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Micromorphological Analysis of the Fine Stratigraphy of a Pit Fill (Corneşti-Iarcuri)

Micromorphology is a suitable method to study the contents and stratigraphic relationships of pit fills. Within the ramparts of Corneşti-Iarcuri, fill layers of a pit were sampled. The pit fill was macroscopically divided into primary and secondary fill due to striking differences. These differences could be verified and concretized micromorphologically.

Overview

For the last ten years the largest known Bronze Age ramparts in Europe close to the village of Corneşti in the Romanian Banat have been the focus of archaeological research. Within the framework of the DFG research project "Investigations on the Settlement Structures and the Chronology of the Late Bronze Age Fortification of Corneşti-Iarcuri in the Romanian Banat" in 2016 trench XII was created in the settlement area. Special features in this trench were the find contexts 1, 13 and 91. Finding 13 (AU 013) proved to be a nearly rectangular pit with dimensions of 2.4 m × 1.4 m and a preserved depth of 1.2 m. Compared to other findings it was considerably large. The pit is part of an ensemble in the context of two indirectly proven houses, which were clearly identified as houses in the field campaign 2017.[1] The surveyed stratified pit contained a primary backfill with no burnt clay found inside. It was separated from a secondary backfill by a charred wooden construction. The secondary backfill layer, above the wooden construction, was characterized by abundant burnt clay.

Pit fills at representative sites were sampled for micromorphological analysis, and the samples were made available to the author for thin section analysis (**Tab. 1**). The undisturbed sediment blocks required for this purpose were made to large-format sediment thin sections. The preparation of the thin sections followed the protocol of Altemüller.[2] For this purpose, the samples were prepared in the micromorphology laboratory of the Institute of Physical Geography of the Goethe University Frankfurt for thin sections with a thickness of about 30 µm. The thin sections are almost transparent in this thickness and can be described in transmitted light under a polarizing microscope. The description of the thin sections was made with the Zeiss Axioskop 40 polarizing microscope in linear polarized transmitted light (PPL) and in crossed polarized transmitted light (XPL) with a magnification of 25- to 400-fold. Microimages were taken with a connected camera (AxioCam MRc).

Soils in the immediate vicinity of section XII can be described as Vertic Phaeozem (clayic) according to international nomenclature.[3] According to the German soil classification it is named humus-rich Pelosols.[4] These dark humus-rich soils are characterized by a high clay content, which is macroscopically represented by a segregation structure. These pedogenic features – high clay and humus contents – can be found in the pit fillings as well.

Loess-dominated soils with low clay contents, as described by Nykamp,[5] are not found on the basis of the results of grain-size analysis after DIN 19 683.[6] Although the silt content, which represents the loess, reaches approximately 50 %, the clay content regularly reaches 40 to 45 %, which is much higher than described by Nykamp.[7] This was found in the field analysis as well.

1 See Lehmphul *et al.* in press.
2 Altemüller 1962, 165 f.
3 IUSS Working Group 2015, 97.
4 AG Boden 2005, 214.
5 Nykamp 2016, 608.
6 DIN 19 683, 1973.
7 Nykamp 2016, 608.

thin section	depth [cm]	field description	
1	about 20	secondary filling	above wooden construction
2	about 30	secondary filling	above wooden construction
3	about 70	secondary filling	above wooden construction
4	about 80	secondary filling	above wooden construction
5	about 110	secondary filling	above wooden construction
6	about 130	primary filling	below wooden construction

