Convention DMS-ARC/CReA-Pat/2017-247 entre la Région Bruxelles-Capitale et le Centre de Recherches en Archéologie et Patrimoine de l'ULB : études archéopédologiques en Région de Bruxelles-Capitale

Micromorphological report of Hof ter Coign (WB001)

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June 2018

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1 Introduction

This report presents the micromorphological study of the soil blocks retrieved from Hof ter Coign. Details on the topography, edaphology and general characteristics of the site can be found in Devos (2009) and Devos (2013).

2 Materials and methods

The description of the thin sections (TSs henceforth) follows the guidelines set forth in Stoops (2003). The interpretation of the micromorphological features is based on Stoops et al. (2010), Nicosia and Stoops (2017), MacKenzie et al. (2017) and Barker (2014). Microphotographs have been taken under plane polarized light (PPL) and cross polarized light (XPL) using a Motic BA310Pol® trinocular microscope equipped with a 5X Moticam®.

3 Stratigraphic profile

Figure 1A presents the stratigraphic profile of the deposit identified in the field as a possible Plaggen Anthrosol (US 154–US 157). Three undisturbed soil blocks were collected from the stratigraphic profile in order to check this hypothesis through soil micromorphology (Figure 1B).

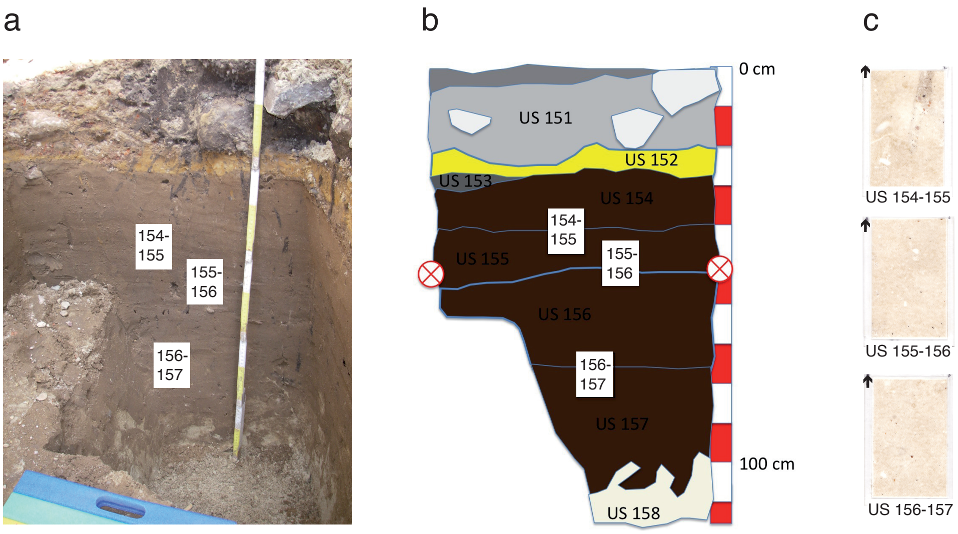

Figure 1: Stratigraphic profile of Hof ter Coign. a) and b) Picture and drawing of the stratigraphic profile, both by Devos (2013). The white squares show the position of the undisturbed soil blocks extracted for soil micromorphology. c) Thin sections produced from the soil blocks in a) and b).

3.1 Micromorphological description

3.1.1 TSs US 154-155, US 155-156, US 156-157

All three TSs are very similar in terms of micromorphological features. The soil is mostly homogeneous and is characterized by an intergrain microstructure (single spaced/close porphyric c/f related distribution). Some areas on the uppermost part of TS 154–155 also show a single spaced equal enaulic c/f related distribution, with the aggregates being over weakly to moderately developed porous crumbs. A slight degree of bioturbation is also suggested by the presence of channels and chambers, specially concentrated in TS 154-155, as well as by very rare smooth, ellipsoidal mite excrements (Figure 2A). No earthworm granules were identified in the TSs groundmass (but see below). The mineral fraction consists of very dominant monocrystalline quartz grains of two clearly differentiated and well-sorted grain size fractions, one c. 200 µm in diameter and the other c. 40 µm in diameter. Many quartz grains present signs of alteration in the form of cracks and internal fractures, probably caused during the fabrication of the TSs (Figure 2B). Very few glauconite grains, as well as fragments of siltsone, have also been identified.

