ANTHROPEDOGENIC CYCLES IN A CHRONOSEQUENCE FROM THE BRONZE AGE TO RENAISSANCE PERIOD (BOLOGNA, ITALY)

CYCLES ANTHROPEDOGÉNIQUES DANS UNE CHRONOSÉQUENCE DE L'ÂGE DU BRONZE A LA RENAISSANCE (BOLOGNA, ITALIE)

CICLI ANTROPEDOGENICI IN UNA CRONOSEQUENZA DALL'ETÀ DEL BRONZO AD EPOCA RINASCIMENTALE (BOLOGNA, ITALIA)

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Abstract

In a building site located near the historic centre of the city of Bologna (Italy), archaeological and geopedological studies supplemented by chemical and physical analyses of the soil made it possible to identify 17 pedogenic cycles. These cycles, distributed in a continuous chronosequence from Reinassance period back to the Bronze Age, show a persistent anthropogenic presence as demonstrated by the different distributions of P_2O_5 and $CaCO_3$, by the concentrations of some elements (Cu, Pb, Sn) and by the presence of fragments of charcoal, brick and ceramics, which overall reach the highest values during the Iron Age (Etruscan and Villanovan). According to the WRB taxonomic system, the soil units of the pedogenetic cycles belong to the groups of Anthrosols, Cambisols and Technosols.
Keywords: *anthropogenic cycles; multi-analysis; WRB; anthrosols; technosols*

Résumé

En concomitance avec l'aménagement d'un important chantier archéologique destiné à la connaissance de la colonisation de l'ancienne cité de Bologne à l'époque étrusque, a été effectuée dans le même site une étude pédologique et stratigraphique avec le but de mettre en évidence la présence humaine aux diverses époques sur une période d'environ trois mille ans à partir de l'âge du bronze. L'examen de facteurs physiques du sol ceux-ci associés à la multi-analyse, a permis de reconstruire une séquence évolutive dans laquelle ont pu être reconnues 17 unités de sol. La concentration significative en Cu, Pg et Sn des sols des périodes Etrusque et Villanovienne ont confirmé l'activité artisanale de ces populations de l'âge du fer. D'après le système WRB, les unités de sols entrent dans trois principaux groupes taxonomiques (Anthrosols, Cambisols et Technosols).
Mots-clés: *cycles anthropedogéniques; multi-analyse; WRB; anthrosols;technosols*

Riassunto

In un cantiere ubicato in prossimità del centro storico della città di Bologna (Italia) gli studi archeologici e geopedologici integrati dalle analisi chimiche e fisiche dei
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suoli hanno permesso di evidenziare 17 cicli pedogenici. I cicli, distribuiti in cronosequenza continua dal periodo rinascimentale all'età del bronzo hanno mostrato una persistente frequentazione antropica come evidenziato dalla diversa distribuzione di P_2O_5 e $CaCO_3$, dalle concentrazioni di alcuni elementi (Cu, Pb, Sn) e dalla presenza di frammenti di carbone, laterizi e ceramiche, che raggiungono nel loro complesso i massimi valori durante l'età del ferro (Etruscan and Villanovan). Le unità di suolo dei cicli pedogenetici rientrano, secondo il sistema tassonomico della WRB, nei gruppi degli Anthrosols, Cambisols e Technosols.
Parole chiave: *cicli antropedogenici; multi-analisi; WRB; anthrosols; technosols*

Introduction

Soil chemical analysis applied to archaelogical sites is increased using a wide variety of macro and trace elements (Homsey and Capo, 2006; Guttman et al., 2008). Multi-element soil characterization allows archaeologists the identification of anthropogenic activities (Wilson et al., 2008). The aim of the study was to identify the pedogenetic cycles that characterised the soils of the different archaeological periods from late Medieval times to the Bronze Age in an important archaeological site in the city of Bologna. The chemical and physical analyses were used to define the anthropogenic characterisations of the epipedons in the chronosequence according to the World Reference Base for Soil Resources (IUSS, 2007). In particular, attention was focussed on the concentrations of absorbable phosphates and heavy metals (Cu, Pb and Sn) for the characterisation of the anrthropogenic horizons.

