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Preliminary geomorphological and stratigraphic settings of a large Roman-age village near Maccaretolo (low alluvial plain between Bologna and Ferrara, Italy).

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ABSTRACT. — At Maccaretolo, near San Pietro in Casale, 27 km north of Bologna, a large Roman-age archaeological site covering more than 40,000 sqm is preserved at ground level on the inner part of a large geomorphic window displaying 3D features and photographic patterns related to a paleochannel of the river Reno. At depth, the site is definitely larger than at the ground level and more complex than previously thought. The Emilia-Romagna Regional Bureau for Archaeology (*Soprintendenza Archeologica*) surveyed the site for the first time in autumn 2000 by means of a 2-m wide trench system extending for a total length of 800 m, i.e. 1.6 km of exposed stratigraphic sections of varying heights.

The archaeological site was probably a *vicus*, i.e. the most important service centre in the southern Po River plain along the ancient regional roadway from Bologna to Padova. Its development began in the Roman Republican period (2nd century BC) near a river paleochannel; a second channel (the last to disappear) was 800 m further west. The village is multi-layered down to a depth of 1.75 m . The first structural level is characterised by a remarkable presence of Fe-slags, while the last one (5th-6th century AD) is contained inside present day plowed horizon, signalling the definitive end of the activity of the main river channel (3rd-5th century AD).

RIASSUNTO. — Nella frazione Maccaretolo di S.Pietro in Casale, 27 km a N di Bologna, una finestra geomorfica che mostra le unità morfologiche attinenti ad un paleoalveo del fiume Reno databile all'età romana conserva in affioramento un grande sito archeologico coevo esteso oltre 4 ettari. Il sito, che in profondità risulta certamente più ampio, complesso e problematico di qualsiasi preventiva lettura, è stato indagato per la prima volta in via preliminare dalla Soprintendenza Archeologica dell'Emilia-Romagna (SAER) tramite un sistema di grandi trincee (2 m di ampiezza) per uno sviluppo complessivo di 800 m lineari, pari a 1,6 km di sezioni esposte di varia altezza e complessità.

Il sito, polifunzionale, inquadrabile come vicus itinerario lungo l'asse stradale BO-PD, si sviluppa dall'età repubblicana romana (II sec. a.C.) presso un paleoalveo del fiume antico (ma circa 800 m ad W è presente un secondo ed ultimoalveo) ed è pluristratificato fino alla profondità di 1,75 m dal piano di campagna. Il livello strutturale d'impianto è contrassegnato da una massiccia presenza di residui siderurgici (scorie di Fe), mentre l'ultimo livello strutturale (V-VI sec d.C.), ampiamente rimaneggiato dalle pratiche agricole, sancisce la completa disattivazione del canale.

Dal punto di vista paleoambientale di primario interesse risulta la definizione della originale realtà paleoidraulica locale e della sua evoluzione, che si sviluppa verso il volgere dell'età classica (III-V sec. d.C.).

KEY WORDS: *geomorphology, stratigraphy, roman geoarchaeology, paleoclimate, Po plain.*

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INTRODUCTION

This study is the first preliminary report concerning a completely new campaign of stratigraphic soundings and explorations of a very large archaeological Roman site situated in the middle of the low alluvial plain between Bologna and the river Po.

This geographical area is the richest in terms of archaeological discoveries in the whole of the Bologna plain, providing evidence of several funerary monuments buried under a variously thick sedimentary layer, as deep as 3 m down (Minozzi, 1991). In particular, the Maccaretolo Archaeological Site (MAS) has hitherto been the only archaeological outcrop in this area, and is furthermore the largest, covering over 40.000 sqm. The site position had already been known of since 1984 and was registered as no. 37047 on the Emilia-Romagna regional «*Archaeological Landscape Map* – Sheet 203 NW». In 1999, it was surveyed a surficial square-grid archaeological detection, unpublished. In 1996, another unpublished special geoarchaeological survey was performed in the surrounding fields over a very large area, about 3 km in diameter (Parenti, 1997).

Lastly, in October-November 2000 (and up to February 2001), the Emilia-Romagna Regional Bureau for Archaeology (*Soprintendenza Archeologica*: hereinafter *SAER*) surveyed the site after reaching an agreement between the Bureau, the local city authorities and the owner of the land.

Technical operations consisted of creating a 2m-wide trench system up to 1-2 m deep (fig. 3) , 800 m long, exposing 4.000 sqm: 3.5% of these (140 sqm) were studied in detail. About 40 hand-corings (45 m in the intrasite and 32 m in the extrasite) were also made and compared with the previous 70 m soundings already available (Parenti, 1997). Each sounding was correlated with a national-reference benchmark (I.G.M.I. 38'/6) to express every single height in absolute terms (m. asl.).

