

THE UPPERMOST MIDDLE PLEISTOCENE-HOLOCENE ALLUVIAL DEPOSITS OF THE UPPER TIBER BASIN (NORTHERN APENNINES, CENTRAL ITALY): CHRONOLOGIC CONSTRAINTS FROM ARCHAEOLOGICAL DATA

Marco Benvenuti¹, Adriana Moroni², Francesca Tangocci¹,

¹Dipartimento di Scienze della Terra, Università di Firenze, Italy

²Unità di Ricerca di Ecologia Preistorica - Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente - Università di Siena, Italy

Corresponding author: Marco Benvenuti <marcob@geo.unifi.it>

ABSTRACT: The paper reports the results of a geomorphologic and stratigraphic study of the NW portion of the Upper Tiber Basin (Central Italy), and focuses on the terraced alluvial deposits which are grouped into late Middle-Upper Pleistocene (MUP) and Holocene (HOL) units. The drainage development in the basin was deeply influenced by an active tectonic setting characterized by orthogonal fault systems, which forced river deviations and attracted alluvial deposition in the subsiding portions of the basin. The occupation of this intermountain territory by ancient human communities is recorded by late Prehistoric-Protohistoric archaeological findings collected within or on the surfaces delimiting these units. This archaeological dataset allowed an indicative dating of the major stages of the fluvial evolution between the end of the middle Pleistocene and the late Holocene. The chronological constraint indicates that the morpho-stratigraphic events recorded in the MUP and HOL units, have reasonably occurred within the two last glacial-interglacial cycles. Rapid climate changes, affecting the surface hydrology and the sediment supply to the river systems, and the active tectonic setting, thus, may account for the gaps in the local archaeological record, including most of the late Paleolithic, the Mesolithic and the early Neolithic. Late Pleistocene and the early Holocene stages of relevant alluvial deposition in a subsiding basin may have caused the burial of the missing cultural stages or may have prevented the human occupation of hydraulically unsafe valley floors.

Keywords: Alluvial terraced deposits, Intermontane basin, Archaeology, Middle Pleistocene-Holocene, Central Italy.

1. INTRODUCTION

Despite several techniques are suitable for the geochronological calibration of the Quaternary successions (Walker, 2005), a major problem in the study of terraced alluvial deposits is frequently represented by their dating. Nevertheless, temporary or stable human settlements have occupied alluvial plains, especially during the Late Quaternary. This is testified by archaeological remains spanning the late prehistorical-historical cultural stages. The Geoarchaeology of alluvial plains (Brown, 1997; Woodward & Huckleberry, 2011), thus, may provide suitable tools for analysing the dynamics of these environments induced by concurrent natural and anthropic processes. In the Northern Apennines (Central Italy) terraced fluvial deposits occurring in several intermountain basins (Fig. 1a), are ascribed to the late Quaternary on the basis of weak morpho-stratigraphic constraints, often lacking absolute dating. The occurrence of archaeological remains on the surfaces and within the alluvial deposits of this region, attests to a human occupation dating back to the Prehistory. The dating of different cultural stages that developed in Central Italy may be quite precise for the late Prehistory (late Pleistocene-early Holocene)-Protohistory (mid-late Holocene) interval, becoming extremely accurate in historic periods. This feature makes the archaeological data a suitable tool for an indicative to accurate chronologic constraint of late Quaternary landforms and deposits occurring in this region.

In this paper we present the spatial and strati-

graphic distribution of terraced alluvial deposits in the intermountain Upper Tiber Basin (NE Tuscany, Central Italy) referred to the latest Middle Pleistocene-Holocene on the base of the distribution and dating of archaeological materials collected in the last decades.

2. REGIONAL SETTING

The study area is located in the upper reach of the Tiber River, barred by the Montedoglio Dam and including the tributaries Singerna, Sovara, Tignana and Afra creeks. This is a portion of the Upper Tiber River basin (UTB, Figs. 1, 2), a NW-SE trending intermountain depression about 21 km long and 10 km wide, flanked by steep hills composed of Miocene turbiditic sandstones (Tuscan and Umbro-Marchean units respectively) to the NNE and SSW and Jurassic-Eocene ophiolites, limestone and marls (Ligurid units) to the NNW. The basin is bounded by the Alto Tiberina Fault along the SW shoulder (ATF, Figs. 1b, 2) and by the antithetic Sansepolcro Fault on the opposite side (SsF in Fig. 2; Barchi & Ciaccio, 2004). The NW-SE elongated Anghiari-Citerna hills are delimited toward the Tiber plain by the ATF-synthetic Anghiari Fault and cross-cut by NE-SW trending faults (Fig. 2). A portion of a basin fill about 1,000 meters thick (Sani et al., 2009), is exposed on the flanks of these hills (Benvenuti, 1989; Cattuto et al., 1995; Piali & Plesi, 2009), consisting of 150 m thick Lower-Middle Pleistocene alluvial gravels, sands and subordinated