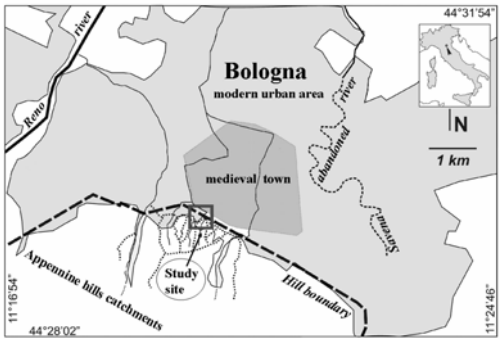
Materials and methods

Site description and soil sampling. The archaeological site in question, situated immediately outside the ancient medieval city walls of the city of Bologna, in Viale Aldini (Fig. 1), is located on an alluvial fan, consisting of sandy-muddy deposits, the result of erosion by ditches and streams of the Pleistocene formations (yellow sands of Imola) which characterise the lithology of the immediate inland foothills (Amorosi et al., 1998).. The viale Aldini excavation, carried out in 2008 by the Soprintendenza per i Beni Archeologici dell'Emilia Romagna, extends over an area of 340 m2 to a depth of around 4.50 m below street level, in contact with important findings from the Etruscan age. Subsequent continuous drilling made it possible to reach a depth of 8.20 m below street level and to extract soil samples at various depths. The soil profile of the northern main trench-wall were described according to methodological Soil WRB criteria (FAO, 2006). Bulk soil samples were collected on thench walls along the column on the northern wall and in hand-borehole cores.

Chemical and physical analysis. Soil samples were air died at room temperature, and then sieved by means of a 2-mm sieve and finally ground in an agate mill. Physicochemical characterisation was carried out according to the Italian official methods of analysis (MIPAF, 2000): texture, using a wet sieving and sedimentation

method); total carbonate was determined to volumetric method; total organic C was determined by wet oxidation with potassium dichromate at 160°C according to Springer and Klee (1954); reaction (pH in H_2O – 1:2.5 w:v) was determined by a potentiometer. The Cu, P, Pb, Sn, Cu concentration was determined by ICP-OES (Spectro Ciros^{CCD}): approximately 0.25 g of dried samples of soil were treated with aqua regia (6 mL HCl Plus 3 mL HNO3 37 and 65% Suprapur respectively); the mineralizations were carried out in Teflon bombs in a microwave oven Milestone, 1200. The analysis of 14C dating was oerformed at the CEDAD lab – University of Lecce with AMS technique.

Figure 1 – *Geographical location of archaeological site and northern wall trench sight*



Results and discussion

Figure 2 shows the various pedogenic cycles in spatial-temporal sequence. In particular, 17 pedogenetic cycles can be identified and are classified as Terric Anthrosols (PCs 2, 3, 4 5, 6, 7, 8 ,9, 16, 17), Tecnic Anthrosols (PC 11), Urbic Technosols (PCs 10, 12), and Terric Cambisols according to WRB indications (IUSS, 2007). Figure 3 shows the characteristics of the epipedons with different degrees of anthropisation. The absorbable phosphorus is higher than 1.5 g/kg (expressed as P_2O_5), and all the horizons can thus be considered anthropogenic. The varying volumes of fragments of brick, ceramics and charcoal show that there was a prevalence of non-agricultural activities over the various historic periods. In particular, the most recent pedogenetic cycles of the Roman and Medieval periods present a lower concentration of phosphates and fragments, indicating less anthropogenic presence at the site. A high level of human presence, connected also to craft activities, is linked to the Villanovan-Etruscan period in which an increase in the values of phosphorus concentrations can be noted. PCs 10, 11 and 12, corresponding to the Etruscan-Villanovan period, differ from the others for the significant concentrations of heavy metals such as: Cu, Pb and Sn, which can be attributed to metal-working activities.

