Atti Soc. tosc. Sci. nat., Mem., Serie A, 112 (2007)
pagg. 145-151, figg. 4, tabb. 2

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CONTRIBUTION OF ARCHAEOPEDOLOGY TO THE PALAEOENVIRONMENTAL RECONSTRUCTION OF (PRE-) URBAN SITES AT BRUSSELS (BELGIUM). THE EXAMPLE OF THE TREURENBERG SITE

Abstract - During excavations conducted at the Treurenberg site, one of the seven city-gates of the medieval town of Brussels (Belgium), the basal construction level of the gate was found. Historical sources point to the beginning of the 13th century as the erection period. This level covers a layer that was shown by the archaeopedologists not to be the natural soil. Unfortunately, it was too poor in archaeological material to deliver a date or interpretation without absolute methods, but it was very characteristic from a palaeoenvironmental point of view. An interdisciplinary study involving archaeopedology, phytolith analysis and anthracology, adapted to the requirements of urban archaeology, has proved to be a useful tool to gain evidences of agricultural and quarrying practices older than the construction level of the 13th century city gate. This was a remarkable discovery, because it was the first time that we uncovered such activities in a well-defined stratigraphical context and in direct association with the city wall.

Key words - Archaeopedology, urban archaeology, multielement analyses, soil micromorpholgy, Brussels, Belgium.

Riassunto - *Il contributo dell'archeopedologia alla ricostruzione paleoambientale dei siti (pre-) urbani di Bruxelles (Belgio). L'esempio del sito di Treurenberg*. Durante gli scavi condotti nel sito di Treurenberg, una delle sette porte della cinta medievale di Bruxelles (Belgio), è stato posto in luce il livello di base della costruzione. Fonti storiche indicano che fu eretta all'inizio del XIII secolo. Questo livello ne copre un altro che, come dimostrato dall'archeopedologia, non è il suolo naturale e che purtroppo era troppo povero in reperti per poter essere interpretato o datato senza metodi di datazione assoluta; tuttavia, le sue caratteristiche sono peculiari dal punto di vista paleoambientale. Uno studio interdisciplinare che ha incluso archeopedologia, analisi dei fitoliti ed antracologia, adattate alle peculiarità dell'archeologia urbana, ha permesso di raccogliere indizi di pratiche agricole e di attività di cava di un'epoca più antica della porta del XIII secolo. Questa scoperta è stata notevole, poiché per la prima volta è stata trovata traccia di queste attività in un contesto stratigrafico chiaro ed in associazione diretta con la cerchia muraria.

Parole chiave - Archeopedologia, archeologia urbana, analisi multielemento, micromorfologia dei suoli, Bruxelles, Belgio.

INTRODUCTION AND GEOGRAPHIC AREA

The Brussels archaeological survey and the development of palaeoenvironmental studies in Brussels

Since 1995 the Service of Monuments and Sites of the Brussels Capital Region has conducted a systematic archaeological follow up. One of the emerging research topics is the first city wall (13th century AD) (Blanquart *et al.*, 2001). This includes the mapping of the remains of the city wall and the archaeological interventions. One of these was the investigation of the Treurenberg site in 2000.

At the same time there has been a development of palaeoenvironmental studies (especially microarchaeology, carpology, archaeozoology and archaeopedology and more recently phytolith analysis) in the urban area of Brussels. Table 1 details the published palaeoenvironmental studies on archaeological excavations in Brussels.

Today these environmental studies have become an integral part of the archaeological excavation strategy.

Geographic area

The Treurenberg site is situated in the northeastern part of the centre of Brussels, near the cathedral of Saint Michael and Gudula. This uptown part encompasses also the palace of the Coudenberg, residence of the Dukes of Brabant (burned in 1674).

The study of the existing maps shows that the Treurenberg site is situated in zone X, an area characterised by the presence of Tertiary sand deposits (Brussellian sands) covered by a thick layer of rubbish (Fig. 1).