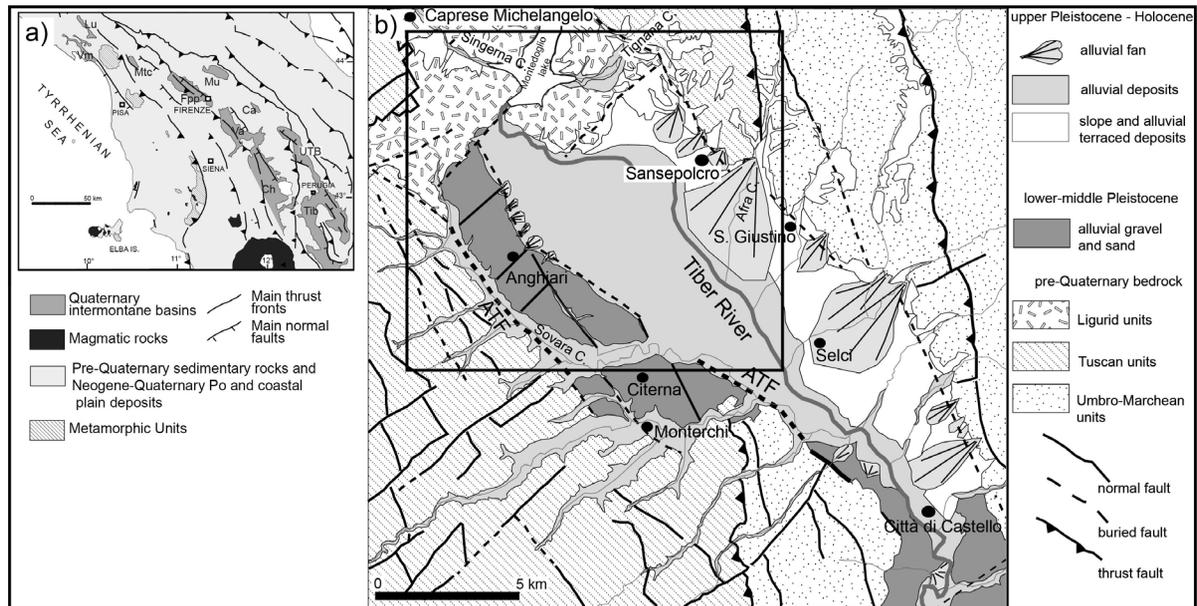


Fig. 1 - Generalized geological maps: a) distribution of intermontane basins of the Northern Apennines. Codes of the basins: Lu: Lunigiana; Vm: Val di Magra; Mtc: Montecarlo; Fpp: Firenze-Prato-Pistoia; Mu: Mugello; Ca: Casentino; Va: Upper Valdarno; Ch: Valdichiana; UTB: Upper Tiber Basin; Tib: Tiberino (after Sani et al., 2009); b) schematic geology of the UTB; ATF: Alto Tiberina Fault. The boxed area represents the portion of the basin investigated in this study (Fig. 2).

muds subdivided in this study into four main units (Fig. 2; Tab. 1). The older, Monterchi-Citerna-Fighille unit (MCF, Fig. 2), includes final lower Pleistocene floodplain-palustrine sands and muds (MCF1) (Ciangherotti & Esu, 2000; Argenti, 2003-2004) erosively overlain by early Middle Pleistocene fluvial arenaceous-calcareous gravels, sands and muds (MCF2) (Benvenuti, 1989). The MCF unit is tilted against the ATF (cross section in Fig. 2; Sani et al., 2009) and unconformably overlain by the Anghiari unit (ANG), made of Middle Pleistocene fluvial calcareous gravels (ANG1) unconformably overlain by deeply weathered fine conglomerate and sand (ANG2) (Van Waveren, 1986). The Tiber River plain is characterized by alluvial and colluvial deposits (MUP and HOL units, Fig. 2) that are described and discussed in more detail in section 4.

3. ARCHAEOLOGICAL RECORDS

Since Prehistory and Protohistory the Upper Tiber Valley has represented a strategic connection route across the Northern Apennines divide as documented by extensive archaeological surveys (Moroni Lanfredini & Benvenuti, 2010; Fig. 2). The Middle Palaeolithic is the earliest period recorded. This is represented by stone tools collected southwest of Anghiari on the surfaces of the ANG2 unit and in the palaeoSovara terraced deposits (MUP2 at *Castel di Sorci* and nearby sites, site 1 in Fig. 2; Cocchi et al., 1978; Borgia & Moroni Lanfredini, 2004, Moroni et al., 2011) attesting to the presence of Neanderthal groups for seasonal hunting and gathering. The lithic assemblages are characterized by *Levallois* and, subordinately, discoid production systems and include mainly side scrapers, points, denticulates (Fig. 3a-c) and rare handaxes.

The Early Upper Paleolithic is documented on the

NW slopes of the basin by an Aurignacian lithic industry, very rich in *burins des Vachons* (Fig. 3d-e), recovered near Caprese Michelangelo (Fig. 1b) (Moroni Lanfredini & Ronchitelli, 2001), which dates back around 30 ka ago (Arrighi et al., 2006). The floodplain occupation is recorded from the Final Upper Paleolithic in the *Consuma 2* site (site 2 in Fig. 2; Moroni, 1990), presently flooded by the Montedoglio lake, by a Final Epigravettian lithic assemblage dating back to around 12 ka ago, characterized by microlithic backed tools. Evidence of the human presence on the valley floor during the early Holocene is fragmentary with a missing Mesolithic stage and only few Early Neolithic findings discovered in the Tiber plain (*Consuma*, site 2 in Fig. 2). The Neolithic to Eneolithic (Copper Age) transition is recorded near the Tiber River (*Consuma 1* and *Moresco*; sites 2 and 3 in Fig. 2; Castelletti et al., 1992; Moroni Lanfredini, 1995-1996), by two open-air sites which yielded pottery decorated with the Late Neolithic *Chassey* style and pot-shapes and handles typical of the Early Eneolithic of Central Italy. The Middle Eneolithic is currently attested by sporadic material, while the late Eneolithic/Early Bronze Age period (*Vaso Campaniforme* stage) is represented by the *Consuma 2* and *Salcastrino delle Lole* sites (Fig. 3f-i) (sites 2 and 4 in Fig. 2; Moroni, 1990; Guidi & Moroni Lanfredini, 2001). The Bronze Age, particularly its middle stage, marks a period of wider occupation in the plain close to the Tiber River banks or in the narrow valleys of its tributaries. Almost the whole of the Early Middle Bronze Age sites is on the Tiber floodplain (*Salcastrino delle Lole upper layer*, *Consuma 4*, *Gragnano*; sites 2, 4, 5 in Fig. 2; Moroni Lanfredini & Ronchitelli, 1997; Guidi & Moroni Lanfredini, 2001). The Middle Bronze Age (Apennine phase) recorded at *Gorgo del Ciliugio* (site 6 in Fig. 2; Fig. 3l-m; Arrighi & Moroni Lanfredini, 2004) and around Caprese Michelangelo, points to settlements on the higher slopes. A significant

