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PLIO-PLEISTOCENE DELTAIC DEPOSITS IN THE CITTÀ DELLA PIEVE AREA (WESTERN UMBRIA, CENTRAL ITALY): FACIES ANALYSIS AND INFERRED RELATIONS WITH THE SOUTH CHIANA VALLEY FLUVIAL DEPOSITS

Roberto Bizzarri & Angela Baldanza
Dipartimento di Scienze della Terra, Università degli Studi di Perugia, Perugia (Italy)
e-mail: roberto.bizzarri@libero.it

ABSTRACT: Bizzarri R. & Baldanza A., *Plio-Pleistocene deltaic deposits in the Città della Pieve area (western Umbria, central Italy): facies analysis and inferred relations with the South Chiana Valley fluvial deposits.* (IT ISSN 0394-3356, 2009).
The Plio-Pleistocene coastal marine deposits in the *Città della Pieve* area (western Umbria, central Italy) can be considered as a borderline among the *Paglia* Valley marine basin southward, and the South *Chiana Valley* and *Tavernelle-Pietrafitta* continental basins, north- and eastward respectively. Deposits, particularly on the *Città della Pieve* hill, have been traditionally referred to a deltaic environment and put in relation with river systems (Paleo-Tiber, Paleo-*Nestore*) draining the *Tavernelle-Pietrafitta* Basin. Moreover, previous authors considered the *Città della Pieve* lithostratigraphic succession as a reference scheme to reconstruct the evolution of western Umbria marine environments during Pliocene and Pleistocene. New data allow a revaluation of the *Città della Pieve* stratigraphic succession, whereas sedimentological and stratigraphic analyses lead to both a detailed description and a deltaic depositional context attribution. At the same time, studies on coeval South *Chiana* Valley continental deposits suggest a depositional continuity with coastal marine deposits and, in spite of previous authors' interpretations, a main northern (*Chiana* Valley) alimentation for the *Città della Pieve* deltaic system.

RIASSUNTO: Bizzarri R. & Baldanza A., Depositi deltizi plio-pleistocenici nell'area di Città della Pieve (Umbria Occidentale, Italia Centrale): analisi di facies e ricostruzione dei rapporti con i depositi fluviali della Val di Chiana. *(IT ISSN 0394-3356, 2009).*
I depositi marino costieri plio-pleistocenici, affioranti nell'area di Città della Pieve (Umbria occidentale, Italia centrale), fanno idealmente da confine tra il Bacino marino della Valle del Paglia, a sud, e i bacini continentali della Val di Chiana meridionale e di Tavernelle-Pietrafitta, rispettivamente a nord e a est. Tali depositi, in particolare nella collina di Città della Pieve, sono stati tradizionalmente riferiti a un ambiente deltizio e messi in relazione con i sistemi fluviali (Paleo-Tevere, Paleo-Nestore) che drenavano il Bacino di Tavernelle-Pietrafitta. Inoltre, gli autori precedenti hanno considerato la successione litostratigrafica di Città della Pieve come uno schema di riferimento per la ricostruzione dell'evoluzione paleoambientale dell'Umbria Occidentale durante il Pliocene e il Pleistocene. I nuovi dati stratigrafici hanno permesso una riconsiderazione della successione pievese. Inoltre, l'analisi sedimentologica e stratigrafica ne ha consentito sia una descrizione dettagliata che l'attribuzione a un contesto deposizionale deltizio. Gli studi parallelamente condotti su coevi depositi continentali della Val di Chiana meridionale hanno permesso di verificare la contiguità di ambienti deposizionali con l'area pievese e di suggerire, contrariamente a quanto proposto in letteratura, una prevalente alimentazione dalla Val di Chiana per l'apparato deltizio di Città della Pieve.

Keywords: River deposits; Deltaic deposits; Pliocene; Pleistocene; Umbria; Tuscany.

Parole chiave: Depositi fluviali; Depositi deltizi; Pliocene; Pleistocene; Umbria; Toscana.

1. INTRODUCTION

The main features of the Plio-Pleistocene *Città della Pieve* deltaic deposits and South *Chiana* Valley gravel braided river deposits are here illustrated. The aim is to mark their sedimentological and petrographic affinity and the paleodepositional contiguity, as well as to propose a reliable depositional model. Some resulting considerations on origin and provenance of the gravel are also proposed.

Since the end of 19th Century, the *Città della Pieve* area (western *Umbria*, central Italy) has been considered as a key-zone to understanding Plio-Pleistocene paleoenvironmental evolution across the South *Chiana* Valley (Fig. 1A), particularly in the *Trasimeno* Lake area, and *Paglia* Valley. Deposits cropping out on the *Città della Pieve* hill have been traditionally referred to a deltaic environment and linked to the Paleo-Tiber (VERRI, 1877; 1885; 1889; 1892; 1918; LOTTI, 1926; MERLA, 1944) or to the Paleo-*Nestore* river systems (AMBROSETTI *et al.*, 1977; 1987; 1989; CATTUTO *et al.*, 1983; 1992) draining the *Tavernelle-Pietrafitta* Basin (Fig. 1). Eastern alimentation, therefore, has been classically considered as prevailing, although some authors also hypothesized a subordinate northern provenance (CATTUTO *et al.*, 1992).

North of *Città della Pieve*, the South *Chiana* Valley Basin evolved as a river environment from Middle-Late Pliocene to Early Pleistocene (BARBERI *et al.*, 1994; ARUTA *et al.*, 2004; 2006; BIZZARRI, 2006; BARCHI *et al.*, 2007; BIZZARRI *et al.*, 2008), becoming a fluvial-lacustrine environment, with the early development of "Paleo-*Trasimeno*", from Middle Pleistocene onward. On the other hand, AMBROSETTI *et al.* (1977; 1987; 1989) discussed the implications of the *Città della Pieve* lithostratigraphic succession and proposed a reference scheme for western Umbria marine deposits (Fig. 2), underlining the occurrence of two main depositional cycles: an Early-Middle Pliocene cycle, made up of three superimposed Units ("*Argille di Fabro*", "*Sabbie a Flabellipecten*" and "*Conglomerati di Città della Pieve*"), cha-

