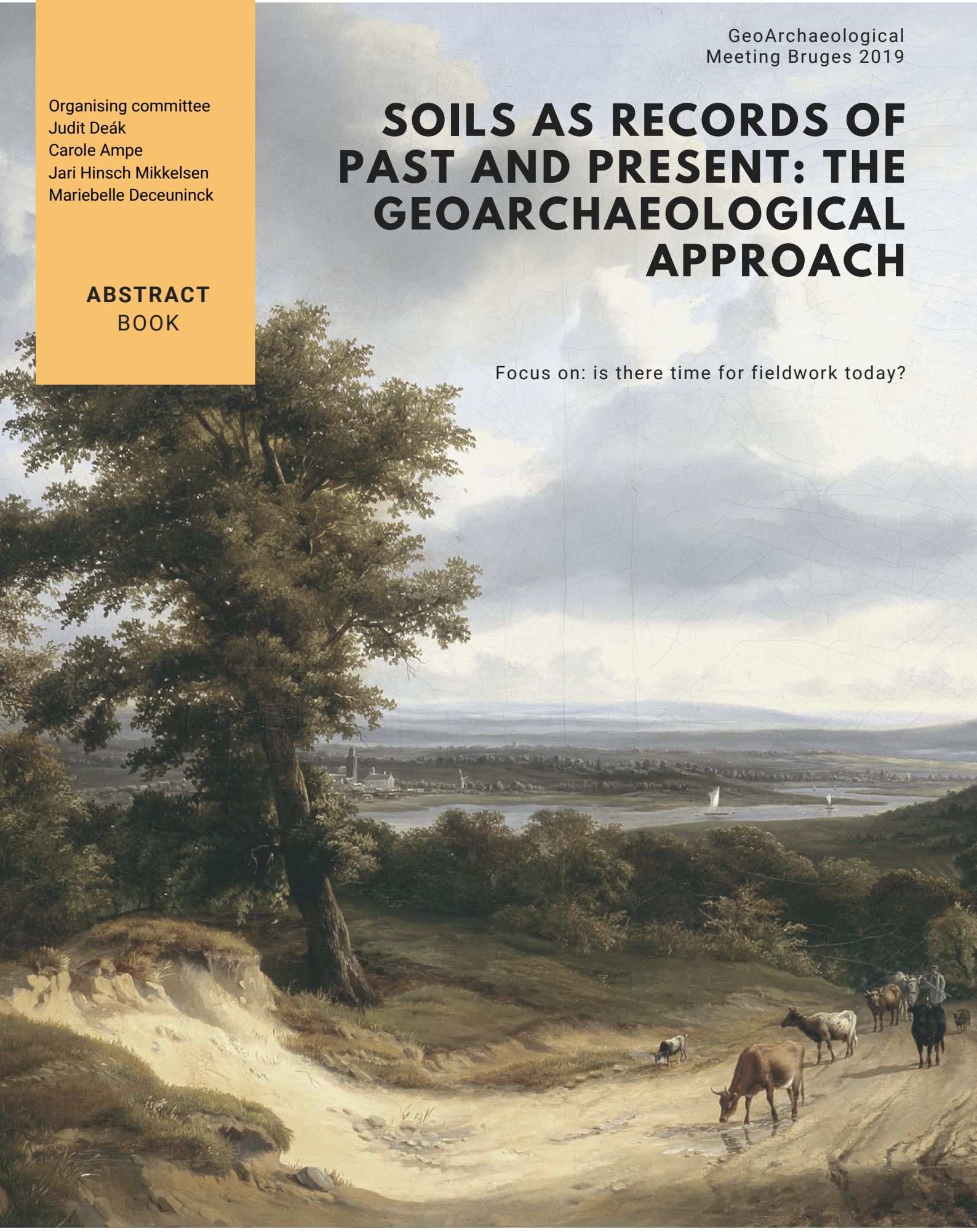
GeoArchaeological
Meeting Bruges 2019

# SOILS AS RECORDS OF PAST AND PRESENT: THE GEOARCHAEOLOGICAL APPROACH

Focus on: is there time for fieldwork today?

Organising committee
Judit Deák
Carole Ampe
Jari Hinsch Mikkelsen
Mariebelle Deceuninck

**ABSTRACT**
BOOK



**2019 | 6 & 7 NOVEMBER**

**GAMB19**

Title page: Jean Baptiste, Landschap met koeien nabij Oudenaarde; ©Musea Brugge, Dominique Provost Art Photography, Lukas Art in Flanders vzw

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# FOREWORD

J. Deák, C. Ampe, J. Hinsch Mikkelsen, M. Deceuninck

This document is edited at the occasion of the Geoarchaeological meeting of Brugge: Soils as records of Past and Present: the geoarchaeological approach. Focus on: is there time for fieldwork today? - Bruges (Belgium), 6 & 7.11.2019. It contains the abstracts of talks and posters presented during the scientific meeting and the abstracts of papers of the book edited at this occasion (Deák et al., 2019)

In the past few decades, soil science has contributed greatly to discussions on climatic and environmental changes, as well as to the understanding of various topics of human impact on landscapes and the environment. This meeting aims to address these complex issues and to demonstrate how they are approached and unravelled through past and current interdisciplinary research. The plenary talks, the posters and the scientific paper of the book edited at the occasion of this meeting try to answer the following questions:

- What is the current state of research on soils as a record of past and present?
- How is soil research able to contribute to the unravelling of important archaeological issues?
- How do formerly collected soil data help us today?
- Can we still learn from nature through field observation?
- Is there still time to do fieldwork?
- Is fieldwork sufficiently relevant, or should it be entirely replaced by graphs and modelling?
- How do we deal with limited budgets when an infinite number of soils characteristics exist and many analyses are possible?
- How to continue when sometimes authorities are reluctant and collaborations are hampered?
- What are some of the future challenges?

By organising this meeting, we would like to pay honour to all the scientific contributions of Roger Langohr, who manages to fascinate, motivate and promote scientists that are active in various research fields and come from all parts of the world.

November 2019

## References:

Judit Deák, Carole Ampe and Jari Hinsch Mikkelsen (Eds.). 2019. Soils as records of past and Present. From soil surveys to archaeological sites: research strategies for interpreting soil characteristics. Proceedings of the Geoarchaeological Meeting Bruges (Belgium), 6 & 7 November, 2019. Raakvlak, Archaeology, Monuments and Landscapes of Bruges and Hinterland, Belgium. 320 pp.
*doi.*: https://10.5281/zenodo.3417724


Photos: Roger Langohr

**9:15-9:40** **Welcome words**

Jari Hinsch Mikkelsen – Soil science, archaeology and fieldwork, a brief reflection.
Judit Deák and Carole Ampe – GAMB19: why and how? Short overview of a participative project.
Mariebelle Deceuninck – The venue, some practical information.

**Session 1** **Soil science for understanding past and present**
**Chair: Dr. Erzsébet Horváth**

9:40-10:00 Andrea Mindszenty - Soils or sediments? The role of Roger Langohr's process-oriented approach in understanding carbonate-related palaeosols of the stratigraphic record.

10:00-10:20 Stefaan Dondeyne and Seppe Deckers - The Abc soil type: Podzoluvisols, Albeluvisols, or Retisols? A review.

10:20-10:35 Veerle Vanwesenbeeck and Katrien Oorts - Use of the Database of the Subsoil of Flanders (DOV) in soil and archaeological research.

10:35-11:00 **Brief presentation of posters**
**Chair: Dr. Judit Deák**

11:10-11.30 Coffee break

**Session 2** **Soil science in rescue archaeology**
**Chair: Prof. Em. Dr. Seppe Deckers**

10:30-11:50 Jan Vanmoerkerke - Les faux poteaux plantés, et après ?

11:50-12:10 Anne Gebhardt - Study of past and present records in soils from Lorraine (France) : a geoarchaeological approach in rescue archaeological context.

12:10-12:30 Frederic Cruz et al. - Méthodologie d'une recherche paléoenvironnementale en archéologie préventive : l'exemple du site de Kerkhove Stuw (Belgium).

12.30-13:50 Lunch and poster presentations

**Session 3** **Soils and landscapes in prehistory and history**
**Chair: Prof. Em. Dr. Eric Van Ranst**

13:50-14:00 Surprise event.

14:00-14:20 Kai Fechner et al. - Contribution of soil science to some neglected aspects of the Neolithic way of life. Synthesis of recent works between Rhine and Seine.

14:20-14:40 Judit Deák et al. - Land use and settlement dynamics in the bays of Bevaix and Cortaillod (Neuchâtel Lake, Switzerland) during the Late Bronze Age (HaB).

14:40-15:00 Dieter Verwerft - Pioneers in a tidal landscape: tracking down the Roman colonisation of the Zwin area

15:00-15:20 Yannick Devos et al. - 25 years of urban geoarchaeology in Belgium.

15.20-15.50 Coffee break and poster presentations

**Session 4** **Key-note presentation (15:50-17:00)**
**Prof. Em. Dr. Georges Stoops – Introduction words**

Roger Langohr - Prospection for Geo-, Eco- and Archaeopedology. Potentials, limitations, gaps and problems for the future.

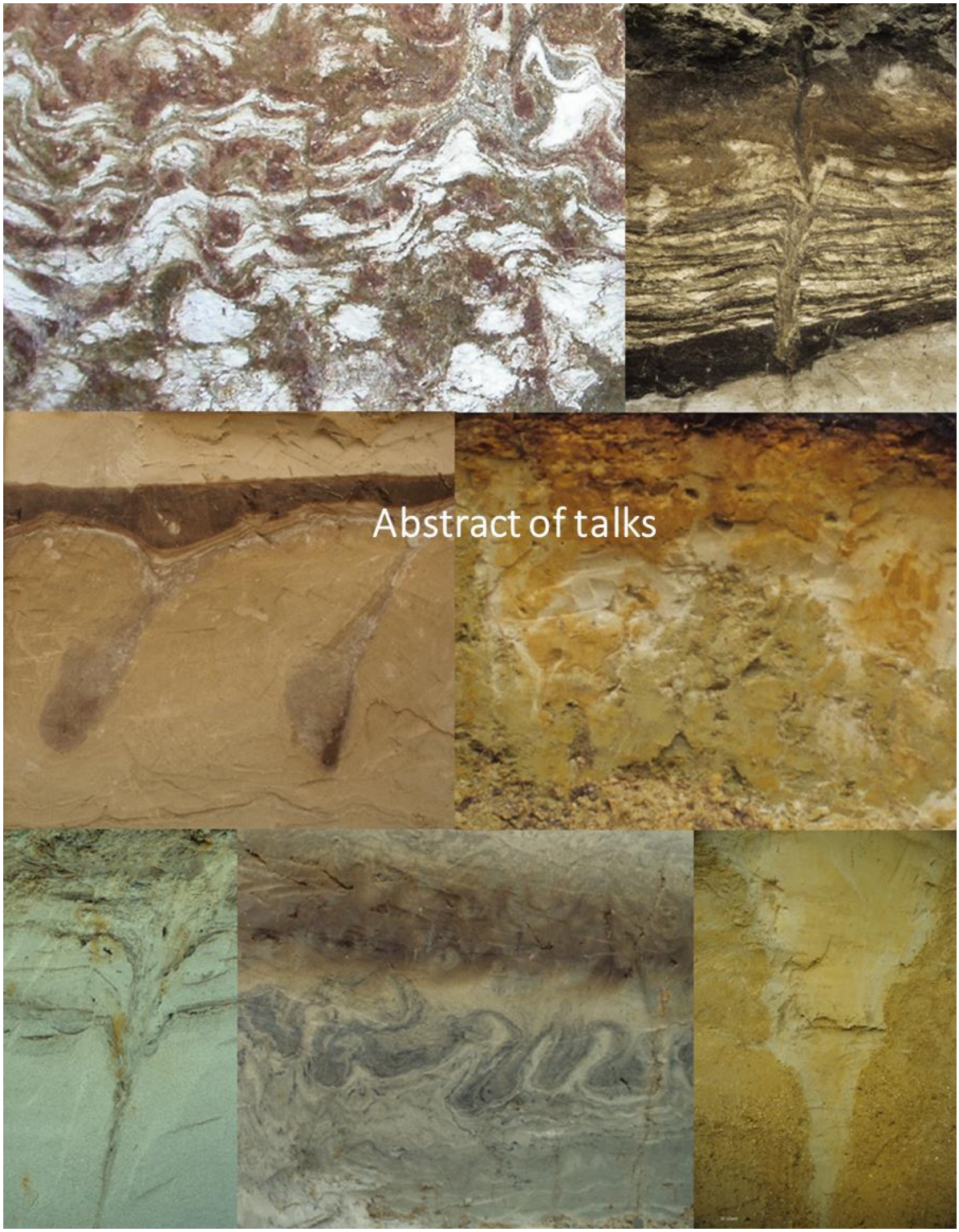
**17:00-17:15** **Concluding on- and closing of the meeting**
**Prof. Dr. Philippe Crombé**

17:15-17:30 Walking to the townhall of Bruges

17:30-17:45 Welcome by Nico Blontrock, Alderman for culture of the city of Bruges in the Gothic Hall

Interview with the editors of the Proceedings of the Geoarchaeological Meeting: Soils as records of Past and Present.

**17:45-19:00** **Reception offered by the City Council of Bruges**




Photos: Roger Langohr

SESSION 1 SOIL SCIENCE FROM PAST TO PRESENT

## Soils or sediments? The role of Roger Langohr's process-oriented approach in understanding carbonate-related palaeosols of the stratigraphic record

A. Mindszenty

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This paper is a summary of palaeopedologically-oriented research on and the interpretation of subaerial exposure-related features in cyclically organised shallow marine carbonates. We point out that the structure of soil profiles in such environments cannot be interpreted simply in terms of pedogenesis. Apparent soil-thickness is not necessarily proportional with soil-maturity and clays and secondary carbonates are not always direct indicators of climate, either.

**Keywords**: carbonate palaeosols, soil-maturity, climate signal, Late Triassic, Hungary

## The Abc soil types: Podzoluvisols, Albeluvisols, or Retisols? A review

S. Dondeyne[1] and J.A. Deckers[2]

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At an archaeological excavation site in central Belgium, we found whitish soil material interspersing a clay illuviation horizon under a Roman road. Starting from this case, we will illustrate how insights into soil formation and soil geography are relevant for understanding landscape evolution and archaeology. We do this by focusing on the 'Abc' soil types, which are silt-loam soils that are well-drained and have a mottled and discontinuous clay illuviation horizon. In Belgium, these soils are, almost exclusively, found under ancient forests. To explain their formation, two hypotheses have been proposed. A first assumes that chemical weathering leads to the degradation of the clay illuviation horizon, a process enhanced by the acidifying effect of forest vegetation. A second hypothesis explains their morphology as relict features from periglacial phenomena. We further review how views on their formation were reflected in Soil Taxonomy (Glossudalfs), the FAO legend of the soil map of the world (Podzoluvisols) and in the World Reference Base for soil resources (Albeluvisols and Retisols). If we accept the hypothesis that the morphology of the Abc soil types has to be attributed to periglacial phenomena, Abc soil types must have been more widespread before deforestation. Agricultural activities promoted the homogenisation of the subsoil and the fading of their morphologic characteristics. A Roman road would have prevented such a homogenisation process. These insights help elucidate the evolution of past and current landscapes.

**Keywords**: soil formation, archaeology, Soil Taxonomy, World Reference Base, Belgian soil classification

## Use of the database of the subsoil in Flanders (DOV) in soil and archaeological research

V. Vanwesenbeeck et al.

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**Corresponding author:** Veerle Vanwesenbeeck, veerle.vanwesenbeeck@vlaanderen.be

Soil data in Flanders are included in the DOV soil database available to all users. As such, the work done by soil surveyors and scientists is still very relevant today. This paper explains what kind of soil data are included in DOV and how they can be consulted. The aim of DOV is to become the reference for sharing data, knowledge and services, about the soil and subsoil of Flanders. It concerns open data, which can be integrated and linked to other data sources. In addition to raw data, DOV offers professional knowledge and interpreted information, as well as the services and applications to activate and mobilize these data.

**Keywords**: soil, soil data, database, DOV, soil profile, soil map, soil heritage, photographs, erosion, soil organic carbon content, landslides, archaeological research

SESSION 2 SOIL SCIENCE IN RESCUE ARCAEOLOGY

## Les faux poteaux plantés, et après ?

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[2] Institut für Waldwachstum und dendroökologie, Universite de Freiburg, Allemagne
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Pour un archéologue, une pièce de bois dans le substrat, en positon verticale ou légèrement incliné, est un « poteau », d'autant plus quand le bois est conservé et apparaît régulier et aménagé. Ce véritable dogme archéologique a du mal à être battu en brèche et son identification alternative comme une simple branche enfoncée dans le sol, n'est que rarement envisagé et généralement exclue par maintes archéologues. Vingt ans après il est donc plus que jamais utile, au moins pour les archéologues, de décrire ces structures. Nous discutons également de l'intérêt potentiel de ces branches, qui s'avèrent extrêmement courantes en plaine alluviale, pour d'autres types d'étude.

**Mots-clés** : archéologie, dendrochronologie, poteau planté, chêne, branche enfoncée, faux poteau planté, pseudo trou de poteau

## Study of past and present records in soils from Lorraine (France): a geoarchaeological approach in a rescue archaeological context

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INRAP Grand Est, France

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This paper presents some aspects of past and present records gathered during the last two decades, examining soil profiles in rescue archaeological contexts in Lorraine. After a general presentation of the regional geomorphological context, the paper will report and discuss some results collected through both archaeological prospection and excavation phases.
Finally, this report is an opportunity to make some conclusions on the possible geoarchaeological approach to rescue archaeology in Lorraine (France).

**Keywords**: rescue archaeology, geoarchaeology, case studies, Lorraine, France

## Méthodologie d'une recherche paléoenvironnementale en archéologie préventive : l'exemple du site de Kerkhove Stuw (Belgique)

F. Cruz[1], J. Sergant[1], A. Storme[2], L. Allemeersch[1], K. Aluwé1, J. Jacops[1], H. Vandendriessche[3], G. Noens[1], J. Mikkelsen[1], J. Rozek[1], P. Laloo[1] and P. Crombé[3]

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En archéologie comme dans les études paléoenvironnementales, la phase de terrain est essentielle, car elle constitue la collecte des données et du matériel qui vont servir aux études en laboratoire. Cette étape est d'autant plus délicate en contexte préventif que le temps est un facteur clé. La méthodologie employée lors des fouilles préventives du site de Kerkhove Stuw a permis une étude paléoenvironnementale approfondie, apportant de nouvelles informations sur l'évolution du paysage de la vallée de l'Escaut depuis la fin du Weichsélien.

Mots-clés : méthodologie, fouilles préventives, paléoenvironnement, alluvial, Tardiglaciaire, Holocène

SESSION 3 SOILS AND LANDSCAPES IN PREHISTORY AND HISTORY

## Contribution of soil science to some neglected aspects of the Neolithic way of life. Synthesis of recent works between Rhine and Seine

K. Fechner[1, 2], D. Bosquet[3] and F. Broes[4]
avec la collaboration de Laurence Burnez-Lanotte[5], Viviane Clavel[1], Laurent Deschodt[1], Hugues Doutrelepont (†), Guillaume Hulin[6], Joseph Hus[7], Roger Langohr[8]

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La zone entre Rhin et Seine a été étudiée avec l'aide de pédologues depuis les années 50, avec un focus particulier sur les périodes néolithiques et de l'âge du Bronze. Depuis les années 90, les auteurs ont été actifs en continu sur les sites d'archéologie préventive et proposent un état d'avancement sur une série de sujets étudiés depuis sur le terrain et par des analyses de laboratoire et/ou des lames minces. Il s'agit de remplissages de fossés et de palissades, de fosses de différentes tailles y compris les Schlitzgruben, les horizons de surface bien datés hérités et transformés par les humains, comprenant horizons naturels tardiglaciaires et début holocène des milieux bien drainés, surfaces d'activités et de mise en culture, et pour finir les enclos, avec un focus sur les cartographies de phosphate.

Mots-clés: analyses physico-chimiques, micromorphologie, phosphore, Europe du nord-ouest, Mésolithique, Néolithique, âge du Bronze, fossé, palissade, fosse, Schlitzgruben, four, foyer, pédogenèse tardiglaciaire, horizon de surface, labours, fertilité, «sol» d'occupation, jardin, champs, chasse, rituel

The area between Rhine and Seine has been investigated with the help of soils scientists since the fifties, with a special focus on the Neolithic and Bronze age periods. The authors have been active here continuously on survey archaeological sites since the nineties and propose a state of advancement on a number of issues that have been studied since then on the field and by soil analyses and/or thin sections: ditch fillings, palisades, pits of different sizes including Schlitzgruben, well dated surface horizons, inherited or transformed by the humans, including Tardiglacial and Early Holocene natural horizons in well-drained conditions, occupation levels and plough horizons, and finally enclosures, focusing on their phosphate analyses.

Keywords: soil analysis, micromorphology, phosphorus, north-western Europe, Mesolithic, Neolithic, Bronze age, ditch, pit, Schlitzgruben, oven, fireplace, tardiglacial soil formation, surface horizon, ploughing, fertility, occupation level, garden, field, hunting, ritual.

