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ARCHAEO-GEOSITES IN URBAN AREAS: A CASE STUDY OF THE ETRUSCAN PALAZZONE NECROPOLIS (PERUGIA, CENTRAL ITALY)

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ABSTRACT**:** In addition to practical and cultural motivations, there is also a geological reason for the establishment of an urban area. In central Italy, a large part of the main historical and cultural towns derived from very ancient villages located on hilltops, close to alluvial plains. Height guaranteed a healthy environment compared to the lowlands, where wetlands, marshes and flooding favoured malarial conditions. At the same time, proximity to lowlands was essential for accessing communication networks, drinking water availability and raw materials. In most cases, the morphology of these hills has been a decisive limitation for urban development. On the contrary, the Pliocene-Pleistocene fluvial and lacustrine sediments forming these reliefs have been used for housing some important civil and religious facilities such as houses, storage areas, and tunnels, but also wells and tanks, tombs and necropolises.
Thus, the central areas of the most important historical cities still preserve valuable archaeological sites. Moreover, the original sedimentary deposits can often be observed along the perimetric walls of these buildings, and these sites provide a unique opportunity to reconstruct a 3D geological view. When both archaeological and geological values are high, these sites can be defined as “archaeo-geosites” and offer a unique opportunity for a multidisciplinary study of the urban areas.
The Etruscan Palazzone Necropolis in Perugia (Umbria, central Italy) is an ideal case study for this approach.
A detailed study of the sedimentological and lithostratigraphic features of the deposits cropping out in the Necropolis led to the identification of two distinct, superimposed fluvial systems, separated by a main unconformity, which could be interpreted in terms of different ages and/or changes in the main fluvial regime. A geomorphological overview of the area is also proposed, with the aim of expanding the palaeoenvironmental reconstruction to a larger area, including the Perugia Hill.
Finally, the Palazzone Necropolis, as an archeo-geosite, could be considered as a prototype for the promotion of geotourism in urban areas, contributing to a new added value to conventional touristic tours of cities.

Key words: Geoarchaeology, archaeo-geosite, Etruscan hypogeum, Umbria, Italy

1. INTRODUCTION

Geology, in popular opinion, is a scientific discipline associated with natural scenery where abiotic elements of the landscape, outcropping of rocks or landforms are evident. However, nowadays increasing attention is directed towards urban areas as places where the geological component plays an important role both as a fundamental piece in gaining knowledge of the initial settlement and as a constraint for architectural development. On this topic, one main aspect already investigated in the scientific literature involves the natural hazards characterizing some urban areas (Bathrellos et al., 2017). Hydrogeological instability, such as flood and drought (Güneralp et al., 2015) and their increasing impact due to climatic change (Christenson et al., 2014) are the most evident aspects of the relationship between human presence and the natural setting. The susceptibility to volcanic phenomena (Chester et al., 2000; Orsi et al., 2004) or seismic events (Carreño et al., 2007) is also fundamental. On the contrary, the geological component may be considered not only a risk factor, but also a resource. Traditionally, the most important human settlements have been located in close proximity to drinking water supplies such as underground reserves, and springs, or to fluvial networks used for communication. Moreover, accessibility to mineral resources or building materials played a significant part in determining locations for urban placement. The scientific community is nowadays adding a new value derived from the geological features of a site, mostly in urban areas. It is thought that geological information could stimulate touristic interest and attract a growing number of visitors. With this in mind, heritage stones could be a powerful thread for creating touristic itineraries in urban areas and in particular in the historical centres of cities (De Wever et al., 2017). The natural stones used for historical buildings, churches, roads and monuments offer unique opportunities to increase the knowledge of the bedrock present under a city and in the surrounding areas (Borghi et al., 2014; De Wever et al., 2017). Especially in the past, it was common to quarry building materials close to the settlements, except for re-using materials or for some buildings of great value for which the building materials might also have come from further distances. In addition, the geological nature of the bed-