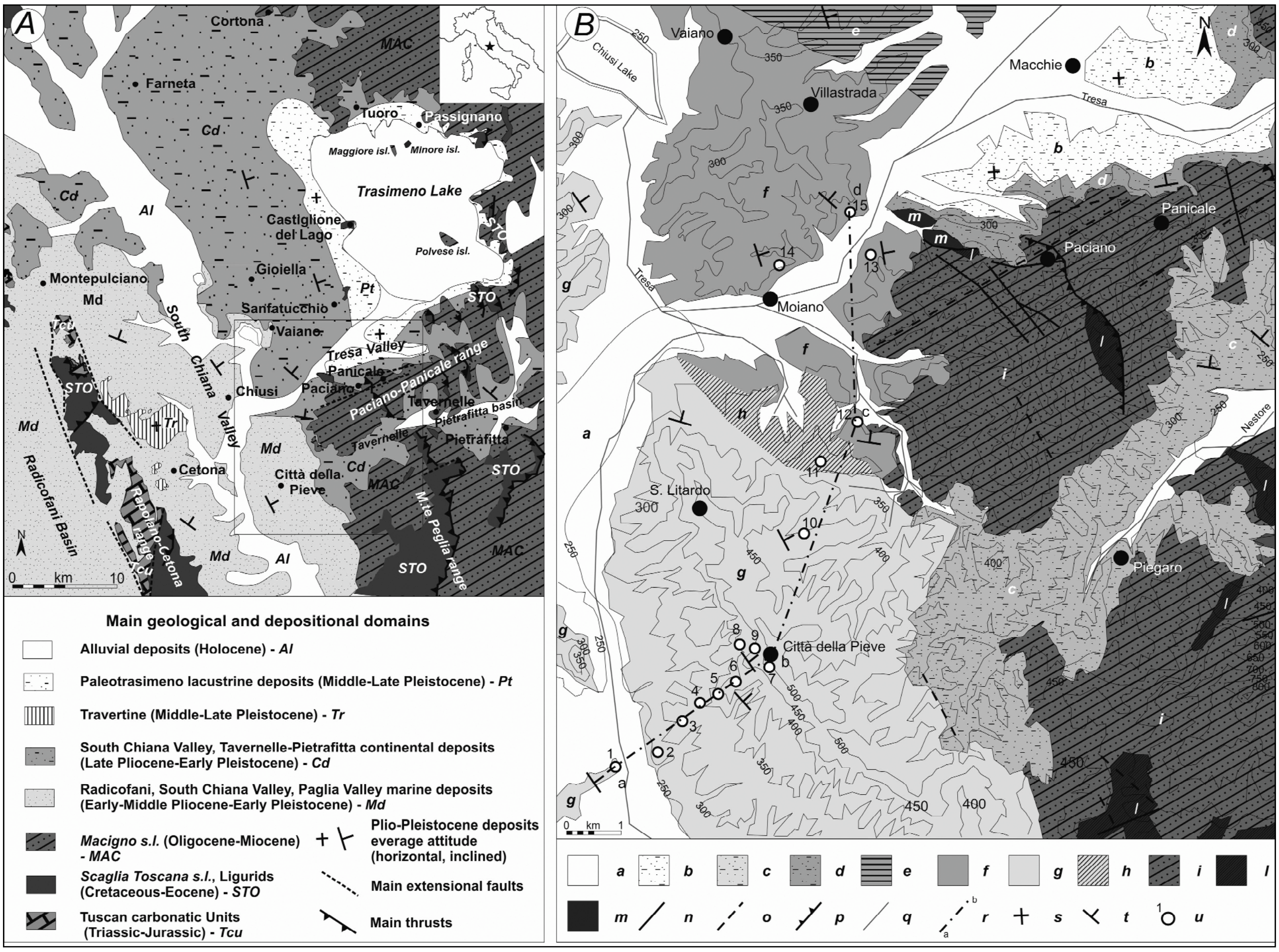

Figure 1 - *A)* Geographic location of study area and main geological and depositional domains. *B)* Simplified geological map for study area (detail). *a)* Alluvial deposits (Holocene); *b)* "*Paleotrasimeno*" fluvial and lacustrine deposits (Middle-Late Pleistocene); *c)* Ancient Chiana Valley piedmont deposits (Early Pleistocene); *d) Tavernelle-Pietrafitta* Basin piedmont and fluvial-lacustrine deposits (Early Pleistocene); *e) Chiana* Valley sandy braided river deposits (Early Pleistocene); *f) Chiana* Valley gravel braided river deposits (Late Pliocene-Early Pleistocene); *g) Città della Pieve* deltaic deposits (Late Pliocene-Early Pleistocene); *h)* Brackish-transitional deposits (Late Pliocene-Early Pleistocene); *i) Macigno s.l.* (Oligocene-Miocene); *l) Scaglia Toscana s.l.* (Cretaceous-Eocene); *m)* Ligurids (Cretaceous-Palaeocene); *n)* Main extension faults; *o)* Faults (presumed); *p)* Main thrusts; *q)* Main rivers; *r)* Geological profile tract; *s)* Sub-horizontal strata; *t)* 5° to 10° dipping strata; *u)* Main outcrops: 1) *Frazzi* Brickyard, 2) CDP1, 3) CDP2, 4) CDP3, 5) CDP4, 6) CDP5, 7) CDP6, 8) CDP7, 9) CDP8, 10) *P.gio al Piano*, 11) *S. Biagio*, 12) *Casaltoldo*, 13) *P.gio Vaccaio*, 14) *Le Coste*, 15) *La Trincea*.

A) Collocazione geografica dell'area di studio e principali domini geologici e deposizionali. B) Carta geologica semplificata (ingrandimento). a) Depositi fluviali recenti (Olocene); b) Depositi fluvio-lacustri del "Paleotrasimeno" (Pleistocene medio-superiore); c) Depositi pedemontani antichi della Val di Chiana (Pleistocene inferiore); d) Depositi pedemontani e fluvio-lacustri del Bacino di Tavernelle-Pietrafitta (Pleistocene inferiore); e) Depositi di fiumi a canali intrecciati sabbiosi della Val di Chiana (Pleistocene inferiore); f) Depositi di fiumi a canali intrecciati ghiaiosi della Val di Chiana (Pliocene superiore-Pleistocene inferiore); g) Depositi deltizi di Città della Pieve (Pliocene superiore-Pleistocene inferiore); h) Depositi di ambiente salmastro-transizionale (Pliocene superiore-Pleistocene inferiore); i) Macigno s.l. (Oligocene-Miocene); l) Scaglia toscana (Cretaceo-Eocene); m) Liguridi (Cretaceo-Paleocene); n) Faglie dirette; o) Faglie presunte; p) Sovrascorrimenti; q) Fiumi principali; r) Traccia di sezione geologica; s) Strati a giacitura suborizzontale; t) Strati con inclinazione tra 5° e 10°; u) affioramenti principali: 1) Fornace Frazzi, 2) CDP1, 3) CDP2, 4) CDP3, 5) CDP4, 6) CDP5, 7) CDP6, 8) CDP7, 9) CDP8, 10) P.gio al Piano, 11) S. Biagio, 12) Casaltoldo, 13) P.gio Vaccaio, 14) Le Coste, 15) La Trincea.

racterized by an average north-east inclination of deposits, and an Early Pleistocene cycle, coinciding with the "*Argille e Sabbie del Chiani-Tevere*" Unit, whose deposits are prevailing sub-horizontal. On the basis of geomorphologic data (orientation of main valleys, asymmetry on valley profiles, different altitude of river terraces), chiefly documented east and north-east of *Città della Pieve*, a strong structural and tectonic control on landscape evolution has been inferred (Ambrosetti *et al*., 1989; Cattuto *et al*., 1983; 1992). According to stratigraphic data, previous authors individuate a main tectonic event corresponding to "*Acquatraversa*" phase (Late Pliocene-Early Pleistocene: Ambrosetti *et al*., 1977; 1987; 1989; Cattuto *et al*., 1983; 1992).

Most of the data collected during the last few years (Bizzarri, 2006; Bizzarri & Baldanza, 2007) can hardly be included into the former scenario; thus, a revaluation of supply origin, as well as of paleodepositional and stratigraphic implications for the *Città della Pieve* succession, seems to be appropriate.

2. GEOLOGICAL SETTING

The study area (Fig. 1A) is located in central Italy, across the Umbria-Tuscany boundary; it covers a branch of the South *Chiana* Valley Basin, a NW-SE oriented extensional basin bounded to the east by the Mt. *Peglia* range, the *Paciano-Panicale* lineage and the *Trasimeno* Lake and to the west by the *Rapolano-Cetona* range. On western areas, the pre-Pliocene substratum is referable to the *Scaglia Toscana Auct*. and Ligurids *Auct*. Units. Whereas on the eastern ones it is ascribable to the *Macigno s.l. Auct*. Unit, with a subordinate occurrence of *Scaglia Toscana* and Ligurids, mainly south of Città della Pieve (Fig. 1A). East of *Città della Pieve*, on both the *Paciano-Panicale* lineage and the northern termination of Mt. *Peglia* range the substratum is represented by prevailing Oligocene to Miocene "Turbiditic" sandstone Units (*Macigno s.l. Auct*.); limestone occurrence is very scarce in the area. Ligurids locally crop out west of *Trasimeno* Lake (near *Castiglione del Lago, Sanfatucchio* and *Paciano*), whereas they are more widely documented on the eastern side of *Rapolano-Cetona* range, respectively north and west of *Città della Pieve*. The South *Chiana* Valley Basin developed as a marine environment from Late Miocene?-Early Pliocene to Middle Pliocene (Passerini, 1965; Jacobacci *et al*., 1967; 1969; Barberi *et al*., 1994; Costantini & Dringoli, 2002; Aruta *et al*., 2004; 2006); between Middle Pliocene and Early Pleistocene, a continental and coastal marine sedimentation took place. Coastal marine deposits crop out in the *Città della Pieve* and *Chiusi* areas (deltaic deposits), as well as in the eastern side of the *Rapolano-Cetona* range (beach to offshore deposits). Previous authors attributed the same Early-Middle Pliocene age to deposits on both sides of the valley (Fig. 2), with local occurrence of Lower Pleistocene deposits both north and south of *Città della Pieve* (Passerini, 1965; Jacobacci *et al*., 1967; 1969; Ambrosetti *et al*., 1977; 1987). Particularly, Ambrosetti *et al*. (1977; 1987) individuate two main depositional cycles in western Umbria marine deposits, Early-Middle Pliocene and Early Pleistocene in age, respectively, separated by a hiatus coincident with "*Acquatraversa*" erosion phase (Fig. 2). Costantini & Dringoli (2002) still confirm the Early-Middle Pliocene age attribution for the western *Cetona* coastal marine deposits, whereas a Late Pliocene-Early Pleistocene age has been recently inferred for the *Città della Pieve* deltaic deposits (Fig. 2: Bizzarri, 2006; Bizzarri & Baldanza, 2007). As a result of the average NE dip of both deltaic and coastal marine sediments (Fig. 1), older deposits crop out on the western side of the *Chiana* Valley Basin, at least across the *Cetona–Città della Pieve* transect. Lower Pleistocene continental deposits cover a wide area north of *Città della Pieve*, west of *Trasimeno* Lake, at least from *Tresa Valley*