## Land use and settlement dynamics in the bays of Bevaix and Cortaillod (Neuchâtel Lake, Switzerland) during the Late Bronze Age (HaB)

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Several bays located on the north-western shores of Neuchâtel Lake (Neuchâtel canton, Switzerland) were intensively occupied during the Late Bronze Age (HaB, corresponding to 1060-850 BC). The dendroarchaeological data of the two bays, Bevaix and Cortaillod, were confronted with evidence stemming from the terrestrial sites and archaeopedological study, in order to get insight into the interaction between settlement dynamics, land use, and handling environmental challenges. Although these bays were occupied almost continuously between 1060-1050 and 850 BC, archaeological data reveal that in the hinterland, behind the bays, only few structures attributed to the HaB period are documented. This absence seems to be related to occupational dynamics. The exhaustive study of the piles of the palafittic villages indicates that shoreward colonisation of the lake was carefully planned. The synchronous expansion of satellite villages in two bays has been interpreted as an indication of recurrent interaction between their populations. Moreover, the oak piles, mostly used for the construction of houses, suggest that forest resources exploited by inhabitants of the two bays were considerably different. These data correspond well with the agronomic and forestry potentials of the hinterland as it is reconstructed by applying the principles of land evaluation. This investigation showed that a large part of the soilscape was too humid or too clayey both for cereal production and optimal oak growth. Significant differences of agricultural and forestry suitability of soils in the vicinity of the two bays was revealed as well. To conclude, the superposition of data permitted us to unravel new understandings of the occupation dynamics and management strategies of the environmental challenges faced by the Late Bronze Age population in the studied region.

**Keywords**: Neuchâtel Lake, bays of Bevaix and Cortaillod, Bevaix Plateau, Areuse delta, Late Bronze Age HaB, lake-dwellings, hinterland, village organisation, terrestrial settlements, dendrochronology, archaeopedology, land evaluation, forest resources, agronomic potentials of soils

## Pioneers in a tidal landscape: tracking down the Roman colonisation of the Zwin area

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**Keywords**: Roman archaeology, coastal plain of Flanders, terp, soil science, micromorphology

## 25 years of urban geoarchaeology in Belgium

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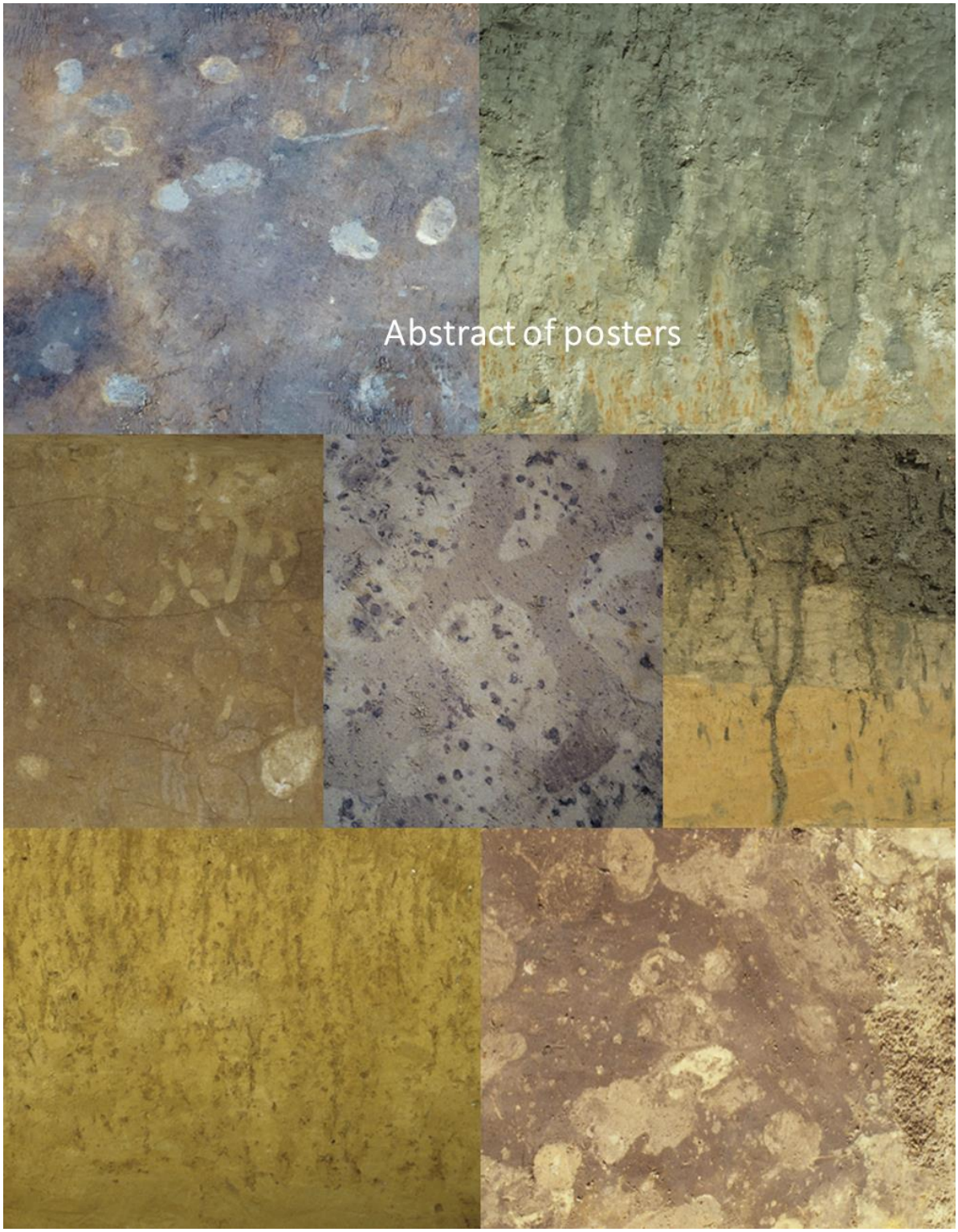
Urban geoarchaeology concerns the application of earth science methods and concepts (geomorphology, geology, pedology, soil chemistry, physics and mineralogy) to archaeological research in urban contexts. Whereas UK, France and Italy have longstanding traditions, in Belgium, pioneering studies date only back to the 1990's. Since then, the number of geoarchaeological interventions increased significantly and the discipline experienced some important developments (Devos et al., in press). Present contribution intends to discuss some of the main current topics and challenges of the discipline, including site stratigraphy and Dark Earth, reconstruction of the physical (geomorphological) environment, ancient soil pollution and the impact of urbanisation on soils.

**Keywords:** urban archaeology, urban soils, pollution, urban stratigraphy

Reference
Devos, Y., Nicosia, C. & Wouters, B., in press. Urban geoarchaeology in Belgium: Experiences and innovations. *Geoarchaeology*. DOI: 10.1002/gea.21755




Photos: Roger Langohr

## Soil and archaeological groundworks for landscape development projects of the Flemish Land Agency

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This paper describes the preliminary soil and archaeological research carried out by the Flemish Land Agency, to achieve a well substantiated project design. At the circular structure of Ver-Assebroek (Bruges), the site of a former medieval castle, a landscape development project aims to increase the visibility of the structure while respecting the soil values and archaeological structures on the site.

**Keywords:** circular structure, peat, limnic material, land development project

## Drift sand-Podzol hydrosequences in the Mol-Dessel area, NE Belgium

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This paper explores the concept of drift sand-Podzol hydrosequences, based on recent observations (exposures and hand augerings) at a small interfluve in the Mol-Dessel area, NE Belgium. It shows that drift sand characteristics and the soil horizon morphology of the buried Podzols covary in a slightly undulating landscape, according to their vertical position with respect to an assumed palaeogroundwater table. Notwithstanding the fact that several issues still need to be resolved, the investigated sequences have great potential as a palaeohydrological archive.

**Keywords:** soil horizon morphology, Podzol, drift sand facies, palaeohydrology, groundwater table, Holocene

## Early Middle Age soils and sediments formation in artificialised environment: new evidence from micromorphology

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In artificialised environment the soils and stratifications are the result of hundreds years of formation processes strongly dependent on human activities. In northern France, early Middle Age occupation layers were mainly studied by the analysis of Dark Earth (Borderie et al. 2014, Nicosia et al. 2013), less often were made studies on micro-stratified indoor remains (Gebhardt and Langhor 1999). Here are presented results acquired from 15 years of study focused on floors, filling of pit houses, and artisanal features. They show that artificial surfaces can be made by hardened manufactured mineral layers or directly by the geological substratum. The surfaces are then covered by trampled refuse material and show a continuous process of accumulation and maintenance layers. Erosion or deformation of the surface are often noticed. The maintenance of the surface is characterised by inputs of ash and mineral layers. Thin layers of plants mats can be preserved in the shape of decayed wood, grass or even articulated phytoliths (Borderie *et al.* 2019). In big pit houses, the organisation of activities within the building can be precise by floors formation processes. The smaller ones can show a more complex history of use, a thick accumulation of floors, phytoliths mats and excrements (Borderie 2019). The study of refuse produce in artisanal pits give information on the type of fuel used (grass, dung) and even the multiple use of the oven, such as cooking into pottery dedicated oven. The comparison of contemporaneous indoor and outdoor contexts show that different refuse is discarded inside and outside a building. Finally, the study of elites settlement ($9^{th}$-$11^{th}$ castra) shows that agricultural activities are taking place within those centre of power, such as crop processing or goat/sheep housing (Borderie *et al.* 2019).

**Keywords**: micromorphology, floors, dark earth, early Middle Ages, phytolith, town, pit house, castle

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# Early Middle Ages soils and sediment formation in artificial environments

## new evidence from micromorphology

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## An european question

**Do has the production of soils in artificialised environment a social meaning?**

**What are the "anthropogenic pedo-sedimentary processes"?**

**= stratifications & soils formation processes**

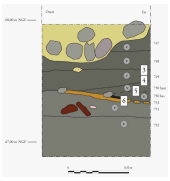
| | |
|---|---|
| Dark earth | Macphail 1981, 1994, 2003, 2010, Macphail & Courty 1985, Macphail et al. 2000, 2003, 2008, Courty et al. 1989, Gebhardt 1997<br>Nicosia 2007, 2018, Nicosia et al. 2012, 2013, 2017, Devos et al. 2007, 2009, 2011, 2016, 2019, Cammas 2004, Wouters 2011, Borderie 2011, 2012, 2014, Borderie et al. 2010, 2012 |
| Pit houses | Macphail & , Gebhardt 1995, Guélat 1999, Macphail et al. 2006, French & Milek 2012, Milek 2012, Macphail 2017… |
| Floors | Gé et al. 1993, Gebhardt 1995, Matthews et al. 1997, Gebhardt & Langhor 1999, Rentzel & Narten 2000, Cruise & Macphail 2001, Macphail et al. 2004, 2016, Milek & French 2007, Milek & Roberts 2013, Banerjea et al. 2015, Lisá et al. , Wouters 2017, Rentzel et al. 2017, Borderie et al. 2018… |

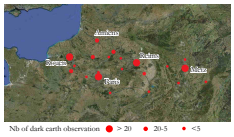
Geneva (Samson 1994)

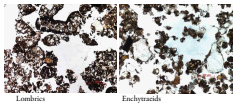
## From dark earth....

Dark earth, Evreux

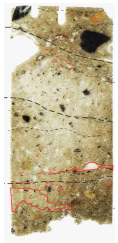
Dark earth, Neuvy





Lombrics Enchytraeids

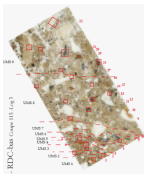


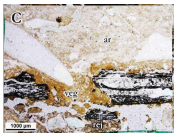
### Complex formation processes

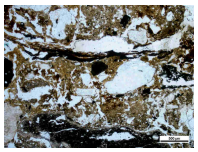
| | Progressive | Small layers | Thick layers | Nearby material | Heterogeneity |
|---|---|---|---|---|---|
| 1 | +++ | | | +++ | ++ |
| 2 | ++ | | + | | + |
| 3 | +++ | + | | ++ | ++ |
| 4 | + | + | | | + |
| 5 | + | + | + | | + |

| | Arch. features | Bioturb. during acc. | Bioturb. after acc. | Mechanical reworking | Sub-surface soil |
|---|---|---|---|---|---|
| 1 | ++ | + | + | | |
| 2 | | ++ | ++ | + | ++ |
| 3 | + | ++ | | | + |
| 4 | | + | + | + | ++ |
| 5 | | + | + | + | ++ |

**Dark earth, Metz** (Borderie, Nicosia, Gebhardt 2016 (CeAeC. Brussel)



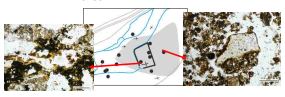


**Refuse and surface maintenance**

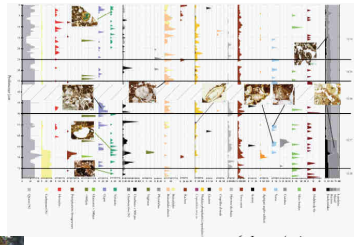
**Reworking of surfaces and soils from outdoor and indoor**

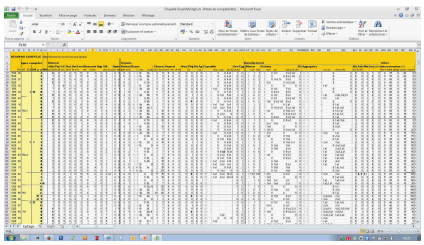
**Evreux**

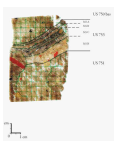


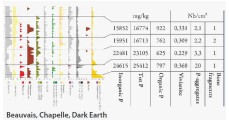
**Urban life and organisation**

## Systematic counting on thin section

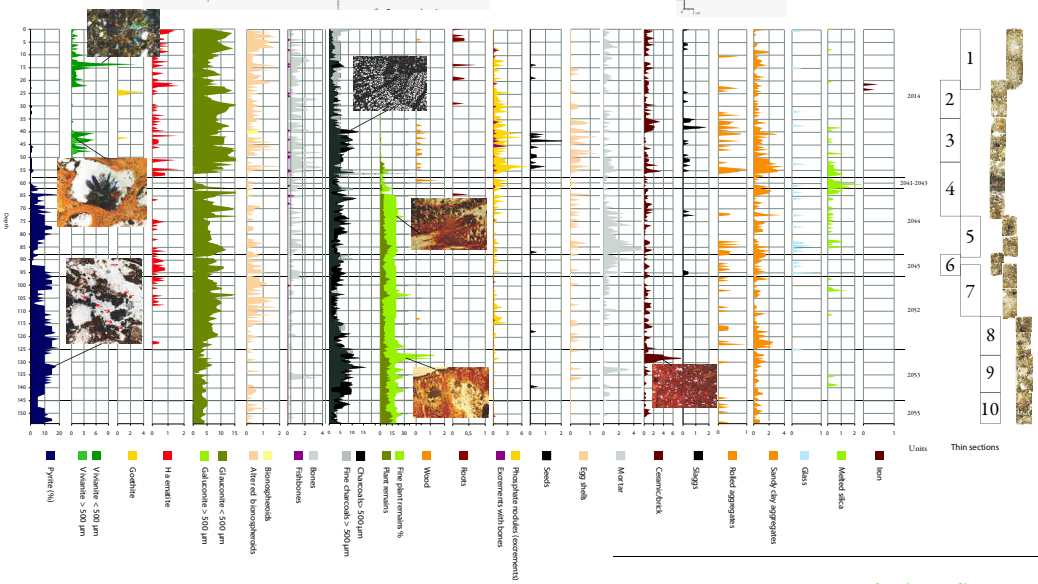




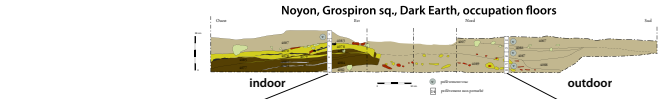




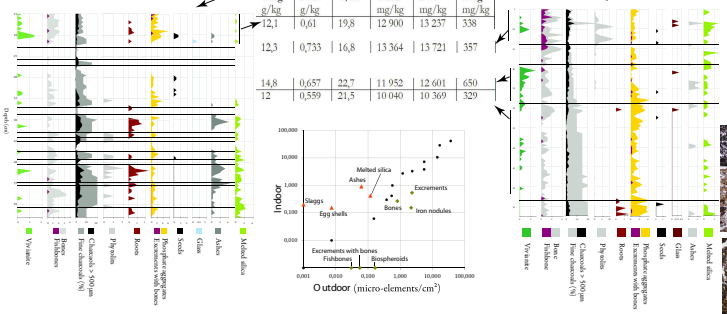
Beauvais, Chapelle, Dark Earth




## ...to indoor floors.



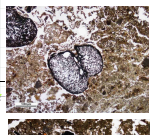

| | Corg g/kg | Ntot g/kg | C/N | Pinor mg/kg | Ptot mg/kg | Porg mg/kg |
|---|---|---|---|---|---|---|
| | 12,1 | 0,61 | 19,8 | 12 900 | 13 237 | 338 |
| | 12,3 | 0,733 | 16,8 | 13 364 | 13 721 | 357 |
| | 14,8 | 0,657 | 22,7 | 11 952 | 12 601 | 650 |
| | 12 | 0,559 | 21,5 | 10 040 | 10 369 | 329 |



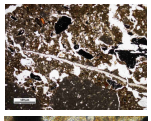

**Noyon**

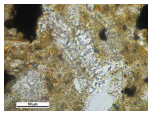
**New evidence of floors**

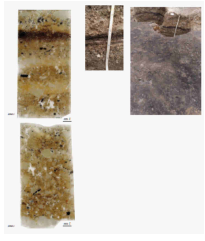
**Beyond waste vs floors**



**Boves**







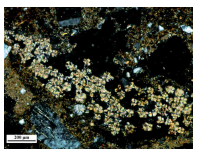
## Relations between human, surfaces and floors

**Ways of maintening and building**
Waste as floors
Clean *vs* dirty

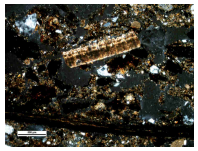
**Waste management**
Recycling, gardening...

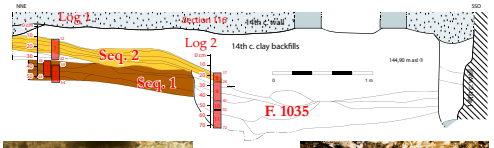
**The use of space**
Multiple functions: cooking and forging

**The nature of urban sites**
Urban + agriculture (Noyon, Gien, Saint-Denis)

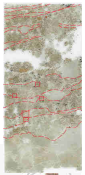


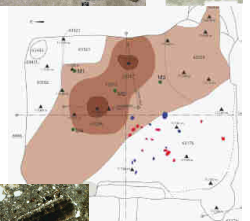
**Gien**

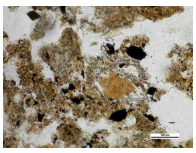


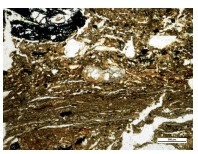


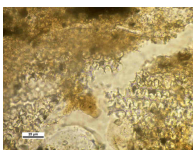

**Saran**

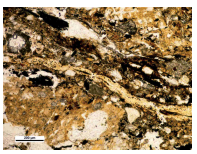












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Ministère de la Culture

## The role of soils in the management of the archaeological heritage of Wallonia

O. Collette

Agence wallonne du Patrimoine, Namur, Belgique

**Corresponding author:** Olivier Colette, Olivier.collette@awap.be

In Wallonia, the Walloon Heritage Agency (AWaP) aims in particular to manage the buried archaeological heritage. In practice, it is involved in preventive excavation operations to discover, preserve and enhance the vestiges of the past. The archaeologists in charge of these operations are assisted by a scientific and technical team in the preparation of preliminary files, during the field intervention phases as well as during studies and valorization of their research. The place of the sciences of the earth whose pedology is predominant there. The Walloon examples where the recording of the past is clearly recorded in soils are numerous and varied. In some cases soil science remains the only one able to identify traces of the past.
The poster presents various aspects of the interventions in which geo-pedology participates in the management of the archaeological heritage of Wallonia and various case examples.

# The role of soils
## in the management of the
# Archaeological Heritage of Wallonia

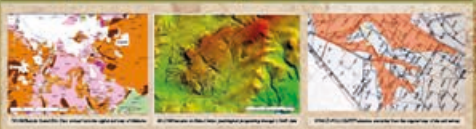
Among its various missions, the **Walloon Heritage Agency (AWaP)** aims to manage the subsoil archaeological heritage. It intervenes in the framework of operations of **preventive excavations** in order to discover, preserve and valorize the vestiges of the past.

Soils occupy a central place in archaeology because they contain most of the vestiges and they are the **privileged witnesses** of ancient human activities. Moreover, they often contain the last traces, visible or invisible, of past occupations.

In order to better understand the soils during their operations, AWaP archaeologists are assisted by a **team** specialized in Earth sciences. Their services are spread throughout the processes implemented by preventive archeology:
- **provision** of information and cartographic data during the exploration phase,
- **field** assistance during the excavation phase,
- **sample processing** and
- **valorisation** of the results in the dissemination phase.

