THE GEOLOGICAL FIELD APPROACH TO THE ARCHAEOLOGICAL SITE YARD

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Abstract

The main duties of the geologist's contribution to the field work in the archaeological excavation sites are briefly recalled. The need for a preliminary conceptual and pragmatic approach for a correct understanding of the local context of each field campaign is stressed. Furthermore, as an example of the importance of the stratigraphic understanding in "delayed" field-microenvironment, a microstratigraphic sequence is proposed concerning the sedimentation that can occur in some ancient grave-coffin in an open alluvial environment and the problems related to the processes involved in such a restricted environment. Finally some peculiar, unusual study-settings are shown that may bring about mistakes or misunderstanding of the stratigraphic themes and therefore can be of interest for both the soil scientists and archaeologists as well as for geologists.

Key words: *field geology, geoarchaeology, geomorphology, sedimentology, pedology, postdepositional process; micro-stratigraphy.*

Why the field geologist

The *mid-common-point* between Archaeology and Geology is the stratigraphic suite; that between Geology and Pedology is again the vertical perspective of the study approach. Barker (1993) already recognized, "*obtorto collo*", that the presence of a geo-pedologist in the archaeological excavation could be necessary as well as interesting. Instead, the need for the geologist as a fundamental part of the archaeological field-staff was stressed by Rapp (1975) who also concluded his paper by indicating that "*one individual would not likely have the time or expertise to perform all of the tasks described in this article as responsibilities of an excavation staff geologist*". This attempt to list the musts of each archaeological staff component, including the geologist, was successively upheld by other Authors as well due to the pragmatism that distinguishes the Anglo-American scientific environment (e.g., Joukowsky, 1980). In the more recently published technical literature the figure of the geologist has already been replaced by that of the geoarchaeologist *tout court* (Goldberg et al., 2001; Goldberg and Macphail, 2006) and the technical suggestions are highly detailed and are performed by means of

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case-study examples. In this kind of good literature the first step of the real approach to an already started archaeological yard (the first section-reading and comprehension-phase) appear to be sidestepped (see also: Garrison, 2016) probably because it is perceived as too simple and banal. Hence the distinction/difference between the figures of the geologist and the archaeologist comes really to fall in the same way in at which the distinction between the archaeologist and the architect becomes very subtle. Even if the final result of this evolution in knowledge at last appears to be directed toward an environmental archaeology (O'Connor and Evans, 2005; Dincauze, 2006; Wilkinson and Stevens, 2008), perhaps the recalling of the elementary fundaments of the field-geological observation can still be of some interest. The geologist's contribution to the archaeological yard work is not the mere "field-description" of the section and its sampling but also, first of all, the correct understanding of the general stratigraphic theme that can subsequently be checked by means of the analytical lab results.

Due to the fact that archaeological excavation destroys the sedimentary record, the field phase of the site study is almost more important than the subsequent routine lab analyses; hence, the main understanding of the original layering can be performed only on the field and the geologist would have to be continuously present in the archaeological yard and even be taken into account in every decision phase as required by the ongoing excavation (Cremaschi 1990). In the same paper and subsequent ones (Cremaschi 2000), Cremaschi summarizes the various technical approaches and methodologies involved in the geological studies of the archaeological site, the fundamental "*trio*" being that of Sedimentology, Pedology and Geomorphology. The respective order of these three terms can be debated if we recall a famous sentence of Potter's *"...in making environmental reconstructions the geologist is in reality a geomorphologists of the past"* (Potter 1967). This is not a unimportant claim because the relationships between the physical landscape and the palaeoenvironment relies on this statement, depending on a causative "cascade"-link existing between Geomorphology→Sedimentology →Pedology. If the physiographic kind of the site (riverine, coastal, mainly tectonic, etc.) is certainly the first highly conditioning factor of the geological site-survey then a further three factors exist: i) the kind of human settlement (typology of the artificial structure); ii) the palaeoclimatic/palaeoenvironmental setting; iii) the "marketing"/economic limitation, i.e. the prominently scientific research or emergency/preventive character of the excavation, defining the timescale and funding available for the archaeological yard. In particular, the last factor risks transforming the geologist into a sort of geological "*medical officer*" who must ideally respect work flux-diagrams like those of Butzer (1982: Tables 3.1-3.2).

Priorities: what is necessary and why

The geological approach to the archaeological yard must be anyway prepared before starting the field operations. A wide range of specific documentation concerning the site area should be taken into consideration: geological notes, maps, aerial photographs and so on, as well as archaeological maps and literature, but before all else the geographical location of the site and the local geomorphology. It is quite dangerous to face any new area/site without having examined at least a contour level map or geomorphological map. This indeed makes available the palaeogeographic reconstruction of the study area and above all the kind, number and location of the morphotypes (alluvial fans and ridges, deltas and so on) characterising the local natural landscape as well as an easy way to forecast or suppose the main ancient land management and economic sectors that were acting on it (Rigato and Vitelli Casella, 2017). Being Geography at any level *the topography of the diversity* or geodiversity (Gray, 2004) each geographic area possesses an its own set of morphotypes and then a different landscape. The physiology of each morphotype, that ultimately is the landscape evolution, accounts for the settlement distribution and its archaeological remnant depth.