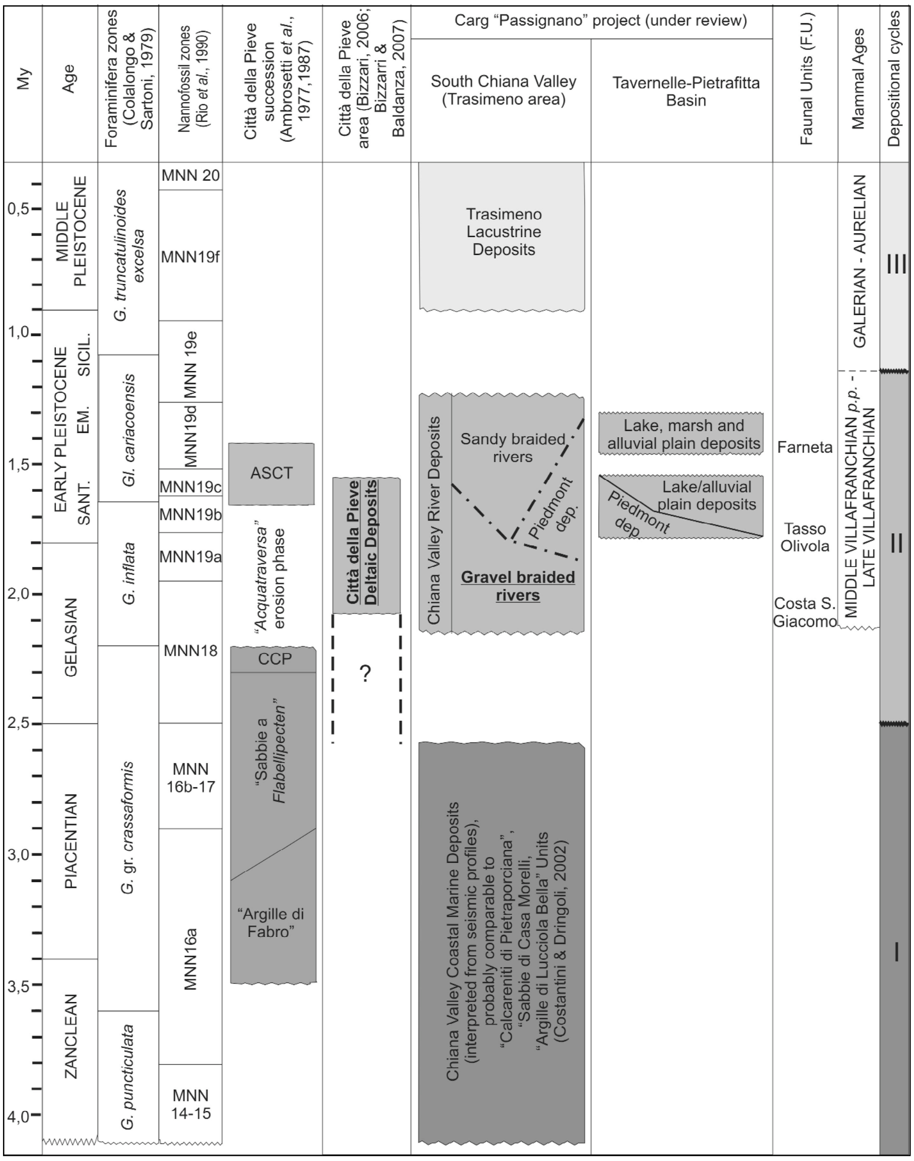

Figure 2 - Summarized stratigraphic scheme for Plio-Pleistocene deposits between *Città della Pieve* (Bizzarri, 2006; Bizzarri & Baldanza, 2007) and *Trasimeno* Lake areas (CARG project *"F. 310 - Passignano sul Trasimeno")*. A comparison with Units proposed by Ambrosetti *et al*. (1977; 1987) for the *Città della Pieve* area is also provided. CCP=*"Conglomerato di Città della Pieve"*; ASCT=*"Argille e Sabbie del Chiani-Tevere"*.

Schema stratigrafico riassuntivo per i depositi plio-pleistocenici dell'area tra Città della Pieve (Bizzarri, 2006; Bizzarri & Baldanza, 2007) e il Lago Trasimeno (Progetto CARG "F. 310 - Passignano sul Trasimeno"). Viene proposto il confronto con le Unità proposte per l'area Pievese da Ambrosetti et al. (1977; 1987). CCP="Conglomerato di Città della Pieve"; ASCT="Argille e Sabbie del Chiani-Tevere".

to *Farneta* village; Upper Pliocene continental deposits are documented only in south-western areas, south from Vaiano-Villastrada alignment (Fig. 1B). The development of *Trasimeno* Basin (Figs. 1A, 2), from Middle Pleistocene onward, reflects the definitive emersion of western Umbria and the sea retreat from *Trasimeno* hills to *Orvieto* area (Girotti & Mancini, 2003; Mancini *et al*., 2004; Bizzarri, 2006; Barchi *et al*., 2007). Sedimentological analysis, as well as geological mapping for the CARG "F. 310-*Passignano sul Trasimeno*" project (Bizzarri, 2006; Barchi *et al*., 2007; Pazzaglia, 2007; Bizzarri *et al*., 2008), allow us to describe four main Unconformity-Bounded Stratigraphic Units (UBSU), in the area amongst *Città della Pieve*, the *Trasimeno* Lake and the *Tavernelle-Pietrafitta* Basin, with a time span from Late Pliocene to Early Pleistocene (Figs. 1B, 2): i) *Città della Pieve* deltaic deposits; ii) South *Chiana* Valley gravel braided river, sandy braided river and piedmont deposits; iii) Tavernelle-Pietrafitta piedmont and lacustrine deposits; iv) Tavernelle-Pietrafitta lacustrine, swamp and alluvial plain deposits. This paper deals with *facies* associations, depositional setting and stratigraphic implications of *Città della Pieve* deltaic deposits and South *Chiana* Valley gravel braided river deposits (Figs. 1B, 2), hence designated simply as **Unit A** and **Unit B**, respectively.

3. *FACIES* ANALYSIS

Some outcrops (Fig. 1, Tab. 1), roughly aligned along a SW-NE transect, have been chosen as representative of the *facies* variation documented in the area (Bizzarri, 2006; 2007). Furthermore, they allow both the collection of paleontological and stratigraphic samples and statistic sedimentological analyses.

Table 1 - Geographic data (Latitude, Longitude, Elevation a.s.l.) of sampled sites and sedimentological logs.