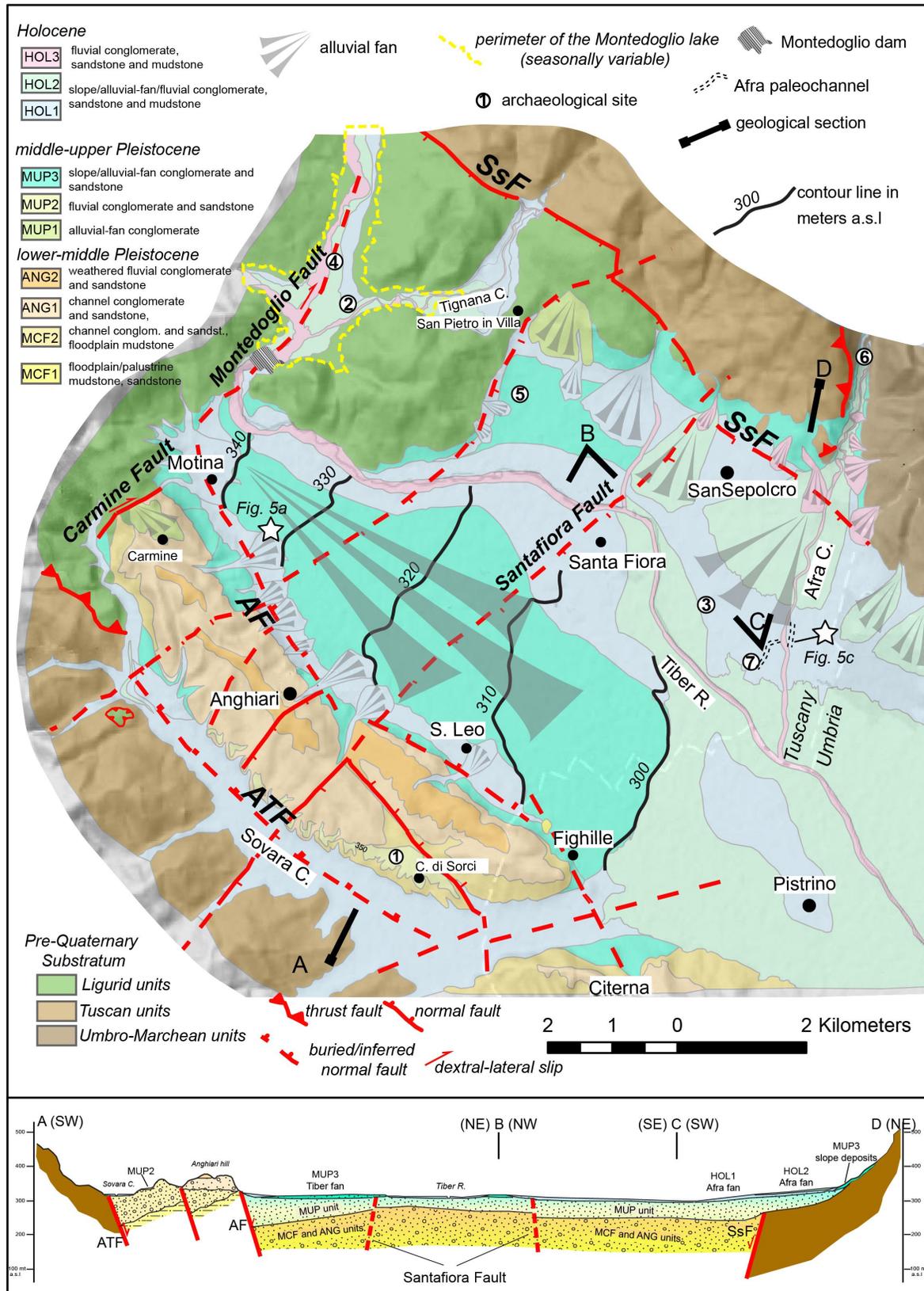


Fig. 2 - Detailed geological map and cross section of the study area with the location of selected archaeological sites discussed in the text: 1: Castel di Sorci; 2: Consuma 1-4; 3: Moresco; 4: Salcastrino delle Lole; 5: Gragnano; 6: Gorgo del Ciliegio; 7: Trebbio. ATF: Alto Tiberina Fault; AF: Anghiari Fault; SsF: Sansepolcro Fault.