The present study only covers geo-environmental aspects of the excavation, omitting purely archaeological ones, as stated by the SAER official.

GEOLOGICAL AND GEOMORPHOLOGICAL SETTINGS

The study area lies in the Appenninic perisutural basin of the Po plain, at the southern edge of the buried structural high known as the *Dorsale Ferrarese*. Today this basin is still subsiding at a 5-17 mm/y (Bondesan *et al.*, 1997): the natural component of this rate is about 1.2 mm/y (Carmanati and Di Doanto, 1999); the rest is mainly due to artificial water withdrawal. Here the thickness of the Holocene sediments is probably about 20 m (Cremonini, 1991) but it is probable that this fluvial sedimentation took place exclusively after the cold event of 8.200 years BP (Alley *et al.*, 1997), principally due to the terminal eustatic sea-level rise and to natural subsidence (Cremonini 2000; Amorosi *et al.*, 2000).

The MAS is situated on the right flank of the alluvial paleoridge of the river Reno (fig. 1), near the uppermost zone, close to the paleochannel belt. The ancient alluvial ridge developed regularly through pre-Roman and Roman times (fig. 2) through a series of lateral crevasse splay deposits, exemplified in Cremonini (1991) as fining-upward sequences ranging from sand to clay and characterized by high lateral variability. This development led to the genesis of immature alluvial soils partially similar to present day ones. Today, inceptisols (udifluventic ustochrepts) are developing at ground level on the highest reaches of the ridge, while vertic soils (ustic endoaquerts) are developing in the lowest areas (Regione Emilia-Romagna, 1999).

Although available aerial photographs are completely useless for a detailed analysis of the local landscape due to the total opacity of the sedimentary cover, two sets of photomarks seem to exist, relating to two different sinuous paleochannels: the most recent one is 300-900 m west of the older one. The MAS lies close to the older river channel.In addition, all along the right side of this channel, from the MAS 4 km northwards, the ground shows the most interesting local geomorphological features (fig. 3), i.e. a clear, regular field slope for more than 10 m/km, in comparison with the normal