In line with its public service mission, the study of the soils by the AWAP contributes to the management of the archaeological heritage while disseminating the information to the citizens and the scientific community.

## Exploration phase



Development of a geomorphological dossier with recommendations concerning the human settlement potential (position in the landscape, soils quality) and conservation potential (colluvium, drainage, erosion, reworking ...).

**ASSISTANCE IN DISCOVERY AND DECISION**

## Treatment phase

Management of samples and data in order to acquire additional information. Analyzes (chemical, granulometric and micromorphological) entrusted to external laboratories. Treatment phase in co-operation with other disciplines.

**ASSISTANCE IN UNDERSTANDING AND INTERPRETATION**

## Field phase

Field presence including assistance to the archaeological team and collection of information by description of cuts, mechanical surveys and manual auger.

**ASSISTANCE IN READING AND RECORDING**

## Dissemination phase

Highlighting results. Taking part in the redaction of reports, summaries and publications.

**ASSISTANCE IN VALORISATION AND DISSEMINATION**

GAMB19

GeoArchaeological Meeting, Brugge 2019

Agence Wallone du Patrimoine (AWaP), Direction d'appui scientifique et technique, Olivier COLLETTE olivier.collette@awap.be

Wallonie patrimoine AWaP

## Facing complexity: an interdisciplinary study of a medieval pre-urban Dark Earth from the centre of Aalst (Belgium)

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[2] Vrije Universiteit Brussel, Belgium
[3] Flanders Heritage Agency, Belgium
[4] Flanders Heritage Agency, Belgium
[5] Centre de Recherches en Archéologie et Patrimoine, Université Libre de Bruxelles, Belgium
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The ubiquitous urban Dark Earths composes a main challenge for urban archaeologists. Due to their homogeneous character they cannot be readily understood based on field data alone. Geoarchaeology (field study and micromorphology) has shown to be particularly well suited to tackle these layers, and to reveal their complex formation histories and the human activities and natural events involved. During the excavations of the site of Sint-Jozefs college in the centre of Aalst (Belgium) a thick dark earth was discovered underneath the remains of the rampart of the 11th century town wall. An interdisciplinary study, involving archaeology, geoarchaeology and phytolith analysis has been performed. It demonstrates that the Dark Earth layer has a long formation history involving pasture and crop growing, intimately mixed with soil processes such as bioturbation and colluviation. The identified activities confirm the rather rural character of the area until the 11$^{th}$ century AD.

**Keywords**: urban geoarchaeology, soil micromorphology, phytoliths

## Apports de la micromorphologie des sols à l'interprétation de trois séquences sédimentaires lorraines bien datées

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Poster présenté aux 10èmes Journées d'Etude des Sols , Strasbourg, 11-15 /5/08.

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This study of three buried and well dated pedo-sedimentary sequences from Lorraine helps to better understand the impact of ancient agro-pastoral activities on the soils. It also points out soil micromorphology concern for understanding passed interactions between Man and his natural environment. Erosion seems to occur earlier on the sandstony vosges mountains slopes (Varrinchatel, late Iron age) than on the marl substrate from the *plateau lorrain* (Imling, early Roman), but is, in both cases, due to deforestation and soil exposure for cultivation. In the Forêt de Haye (Roman time), the soil buried under the stone heap, removed from the cultivated area, seems less eroded. The terraces formation and the use of organic manuring probably helped to stabilized the soil in an already controlled landscape.

**Keywords**: erosion, Iron Age, pedology, soil micromorphology, Lorraine, France

Reference
Gebhardt A., Georges-Leroy M., Rohmer P., Triboulot B., 2009. Apport de la micromorphologie des sols à l'interprétation de trois séquences sédimentaires lorraines bien datée. *Archives pédologiques : pédoarchéologie et dynamique des paysages*. Actes des 10èmes Journées d'Etude des Sols, Strasbourg, 11-15/5/08 session 1, 39-40.

# APPORTS DE LA MICROMORPHOLOGIE DES SOLS A L'ETUDE DE TROIS SEQUENCES PEDO-SEDIMENTAIRES LORRAINES fossilisées sous des structures archéologiques bien datées

Anne GEBHARDT[1,2,3], Muriel GEORGES-LEROY [4,5], P. ROHMER[2], B. TRIBOULOT [6,7,3]

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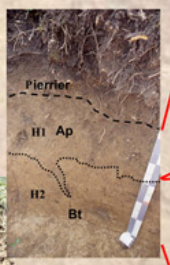
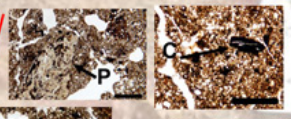
(anne.gebhardt-even@inrap.fr)

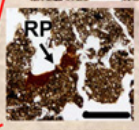

**Les recherches pédo-sédimentaires effectuées sur une trentaine de sites archéologiques lorrains montrent que les paléosols complets et peu anthropisés, préservés sous des structures bien datées, sont rares. Ces premiers travaux démontrent que l'érosion des sols, qui semble débuter très tôt (dès l'Age du Bronze ?), se généralise largement durant l'Age du Fer en Lorraine. Dans la majorité des cas, les sols érodés se retrouvent accumulés en fond de vallons ou piégés dans des dépressions à mi-pente. L'analyse de trois séquences pédo-sédimentaires a permis de mettre en évidence les actions anthropiques sur le paysage et les sols au cours de l'Age du Fer : Forêt de Haye (Nancy – 54), Imling (Sarrebourg - 57), Varrinchâtel (Saint-Dié-des-Vosges – 88)**

## Un paléosol enfoui sous un pierrier, en limite du parcellaire romain

Implantée dans une boucle de la Moselle entre *Nancy* et *Toul*, la *Forêt de Haye*, est limitée à l'est par la *Côte Bajocienne* surplombant la vallée de la Meurthe et sa confluence avec la Moselle. 12 000 ha de forêts domaniales et communales ont fossilisé environ *8000ha* de vestiges viaires, d'habitats et de *structures agraires* attribuées au *1er siècle ap. J.-C.* A ces vastes pierriers de quelques dizaines de cm de large mais qui peuvent s'étaler sur plusieurs centaines de mètres, délimitant des parcelles, des enclos ou encore des chemins, sont associés à des tas de pierres circulaires plus petits qui ont localement préservé le paléosol.


Partie supérieure perturbée du paléosol : *ouverture anthropique du milieu*, (charbons-*C*, revêtements poussiéreux-*RP*, fragments phosphatés-*P*).

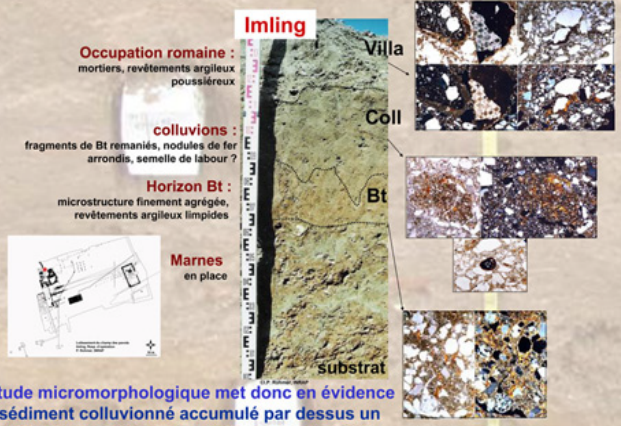


Racine de sol de type *brun lessivé forestier* intacte à la base… (revêtements argileux limpides-*RL*, terriers de vers de terre-*VT*).

**L'étude micromorphologique met donc en évidence :**
**une ouverture du milieu** (déboisement, mise à nu du sol) et **des apports anthropiques** (amendement phosphaté).

## Une forte érosion figée sous une villa romaine

A Imling, au lieu dit 'Les Pavots', la présence humaine se caractérise par une villa gallo-romaine construite au début du Ier siècle ap. J.-C. La fouille a aussi permis la mise au jour de bâtiments annexes situés dans la cour de la villa, de fossés de drainage et d'un aigayoir, bassin de nettoyage des sabots des bêtes de trait après les labours.




**L'étude micromorphologique met donc en évidence un sédiment colluvionné accumulé par dessus un sol déjà très érodé bien avant l'installation antique**

## Dégradation forestière et érosion avant enfouissement sous le second rempart gaulois.

Le site de hauteur de « *Varrinchâtel* » (Saint-Benoît-la-Chipotte, 88), cerné par deux enceintes talutées, est *le plus ancien habitat celtique fortifié* connu dans le département des Vosges. A une trentaine de mètres en contrebas du sommet gréseux, une petite carrière moderne laisse apparaître une séquence pédo-sédimentaire scellée sous une *enceinte secondaire* datée du *Vème s. av. Jésus-Christ*.


**L'étude micromorphologique met en évidence trois phases d'évolution dans l'évolution du paysage**

**Ces trois exemples montrent combien les sols lorrains ont été influencés par les activités humaines depuis au moins 2500ans, mais que ces perturbations ne semblent pas affecter également tous les secteurs.**

**Sur les pentes des montagnes vosgiennes gréseuses et les collines marneuses d'Imling, l'érosion est précoce et les formations pédologiques sont fortement affectées par les activités humaines. Cette érosion peut être liée à une déforestation rapide et une mise en culture intense.**

**Sur le plateau de la Forêt de Haye, par contre, le sol étudié est anthropisé, mais moins fortement affecté par l'érosion car sans doute rapidement enfoui sous le pierrier. De plus, il semble que des amendements organiques et le parcellaire plus ou moins terrassé ont participé à une stabilisation des sols et la mise en place d'un paysage maîtrisé que la forêt actuelle a fini par figer.**

## Impact anthropique anciens sur les sols forestiers. Quelques études de cas en contexte archéologique et expérimental

A. Gebhardt

Poster présenté au colloque La mémoire des forêts : Forêt, archéologie et environnement à INRA Nancy, les 14-16 déc 2004.

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Imprinted with numerous traces of historic anthropogenic occupation, our modern forests are in fact not so natural if we take time to look at them closely. Over time, the history of these forests has been punctuated by phases of deforestation and reforestation which has caused significant changes in the substrate at different scales from the soil microstructure up to the local landform scale. Once forest is re-established, and where a protective forest cover is retained, evidence of these earlier changes is preserved up to the present day. Although forested environments are often considered stable, they are still fragile. A range of forest and activities (e.g, cattle grazing, charcoal making, and timber getting) will result in localized, but very real, erosion that we need to take into account in reconstructing the history of forest and woodland landscapes and their evolution.

**Keywords**: archaeology, pedology, experimental analogue, forest, soil micromorphology, France, Germany

Reference
Gebhardt A., 2007.Impact anthropique anciens sur les sols forestiers. Quelques études de cas en contexte archéologique et expérimental. *La mémoire des forêts, Forêt, archéologie et environnement*, INRA Nancy, 211-218 (https://hal.archives-ouvertes.fr/hal-02064272)

# IMPACTS ANTHROPIQUES ANCIENS SUR LES SOLS FORESTIERS
## Quelques études de cas en contexte archéologique et expérimental

**A. GEBHARDT**
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Mots clefs : Archéologie, Pédologie, Forêt, Micromorphologie des sols, France


**Marquées par de nombreuses traces d'occupations humaines anciennes, nos forêts actuelles n'apparaissent finalement pas si naturelles à qui sait les regarder de près. Outre un grand nombre de structures d'habitats anciens attestant de l'ouverture passée du milieu, on peut y observer de nombreuses traces d'exploitation forestière ancienne.**

**Plus qu'un travail exhaustif, ce poster propose quelques pistes de réflexion à travers l'étude de perturbations d'origine anthropique du milieu forestier, effectuées au cours de 20 années de recherches archéopédologiques sur les paysages du Nord de la France et des régions limitrophes.**

Des chemins creux ont été étudiés au **Grand Hachu** (Contrexéville) et à **Mandray** (Vosges). Leur grand nombre en parallèle, leur orientation suivant la pente, et l'absence de carrières plaident en faveur de chemins d'exploitation forestière de type débardage.


*Ils prennent naissance en haut du relief et leur profondeur augmente en bas de pentes (1,5m à 2m).*


*Il ont des similitudes avec les voies de vidange modernes. On notera la rigole d'érosion observée sur les deux sites.*



*Les 15 centimètres supérieurs du chemin montrent une alternance, aux limites nettes, d'horizons humiques bioturbés à microstructure très ouverte et d'horizons minéraux massifs, contenant encore de la matière organique micro-fragmentée, renforçant l'idée du rôle drainant de ces chemins creux.*

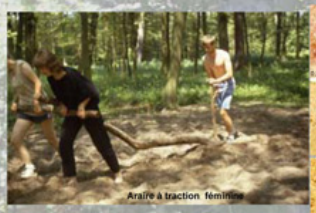
Le mode d'utilisation des chemins de vidange souligne leur rôle dans le transport des sédiments au sein d'un milieu forestier considéré comme stable par ailleurs.

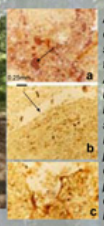

*Tout passage intense déstabilise l'humus ce qui favorise l'érosion à la moindre pluie.*



*Le schlitteur doit pouvoir enfoncer ses pieds dans un sol meuble débarrassé de tous cailloux ou racines, afin de bien freiner sa cargaison.*

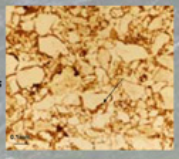
En 1985, une expérimentation de labour à l'araire néolithique à été menée sur sol limono-lœssique dans la hêtraie/charmaie de **Hambacher Forst**, par J. Meurers Balke et son équipe (Université de Cologne, Allemagne), afin d'étudier au sol les traces aratoires. Huit séries de 4 labours croisés ont été effectuées pendant 1 an sur une parcelle préalablement défrichée et débarrassée des feuilles.




*A la structure très compacte du sol naturel succède une microstructure finement agrégée ( a) A la base de l'horizon de labour la pointe de l'araire génère une semelle de labour ( b) . Les revêtements argileux poussiéreux observés dans tous les profils proviennent sans doute de la mise à nu du sol à l'époque romaine (c).*

Au **Wasserwald** (Bas-Rhin), dans la forêt des Vosges gréseuses du nord, le village gallo-romain dit «des hauteurs » fouillé par F. Petry en 1985, présente bâtiments et chemins encore bien visibles. Y sont associés des tas d'épierrement, indices probable d'agriculture.

*Au microscope, les nombreux revêtements argilo-poussiéreux visibles dans le paléosol, témoignent d'une mise à nu du sol.*

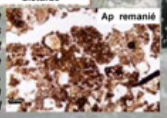
En 1995, à l'**Ecomusée de Haute Alsace** (Haut Rhin) les différentes étapes de la fabrication du charbon de bois ont pu être suivies pour en étudier l'impact sur la microstructure d'un sol forestier alluvial de l'Ill, à priori jamais cultivé. Ce travail a permis de mieux comprendre l'étude de charbonnières anciennes comme celles de la Forêt de Paimpont en Bretagne.

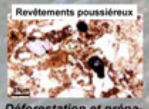

*La préparation du sol est essentielle pour la réussite de la carbonisation. Ainsi, la recolonisation de la végétation est faible sur les anciennes aires de faulde ce qui facilite leur réutilisation.*




*Les fragments de silice fondue proviennent de mottes de tourbe utilisées pour consolider la meule.*

*La surface de travail doit être horizontale, débarrassée des feuilles; les racines sont extraites à l'aide d'une bêche voire d'un motoculteur, modifiant profondément la structure du sol*

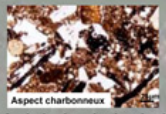




*Sous la meule, la température au sol n'augmente pas. Les fragments brûlés observés viennent probablement du sédiment local microfragmenté qui, en pénétrant au coeur de la meule par les interstices du bois, participe au ralentissement d'une combustion réductrice.*

*Déforestation et préparation rigoureuse du sol entraînent sa mise à nu, propice à la formation de revêtements argileux poussiéreux.*

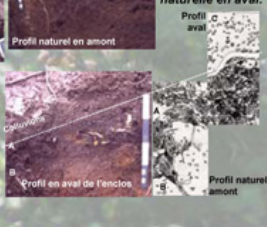



*Après la récupération du charbon de bois, la dernière étape consiste en un nettoyage de la place : le sédiment restant, très charbonneux sera tamisé et réutilisé.*

Au village médiéval de **Lann Gouh** en Melrand (Morbihan), deux 'cochons de Bayeux' ont été parqués dans une zone de taillis clairsemés. Après deux semaines, l'état du sol soulignait le rôle érosif du sur-pâturage porcin sur un sol forestier. Un horizon colluvionné est apparu en aval de la parcelle.


*Etat de la parcelle boisée après 2 semaines de pacage par les porcs de Bayeux .*


*En lame mince on note l'apport de sédiments issus de l'horizon minéral (C) colluvionné par dessus la séquence naturelle en aval.*



## Approche interdisciplinaire d'un atelier minéralurgique du XV$^{e}$ s à Sainte-Marie aux-Mines (Haut-Rhin, France)

A. Gebhardt[123], E. Camizuli[45], J. Gauthier[5], A. Poszwa[1], D. Bartier[6], C. Guilleux[1] and P. Fluck[4]

Poster présenté aux Rencontres Géosciences- Archéologie, Strasbourg, mai 2019.

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[2] LIVE UMR 7362, CNRS-Université de Strasbourg, France
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[4] CRESAT EA 3436, Université de Haute-Alsace, Mulhouse, France
[5] Chrono-environnement UMR 6249, CNRS-Université de Franche-Comté, Besançon, France
[6] CREGU, Georessources, CNRS-Université de Lorraine, Nancy, France

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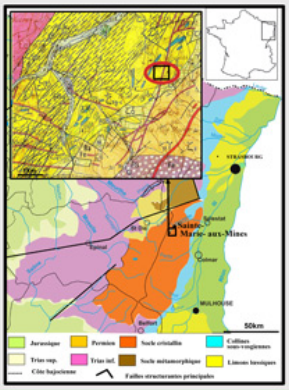
The mineral processing site of *Berg Armuth* (Alsace, France, XV$^{e}$ s. AD) brought to light finely layered washed residue stored in structures related to galena and grey brass exploitation. Through a multidisciplinary study between geosciences and archaeology, we try to understand the sedimentary processes and taphonomy of those metallic residues accumulated in storage basins.
Micromorphological analysis confirmed the cyclical organisation of the deposits revealing micro-sedimentary features related to functioning and interruption phases of the basin. But the rhytmicity is still to be defined. Core-scanner XRF analysis, done on the corresponding consolidated blocks, allowed us to follow the stratigraphical evolution of the relative quantities in lead (Pb), in the same level identified by the micromorphological analysis. MEB cartography pointed out alternation between silicates and sulfides, but can also inform on the decantation phases and the form of the grains. Beside X-ray diffraction, which provided mineralogical informations, geochemical analysis help to understand the chemical behaviour of elements likely to be present in the environment: total content (major and traces) and content of elements mobilizable by erosion (Cd, Cu, Ni, Pb, et Zn).

**Keywords:** ore mineral processing workshop, sedimentation dynamic, soil micromorphology, geochemistry, Sainte Marie aux Mines France

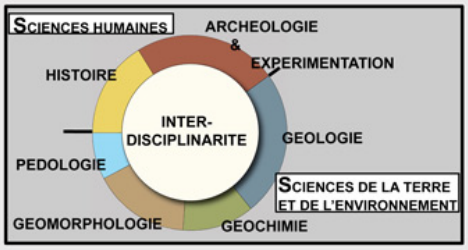
(https://hal.archives-ouvertes.fr/hal-02265799v1)

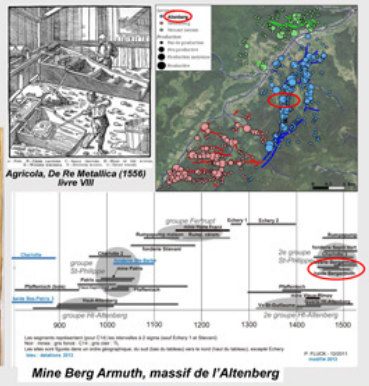
# APPROCHE INTERDISCIPLINAIRE D'UN ATELIER MINERALURGIQUE VOSGIEN DU XV$^{e}$s. (SAINTE-MARIE-AUX-MINES, HAUT-RHIN, FRANCE).