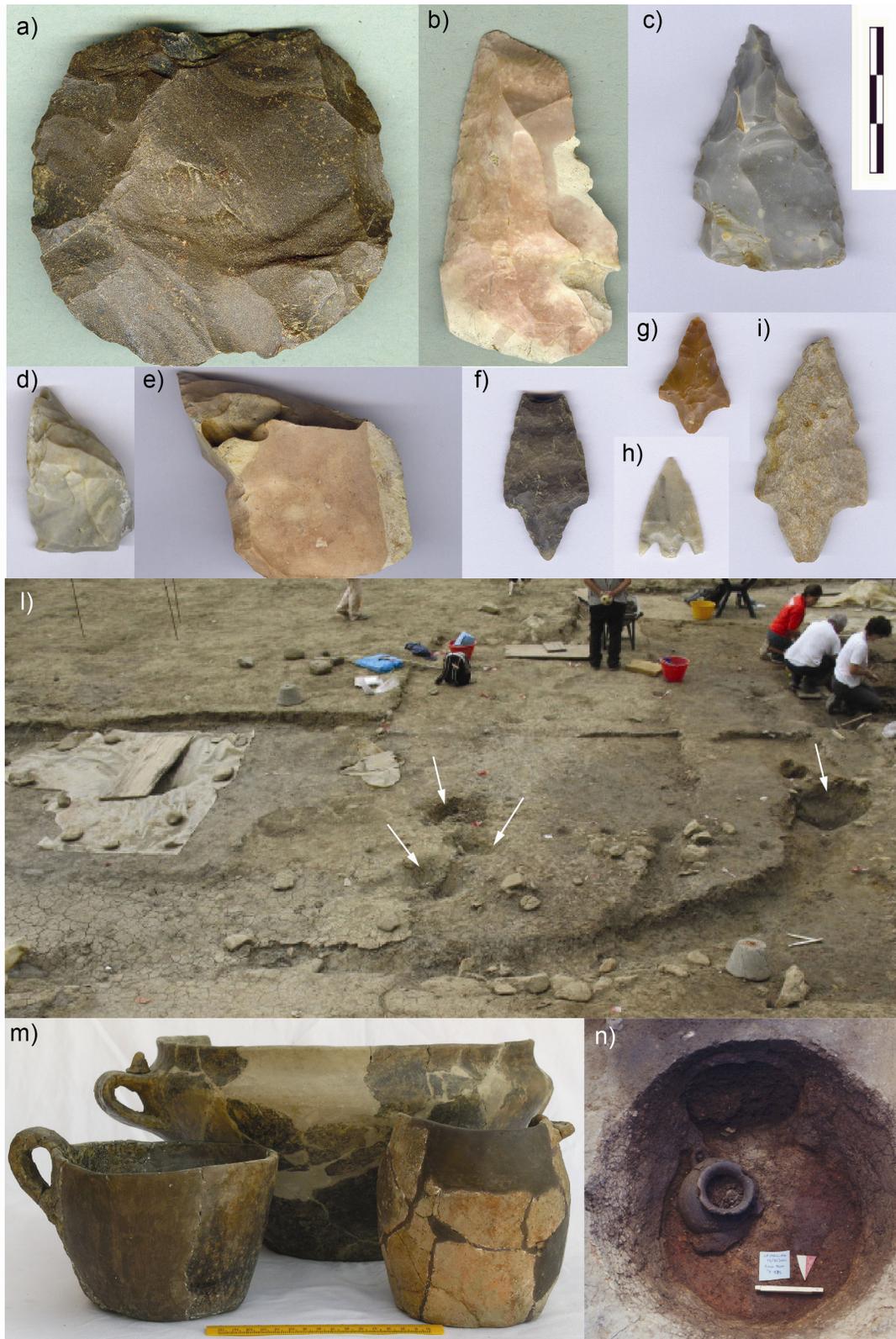


Fig. 3 - Archaeological materials from the UTB: a-c) Middle Paleolithic stone tools from *Castel di Sorci*: a) *Levallois* core; b) sidescraper; c) point; d-e) Aurignacian *Burins de Vachons*; f-i) Late Eneolithic/Early Bronze Age flint arrowheads from various sites. The division of the graduate bar for a) to i) is 1 cm; l) the *Gorgo del Cillegio* site excavated in the late summer of 2011: the semi-circular ditch and some postholes (white arrows) attests to dwelling remains, persons for scale; m) a selection of pottery from the *Gorgo del Cillegio* site, the rod for scale is 20 cm long; n) an oven from the Iron Age *Trebbio* site, reused as a dustbin for pottery and other materials. Rod for scale is 20 cm long.

occupation of the floodplain during the Iron Age is recorded south of Sansepolcro by a 20-hectares wide proto-urban settlement (*Trebbio*, site 7 in Fig. 2; Iaia & Moroni Lanfredini, 2009), characterized by well-developed handicraft activities mostly related to pottery production (Fig. 3n).

When plotted against time, the Prehistoric-Protohistoric archaeological record of the UTB, thus, shows a pattern of documented cultural stages separated by quite long periods of missing or occasionally represented cultures (Fig. 4a). The calibration of artefact assemblages mostly collected within the deposit of the different units described below has been obtained by a variety of methods, reported in the papers cited above, including comparison with well-dated archaeological materials from other Italian localities, and radiocarbon dating of charcoal derived from the human activity.

4. GEOMORPHOLOGY AND STRATIGRAPHY OF THE LATEST MIDDLE PLEISTOCENE-HOLOCENE SUCCESSION

The landforms and the underlying sediments referred to units MUP and HOL (Fig. 2) are briefly described in this section providing a geomorphologic picture quite different from those represented in the existing geological maps (Jacobacci & Malatesta, 1969; Piali & Plesi, 2009).

4.1. MUP Unit

Landforms and deposits referred to this unit (Fig. 2) are further subdivided in sub-units MUP1-3 on the base of geomorphologic and stratigraphic lines of evidence.

4.1.1. MPU1 sub-unit

Arenaceous-ophiolitic boulder to pebble-sized gravels (MUP1) is exposed for few meters at a road cut NW of Anghiari. The gravels are poorly stratified and show a clast-supported texture with abundant sandy-silty interstitial matrix. Clasts are rounded to well-rounded showing an embriation hinting to paleocurrents from NW. This outcrop is at the base of a fan-shaped, relief considered the evidence of a small alluvial fan fed by the paleoSovara Creek that flowed from NW to SE. A SW-NE trending fault (Carmine fault in Fig.

2) that places the ophiolites of the Ligurid Units in contact with these and older Quaternary deposits of the Anghiari hill, suggests a tectonic control on a possible diversion of the Sovara Creek, today flowing to SW.

4.1.2. MPU2 sub-unit

Remnants of a fluvial terraced surface occur on the right of the Sovara Creek with a wider patch near *Castel di Sorci*, a few kilometers SE of Anghiari. At this location, the terrace, standing about ten meters above the modern valley floor, contains gravel, sand and mud referred to the MUP2 sub-units. These deposits are affected by a deep yellowish-reddish paleosol bearing Middle Paleolithic stone implements (Fig. 3a-c; Cocchi et al., 1978; Moroni Lanfredini & Benvenuti, 2010; Moroni et al., 2011).

4.1.3. MPU3 sub-unit

The Tiber River plain between Montedoglio Dam and Santa Fiora village is a large NW-SE trending fan-shaped surface topographically outlined by contour lines oriented transversally to the basin (Fig. 2). Such morphology indicates an abandoned large alluvial fan possibly fed by the Tiber and/or Singerna rivers. The latter behaved as distributive fluvial systems (Hartley et al., 2010), that is, axial rivers flowing into a subsiding basin that expand into terminal alluvial fans. Notably, the occurrence of such a large relict fan in the Tiber plain is not detectable in the existing geological maps (Jacobacci & Malatesta, 1969; Piali & Plesi, 2009), which represent it as the active floodplain of the Tiber River (Tab. 1). The deposits subtended by this fan-shaped plain are referred to sub-unit MUP3 and have been partially observed in a 2.5 meters deep excavation (Fig. 5a, location on Fig. 2). From the base, the deposits consist of about 2 meters thick clast-supported and well-rounded arenaceous pebble-sized gravels and sand affected on top by a well-developed reddish paleosol. This is buried by medium-fine yellowish sand, 0.5 meters thick. The buried soil suggests that the fan remained morphologically stable for a relatively long time, later on covered by the toe of a small alluvial fan (HOL 1 sub-unit, see below) fed by a local stream and not by the main Tiber River. The soil development, thus, indicates that the fan was abandoned due to a possible feeder deviation. The NW-SE trend of the MUP3 fan does not

Geological Map of Italy, 1:100,000 sheet 115 "Città di Castello"	Geological Map of Italy, 1:50,000 sheet 289 "Città di Castello"	This study
dt (slope talus) q1 ("old" terraced alluvial deposits) q2 (terraced alluvial deposits) a (recent alluvial deposits)	b2 (colluvial deposits) bn (terraced alluvial deposits) b (recent alluvial deposits)	HOL1-3 sub-units MUP3 sub-unit
QT2 (fluvio-lacustrine clay, sand and gravel)	MCT2 (Monterchi Synthem: Anghiari sub-synthem)	MUP1-2 sub-units ANG1-2 sub-units
	CTA2a-CTA2c (Citerna Synthem: Monte Rodondo sub-synthem)	MCF2 sub-unit
QT1 (lacustrine clay)	FHL (Citerna Synthem: Fighille sub-synthem)	MCF1 sub-unit

Tab. 1 - Comparative scheme of the stratigraphic subdivisions adopted in this study and in the existing geological maps (Jacobacci & Malatesta, 1969; Piali & Plesi, 2009) of the study area.