In this preliminary phase of the approach the *traces palimpsest* (the "*transparent landscape*") analysis, inferred from aerial photographs or satellite imagery, must be handled with a great care because it can very easily induce incorrect interpretative bias and a mistaken reconstructive frame, in particular when a relative chronology of the traces is attempted without any further field-stratigraphic control. Hence this is the *moment* and *ambit* where Geology and Archaeology mutually intersect, profoundly needing each another.

Nontheless, the *geoenvironmental coordinates* of the archaeological site with which the geologist preliminarily tries to approach the local excavation are basically four: i) topographic location, assuring the link to the landscape; ii) burial depth, suggesting the processes set that acted through the time; iii) age as *terminus ante/post quem* for dating the palaeoenvironmental events; iv) typology of the human structures contained in the strata set.

When the archaeological yard is already triggered the first and main task of the geologist then prominently becomes of stratigraphic kind. The geologist enter this phase with his cultural endowment chiefly imprinted by Stensen's four basic *Dissertationis Prodromus* stratigraphic principles (i.e. original superposition, horizontality, lateral continuity, cross-cutting relationships and stratal faunal assemblage) together with some other "improvements", e.g. *Walther*'s rule (Middleton 1973), and light adjustments for matching some peculiar characters of the geoarchaeological sphere. In actual fact, the first question that the geologist must try to answer, even before and beyond the Stensen's principles, concerns the definition itself of the term "*stratum/layer*" because the analytical detail required by an archaeological excavation is so high that sometimes the rules proposed by the *International Commission* on *Stratigraphy* (ICS, 2017) could be result to be unsatisfactorily effective. Among the various and intimately problematic definitions (Balista 1992; Carandini 1996, pp. 66-67) possibly the most interesting are still those of "*Stratum"* as a sediment thickness laid down under constant physical conditions (Otto 1938) and above all of the "*Sedimentation Unit*" as a depositional unit depending on the observation scale adopted and the chosen resolution degree (Jopling 1964). Furthermore, in particular in the

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geoarchaeological aspects of an excavation, this problem is closely linked to two important questions. The first concerns wether an average layer thickness characterising each archaeological facies exists as a guide parameter for highlighting easily a possible repetition or cyclicity of a basic stratigraphic microsequence (e.g., building-use-destruction phases sequence). As a consequence, the second question concerns the role and temporal extent of the depositional iatuses involved in the stratigraphic suite. The geologist must also deals with many other problems such as the recognition of the organic matter forms, peculiar anthropogenetic deposits (e.g. the *Dark-Earth*) and natural facies induced by the voluntary (preordained) or unintentional human acting on the landscape at various size scales; but the origin of these deposits cannot be immediately recognized and is usually speculative thus lying outside the field phase of the study.

The geologist plays a key-role not only for the sedimentological reading but also for assuring: i) the recognition of deformations as well as any other postdepositional transformations; ii) a correct linking of the site-specific context to the regional chronostratigraphic scale; iii) a chronological frame allowing for a reliable definition of the soils development and related processes. It could also be said that the ultimate role of the field geologist is thus that to procure a final "*reference stratigraphic suite*" (stratigraphic scheme) for the excavation site to which the sampling operations performed for other purposes (e.g. palynology) can be linked and significantly correlated. Even if desirable, a unique statistical site sampling, valuable for "all" purposes, cannot exist, because each specific scientific approach requires its own methodology and characteristics (Gale and Hoare, 2011; Bravard et al., 2009) and sometimes adequate amounts or characteristics of the sediments are unavailable. In other words it is worthwhile bearing in mind that when a sampling is performed six fundamental questions must be answered: what, where, when, why, how and how much must be sampled?

However, due to the fact that the excavation is a continuous *work-in-progres*, it is also necessary to define the choice both of the "*suitable place/location*" for performing the specific sampling and of the "*suitable moment*" at which the reference section(-s)/log(-s) and related sampling can be recorded. This is a true "*hot-spot*" because if the yard is characterized by a rather complex general setting the amount of sections and samples can become very huge and adequate depositories, time and funding will be necessary.