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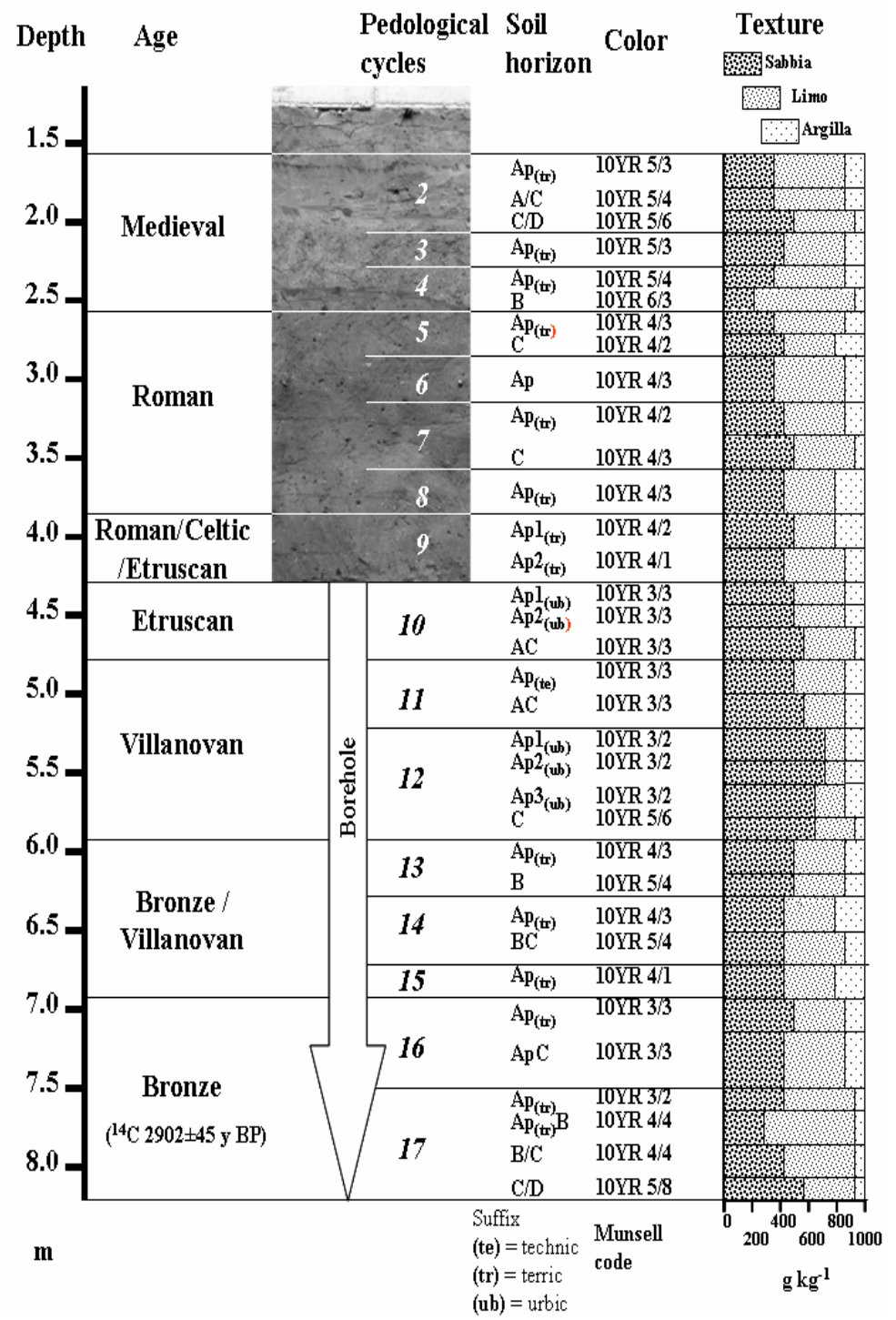
Depth
Age
Pedological cycles
Soil horizon
Color
Texture
Sabbia
Limo
Argilla
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
m
Medieval
Roman
Roman/Celtic /Etruscan
Etruscan
Villanovan
Bronze / Villanovan
Bronze
(14C 2902±45 y BP)
Borehole
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Ap(tr) 10YR 5/3
A/C 10YR 5/4
C/D 10YR 5/6
Ap(tr) 10YR 5/3
Ap(tr) 10YR 5/4
B 10YR 6/3
Ap(tr) 10YR 4/3
C 10YR 4/2
Ap 10YR 4/3
Ap(tr) 10YR 4/2
C 10YR 4/3
Ap(tr) 10YR 4/3
Ap1(tr) 10YR 4/2
Ap2(tr) 10YR 4/1
Ap1(ub) 10YR 3/3
Ap2(ub) 10YR 3/3
AC 10YR 3/3
Ap(te) 10YR 3/3
AC 10YR 3/3
Ap1(ub) 10YR 3/2
Ap2(ub) 10YR 3/2
Ap3(ub) 10YR 3/2
C 10YR 5/6
Ap(tr) 10YR 4/3
B 10YR 5/4
Ap(tr) 10YR 4/3
BC 10YR 5/4
Ap(tr) 10YR 4/1
Ap(tr) 10YR 3/3
ApC 10YR 3/3
Ap(tr) 10YR 3/2
Ap(tr)B 10YR 4/4
B/C 10YR 4/4
C/D 10YR 5/8
Suffix
(te) = technic
(tr) = terric
(ub) = urbic
Munsell code
0
200
400
600
800
1000
g kg-1