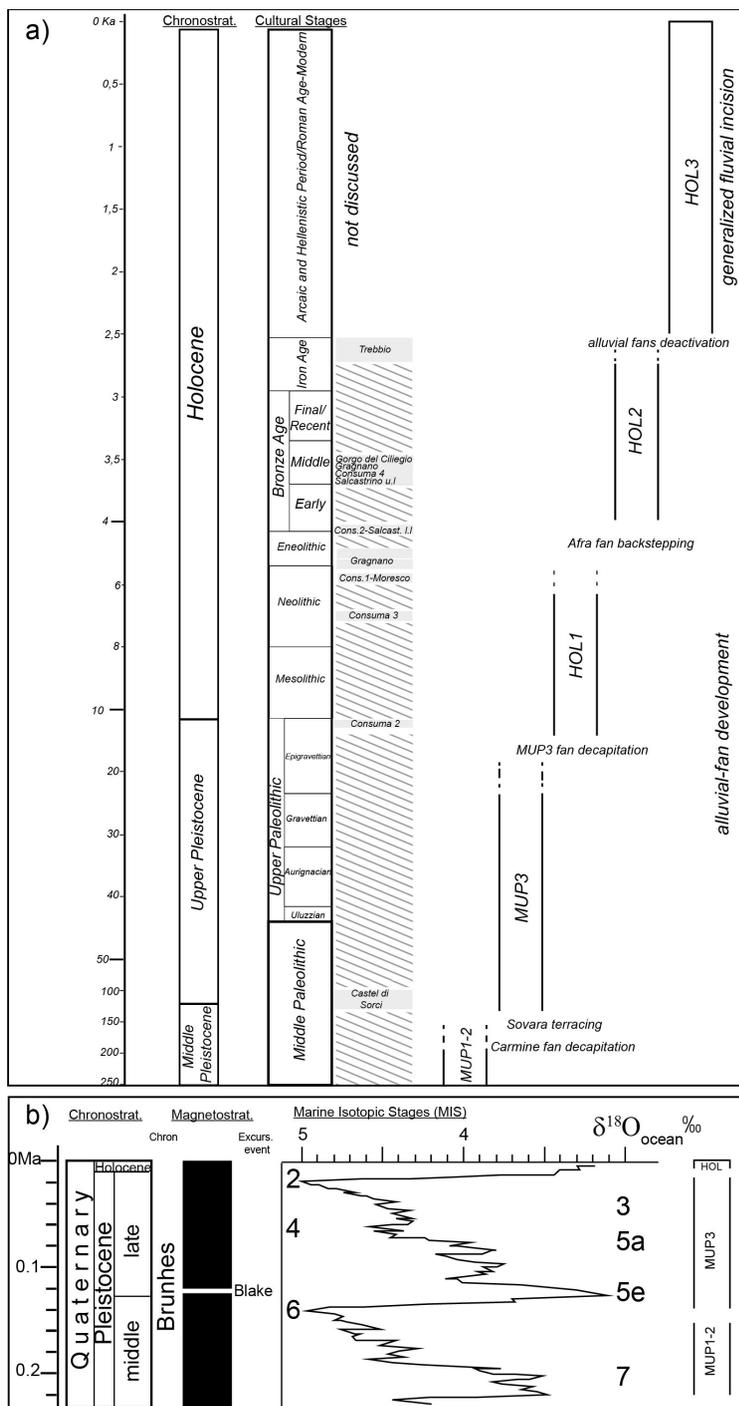


Fig. 4 - Archaeology and Chronology of the UTB: a) the archaeological stages documented in the UTB and the approximate duration of the morpho-stratigraphic units. Hatched intervals refer to missed cultural stages possibly due to: 1) still not discovered materials, 2) prevented occupation of unsafe alluvial plains, 3) materials eventually buried by alluvial deposition; b) the basin stratigraphy compared with the chronostratigraphy, magnetostratigraphy and marine isotope stages of the late Quaternary.

match the WSW-ENE orientation of the present Tiber valley upstream the Montedoglio Dam fitting on the contrary the proximal valley reaches of the Singerna and Tiber rivers which may represent the original fan feed-

ers, then displaced by a NE-SW dextral fault (Montedoglio Fault in Fig. 2; see Sani et al., 2009).

A few km east of San Pietro in Villa (Fig. 2), a further N-S trending fan-shaped hill faces the NW corner of the Tiber plain. Despite the lack of outcrops, the surface sediments are arenaceous and subordinate calcareous gravels indicating a thin clastic sedimentary cover on the Ligurid limestone and marlstone bedrock. This landform and the related clastic deposits are ascribed to MUP3 sub-unit and interpreted as the evidence of a further small alluvial fan originally prograding in the Tiber plain and then beheaded from its original fluvial feeder. The latter was the precursor of the Tignana Creek whose entrenched valley is characterized by a proximal N-S trending reach, coaxial with the San Pietro in Villa fan. In proximity of the NW prosecution of the Sansepolcro fault, the valley turns in a NE-SW trend reach. This evidence suggests that also the Tignana Creek may have diverted as the consequence of active faulting.

4.2. HOL unit

Landforms and deposits ascribed to the HOL unit (Fig. 2), occur in the lowermost and partly still active alluvial plains. This unit is further subdivided in the HOL1-3 sub-units coinciding with three distinct alluvial surfaces.

4.2.1. HOL1 sub-unit

The HOL1 alluvial plain is entrenched in the MUP and older units. The distribution of this landform in the Tiber River valley as well as in the valleys of its tributaries, testifies to the development of stream channels and adjacent floodplains upstream from the bridge between Santa Fiora village and Sansepolcro town (Fig. 2). Downstream, the HOL1, though dissected by the HOL2 and the modern river network (HOL3), widens in a surface that hints to a further Tiber alluvial fan. A lobed morphology, with a main NE-SW oriented axis, ascribed to this sub-unit characterizes also the plain of the adjacent Afra Creek, suggesting the possible coalescence of the tributary HOL1 Afra fan. The deposits subtended by these surfaces are not exposed and a partial view of the HOL1stratigraphy derives from the excavation of the Consuma 2 site before the valley flooding upstream the Montedoglio dam (Fig.2; Moroni, 1990). In a 3-meter deep trench excavated in deposits morphologically correlated to the HOL1 sub-unit, the lower part consisted of brownish pebblesize and clast-supported conglomerate (Fig.5b), overlain by mottled sandy mudstone with pebbly lenses on top.