***Le site minéralurgique Berg Armuth (Alsace, France, XV$_{e}$ s. A.D.) a livré des structures de stockage de résidus de lavage finement lités, en lien avec l'exploitation de la galène et des cuivres gris.***




*Une étude interdisciplinaire, à différentes échelles, entre géosciences et archéologie, y est menée pour mieux comprendre les processus de sédimentation et la taphonomie des résidus minéralurgiques accumulés dans un bassin lavage.*




*Mine Berg Armuth, massif de l'Altenberg*

## 1. TERRAIN :

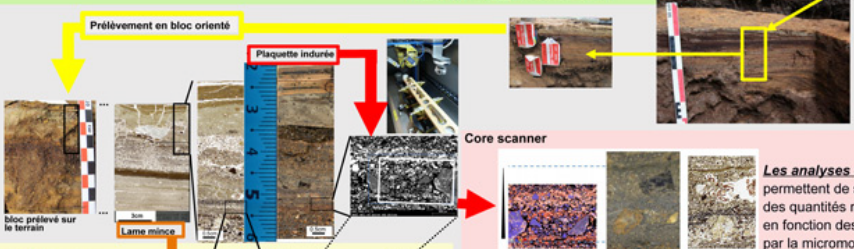
***a. Contexte*** *géologique, géomorphologique, pédologique, archéologique.*

***b. Description*** *stratigraphique, pédo-sédimentaire*

***c. Prélèvements*** *en vrac, en blocs orientés, carottes...*

## 2. LABORATOIRE :

*Micromorphologie*
*Géochimie*
*MEB*
*XRF Core Scanner*
*XRF portable (NITON)*
*DRX*

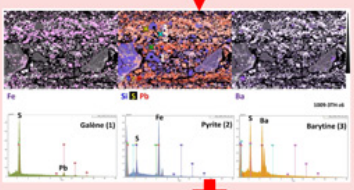




Core scanner

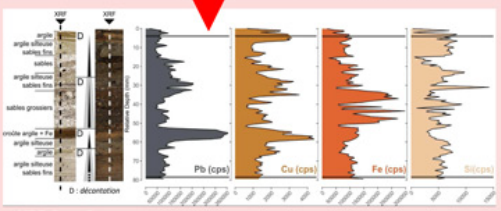


***Les analyses core-scanner XRF,*** permettent de suivre l'évolution des quantités relatives de plomb en fonction des niveaux identifiés par la micromorphologie des sols.




***Les cartographies MEB*** mettent en évidence :
- des alternances entre silicates et sulfures,
- la nature des phases et la forme des grains.

identification de : Pb, Fe, Ba, S, Cu, Zn, As, Sb

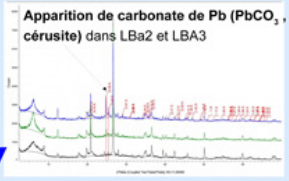



***XRF Core Scanner*** Mesure en coup/seconde, 30s tous les 500µm, fenêtre de 2mm/50µm
→ composition élémentaire relative

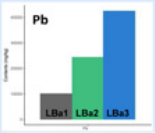
***Diffraction des Rayons X*** (DRX)
Analyse sur roche torale (D2 Phaser Bruker)

**Cortège minéralogique classique :**
- Quartz,
- Argiles (Smectites, Intertratifiés Illite-Smectite, Kaolinite)
- Feldspaths (Orthose, Albite)
- Hématite, Anatase

**Apparition de carbonate de Pb ($PbCO_3$, cérusite) dans LBa2 et LBA3**



***XRF portable*** (NITON)
Analyse sur poudres séchées à l'air libre, tamisées à 2mm puis broyées

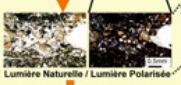


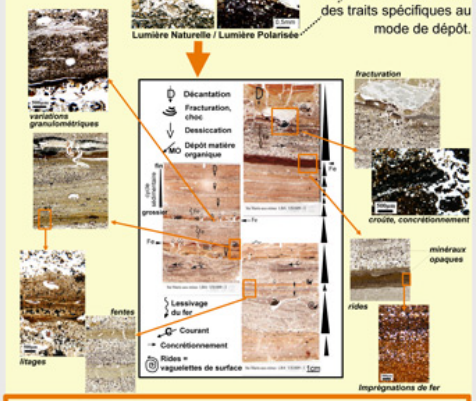

→ Ordre de grandeur des concentrations dans les sédiments.

| mg/kg | Cu | Zn | Ni | Sb | Pb |
|---|---|---|---|---|---|
| Min | 528 | 221 | 269 | 71 | 10 049 |
| Max | 1095 | 476 | 543 | 101 | 42 620 |

Microscope optique

***L'analyse micromorphologique*** permet d'observer plus finement la sédimentation et de mettre en évidence des traits spécifiques au mode de dépôt.




***Analyse micromorphologique*** :
**Affine et précise la cyclicité observée sur le terrain (alternance de dépôts grossiers et plus fins, accumulations micro-organiques), Révèle des figures micro-sédimentaires de courants, érosion, figures de charge, dessiccation, … liées au fonctionnement du bassin.**

***MEB et Core Scanner :***
**Identifient différents cycles en fonction de l'échelle d'étude et les met en relation avec la chimie des sédiments, comme l'alternance d'éléments en lien avec leur densité : niveaux argileux riches en plomb (la galène se broie facilement) / niveaux sableux riches en silice.**

***Analyses minéralogiques et géochimiques :***
**Identifient la nature des sédiments de lavage et donnent les teneurs totales (majeurs et traces) en éléments potentiellement mobilisables par les eaux.**

**Nos études permettent :**
**1. d'affiner l'observation des processus de sédimentation et mettent en lumière une certaine rythmicité dans le travail du minerai (rythmicité qu'il reste à expliquer).**
**2. de préciser la qualité de ces matériaux archéologiques et d'estimer l'influence de ces résidus sur l'environnement actuel.**


**Anne Gebhardt[1, 2, 3], Estelle Camizuli[4, 5], Joseph Gauthier[4, 5], Anne Poszwa[2], Danièle Bartier[6], Camille Guilleux[2], Pierre Fluck[4]**
[1]LIVE UMR 7362, CNRS-Université de Strasbourg ; [2]LIEC UMR 7360, CNRS-Université de Lorraine, Nancy ; [3]INRAP ; [4]CRESAT EA 3436, Université de Haute-Alsace, Mulhouse
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## Assèchement et dégradation des sols durant le Subatlantique : un niveau repère antique dans le Grand Est ?

A. Gebhardt[123], A. Champougny[1] and P. Wuscher[1]

Poster présenté au GMPCA de Rennes, avril 2017.

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[3] INRAP Grand Est, France

**Corresponding author:** Anne Gebhardt, anne.gebhardt-even@inrap.fr

In north-eastern France, minor-range polygonal networks with finger-like structures or digitations are frequently observed during archaeological fieldworks and were commonly interpreted as small periglacial networks of frost cracks. From the study of four archeological sites, this type of minor network is developed in a sediment of an age constrained between the end of the Iron Age and Early Middle Age, and the periglacial origin systematically given is questioned. The origin of such polygonal digitations in Late Holocene soils is related to a network of desiccation cracks developed under hydric stress and drying- out of water-saturated clay-loamy sediments. The origins of this well marked regional desiccation of soils seem both anthropogenic and climatic.

**Keywords:** soil desiccation, soil marker, Antic period, North eastern France, France

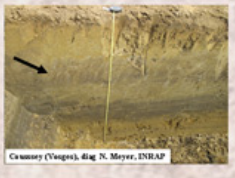
Reference
Gebhardt A., Champougny A., Wuscher P., 2018. Assèchement et dégradation des sols durant le Subatlantique : un niveau repère antique dans l'Est de la France, *Archéosciences*, 42-2, 77-84 (https://hal.archives-ouvertes.fr/hal-02073987)

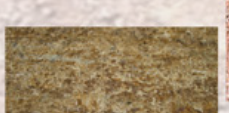
# ASSECHEMENT ET DEGRADATION DES SOLS DURANT LE SUBATLANTIQUE

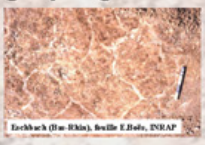
GEBHARDT Anne[1,2], Champougny Anaïs[1,2], Wüscher Patrice[1,3]
[1]UMR 7362, LIVE, Univ.de Strasbourg ; [2]INRAP ; [3]Archéologie Alsace

**Dans le Grand Est, lors de travaux de diagnostic archéologique, il est fréquent d'observer un réseau pseudo-polygonal de faible amplitude, longtemps interprété comme des petites fentes de gel périglaciaires.**


La Salle (Vosges), Diag. V. Rachet, INRAP


Coussey (Vosges), diag N. Meyer, INRAP




Eschbach (Bas-Rhin), fouille E.Boës, INRAP


Cerville (Meurthe et Moselle), diag S. Jeandemange, INRAP

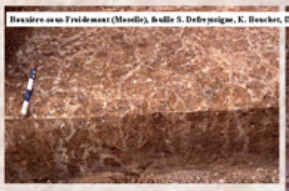

Terville (Moselle), fouille M.-P. Pétolidier, INRAP

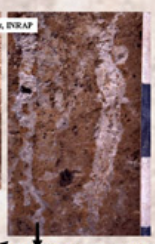

## *Un premier calage chronologique...*

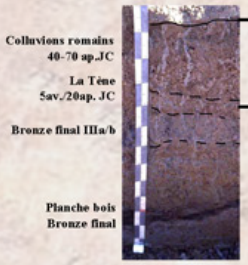
En 2009, sur la fouille du site de Bouxière-sous-Froidemont (Meurthe-et-Moselle), situé en bordure d'un petit vallon, ces traces impactent le sommet d'une séquence sédimentaire colluviale d'environ 1m de puissance, calée par le matériel archéologique entre l'Age du Fer et l'Antiquité romaine...

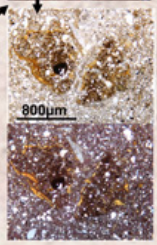
## *...entre fin de l' Age du Fer et Mérovingien*

Depuis, une attention particulière à été portée à ce type de figure pédologique et d'autres sites (Marspich; Bernolsheim) ont permis d'affiner le calage chronologique de cet événement, qui semble pour l'instant, antérieur à l'époque mérovingienne .


Bouxière-sous-Froidemont (Moselle), fouille S. Defreyssigne, K. Boucher, INRAP



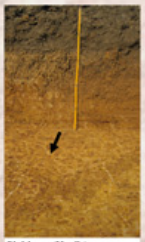


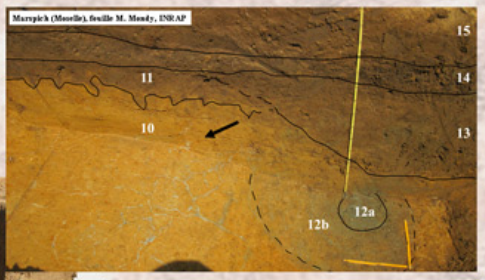




### *Les fentes de dessiccation*

Forme pseudo-polygonale de faible diamètre, remplissage limoneux blanchâtre, éléments organiques, masse appauvri en fer et argile, traversent des fragments d'horizon 'BT' remaniés.

Prennent forme à la surface du niveau gallo-romain fouillé, et traversent les forma-tions protohistoriques sous jacentes.


Phalsbourg (Moselle), diag. S. Jeandemange, INRAP





Bernolsheim (Bas-Rhin), fouille C. Leyrevost, Alsace Archéologie

## *Un gros stress hydrique*


Fentes actuelles Marspich (Moselle)

Le développement de telles fentes dans le sol est le résultat d'un stress hydrique au sein de sédiments argilo-limoneux. Ce stress n'est pas uniquement attribué au gel, mais peut-être lié à déficit en eau au cours une saison chaude et sèche.


Fentes actuelles, Pise (Italie) CLA. Gebhardt

Or, ce petit réseau réticulé est généralement observé en bas de versant bordant un milieu humide.

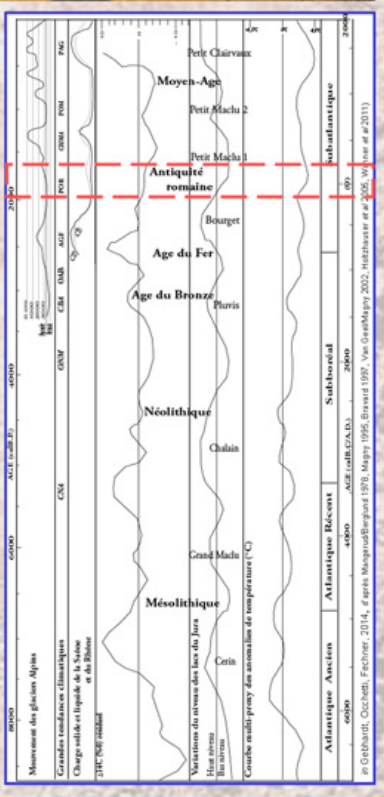
## *Impact du Petit Optimum Romain ...*

Au début de l'Antiquité, le recul des glaciers alpins, la faible charge des eaux du Rhône et de la Saône, la baisse du niveau des lacs jurassiens attestent une période climatique plus clémente (POR).

## *...ou drainage des fonds de vallée au début de l'Antiquité ?*

Mais à cette époque plus clémente, dans l'est, on voit l'installation de nombreuses infrastructures et occupations romaines des zones basses (Lesmesnils/Bouxière, Damblain, Coussey, Haut Clocher...).

## *Deux hypothèses non exclusives !*





Seichamp (Meurthe et Moselle), fouille F. Thiériot, INRAP

**Ces premières conclusions élaborées à partir d'observations de terrain sur divers diagnostics et fouilles archéologiques préventives demandent encore à être affinées par des calages chronologiques. Mais on semble déjà s'orienter, dans le Grand Est, vers la reconnaissance**

## *d'un NIVEAU REPERE du DEBUT de l'ANTIQUITE !*

## Traces de roulage ou de labour ? Le diagnostic micromorphologique

A. Gebhardt[1] and R. Langohr[2]

Poster présenté au GMPCA de Caen, avril 2013.

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Université de Lorraine, CNRS, LIEC UMR 7360, France
INRAP Grand Est, France
[2] Laboratory of Soil Science, University of Ghent, Belgium
Association for Diffusion of Sciences, (ASDIS), non-profit Association, Brussels, Belgium

**Corresponding author:** Anne Gebhardt, anne.gebhardt-even@inrap.fr

Field observations on the many effects of wheeled traffic and ploughing noted during geoarchaeological site investigations in Belgium and France permitted the authors to identify three main characteristics differentiating these phenomena. 1: ploughing produces a better aerated soil microstructure while compression characterized the effects of heavy wheeled traffic; 2: redoximorphic mottling is more common in the compressed soils of wheel tracks; 3: anthropogenic artefacts transported along with farmyard manure occur more often in ploughed soils than in the trackways themselves. These broad differences should be evident in soil thin section studies, further aiding the differentiation of trackway deposits from ploughed soils.

**Keywords**: carriage track, plough mark, soil micromorphology, pedology, France, Belgium

Reference
Gebhardt A. et Langohr R., 2015. Traces de roulage ou de labour? Le diagnostic micromorphologique, *Archéosciences*, 39, 31-38. (https://hal.archives-ouvertes.fr/hal-02005122)

# TRACES DE ROULAGE OU DE LABOUR ?
## Le diagnostic micromorphologique


**A. GEBHARDT[1] et R. LANGOHR[2]**

[1]UMR 7362 LIVE, Univ.de Strasbourg ; INRAP GE, anne.gebhardt-even@inrap.fr
[2]Laboratoire des sols, Univ. Gand (Be) ; ASDIS, roger.langohr@skynet.be


**Le décapage archéologique en plan fait parfois apparaître des traces linéaires qu'il est souvent difficile de déterminer par de simples critères de terrain. De plus, en lame mince, la simple reconnaissance de revêtements argileux poussiéreux caractéristiques d'une mise à nu du sol reste insuffisante.**

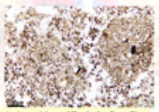
## *Les effets du labour*

Les traces de labour apparaissent souvent ondulantes. On y observe aussi souvent des formes de reprise du sillon, après un dérapage du soc.

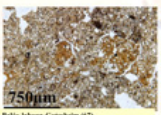
Labour profond après invasion de sable, côte ouest du Jutland, Danemark
R. Langohr, Univ.-Gent

Sillon de l'Age du Fer, dans schistes altérés,
Paule (29), fouille Y. Menez, SRA Bretagne.

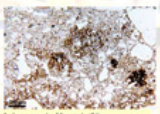
Concrétions calcaires diagénétiques développées dans des paléo-sillons, limons loessiques,
Gotesheim (67), fouille E.Bois, INRAP.



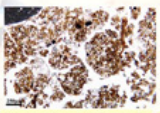
Araire expérimental Hambacher Forst (D) ,
J. Meurers-Balke, Univ.-Frankfort.



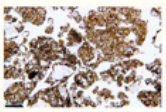

Paléo-labour, Gotesheim (67),
fouille E. Bois, INRAP.



Labour romain, Moyenvic (54),
fouille J.-D. Laüer, INRAP.

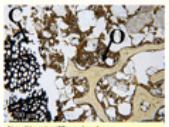


Paléo-labour, Aérogare Liddl, Entzheim (67),
fouille M. Landolt, PAIH.

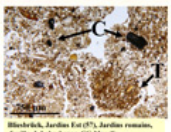


Araire expérimental, Butser Farm (GB),
P. Reynolds.

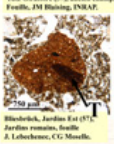
**A l'araire ou la houe, le travail du sol se fait plutôt sous condition sèche ou légèrement humide. Il provoque l'émiettement du sédiment, avec variation de la taille et de la forme des agrégats en fonction de l'outil employé et du type de sol.**




Yutz Géraisire (57), ancien champ,
Fouille, JM Blaising, INRAP.




Bliesbrück, Jardins Est (57), Jardins romains,
fouille, J. Lebechenec, CG Moselle.



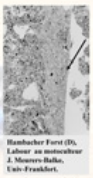

Bliesbrück, Jardins Est (57),
Jardins romains, fouille
J. Lebechenec, CG Moselle.

**Petits fragments de tessons (T), charbons (C) et os (O), roulés sont abondants dans les parcelles régulièrement amendées par du fumier de ferme.**

**La charrue retourne de grosses mottes générant de gros agrégats anguleux, avec certaines parois lissées parfois visibles sur le terrain.**

**Leur taille et forme sont aussi fonction de l'outil employé et du type de sol.**

Hambacher Forst (D), Labour motoculteur
J. Meurers-Balke, Univ.-Frankfort.



Hambacher Forst (D),
Labour au motoculteur
J. Meurers-Balke,
Univ.-Frankfort.

Mercheim (67), référentiel actuel
A. Gebhardt, UMR 7362-UDS.

**Les semelles de labour anciennes étudiées ne montrent en général qu'une légère orientation horizontale des grains ou de la porosité, marquant la limite entre l'horizon labouré et les horizons inférieurs jamais perturbés.**

Hambacher Forst (D), Labour araire
J. Meurers-Balke, Univ.-Frankfort.

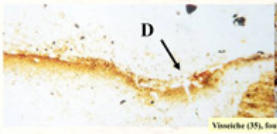
**Un léger tassement est signalé par Duhamel de Monceau (18ème s), qui fait mention d'un niveau de compaction favorisant le glissement du soc, mais que la faune peut aisément perforer.**

## *Les effets du roulage*

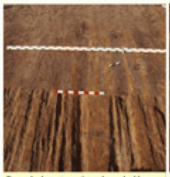
**Phénomènes de surface, les traces de roulage sont caractérisées par une orientation linéaire avec de possibles recoupements et un fort tassement, vers le bas et latéralement, qui remanie les horizons de surface sous la forme d'involutions plus ou moins bien marquées. Les traces sont parfois associées à des empreintes de sabots ou accompagnées de fers d'animaux tractant.**

Traces d'ongin de carrière, sol argileux, Nancy (54), R. Langohr, Univ-Gent.

Ornières, limons, Duntzenheim (67),
fouille C.Veber, INRAP.



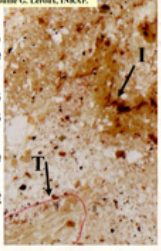

Vinseiche (35), fouille G. Leroux, INRAP.



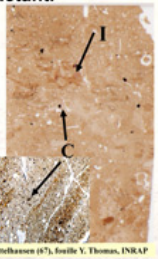
Traces de charrettes antiques dans sol sableux,
Maldegem, Belgique, R.Langohr, Univ.-Gent.

Traces de bovidés antiques tractant,
Vinseiche, (35), G. Leroux, INRAP

Traces de charrettes, limons, Roberst
(Be), R. Langohr, Univ-Gent.




**Le tassement (T), lié au roulage, apparaît compacte en lame mince. Il est caractérisé par :**
**-l'orientation très localisée des argiles poussiéreuses et des intercalations (I),**
**- un léger tri granulométrique suivant les forces de tassement**
**- la quasi-absence de charbons et autres artéfacts anthropiques.**

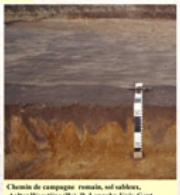



Mittelhausen (67), fouille Y. Thomas, INRAP

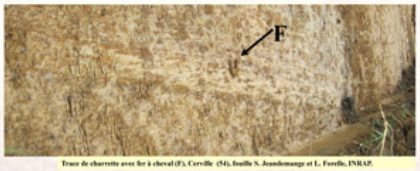

Duntzenheim (67), fouille C. Veber, INRAP

**Des caractères d'humidité temporaire, voire de saturation en eau, sont révélés par l'abondance de petites concrétions d'oxyde de Fer/Manganèse (C) et des fentes de dessiccation (D) dans les accumulations d'argile.**

Traces de charrette, limons, Mittelhausen (67), fouille Y.Thomas, INRAP.



Chemin de campagne romain, sol sableux,
Aalter Wouestijne (Be), R. Langohr, Univ.-Gent.