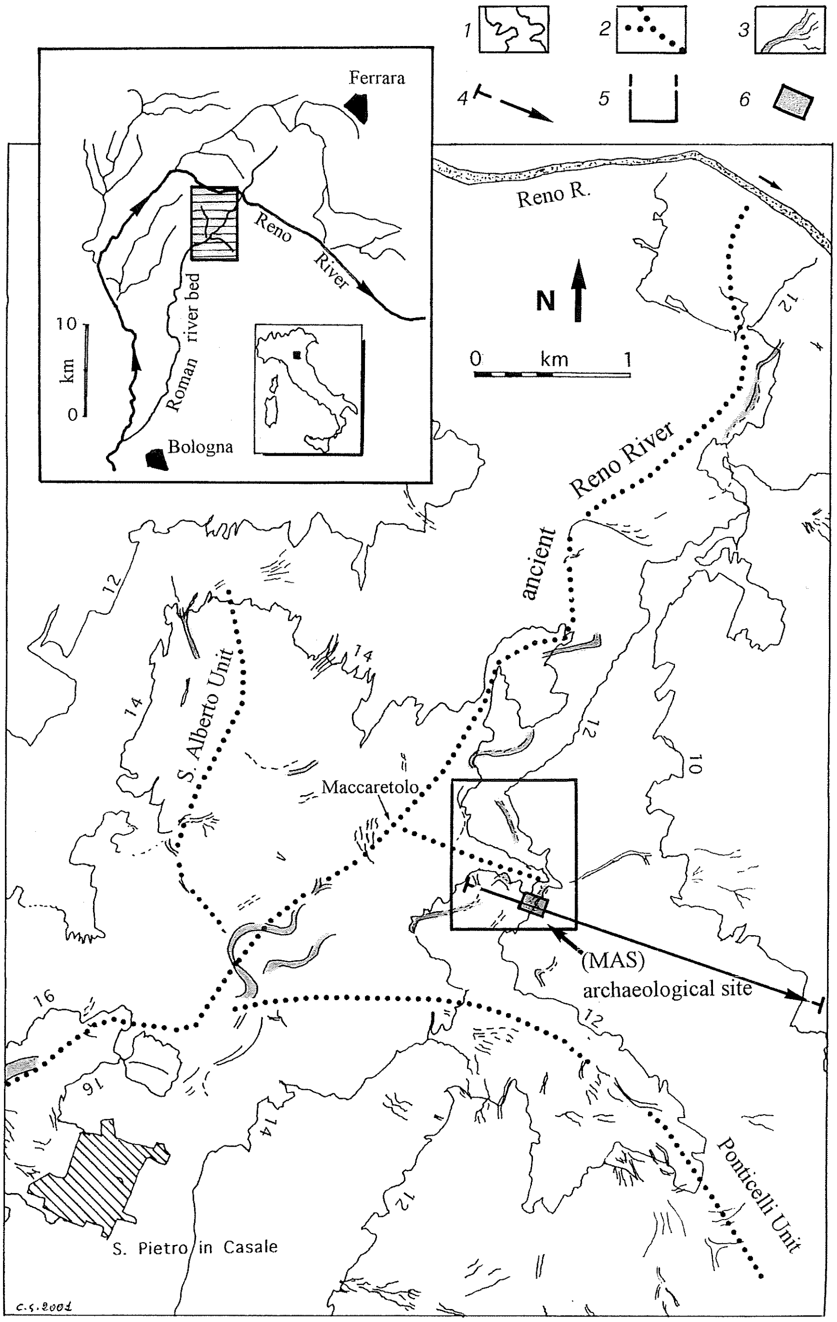

Fig. 1 – Paleohydraulic and geomorphological settings of Maccaretolo Archaeological Site (MAS). 1) Contour lines (2 m); 2) Morphological axis of ground (paleoriver belt highs); 3) Photomarks; 4) stratigraphic section of fig. 2; 5) Area of fig. 3A; 6) Area of Maccaretolo archaeological site (MAS).

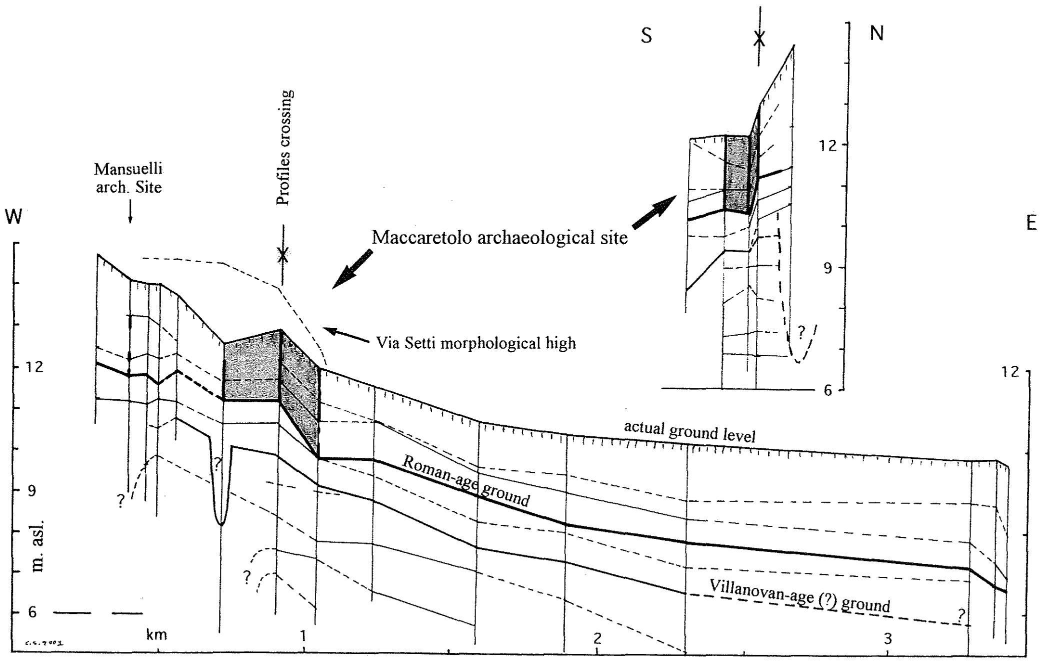

Fig. 2 – General stratigraphic sections of the MAS area: the two sections are mutually orthogonal. For location see fig. 1.

topographic gradient of about 0.5-2 m/km. This feature had already been interpreted as the remains of the fluvial hanging terrace of an ancient artificial embankment system (Cremonini, 1991). A small, straight, low morphological unit, 1 km long, linking the last paleochannel to the MAS area, is perhaps another artificial work, although until now detailed diagnostic evidence is still lacking.

All these ancient morphological features have perhaps been preserved due to a relative lack of natural sedimentation in the lower river bed branch in Roman times. There is in fact a special multi-avulsion knot 2 km upstream from the MAS, from which two very large crevasse systems (Sant'Alberto and Ponticelli Units) branch off respectively east and west.