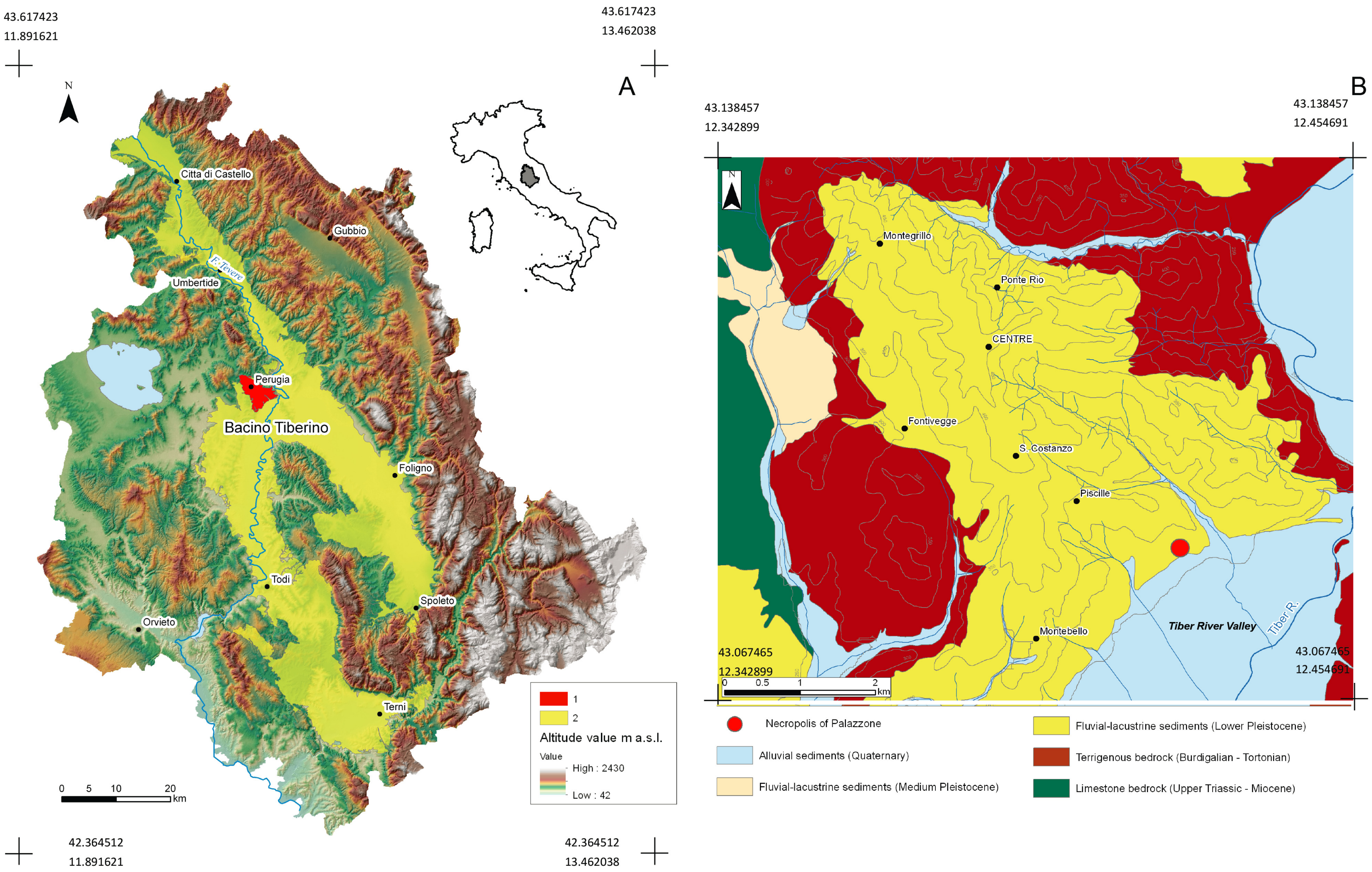

Fig. 1 - A) Location map of the study area in the Region of Umbria. The Perugia Hill (1) is located in the Tiberino Basin (2). B) The Palazzone Necropolis develops at the bottom of the hill, inside Pleistocene fluvial sediments.

rock and the original natural morphological setting have become a new and significant tourist attractor. The experiences of several large cities in the world confirm the potential importance of this approach (Reynard et al., 2011; Pica et al., 2016; Reynard & Brilha, 2017).

In this study the possibility of using geoarchaeology as a connection between the geological component and the archaeological heritage in urban areas was investigated. Geoarchaeology is a multidisciplinary research field, using contents and methods deriving from the Earth Sciences for investigating archaeological sites. Moreover, for cities with a very ancient background, the link between archaeological sites and geological data is even more significant. Up to now, the main results of the geoarchaeological approach have been used for archaeological purposes. Recently this approach has also provided interesting data for geological research (Melelli et al., 2016). For example the techniques used for constructing public or private buildings, as for instance, houses or graves, including underground excavations, and in some cases the perimetric walls offer unique opportunities to develop a 3D view of rocky outcrops.

Archaeological sites are points of interest for geological knowledge to such an extent so as to be classified as archaeo-geosites (Melelli et al., 2016).

In this study the Etruscan Palazzone necropolis (Perugia, Umbria Region, central Italy) was investigated in order to highlight its potential as an archaeo-geosite and to be considered as a prototype for other similar sites.

2. PERUGIA HILL TOWN: THE IDEAL SITE LINKING GEOLOGY AND ARCHAEOLOGY

Perugia (Region of Umbria, central Italy) is located along the western edge of the Tiberino Basin, the largest intermountain basin in Umbria (about 1800 km^2) and one of the largest in central Italy (Fig. 1A). Perugia stands on a triangular-shaped hill with a maximum altitude of about 493 m a.s.l. and covers about 27 km^2 (Fig. 1B). Observing the hill from above, five main ridges spread towards the NE, E, SSE, SW, W, resembling the five fingers of a hand. The ridges decrease in altitude as they reach the Tiber River Valley, flowing at the foot of the hill towards the SSW. The historical centre of the town is located at the apex of the triangle, on the highest part of the hill. At its highest point, the early shape of the hill was a saddle between two peaks facing the steep slopes below. That morphology favoured the first Villanovan settlements around the 11th-10th century BC. It is at the very top of the hill that the most important witnesses of the past civilizations (Etruscan: 6th-3rd century BC; Roman: from 1st century BC) occur. At the bottom of the hill there are still precious historical remains, too.

The Tiberino Basin, crossing the entire region from north to south with an upside down Y shape, close to Perugia splits into two branches, both with a N-S direction (Ambrosetti et al., 1995). The basin is the consequence of extensional tectonics, started in the Pliocene, and is still active in the area. The basin, filled by fluvial and/or lacustrine sediments, was not a single connected area but rather a set of minor coalescing sub-basins, each one characterized by its peculiar evolution through time and space (Pucci et al., 2014). Terrigenous sediments of different sizes, from blocks and gravels to sands and clays are arranged in a sedimentary sequence above the bedrock, with thicknesses of even hundreds of meters. The centre of Perugia lays entirely on this sedimentary sequence, preliminarily dated between Early and Middle Pleistocene (Regione Umbria, 2010).

The underground cavities are quite numerous, due to the lithological features of the sediments, which are easy to dig. Through time, they had different uses, such as wells for groundwater, food remittances, anti-aircraft rigs, and drains to facilitate the flow of groundwater and graves, too.

"Perugia Underground" is located in several parts of the hill, just because everywhere the sediments were easy to work and the only constraint was the topographic and morphological setting. It is possible to see the sediments in their original setting in the majority of these underground cavities. In addition to the lithological composition and the grain size of the sediments, these unique outcroppings allow the spatial pattern of many geological structures to be understood, being the key to rebuilding the palaeogeographic environments of sedimentation.

This being so, in many cases these places are an excellent opportunity to link archaeology and geology. In fact, while the archaeological value is already known and promoted, the geological one is still not well highlighted.

2.1. The Etruscan civilization in Perugia: underground and surface sites

The Etruscan civilization started in central Italy in the first millennium BC (Haynes, 2000). During its maximum expansion, it ranged from the Po Valley in Northern Italy to the Campania Region in Southern Italy. Perugia was one of the twelve confederate cities (Lucumonie) of the Etruria league, because of its strategic geographical position, on the top of a hill overlooking the Tiber Valley where the main roads towards the neighbouring cities passed through. Numerous indications of the Etruscan presence, including city walls and artefacts and several necropolises (Nati & Nardelli, 2010), still offer considerable evidence of the significant signs left by the Etruscan people. Between the 6th and the 3rd centuries BC great new walls, built using large blocks of travertine, fortified the city. Running for almost three kilometres, the walls mark out the highest portion of the hill. There are seven gates in the walls; the Etruscan Arch (3rd century BC, Fig. 2A) is the most famous also because of the two lateral trapezoidal-shaped towers, which, together with the wide arch, render the image of a majestic building. In addition to the city walls, other relevant remains of the Etruscan civilization are still present in the city centre. One of the best preserved is the Etruscan Well (second half of the 3rd century BC, Fig. 2B). It is a cylindrical structure with a diameter of 5.6 m in the upper portion and reaches a depth of 37 m. It is covered with a series of travertine slabs, supported by a system of massive stone beams ("trusses") that