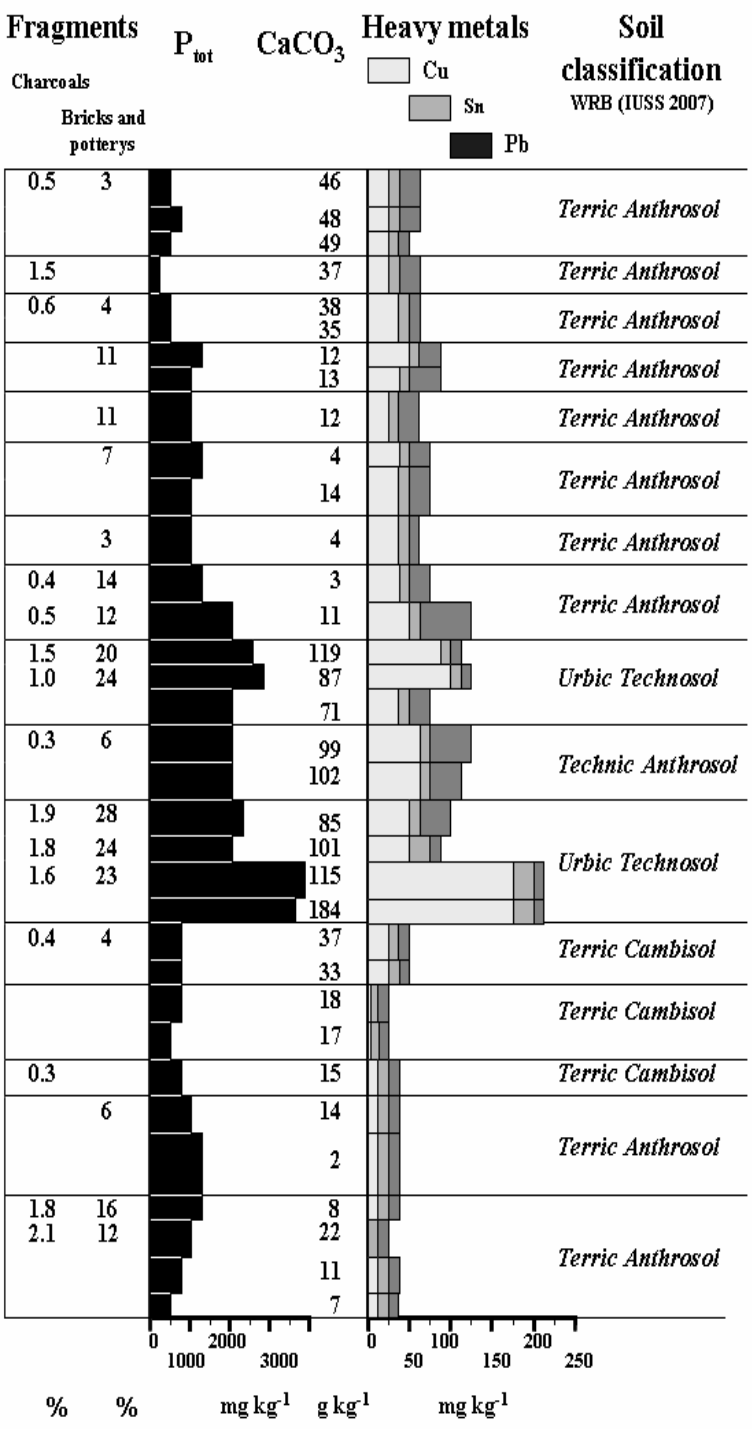

Figura 2

Reference chrono-stratigraphic column from the top soil to 820 cm depth with pedological cycles and physical - chemical properties of the soil horizons.

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The increasing concentration of the sandy component and of the carbonates in addition to the high content of fragments of brick and ceramics highlight the prevalence of non-agricultural craft-type activities such as metal smelting and the production of artefacts.

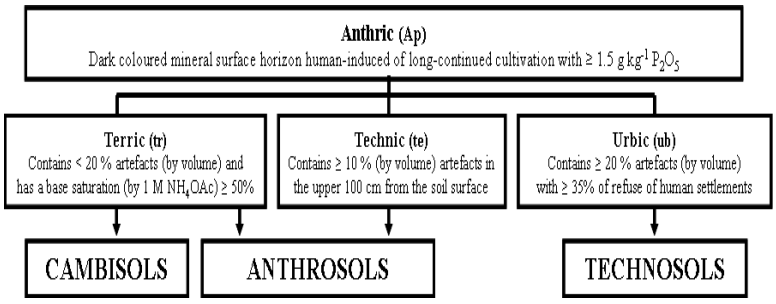

Figure 3

Classification of the Ap horizons based on the diagnostic characteristics and properties according to the WRB (IUSS, 2007)

Conclusions

The integrated study of the diagnostic physical and chemical characteristics relative to each pedogenetic cycle could be significantly applied in taxonomic terms based on the classification criteria proposed by the World Reference Base for Soil Resources (IUSS, 2007) relative to soils affected by anthropogenic action. This contributes to a better understanding of the type of human activities in the different archaeological periods.

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