The site

Underneath the foundations of the city wall a layer has been encountered that was very poor in classic artefacts. The archaeopedological field study showed this layer to be crucial to an understanding of the development of the area before the construction of the city wall.

METHODS, TECHNIQUES, MATERIALS STUDIED

Three trenches have been subjected to an archaeopedological study.

The archaeopedological field study has been conducted following a specific methodology:

– a site description based on the *F.A.O. Guidelines for soil profile description* (FAO, 1990) and the ITC-Ghent *Handbook for Comprehensive and Adequate Field Soil Data Bases* (Adiwiganda & Langohr, 1989);
– the study of the Geotechnical map of Brussels (Dam *et al.*, 1977), as a surrogate for the non-available traditional soil maps for the city of Brussels;

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Tab. 1 - Published palaeoenvironmental studies on archaeological excavations in Brussels since 1986.

Site	**Year**	**Micro-archaeology**	**Archaeobotany**			**Archaeozoology**				**Earth sciences**	
			Carpology	**Palynology**	**Phytolith**	**Archaeo zoology ss.**	**Fish studies**	**Malacology**	**Entomology**	**Geology**	**Archaeo pedology**
rue de la Montagne	1987			X						X	
Riches Claires	1991-1993	X				X					
Marolles	1993-1994	X	X			X		X			
rue d'Une Personne	1992-1994	X	X		X	X					X
Vieille-Halle-aux-Blés	1994-1996	X	X		X						X
rue de Namur	1993	X	X								X
place Sainte-Catherine	1993	X	X					X			X
rue du Midi	1994	X	X	X		X		X			X
Vieux-Marché-aux-Grains	1995	X	X		X						
rue de Dinant		X	X			X					
Impasse du Papier	1996	X	X		X		X				X
Ancienne Maison De Greef	1986-1987		X			X			X	X	