Dati geografici (Latitudine, Longitudine, Quota s.l.m.) dei siti campionati e dei log sedimentologici.

Geographical data of study outcrops
(Latitude, Longitude, Elevation a.s.l.)

F.ce Frazzi:	42°56'00"N	11°58'00",40E	268m
CDP1:	42°55'52"N	11°58'35",40E	272m
CDP2:	42°56'31"N	11°59'05",40E	340m
CDP3:	42°56'33"N	11°59'13",40E	345m
CDP4:	42°56'37"N	11°59'24",40E	390m
CDP5:	42°56'51"N	11°59'48",40E	410m
CDP6:	42°57'03"N	12°00'14",40E	480m
CDP7:	42°57'34"N	11°59'24",40E	380m
CDP8:	42°57'36"N	11°59'28",40E	400m
P.gio al Piano:	42°58'21"N	12°00'43",40E	456m
S. Biagio:	42°59'11"N	12°00'46",40E	409m
Casaltoldo:	42°59'34"N	12°01'34",40E	300m
P.gio Vaccaio:	43°01'17"N	12°01'38",40E	275m
Le Coste:	43°01'10"N	12°00'11",40E	320m
La Trincea:	43°01'43"N	12°01'44",40E	280m

3.1 Unit A - *Città della Pieve deltaic deposits*

The Unit is characterized by about 250 m thick superposition of coastal marine deposits, related to a deltaic environment, with an average 5°÷8° NE dip. Five facies associations are described (Fig. 3):

A_1 facies association – Mixed marine and brackish deposits – It is made up of heterogeneous deposits represented by alternations of three prevailing facies: i) 10÷20 cm thick alternations of silty sand, silt and clay, with occurrence of wave ripple and clay chips on coarser horizons. ii) Ripple-laminated, moderately well sorted fine to medium sand, with <2 cm thick clay horizons. iii) 0,5 to 1 m thick, weakly cemented lenticular-shaped conglomerate, made up of sub-rounded to rounded, plate to equi-dimensional cobbles (ϕ_{max}12-15 cm, MPS-Mean Particle Size, *sensu* Nemec & Steel, 1984, ranging from 4 to 8 cm). Parallel orientation of flattened clasts is common, as well as surface oxidation and borings. Samples collected on fine-grained deposits reveal a brackish mollusc assemblage, associated to rare benthic foraminifera and Late Pliocene-Early Pleistocene nannofossil assemblages (Tab. 2).

A_2 facies association - Proximal delta front deposits – Association is represented by about 2 m thick, wedge-shaped, roughly cross-stratified gravel, laterally grading to sand, alternated to up to 5 m thick, dune- to ripple-laminated sand (Figs. 3A-C). Gravel bodies locally show a channelled basal surface, chiefly on E-W oriented cuts, and are mainly represented by rounded to well rounded, diffusely bored, limestone medium pebbles to coarse cobbles (Fig. 5A). Gravel lithology implications will be discussed further (see § 3.3, 5). Sandy bodies, made of well sorted, medium to fine sand, show an upward transition of sedimentary structures from 2D-dunes to wave ripples (Fig. 3C). Some less than 5 cm thick, leaf-bearing silty horizons locally occur (Fig. 3B). An oligotypic association with oysters and pectinids, as well as Late Pliocene-Early Pleistocene nannofossil assemblages, have been documented on sandy horizons (Tab. 2).

A_3 facies association - Outer delta front deposits

A_{3a} - Sand bars – They are organized in sets of about 4 m thick, parallel cross-laminated sand bodies, made up of medium to fine, locally cemented and diffusely bioturbated, well sorted sand (Fig. 3D). Each body shows a similar organization, with a mollusc horizon (mainly *Flabellipecten* sp.) at the base, a tangential and concave-upward cross-lamination and a diffuse *Thalassinoides* isp. and *Ophiomorpha* isp. bioturbation. Scattered pectinids, oysters and rare gastropods are also present, whereas only scarce Late Pliocene-Early Pleistocene benthic foraminifera and nannofossil assemblages have been documented (Tab. 2).

A_{3b} - Interdistributary bay deposits – The sub association is represented by up to 2 m thick, locally ripple-laminated, fining-upward moderately sorted medium to very fine sand, alternated to 10 cm thick pebbly sand (Fig. 3E). Erosion surfaces and bioclastic lags are common, as well as large pectinid horizons. Irregular cementation also occurs. Some levels also grade upward to parallel-laminated silty clay. Scarce Late Pliocene-Early Pleistocene benthic foraminifera and nannofossil assemblages (Tab. 2) have been collected.

A_4 facies association - Prodelta deposits – Association **A_4** is represented by massive to thinly laminated silty clay (Fig. 4), passing upward to sandy silt and very fine sand; cemented horizons also occur. Marine macrofossils, vegetal remains, rich foraminifer

Table 2 - Paleontological assemblages collected on main sampled sites.
Associazioni paleontologiche documentate nei principali siti campionati.

ENVIR.	FACIES ASS.	SAMPLED SITES	LATE VILLAFRAN. FOSSIL ASSEMBL.	LATE PLIOC.- EARLY PLEISTOC. FOSSIL ASSEMBLAGES	EARLY PLEISTOCENE FOSSIL ASSEMBLAGES
Braided rivers, alluvial plain	B_1	**Vaiano area** (Argenti, 2004)	*Anancus arvernensis* (Croizet & Jobert)		
	B_2	**La Trincea Casaltoldo P.gio Vaccaio**	*Gyraulus albus* (Muller) *Bithynia leachi* (Sheppard)		
Mixed marine and brackish	A_1	**S. Biagio**		*Cerastoderma edulis* (Linnaeus), *Anadara diluvii* (Lamark), *Amyclina* sp., *Thericium vulgatum* (Bruguiere), *Ammonia beccarii* (Linnaeus), small *Gephyrocapsa* spp., *Coccolithus pelagicus* (Wallich) Schiller *Helicosphaera carteri* (Wallich) Kamptner, *Reticulophaenestra productella* (Bukry) Gallagher, *R. pseudoumbilica* (Gartner) Gartner, *Discoaster* spp.	
Delta front	A_2	**P.gio al Piano**			*Ostrea* spp., *Chlamys* spp., small *Gephyrocapsa* spp.,*C. pelagicus, Coccolithus sp., Pseudoemiliania lacunosa* (Kamptner) Gartner, *Helicosphaera sellii* (Bukry & Bramlette) J afar & Martini, *H. carteri, R. productella , Calcydiscus macyntirei* (Bukry & Bramlette) Loeblich & Tappan, *C. leptoporus* (Murray & Blackman) Loeblich & Tappan*, Discoaster* spp., *Sphenolithus* spp.
	A_2	**CDP6**		*Ostrea* spp., barnacles, echinoids, leafs *Ammonia* spp.	
	A_3	**CDP5 CDP1**		*Ostrea* spp., *Chlamys* spp., *Flabellipecten flabelliformis* (Brocchi) *Ammonia* spp., *Elphidium* spp., *Globigerina bulloides* d'Orbigny, *Globigerinoides* spp. small *Gephyrocapsa* spp.,*C. pelagicus, Discoaster* spp.	
	A_3	**CDP4 CDP3 CDP2**		*Ostrea* spp., *Chlamys* spp., *F. flabelliformis* *Ammonia* spp., *Elphidium* spp., *Globigerinoides* spp.	
Prodelta	A_4	**F.ce Frazzi**			*Glycimeris* sp., *Ostrea* spp., gastropods, echinoids, leafs, *Cyteropteron alatum* Sars, *C. testudo* Sars, *Ammonia* spp., *Bolivina* spp., *B. spathulata* (Williamson), *Bulimina* sp., *B. aculeata* d'Orbigny, *B. marginata spinata* d'Orbigny, *Gyroidina altiformis* Stewart & Stewart, *Hastigerina siphonifera* d'Orbigny, *Lagena* sp., *Lagenonodosaria* sp., *Lenticulina calcar* (Linnaeus), *Melonis padanum* (Perconig), *Nonion* sp., *Nonionella turgida* (Williamson), *Pullenia* sp., *Robulus* sp., *Textularia* sp., *Uvigerina* spp., *U. mediterranea* Hofkar, *G. bulloides*, *Globigerinoides ruber* (d'Orbigny), *G. sacculifer* (Brady), *Neogloboquadrina* spp., *Orbulina universa* d'Orbigny, medium *Gephyrocapsa* spp.*, H. sellii, H. carteri, Helicosphaera sp., C. pelagicus, Discoaster spp.*

and Early Pleistocene nannofossil assemblages have been documented (Tab. 2).