Tab. 1 Number, depth and short field description

Micromorphology

Samples 1 to 5 were taken from the secondary fill of the pit above the charred wooden construction (**Tab. 1**). In addition to pedogenic features, these samples show typical anthropogenic contents of pit fillings. These contents could also be described macroscopically.[8] Bone fragments, as shown in Figure 1, which presumably originate from animal bones, appear bright yellowish in colour, which indicates a low temperature influence.[9] The bone fragment (**Fig. 1**) is from a very low or not heated bone. However, the vitrified material (**Fig. 2**) in the same layer indicates high burning temperatures. This highly heated material most likely originated from phytoliths. Phytoliths are mineral plant components composed of amorphous silicon. The biogen silicon merges at temperatures above about 800 °C (**Fig. 2**).[10] In addition to the vitrified phytoliths, intact phytoliths (**Fig. 3**), e.g. of reed (phragmites) (**Fig. 4**), are present in the pit filling. The large number of burnt clay fragments could be described macroscopically. Under the microscope the fragments show elongated pores that are oriented parallel. These pores form during production due to the biogenic tempering of clay with straw. Since the organic components were decomposed, the traces of the straw remain and build so-called plant pseudomorphoses, which characterize the typical microstructure of burnt clay (**Fig. 5**). The mixture of burnt, heat-affected material and unheated materials proves the intermixing of the sediments during backfilling. An *in situ* fire event in the secondary pit fill above the charred wooden construction can be excluded.

The sediments of the pit fill above the charred wood are characterised by post-depositional, pedogenic processes. Clay cutans on the surface of cracks, so-called slickensides, are visible (**Fig. 6**). This phenomenon can be observed in clay-dominated soils with clay contents of more than 45 % in the characterising horizon.[11] These slickensides are the result of high swelling pressure. Through repeated swelling and shrinking processes of the clays, clay minerals are reoriented at the cleavage.[12]

These slickensides are clearly distinguishable from vertically relocated clay (**Figs. 7–8**). Vertically displaced clay minerals, transported with percolating water, are deposited pore-oriented. They cover the walls of chambers, channels and planes or completely fill these pores. This accumulation can happen in several phases.[13] Due to these repeated phases based on different precipitation events, laminated clay coatings can accumulate. Figure 7 shows multi-layered clay coatings in different colours. Light brown clay alternates with greyish brown clay. The dark, so-called dusty clay is characterized by organic enrichment and is often based on anthropogenic influence.[14]

The formation of blue vivianite crystals ($Fe_3^{2+}[PO_4]_2 * 8H_2O$) should also be regarded as a pedogenic feature within the pit fill (**Fig. 9**). In natural soils, however, the phosphate contents are too low to form this iron phosphate mineral. Phosphates are present in sufficient quantity in the pit fill due to anthropogenic use. In the archaeological context, these available phosphates often derive from the degradation of plant material, excrements, urine, ashes, meat, fish, fish bones or bones and ashes.[15] Under reductive conditions vivianite

8 See Lehmphul *et al.* in press.
9 Villagran *et al.* 2017, 22.
10 Fritzsch *et al.* 2018, 70; Röpke/Dietl 2017, 175.
11 AG Boden 2005, 214.
12 Scheffer/Schachtschabel 2010, 350.
13 Kühn *et al.* 2010, 218 f.
14 Kühn 2003, 550; Kühn *et al.* 2010, 223.
15 Nicosia *et al.* 2017, 337; Holliday/Gartner 2007, 302.

Fig. 1 Fragment of bone (PPL) (thin section 1) (photo by D. Fritzsch)

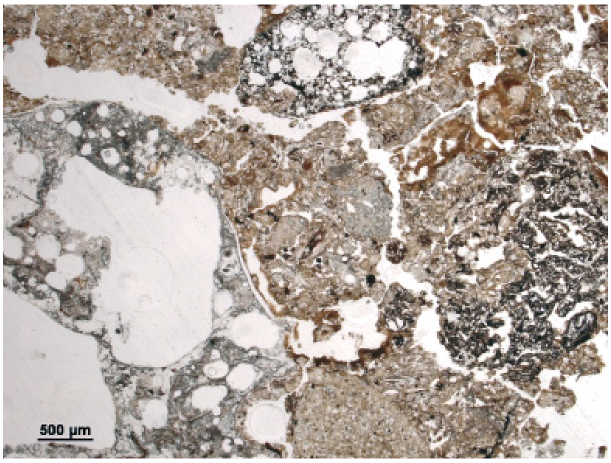

Fig. 2 Vitrified material (PPL) (thin section 4) (photo by D. Fritzsch)