In the Authors' opinion, based on archaeological evidences and chronological and paleoclimatic comparisons with various studies on regional paleoriver beds (e.g., Cremonini, 1991), the whole of the ancient river (from Bologna to the confluence with the river Po) ceased to exist as such between the 4th and 6th centuries AD. However new studies for careful revision of this topic are planned in the near future, to define the problem better.

The most important and clearest of the minor photomarks is a straight one, lying immediately NE of the MAS. It appears as a small crevasse channel 1600 m long: this paleohydraulic element directly involved the life of the MAS.

Also from a geomorphological standpoint, it should be stressed that the original ground level at the time of the village settlement was characterised by a slight counterslope from S to N (i.e., dipping south) by no more than 0.3 m; from W to E a normal slope is shown, in accordance with the transverse slope of the alluvial ridge. This may imply the existence of a sort of morphological «proto-high» all along

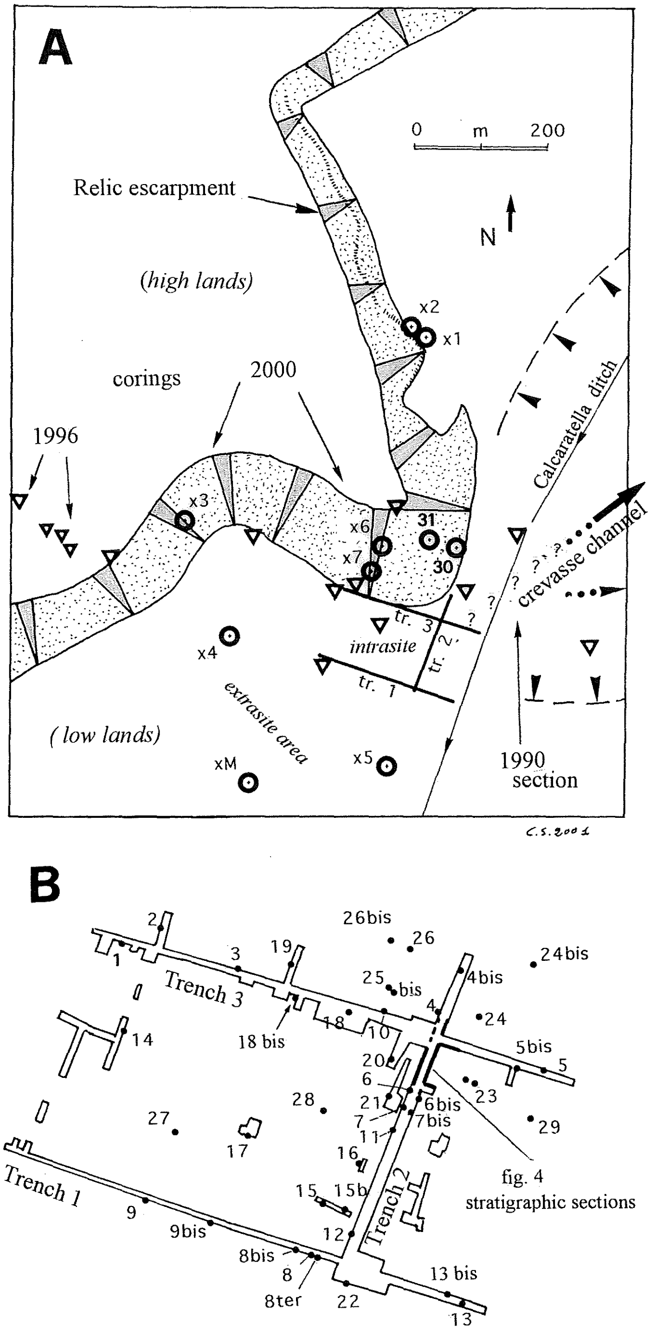

Fig. 3 – Detailed ground morphology of MAS area with trenches and corings settings. . For location of A see fig. 1. In A irregular, stippled strip (with big, narrow and empty triangles) indicates the boundary of high terrace (left) of the paleoriver up to height of 1,5-2 m high. B: trench system of the excavation simplified and redrawn in A (as tr.1, tr.2, tr.3).

the northern side of the village, to be identified as the natural levee development of a possible outer side meander-loop.

The large slope increasing in the present field ground, visible in the same position as the original proto-high, is more than 2m high and its top lies 3 m above the original one, perhaps proving that the last steep slope was artificial in origin.

STRATIGRAPHIC EVIDENCE AND PROBLEMS

Field observations on trench exposures were supplemented by various corings, because many of the original Roman settlement ground features (particularly the negative units) exhaust themselves well beneath the trench bottom and are often wider than the MAS itself. The same sections were repeatedly observed during five months of exposure in conditions of differing brightness and climate (e.g., temperature, dryness, etc.), in order to improve the overall interpretation and understanding of a complex of exposed sections that was far too large to be documented in great detail. The trench system consisted of three main units (each about 200 m long; see fig.3) and more than a dozen minor ones opening on to the intrasite area.