Based upon what has been said above, the field work performed by the geologist in the archaeological yard can briefly be summarized as the list below. According an ideal chronological order one must pay attention to the:

1) understanding of the whole yard's 3D layering: preliminary observation of all available sections;

2) USs (stratigraphic units) grain size and their inner structure and lateral variability description;

3) facies correlatability;

4) progressive appearance of new stratigraphic sections/suites;

5) careful control of USs boundaries;

6) reading of a number of meaningful stratigraphic suites in different locations in the inner yard;
7) relative and absolute, correct levelling (and positioning) of each recorded stratigraphic suite;
8) distinction between naturally and anthropogenetically generated USs;
9) recognition of erosional boundaries and related extent recorded in the sedimentary suite;
10) clear and hidden aggradational surfaces (microsequences top/trampling surfaces) recognition;
11) whole geometry understanding of USs and sedimentary bodies;
12) USs inner structure and related content (common and marker materials);
13) recognition of USs dip/counterdip;
14) comprehension of USs and whole site relationships with ancient and present day geomorphology by means of direct geognostic and/or geophysical surveys (if necessary);
15) USs deformation recognition;
16) recognition of buried soil profiles with related horizons;
17) detailed inspection of the Ap horizon characteristics (thickness, included materials, etc.) or its erosional lack;
18) existence of pedorelics embedded in some USs;
19) the kind of the specific archaeological structure being excavated;
20) recognition of the relative elevation of the street/pavement/tramping floors in respect to the coeval natural topographic surface;
21) evaluation of anthropogenetic deposits thickness and their inner order/disorder degree;
22) evaluation of the height of the relic vertical structures (walls);
23) existence of stratigraphic microsequence like "*Carandini's Model*" (building-use-destruction phases sequence);
24) recognition of the relationships existing between vertical structures and the nearest natural USs 3D geometry;
25) recognition of the natural sediment sampling mode of peculiar structures or artefacts;
26) recognition of the peculiar disturbance patterns/figures induced by postdepositional processes;
27) recognition of the ancient water table depth below the coeval topographic surface;
28) existence of buried, ancient hydromorphic halos;
29) existence of modern pollution halos (induced by pollutant plumes);
30) definition of peculiar facies of unclear origin;
31) choice of the "*suitable place/location*" and "*suitable moment*" at which the reference section(-s)/log(-s) and related sampling can be recorded for the best explanation of the relationships between the anthropogenetic lithosome and the embedding natural sediments.

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32) (if possible) description of the typical “reference section” of the whole site yard useful for linking vertically-profiled sampling (e.g. soils, etc.);
33) reconstruction of a preliminary general stratigraphic scheme (“geoenvironmental matrix”) characteristic of the site;
34) multiple sediment samplings performed to solve open questions (mainly depending on funding availability).

Finally, a last *hot-item* is the relationships that should exist between the field inspection phase and the preliminary basic chronometric and palaeoenvironmental data availability necessary for a first and quick, correct initial framing of the yard context. The unavailability in real time data can in fact stall the research in its embryonal phase or, worse still, can deviate it. This topic obviously depends only on adequate organization and funding, although a total funding can never exist because the research is fundamentally insecure, partial and inconclusive: what was deemed to be correct yesterday tomorrow could turn out to be wrong!

An extension of the field study. A case of microstratigraphic *in-door* excavation

As regards the previously listed points 24-25, some stratigraphic details concerning the archaeological excavation of a Roman age sarcophagus are briefly reported here to highlight the importance and complexity of the stratigraphic implications. The stone coffin was found in 2011, buried at the northern border of the Bologna outskirts. An initial stratigraphic suite of the natural deposits around the coffin was drafted in Cremonini et al. (2013, Site BO 4), suggesting the year 495-/+65 AD as a broad *terminus ante quem* for the starting of the multiple crevasse sedimentation covering it. Although the study is not yet complete, according to further two ^{14}C datings performed on samples given by Soprintendenza Archeologica dell’EmiliaRomagna it is likely that the last corpse was deposited in the coffin in around 5-/+ 55 BC. After that date the topographic surface around the coffin aggraded and probably during the 4th century AD the outer natural sedimentation was able to reach the join of the coffin-lid thus inducing the definitive burial of the monument beneath the more size-grained and thick alluvial deposits.
The coffin was excavated according Barker’s method in the lab. The sediment contained in the coffin was only about 25 cm thick, completely masking the materials contained therein. It was still plastic and characterized by a surficial polygons network of centimetric sinform deformations only resembling a fracturing net. At places, in particular at northern edge of the coffin, where the rthe sediment was less thick the polygons boundaries were true fractures successively filled up with younger clay thus generating a sort of “muddy wedges”. The deformation nets were likely more than one, mutually superimposed upon one another along the plumb line. A centimetric peripheral furrow was seen all along the contact between the filling mud (sedimentary lithosome) and the inner wall of the coffin. In it a grey-blue clayey infilling was present. To obtain the continuous suite sampling, avoiding disturbing the archaeologists work, two small cores were

made applying a "*reverse coring*" technique. This very simple and slow method allowed the operator not to damage the archaeological material (if present) in the fine mud and deform the sampling sediment because the liner pushing down was performed slowly according a progressive shaping of the core diameter, pulling away the outer sediment. A number of thin sections was obtained from the cores. In figure 1 the assemblage of the various thin sections is shown as well as their mutual location in the coffin core.