The fine material is mostly dusty clay with brown to yellowish colours and low birrefringence, sometimes with a stipple-speckled b-fabric. The organic fraction is very infrequent and includes very scarce and moderately to highly decomposed root fragments, organic punctuation, small cellulose fragments and charcoal. Pedofeatures are rare, and mainly consist of very infrequent limpid typic and crescent clay coatings and few dusty clay coatings and infillings, as well as very few poorly to strongly impregnated phosphatic and iron-manganese pedofeatures (Figure 2C–F). No clear differences in the distribution of pedofeatures have been observed between the topmost and the bottommost slide. Phytoliths include elongated, blocky and bulliform phytoliths randomly distributed throughout the three TSs (Figure 3A–C). No peat fragments have been observed.

Anthropic inclusions concentrate in a 1 cm-wide, 6 cm-large root channel that goes top to bottom in TS 154–155 (Figure 4). This channel is filled by sediment containing a higher proportion of organic matter and black carbonised material than the surrounding groundmass. It also includes plant pseudomorphs, an earthworm granule, fragments of siltstone, one compact fragment of bone, charcoal and partially dissolved fragments of calcareous mortar with inclusions of microfossils (Figure 5A–F). It also contains aggregates of subrounded, reddened soil and three slag droplets less than 200 µm large with punctuations of magnetite, a porous, vesicular microstructure and fayalite crystals (Figure 6A–F). Anthropic inclusions in the rest of the TS, as well as in TSs 155–156 and 156–157, are highly infrequent and only very scarce fragments of dissolved calcareous mortar, charcoal and reddened soil aggregates have been observed.