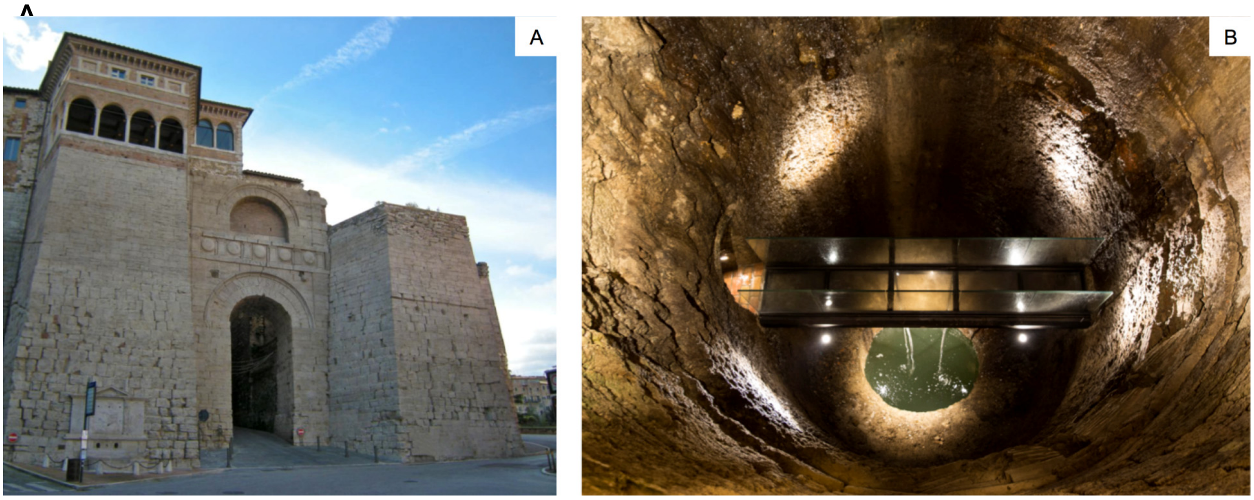

Fig. 2 - A) The Etruscan Arch, made of travertine blocks, is one of the gates along the Etruscan wall. B) The Etruscan Well, entirely dug inside Pleistocene gravel.

completes the engineering of the construction. The building of magnificent graves also reflects the advanced economic and cultural level reached by the Etruscan population from the 2nd century BC. Beginning with the belief that life continued beyond death, graves were built to ensure durability and future expansion. Like many other ancient peoples, the Etruscans built their graves underground and, in order to reproduce the idea of a life after the death, tombs were grouped in necropolises, which are “cities of dead people”. Generally, the necropolises were placed outside the city walls according to the topographic setting.

The Palazzone Necropolis is located at the bottom of the hill, in the south-eastern part of the boundary between the Pleistocene deposits and the alluvial sedi-

Fig. 3 - The Volumni Hypogeum, the most famous tomb in the Palazzone Necropolis. The interior was entirely dug inside gravel and sand belonging to the Volumni Unit (see text for details).

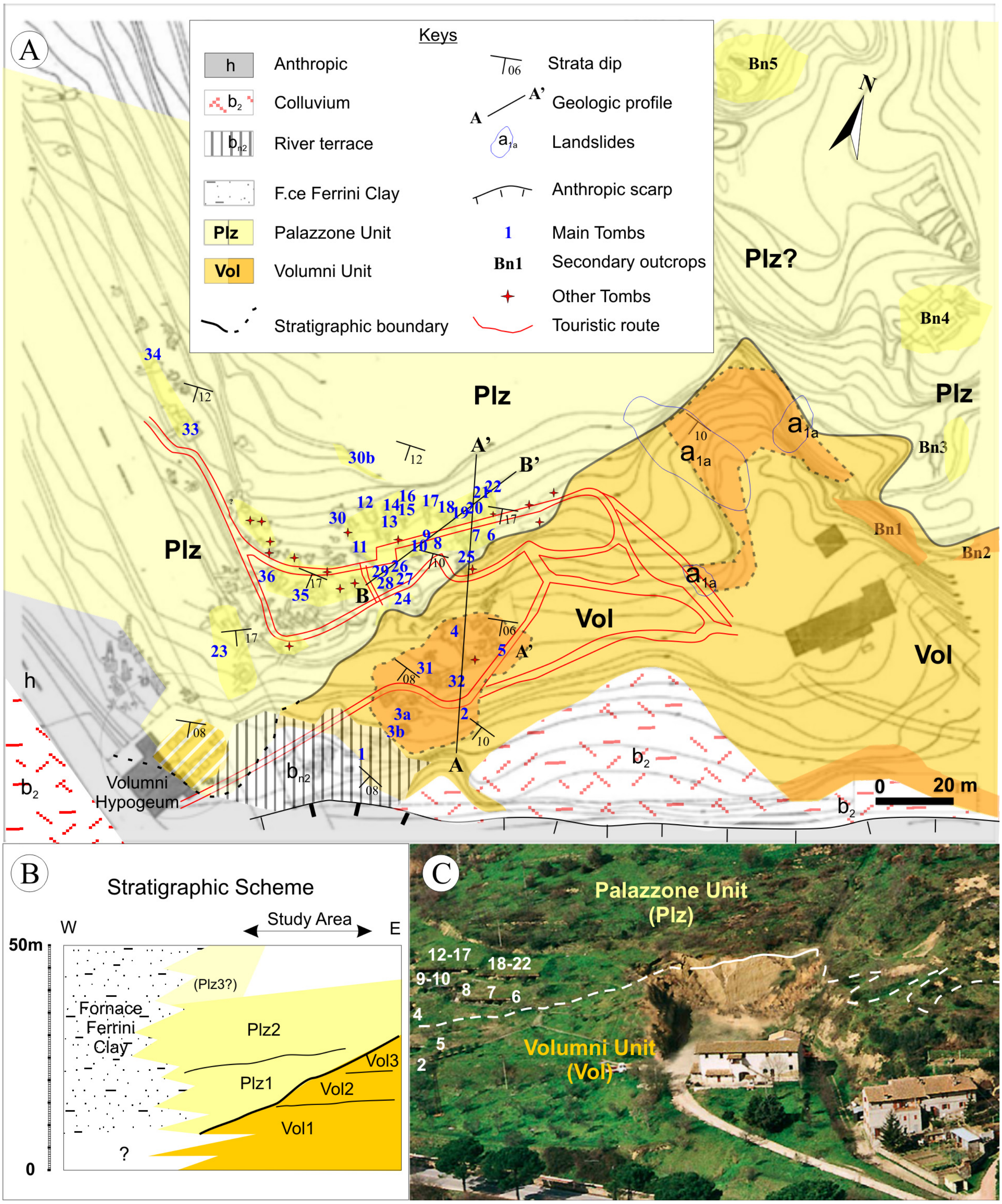

Fig. 4 - A) Detailed geological map of the Palazzone Necropolis, with the location of tombs (numbers). Tracing of cross sections (see Fig. 7) is also shown. B) Stratigraphic scheme for the study area. C) Old quarry front (no longer visible), showing the stratigraphic boundary between the Volumni and Palazzone units.

