common fragments of burnt loamy material (1-2 mm); ceramic material(potsherds?) (1-2 mm); rare burnt bone fragments (100-300 µm) **Inorganic residues of biological origin:** phytoliths (smooth and non-smooth elongate cells, trichomes) **c/f10µm -ratio**: 70:30 **c/f related distribution**: porphyric **B-fabric:** undifferentiated to stipple-speckled **Pedofeatures:** compaction features associated with Fe- and dusty clay, and particle sorting; amorphous excremental matter; ash with phytoliths; crescentic dusty clay coatings and infillings; common typic iron nodules 50-300 µm; rare iron nodules with vesicular porosity and loamy inclusion, poss. metal (iron) slag (100 µm - 1 mm), as seen in BOR2.3	Same as BOR2.3. Loamy (colluvial) material mixed with anthropic waste with traces of compaction by trampling.

7.3/ South Gateway

Note: the orientation marked on the slide is likely to be wrong and probably needs tilting of about 90 degrees. However, given the mixed nature of the deposit captured in this thin section it was not possible to establish with certainty the correct orientation. Therefore, the description follows the orientation marked on the slide.

Sample		**South Gateway, P88 (7,8 cm)**	
Unit	*Sub-unit*	*Description*	*Interpretation*
	c (6-3 cm)	**Voids**: few channels, compound packing, rare moldic pores (100-300 µm) **Microstructure:** crumb, moderately separated **Mineral constituents:** loamy medium to very sand silt – few coarse sand, rare coarse sand (quartz, plagioclase, feldspars), subangular grains **Organic components:** predominant charred amorphous aggregates, no traces of cell structure; excremental matter (amorphous and mites, 10 µm) **Anthropogenic elements: /** **Inorganic residues of biological origin:** few phytoliths (trichome), **c/f10µm -ratio**: **c/f** 50:50 **related distribution**: single spaced enaulic **B-fabric:** undifferentiated **Pedofeatures:** Coaleshed phosphatic extremental matter	Sub-unit associated with burning of organic (plant) material and mixed with same material as (a). Chaotic mixing with medium to fine loamy and organic-rich material might suggest rapid accumulation of burnt material.
	b (6-6,9 cm)	Fine to very fine loamy silty material as (a) but a massive, iron-rich, dark red ground mass, microcharcoal - Charcoal fragments (10-50 µm) and common microcharcoal - Phytoliths (smooth elongate)	Horizontal sub-unit embedded in (a), probably part of it exposed to burning (low intensity heating).
	a 7,8-0 cm	**Voids**: few channels, compound packing **Microstructure:** crumb, close to weakly separated **Mineral constituents:** loamy fine to very sand silt – few coarse sand, rare coarse sand (quartz, plagioclase, feldspars), subangular-subrounded grains **Organic components:** rare charcoal fragments (50-100 µm); rare amorphous plant organic matter **Anthropogenic elements: /** **Inorganic residues of biological origin:** very rare shell fragments (10-50 µm); rare pollen (globular grains),sclerotia **c/f10µm -ratio**: **c/f** 70:30 **related distribution**: close porphyric **B-fabric:** undifferentiated **Pedofeatures:** Few moderately impregnated iron nodules and aggregates (100 µm); fragments and domains of iron-rich, loamy soil material (exposed to heat?) (100-300 µm)	Mixed fine loamy colluvial material embedded in a very fine silty matrix. More disturbed in the upper part of slide, where fragments of burnt soil material and charcoal are more common. No clear traces of compaction were noted.

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