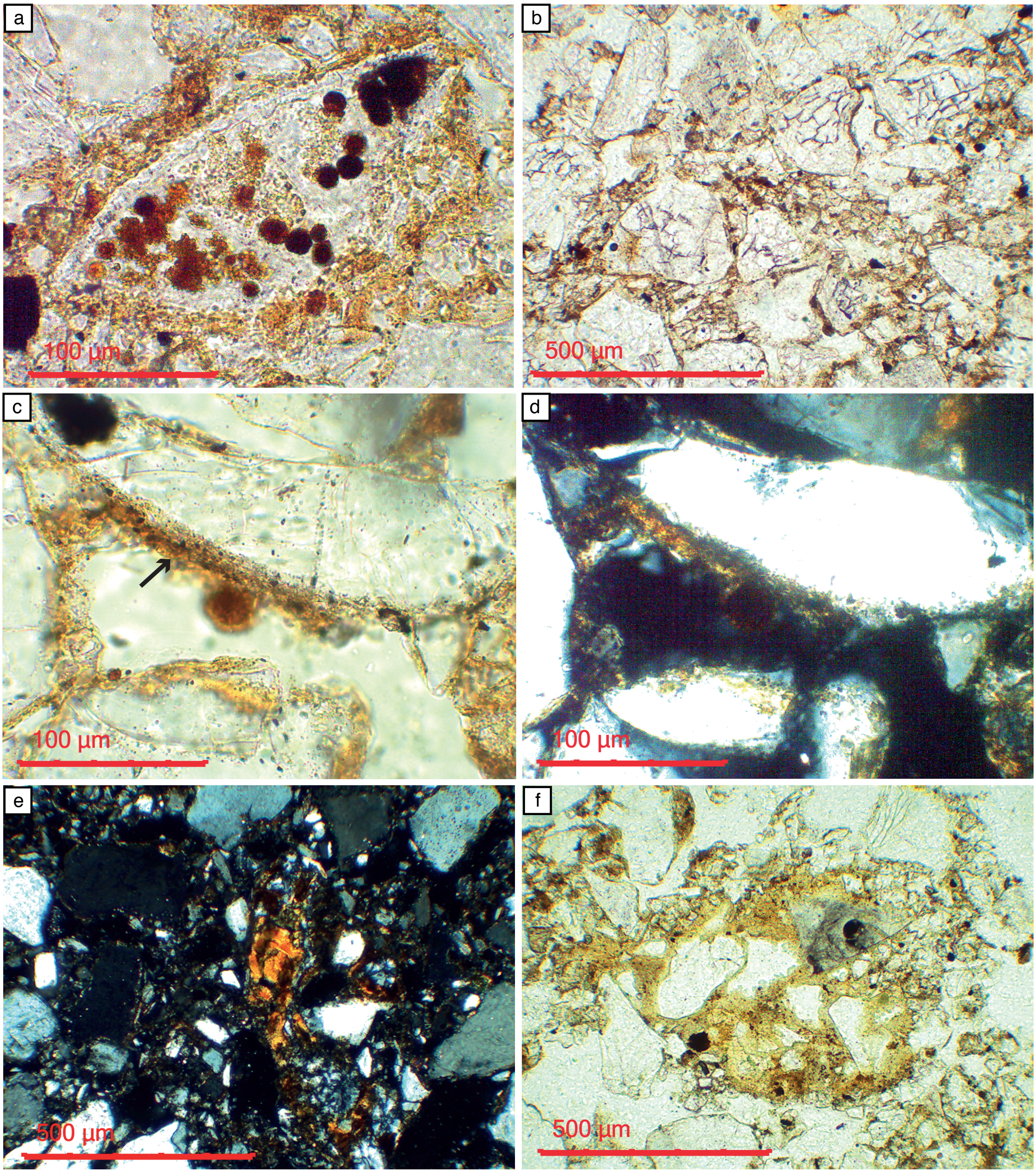

Figure 2: Microphotographs taken under plane polarized light (PPL) and cross-polarized light (XPL). a) Ellipsoidal mite excrements in a plant void (PPL). b) Cracks in quartz grains, probably caused during the production of the TSs (PPL). c) Dusty clay coating a quartz grain (black arrow). Note the organic matter punctuations along the coating (PPL). d) Same as in b) but in XPL. Note the low birrefringence of the dusty clay coating (XPL). e) Limpid crescent clay infilling. Note the characteristic extinction bands (XPL). f) Phosphatic impregnation (PPL).