ments of the Tiber River. It extends over an area of almost 19,000 m^2, representing one of the most important Etruscan burial sites in Central Italy. The tomb (Fig. 3), named after the "Volumni Hypogeum" (from the name of the Etruscan family Velimna - lat. Volumni), was discovered in a completely accidental way, during the construction of some roads on February 5, 1840. It is currently the most important of the entire necropolis (lower left in Fig. 4A). The Palazzone Necropolis includes about two hundred graves, most of which can be visited (marked by numbers in Fig. 4A). The age of the tombs is mostly Hellenistic and only five date to the Archaic period (second half of the 6th century BC - beginning of the 5th century BC). Although not very numerous, these graves are essential for confirming the Etruscan presence in Perugia since the 6th century BC. In most cases, the tombs have a single chamber, but others have a more complex plan, such as the Volumni Hypogeum, where, in addition to a central corridor, the excavation is divided into side cells and a tablinium, on the farthest side from the entrance. In the centre, in the vestibule, some benches built of sediments house the urns. The ceiling, in the shape of a sloping roof, and figures connected to the world of the dead are reproduced in the gables on the highest part of the excavation. The urns, mostly in travertine, and the items found in the Hellenistic tombs are kept in the vestibule of the entrance of the Volumni Hypogeum (Fig. 3).

3. SEDIMENTOLOGICAL CHARACTERIZATION OF THE PALAZZONE NECROPOLIS

The archaeological area of the Palazzone Necropolis is also to be considered as a key-point in reconstructing the Plio-Pleistocene geological evolution of the Perugia Hill. Nonetheless, the presence of graves in the surroundings, known by the Superintendence since the 1960s, suggests a greater extension of the area. The two hundred documented tombs, many of which are no longer visible or accessible today, were all excavated in the natural sediments (Figs. 4A, 5, 6).

Both within and outside the tourist route, the tombs were excavated on at least five main superimposed levels, between ~210 m (floor of the Volumni Hypogeum) and ~238 m above sea level (tombs 12, 16).

The area of the Necropolis is covered with gravel and cemented gravel, mainly in the lower portion, while sand is well represented in the upper portion of the hill and dominates on the western side. Both lithotypes are quite solid, so as to support the vertical walls and vaulted ceilings, and are associated with levels and lenses of finer deposits. As will be discussed later, all deposits inside the tombs are of fluvial origin.

The deposits maintain some stable sedimentary features throughout the whole stratigraphic succession, even though there are variations in grain size from level to level.

Pebble to cobble gravel beds have a grain-supported texture, with the abundant presence of a coarse sand matrix, sometimes at the edge of the granules, and a moderate degree of selection ($\sigma = 1.00\ \Phi$ sensu Folk & Ward, 1957). Clasts are mainly rounded/sub-rounded to sub-angular (rounding 0.6-0.8: Powers, 1953; Pettijohn, 1957), mainly blade and rod-shaped, subordinately equi-dimensional, in accordance with Zingg (1935). Gravels are mostly formed by grey to brown calcarenites and medium to coarse-grained arenites, all presumably derived from lithostratigraphic units of the Tuscan Succession; quartz and/or calcite monomineralogic gravels, light brown micrites and occasionally green volcanites (fragments of ophiolites) were also documented. Gravel usually has a dark brown or reddish oxidized surface.

Sands are mainly light yellow in colour, moderately to well sorted ($1.00 < \sigma < 0.5\ \Phi$ sensu Folk & Ward, 1957), made of angular to subangular grains of variable sphericity: mainly quartz grains, with high sphericity, and lithic fragments of more irregular shape.

Finer deposits, occurring either, as very discontinuous and thin layers, lenses or chips, are light grey silty clay to clay (Fig. 7).

As will be discussed later, this overall uniformity seems to indicate that the supply came from a rather similar feeding area through time, or several sedimentation phases of similar material. Nonetheless, throughout the area the presence of two overlapping lithostratigraphic units is documented and distinguished on the basis of sedimentological and lithostratigraphic features. The two units were preliminarily identified and partly described in Melelli et al. (2016), where they were indicated as Units A and B. Here, the two units are named, in stratigraphic succession, Volumni (Vol) Unit and Palazzone (Plz) Unit (Fig. 4A, B). In this paper the Palazzone Unit is extensively described for the first time. The contact can be observed directly only within the tombs in the intermediate levels (tombs 6, 7, 25, and 17), over the stairs leading to the Volumni Hypogeum. It is also quite clear through the old quarry front (Fig. 4C).

A third unit is indicated as Fornace Ferrini Clay. It crops out fairly close but is not documented inside the boundaries of the Necropolis (see the stratigraphic scheme in Fig. 4B).

3.1. Depositional architecture

Codes used in facies description and depositional architecture were derived from Miall (1991, with references therein) and Einsele (1992). Channels (Ch), gravel bars and bedforms (GB) and sandy bedforms (SB) are the only macro- and mesoforms recognizable throughout the Necropolis area, while overbank fines (OF) crop out just outside. Gravel and sand with parallel (Gp, Sp) and trough (Gt, St) cross-stratification are commonly described facies, accompanied by massive gravel (Gm), plain parallel-laminated sand (Sh), ripple-laminated sand (Sr), and plain parallel-laminated silt and clay (Fl).