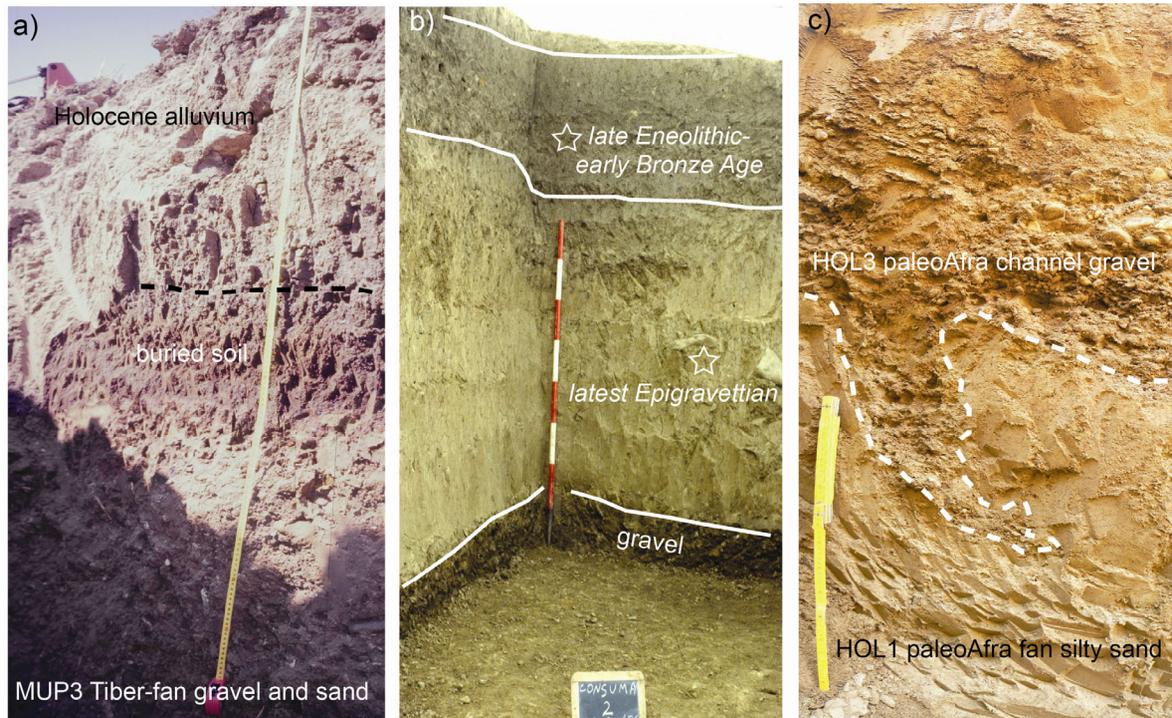


Fig. 5 - Stratigraphy of selected trenches excavated in the UTB: a) the stratigraphic profile in the trench dug onto the MUP3 Singerna-Tiber fan, location in Fig. 2); b) the Consuma 2 site stratigraphy (location in Fig. 2 site 2); c) HOL3 palaeoAfra channel fill (delimited by the dotted white line) resting over the distal deposits of the HOL 1 Afra fan. The gravelly channel fill is characterized by a pillar-like structure protruding into the underlying muddy sand which hints to the liquefaction of the latter deposits, of possible paleoseismic origin. Trench location in Fig. 2.

Final Epigravettian stone tools (Moroni, 1990) have been found in the middle of these deposits together with isolated arenaceous cobbles. The upper part was characterized by a lag of pebble-sized conglomerate overlain by massive dark mudstone bearing late Eneolithic-Early Bronze age stone tools indicating a middle Holocene reoccupation of this river bank. At the SW margins of the Tiber plain, slope deposits and small alluvial fans developed at the foot of the Anghiari hills represent the HOL1 sub-unit. These fans, fed by the gravel-rich ANG1-2 units, evidently graded at a base level different from that of the main river network. The inferred activity of the Anghiari fault (Delle Donne et al., 2007) and the confinement of the MUP3 fan lobe, concurrently determined a local topographic low for the fan deposition fed by the short and steep creeks draining the Anghiari hill.

4.2.2 HOL2-3 sub-units

In the Tiber plain the landforms and deposits ascribed to HOL2 unit point to a geomorphic development similar to that recorded by the HOL1. A river channel entrenchment widens downstream in a relatively larger plain attesting to a progressive telescopic shift toward SE of the Tiber fluvial-fan complex. Similarly to the previous unit, small alluvial fans graded to a higher base level with respect to the HOL2 plain. Notably, the alluvial fans ascribed to HOL2 sub-unit occur only SE of Santa Fiora on the left of the Tiber River. The HOL2 Afra fan is the largest one. Unit HOL3 represents the recent fluvial landforms in the plain. These are related to the narrow (and up to 5 meters deep) river valleys incised in the older units and by small alluvial fans that aggraded onto

the fans of the HOL2 unit. The related deposits have been investigated in a trench excavated on the left of the modern Afra channel, about 0.9 km NE of the *Trebio* site (Figs.5c; 2 site 7). The alluvial succession is composed of about 1.30 meters of mottled muddy sand with land snail shells referred to the distal portion of the HOL1 Afra fan. These deposits are overlain by 0.8 m thick lenticular gravel bed that records a HOL3 palaeoAfra channel, in turn overlain by 0.4 meter thick muddy sand representing the overbank deposits of the nearby active Afra channel.

5. THE ARCHAEOLOGICAL CONTRIBUTION TO A CHRONOLOGIC CONSTRAINT OF MUP AND HOL UNITS

The ancient human occupation of the UTB is considered largely controlled by the alluvial dynamics recorded by the MUP and HOL units, which in turn resulted from a balance between active tectonics and climate variations. From one side the material evidence of occupation of alluvial plains is considered a proof of local reduced alluvial sedimentation and attitude to flooding, conditions that made safe the temporary and/or stable settling of human communities on these surfaces. From the other side the gaps in the archaeological record of the UTB, beside indicating still undiscovered cultural stages, may reflect: 1) sporadic and/or absent occupation of areas of active alluvial deposition such as the documented large alluvial fans or 2) sediment deposition that buried any material evidence of possible land occupation.