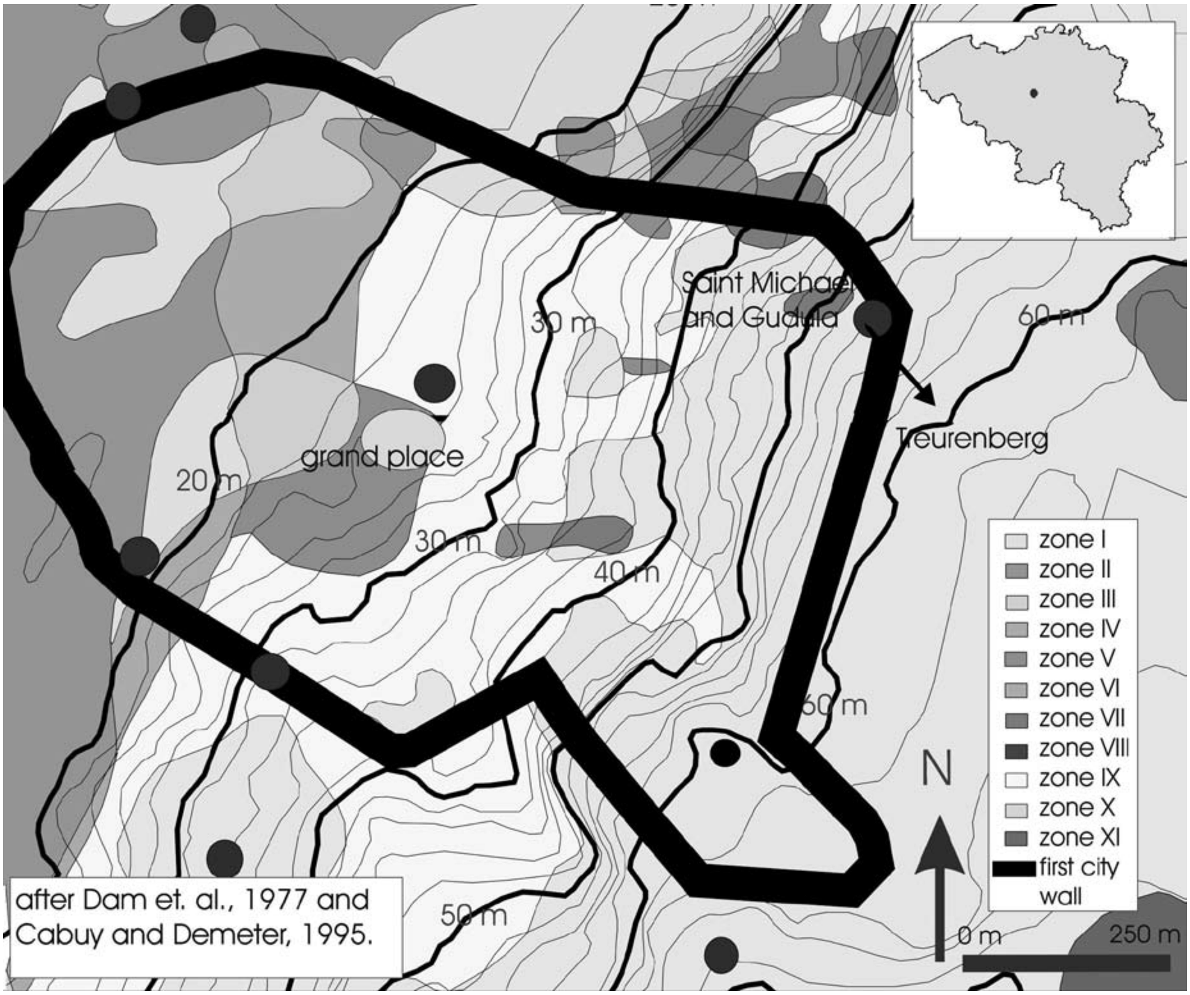

Fig. 1 - Site map, showing the ancient city walls of Brussels.

- describing, drawing and photographing the different soil profiles;
- describing the soil characteristics and the phenomena associated with archaeological structures or layers by using appropriate checklists as a reference (Fechner, 1992; Fechner & Langohr, 1993; Fechner *et al.*, forthcoming);
- determination of the absence or presence of $CaCO_3$ by the reaction of the sediments with HCl and, in the case of dark spots, of the presence or absence of manganese with H_2O_2;
- decision about which samples should be taken for further analysis.

Further analyses include a micromorphological study for which oriented monoliths have been taken in the field. The samples were dried and cut to the right size, either 9 x 5 cm or 4 x 6 cm; both sizes are of a thickness of 30 µm. The thin sections were produced by Th. Beckmann in Germany and have been described following the international nomenclature of the *Handbook for soil thin section description* (Bullock *et al.*, 1985). On selected samples a series of standard chemical analyses were applied: the determination of the soil pH (H_2O) and the soil pH (KCl) 1 N, the determination of the organic carbon content (NF 10694), the nitrogen content (NF 13878), the total sulphur content (elemental analysis). Finally organic, inorganic and total phosphate (Mikkelsen, 1997) are determined. All the analyses, except the analysis of the phosphates, which has been performed by J.H. Mikkelsen of the Ghent University, are performed by the laboratory of soil analysis of the *Institut National de la Recherche Agronomique d'Arras* (France).

The following trace elements have been analysed by ICP-MS: V, Rb, Y, Zr, Nb, Ba, La, Ce, Pr, Nd, Eu, Sm, Gd, Dy, Ho, Er, Yb, Lu, Hf, Ta, W, Th and U. The Sc-concentration is determined by ICP-AES. These analyses are carried out at the laboratory of geochemistry of Prof. Dr. Luc André of the Royal Museum of Central Africa, Tervuren.