Trace de charrette avec fer à cheval (F), Cervilla (54), fouille S. Jeandemange et L. Forelle, INRAP.

**Cette étude comparative sur le terrain et au microscope, de quelques exemples archéologiques ou expérimentaux, montre que la reconnaissance de critères diagnostics micromorphologiques et macroscopiques, rend possible la distinction entre roulage et labour.**

Image Ville Environnement
UMR 7362
UNIVERSITÉ DE STRASBOURG

UNIVERSITEIT GENT
ASsociation pour la Diffusion des Sciences
Institut national de recherches archéologiques préventives

## Palaeosoils as indicators of local palaeoenvironmental changes. Mosaics from the Hungarian loess studies

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The loess palaeosoils are known for their palaeoclimatic significance and have also been used for regional stratigraphic correlations. In this paper, three important loess section sites were studied in the frame of an interdisciplinary approach. The soil-sedimentary sequences presented here cover the timespan between the MIS9 and MIS3. Basaharc is one of the key loess sections of the European loess belt. New sections allow for the description of so far unknown facies of the famous Basaharc Double (BD) and Basarharc Lower (BA) palaeosoils. Moreover, they indicate so far unknown sudden environmental changes during the development of the Upper Mende (MF) palaeosoil.
The seven analysed sections of Verőce brickyard allowed the characterisation of the Last Interglacial palaeosoil in various landscape positions.
The detailed investigations of the loess-palaeosol series at Hévízgyörk suggest hiatuses which may have been hidden by a well-developed palaeosol complex formed over multiple interglacial periods during the Late Middle Pleistocene.
This research allows us to complement former knowledge by applying newly available research methods, to obtain new chronological data, and to highlight that soil characteristics of loess palaeosoils are not only influenced by climatic parameters, but also by geomorphological settings.

**Keywords**: loess-palaeosol sequences, climate changes, paleoenvironmental reconstruction, Hungary, Basaharc, Hévízgyörk, Verőce

# Palaeosoils as indicators of local palaeoenvironmental changes
# Mosaics from the Hungarian loess studies

**E. Horváth*[1], Á. Novothny[1], G. Barta[1], D. Csonka[1], T. Végh[1], B. Bradák[2]**

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*E. Horváth: erzsebet.horvath@ttk.elte.hu

## Introduction

The role of the palaeotopographical position and the sudden environmental changes in the palaeosoil formation were studied in three important loess section sites in the frame of an interdisciplinary approach. The soil-sedimentary sequences presented here cover the timespan between the MIS9 and MIS3. Basaharc is one of the key loess sections of the European loess belt. New sections allow for the description of so far unknown facies of the famous Basaharc Double (BD) and Basaharc Lower (BA) palaeosoils. Moreover, they indicate so far unknown sudden environmental changes during the development of the Upper Mende (MF) palaeosoil.

In the Verőce brickyard the analyses of seven sections allowed the characterisation of the Last Interglacial palaeosoil in various landscape positions.

At Hévízgyörk the detailed investigations of the loess-palaeosoil series suggest hiatuses which may have been hidden by a well-developed palaeosoil complex formed over multiple interglacial periods during the Late Middle Pleistocene (Fig. 1a, b).

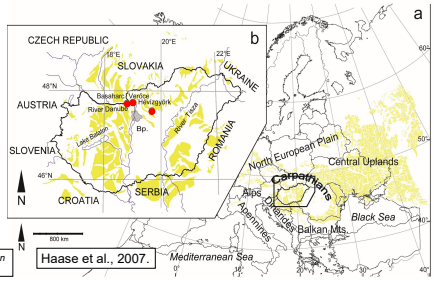



*Figure 1. Distribution of loess sediments in Europe (a) and in Hungary with the location of the profile (b) (based on Haase et al., 2007 and Csonka et al. 2019)*

## Methods

- low field volumetric magnetic susceptibility (κlf)
- frequency depended susceptibility (χfd) and the anisotropy of low field magnetic susceptibility (AMS)
- granulometry, bulk stable isotope investigation, geochemical investigation
- stable isotope investigations on secondary carbonates (mainly hypocoatings)
- palaeomagnetic research
- absolute age determination (luminescence dating, 14C)
- soil meso- and micromorphology
- Harden test and the soil development index (SDI)
- calculation of micromorphological soil development index (MISODI)

(see more in: Bradák 2009, Bradák et al. 2011, 2014, Bradák – Kovács 2014, Barta 2014, Barta et al. 2018, Csonka et al. 2019, Novothny et al. 2010)

## Basaharc

In the new **continuous profile** the palaeosoils are in a higher topographical position than the classic profiles. Even so, the **MF1-2** palaeosoil is very weakly developed in this wall. The presumption is that the pedogenesis could not keep up with the aggradation of the surface by the dust accumulation during MIS5, although the outcrop seems to be on a **local hilltop** position (Fig. 3.).

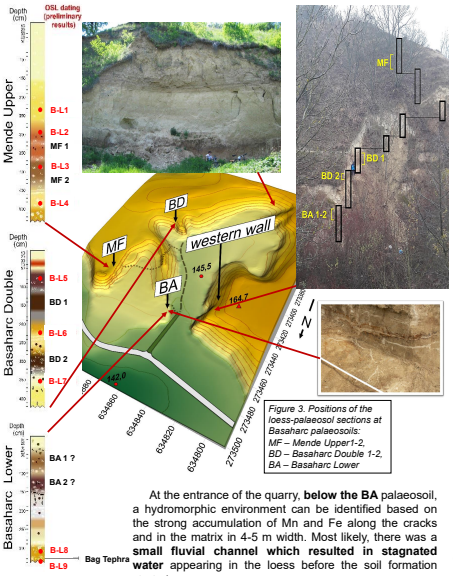



*Figure 3. Positions of the loess-palaeosol sections at Basaharc palaeosoils: MF – Mende Upper1-2, BD – Basaharc Double 1-2, BA – Basaharc Lower*

At the entrance of the quarry, **below the BA** palaeosoil, a hydromorphic environment can be identified based on the strong accumulation of Mn and Fe along the cracks and in the matrix in 4-5 m width. Most likely, there was a **small fluvial channel which resulted in stagnated water** appearing in the loess before the soil formation started.

In the backyard of the quarry, a larger fluvial channel is recognizable based on the **layered** soil material and the slightly layered loess with andesite blocks of 15-50 cm diameter. Below this reworked material a thick and **strongly developed palaeosoil** is located. Based on its topographical position, it is **presumably the BA** palaeosoil, which developed here in an environment with more water supply, possibly in a palaeovalley position. The layered material could be the result of a **gully erosion**, connected to the Palaeo-Danube after the development of the BA palaeosoil between MIS8 and MIS3 (Horváth et al. 2019).

*Figure 2. Luminescence ages of the investigated profiles*

| Profiles | Sample number | Layer | Age (ka) Post-IR IRSL (290) | MIS |
|---|---|---|---|---|
| Basaharc | B-L1 | MF 1 cover | 29,9 ± 1,5 | 2-3 |
| | B-L2 | MF 1 | 48,3 ± 2,5 | 3 |
| | B-L3 | MF 2 | 77,8 ± 4,3 | 5 |
| | B-L4 | MF 2 bed | 113 ± 6 | 5 |
| | B-L5 | BD 1 cover | 135 ± 17 | 6 |
| | B-L6 | BD 1-2 | 194 ± 14 | 7 |
| | B-L7 | BD 2 bed | 214 ± 13 | 7-8 |
| | B-L8 | Bag Tephra cover | >264 | 8-10 ? |
| | B-L9 | Bag Tephra bed | >265 | 8-10 ? |
| Verőce | V-L1 | L2a | 21,9 ± 1,1 | 2 |
| | V-L2 | L2b | 40,5 ± 2,3 | 3 |
| | V-L3 | L3-L3r | 97,8 ± 4,4 | 5 |
| | V-L4 | L4 | 110 ± 5 | 5 |
| | V-L5 | L5 | 208 ± 12 | 6-7 |
| | V-L6 | P3,2r L? | 138 ± 7 | 6 |
| Hévízgyörk | H-L1 | Unit 2b | 46,4 ± 2,5 | 3 |
| | H-L5 | Unit 3a | 79,9 ± 4,4 | 5 |
| | H-L6 | Unit 3b | 245 ± 13 | 7-8 |
| | H-L2 | Unit 5 | >311 | 8-10 ? |
| | H-L3 | Unit 7a | >255 | 10 ? |
| | H-L4 | Unit 7b | >363 | 10 ? |

## Verőce site

A **characteristic palaeosoil (P4)** formed in MIS5e was identified from different sections and three of its facies were characterised (Bradák et al. 2014) (Fig. 4., Fig. 5.).

In the **palaeovalley position** (most likely in a former oxbow lake or a tributary valley connected to the Palaeo-Danube), the P4 palaeosoil is **well-developed and more than 2 m thick**. It can be divided into a lower red, a middle brown, and an upper black horizon. The soil development index (SDI) is very high compared to those of the other P4 palaeosoils, most likely because of the great thickness due to the continuous pedogenesis during sediment accumulation. The stable isotope investigations revealed signs of the effects of **hydromorphic** phenomena, implying significant evapotranspiration under dense vegetation cover (Barta et al. 2018).

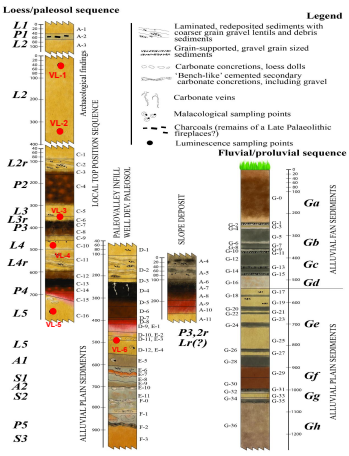



*Figure 4. Summarised and dealised image of the palaeoenvironments in the Verőce brickyard (based on Bradák et al., 2014)*

The thinnest P4 palaeosoil is in the **palaeoslope position**. Although the pedogenetic horizons of this palaeosoil were difficult to detect in the field, further analyses showed that several of its soil characteristics, such as the SDI value, are similar to the ones documented for the P4 palaeosoil situated on the hilltop position (Bradák et al. 2014, Barta et al. 2018). In addition, its uppermost part is mixed with new sediments and covered by fine layered material, suggesting **reworking**. Sedimentation by run-off processes could be also observed. These signs of overland flow have been interpreted as indicators of higher influence of water in this palaeoslope position.

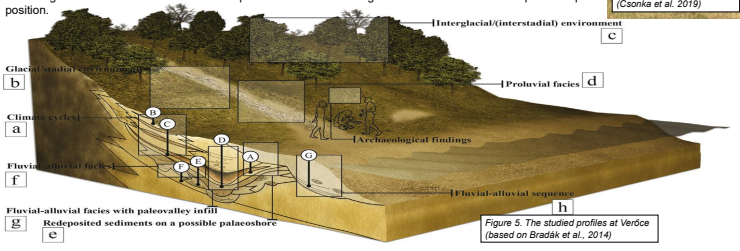



*Figure 5. The studied profiles at Verőce (based on Bradák et al., 2014)*

## Hévízgyörk

The section of the abandoned brickyard of Hévízgyörk contains only **two fossil soils without a visible hiatus** (Fig. 6.). In the lower part of the upper palaeosoil (Unit 3) a strong secondary carbonate accumulation appeared along vertical cracks which **suggested the polygenetic development** of this palaeosoil. The low field volumetric magnetic susceptibility (κlf) curve indicated a **strong pedogenesis with at least two periods in the upper palaeosoil**. In addition, these soils are characterised by a higher clay and CaCO3 content than the other units. The simultaneous presence of the clay coating and secondary carbonate accumulations, as well as the absence of the humiferous surface horizon are most probably related to the combined effect of eolian and/or water triggered erosion processes and of the passage from a leaching to a non-leaching environment during the long evolution of this sequence. Furthermore, it is possible that a lower loess sedimentation rate occurred during the cold phases in this landscape position. Preliminary luminescence results confirmed **an important hiatus between the upper part (79,9±4,4ka) and the lower part (245±13ka)** of this palaeosoil (Unit 3), therefore, the two parts formed in different interglacial periods (Csonka et al. 2019, Novothny et al. 2019). Based on the luminescence age of the uppermost loess unit (46,4±2,5ka) another hiatus is detectable above this palaeosoil.

The thickest loess-palaeosoil section is in a **local hilltop position**, where the P4 palaeosoil is characterised by **well-developed** and separated, differentiated pedological horizons, the same as in P4 in palaeovalley position, but with a smaller thickness and its SDI is lower. The stable isotope patterns of hypocoatings from this palaeosoil can be used as palaeoclimate indicator because it developed primarily under climatic influence and therefore, it can be correlated with other profiles in hilltop position as well.

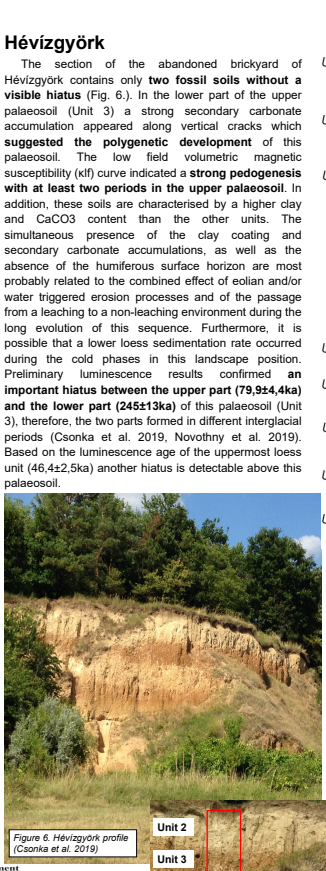
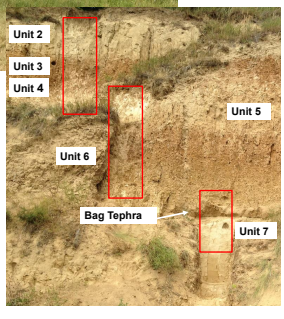



*Figure 6. Hévízgyörk profile (Csonka et al. 2019)*




## Conclusions

The development of the palaeosoils was strongly influenced by the climate, but the local palaeoenvironment had a great influence on it as well. The sites presented here provide a great opportunity to investigate coeval palaeosoils in different geomorphological positions and therefore recognise the distinct balance among pedogenesis-erosion-sediment accumulation. At Verőce, the local top, the palaeovalley and the palaeoslope landscape positions were clearly characterised by different soil features of the same P4 palaeosoil. At Basaharc, various environments and geomorphological processes were described as well. It was possible to detect unconformities in the Hévízgyörk profile by using a multiproxy analysis.

The palaeosoils developed in a higher landscape position (such as local plateaus or intervalley ridges) are suitable for the determination of the intensity (the strength) of the interglacial and interstadial periods, and can be used as a basis for the interregional correlation. Other geomorphological positions (slopes and valley bottoms) were more sensitive to the local changes, therefore they carry information about the development of their local environment.

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## Can we learn more about vanished Neolithic loess soil monuments based on the depth of decalcification?

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In the outskirts of the city of Ninove (central Belgium) the intercommunal SOLVA excavated a 23 Ha large business park in 2018-2019. During the excavation two burial monuments dating back to the later prehistory (2500-2000 BC) were uncovered also. The monuments were interpreted as burial mounds with ditches and ramparts (hills), but during the excavation only the ditches could be documented. The existence of ramparts remains a hypothesis. The 2nd monument has two circular ditches, respectively at 3m and 18m from the centre.

In the leaching climate of Belgium, in natural conditions, one of the soil forming processes is the decalcification. In landscapes affected by anthropic changes the progress of this process might be influenced by the displacement of soil horizons. In the studied case we formulated the hypothesis that after the construction of the monuments, the decalcification will speed up below a ditch due to a higher infiltration rate as the upper part of the soils is removed. Opposite, below a rampart the decalcification will slow down due to the thicker deposit here.

A NW-SE augering transect, crossing the centre of the monument, with observations points each meter, was executed in order to test the decalcification depth along this structure.

The detailed study of the decalcification depths allowed us to recognise 5 positions of deeper decalcification: at distances of 3m, 8m, 18m, 23m, and 36m from the circular centre. Moreover, these deeper decalcification spots have symmetric distribution pattern being present both to the NW and SW part of the transect. During the archaeological excavation at 3m and 18m distance from the centre two closed ditches were recognised, confirming thus the hypothesis that a zone characterised by a deeper decalcification corresponds to a ditch. No ditches have been unravelled for the deeper decalcification spots of 8m, 23m and 36m though. This suggest that there was a chronological difference in the digging and functioning of the ditches. As an example, most probably, the ditch at 23m was part of the original monument or belonged to an early renovation phase of the monument. In a later or final renovation phase the ditch at 18m was dug; possibly at this occasion the sedimentary remains of the earlier phase (23m) were removed as well. Further research is required to confirm the suggested ditches at 8m and 36m distance from the centre. It is not excluded though that a ditch was never dug out, but due to the location between two ramparts a depression is created that will have the same effect on the decalcification rate as that of a ditch. Attempting to interpret where and how ramparts had been constructed is a much more difficult exercise. We suggest that 4 ramparts may have been constructed at one or more periods through the lifetime of this monument. Possibly ramparts were constructed peaking at 6m, 12m, 27,5m and 32m from the centre. Obviously not all ramparts were visible at the same time.

Finally, the data on decalcification depths suggest a monument that must have undergone several major renovation phases. During these phases of renovation, the ditches and ramparts were relocated, but the resurrected monument would always maintain the same circular centre. The data also suggest that the circular structure is considerable larger (72m diameter) than what the excavation data suggest (36m diameter).

**Keywords:** Prehistoric, burial mounds, loess, decalcification, auger observations

## Soil type versus archaeological potential – a complex story

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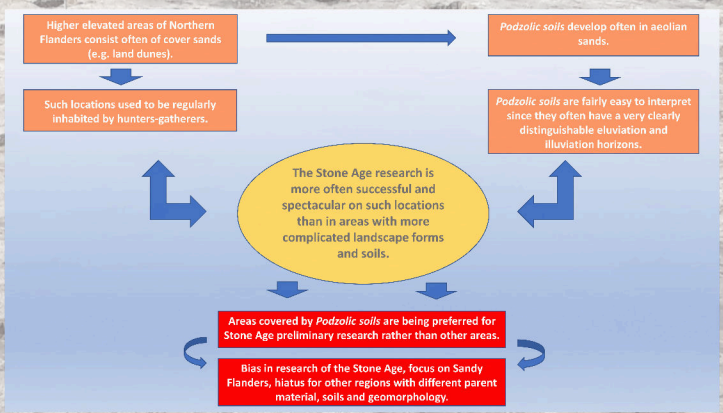
Since the introduction of the new archaeological legislation in Flanders in 2016 soil documentation became a standard and obligatory element at various stages of commercial archaeological research from desktop analyses to large scale excavations. At the same time more pressure has been put on the integration of Stone Age archaeology into the research strategy. As an answer to this needs BAAC Vlaanderen has developed a holistic and interdisciplinary geoarchaeological approach towards potential Stone Age sites. However, this new situation revealed some gaps in the archaeological understanding of soil development and how it needs to be interpreted. One of the main problems is the perception of the dependency between a soil type and an estimated archaeological potential of a study area. A peculiar approach is to be found in the Stone Age preliminary research strategy which is often limited to the areas dominated by *Podzolic soils*. Such an approach cannot be justified, neither by means of soil-related insights nor archaeological practice. Recent works of BAAC Vlaanderen within the loam and sandy loam belt in Flanders give clear indications for a wider distribution of preserved Mesolithic sites in Flanders, located on other soil types than *Podzols*. The aim of the poster is to present a summary of this research alongside general remarks regarding the methodological approach.