3.1.1. Volumni Unit (Vol)

It crops out inside the Hypogeum and all the lowermost tombs (2, 3a, 3b, 4, 5, 31, 32, 32b), as well as in the lower part of tombs 6, 7, 17 and 25, and the quarry front (Fig. 5). Clearly identifiable channels characterize the unit, with longitudinal continuity and a wideness not able to be evaluated, due to outcropping conditions. The channel fill (Fig. 5) is organized in gravel bedforms (GB) in the lower part and upstream, passing upward and downstream into sandy bedforms (SB). In both cases, longitudinal to transversal migrant bars, with downstream Gp and Sp cross stratifications, prevail. Whereas facies Gm, Gt, St, and Sh are less frequent and only locally visible (for instance, see fig. 4 in Melelli et al., 2016), particularly within the Hypogeum, as well as lenticular horizons of clay/silt with Fl facies. The progradation of bars, the axes of channels and secondary flows, evaluated by measuring imbrications, identify transport directions dispersed between SSE and SSW. Three overlapping intervals are identified (depositional sequences), here indicated as Vol1, Vol2 and Vol3 respectively. The lower portion (but not the base) of the Vol1 interval is only visible within the Volumni Hypogeum (Ch 1 - Ch 4), and was previously described by Melelli et al. (2016), while the other two intervals are only described throughout the Palazzone Necropolis. The first two intervals (Vol1, Vol2) clearly show a fining-upward trend, whereas the third one is cut in its coarse portion by the deposits of the overlying Unit.

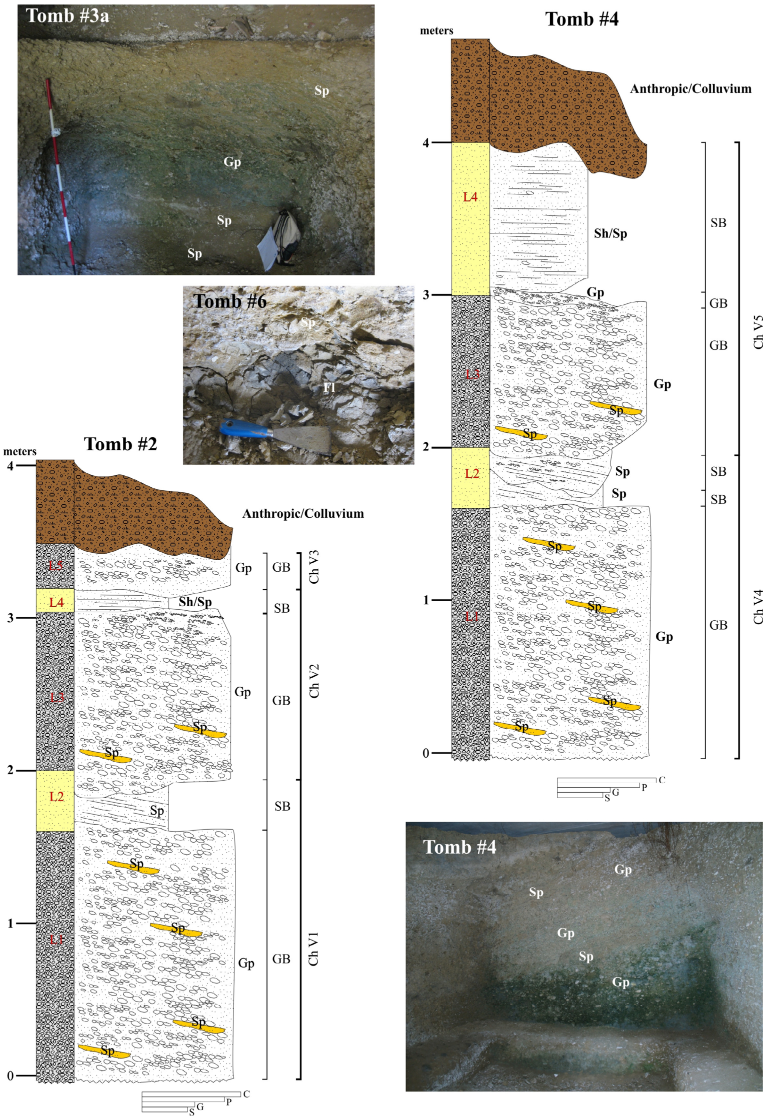

Fig. 5 - Lithofacies and sedimentary structures documented inside the Volumni Unit. L1-L5=levels measured inside each single tomb, Ch=Channel (V1-V5 refer to their progressive number inside the Volumni Unit), GB=gravel bars and bedforms, SB=sandy bedforms, Gp=parallel cross-stratified gravel, Sp=parallel cross-stratified sand, Sh=plain parallel-laminated sand, Fl=plain parallel-laminated silt and clay. Grain size scale: S = Sand, G = Granules, P = Pebbles, C = Cobbles.

3.1.2. Palazzone Unit (Plz)

It crops out inside tombs from 8 to 16, from 18 to 24, from 26 to 30b and from 33 to 36, in the upper part of tombs 6, 7, 17 and 25, and above the access stairway to the Volumni Hypogeum. It is finally visible at the top of the quarry front (Fig. 4C). Unlike the Volumni Unit, the depositional architecture appears more complex (Fig. 6), with channels showing a complex fill (multi-storey channels), first gravely/sandy (alternating GB and SB), then sandy (prevailing SB), with cross stratification Gt, St and Sp that overlap and intersect laterally, often with little continuity. Gravel and sands alternate with silt to clay horizons and lenses (facies Fl), often partially or totally reworked within channels and/or bars (clay chips). The continuity and/or lateral heteropy of facies is not easy to follow through the tombs. However, it is possible to recognize the progradation of structures in the current direction dispersed between NW and S (downstream accretion), according to a main transport axis (the axis of the channels) towards SW. Variation of the lateral facies is very marked transversely with respect to this axis (approximately towards NW-SE). Similar to what was observed for the underlying unit, two overlapping intervals (depositional sequences), indicated as Plz1 and Plz2, can be identified (Fig. 4B). The boundary is marked by a very extensive erosional surface both in the main transport direction and transversally to the same, which indifferently cuts both silty, and clay overbank deposits and channels/bars of the interval below. The Plz1 interval is partially visible above the entrance stairs to the Volumni Hypogeum and in the lower part of tombs 33 and 35-36, while the upper part of the latter and all the other outcropping situations of the Palazzone Unit can be traced back to interval Plz2.