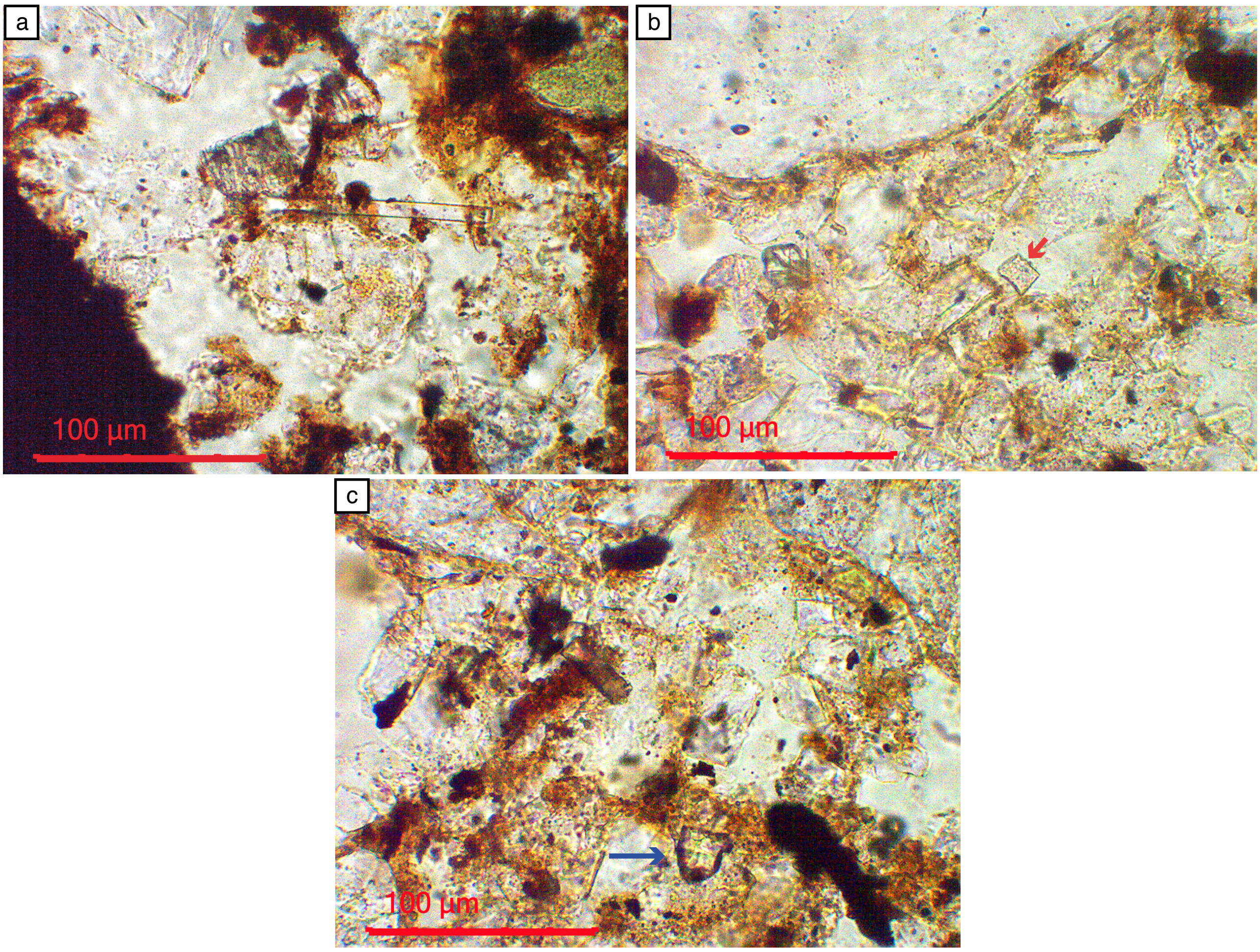

Figure 3: Microphotographs taken under plane polarized light (PPL) and cross-polarized light (XPL). a) Elongated phytolith (PPL). b) Blocky phytolith (red arrow) (PPL). c) Bulliform phytolith (Blue arrow) (PPL).

Figure 4: Detail of the channel filled with sediment and anthropic materials identified in TS 154-155.