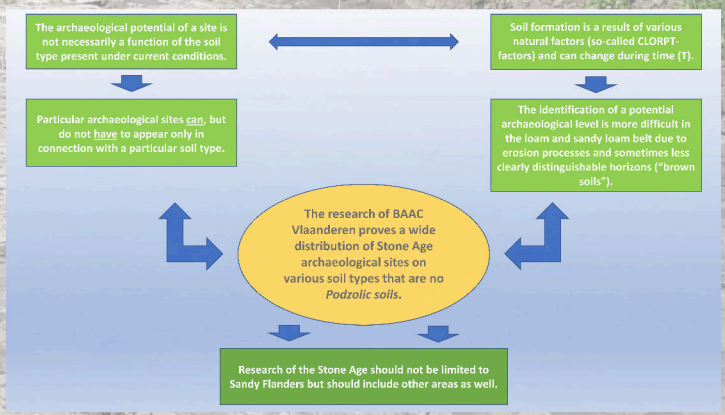
Keywords: archaeological potential, soil type, Stone Age, Flanders, sandy loam belt, loam belt, archaeological prospection

# SOIL TYPE
# VS ARCHAEOLOGICAL POTENTIAL
## *A COMPLEX STORY*

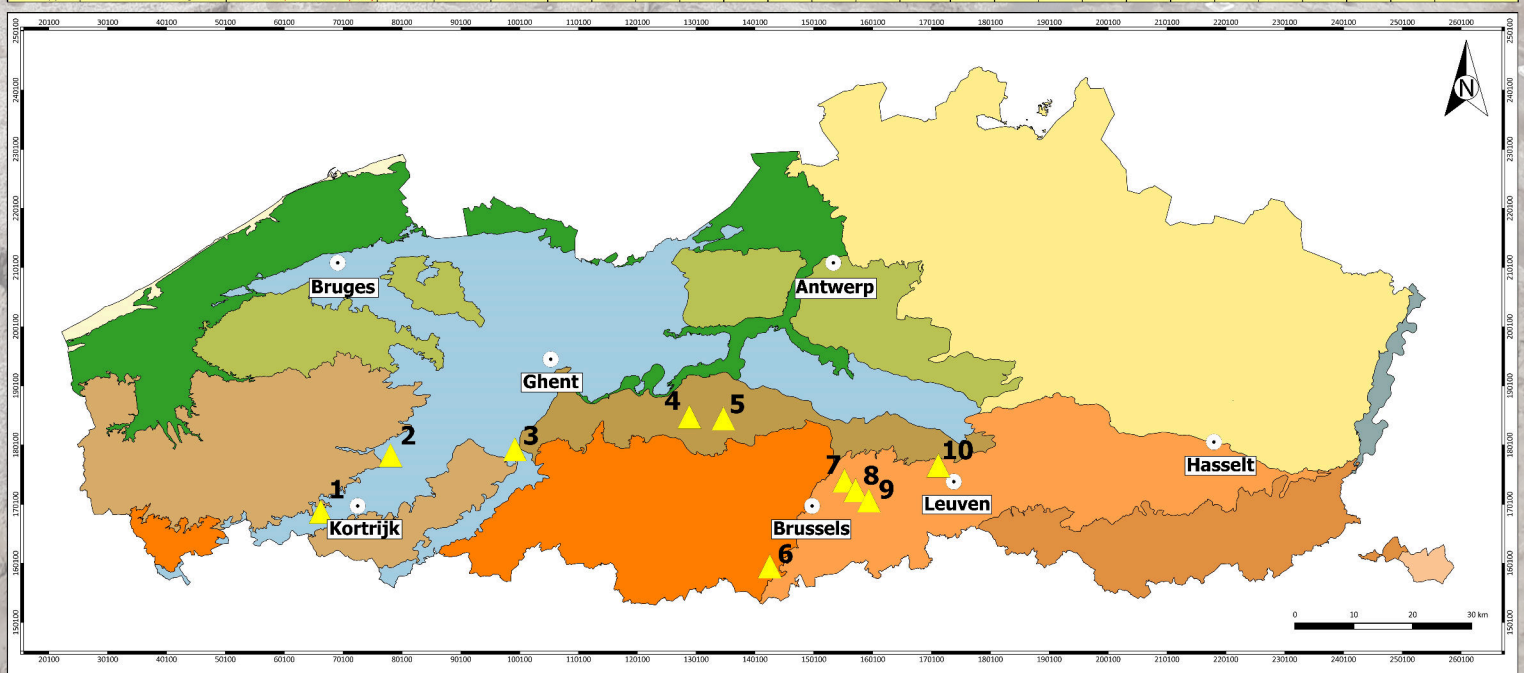
BAAC
ARCHEOLOGIE EN BOUWHISTORIE

Since the introduction of the new archaeological legislation in Flanders in 2016 soil documentation became a standard and obligatory element at various stages of contract archaeological research from desktop analyses to large scale excavations. At the same time more pressure has been put on the integration of Stone Age archaeology into the research strategy. As an answer to this needs BAAC Vlaanderen has developed a holistic and interdisciplinary geoarchaeological approach towards potential Stone Age Sites. Recent work of BAAC Vlaanderen within the loam and sandy loam belt in Flanders gives clear indications for a wide distribution of preserved sites on *Luvisols*, *Retisols* or *Cambisols*. This contradicts the common approach in contract archaeology which tends to limit Stone Age preliminary research to the areas covered by cover sands and *Podzolic soils*, that are mainly situated in Sandy Flanders.




| Municipality | Location | Soil group (sampled horizons) | number of augerings | Grid | Number of positive samples (flint) | Positive samples (%) | Number of uncovered artefacts (flint) | Number of positive samples (pottery) | Positive samples (%) | Number of uncovered artefacts (pottery) | Number of positive samples (bone) | Positive samples (%) | Number of uncovered artefacts (bone) | | Chips | Flakes | Blade/lets | Cores | Rejuvenation | Debris | Tools | Toolproduction | Pot lids | TOTAL | verkoolde macroresten | Charred macrofossils |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Herent | Kouterstraat-Novus | *Luvisols* (Ap+Bt) | 326 | 10x12 | 24 | 7 | 28 | 2 | 8 | 2 | 0 | 0 | 0 | | 21 | 2 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | **28** | 0 | |
| Herent | Kouterstraat-Novus | *Luvisols* (Ap+Bt) | 163 | 10x12 | 12 | 7 | 13 | 1 | 8 | 1 | 0 | 0 | 0 | | 11 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | **13** | 0 | |
| Herdersem | De Cockstraat | *Retisols* (Bw) | 19 | 5x6 | 1 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | |
| Herdersem | De Cockstraat | *Retisols* (Bw) | 33 | 10x12 | 2 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **2** | 0 | |
| Opwijk | Vlaamse Staak | *Retisols* (Bts) | 152 | 10x12 | 11 | 7 | 13 | 2 | 18 | 2 | 0 | 0 | 0 | | 12 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | **13** | 1 | grain |
| Opwijk | Vlaamse Staak | *Retisols* (Bts) | 153 | 5x6 | 6 | 4 | 7 | 4 | 67 | 5 | 1 | 0 | 1 | | 5 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | **7** | 0 | |
| Asper | Ouden Herreweg | *Retisols/Cambisols* | 13 | 10x12 | 3 | 23 | 4 | 3 | 100 | 61 | 8 | 5 | 41 | | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **4** | 0 | |
| Asper | Ouden Herreweg | *Retisols/Cambisols* | 37 | 5x6 | 6 | 16 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | | 6 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | **11** | 1 | grain |
| Waregem | Tavas | *Cambisols* (Bts) / *Podzols* | 286 | 10x12 | 10 | 3 | 10 | 0 | 0 | 0 | 4 | 12 | 4 | | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **10** | 0 | |
| Waregem | Tavas | *Cambisols* (Bts) / *Podzols* | 226 | 5x6 | 6 | 3 | 6 | 0 | 0 | 0 | 2 | 1 | 2 | | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | **6** | 1 | hazelnut shell |
| Zaventem | Fluxys-Harenweg | *Luvisols* (Bw) | 25 | 10x12 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | |
| Zaventem | Fluxys-Harenweg | *Luvisols* (Bw) | 25 | 5x6 | 2 | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **2** | 0 | |
| Zaventem | Fluxys-Oude Keulseweg | *Luvisols/Cambisols* (Bt) | 37 | 10x12 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | |
| Zaventem | Fluxys-Tramlaan | *Luvisols/Cambisols* (Bt) | 151 | 10x12 | 4 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | **4** | 0 | |
| Zaventem | Fluxys-Tramlaan | *Luvisols/Cambisols* (Bt) | 25 | 5x6 | 2 | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **2** | 0 | |
| Zaventem | Fluxys-Woluwedal | *Luvisols/Cambisols* (Bt) | 106 | 10x12 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | **3** | 0 | |
| Wez.-Oppem | Centrumontwikkeling | *Luvisols/Cambisols* (Btw) | 44 | 10x12 | 2 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **2** | 0 | |
| Wez.-Oppem | Centrumontwikkeling | *Luvisols/Cambisols* (Btw) | 115 | 5x6 | 3 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **4** | 0 | |




**Legend**

- Main cities of Flanders
- Location archaeological sites

ECOREGIONS

- Pleistocene rivier valleys
- Gravelly rivers region
- Cuestas
- Polders and the tidal Scheldt
- Campine area
- Coastal dunes
- Chalk areas
- Loess-on-chalk areas
- Middle Flemish transition region
- Western interfluvia
- Southeastern hills
- Southwestern hills

**Archaeological sites**

1 - Wevelgem Vinkenstraat
2 - Waregem Tavas
3 - Asper Ouden Herreweg
4 - Herdersem De Cockstraat
5 - Opwijk Rodeveld
6 - Halle Alsembergesteenweg
7 - Zaventem Fluxys-Harenweg
8 - Zaventem Fluxys-Oude Keulseweg, Tramlaan, Woluwedal
9 - Wezembeek-Oppem Centrumontwikkeling (running)
10 - Herent Kouterstraat-Novus

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## Decarbonation in semi-arid Mediterranean soils: how is it possible?

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The Areny Formation is an Upper Cretaceous sandstone outcropping in the South Pre-Pyrenean area. It is composed of well-sorted quartz sand and gravel, cemented by calcite. It outcrops at a wide range of altitudes (400 to 1700 m). Soils developed on this formation in the Tremp basin (NE Iberian Peninsula) have xeric/ustic and mesic soil climate regimes. They display several soil characteristics corresponding to advanced stages of pedogenesis such as decarbonation, clay formation, and illuviation and rubefaction, ranging from Cambisols and Luvisols to Lixisols. These pedofeatures are absent in adjacent soil units of similar age, developed on finer materials, such as marls and calcareous conglomerates, where the dominant soil formation processes are carbonate translocation and weak cementation. These neighbouring soils are mainly Calcisols, some of them with a petrocalcic horizon. Six profiles formed on the Areny sandstone were selected for an in-depth study of their soil formation processes. A multi-scale approach, from geomorphological to micromorphological analyses, was employed. The soils have a neutral to slightly acidic reaction in the Bt horizons, with loamy sand textures and a clay content of 10 % that appears completely as illuviated clay in the thin section; reddish hues (2.5YR) and high chromas, the absence of calcite in the upper horizons or in the whole profile, and the presence of iron pans in some locations. Amorphous iron is found in low amounts compared to Fe in silicates and as finely crystalline forms. The latter increases with depth in the decarbonated profiles. The high weathering degree of the oldest profiles is shown by kaolinite being the dominant clay, which was probably inherited from the pre-Quaternary period. The clay fraction also contains remarkable amounts of mixed layers chlorite/smectite, chlorite/vermiculite or illite/smectite, which may be considered products of present-day pedogenesis. The geomorphological analyses allowed us to determine the ages of the surface formations of four of the profiles (50 to more than 350 ky), which indicated much faster soil formation rates than those reported in similar Mediterranean environments. Thus, the proposed stages of soil evolution in these sediments imply a fast decarbonation, followed by clay formation, and illuviation. These processes have strong implications in establishing the soil-landscape relationships in the area.

**Keywords**: carbonate, decalcification, rubefaction, clay illuviation, clay formation, Catalonia

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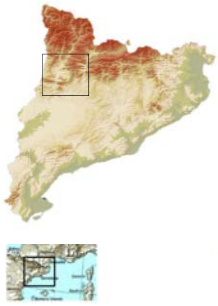
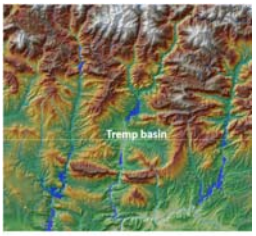
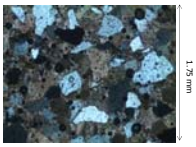
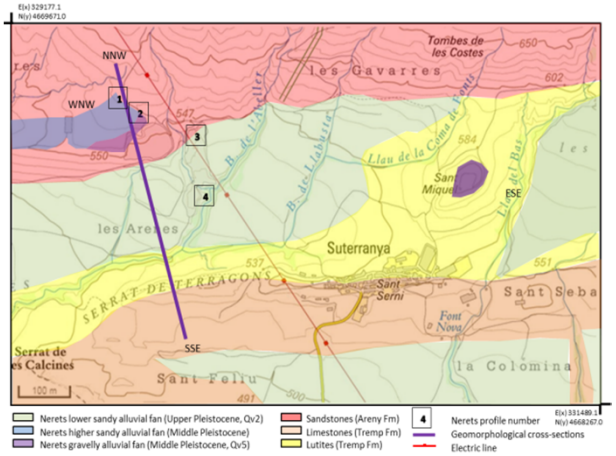





Tremp Basin: Mean anual rainfall: ~500 mm. Mesic and Xeric climate regimes

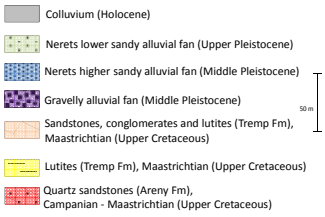


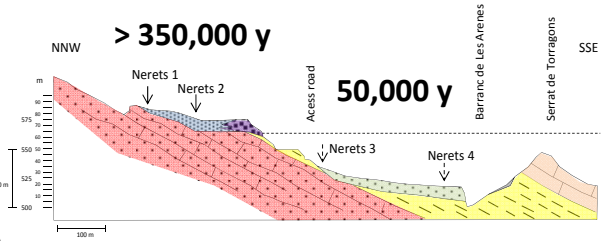

Areny sandstone: quartz sands and gravels with $CaCO_3$ cement

| Profile / horizon | Depth (cm) | Munsell colour (moist) | Clay coatings<br>Calcitic pedofeatures |
|---|---|---|---|
| **Nerets 1** | | | |
| A | 0-11 | 2.5YR 5/4 | - |
| AB | 11-25 | 2.5YR 5/8 | - |
| Bt1 | 25-42 | 2.5YR 5/8 | Frequent clay coatings |
| Bt2 | 42-75 | 2.5YR 4/8 | Abundant clay coatings |
| Bt3 | 75-113 | 2.5YR 4/6 | Continuous clay coatings |
| Bt4 | 113-140 | 2.5YR 4/8 | Abundant clay coatings |
| **Nerets 2** | | | |
| Bt | 0-40/150 | 2.5YR 5/6 | Abundant clay and silt coatings |
| 2Btk1 | 40/150-155/160 | 5YR 5/8 | Few clay and silt coatings, Carbonate pseudomycelia, |
| 2Bk2 | 155/160-160/200 | - | Carbonate pseudomycelia and rhyzocretions. |
| 3Bk3 | 160/200->230 | 5YR 5/8 | Carbonate pseudomycelia and rhyzocretions. |
| **Nerets 3** | | | |
| Oa | -1-0 | - | - |
| A | 0-9 | 5YR 3/4 | - |
| Bt | 9-38/49 | 2.5YR 4/5 | Clay coatings |
| 2Bwk1 | 38/49-41/70 | 5YR 5/6 | Frequent carbonate pseudomycelia and queras. |
| 2Bwk2 | >41/70 | 5YR 4/6 | Frequent carbonate pseudomycelia and queras. |
| **Nerets 4** | | | |
| A | 0-8 | 5YR 5/6 | - |
| Bt | 8-36 | 2.5YR 4/6 | Few clay coatings around quartz grains |
| 2Bk | 36-127 | 7.5YR 6/6 | Carbonate pseudomycelia and few queras |
| 3Bwk | 127-177 | 7.5YR 5/6 | Carbonate pseudomycelia, abundant rhyzocretions |
| 4Bk | 177->277 | 10YR 6/6 | Generalized carbonate accumulation |

**Petric Calcisol on a surface of the same age in the Tremp basin on different materials**

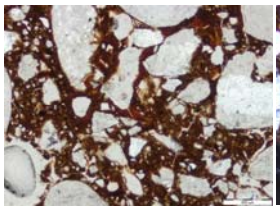


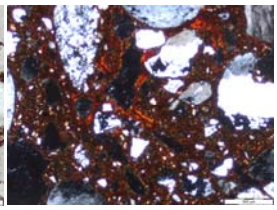

Four profiles on two alluvial fans made of weathering products from Areny sandstones



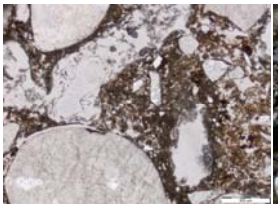

| Profile and horizon | pH $H_2O$ 1:2.5 | $CaCO_3$ (%) | OM (%) | Clay % < 2µm | Texture | CIC (cmol +/kg) | V% |
|---|---|---|---|---|---|---|---|
| **Nerets 1** | | | | | | | |
| A | 7.1 | 0 | 1.1 | 6.9 | S | 2.7 | 100 |
| AB | 6.0 | 0 | 0.6 | 8.4 | S | 2.3 | 72 |
| Bt1 | 7.2 | 0 | - | 11.1 | LS | 2.1 | 100 |
| Bt2 | 6.7 | 0 | - | 10.1 | LS | 2.5 | 87 |
| Bt3 | 6.4 | 0 | - | 18.2 | SL | 6.6 | 85 |
| Bt4 | 6.1 | 0 | - | 17.3 | SL | 5.2 | 80 |
| **Nerets 2** | | | | | | | |
| Bt | 8.4 | 0 | 0.4 | 16.2 | SL | 5.6 | 100 |
| 2Btk1 | 7.2 | 0 | 0.5 | 18.2 | SL | 5.5 | 100 |
| 2Bk2 | 8.7 | 4.4 | - | 7.5 | S | 3.8 | 100 |
| 3Bk3 | 8.5 | 4.7 | - | 4.2 | S | 3.9 | 100 |
| **Nerets 3** | | | | | | | |
| A | 8.4 | 2 | 0.67 | 12.5 | SL | 6.6 | 99 |
| Bt | 8.5 | 3 | 0.36 | 22.3 | SCL | 9.9 | 100 |
| 2Bwk1 | 8.5 | 18 | 0.2 | 10.1 | SL | 5.1 | 100 |
| 2Bwk2 | 8.5 | 10 | 0.05 | 10.2 | SL | 3.4 | 100 |
| **Nerets 4** | | | | | | | |
| A | 7.6 | 1 | 2.22 | 6.9 | LS | 5.4 | 100 |
| Bt | 7.6 | 0 | 0.68 | 17 | SL | 8.2 | 100 |
| 2Bk | 8.5 | 8 | 0.01 | 7.9 | LS | 2.9 | 100 |
| 3Bwk | 8.6 | 8 | 0.1 | 14 | SL | 6.8 | 100 |
| 4Bk | 8.2 | 23 | 0.1 | 12.3 | SL | 4.9 | 100 |

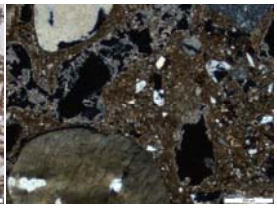
An advanced weathering stage occurs in the Nerets soils, as evidenced by the red colour, the decarbonation, and by the predominance of kaolinite. While the red colour might be attributed to present-day processes under a Mediterranean climate, decarbonation and kaolinite are apparently not in agreement with the climate of the area.





Progressive clogging of packing pores by micromass in Bt2 horizon of Nerets 1, resulting in a close porphyric c/f related distribution. Note also the clay coatings.





Loose discontinuous infilling of needle calcite in a channel (upper left) and micrite coating and impregnative hypocoating in a pore (lower right) in 2Bk horizon of Nerets 2.

The Areny sandstone is easily decarbonated because of its sandy nature, partial brecciation and because calcite is present as cement.

| Profile and horizon | Fine earth mineralogy | | | | | Clay mineralogy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quartz | K-Feldspar | Plagiocl. | Phyllos. | Calcite | Kaolinite | Illite | Smectite | Chlorite | Chl/Sm | Ill/Sm |
| **Sandstone A** | 46 | 0.4 | - | 3.5 | 49.5 | 2.0 | 5.3 | - | - | - | 92.8 |
| **Sandstone B** | 17.5 | 0.2 | - | 1.5 | 80.9 | 90.0 | 9.8 | - | - | - | - |
| **Nerets 1** | | | | | | | | | | | |
| A | 60.0 | 21.0 | - | 19.0 | - | 50.0 | 8.3 | 8.3 | - | 20.0 | 16.7 |
| AB | 67.8 | 3.0 | 2.0 | 27.2 | - | 46.7 | 13.3 | 6.7 | 6.5 | 19.0 | 6.4 |
| Bt1 | 85.2 | 2.1 | - | 13.1 | - | 42.9 | 14.3 | 4.8 | 9.5 | 20.0 | 4.8 |
| Bt2 | 37.8 | 15.2 | 5.2 | 41.8 | - | 42.1 | 26.3 | 5.3 | - | 18.0 | 5.3 |
| Bt3 | 27.0 | 1.4 | 0.9 | 70.7 | - | 40.0 | 24.0 | 4.0 | - | 20.0 | 12.0 |
| Bt4 | 42.3 | 2.6 | 1.8 | 53.3 | - | 88.9 | 4.4 | 0.7 | - | 19.0 | 2.2 |
| **Nerets 2** | | | | | | | | | | | |
| Bt | 44.8 | 5.2 | 1.4 | 48.6 | - | 33.3 | 25.9 | 3.7 | - | 20.0 | 11.1 |
| 2Btk1 | 57.6 | 2.0 | 0.9 | 39.6 | - | 28.6 | 21.4 | 3.6 | - | 20.0 | 28.6 |
| 2Bk2 | 57.8 | 1.1 | 11.4 | 29.7 | - | 50.0 | 50.0 | - | - | 18.0 | - |
| 3Bk3 | 50.6 | 15.3 | 22.9 | 11.2 | - | 33.3 | 41.7 | 4.2 | - | 20.0 | 4.2 |

The formation of kaolinite must be due to past (wet, warm) climates, thus decarbonation, kaolinite formation and redness probably occurred consecutively in a short time in the past, and therefore are palaeofeatures. Clay illuviation should be seen as a present-day process.