3.1.1 Depositional architecture

A transition from distal to proximal environments can be documented in the SW-NE distribution of *facies* associations (Figs. 4, 6). Concerning the attribution of facies associations to sub-environments (Fig. 4), mixed marine and brackish deposits of the $\mathbf{A_1}$ *facies* association represent the distributary channel zone, at the transition between the external delta plain and the delta front. In turn, the latter seems to be articulated, both along- and across-shore (NW-SE, NE-SW respectively), with documentation of proximal and distal mouth bars ($\mathbf{A_2}$-$\mathbf{A_{3a}}$), as well as of interdistributary bays among channel mouths ($\mathbf{A_{3b}}$). On proximal zones, mouth bars show alternations of cross-stratified prograding beach-face gravel and dune- to ripple-laminated shoreface sand ($\mathbf{A_2}$). Outer delta front is represented by tangential cross-laminated sandy dunes ($\mathbf{A_{3a}}$), related to high flow velocity and shallow water conditions. Finally, silty clay deposits correspond to the prodelta ($\mathbf{A_4}$). *Facies* associations suggest a broad and long-lasting river-fed coastal environment. Both river and marine sedimentation processes are well represented (Fig. 5C), with important effects on deposit organization. This leads to a hypothesise of shallow water, wave dominated delta, in which river supply and wave reworking alternated (Fig. 6). The large amount of gravel implies high-competence river flows, at least during build-up phases, and suggests alimentation from one or more gravel braided rivers. Due to a total 250-300 m thickness of the *Città della Pieve* deltaic deposits, a long-lasting river system may be supposed, although a discontinuous supply, related to the complex interplay of climatic, tectonic and eustatic changes, may be expected.

3.2 Unit B – South Chiana Valley coarse-grained river deposits

The Unit is constituted of at least 200 m thick continental deposits, showing a common 5÷10° NE inclination. Two main *facies* associations have been documented:

B_1 facies association - Channelled gravel deposits - It is represented by about 1-2 m thick and 10 m wide lenticular-shaped bodies, with a bi-parted gravel and sand fill. The lowermost part is filled with 0,5-1,5 m thick clast-supported gravel (Fig. 3F); clasts are variable in shape but always from sub-rounded to well rounded, and range from coarse cobbles to fine pebbles, with MPS~10-15 cm. Limestone lithology dominates (Fig. 5B). The **a** and **b** axes tend to dispose horizontally or with **a(t)b(i)** current imbrications (Collinson & Thompson, 1982). A subordinated poorly to moderately sorted, very coarse sand/granules matrix also occurs. A weak cementation has been locally documented, as well as occurrence of surface oxidation, due to subaerial exposition. The uppermost part of channel fill consists of trough cross-laminated, well-sorted medium to very coarse sand; locally cross-lamination is not clearly recognizable.

B_2 facies association - Roughly organized overbank deposits - Association $\mathbf{B_2}$ is mainly represented by finer deposits, compared to association $\mathbf{B_1}$, with prevalence of sand and only a local sensible amount of clay and silt (Fig. 4). Sandy deposits are represented by tabular to lenticular bodies, 2÷5 m thick and up to 20 m long, made up of through cross-laminated, moderately sorted to well sorted, fining-upward coarse to fine sand. Clay/silt deposits are subordinate and represented by alternations of weakly cemented, massive sandy silt, massive clay bearing freshwater molluscs, mainly *Gyraulus albus*

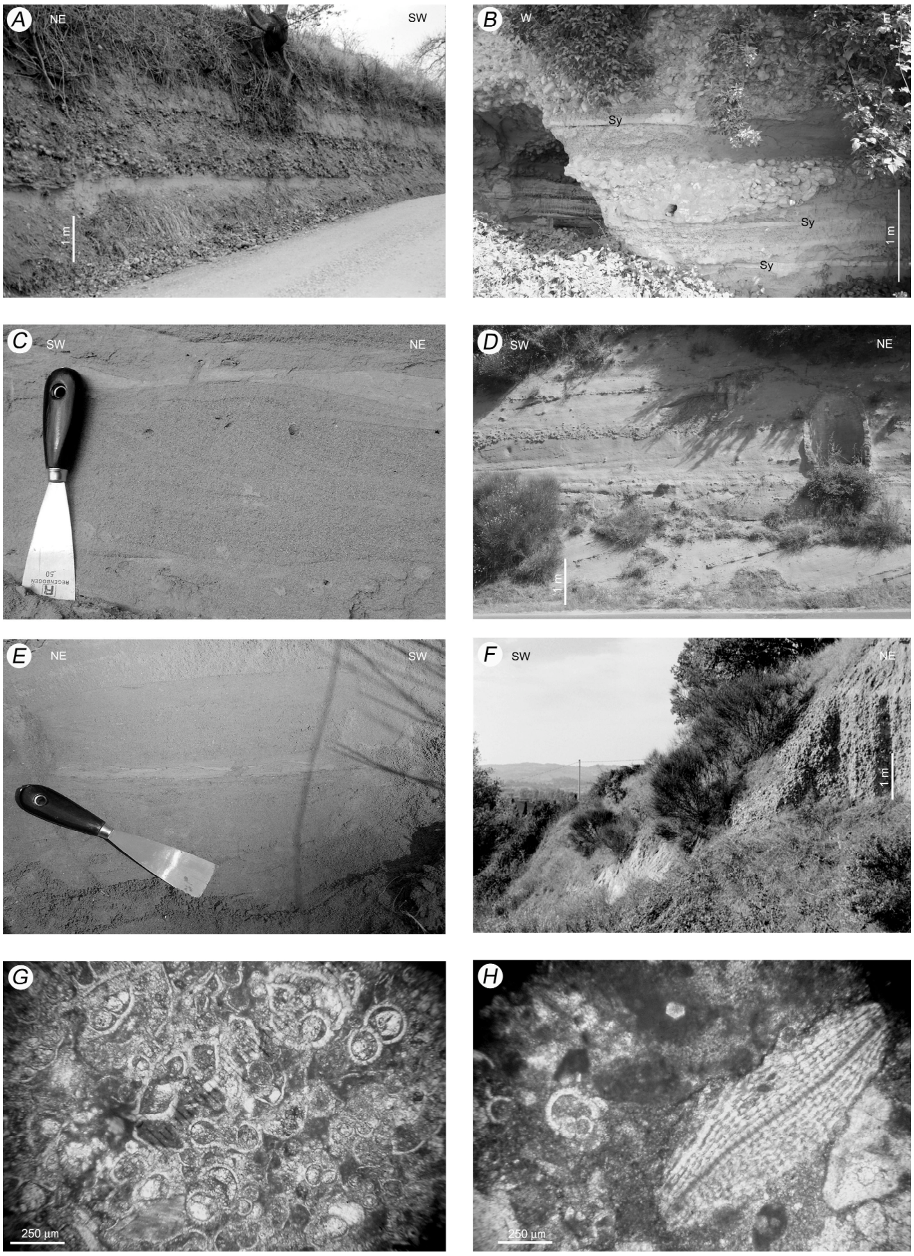

Figure 3 - Described facies associations. *A)* Gravel-sand alternations of $\mathbf{A_2}$ *facies* association (NE-SW cut). *B)* Channelled gravel of $\mathbf{A_2}$ *facies* association (E-W cut); Sy=leaf-bearing silty horizons. *C)* Particular of dunes and ripple in the sand from $\mathbf{A_2}$ *facies* association. *D)* Cross-laminated and bioturbated sand of $\mathbf{A_{3a}}$ *facies* association. *E)* Ripple-laminated sand and silt-clay draping of $\mathbf{A_{3b}}$ *facies* association *F)* Gravel-sand alternations of **Unit B**. *G, H*) Thin section features of calcarenite clasts from $\mathbf{A_2}$ gravel.