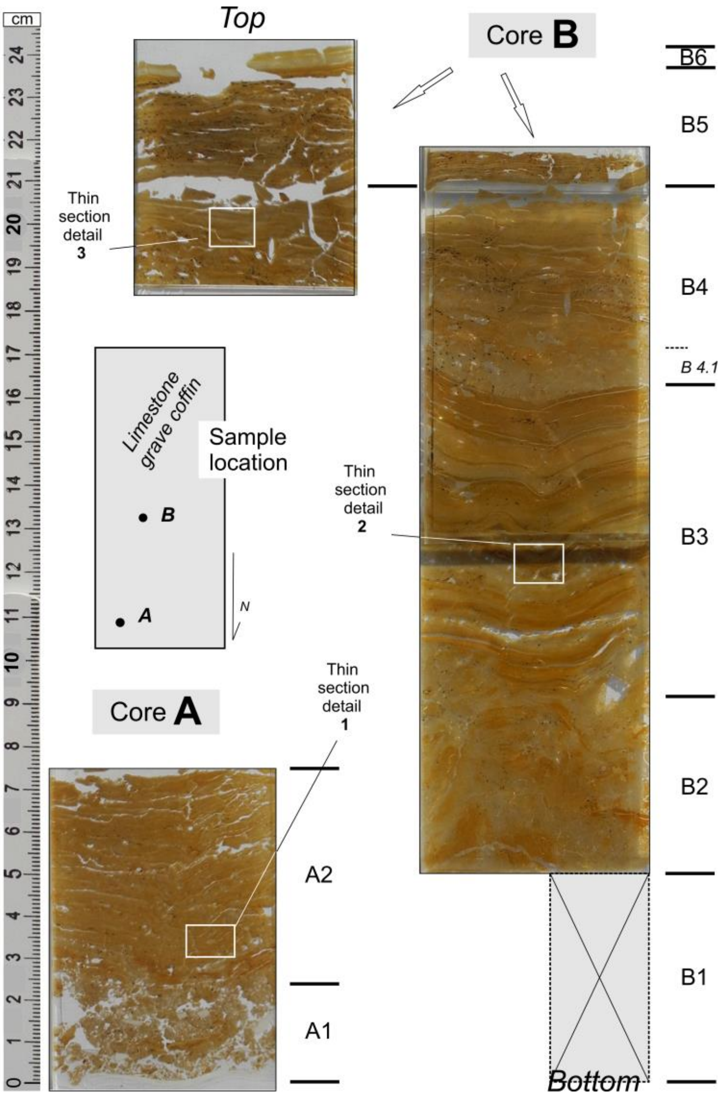

Figure 1
Mosaic of the thin sections of the inner deposits of the Roman age grave. The location of the thin section details are indicated.

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A sieve and pipette sediment size analysis was performed on sediment samples respectively taken by outer and inner deposits as well as by those sealing the coffin/cover join (Fig. 2).

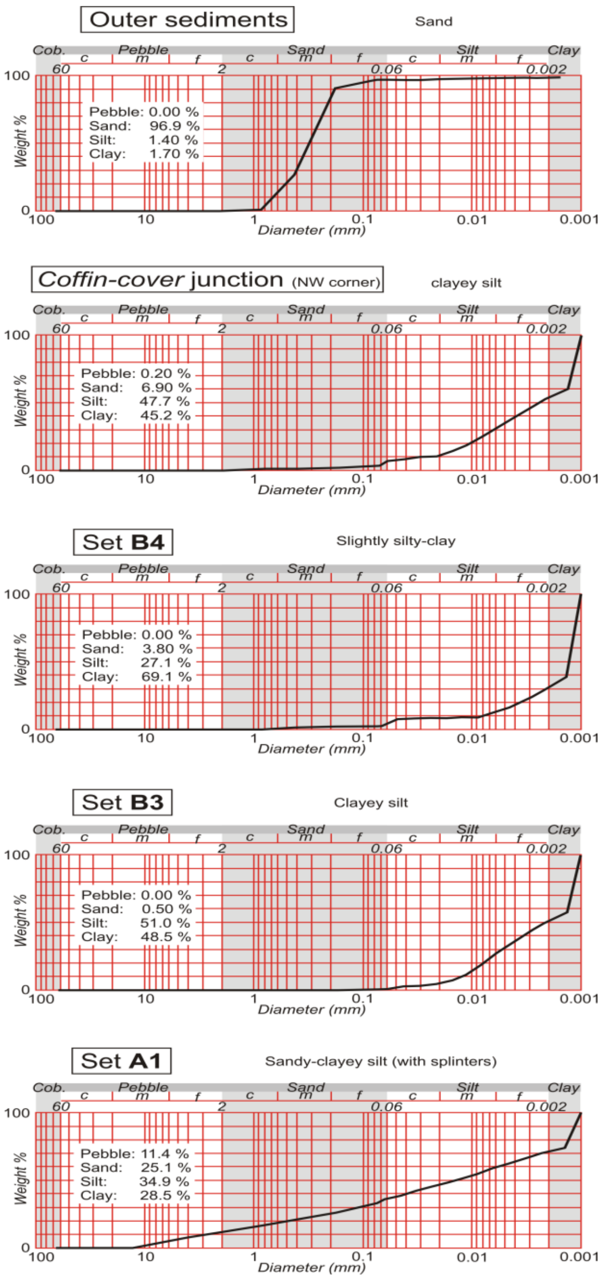

Figure 2
Granulometric curves of the inner, outer and cover/coffin join sediments.