Eight granulometrical fractions without decarbonisation are determined (< 2 µm, 2-20 µm, 20-50 µm, 50-100 µm, 100-200 µm, 200-500 µm, 500-1,000 µm, 1,000-2,000 µm). The limits of the 3 principal granulometrical fractions (sand, silt and clay) are defined following the USDA classification.
Similarity indexes (SI) were calculated on these fractions to estimate the magnitude of discontinuity or similarity in the soil parent material (Langohr *et al.*, 1976). The SI was checked on the 8 fractions and on 7 fractions (with exclusion of the clay fraction). SI-indexes were calculated in a similar way for the trace elements.
Two kinds of phytolith analysis were performed: the investigation of bulk samples and the study of soil thin sections taken in specific layers of each trench. The former were taken in each layer of the archaeological sequence. Of the seven studied thin sections, three were made of undisturbed sediment from the proposed plough horizon (US115).
Methods, concepts and results of the phytolith analysis of the thin sections are presented elsewhere (Vrydaghs *et al.*, accepted).
The bulk samples were treated according to Bowdery (1999). Results obtained for the bulk sample taken in the supposed plough horizon were compared with those obtained by the phytolith analysis of the thin sections taken in the same horizon. Afterwards, synthetic spectra were established.
Critical horizons have been sampled for anthracological analysis. Charcoal fragments have been collected by sieving the samples at different mesh width. They were identified and studied under an optical microscope. The identification has been made by comparison with the reference collection from the Xylarium of the Royal Museum of Central Africa, Tervuren and literature.

RESULTS

The study permits the identification of two sequences of activities before the construction of the first city wall: quarrying and ploughing.

The quarry

The archaeopedological field study revealed the first traces of human activity based on the following evidence:

- the presence of an *in situ* layer of sandstone;
- the intersection of this layer by the structure;
- the fact that the intersection stops once the layer of sandstone is reached;
- small pits have been found at the base of one of the trenches. One of these pits cuts the first microlaminated deposits, and contains sandstone as well as archaeological material; all this informs us that there has been a human intervention at that level;
- the pit has a minimum size of several meters.

Altogether, these data seem to support our hypothesis of the presence of a quarry.
The study of thin sections taken from the fill distinguished between layers which contain coarse sand particles and traces of human activity like bones, charcoal and plant remains, and the small microlaminated layers which mostly did not contain any of these anthropic elements, suggesting natural deposition.
Putting together all this evidence has permitted us to reconstruct this first phase of human occupation as follows (see Fig. 2). The digging of a large extraction pit for the extraction of the stones, followed by its infilling. The fill probably happened in different phases but we cannot be more precise as we do not know the base nor the exact limits of the pit.

The presence of a dark horizon

The upper decimetres of the quarry fill have been altered into a dark horizon (see Fig. 3) that presented the following characteristics:

- a homogeneous and humiferous horizon;
- an abrupt and more or less horizontal boundary at the base;
- a high textural and structural similarity between this layer and the underlying horizon. Both horizons present similar inclusions. These observations indicate that they share the same soil matrix;
- the absence of any traces of microlamination or stratification.

The totality of these characteristics corresponds to traces left by ploughing activities in a large sense, whether it may be ploughing, arding or hoeing.
This was a remarkable discovery, because it was the first time that we uncovered such activities in a well-defined stratigraphical context and in direct association with the city wall, although former excavations in the lower part of the city revealed the existence in the