The Nerets soils formed on pre-weathered pedosediments that underwent strong weathering. This pedogenesis is confronted with the formation of petrocalcic horizons on surfaces of similar ages in the same basin. Thus, the degree of development of the studied soils is being controlled by the nature of the parent material

## On the castle at Den Everberg, the Kruisborrekapel and the Oud Verbrand Hof van Boyendael. An archaeological evaluation of the alleged castle of the Heren van Everberg on and around the Everberg in Everberg (Kortenberg, prov. Vlaams-Brabant, Belgium)

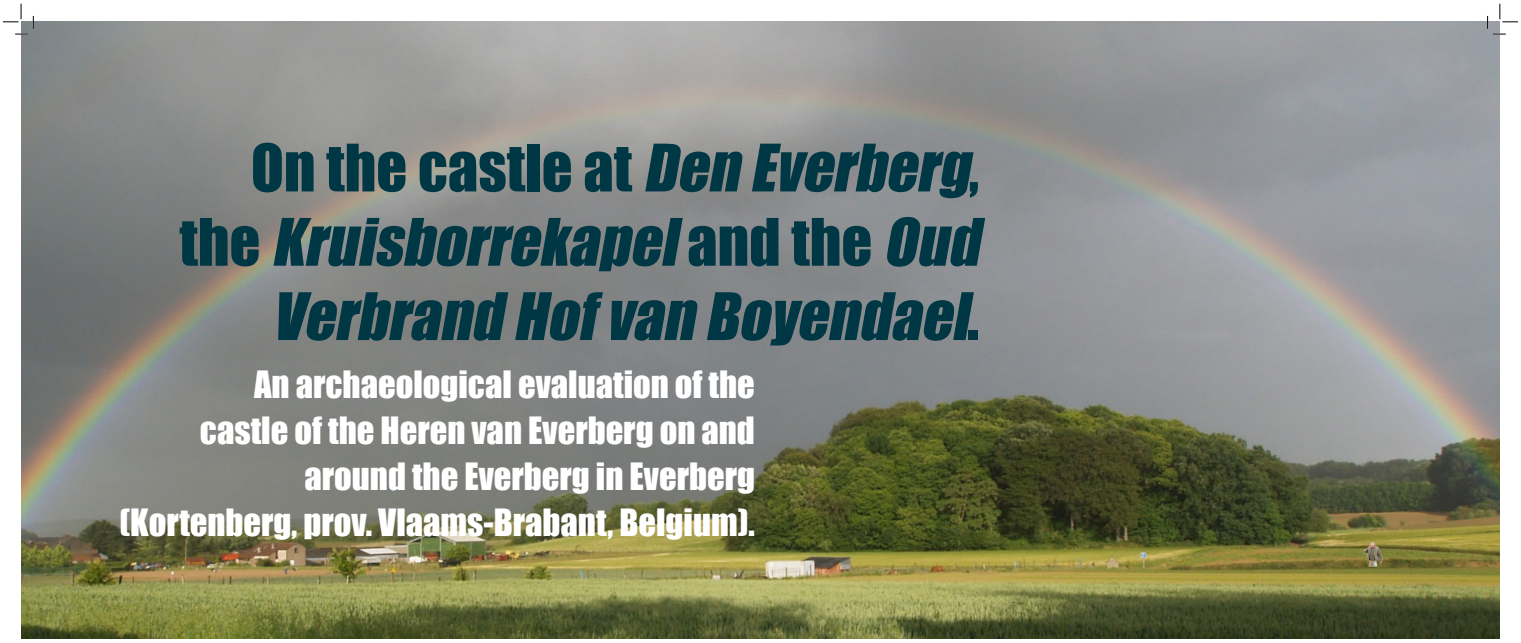
W. Sevenants

Archeologische Werkgroep Kortenberg (Belgium)

**Corresponding author**: Walter Sevenants, walter.sevenants@triharch.be

*Den Everberg* is a special and mysterious place for the inhabitants of this eponymous municipality in the province of Vlaams-Brabant in Belgium. According to a number of historians, the first castle of the *Heren van Everberg* stood on this hill in the 11th - 12th centuries. At the foot of the hill, the *Kruisborrekapel* and the place name *Oud Verbrand Hof van Boyendael* are said to refer to the church and the farm of these Heren van Everberg. The Everberg is also cited within archaeological circles as one of the few well-preserved small ringwall fortifications from the 11th - 12th century.
The fact is, however, that these claims have never been archaeologically investigated. The Archeologische Werkgroep Kortenberg has changed this, with the financial support of the province of Vlaams-Brabant. From 2013 to 2016, an area of approximately 12 hectares on and around the Everberg was systematically investigated. This research consisted of a desktop study into the physical-geographical, cultural-historical and archaeological context of the project area, and various field studies in the form of visual terrain studies, landscape soil studies, geophysical studies, field mapping, archaeological coring and trial trenching.
The research clearly refutes the presence of a medieval castle site on and around the Everberg. To such an extent that we have to ask ourselves whether the small ringwall fortifications have existed at all as an independent medieval fortification type in the low countries.
On the other hand, the research revealed a number of sites and insights which allowed us to rewrite part of the history of the landscape on and around the Everberg, and the role man played in this.

**Keywords:** community archaeology, landscape archaeology, geoarchaeology, medieval castle, small ringwall fortification, dormice (*Gliridae*)

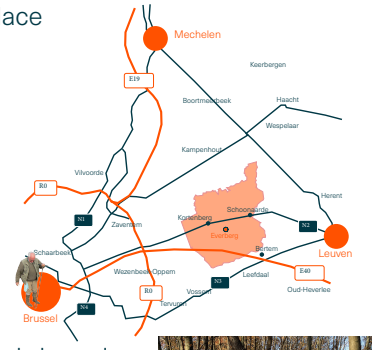


# On the castle at *Den Everberg*, the *Kruisborrekapel* and the *Oud Verbrand Hof van Boyendael*.

## An archaeological evaluation of the castle of the Heren van Everberg on and around the Everberg in Everberg (Kortenberg, prov. Vlaams-Brabant, Belgium).

AN INITIATIVE FROM THE ARCHEOLOGISCHE WERKGROEP KORTENBERG UNDER GUIDANCE OF WALTER SEVENANTS

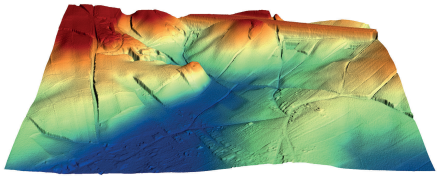
The *Everberg* is a special place for the inhabitants of this municipality with the same name. According to some historians, the first castle of the *Heren van Everberg* stood on top of this hill in the 11th - 12th century.
At the foot of the hill, the *Kruisborrekapel* and the place named *Oud Verbrand Hof van Boyendael* are said to refer to the church and the farm that belonged to this castle. Even within archaeological circles, the *Everberg* is still cited as one of the few well-preserved small ringwork fortifications from the 11th - 12th century in the Low Countries. This is largely based on the name relationship between hill, nobility and municipality, and on the specific shape of this hill: a truncated cone with earthworks at the top reminiscent of a manmade earthen wall.




1

### The castle of the *Heren van Everberg*

The research clearly showed that there was never a medieval castle on top of the *Everberg*. What was considered the remains of a manmade earthen wall turned out to be the remains of a 14th century stone quarry. The *Everberg* can therefore no longer be regarded as a typical example of a well-preserved 11th - 12th-century small ringwork fortification. This even raises the question whether the small ringwork fortification did exist as an independent type of medieval fortification in the Low Countries.



2

### The Kruisborrekapel

Research at the *Kruisborrekapel* did not demonstrate the presence of a medieval church either. However, it could be established that a small chapel was built on top of a stone well. By linking the archaeological findings to the legends surrounding the chapel and the linguistic analysis of the name *Kruisborrekapel*, it was possible to identify the following chronological evolution of this place. The story of the *Kruisborrekapel* begins with the erection of a cross by Elisabeth van Grave in memory of her husband, Jonkheer Jan de Mol, who was killed by falling from his horse on this spot in 1610. During or a while after the erection of the cross a stone well was built. Both were called *Kruisborre*. In the first half of the 19th century a small (brick) chapel was built on top of the well, possibly to replace the cross. From that moment, the well and the chapel were called the *Kruisborrekapel*. At the end of the 19th century, the well was decommissioned and the chapel continued to exist as the *Kruisborrekapel*.

3

### The Oud Verbrand Hof van Boyendael

Based on records from the 16th century, a farm would have existed near the *Everberg*: *the Hof van Boyendael*. Geophysical research carried out on the area between the *Everberg* and the *Kruisborrekapel* provided indications of the location of the sought-after farm. However, research by means of trial trenches showed that the anomalies found were due to differences in soil texture and to filled erosion channels. Hence, the *Oud Verbrand Hof van Boyendael* could not (yet) be located.

The filled up erosion channels brought back memories for the local inhabitants. It was told that in the winter of 1941-'42, stones weighing dozens of kilos were swept away by a mud stream hundreds of metres and were deposited at the foot of the *Everberg*. May 14 1906, rain gushed down so badly that it resulted in catastrophic floods. The small town of *Everberg* shared in the misery. But in the neighbouring municipality of *Bertem*, however, this was not limited to material damage: four people drowned in their homes as a result of a mudslide.

4

### The catch of the day

Archaeological research often leads to unexpected discoveries. Also in this project! On top of the *Everberg*, remains were found of a construction in which dormice were kept in (semi-)captivity in Roman times. In that period edible dormice (Glis glis) were a delicacy in the Mediterranean, but this species probably did not live in this northwestern part of the Roman Empire. There are indications that this enviable role was taken over by the garden dormouse (Eliomys quercinus).

### A PROJECT BY AND FOR THE COMMUNITY

On the occasion of the celebration of 900 years of *Everberg* in 2012, the *Archeologische Werkgroep Kortenberg* took the initiative to challenge these assertions by executing an archaeological survey of this area. This project was set up as a community project in which the local population, governments and scientific experts and institutions were involved.

### INVESTIGATION

From 2013 till 2016 an area of 12 hectares on and around the *Everberg* was surveyed. This research consisted of a desktop study into the physical-geographical, cultural-historical and archaeological context, interviews with locals, pedological research, geophysical research, field walking, archaeological augering and coring, trial trenching, ...

### Would you like to find out more?

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**The Archeologische Werkgroep Kortenberg, as part of the Erfgoedhuis Kortenberg vzw, is a voluntary association that promotes the conservation of archaeological heritage in the municipalities of Erps-Kwerps, Everberg, Kortenberg and Meerbeek. Our thanks goes out to:** Bas Aarts | Sara Adriaenssens | Jan Aerts | Blondina Belis | Germaine Belis | Julia Belis | Ilse Bogaerts | Chris Borgions | Marc Brion Hedwig Buls | Danny Claes | Jacques Cochet | Kristof Coeckelbergh | Pierre Colson | Leonia De Coninck | Raymonde De Coster | Henri De Kelver | William De Keyzer | Danni De Laere | Luc De Muylder | Alfons De Wit | Jozef De Wit | Luc De Wit | Pieterjan Deckers | Sofie Declercq | Marie-Louise Defrancquen | Hadewijch Degryse | Wouter Dhaeze | Stefaan Dondeyne | Denise Dossche | Michiel Dusar | Anton Ervynck | Maria Fransina | Peter Geerts | Rita Geulinckx | Carl Gillis | Marc Gillis | Geert Gillis | Karin Gillis | Nele Goeminne | Johan Grootaers | Dieter Hendrickx | Ilse Hermans | Constanze Höpken | Isabel Jansen | Carlo Jengember | Ludo Jonckheer | Paul Kempeneers | Ewoud L'Amiral | **Roger Langohr** | Daniel Lauwereys | Maria Lauwereys | Marie Louise Lauwerys | Jan Levens | Marc Lodewijckx | Lisette Luyten | Marleen Martens | Maria Mees | Freddy Meulemans | Monique Meys | Roger Mollie | Steven Mortier | Bernadette Noppen | Ghislain Noppen | Dirk Ooms | Sten Pardon | Tony Pijls | Jasmijn Ramaekers | Freek Rombouts | Hans Roskam | Timothy Saey | Luc Salens | Simone Scheers | Walter Sevenants | Linda Shine | David Simpson | Yvonne Spruyt | Dries Thys | Frans Trappeniers | Hendrik Trappeniers | Angelica Trappeniers | Emmanuel Trappeniers | Gustaaf Trappeniers | Ward Van Dijck | Thomas Van Driessche | Herman Van Erps | Tacco Van Geertruyen | Nicholas Van Laerhoven | Franciscus Van Lint | Ludovicus Van Lint | Marc Van Meirvenne | Jacqueline Vancoillie | Karin Vandeneynde | Alain Vanderhoeven | Sofie Vanhoutte | Bart Vanmontfort | Henri Vannoppen | Roan Vercammen | François Wijnants | Sonja Willems | Werner Wouters

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## The importance of geoarchaeology to deepen the knowledge of ancient monuments: sustainable research and development. Cases studies from Basarabi, Adamclisi, Lower Silvas (Romania) and Barcelona (Spain)

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Thanks to interdisciplinarity, the vast field of study called geoarcheology becomes increasingly important for deepening the understanding of already well-know monuments and for their preservation. Through experimentation and critical approaches, the geo-archaeological involvement takes place in all the stages of the archaeological investigations. It includes a whole set of techniques of geophysical/chemical/biological exploration, in order to better identify the geographical and historical context of the sites, as well as to look into their formation processes, both the natural and the cultural one.

Four archaeological sites were chosen for the present work. The Basarabi Chalk Churches, located in the Constanţa district (Romania), dating from the IX th century, a cave complex that was excavated in chalk deposits of Senonian age; Adamclisi (Civitas Tropaensium), a Roman castra, promoted to municipium around 200AD, also located in Constanţa region; the so-called Goat Hill Site of Lower Silvas, a Bronze age tumular necropolis, located in the Hunedoara district (Romania); and, finally, the Roman city of Barcino (Barcelona, Spain), founded at the end of the first century BC, whose shape was defined by its imposing Augustan city walls. In all those sites, the heritage value can be deepened by geomorphological and geophysical investigations. In Silvas, for exemple, geomagnetic measurements and electrical resistivity tomography revealed several anomalies, suggested a stratigraphic sequence and allowed the delimitation between the anthropic levels and the underlying geological layers.

The reconstruction of the ancient landscape on which the city of Barcino arose – an approach started in 1997 by J. M. Palet and developed today in various forms by different researchers - continues to be an essential aid in the interpretation of the genesis and subsequent development of the Roman colony. Recently, a strict correspondence has been found between the results of a "channel network" algorithm, executed over an historic digital elevation model, and some archaeological evidences related to urban wastewater management.

Finally, in Constanta district specific geotechnical measurements for the evaluation of the resistance of the massive chalk to physical wear and chemical action, will lead, along with other geoarchaeological studies, to find realistic solutions to protect the site.

Keywords: geoarchaeology, geophysical methods, interdisciplinarity, soil stratigraphy, sediments.

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# THE IMPORTANCE OF GEOARCHAEOLOGY TO DEEPEN THE KNOWLEDGE OF ANCIENT MONUMENTS: SUSTAINABLE RESEARCH AND DEVELOPMENT. CASES STUDIES FROM BASARABI, ADAMCLISI, LOWER SILVAS (ROMANIA) AND BARCELONA (SPAIN)

Poster presentation: Daniela Turcanu- Carutiu &Alessandro Ravotto  Session 1: 7 November 2019, 10:35-11:00

**Daniela Turcanu- Carutiu[1], Alessandro Ravotto[2], Sorin Tincu[3], Verginica Schroder[4], Rodica- Mariana Ion[5]**

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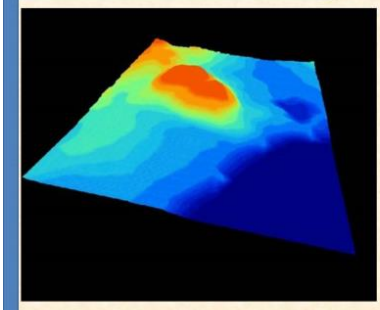
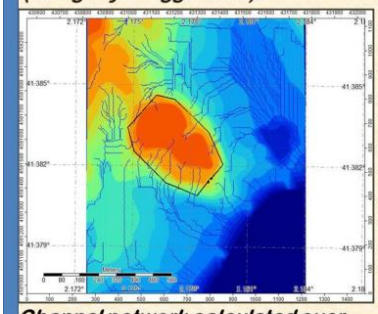
3 Corvin's Castle, Hunedoara, Romania, 4 Ovidius University of Constanta, Romania, 5 ICECHIM, Bucharest, Romania

**Four archeological sites are presented here: The Basarabi *Chalk Churches,* located in the Constanța district (Romania), dating from the IX th century, a cave complex that was excavated in chalk deposits of Senonian age; Adamclisi (*Civitas Tropaensium),* a Roman *castra*, promoted to *municipium* around 200AD, also located in Constanța region; the so-called *Goat Hill Site* of Lower Silvas, a Bronze age mound necropolis, located in the Hunedoara district (Romania); and, finally, the Roman city of *Barcino* (Barcelona, Spain), founded at the end of the first century BC, whose shape was defined by its imposing Augustan city walls. Those sites have been chosen to illustrate how several geoarchaeological techniques can be used to contribute to the Cultural Heritage approach, whether it concerns the conservation of monuments (Basarabi, Adamclisi), the elaboration of archeological research strategies (Lower Silvas) or a better understanding of a historic urban project within its territory (Barcelona).**

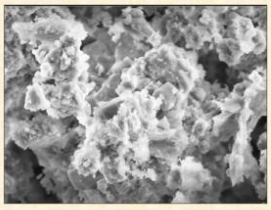
**Barcelona** was founded around 15-10 BC, in a slight relief next to the sea. In order to better understanding the relationships between the urban project and the landscape, a digital elevation model (DEM) of the terrain has been obtained from XIX century data. Then, an algorithm for calculating the "channel network" (i.e., roughly, the water flowing directions) has been applied to the model.
The result has shown that several archaeologically documented Roman sewers that carried the wastewater out of the city took advantage of those natural channels, suggesting a rational adaptation of the builders to the landscape. Also, this kind of study allows approximating the position of two streams surrounding the city, recorded by the literature but nowadays disappeared.



***3D view of the DEM of the Barcelona surroundings (Z slightly exaggerated).***



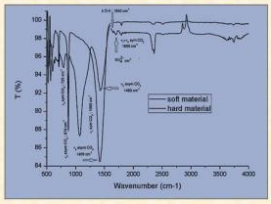
***Channel network calculated over the DEM , superposed on the Roman city perimeter.***



***Detail of the inside of the Basarabi churches (left), and degraded chalk sample under SEM (right)***

The rock complex from **Basarabi**, excavated in chalk deposits, is in an extremely critical condition. The geological studies are being considered as an important part of a project of evaluation, control and limitation of the process of degradation of the monument. First, a characterization of the area from the geomorphological and, especially, hydrogeological point of view was undertaken, thanks to the use of previous coring surveys conducted by commercial companies, as well as new specifically oriented boreholes and geophysical surveys (gravimetric and "vertical electric sounding" methods).
Secondly, the humidity effects on the walls of the monument have been assessed by using different analytical techniques: "Fourier-transform infrared spectroscopy" (FTIR), optical and *scanning electron microscope* (OM, SEM), freeze-thaw.
Currently, the influence of Fântânița Lake water composition situated very close to the church is discussed, pointing out the salts migration from the lake to the church walls.

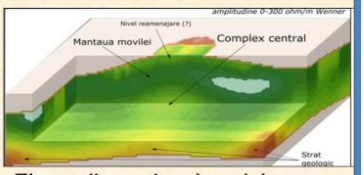
***Tropaeum Traiani, Adamclisi***



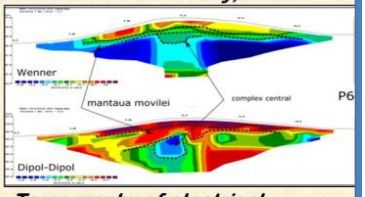

***FTIR : Calcium sulphates as indicator of degradation***

At **Adamclisi** (ancient *Civitas Tropaensium*), geoarchaeology techniques were used to assess the state of preservation and the risk of degradation of the "*Tropaeum Traiani*" monument. On the one hand, the biochemical characteristics of the surrounding soil have been monitored, for a few months, to approximate the predisposition of the soil to the uncontrolled growth of vegetation: the results indicate, in effect, that it is a soil favourable to the proliferation of plant species. On the other hand, a couple of techniques have been carried out on the monument itself to assess its state of conservation. "Epifluorescence microscopy" has highlighted the morphology of the species of lichens on the limestone surfaces, while "Fourier-transform infrared spectroscopy" (FTIR) helped to monitoring the presence of calcium sulphate, that is a major factor of degradation.