Under these assumptions the archaeological record, included its hiatus, may be considered for dating the depositional stages represented by the units and sub-units described above (Fig. 3a).

1) The Middle Paleolithic stone tool assemblage found within the MUP2 deposit of the *Castel dei Sorci* terrace indicates that possibly around 130-100 ka ago Neanderthal populations moved on the Anghiari hills flanked to SW by a terraced paleoSovara valley. The fault-controlled deactivation of the MUP1 Sovara fan was followed by the incision of a MUP2 Sovara valley trending as the present one.

2) From the Anghiari hills Neanderthals could have seen the MUP3 fans in the plain, which were active up to the latest Pleistocene. This chronologic reference is suggested by the final Epigravettian tools, collected in the stratified *Consuma 2* site, upstream the Montedoglio dam, and confidently referred to about 12 ka ago. The latest Palaeolithic people occupied the left bank of the WSW-ESE trending Tiber valley evidently when the MUP3 fans would have been inactive due to the fault-controlled deviation of the Singerna-Tiber and Tignana rivers. The long span of time, characterized by the missing of most of the late Paleolithic during the late Pleistocene, coincided with huge sedimentation on the Tiber alluvial fan that may have prevented a stable human occupation of the plain and/or may have buried any artefact.

3) Similarly, the missing/sporadic Mesolithic and Neolithic stages suggest that the Tiber valley floor was unsuitable for stable human occupation also during the early Holocene. The HOL1 sub-unit developed during this span of time.

4) The geomorphic setting related to less intense fluvial processes evidently determined favourable condition for a safe settling on the valley floor since the Eneolithic and particularly in the mid-late Holocene when the alluvial plains were occupied by Bronze-Iron ages people. HOL 2 unit testifies to a period of renewed alluvial-fan development particularly in the Afra Creek plain. Here the human occupation shows a gap from the Middle Eneolithic (*Moresco* site) to the Iron Age (*Trebbio* site) which is considered an approximate duration of the HOL2 Afra fan development.

5) Finally, the large *Trebbio* settlement in the Afra plain is indicative of the human presence during the development of the HOL3 sub-unit. The latter marks a period of generalized fluvial incision in the basin and definitive deactivation of the large alluvial fans, which established safe hydraulic conditions on the terraced alluvial plains.

Despite the active tectonic setting may have represented a primary factor controlling the alluvial dynamics, autogenic processes of alluvial-fan deposition (Schumm et al., 1987; De Celles et al., 1991) may be not ruled out. The progressive south-eastward migration of MUP3-HOL2 alluvial fans in the Tiber plain may have also determined by channel entrenchment in response to local modification of base level induced by the fan lobes.

When compared with the Marine Isotope Stratigraphy (Fig. 3b), the latest Middle Pleistocene-Holocene alluvial deposits and landforms of the UTB reasonably encompass at least two major glacial/interglacial cycles including the marine isotopic stages (MIS) 7-1. The effects of these climatic changes on water discharge, sed-

iment production and transfer may have affected the geomorphic dynamics recorded by the MUP and HOL units. An analysis of the fluvial response to climate change during the last 200 ka in the Mediterranean Basin (Macklin et al., 2002), indicates that, despite differences related to local morpho-tectonic settings, alluvial deposition occurred particularly during glacial stages (i.e MIS6 and between the late MIS5 and MIS2). In the studied case this seems confirmed by the large MUP3 Tiber fan whose development reasonably encompasses the MIS 4-2 interval. Due to an uncertain dating of MUP1-2 sub-units, older than 130 ka, at the moment clear relations with glacial/interglacial stages cannot be established and a partial correlation to MIS 7 and 6 is only hypothetical.

6. CONCLUSIONS

A portion of the alluvial intermontane Upper Tiber Basin and its occupation by ancient human communities have been investigated through the integration of geomorphology, stratigraphy and archaeology. Not excluding intrinsic factors, alluvial deposition, recorded by the MUP and HOL units, was primarily influenced by an active tectonic setting characterized by orthogonal NW-SE and NE-SW trending fault systems which created sediment accommodation through differential subsidence and forced river deviations through vertical and lateral displacement of faulted blocks. The spatial and chronological distribution of late Prehistoric-Protohistoric archaeological findings, collected on and within these units, has allowed an indicative dating of the major stages of fluvial network modification occurred between the end of the middle Pleistocene and the late Holocene. This chronologic calibration indicates that, besides the active tectonic setting, the morphostratigraphic events recorded in the described units have occurred within two major glacial-interglacial cycles. The latter may have controlled the local surface hydrology and the sediment supply to the fluvial systems. Accordingly, gaps in the archaeological record, including most of the late Paleolithic, the Mesolithic and the early Neolithic, attest to stages of huge alluvial deposition in a highly subsiding basin. This may have determined the burial of the missing cultural stages or may have prevented any occasional or stable occupation in lowlands during the development of large alluvial fans. From a methodological point of view the integration of geological and archaeological data, adopted in this study, demonstrate the potentiality of cooperation between physical and human sciences in revealing the complex interaction of Man and Environment.

ACKNOWLEDGEMENTS

The authors are indebted with Luca Trombino, Marco Mancini and an anonymous reviewer for the constructive comments to an early version of this paper. The authors are also grateful to the Archaeological Office of Tuscany which authorized and supported the research in the Upper Tiber Valley over the years and to Centro Studi sul Quaternario onlus for its assistance during excavations.