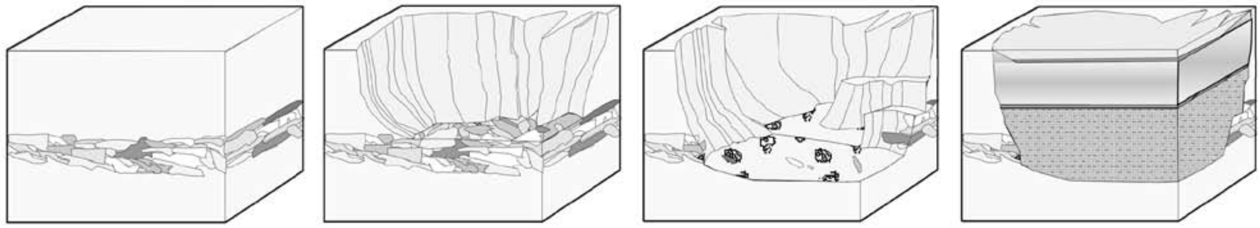

Fig. 2 - Block-diagram showing the evolution of the quarry area. From left to right: original situation; excavation down to the sandstone level; anthropic features at the bottom of the quarry; infilling of the quarry.

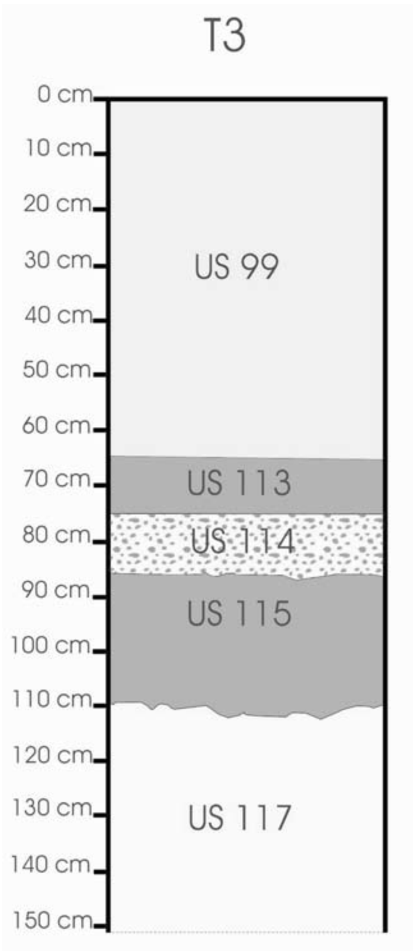

Fig. 3 - Upper decimetres of the quarry fill; US 115 is the supposed plough layer.

12th-13th century of gardens and or fields inside the city wall (Rue d'Une Personne [Fechner, 1997a], Impasse du Papier [Blanquart *et al.*, 2002], Halles-aux-Blés [Fechner, 1997b]).

Unfortunately urban archaeology offers restricted space for excavations and it was impossible to study a large horizontal section in order to collect further macroevidence of ploughing activities (*e.g.* plough marks).

The alternative appeared to be an interdisciplinary approach combining micromorphology, chemical and physical soil analysis, phytolith analysis and anthracology.

The study of the thin sections has been undertaken in order to determine the exact composition of the sediment and to understand its internal structure (for a description of the thin sections we refer to Vrydaghs *et al.*, accepted).

The following set of observations supported our field hypothesis of a plough layer:

– the comparison of the different thin sections of US 115 (the proposed plough horizon) showed the homogeneity, already revealed at a macro scale during the field study, and the absence of any lamination or stratification;
– we also witnessed the presence of textural pedofeatures, especially clay coatings around the quartz grains and dusty/impure clay coatings along the pores;
– moreover we attested to the presence of angular fragments;
– finally there is the presence of phosphates, the abundant presence of charcoal fragments, rare bone fragments and rare organ/tissue residues.

Comparison of this suite of observations with the literature (Courty *et al.*, 1989; Fechner *et al.*, 1995) supports the identification of the investigated horizon as a plough horizon.

Nevertheless the presence of excremental pedofeatures caused by bioturbations needs to be pointed out. They may be an indicator of a pastured soil, but, compared to the conservation of so many traces of ploughing activities, it is probably of minor importance. As these features are coming in later, the possible pasturing of the soil must be placed after the end of the ploughing of the soil. One might imagine that between the decision to build the city wall and the actual construction there might have been grassland.