3.1.3. Fornace Ferrini Clay

Finer deposits crop out widely just westward of the study area, although recent alluvial sediments and/or colluvium often cover them. This unit is made of crudely to thin-bedded clay and/or silty clay, and was previously reported as “Argille ad Helix” Unit (De Angelis D’Ossat, 1918) or “Fornace Ferrini Lithofacies” (Regione Umbria, 2010). This Unit consists of overbank and alluvial plain sediments, lateral to deposits visible inside the Necropo-

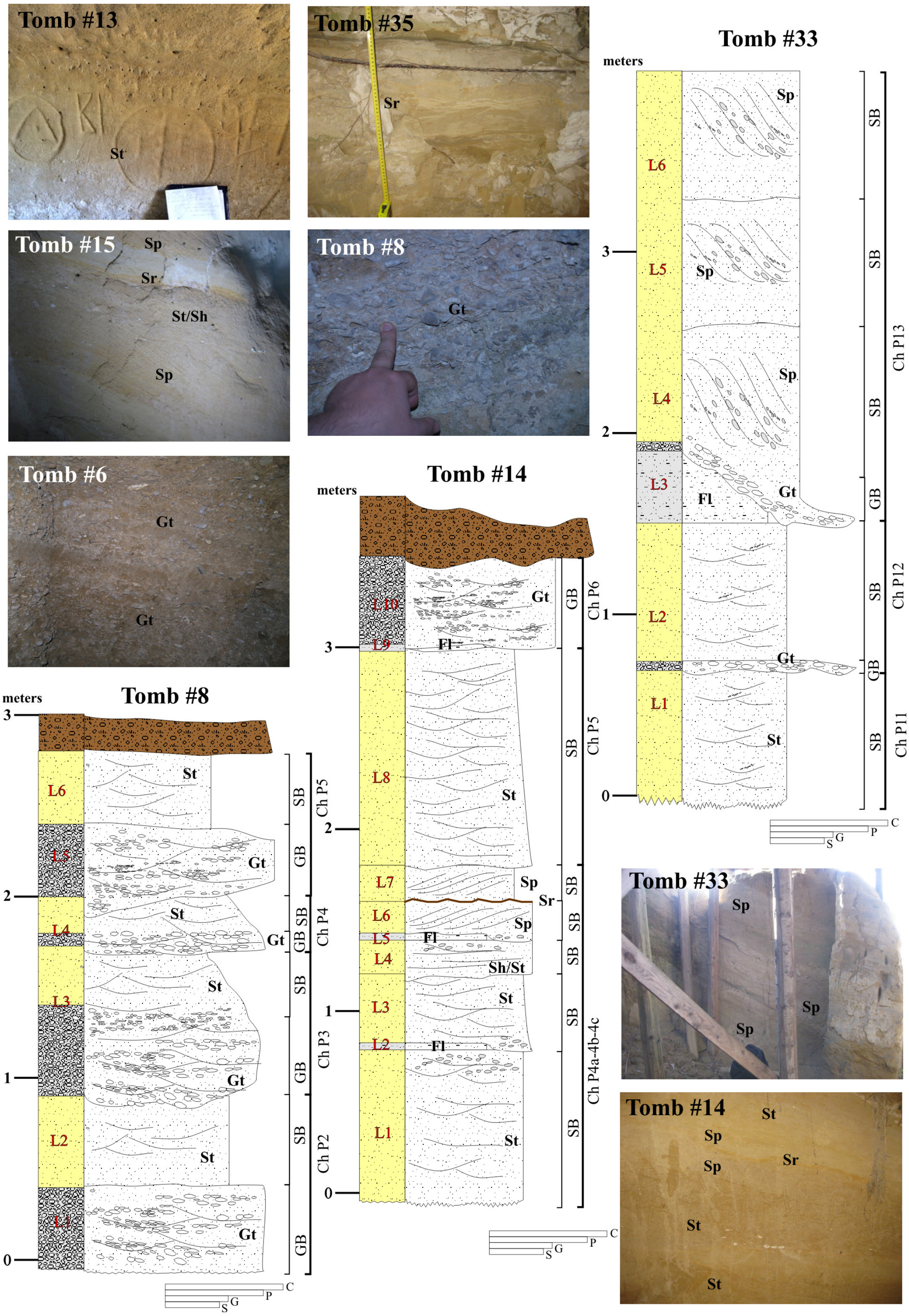

Fig. 6 - Lithofacies and sedimentary structures documented inside the Palazzone Unit. L1-L10=levels measured inside each single tomb, Ch=Channel (P2-P13 refer to their progressive number inside the Palazzone Unit), GB=gravel bars and bedforms, SB=sandy bedforms, Gt=trough cross-stratified gravel, St=trough cross-stratified sand Sp=parallel cross-stratified sand, Sh=plain parallel-laminated sand, Sr=ripple-laminated sand, Fl=plain parallel-laminated silt and clay. Grain size scale: S = Sand, G = Granules, P = Pebbles, C = Cobbles.