The anthropogenic lithosome of the MAS is 1.5-1.75 m thick (except for local depressions) and covers an area of about 40,000 sqm, for a total volume of at least 60,000 cum. Other buried archaeological structures or facies certainly exist outside the excavated area, towards W and NE, where structural continuity has not yet been ascertained.

Besides the 3D shape of layers surfaces (e.g. clinostratification, etc.), as a pragmatic guide to interpretation of archaeofacies, it was ascertained that the whole strata set of the building use/decay cycle (8 theoretical stratigraphic units make up one cycle, according to Carandini (1996): dressing, use, collapse, wood/charcoal/plaster fragments, decay, organic matter/waste disposal/dark-earth, structural levelling, spoliation) has a medium value of about 35-40 cm in thickness (corresponding to the case of mud-brick walls about 50 cm thick and 3 m high). At points, from three to five such strata sets may be defined: in S 1 twelve stratigraphic units are clustered in five sets; and in S 14 a street displays five running surfaces. The MAS area was also spatially planned and used in different ways: two preferentially structured (i.e., built-up) sub-areas (western and eastern sides) were separated by an «empty» one, apparently devoted to industrial production (brick kilns and furnaces).

An artificial peripheral ditch exists along the eastern side of the village, and at least two other agricoltural drainage ditches (fig. 5) were created, starting from the second structural phase: they all are directed S-N without any clear slope.

The MAS anthropogenic prism may be subdivided into 3 or 4 structural phases, some of which are separated by natural sediment additions. It is thus possible to distinguish a first structural level (R1), corresponding to the original settlement of the Roman village (Roman republican period : 2nd century BC); a complex phase II (R2) dating to the proto-imperial period, up to the 1st century AD; a third phase (R3: 2nd-3rd centuries AD) and a fourth phase (R4: up to the 5th century AD - or even longer ?) poorly preserved in the ploughed horizon. A sediment arrival probably exists (Sed. A) between R1 and R2, and at least another one (Sed. B) is recorded between R2 and R3 : but it is also quite feasible that Sed. B is the sum of several small depositional events, some of which fall inside R2. A third set of sedimentary episodes (thinner than A and B) lies above R3. Sediments A and B are probably of overbank type, but it is difficult to judge the kind of natural deposits, because they were seen episodically in small, deep areas along the trench-walls, repeatedly interrupted and rearranged by the anthropogenic facies and/or the intrinsic 3D geometry of the trench system.

As to be expected in a pseudo-urban site, true natural sedimentation is neither laterally continuous nor homogeneous in thickness due to: 1) variation in the original morphology of ground level of the site; 2) the various geometric relations between water flooding directions and buildings; 3) local removal of sediment and the use-floors reactivation. It is also often difficult to distinguish between thin, natural, newly deposited sediment layers and repeated, inter-layered facies sequences originating from rearranged collapse deposits due to decay of the mud-brick walls degradation.

At the present time, it is impossible to define a single percentage rate linking natural and anthropogenic sediments in the intrasite as a whole. The presence of natural sediment is evident in all the parts of the village, although single stratigraphic occurrences are not the same in different cases. Sand and sandy loam seem to have arrived early in the village area, both in trench 1 (S8 depression/channel) and on the eastern side (S 6 bis) of the village. Natural deposits also seem to be more frequently inter-layered with anthropogenic ones along the northern side of the village, i.e., near the possible right eastern river paleochannel.

Two objects are important as regards size : 1) a large channel-like feature in trench 1 (fig. 5: S 8 ter - 8 – 8 bis) up to 2,20 m in original depth (bottom now at 3,30m); 2) another sandy channel in trench 2, bigger than (1), about 15 m wide and at least 4 m in depth. The first one was already in existence when village settlement began, and was filled up in two different ways and times (first sandy loam, and then clayey loam: fig. 5). Its side slopes are so gentle that they resemble natural features and its sedimentary infilling is water laid and originated from a tractive current; so that although it is still impossible to determine its true expanse and direction, it was probably a natural paleofeature, relic of pre-Roman age.