Associazioni di facies descritte. A) *Alternanze ghiaie-sabbie dell'associazione di facies* $\mathbf{A_2}$ *(taglio NE-SW).* B) *Ghiaie a geometria canalizzata dell'associazione di facies* $\mathbf{A_2}$ *(taglio E-W); Sy=livelli siltosi con materia vegetale (foglie).* C) *Particolare dell'organizzazione a dune e ripple dell'associazione di facies* $\mathbf{A_2}$. D) *Sabbie a laminazione incrociata, bioturbate, dell'associazione di facies* $\mathbf{A_{3a}}$. E) *Sabbie con ripple e drappeggio di silt-argilla dell'associazione di facies* $\mathbf{A_{3b}}$. F) *Alternanze ghiaie-sabbie dell'**Unità B***. G, H*) Sezione sottile di clasti di calcarenite appartenenti ai ciottoli dell'associazione* $\mathbf{A_2}$.

(MULLER) and *Bithynia leachi* (SHEPPARD), and laminated silty clay with root traces and vegetal remains (paleosoils).

3.2.1 Depositional architecture

Deposits of Unit **B** (Figs. 4, 6) can be referred to a braided river environment. The roughly-organized overbank, with only local occurrence of paleosoils, suggests a high lateral mobility of interbedded channels in the river system. Concentration of channelled bodies in well defined portions of the succession, with interbedding to overbank sands, leads to the hypothesis of an intermittent river activity, with alternation of high transport and long-lasting low activity phases, the latter recorded as erosion surfaces and paleosoils, with interpositions of overbank sands. Gravel imbrications, as well as through cross-lamination of the sands, testify the existence of a channelled river current and refer $\mathbf{B_1}$ *facies* association to channel fill. Although the scarce gravel organization could be partially explained with a mass movement component, inside river channel, and large clast movement itself requires high current velocity, **a(t)b(i)** imbrications are related to sub-critic flow conditions (Froude number Fr<1: COLLINSON & THOMPSON, 1982; EINSELE, 1992). Sand is in vertical continuity with gravel, and appears to be part of the same channel fill; through cross-lamination which is indicative of both high current velocity, still in condition of sub-critic flow, and reduced channel depth. The channel bi-partition, with a lower gravel and an upper sandy fill, partially resembles the *Donjek type* river model (MIALL, 1985); it can be interpreted in terms of different sedimentation phases, with alternation of gravel and sand transport and deposition by bed load streams inside channels. Most of the sedimentation took place shallow water channels during floods, with large emersion of deposits during low water phases. Channels of $\mathbf{B_1}$ *facies* association repeat for some tenth of metres, and irregularly alternate to $\mathbf{B_2}$ *facies* association deposits; the latter represent an unchannelled flow/sheetflood dominated environment, only temporarily involved by very fine sedimentation and soil development, referable to the floodplain.

3.3 Preliminary statistic analyses on gravel

On gravels of *facies* association $\mathbf{A_2}$ and $\mathbf{B_1}$, two distinct statistic analyses have been carried out, in

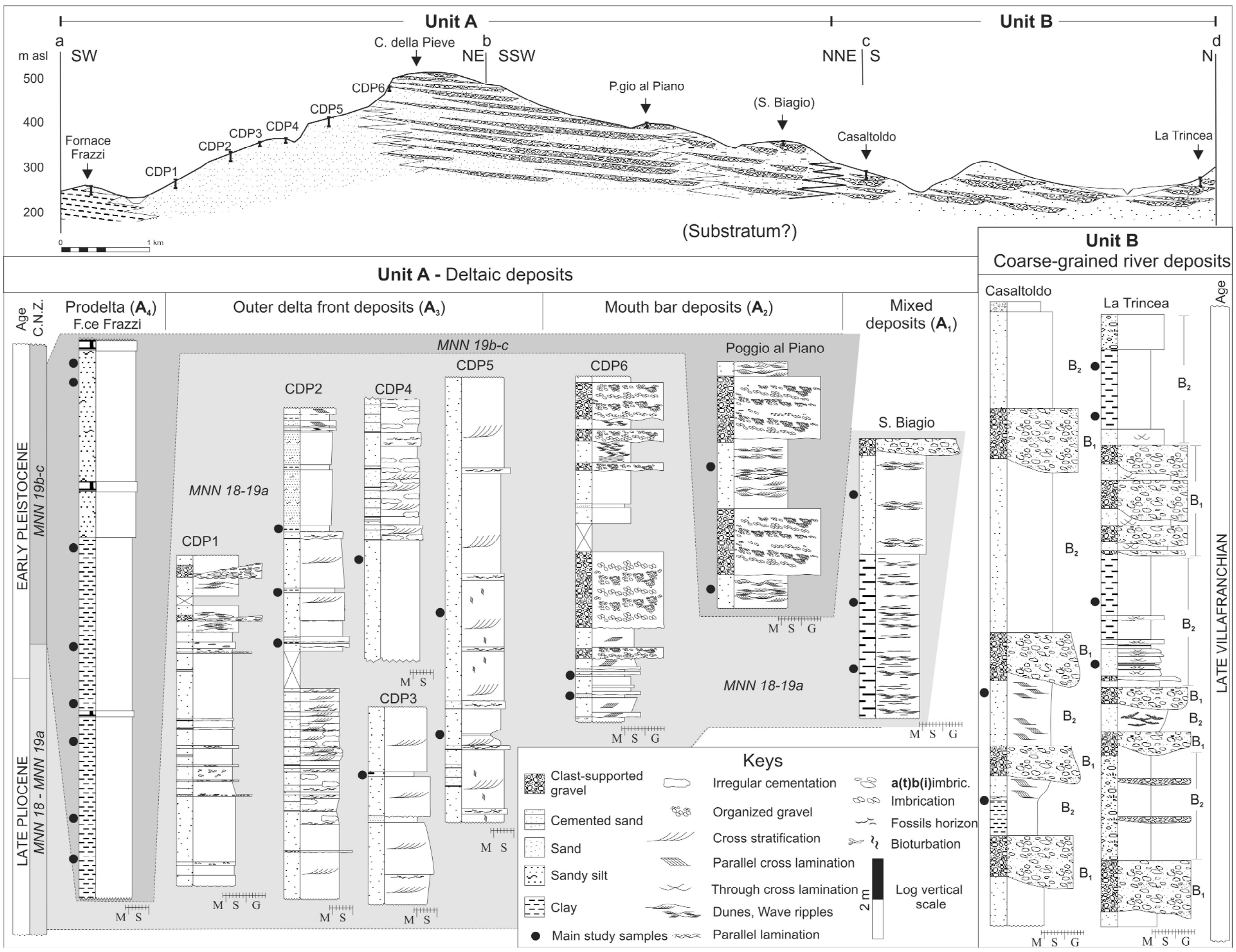

Figure 4 - Top: geological profile across **Units A** and **B**; bottom: selected sedimentological logs crossed by the geological profile. C.N.Z.=Calcareous Nannofossil Zones. See Figure 1B for tract localization and Table 1 for geographical data (Latitude, Longitude, Elevation a.s.l.) of sedimentological logs.