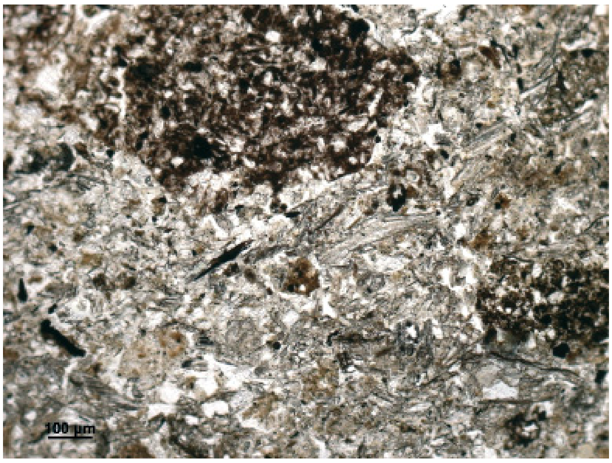

Fig. 3 Phytoliths (PPL) (thin section 4) (photo by D. Fritzsch)

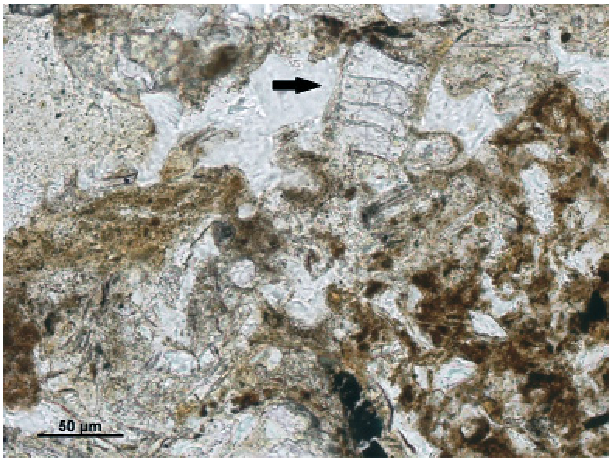

Fig. 4 Phytoliths; arrow: phragmites (PPL) (thin section 5) (photo by D. Fritzsch)

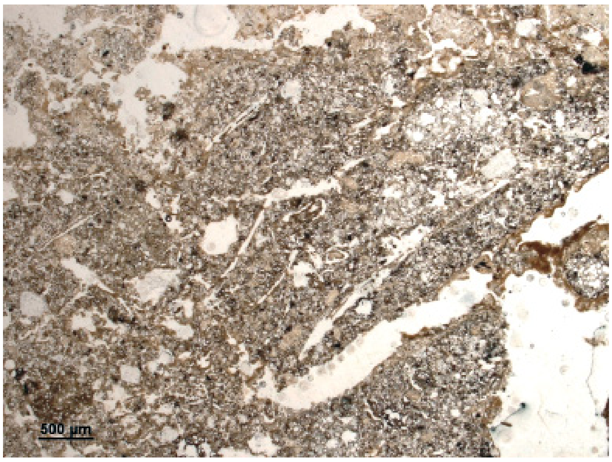

Fig. 5 Fragment of burned clay with pseudomorphoses of organic temper (PPL) (thin section 4) (photo by D. Fritzsch)

Fig. 6 Slickensides (arrow) (XPL) (thin section 2) (photo by D. Fritzsch)

crystallizes.[16] The anaerobic conditions in the clay-rich pit filling is based on the influence of backwater. Figure 9 shows a yellow phosphate precipitation. In the centre blue vivianite has crystallized.

Below the charred wood structure, a single sample, sample 6, was taken. In sample 1 to 5 typical anthropogenically induced contents such as bone fragments, vitrified material etc. could be identified. The filling below the charred wooden structure seems to be free of these anthropogenic materials. Only single microscopic charcoal fragments can be recognized by micromorphological analysis.

Compared to the sediments of the secondary pit fill, the precipitation of phosphates below the charred wooden construction is massive. Phosphatic impregnation is oriented to pores. It is crystallized on pore walls (**Fig. 10**) as well as within the matrix (**Fig. 11**). Such a large input of phosphates in anthropogenic environments is reported from stables, ponds and (waste) pits.[17]

Clay coatings are pedogenic characteristics of the pit fill (**Fig. 12**). Compared to the accumulation of clay within sections 1 to 5 (**Fig. 7**), here the coatings are much darker. Apparently, the clay was translocated together with humus and/or micro-charcoal from the charred wooden construction. Gebhardt describes the connection between dusty, dark clay coatings in the context of charcoal combustion.[18] For the phenomenon of very dusty clay coatings to occur, it is necessary that the surface is without vegetation and that tillage is frequently undertaken.