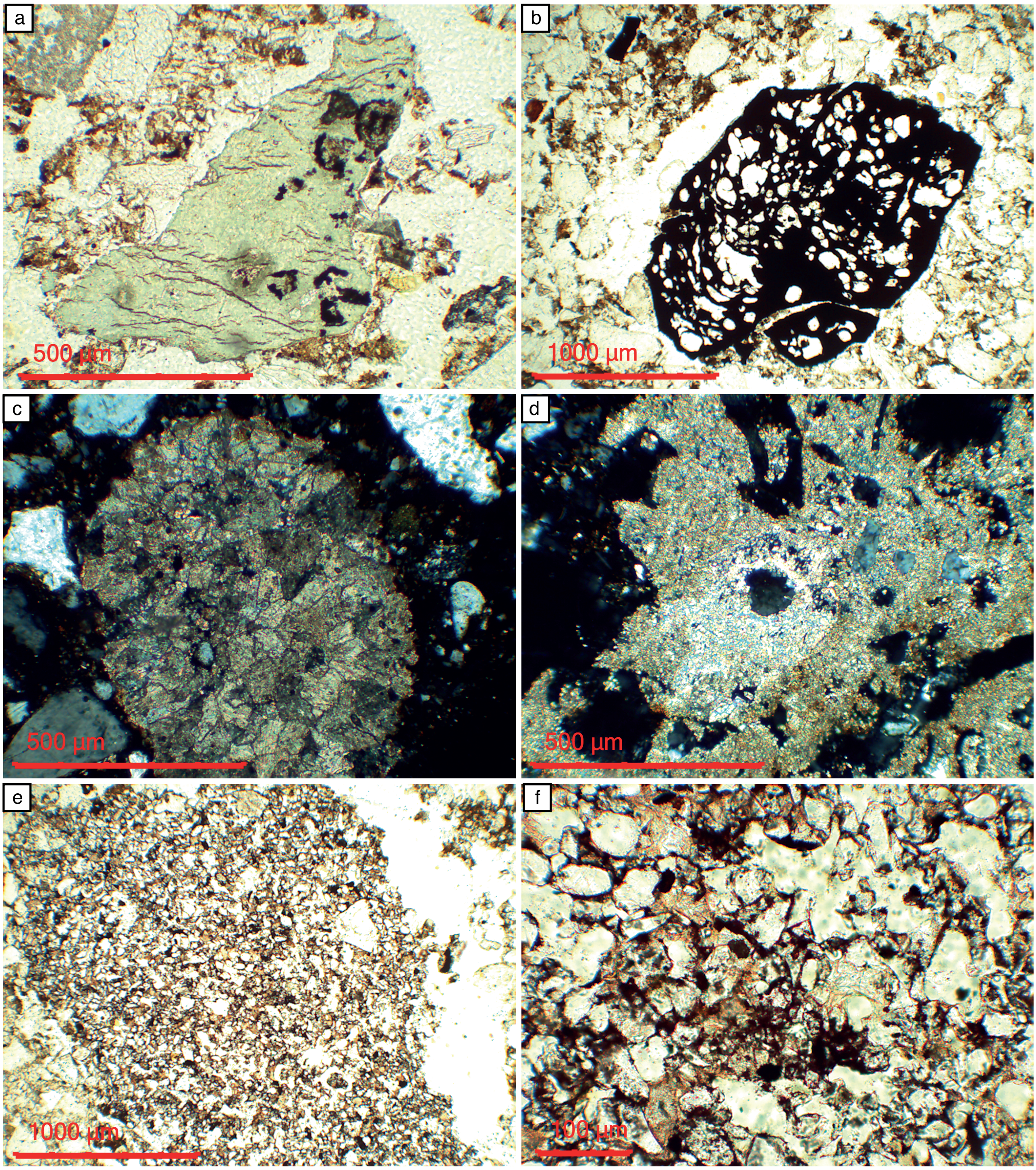

Figure 5: Microphotographs taken under plane polarized light (PPL) and cross-polarized light (XPL). a) Bone (PPL). b) Charcoal (PPL). e) Earthworm granule (XPL). d) Mortar (XPL). e) Siltstone (PPL). f) Detail of the siltstone. Note the quartz grains (<40 µm in diameter), the fine-grained clay material and the inclusions of pyrite (opaque mineral) (PPL).