*In alto: sezione geologica attraverso le **Unità A** e **B**; in basso: log sedimentologici attraversati dalla sezione. C.N.Z.= Zone a Nannofossili Calcarei. La traccia di sezione è riportata in Figura 1B, mentre i dati geografici (Latitudine, Longitudine, Quota s.l.m.) dei log sono riportati in Tabella 1.*

order to reconstruct paleocurrent patterns and gravel lithology, and to verify the hypothesis of a common source. Despite their very preliminary value, the collected data support the hypothesis of relations between the *Città della Pieve* deltaic deposits and the South *Chiana* Valley gravel river deposits. Gravel lithology from four outcrops referable to $\mathbf{A_2}$ *facies* association and from four outcrops referable to $\mathbf{B_1}$ *facies* association has been considered (Figs. 5A, 5B). For each outcrop, a 1 m high and 0,5 m long transect was considered, with determination of lithology of every clast inside. Two lithologies prevail: i) Cretaceous-Palaeogene Tuscan and Ligurid calcarenite and micrite, ii) *Macigno s.l.* sandstones. The percentages of other lithologies, particularly Pliocene calcarenite, are negligible. Limestone prevails on sandstone, with calcarenite dominance (Figs. 5A, 5B); the bioclastic component of the calcarenites document a supply of various benthic and planktonic microfossils, Cretaceous to Oligocene in age (Figs. 3G-H). The micropaleontological assemblages (*Discocyclina* spp., *Nummulites* spp., *Alveolina* spp., *Globotruncana* spp., Globigerinoids, Globorotalids, Bryozoans, Crinoids, Echinoids, red Algae), characterized by marked reworking phenomena, show affinities with the "*Calcareniti di Dudda*" *Auct.* (Tuscan succession) and "*Monte Morello*" *Auct*. (Ligurids) Units. On the whole of coastal marine deposits, paleocurrents concentrate along two main directions, SW-NE and NW-SE, respectively orthogonal and parallel to the paleocoast. Within the first group, SW directed currents prevail on NE ones, while NW and SE directed currents have equivalent distribution (Fig. 5C, left). The paleocurrent pattern can be related both to a SW coastal system progradation, linked to river supply, and to a redistribution of deposits alongshore. On the other hand, paleocurrents measured on a single outcrop referable to **Unit B** (*La Trincea*: Fig. 5C, right), although documenting only local flow directions, seem to be consistent with a W-NW provenance of river deposits.

3.4 Depositional model

The two described units delineate a depositional and paleoenvironmental contiguity, during Late Pliocene and the beginning of Early Pleistocene, between the South *Chiana* Valley continental basin and the *Città della Pieve* delta. The collected data lead to the reconstruction of a gently seaward inclined delta profile, with subenvironment articulation both along- and across-shore (Fig. 6). Mouth bar deposits, seaward decreasing in grainsize, were redistributed alongshore as gravel beaches and organized as prograding gravel and sand dunes across-shore, with interposition of shoreface-like deeper interdistributary bays. On a profile parallel to paleocoast, shallower and deeper zone alternate, referable to channel mouths and bays respectively (Fig. 6B). The *Città della Pieve* delta was fed by one or more braided rivers (Figs. 6A, C). Leaf-bearing silt horizons interposition to gravel (Fig. 3B), as well as occurrence of mixed marine and brackish deposits, document the transitional zone between the two environments (Fig. 6).

4. PALEONTOLOGICAL AND STRATIGRAPHIC DATA

Mollusc and foraminifera assemblages of **Unit A** are scarce and oligotypic on gravelly and sandy deposits ($\mathbf{A_1}$ to $\mathbf{A_3}$ *facies* associations), whereas prodelta deposits ($\mathbf{A_4}$ *facies* association) are characterized by richer and more diversified assemblages (Tab. 2); in any case, they lack biostratigraphic significance. On the other hand, nannofossils provide better stratigraphic data, and two main assemblages have been documented. Samples collected on sands (*S. Biagio*, CDP1, CDP4 outcrops: Figs. 1B, 4; Tab 1) are characterized by the occurrence of small *Gephyrocapsa* spp. and can be referred to Late Pliocene-Early Pleistocene (MNN18–19a Nannofossil Zones). Early Pleistocene richer assemblages come from *P.gio al Piano* and *F.ce Frazzi* quarry outcrops (Tab. 2): the former is characterized by small *Gephyrocapsa* spp. and *Calcydiscus*

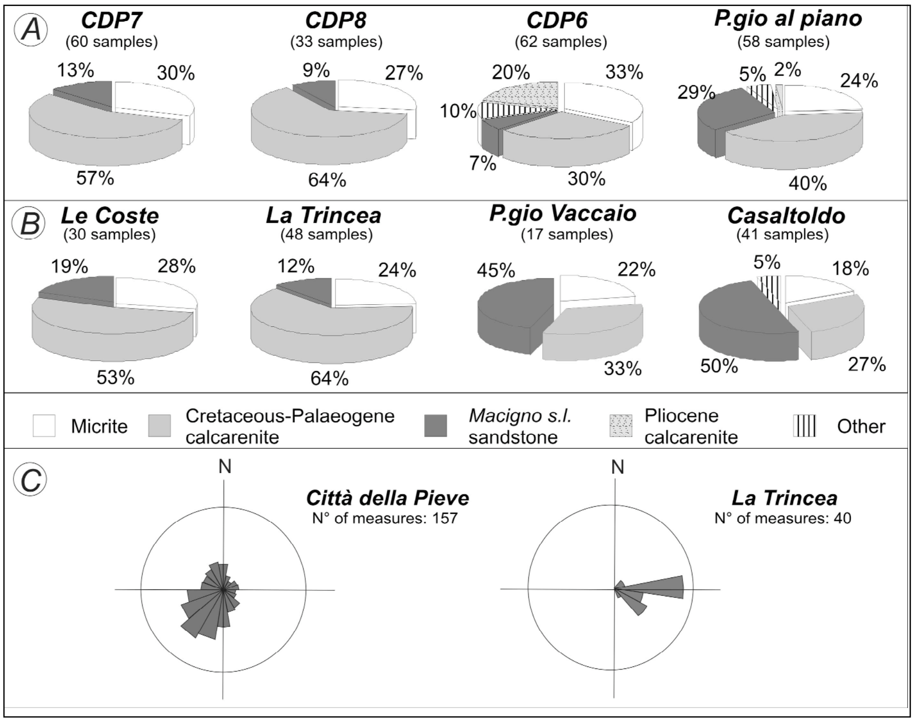

Figure 5 - Statistic analyses on gravel. Lithology of $\mathbf{A_2}$ *(A)* and $\mathbf{B_1}$ *(B) facies* associations gravels on eight selected outcrops (see Figure 1B and Table 1 for outcrop sites, text for details). *C)* Paleocurrent patterns (flow directions) derived from $\mathbf{A_2}$ gravel on *Città della Pieve* area (left) and from $\mathbf{B_1}$ gravel on *La Trincea outcrop* (right).

Analisi statistiche sui ciottoli. Litologia dei ciottoli provenienti da otto affioramenti selezionati e riferibili alle associazioni di facies $\mathbf{A_2}$ (A) e $\mathbf{B_1}$ (B) (si veda Figura 1B e Tabella 1 per l'ubicazione degli affioramenti ed il testo per maggiori dettagli). C) Distribuzione delle paleocorrenti (direzione dei flussi) dedotta dai ciottoli dell'associazione di facies $\mathbf{A_2}$ nell'area pievese (a sinistra) e da quelli dell'associazione di facies $\mathbf{B_1}$ nell'affioramento de La Trincea (a destra).

macyntirei (BUKRY & BRAMLETTE) LOEBLICH & TAPPAN and can be referred to MNN19b Zone, whereas the latter, for the presence of medium *Gephyrocapsa* spp. (*sensu* RAFFI, 2002), can be referred to MNN19b-c Zones. Both marine and brackish Early Pleistocene mollusc and foraminifer assemblages (*G. inflata - Gl. cariacoensis* Zones), reported south and north of *Città della Pieve* (AMBROSETTI *et al*., 1987), agree with the collected data. A Late Pliocene-Early Pleistocene age for the *Città della Pieve* deltaic deposits can be presumed (Figs. 2, 4). Differently to previous authors (AMBROSETTI *et al*., 1977, 1987), Early to Middle Pliocene foraminifera assemblages, with occurrence of *Globorotalia puncticulata* (DESHAYES) and *G*. gr. *crassaformis* GALLOWAY & WISSLER, as well as the nannofossil assemblages dominated by *Discoaster* spp. (AMBROSETTI *et al*., 1977), have not been documented.