Figure 13 shows that these dark clay cutans were deposited on the phosphate-impregnated areas. This illustrates the relative sequence of the two relocation processes. The phosphates were subject to the first translocation process, followed by accumulation of clay, which probably continues until today.

Conclusion

The pit fill reflects layers of sediments at the time of backfilling of the pit. The soils at that time were, just like today, heavily clayey and humic, and differ scarcely or only slightly from today's soils. The secondary pit fill above the wooden structure shows typical anthropogenic contents mixed into the clayey-humic sediments. An *in situ* fire event never occurred, which is substantiated by the intermixing of burnt and unburnt sediments.

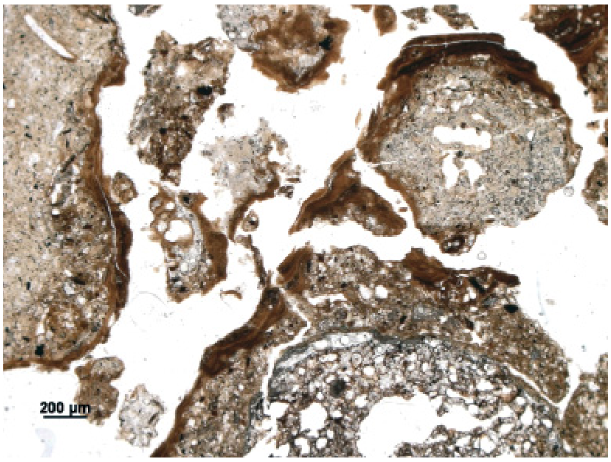

Fig. 7 Clay coatings (PPL) (thin section 4) (photo by D. Fritzsch)

Below the burned wooden construction, the clayey matrix of the primary pit fill, except for tiny charcoal fragments, does not show any anthropogenic additions directly recorded. Conspicuous, however, are massive phosphate inputs in the primary backfill, which are related to the Late Bronze Age anthropogenic use of the pit.

The process of phosphate impregnation cannot be determined. One possibility would be that the settlement pit was used as a waste pit and that high levels of phosphate were thus released into the ground. Thereby, this would have led to a removal of the phosphates through the entire profile to secondarily precipitate below the charred wooden construction. In the secondary pit fill above the wood phosphates are detectable indeed, but to a much lesser extent than below the charred wood. This possible deposition does not explain the large differences in the phosphate contents.

The use as a cesspit would explain the large differences in phosphate content. Due to its location in direct relation to a house structure, this kind of usage seems rather unlikely, but it must be considered based on its micromorphological results.

[16] Karkanas/Goldberg 2010, 535.

[17] Shahack-Gross 2017, 269; Macphail *et al.* 2008, 64.

[18] Gebhardt 2007.

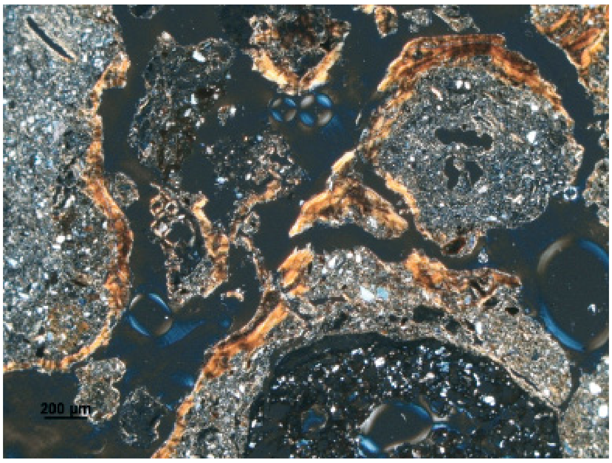

Fig. 8 Clay coatings (XPL) (thin section 4) (photo by D. Fritzsch)

Fig. 9 Vivianite (PPL) (thin section 4) (photo by D. Fritzsch)