The outer sediments were mainly sands whereas the deposits at the lid join and those of the middle of the core B (B3-B4) were clayey silts: the bottom sediments

(A1) were sandy clayey silts (with small limestone fragments of the coffin cover) and those of the suite top (B5) were slightly loamy clay. In figure 3, the thin section 1, an almost homogeneous clayey silty deposit, characterized by high microporosity, appears to show traces of a slightly folded layering. Here it is very difficult to recognize a true, rhythmic succession of silt/clay couplets and each layer could be interpreted as the result of the settling of proximal highly concentrated suspension flows entering the coffin via the cover join.

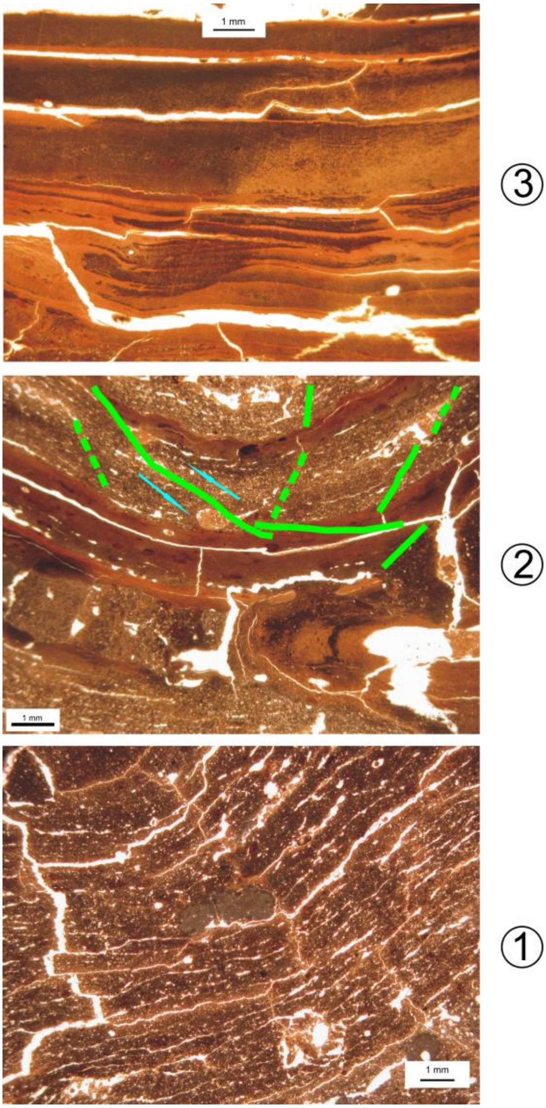

Figure 3
Details of the thick section of the inner sediment of the coffin. The numbers refer to the location reported in figure 1. In the central detail the compressive microfaults (green colour) are drawn.

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Such a sedimentary facies had already been seen in a similar case study (Cremonini,1991). The high porosity resembling a frost figure (e.g. Van Vliet-Lanoë, 1987, 2005) is debateable. Thin section 2, located in an almost barycentric position of the core B and coffin, shows a rhythmic succession of silt/clay couplets each 10-15 mm thick. The coarse/fine thickness of each couple is about 1 or slightly higher. The microporosity is located only in the basal silty layer where a series of low-angle microfaults accommodates the central folding deformation. Each coarse/fine couple was generated by the settling of sediments with their own suspension concentration. Thin section 3 shows a severe transformation of the couplets' texture, the clayey material being prevalent, and the fining of the silty interval grain size. Each layer's thickness of the is lower than 0.5 mm and even in each clayey interval a lot of small thickness sub-episodes probably exist.
In figure 4 the sedimentary suite was split in 8 strata sets (A1-B6). The main layer bottoms (***l.-b***.) between the sedimentary couplets are shown: they separated at least 97 sedimentary micro-events but they are probably many more than these.