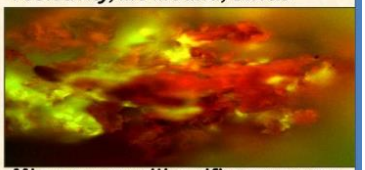
In the Goat Hill Site of **Lower Silvas**, a Bronze age tumular necropolis, the geoarchaeological approach was carried with traditional geophysical methods. Over one barrow (M3) of the ten mounds spotted across the territory, magnetic and resistivity surveys have been carried on. In this case, the interest of the research lies in having carried out a subsequent archaeological verification of the anomalies found; this way, the results can provide clues to the application of geophysical techniques in similar contexts. Geomagnetic measurements and electrical resistivity tomography revealed several anomalies, suggested a stratigraphic sequence and allowed the delimitation between the anthropic levels and the underlying geological layers. The results of the partial excavation of the mound shown a notable degree of coincidence with the hypothesis suggested by geophysics.




***Three-dimensional model of electrical resistivity, Silvas***

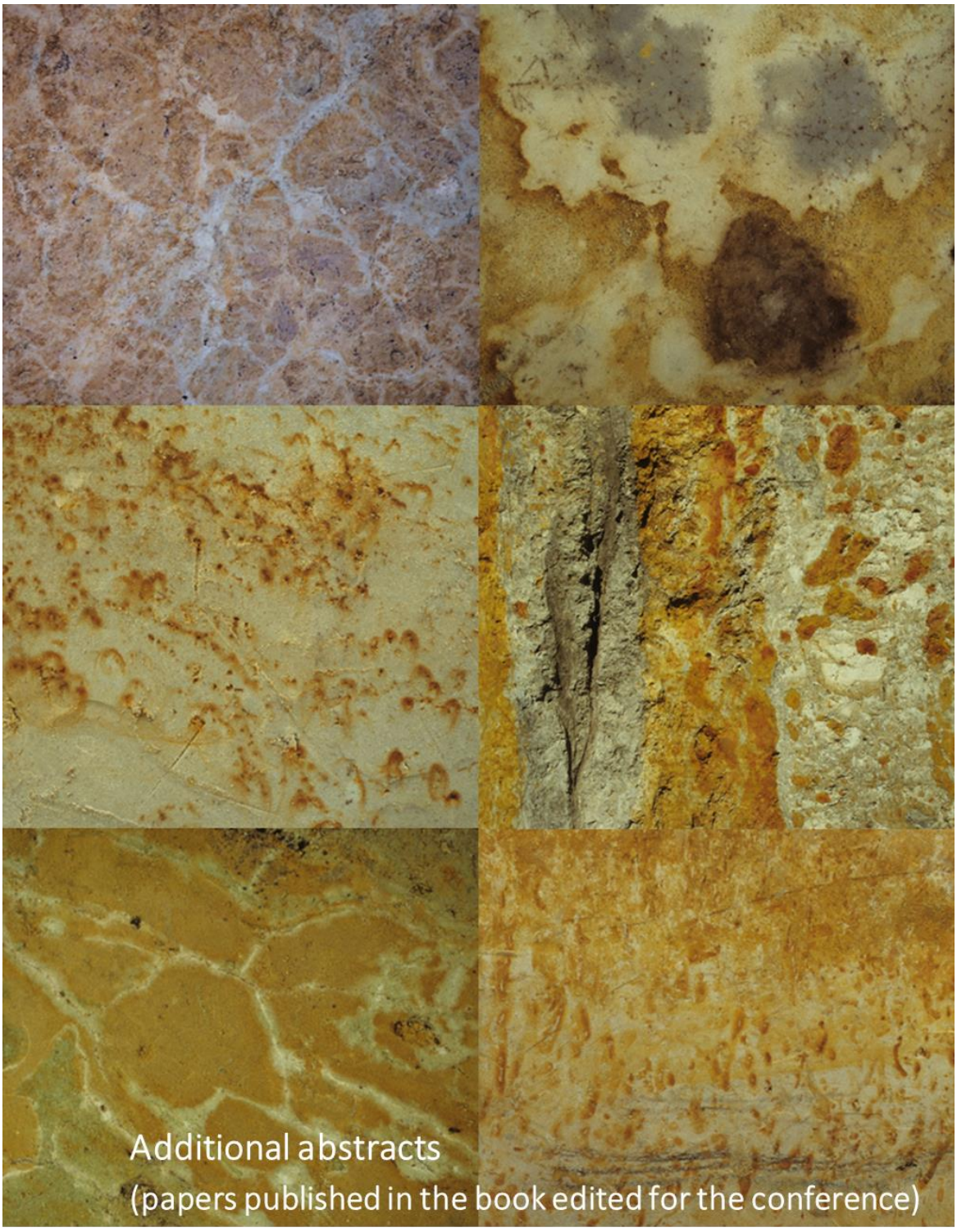



***Tomography of electrical resistivity, M3 Mound, Silvas***



**Microscopy with epifluorescence**
***Hyphae attacking , Adamclisi***

This work was supported by a grant of the Romanian Ministery of Research and Innovation, CCCDI – UEFISCDI, project code PN-III-P1-1.2-PCCDI-2017-0476/Nr.51-PCCDI/2018, within PNCDI III, ACRONIM: ARHEOCONS




Photos: Roger Langohr

## The evolution and medieval re-use of a prehistoric barrow at Wielsbeke (West Flanders, Belgium)

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During archaeological research in the sandy loamy region of north-western Belgium in 2015, a prehistorical burial mound was uncovered. Based on detailed macro and meso soilscape analyses, the archaeological excavation data, and a soil micromorphological study, we were able to reconstruct the life cycle of this barrow. After its initial erection in the Bronze Age, the barrow was restored during the Iron Age. A cremation burial was added to the burial mound in the late Iron Age. Roman pottery finds from the ditch filling illustrate that the barrow was still present in the landscape at the time of founding of a late Iron Age to Roman Age settlement in the direct vicinity of the barrow. Finally, in the High Middle Ages, a new and larger mound was erected superimposing the original barrow.

Keywords: Prehistory, Iron Age, Middle Ages, burial mound, soil micromorphology

## Bioturbation and the formation of latent stratigraphies on prehistoric sites: two case-studies from the Belgian-Dutch coversand area

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*"Soil is not a static body; it is a dynamic, open system, in which a variety of processes may act to move not only soil matter, but objects (including artifacts), from one position to another. It must therefore be included as one of the major natural features we must contend with in interpreting the archaeological record."* (Wood and Johnson, 1978, p. 316)

This paper discusses the vertical distribution of artefacts of two Mesolithic-Neolithic sites within the sand belt of Belgium and the southern Netherlands. Contrary to prevailing theories claiming that sites from these archaeological stages are generally no more than mixed surface sites, the present study demonstrates the existence of a latent stratigraphy, which can be traced in the vertical distribution of the different categories of archaeological finds (lithic artefacts, pottery sherds, carbonized plant remains, calcined bones). Furthermore it is suggested that the formation of these latent stratigraphies is due to long-term faunalturbation occurring in non-podzolic soils.

**Keywords**: sand belt, vertical migration, faunalturbation, prehistory, latent stratigraphy, podzol soil

## Settlement of the first farmers in the Belgian loess belt. The edaphic factor

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The first farmers to settle in the Belgian loess belt belong to the Linearbandkeramik Culture (LBK), formerly Danubian Culture, and the Blicquy/Villeneuve-Saint-Germain group. As elsewhere in Europe, these populations preferred settling on loess soils. We can distinguish three patterns when they reached Belgium. Firstly, they settled only at the southern and eastern fringe of the loess belt. Secondly, the village occupations lasted only about one generation (some 25 years). Thirdly ,after 2 to 3 centuries the occupation ends, leaving a hiatus before the next period of settlements. Several hypotheses are proposed to explain this particular behaviour, such as a research hiatus, contact with the hunter-gatherers that lived in the area, and heredity rules. In this paper attention is paid to the impact of the edaphic factor, an essential element besides climate when it comes to crop production. From archaeopedological research on LBK sites, it appears that the soilscape in this European Atlantic biogeographical area was similar to the soils that occur today in the 50 km2 tall Sonian Forest. Exceptionally, this area situated in the middle of the Belgian loess belt, has never been cleared for agricultural purposes and the soils have very low chemical and physical fertility. This status provides a plausible explanation for the particular behaviour of the first farmers reaching the Belgian loess belt. Simple shifting cultivation, as practised in the equatorial forest, was not sustainable in this temperate climate and therefore whole villages would have to move. Obviously, the workload for these Neolithic farmers was too severe and they abandoned the further colonisation of the Atlantic loess belt.

**Keywords**: LBK farmers, loess, Belgium, soil fertility, crop production, Sonian Forest, shifting village

## L'écobuage, une pratique agricole méconnue des archéologues. L'apport de l'étude archéopédologique du sol écobué de Transinne (Belgique)

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Les feux de végétation naturels ou anthropiques produisent des écofacts qui peuvent perdurer à l'échelle plurimillénaire dans les sols et les sédiments. Les charbons de bois micro- et macroscopiques sont ainsi employés comme marqueur paléoécologique (pédoanthracologie) ou dans l'étude de l'histoire des feux (charbons sédimentaires). La question de la détermination de l'origine, naturelle (climatique) ou anthropique (agropastorale, accidentelle), reste toutefois délicate à l'échelle de chacun des événements des paléo-feux. Parallèlement, la découverte de résidus de combustion, dans des horizons de sols anciens ou le comblement de dépressions naturelles (chablis) est souvent expliquée par les archéologues comme le fait de brûlis anthropiques du couvert forestier ou de feux affectant les souches des arbres. Toutefois, les hypothèses favorisées dans les interprétations archéologiques, concordent peu avec les pratiques de feux agricoles présentes dans la documentation historique des agronomes. De plus, certaines techniques qui possédaient une relative importance à l'époque Moderne ne sont quasiment jamais mentionnées. C'est notamment le cas de l'écobuage, qui au sens classique, fait référence à une technique de préparation du champ, qui procède par une extraction de la couche superficielle du sol, dont les mottes servent à la réalisation de fourneaux de combustion. Des résidus de combustion potentiellement liés à des feux anthropiques, signalés dans un horizon de sol par Roger Langohr et échantillonné avec lui par Kai Fechner, dans le contexte de la carrière de Transinne (Belgique), font l'objet d'une analyse micromorphologique, anthracologique, et de cuissons expérimentales contrôlées. Ces résultats sont interprétés en fonction des connaissances des processus de combustion des feux naturels et agricoles.

Mots-clés: écobuage, essartage, agriculture, incendie, rubéfaction, pédoanthracologie, spectrocolorimétrie

## The byre's tale farming nutrient-poor cover sands at the edge of the Roman Empire (NW-Belgium)

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Prior to the construction of a high-speed railway track (TGV) between Antwerp (Belgium) and the Dutch border, archaeological and geoarchaeological research was conducted at several archaeological sites. All are situated in the northern Campine, a region characterised by quartz-rich, nutrient-poor cover sands. On the site of Brecht-Zoegweg, two well preserved deepened byres ('potstallen') were uncovered in Roman stable-houses. Stables with sunken floors are commonly recorded on Roman-period farms in the sandy part of northern Belgium. Following medieval to sub-recent parallels in the area, they are considered to be features serving agricultural fertilising purposes through the intentional accumulation of dung and the creation of manure by mixing with added organic matter (sods or 'plaggen'). This archaeopedological research investigates several questions concerning the origin and the infill process of these remarkable features. Field observations, analytical and micromorphological data point to a gradual succession of events leading to a byre with a sunken floor, rather than an intentional digging out of the floor concomitant with the house construction and a post-occupational filling or levelling. It is furthermore suggested that plaggen fertilisation could indeed have been applied, at least in some of the phases of the byre use.

**Keywords**: byre, potstal, cover sands, Gallo-Roman period, northern Belgium, soil micromorphology, archaeopedology

## Use of the database of the subsoil in Flanders (DOV) in soil and archaeological research

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Soil data in Flanders are included in the DOV soil database available to all users. As such, the work done by soil surveyors and scientists is still very relevant today. This paper explains what kind of soil data are included in DOV and how they can be consulted. The aim of DOV is to become the reference for sharing data, knowledge and services, about the soil and subsoil of Flanders. It concerns open data, which can be integrated and linked to other data sources. In addition to raw data, DOV offers professional knowledge and interpreted information, as well as the services and applications to activate and mobilize these data.

**Keywords**: soil, soil data, database, DOV, soil profile, soil map, soil heritage, photographs, erosion, soil organic carbon content, landslides, archaeological research

## Archaeology and soil science in Flanders

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This paper presents some of the personal reflections of an archaeologist who studied soil sciences at Ghent University in the 1980s. The paper focuses on how soil science, amongst other sciences, gradually found its place in archaeological practice in Flanders, in part thanks to opportunities and activities at Ghent University between 1984 and 2005. Nowadays, the curricula/ educational programmes of the universities in Flanders do not at all stimulate the interaction between soil sciences and archaeology. This feels like a setback, back to the pre-1984 era, which is unfortunate, as earth scientists familiar with archaeology are needed more than ever for archaeological fieldwork in 21st century Flanders.

**Keywords**: soil science, archaeology, educational programmes, 1963-2019, personal reflections, code of good practice.

# A distinct pedogenetic path under a Mediterranean climate, the case of soils on Areny sandstone formation (Tremp basin, NE Iberian Peninsula)

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The Areny Formation is an Upper Cretaceous sandstone outcropping in the South Pre-Pyrenean area. It is composed of well-sorted quartz sand and gravel, cemented by calcite. It outcrops at a wide range of altitudes (400 to 1700 m). Soils developed on this formation in the Tremp basin (NE Iberian Peninsula) have xeric/ustic and mesic soil climate regimes. They display several soil characteristics corresponding to advanced stages of pedogenesis such as decarbonation, clay formation, and illuviation and rubefaction, ranging from Cambisols and Luvisols to Lixisols. These pedofeatures are absent in adjacent soil units of similar age, developed on finer materials, such as marls and calcareous conglomerates, where the dominant soil formation processes are carbonate translocation and weak cementation. These neighbouring soils are mainly Calcisols, some of them with a petrocalcic horizon. Six profiles formed on the Areny sandstone were selected for an in-depth study of their soil formation processes. A multi-scale approach, from geomorphological to micromorphological analyses, was employed. The soils have a neutral to slightly acidic reaction in the Bt horizons, with loamy sand textures and a clay content of 10 % that appears completely as illuviated clay in the thin section; reddish hues (2,5YR) and high chromas, the absence of calcite in the upper horizons or in the whole profile, and the presence of iron pans in some locations. Amorphous iron is found in low amounts compared to Fe in silicates and as finely crystalline forms. The latter increases with depth in the decarbonated profiles. The high weathering degree of the oldest profiles is shown by kaolinite being the dominant clay, which was probably inherited from the pre-Quaternary period. The clay fraction also contains remarkable amounts of mixed layers chlorite/smectite, chlorite/vermiculite or illite/smectite, which may be considered products of present-day pedogenesis. The geomorphological analyses allowed us to determine the ages of the surface formations of four of the profiles (50 to more than 350 ky), which indicated much faster soil formation rates than those reported in similar Mediterranean environments. Thus, the proposed stages of soil evolution in these sediments imply a fast decarbonation, followed by clay formation, and illuviation. These processes have strong implications in establishing the soil-landscape relationships in the area.

Keywords: carbonate, decalcification, rubefaction, clay illuviation, clay formation, Catalonia

## Micromorphologie des constructions en terre et convergence de faciès. Le cas du site des Genêts à Ablis (Yvelines, France)

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La fouille préventive d'un site ayant initialement livré des restes de constructions en terre néolithiques, dans l'extrémité nord de la Beauce, nous a fourni l'occasion d'étudier plus précisément son contexte stratigraphique (micromorphologie, granulométrie, datation OSL). Les résultats montrent que ces restes ont en réalité été confondus avec des organisations naturelles. L'évolution du sol et la bioturbation sont en effet à l'origine de nombreux faciès qui, aux échelles microscopiques, peuvent imiter ceux produits par un travail de la terre. Cette convergence entre faciès naturels et faciès anthropiques constitue un terrain d'étude encore peu exploré dans la reconnaissance des témoins architecturaux en terre crue. L'élaboration plus systématique d'un référentiel de traits naturels (à partir de lames issues du substrat des sites) et anthropiques (à partir d'éléments façonnés avérés) apparaît nécessaire afin de limiter les biais d'interprétation.

Mots-clés : constructions en terre, Néolithique, Bassin parisien, micromorphologie, équifinalité

## Curbing the tide. The discovery of a Roman terp along the Heistlaan in Ramskapelle (Knokke-Heist)

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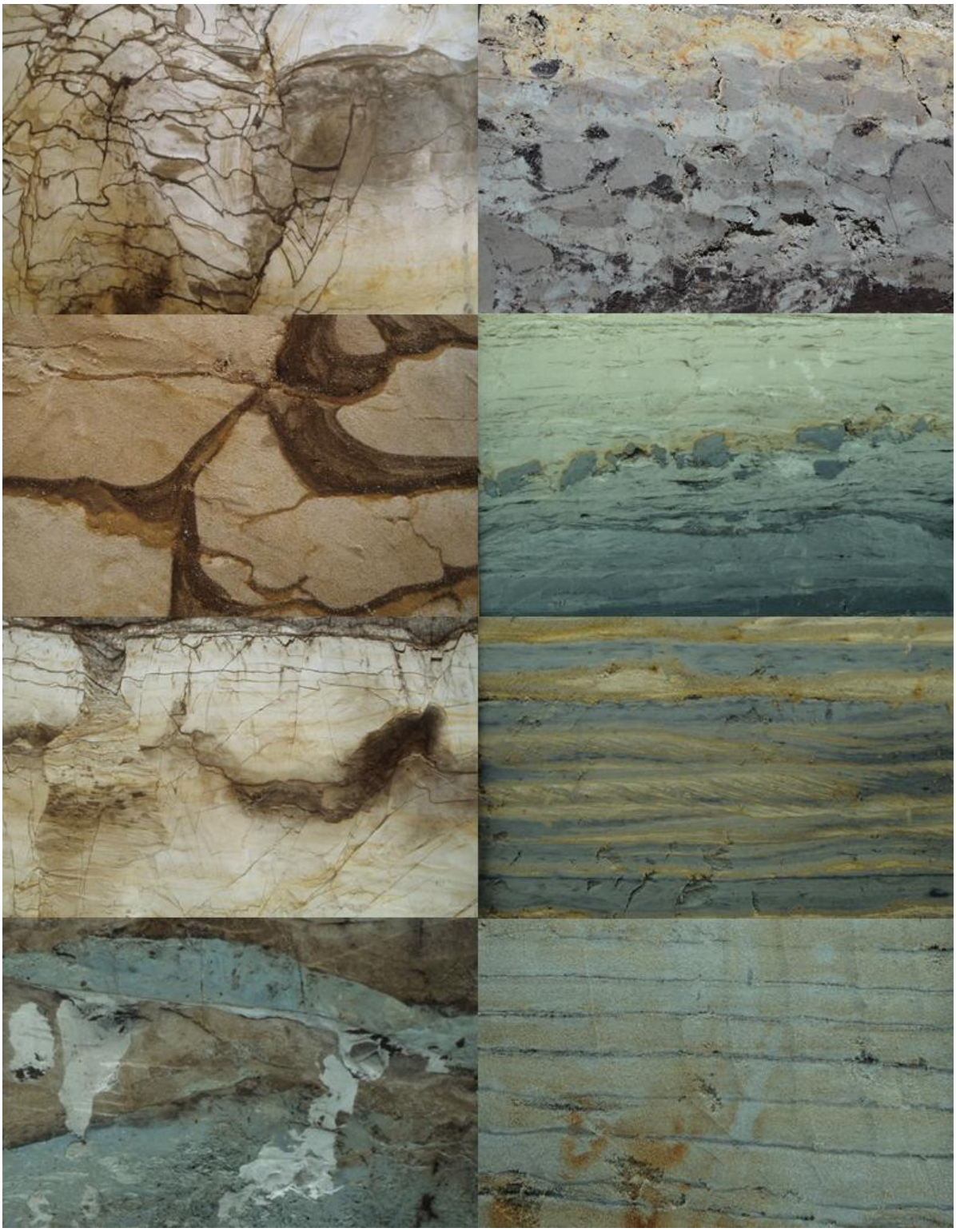
Archaeologists have long struggled trying to understand the nature of the Roman-period occupation of the coastal plain of Flanders. From the start of the 21st century, following academic and development-led projects, knowledge on the nature of the Roman occupation in the coastal plain has gradually been expanding. To assess the possible destruction of archaeological remains in the area along the A11-highway connection between Damme, Knokke-Heist, and Bruges, a different methodology was implemented. This resulted in the discovery of a 2nd to 3rd century AD site along the Heistlaan in Ramskapelle (Knokke-Heist). Based on geo-archaeological and sedimentological observations, coupled with micromorphological data, the site is interpreted as an artificial dwelling mound or terp. This discovery is a significant step in understanding the impact of human activities on the landscape in the coastal plain. The results help reinterpret older excavation data and aid future research projects.

**Keywords**: Roman archaeology, coastal plain of Flanders, terp, soil science, micromorphology



Photos: Roger Langohr