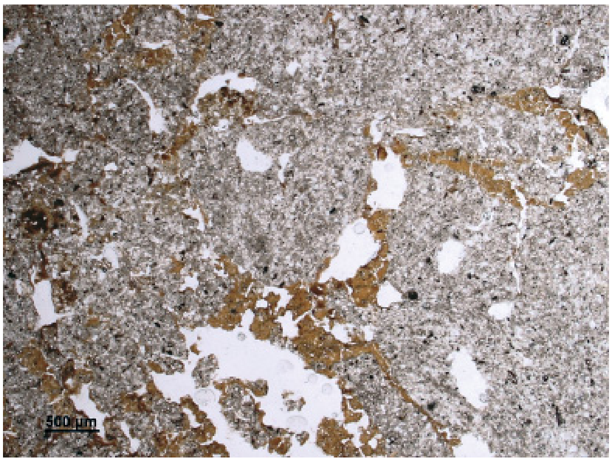

Fig. 10 Phosphatic coatings oriented on pores (PPL) (thin section 6) (photo by D. Fritzsch)

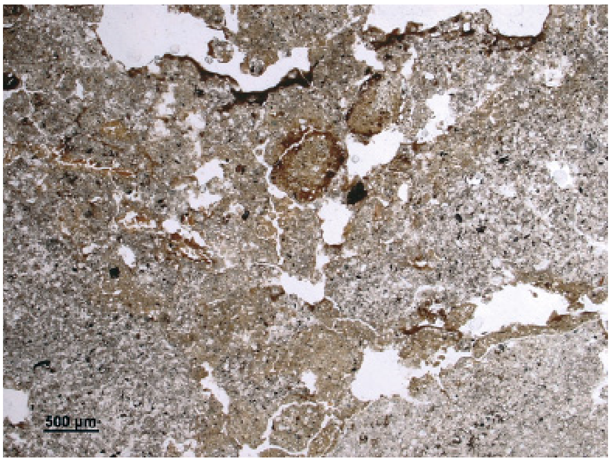

Fig. 11 Phosphatic impregnation of matrix (PPL) (thin section 6) (photo by D. Fritzsch)

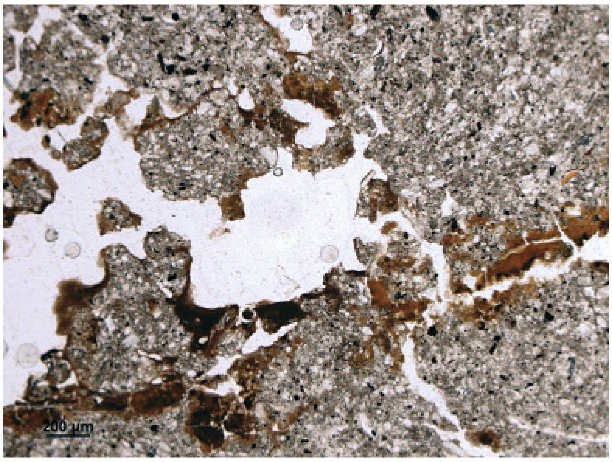

Fig. 12 Dark clay coatings (PPL) (thin section 6) (photo by D. Fritzsch)

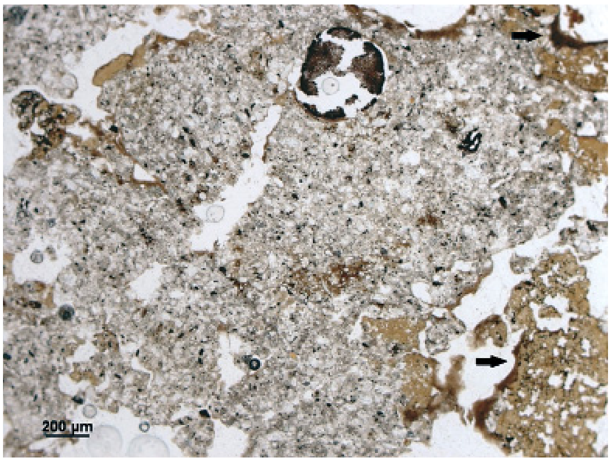

Fig. 13 Phosphatic impregnation covered with clay coating (arrows) (PPL) (thin section 6) (photo by D. Fritzsch)

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