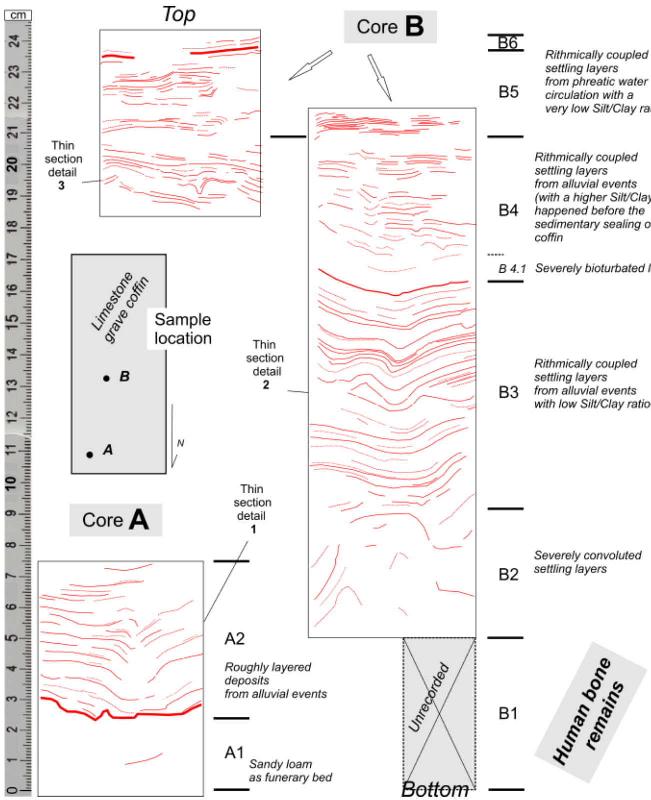

Figure 4
Line draw of each recognizable layer bottom of the thin section of figure 1. The main stratigraphic sets and the related characteristics are reported.

Set A1 (none *l.-b.*) sediments, the coarsest of the suite, could represent the funeral bed on which the corpses were laid down and its dark colour probably is due to the concentration of the decomposition organic fluids. It is highly reworked by the original faunal-turbation and/or corpses readjustment and contains a number of stone coffin splinters originated by the degradation of the lid and the walls. Unfortunately, set A2 (16 *l.-b.*?) (see thin section 1 description) can not be correlated with B1 or B2 due to the lack of the physical continuity. B1 was not sampled because the coring was stopped upon a femur. Set B2 (5 *l.-b.* or more) layering originally consisted of sedimentary couplets like that of the overlying sets but its severe reworking and antiform folding is still hard to explain even if it is clear that it can not be due to corpse decay. B3 (25 *l.-b.* or more) preserves the record of the inner coffin sedimentation expressed by the settling of the suspended load of alluvial flood waters penetrating the coffin. Each fining-upward microsequence is not a real turbidity current but the simple result of Stokes's sedimentation in a completely natural context. It can be thought that each couplet resulted from a single alluvial event able to completely fill up the coffin: each event possessed its own characteristic sediment concentration thus generating a peculiar silt/clay ratio. In this set the ratio indicates on average the prevailing amount of the clay suggesting a relatively distant location of the river "crevasse" spill-point. The bioturbation is generally low and the suite is well preserved. The subset B4.1 is thick, mainly silty and heavily bioturbated by the infauna. It could represent a moment/time lapse in which the outer sedimentation almost reached the coffer-cover join, allowing the infauna to penetrate the coffin. As a matter of fact, on average the set B4 (22 *l.-b.* or more) shows a reverse (higher) silt/clay ratio with respect to set B3, thus suggesting a progressive nearing of the river crevasse waters to the coffin's location or, in any case, a selective sampling of the lower part the flood waters, occurring just before the partial sealing of cover join. The microlayers' upward thinning trend might reflect a fast and progressive obstruction of the join fissure. Sets B5 (26 *l.-b.* or more) and B6 (3 *l.-b.* or more) contain only very thin layers with a very low silt/clay ratio indicating the complete burial of the monument and the development of clay sedimentation originated by phreatic water circulation. No soil development were recorded in the coffin. The suggested interpretation of the whole sedimentary micro-suite is consistent with the aggradation of the Roman age hydrographic network and with the birth of a new paleo-riverbed of the Savena Stream (Cremonini et al. 2013). The best lesson from this example is that due to the relative elevation of the monument above the ancient topographic surface the sampling operated by the coffin was highly selective: it probably did not sample all the flood but only the highest. Only when the new riverbed sufficiently aggraded did the outer sedimentation "style" change, but the grave had already been completely buried. Finally, if other "subsamplers" of a lesser size were present inside the coffin they were able to sample the incoming sediments in a way proportional to the height of the water column they were able to retain. In such a way it can be understood that each kind of sediment sampler recorded in an its own peculiar way a different part of the general sedimentation history of the local paleoenvironment and of the landscape's evolution. An open problem is that of the mud deformation/convolution. During the period in which

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the monument was still exposed before its burial it is reasonable to think that the flood waters entering the coffin during autumn or winter could for some weeks or months remain inside it, disappearing only during the warm season. This could allow us to think that the mud deformations were partly generated under slight cryogenic conditions (van Vliet-Lanoë et al. 2004) possibly coupled with syneresis (Pratt 1998) linked to the underwater conditions. The desiccation-cracking of the surficial mud during the warm season has not anyway to be underestimated .

As a concluding remark, it can be stressed that when the natural layers thinness and deformations are expressed at a high grade, a standard stratigraphic excavation performed according to Barker's rules (i.e. planar removal) might also be questionable, leading to a possible mismatching or loss of detailed information. In such a case the excavation could be performed better, even though with difficulty, according to a closed *tomographic technique* as Barker himself was almost tempted to recognize (Barker 1993, p. 148).