The chemical analyses show that today the chemical conditions of the soil are favourable for agricultural activities (see Tab. 2). Comparing the results of the humiferous horizon with the preceding horizon, an enrichment of organic matter, phosphates and nitrogen is noted. The ratio Ptot/Pinorg differs significantly from the results encountered in archaeological detritus deposits. The hypothesis of intentional fertilisation of the upper horizon also seems to be supported by the presence of bone fragments. Their decomposition might have contributed to the phosphates and calcium enrichment of the horizon.

The application of the SI to the results of the granulometrical analysis (see Fig. 4) demonstrated that the presumed ploughing horizon has a highly comparable distribution of the different granulometrical fractions, compared to the horizon underneath. A comparable result shows up for the SI of the analysed trace elements. This supports our hypothesis that we are facing a plough horizon where the upper decimetres of the upper part of the quarry upfill are mixed up, rather than the possibility of a new deposit.

Finally the study of the phytoliths present in the thin sections and the soil samples gave us some more convincing information and confirmed once more our hypothesis of a ploughing horizon. The revealed cereal phytoliths are well preserved and perfectly released from their original tissues (Vrydaghs *et al.*, accepted). This is in agreement with our hypothesis that the study of phytoliths in thin sections is useful when the soil presents good chemical conditions, *i.e.* pH not too high for phytolith preservation and/or a limited duration of such phytolith alteration (Devos *et al.*, in print). The low C/N-ratio reflects the fast decomposition of organic tissues. This is important for the study of phytoliths under thin sections because the organ remains can mask the presence of the phytoliths. It is also important to

Tab. 2 - Soil chemistry analyses carried out on stratigraphical units (us) of the Treurenberg site.

	pH	**pH**	**C**	**N**	**S**	**Porg**	**PE**	**Ptot**	**V**	**Rb**	**Y**	**Zr**	**Nb**	**Ba**	**La**	**Ce**
US	**H_2O**	**KCl**	**g/kg**	**g/kg**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
87	7.7	7.3	3.71	230	182	2,038	1,405	3,443	16.5	29.0	6.2	176	2.9	143	9.2	18
92	7.4	6.8	2.15	220	145	476	297	773	10.0	19.2	2.3	143	2.1	97	5.7	11
94	7.4	6.8	0.75	90		112	286	398	10.3	16.5	2.5	104	1.8	87	4.7	9
99	8.2	7.4	0.29	50		22	210	232	9.0	10.1	0.2	36	0.4	54	3.2	6
113	8.6	8.0	0.78	140		816	1,381	2,197	14.2	26.7	6.7	194	2.7	147	7.8	16
114	8.9	8.4	1.00	80		238	1,573	1,811	18.9	26.0	5.1	207	2.4	133	6.6	14
115	8.5	8.0	1.54	220	104	236	310	546	16.1	30.7	8.7	242	3.7	174	10.1	20
117	7.7	7.1	0.67	60		73	1,007	1,080	8.9	16.1	10.1	127	1.4	90	5.1	10
US	**Pr**	**Nd**	**Eu**	**Sm**	**Gd**	**Dy**	**Ho**	**Er**	**Yb**	**Lu**	**Hf**	**Ta**	**W**	**Th**	**U**	**Sc**
	ppm	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
87	2.20	8.0	0.28	1.50	1.29	1.14	0.25	0.72	0.82	0.12	4.43	0.22	0.37	2.33	0.83	2.27
92	1.25	4.5	0.15	0.82	0.69	0.60	0.13	0.41	0.48	0.07	3.60	0.13	0.24	1.37	0.53	1.25
94	1.02	3.7	0.12	0.67	0.57	0.48	0.11	0.30	0.37	0.05	2.70	0.14	0.35	1.25	0.46	1.00
99	0.66	2.5	0.08	0.47	0.37	0.27	0.05	0.16	0.16	0.02	0.92	0.09	0.14	0.55	0.20	< 1
113	1.81	6.7	0.21	1.23	1.13	1.10	0.25	0.75	0.84	0.12	5.03	0.17	0.39	2.17	0.79	1.77
114	1.65	6.3	0.24	1.16	0.98	0.83	0.18	0.52	0.59	0.09	5.30	0.17	0.40	1.53	1.10	2.07
115	2.47	9.0	0.28	1.60	1.33	1.21	0.28	0.80	0.92	0.14	6.27	0.25	0.46	2.67	0.94	2.11
117	1.18	4.2	0.12	0.76	0.63	0.57	0.13	0.39	0.45	0.07	3.11	0.05	0.12	1.27	0.47	1.13