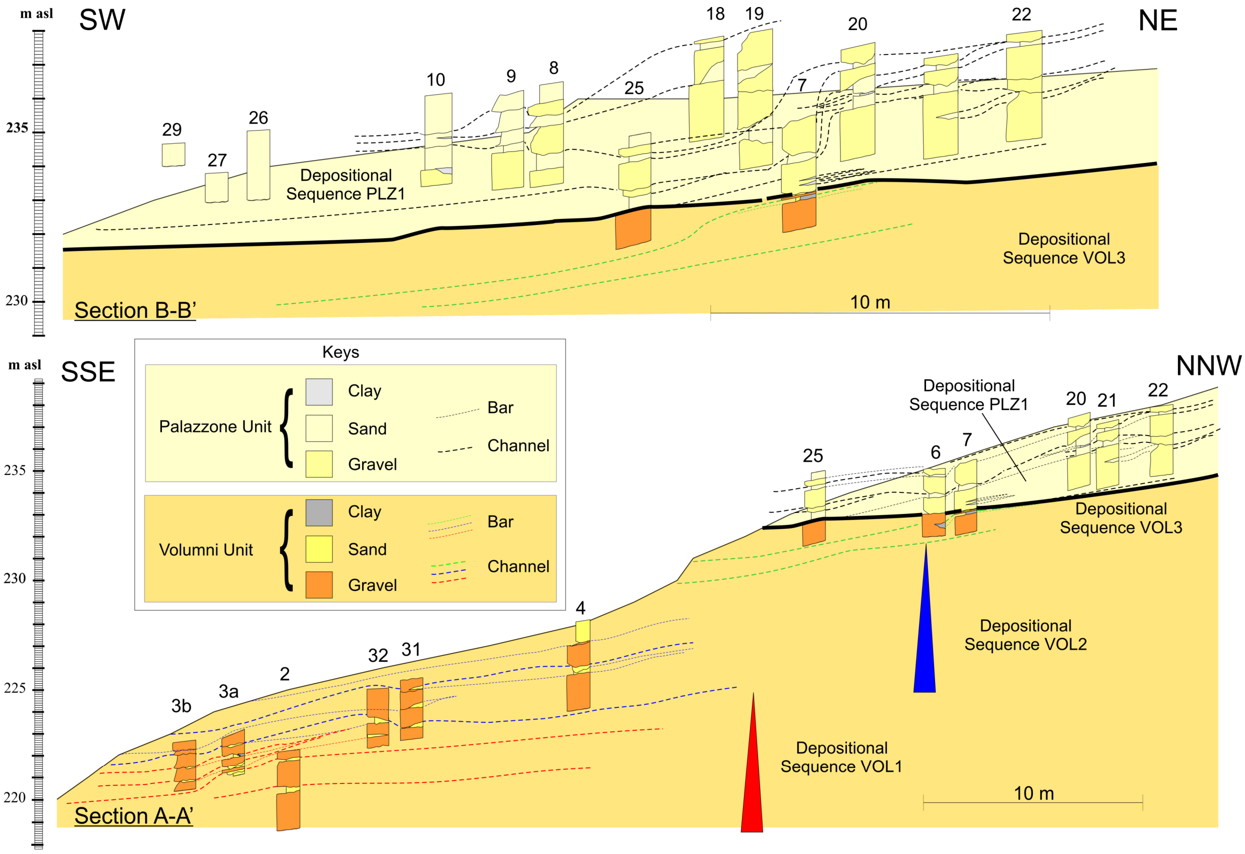

Fig. 7 - N-S (A-A') and SW-NE (B-B') profiles (see Fig. 4) through the Palazzone Necropolis, showing the vertical and lateral depositional architecture for Volumni and Palazzone Units.

lis (Fig. 4A, B).

3.1.4. Vertical and lateral organization

The measured dip directions are fairly constant, with minimal dispersion between SSE and SSW (Fig. 4B, C), and the two units show a minimal difference in slope, with Plz slightly (2° to 4°) more inclined than Vol. The surface separating the two units is a disconformity or a gentle angular unconformity surface (Figs. 4B, 7). Both units disappear southwestward, below recent alluvial deposits. A lateral and vertical transition between the Palazzone Unit and the Fornace Ferrini Clay appears reliable to the west of the area investigated (Fig. 4B). Presently, it is not clear whether the Fornace Ferrini Clay is also heteropic to the Volumni Unit.

4. PALAEOENVIRONMENTAL RECONSTRUCTION OF THE PALAZZONE NECROPOLIS: INSIGHTS FOR THE PERUGIA HILL

All the deposits analysed, based on the sedimentary facies described, can be easily referred to transport and sedimentation produced by traction currents, prevailing channelled, and/or by settlements of fines, and finally they are all associated with fluvial depositional context. As discussed by Melelli et al. (2016) for the Volumni Hypogeum, fluid flow processes dominate also throughout deposits observed in the Palazzone Necropolis, whereas deposits from gravitational processes or from sediment gravity flows sensu Lowe (1979) and Nemec & Steel (1984) are totally absent. The lack of forms due to lateral accretion (LA sensu Miall, 1991, with references therein), the geometries of gravel and sandy bodies, and the dispersion of the palaeocurrents lead us to associate the deposits of both units with braided fluvial systems. However, the depositional architecture assumes different settings for the two units, clearly indicating the overlap of two distinct patterns. Deposits of the Volumni Unit indicating the undercurrents are easily interpretable through classical depositional models for downstream migration of gravely, sandy, or mixed bars (Bluck, 1976; Hein & Walker, 1977; Steel & Thompson, 1983; Rust, 1984; Southard et al., 1984, among others). The depositional architecture of the deposits of the Palazzone Unit is more complex. The marked lateral variability of facies can be referred to the lateral variation of the flows, induced by the presence of previously deposited bars, or as a progressive construction of structures during different phases of flooding and power failure. Both cases refer to the models proposed by Bridge (1993).

The lower portion of intervals Vol1 and Vol2, as well as the visible part of Vol3, can be associated with shallow, gravely braided channels, similar to the Scott Type model, according to the classic river models proposed by Miall (1991, with references therein), as already proposed by Melelli et al. (2016) (Fig. 8). Both Vol1 and Vol2 intervals seem to evolve upwards to sandy braided fluvial systems, always of shallow depth, somehow according to the features of the Platte Type (Fig. 8). On the other hand, the deposits of the Palazzone Unit still identify a braided river system, with deeper major channels and the diffused occurrence of secondary channels and subordinated structures, somehow comparable with the Donjek Type model (Fig. 8). In any case, it should be noted that such parallelism could be exclusively descriptive, as these models are inspired by real cases in specific morphoclimatic contexts and not comparable with what characterized our latitudes during the Pleistocene. In this way, each river is a model in itself, often only partially comparable with those reported in the literature.

The facies described and their vertical and lateral association, both for the Volumni and the Palazzone Units, are probably associated with channel networks developed in the external portions of wide alluvial fans. The hypothesis of channels at the topset of a fan delta apparatus (Cattuto & Gregori, 1988) cannot yet be totally excluded in the case of the Volumni Unit. However, this interpretation seems less solid, in the light of an overlying river system (identified by the Palazzone Unit), lateral to an alluvial plain or in any case to a subaerial overbank.

According to Melelli et al. (2016), the presence of proximal alluvial facies already at low altitude on the present-day valley, added to those described in the past at the top of the Perugia Hill (Rosatini, 2012; Manassei, 2014), seems to refer to several overlapping apparatuses and to a fairly complex geological evolution.

The data collected in this work allow a first fluvial system (Volumni Unit) to be identified, clearly in a regressive phase, and a second system (Palazzone Unit), which, instead, advances towards the valley, at least in a first stage. The two overlapping river systems also have prevailing transport axes oriented in slightly different directions. For both, the area of the Necropolis highlights the pattern of the channels rather than the alluvial plain.

The unconformity dividing the two overlapping fluvial systems could indicate both significantly different ages, and/or an important change in the river regime, as the consequence of important climatic changes or tectonics. The first system can be thought of as an apparatus built at the mouth of a secondary one in the main valley, in a time span of progressive reduction of the energy of the relief due to tectonic stability or rising of the local base level. Such base level, given the lack of definitive geological evidence, could be identified as both an alluvial plain or a lake. The increased energy marked by the downstream progradation of the second system is probably accompanied by a wider and weakly inclined foothills towards the main fluvial plain, drained by a braided river network (braid-plain). Both significant tectonic activity and the setting of drainage in the meridian sense of the main valley (palaeo-Tiber) are possible in this phase.