Useful geological evidences from some peculiar field cases

The matter of clay transport and sedimentation at depth, in the buried realm, is a little debated problem (Buurman et al. 1998; Pipujol and Buurman 1998), but in many archaeological excavations the evidence for thick mud drapes inside of semi-closed artefacts or under the bottom face of the water well bricks is quite normal. But other items also stem from geological observations that can be useful to archaeologists as well as to pedologists: their number could be high. For example, the Author of this report could personally record the existence of a crevasse splay generated by at currently active river that settled a large amount of perfectly preserved Pliocene fossils in the medium alluvial plain of the Emilia region. Such a selective reworking of chronological markers might be very dangerous for the stratigraphic suite interpretation.

The soil units succession (pedostratigraphy) can at times favour examples for debating the question concerning the prominent role of the climate or topography as a driving factor in soil-forming process. An example coming from around the city of Bologna (Fig. 5) highlights a slightly reddened buried soil dating back to the Bronze age: after that period it has never been replicated. In this case a (very) weak possibility could be also taken into account that a more ancient levelling work was performed to erase a very slight break in slope during that age: but no clear evidences exist.

From the archaeological ambit again comes evidence of floating vessels/artefacts of low (wood) or high density (if still sealed) when they are preserved in closed, empty environments such as graves or sewage tunnels.

This can be suggested to be an exception contradicting the first *Stensen's* principle without impugning it. The same can happen in a low alluvial plain marshland if floating bogs are present: when the bog rises due to water inundation the flood-related sediment can settle beneath the bog. In 1809 the agronomist Filippo Re illustrated this situation recalling the Adige river flooding (Martinelli et al., 2012 a).

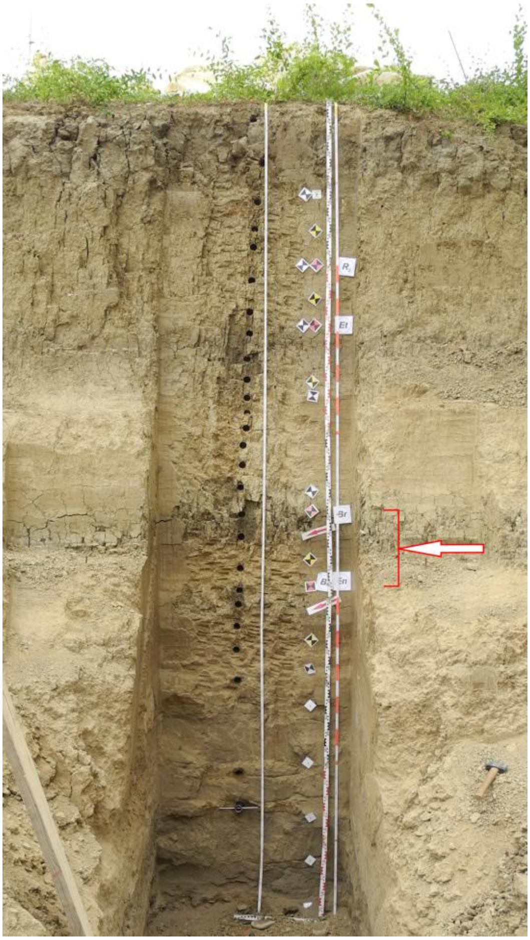

Figure 5
Stratigraphic suite near located Casalecchio di Reno (BO). The red arrow shows the Bronze age soil: above this the Etruscan and Roman ages are present.
A study of the section was performed by Zanni M. (2013) "Studio stratigrafico e palinologico di una sezione olocenica a Casalecchio di Reno" Graduate thesis in Geomorphology for Natural Sciences. School - University of Bologna. Academic Year 2011-2012 (Session III). Tutor: S. Cremonini (Unedited.)

Another field of interest is that of natural gas seepage and its effects. In the Po river plain huge amounts of methane exist and seep continuously from the ground (Martinelli et al., 2012a). Methane seepage induces various effects on the crossed sediments and the materials contained in it. Carbonatic nodules ageing up to 6000-7000 years has been recorded in the former *Valli di Comacchio* (Cremonini et al., 2008). In the same area the gas seepage can also help to trigger peat combustion. This phenomenon generates natural reddish-yellow "fired clays" , i.e. backed-earths (Martinelli et al., 2012 b; Martinelli et al., 2015). Also gas escape structures have recently been found, linked to buried peat layers. On a wider scale, some surficial morphological depressions (*micro-sinkholes*) are thought to be strictly linked to the natural gas escape (Cremonini, 2010). Probably the most interesting effect induced by gas seep is the *gleying* of the sediment throughout which the gas flows. In fact this effect can be recorded even above top of the water table due to the methane aerobic oxidation according to the equation CH_4+$2O_2$+bacterial

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activity = $CO_2+2H_2O+DT^{\circ C}$ (Capaccioni et al., 2015). Besides the gas, it is worthwhile recalling the existence of natural brackish waters rising to the surface of the plain areas (Castellarin et al., 2006). This phenomenon can be potentially involved in the structure change of the buried clays. On the other hand the existence of such an environment was able to imprint the economy of wide plain areas in the ancient times.