The second object is larger than the first, and no direct relation exists with it. The integral cut of fig. 4 results from a low angle intersection

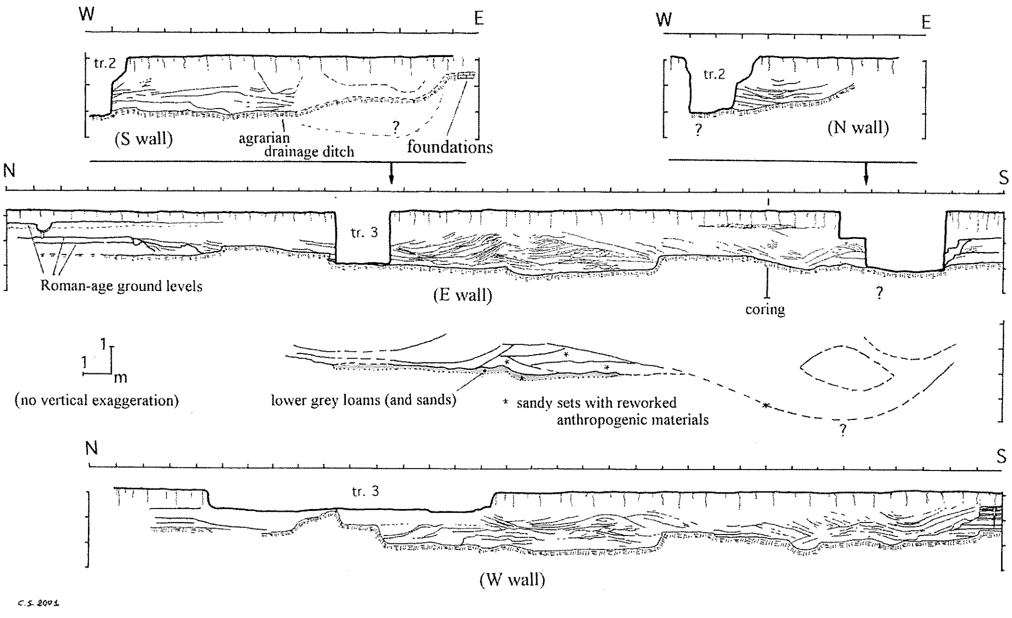

Fig. 4 – Stratigraphic sections of large sandy channel of trench 2.

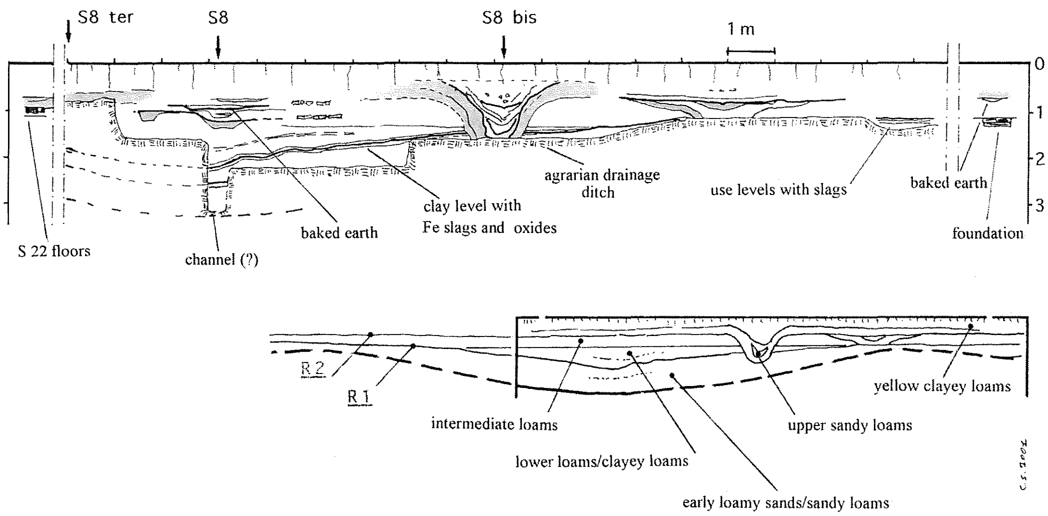

Fig. 5 – Stratigraphic section of S 8 channel-like feature in trench 1 (southern wall).

between channel and trench, so that interpretating the section is complicated to return. Here, a double sandy sequence appears. The lower half shows grey sandy loam (gleyed), rich at the bottom in anthropogenic remains (pottery and brick fragments), covered by sandy cross-bedded sets also rich in artificial materials. The upper half of the section displays yellow medium-grained sand, either without or poor in artifacts, organised in a large concave-upward stratification related to conspicuous channel aggradation. This structure belongs to a NE-running channel which perhaps exploited a pre-existing channel-like structure, because signs of flood sedimentation seem to be lacking outside the channel and no traces of highly destructive inrushes of water are recorded anywhere in the village. Although the direction of the section output flow is towards NE, input comes from the W, i.e., the centre of the village: this point will have to be verified in future excavations. Towards the end of the 3rd century AD the top of the channel deposits was reclaimed.