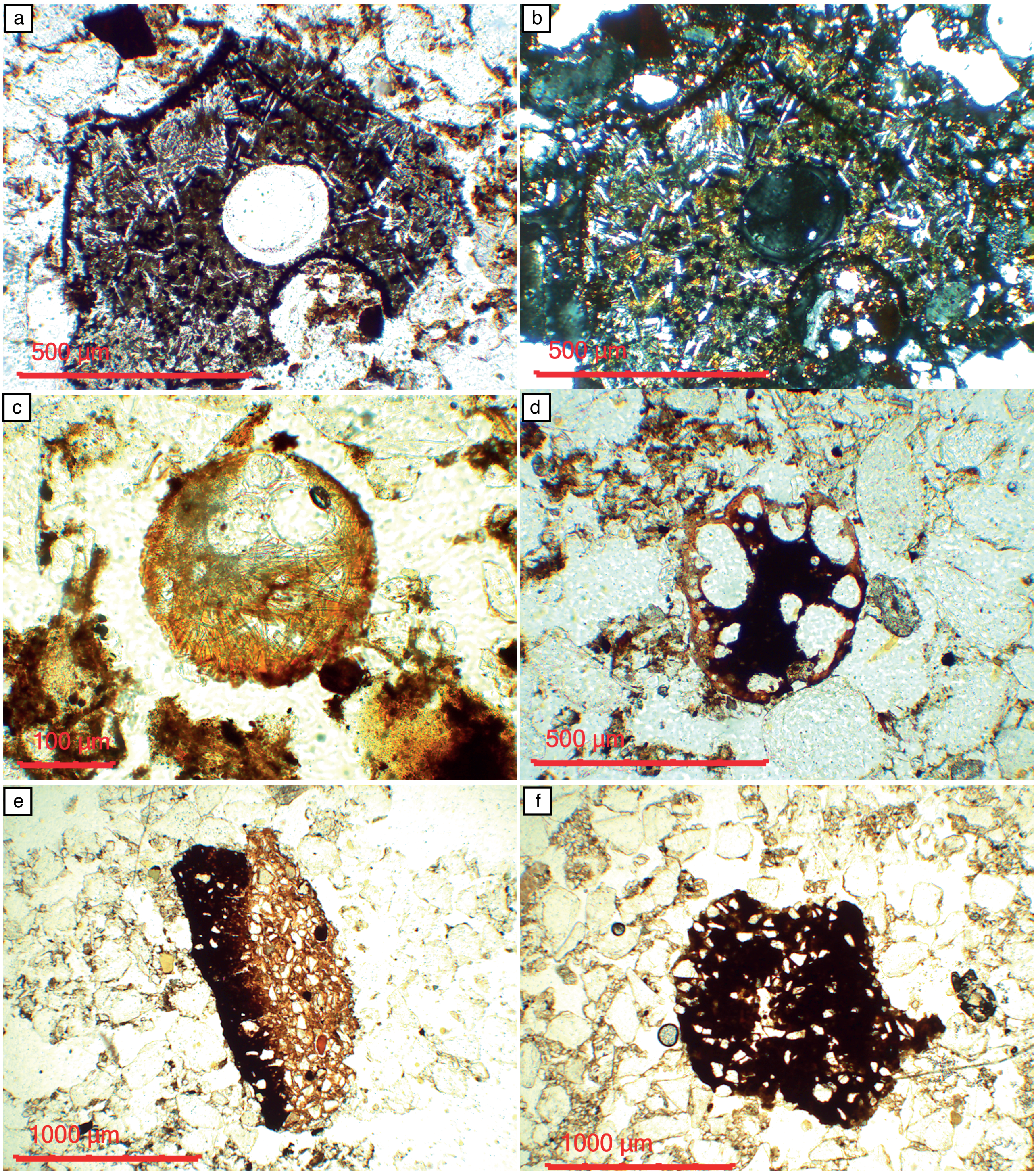

Figure 6: Microphotographs taken under plane polarized light (PPL) and cross-polarized light (XPL). a, b, c and d) Metal slags and droplets. In a), the black dots are magnetite whereas the elongated, white crystals are probably fayalite (PPL and XPL). e) Reddened soil aggregate (PPL). f) Strongly impregnated iron nodule (PPL).