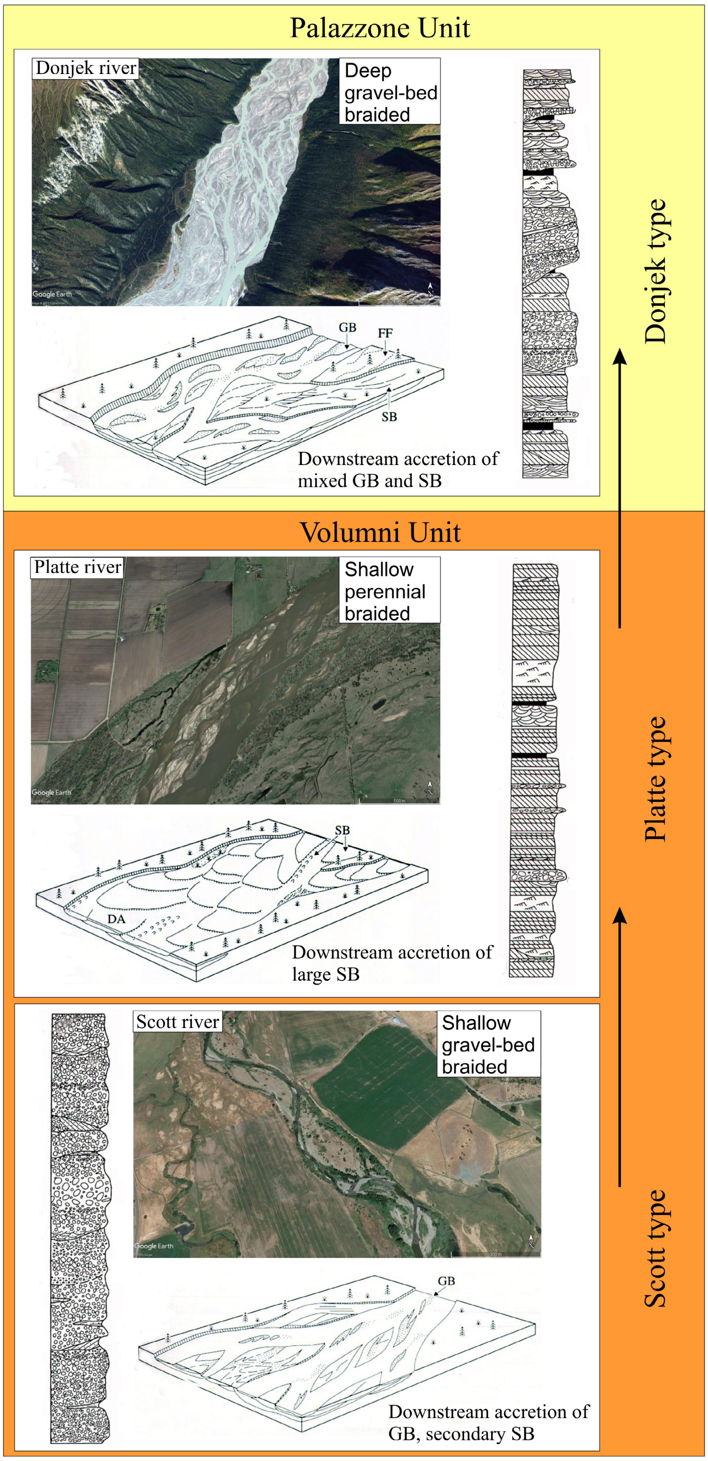

Fig. 8 - Palaeoenvironmental and palaeoecological restoration for study deposits, in accordance with the models of Miall (1991, and references therein). DA=downstream accretion macroforms, GB=gravel bars and bedforms, SB=sandy bedforms, FF=floodplain deposits.

The age for the two systems, as well as reasons for their superpositioning, is currently an open problem. The chronological attribution of the Volumni Unit is unclear, due to the lack of stratigraphic data. On the other hand, the fossil record reported from neighbouring sites (Fornace Ferrini, Villa Spinola, Piscille, and San Costanzo) allow the Palazzone Unit and its fluvial environment to be attributed to the early Pleistocene (probably Tasso F.U.: Argenti & Sardella, 2003; Argenti, 2004). This attribution would place the unit in lateral heteropy southwards with the Santa Maria di Ciciliano Unit (Ambrosetti et al., 1995; Basilici, 2000), westwards with the San Biagio Subsinthem (Regione Umbria, 2010; Argenti et al., 2013), and north- and eastwards with the Fighille Sinthem or equivalent Units (Cattuto et al., 1995; Pialli et al., 2009; Melelli et al., 2010; Plesi et al., 2010). Regarding the Volumni Unit and its palaeoenvironment, this river system could represent both an evolutionary phase immediately preceding and in continuity with the one marked by the Palazzone Unit, or it could be totally disconnected and belong to an even much earlier phase. The data collected up to now and the arguments presented above seem to favour the first hypothesis; however, only by including the two Units in the more general and complex framework of the evolution of the Perugia Hill will a correct and exhaustive evaluation be able to be made.

5. CONCLUSIONS

The land of urban areas is covered with buildings and infrastructures. For this reason and because of frequent transformations of the topographic surface to facilitate human settlement, it is rare to see the natural disposal of the geological succession. This being so, in most cases, the only possibility of determining the type and arrangement of the sediments is by investigating underground urban cavities. In historical cities, some cavities witness to the presence of ancient peoples and contain precious archaeological remains. Combining these two aspects, the geological features and the archaeological ones, some of these places may be defined as archaeo-geosites and could be an excellent attraction for high-level tourism.

The Palazzone Necropolis, one of the most famous Etruscan necropolises in central Italy, was investigated in order to define the area as an archaeo-geosite. The Necropolis is a good starting point in the restoration of the geological and palaeoenvironmental evolution of the Perugia Hill. The sedimentological features and the palaeodepositional restoration, indeed, lead to the reconsideration of the validity of some geological units proposed through time, as well as the scenario of a thick -layered, structured and long-lasting delta/fan delta apparatus. As clearly shown in the Palazzone Necropolis deposits, such evolution was rather articulated. Nonetheless, the Necropolis, as well as the other archaeogeosites in the urban area of Perugia, provides the opportunity to propose a geo-touristic route, expanding the multifaceted offer of Perugia.

In the Perugia Hill, where a fluvial (and alluvial) sedimentary sequence outcrops, urbanization and a very active fluvial and gravitational morphogenesis cover a large part of the natural sediments with buildings, infrastructures or colluvial and debris deposits. For this reason, the underground cavities such as the Palazzone Necropolis can play a key role in the palaeoenvironmental reconstruction of the area. In particular, the sediments where the graves were dug may be explained as two first fluvial systems. The lower, named Volumni Unit, is in a regressive phase, while the second one (Palazzone Unit) is advancing towards the Tiber River Valley. An unconformity divides the two overlapping fluvial systems, indicating significantly different ages and/or an important change in the river regime. Both hypotheses suggest relevant climatic changes or tectonics. Thus, the study site plays a key role in reconstructing the Quaternary evolution of the Perugia Hill and, in a broader sense, the Tiberino Basin.

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