The nearby extrasite appears to be wide, difficult to explain in detail and to correlate with the core of the MAS. The anthropogenic body exhausts itself northwards between S X6 and S X7.

S X7 shows the last Roman baked-clay fragments at 2.2 m depth: these (when dated) will represent the *terminus post quem* for the appearance of the actual northern morphological high across Via Setti.

S 25/25 bis and S 26/26 bis were made to check a large, curved photomark. They show artificial materials interlayered with natural sediments downwards to the log, beginning from a level lower than that of the original Roman settlement.

S 30/31 is sterile, indicating the constitutive difference of the northern morphological high.

The far extrasite has not yet been well explored and will have to be studied.

Lastly, 2 m beneath the first Roman ground level, a archaeological pre-Roman hut settlement (V) was found, as large as the Roman village above it; and another pre-Roman (Ro) frequented ground level was detected at an intermediate level.

Untill now, the most reliable stratigraphic framework (a sort of geo-environmental Harris' matrix) is reported below in accordance with the natural stratigraphic order (1= oldest, 2= latest): bottom and top absolute elevations of the stratigraphic units (in meters above mean sea level) are labelled «**b**» and «**t**» respectively.

(Expanded) Stratigraphic Framework of Maccaretolo Archaeological Site

20) Loam and **high anthropogenic structures** inside Ap horizon (**R4**: 4th-5th cent. AD); t=ground lev.= + 12.40-12.60.
19) New **cleaning of** agricultural drainage **ditches** and undersized **reshaping**.
18) ***Sed. C***: a) **southern yellow loamy clays** (S 9 bis) from southern splays (?): t= + 11.90; b) trench 2 **northern sandy loam** (S4, S 4 bis, S 20).
17) Progressive **sedimentation inside embankment** river belt (S X3, Mansuelli site); **appearance** of **morphological high** of Via Setti.
16) **Cleaning of** agricultural drainage **ditches.**
15) **Local reclamation** of **top of the large sandy channel** in trench 2 by means of brick scraps (**R3**: 2nd-3rd cent. AD up to 260-270 AD); t= + 11.88-11.94.
14) **Appearance** of the large **sandy channel** of trench 2 (or paroxystic continuance?); t= + 12.00, b< + 8.96. ***Sed. B***: a)central and peripheral areas **upper yellow sandy loam**; b) «*ash house*» **sand and loam** (S 18 bis): t= + 11.57-12.27; c) **sand** (S 18); S1 second **loam** (?); d) southern agricultural drainage **ditches inside first sedimentation**.
13) Second **grey clayey loam** (S 5): local thin drapings.
12) «Charcoal-bearing **dark loam of kilns**» sedimentation in trench 2 andnearby; t= + 11.74-11.88.
11) Creation of the **southern agrarian drainage ditches**; b < +10.74.
10) Creation of **longitudinal embankment** of river (?).
9) **Restoration/adaptation of buildings** (**R2**: from time of Augustus to 1st cent. AD); t= +11.47/11.55 – 11.70/11.80: probably in S X7 R2 lies beneath morphological high of Via Setti.
8) ***Sed. A***: a) **intermediate loam** of S 8 (from southern splays ?); b) first **four stratigraphic units** in S 6 bis; c) first **loam/clayey loam** in S 1; t= + 11.49.
7) **Sedimentation** of lower, «***in channel***» **loam/clayey loam** of S 8 (t= + 11.14); b) first sedimentation of **extrasite clayey loams** (S5, S13): t= +10.92.
6) Sedimentation of early, syn-settling, «***in channel***» **loamy sand and sandy loam** of S 8; t= + 10.19; b= + 9.04.
5) **Frequenting and structuring** of the ground of Roman settlement (**R1**: 2nd cent. BC): t= + 10.85 – 11.20; b) S 10 first **lower sand** (large sandy pocket).
4) Second **crevasse splay sedimentary event** (with channel-type relic top paleomorphologies ?): b= + 9.04.
3) **Frequenting** of pre-Roman ground level **Ro** (= early Roman or Villanovan/Etruscan ?) in S 5, S 13, (S 27), X 4, X 5, X M, 16/3; t= + 9.87 – 10.17.
2) First **crevasse splay sedimentary event**.
1) **Frequenting (and structuring)** of Villanovan (?) settlement ground **V** (locally missing, due to small erosional facts or artificial features) in S 5, S 9, S 13 bis, S 24 bis, X 5, (X M), (17/6 ?), *Depuratore* site.

This framework must be verified during future excavations, especially as regards the artificial embankment of the river (point 10).