Another set of peculiar evidence is that of the deformations to some extent linked to the seismic and tectonic activities. This kind of evidence is often highly debateable but it can not be overlooked. In particular, immediately to the west of Bologna, severely deformed Roman age structures have been found whose origin is thought to be linked to an unknown earthquake possibly occurring during the Late Roman age (Curina and Cremonini, 2010). In such cases a careful geological inspection will have to be performed to recognize whether a buried fault/fracture exists beneath the deformed structure. If a fault involved the archaeological USs/layers, the latter may verticalized and the archaeological excavation becomes rather difficult. Furthermore the layer deformation is an unknown category for *Harris' Matrix* as well as that of soil genesis (Leonardi and Balista, 1992). Perhaps it would be better to propose the adoption of a new category, that of the "*deformation Unit*", specifically depending on gravitational and palaeoseismic activities.

A last example of problematic deformation is that shown in figure 6, located just 1 km South of the previous site.

Figure 6
The stratigraphic site located 1 km South of the site of figure 5. 1-2) The bed of the stratigraphic suite showing the Bolling alfisol and the overlying vertisol. In the vertisol the deformed ancient age agrarian ditches can be seen. 3-4) The slickensides of the vertisol and a detail of a deformed agrarian ditch. 6-7) Other aspects of the deformed agrarian ditches.

There (Steffè 1984; Ortalli 2004) a vertic soil with slickensides, dating back to 8455 uncal years BP (about 9470 cal BP) (Martelli et al. 2009), was buried at a depth of no more than 2 m, and was covered by silts and sandy silts. The severe deformation of the ancient age agrarian ditches incised at the top of the vertic soil as well as the related fractures generated after the ditches burial. Therefore it is difficult to state if the deformation can be only linked to the soil shrinkage.

Finally it is in the author's opinion that in the geoarchaeological ambit the need for the use of specific stratigraphic terms and categories (like those used in the sedimentological discipline: e.g. Bosellini et al. 1989, fig 13.33) is already perceivable: in figure 7 an example is proposed after Cremonini (2003).

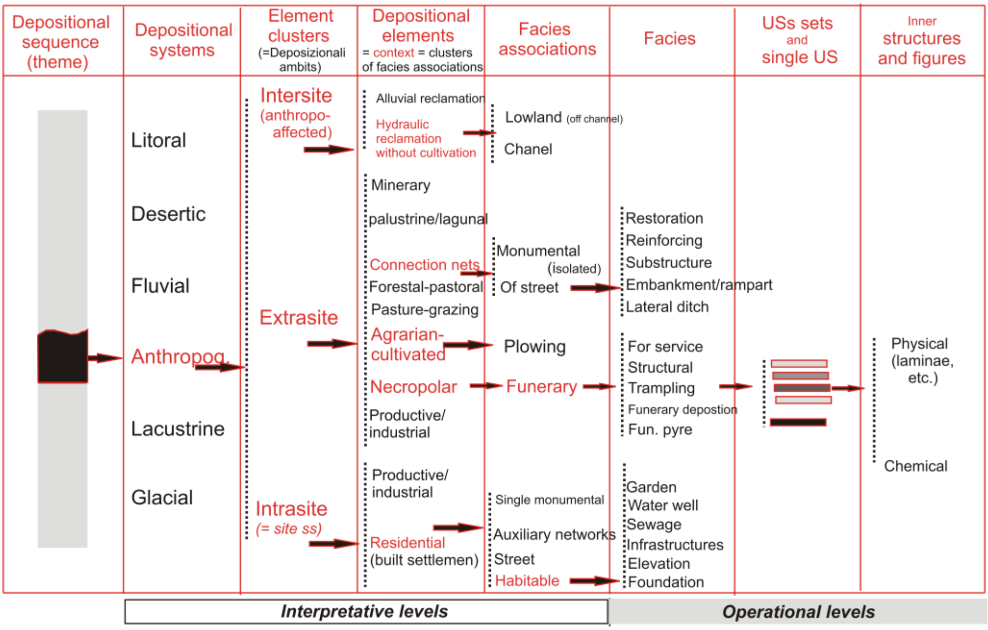

Figure 7. *A propositive example of functional hierarchy for the anthropogenetic deposizional system after Cremonini (2003), modified.*

Conclusions

1) From field-Geology survey Archaeology expects the: i) relationships existing between site and extrasite; ii) timing of natural processes; iii) focusing on peculiar natural phenomena.

2) Archaeology can "give" Geology the opportunity of performing an environmental processes detailed reading.

3) Geology would receive from Pedology an effective "*back-analysis*" of the buried soils for its genetic classification.

4) Pedology can receive by Geology a better knowledge and timing of soil forming processes.

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5) Geology expects from itself the understanding of the: i) process details; i) timing of the chronological iatuses; iii) sedimentation rates; iv) impact of various environmental factors on the landscape.

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