REFERENCES

- Argenti P. (2003-2004) - Plio-Quaternary mammal fossiliferous sites of Umbria (Central Italy). *Geologica Romana*, 37, 67-78.
- Arrighi S., Moroni Lanfredini A. (2004) - L'insediamento appenninico di Gorgo del Ciliegio (Sansepolcro - Arezzo). In: Negroni Catacchio N. (Ed), *Miti simboli decorazioni ricerche e scavi. VI Incontro di Studi Preistoria e Protostoria in Etruria*, Proceedings Volume 1, 505-507.
- Arrighi S., Borgia V., Moroni Lanfredini A., Ronchitelli A. (2006) - Burins des Vachons en Italie: typologie, morphotechnique et tracéologie. *Archéologiques*, 2, 103-118
- Barchi M., Ciaccio M. (2004) - Ricostruzione geometrica del bacino di Sansepolcro dall'interpretazione di profili di sismica a riflessione. 23th GNGTS Meeting, Abstract Volume, 195-196.
- Benvenuti M. (1989) - Stratigrafia e Sedimentologia delle Colline di Anghiari nella Valtiberina Superiore. Unpublished Laurea Dissertation, Università degli studi di Firenze, 80 pp.
- Borgia V., Moroni Lanfredini A. (2004) - Le peuplement de la Haute Vallée du Tevere durant l'Acheuléen (Arezzo, Italie). 14th Congress UISPP, BAR International Series 1272, 193-200.
- Brown A.G. (1997) - *Alluvial Geoarchaeology: Floodplain Archaeology and Environmental Change* (Cambridge Manuals in Archaeology). Cambridge University Press, 404 pp., Cambridge, U.K.
- Castelletti L., Martinelli M.C., Maspero A., Moroni A. (1992) - Il sito neolitico della Consuma 1 (Pieve S. Stefano-Arezzo). *Rivista di Scienze Preistoriche*, 44, 44-114.
- Cattuto C., Cencetti C., Fisauli M., Gregori L. (1995) - I bacini pleistocenici di Anghiari e Sansepolcro nell'alta valle del Tevere. *Il Quaternario* 8(1), 119-128.
- Ciangerotti A., Esu D. (2000) - Paleoecologic and biochronologic meaning of the Early Pleistocene molluscan fauna from the Anghiari basin (Tiber River Upper Valley, Central Italy). *Bollettino della Società Paleontologica Italiana*, 39, 217-224.
- Cocchi D., Gambassini P., Laurenzi G. (1978) - L'industria paleolitica di Castel di Sorci fra Anghiari e Sansepolcro (Arezzo). *Rivista di Scienze Preistoriche*, 33, 283-303.
- De Celles P.G., Gray M.B., Ridgway K.D., Cole R.B., Pivnik D.A., Pequera N., Srivastava P. (1991) - Controls on syn-orogenic alluvial-fan architecture, Beartooth Conglomerate (Paleocene), Wyoming and Montana. *Sedimentology*, 38, 567-590.
- Delle Donne D., Piccardi L., Odum J.K., Stephenson W.J., Williams R.A. (2007) - High resolution shallow reflection seismic image and surface evidence of the Upper Tiber Basin active faults (Northern Apennines, Italy). *Bollettino della Società Geologica Italiana*, 126, 323-331.
- Guidi R., Moroni Lanfredini A. (2001) - L'età del Bronzo nell'Alta Valtiberina toscana. 34th Meeting IIPP, Proceedings, 427-439.
- Hartley A.J., Weissmann G.S., Nichols G.J., Warwick G.L. (2010) - Large Distributive Fluvial Systems: Characteristics, Distribution, and Controls on Development. *Journal Sedimentary Research*, 80, 167-183.
- laia C., Moroni Lanfredini A. (Eds.) (2009) - L'età del Ferro a Sansepolcro, attività produttive e ambiente nel sito di Trebbio. Aboca Museum Edizioni, Perugia.
- Jacobacci A., Malatesta A. (1969) - Carta Geologica d'Italia in scala 1:100.000, Foglio 115 "Città di Castello". Servizio Geologico d'Italia.
- Macklin M.G., Fuller I.C., Lewin J., Maas G.S., Passmore D.G., Rose J., Woodward J.C., Black S., Hamlin R.H.B., Rowan J.S. (2002) - Correlation of fluvial sequences in the Mediterranean basin over the last 200 ka and their relationship to climate change. *Quaternary Science Reviews*, 21, 1633-1641.
- Moroni A. (1990) - Il Paleolitico superiore e l'Eneolitico di La Consuma (Pieve S. Stefano, Arezzo). *Rassegna di Archeologia*, 9, 250-289.
- Moroni A., Abati F., Baldanza A., Coltorti M., De Angelis M.C., Mancini S., Moroni B., Pieruccini P. (2011) - L'alto e medio bacino del Tevere durante il Paleolitico medio. Ipotesi sul popolamento e la mobilità dei gruppi di cacciatori - raccoglitori neandertaliani. *Bollettino di Archeologia*, 2-3, 171-201.
- Moroni Lanfredini A. (1995-1996) - Il Moresco (Sansepolcro, prov. di Arezzo). *Rivista di Scienze Preistoriche*, 47, 439-440.
- Moroni Lanfredini A., Benvenuti M. (2010) - Alta Valtiberina Toscana. Preistoria e protostoria di un territorio. Le ricerche, gli aspetti culturali, il paleoambiente. *IpoTESI di Preistoria*, 3, 1-26, <http://ipotesidipreistoria.unibo.it/article/view/1874>.
- Moroni Lanfredini A., Ronchitelli A. (1997) - Gragnano (Sansepolcro, prov. di Arezzo). *Rivista di Scienze Preistoriche*, 48, 431-432.
- Moroni Lanfredini A., Ronchitelli A. (2001) - S. Cassiano, un sito a bulini dei Vachons. Osservazioni tipologiche e tecnologiche. 34th Meeting IIPP, Proceedings, 325 - 335.
- Pialli G., Plesi G. (2009) - Carta Geologica d'Italia in scala 1:50.000, Foglio 289 "Città di Castello". ISPRA - Servizio Geologico d'Italia.
- Sani F., Bonini M., Piccardi L., Vannucci G., Delle Donne D., Benvenuti M., Moratti G., Corti G., Montanari D., Sedda L., Tanini C. (2009) - Late Pliocene-Quaternary evolution of outermost hinterland basins of the Northern Apennines (Italy), and their relevance to active tectonics. *Tectonophysics*, 476, 336-356.
- Schumm S.A., Mosley M.P., Weaver W.E. (1987) - *Experimental fluvial geomorphology*. Wiley Interscience, 413 pp., New York.
- Van Waveren E. (1986) - *Ecologia del paesaggio dell'Alta Valle del Tevere (dati di base integrati per la land evaluation)*. Giunta Regionale Toscana, Patron Editore, 117 pp.
- Walker M. (2005) - *Quaternary Dating Methods*. Wiley, 286 pp., UK.
- Woodward J., Huckleberry G. (2011) - The Geoarchaeology of river basin systems: an introduction. *Geoarchaeology*, 26, 611-615.