4 Discussion and conclusions

The micromorphological features identified in the Hof ter Coign soil might not be sufficient to unequivocally characterize it as a plaggen soil, e.g. a human-made, thickened soil formed by recurring inputs of animal bedding materials (e.g. heather, grass sods, cattle excrements, urine) aiming at increasing its potential for cropping. Such agrarian practice, which creates soils that are higher than natural ones by 30–140 cm, is widely implemented in NW Germany, the Netherlands, Belgium, Ireland, Scotland and Orkney, probably since 1000 BC (Blume and Leinweber 2004). Compared to natural soils, plaggen are rich in phosphates and animal dung, and might display traces of layering and horizontally-aligned plant remains due to the continuous deposition of material trampled by cattle –although these features can be easily obliterated by periodic tilling and cultivation. Plaggen soils can also present inclusions of peat turf, commonly used for bedding of cattle in order to soak up the animal wastes (Bryant and Davidson 1996), as well as household waste (Goldberg and Macphail 2006) or seaweed (Conry 1971). In their study of the Papa Stour plaggen soils, Adderley et al. (2006) noted that plaggen might also be characterized by very infrequent clay infillings/coatings or calcium/iron phosphate nodules.

Of all the abovementioned micromorphological features, the Hof ter Coign soil only shares the presence of materials reasonably related with household waste (e.g. one bone, mortar, charcoal) and the exiguity of textural pedofeatures. However, the inclusion of almost all the anthropic features in a root channel filled with darker, organic-rich material indicates that they entered the soil profile translocated from above and are by no means representative of the soil groundmass. It is worth emphasizing the presence in the channel fill of fayalitic slags and slag droplets jointly with reddened soil fragments, pointing towards metallurgical activities being carried out on top of the soil profile. According to Angelini et al. (2017), slag droplets can be interpreted as spills during slag tapping from furnaces and/or pouring from crucibles.

As for the very few textural pedofeatures documented, the presence of limpid and crescent clay coatings is often linked to slow clay illuviation in undisturbed, well-drained soils, while dusty clay coatings to the percolation of silt and organic matter due to rainsplash in disturbed or opened-up soils (French 2003). The lack of a clear hierarchy between these pedofeatures in the sampled soil profile hampers determining whether soil disturbance followed a period of soil stability or the other way around. In any case, although dusty clay coatings have been used as a proxy for agrarian activities, they can also result from topsoil erosion, soil truncation, tree throw or freeze-thaw processes (Macphail 1992). The soil aggregates partially observed on the uppermost part of TS 154–155 might be formed by ploughing and ard tilling, but also by bioturbation or soil formation processes (Stoops 2003). Other proxies traditionally used to infer land clearance and agriculture [e.g. presence of ash due to fire clearance; traces of splash or crusts indicative of water action on bare surfaces, see Deák et al. (2017)] have not been observed.

If a control, non-cultivated soil is locally available, phosphorus combined with steroid biomarker analyses might provide an extra line of evidence to eventually support or reject the plaggen soil hypothesis. Manured, cultivated soils tend to show higher P contents than non-cultivated soils due to manure inputs. However, ancient agrarian systems could have also lead to soils depleted in P, as shown by Verheyen et al. (1999). Under such situation, steroid biomarker analysis might help inferring whether eventual low P values are due to lack or excess of cultivation by uncovering the presence of faecal remains from cattle/humans in the soil matrix. The work by Simpson et al. (1998) on the plaggen-like soils of Toft Ness is representative of the potential of combining P analysis and 5β stanols in the characterization of anthropogenic soils.

Until further evidence is collected, the hypothesis of the Hof ter Coign soil being a non-laminated colluvial deposit should not be ruled out. According to Mücher et al. (2010), colluvial deposits present many micromorphological features that also characterize the Hof ter Coign profile, such as massive structure, sorting or mineral homogeneization, as well as weakly developed soil aggregates or brown impure clay coatings/limped clay coatings due to soil formation after deposition.

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