note that most of the dendriform phytoliths are isolated, suggesting a post-depositional disturbance. Moreover the fragmentation of some of the phytoliths might indicate reworking of the soil. Specific phytoliths are present in this horizon compared to the horizon below.

Through the Treurenberg sequence, phytolith analysis notes a diversification of the cultivated crops. Evidence of one genus (*Avena* sp.) is noted at the base of the sequence against three genera (*Triticum* sp., *Hordeum* sp. and *Avena* sp.) for the dark horizon. Even more important, through the sequence, a change in the organ representation is recorded: leaf appendixes (Kaplan *et al*., 1992) disappear with the dark horizon while they are observed at the base of the sequence.

Putting together all of this evidence we can come to the following reconstruction: once the quarry was completely filled up, the landscape was sufficiently flat to permit agricultural activities on the spot. According to the phytolith data, in particular the presence of different cereals, it seems more probable that we are dealing with a field rather than a garden. It is on top of this agricultural horizon that the first city wall has been constructed, thus preserving the underlying remains and most of its characteristics. Whether or not the soil has been intentionally manured is still largely open to debate. Nevertheless it might be useful to develop some of the arguments favouring such enrichment. On the one hand there is the presence of bone and charcoal fragments and the abundant presence of phosphates. On the other hand there is the presence of phytoliths and diatoms that are typical for the facies of manure (Vrydaghs *et al*., accepted).

CONCLUSIONS

The study of sites in present-day urban contexts is extremely difficult for several reasons: problems of accessibility, small profiles, little or no horizontal sections and many occupation phases. An interdisciplinary approach made it possible to collect sufficient data to confirm the hypothesis of the presence of agricultural activities before the construction of the city wall.

The presence of fields or gardens in this part of the city has permitted us to gain some more information on the environment of Brussels in its first phases of early (pre-) city development. It perfectly fits with the information we have collected for the lower part of the city where such activities have been determined in several places. More thorough full dating (^{14}C) will allow us to more precisely determine the timing of these events.

The final aim is to compare the results of this site with other sites in Brussels where we have applied a comparable method in order to reconstruct the environment of Brussels before and during the first phases of city development.

SI on 8 fractions

	US99	US113	US114	US115	US117
US99	100	76	51	76	77
US113		100	73	97	90
US114			100	72	74
US115				100	91
US117					100

SI on 7 fractions

	US99	US113	US114	US115	US117
US99	100	76	51	77	77
US113		100	72	97	90
US114			100	71	74
US115				100	92
US117					100

SI on trace elements

	US99	US113	US115	US117
US99	100	82	81	79
US113		100	98	97
US115			100	98
US117				100

Fig. 4 - Similarity indexes (SI) calculated on grain-size fractions – including clay (top) and excluding it (centre) –, and on trace elements (bottom).

Acknowledgements

We want to thank the Cie Mobilière et Foncière du Bois Sauvage for their ceaseless interest in the archaeology and heritage of Brussels. We equally want to thank the Brussels Capital Region who financed a project on palaeoenvironmental research in the Brussels Capital Region, and thus made this research possible. Finally we want to thank Prof. Dr. Roger Langohr and J.H. Mikkelsen (University Ghent) for their advice.

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