Discussion

From a purely archaeological perspective, the most interesting question regarding the MAS is certainly the discovery of two pre-classical settling phases, one of which probably occurred in the *First Iron age* (Villanovan); the second one has yet to be dated. The importance of this observation consists of the locally vertical persistence (overlap) of the human settlement over a period of about 1,500 years: this astonishing fact probably goes beyond the bounds of casuality and stresses the value of the area as *central locality* in the plain, probably situated along an important axis of ancient communications. But the site is also very important as regards the true Roman period, since this is the first time that such a large, well-preserved village, with a clearcut productive character, can be studied in the Emilia region.

From a paleo-environmental standpoint, the areas surrounding the MAS were surely reclaimed during the Roman age (*centuriatio*), as proved by various archaeological evidence (Minozzi, 1991; Bottazzi, 1991). Analysis of palynological and geochemical Fe-slags already begun, will attempt to identify for the first time the real ancient human impact on the local «natural» environment.

A second set of open basic questions consists of attributing correct values to the large series of data coming from the core stratigraphy of the village in relation to the evolution of the paleofluvial reach.

The repeated arrival of thin natural sediments in the village sequence raises the problem of whether an artificial river embankment really existed and, if so, whether it was effective. On the other hand, it is very hard to imagine an area as large as the Po plain, populated, cultivated and artificially structured (in terms of streets and artificial canals something stretching for perhaps 15.000/20.000 Km in total length in the Emilia-Romagna region alone), with no kind of primary hydraulic regimentation and protection such as river embankments. If they did not exist then we must presume that in roman times the rivers ran in very deep cuts in their mean ground level, but this is certainly not the case (Cremonini, 1991; Giorgi, 2000) as clearly shown in fig. 2. Exhaustive archaeological excavation of the ancient territory as a whole is required to certify this problem, not just study of the village area alone.

In other words, it is necessary to understand to what extent avilable data can provide reliable information about the two parallel river paleochannels (or only about the eastern one). Above all, it will be necessary to verify the significance of this double fluvial presence and/or its chronology. As an anabranch model for the Reno river is highly unlikely, is this pattern a completely natural fluvial response to something special, or were human constraints involved ?

Until now, we have found that the ancient Reno river as a whole showed a anomalous sedimentary behaviour at least from the late 2nd or the early 3rd century AD (Ortalli, 1991 a, b): since that period the summit of the alluvial ridge has grown by about 1.4-2 m. In the following 150 years, the *Aemilia* region suffered severe environmental impact (climatic?), almost always misunderstood and confused for or mixed up with the *latest «Paulus Diaconus' deluge»* (586 AD). In this time-span, for example, the loss of a direct interregional Roman road from Bologna to Padova (together with other details and proof which cannot be dealt with here) must be considered: the *Itinerarium Antonini* (281-282 AD) , in fact, may indirectly highlight this problem, mentioning only a western, longer «path» via *Vicus Serninus* and *Ateste*.

Recent studies (Caiazza *et al.*, 1999; Ortolani and Pagliuca, 2000) hypothesise a peculiar climatic micro-cyclicity due to shifting of global climatic belts and based on four essential sets of environmental conditions:

1) colder than today's climate («Little Ice Age-like») + type A environmental conditions;

2) similar to today's climate + type B1 environmental conditions;

3) warmer than today's climate («greenhouse-like effect») + type C environmental conditions;

4) similar to today's climate + type B2 environmental conditions.

In the ancient micro-cycle (classical antiquity), the chronological divides for these terms are about: 1) 480 BC-350 BC, 2) 350 BC-150 AD, 3) 150 -350 AD, 4) 350 – 480 A.D. According to this peculiar behavioural scheme, the two major river bed aggradation phases occurred at the transition between terms 1 and 2 (Late Iron Age) and the beginning of the subsequent micro-cycle phase A (early medieval Little Ice Age : 480-650 A.D.), after the term 4.

In the MAS area there is clear evidence for the first period of flooding (between Villanovan and Roman period). It seems reasonable, instead, to place the extinction of the main paleo-Reno channel in the second period (although, unfortunately, 14C data are still lacking). In the long time span between these two periods the first signs of flooding in the MAS area may coincide with the beginning of warm term 3, and the extinction of big sandy channel of trench 2 would have to fall in the same period. Furthermore, all along the Reno paleoriver (30 km, not only at the MAS) there is evidence that establishes the date of the aggradational behaviour of the river bed at least a century earlier (late 4th century AD). Thus a sort of *continuum* seems to exhist in the evolution of the ancient river bed.

Therefore, although at the moment this indication comes from only one river and cannot yet have regional value, it is clear that the a climatic interpretation of field data is only one of the possibilities. This interpretation is an analytical tool to be handled with great caution, because the true mechanims of reaction of the ancient river system to environmental and human stresses were more complex in detail than we can imagine or we can yet read.

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