Unit B continental deposits are very scarce in paleontological content; mollusc assemblages (Tab. 2) collected during the CARG-*Passignano* project (BIZZARRI, 2006; BIZZARRI *et al*., 2008), and the remains of *Anancus arvernensis* (CROIZET & JOBERT) reported from gravel bodies in the *Vaiano* area (ARGENTI, 2004), allow the attribution of **Unit B** to Late Villafranchian (Figs. 2, 4).

5. DISCUSSION

In order to allow a reliable inference of the new data here proposed, some considerations about depositional and stratigraphic implications of the *Città della Pieve* deltaic deposits are needed. The occurrence of two main depositional cycles (Fig. 2) proposed by AMBROSETTI *et al*. (1977; 1987) based upon two assumptions: i) deposits have a noteworthy difference in age and ii) they are divided by a main angular unconformity. These statements also lead authors to propose simple superposition contacts among units of lower cycle, and to mark the occurrence of a large non depositional and/or erosive gap, covering a time span from Late Pliocene to Early Pleistocene ("*Acquatraversa*": AMBROSETTI *et al*., 1977; 1987). The gravel and sand alternation (**A_2** *facies* association), in fact, develops with stable features along about the 2/3 of *Città della Pieve* hill thickness and not only on its top, as it was stated by previous Authors, showing lateral continuity to sand of **A_3** *facies* associations (Fig. 4). Furthermore, nannofossil assemblages at the top of *F.ce Frazzi* deposits (**A_4** *facies* association) and on sandy deposits (CDP1, CDP4 outcrops: **A_3** *facies* associations) can be referred to Early Pleistocene and to Late Pliocene-Early

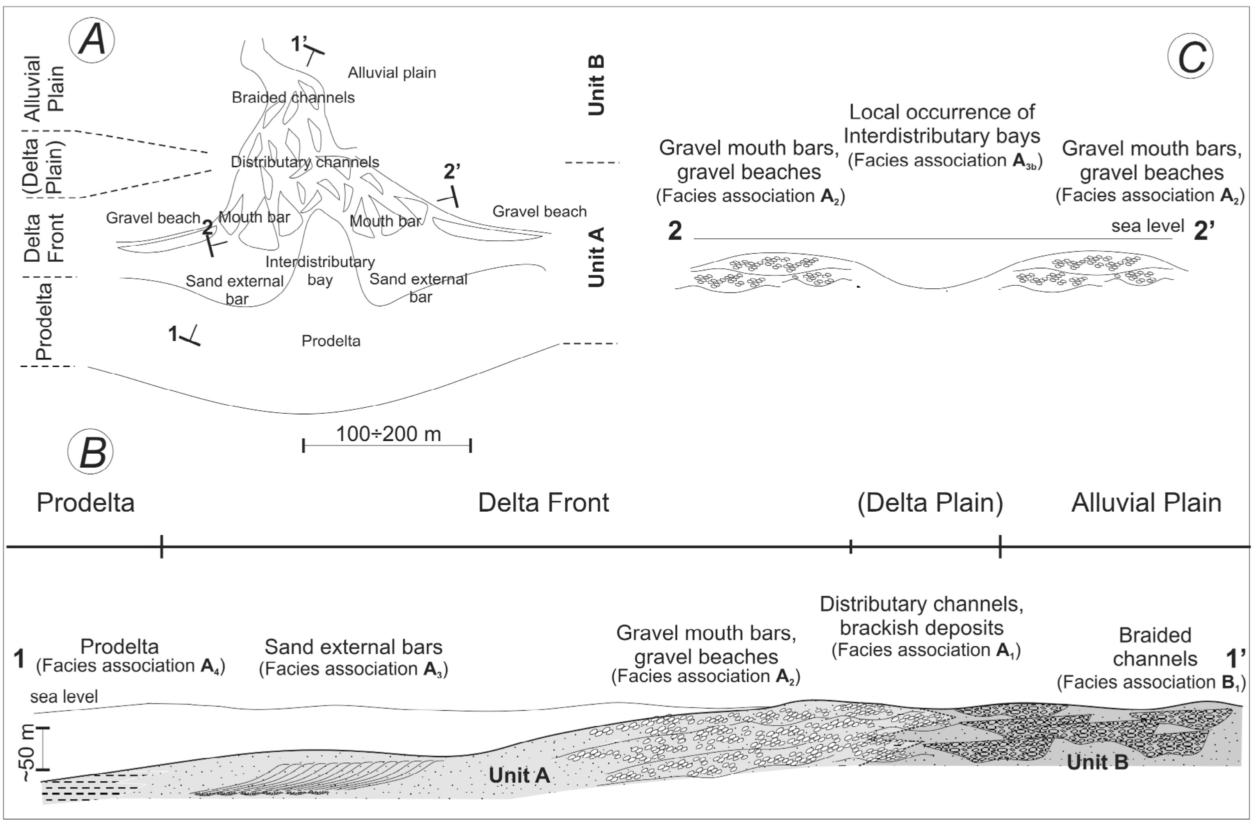

Figure 6 - Depositional model. *A)* Paleoenvironments distribution in plan. *B)* Across-shore section. *C)* Along-shore section. 1-1', 2-2'=section tracts.

Modello deposizionale. A) Articolazione in pianta dei paleoambienti. B) Profilo ortogonale alla paleocosta. C) Profilo parallelo alla paleocosta. 1-1', 2-2'=tracce di sezione.

Pleistocene, respectively (Tab. 2). This little difference in age suggests *facies* eteropy between clays and sands, or a partial superposition of clays top to sands (Fig. 4), but it is in contrast to the hypothesized vertical continuity between "*Argille di Fabro*" clay unit and "*Sabbie a Flabellipecten*" sandy unit proposed by previous authors (AMBROSETTI *et al*., 1977; 1987). Analogous relations of lateral continuity/partial superposition occur between $\mathbf{A_2}$ and $\mathbf{A_1}$ *facies* association (Figs. 4, 6, Tab. 2). As a consequence, hypothetic time lines cross *facies* associations of **Unit A** (Figs. 4, 6, Tab. 2) rather than corresponding to lithological variations, as previously inferred by AMBROSETTI *et al*. (1977; 1987). The hypothesis of vertical unit superposition, indeed, is not confirmed. All these deposits are referable to a deltaic environment, with a time span from Late Pliocene to Early Pleistocene: a single stratigraphic unit, grouping the whole *Città della Pieve* deposits and including also mixed marine and brackish deposits of $\mathbf{A_1}$ *facies* association, seems to be more reliable. On the other hand, all the *Città della Pieve* deposits show a common, less than 10° north-eastern dip, and main unconformities, referable to 3rd order cycle boundaries, which have not been documented on outcrop. Both deltaic and mixed deposits ($\mathbf{A_1}$ to $\mathbf{A_4}$ *facies* associations), documented in the *Città della Pieve* area, belong to a unique stratigraphic unit, Late Pliocene to Early Pleistocene in age, partially referable to the second depositional cycle of the succession proposed by AMBROSETTI *et al*. (1977; 1987) for western Umbria ("*Argille e Sabbie del Chiani-Tevere*" Unit). A better connection can be found with the Late Pliocene – Early Pleistocene depositional cycle ("*Chiani-Tevere*" Unit) recently proposed for Tiber Valley south of Orvieto (GIROTTI & MANCINI, 2003; MANCINI *et al*., 2004).

The other topic to debate regards the source and provenance of sediments that build up the *Città della Pieve* delta. Taking into account deposit thicknesses, gravel-sand alternations of $\mathbf{A_2}$ *facies* association (Figs. 3A-B) repeat 12 to 15 times in the core of *Città della Pieve* hill, for a total of 100-150 m, as can be observed on deep ravines west of the town. Comparable values characterize sandy bodies of $\mathbf{A_{3a}}$ *facies* association (Fig. 3D), whereas $\mathbf{A_4}$ deposits crop out only for ~20 m and show no variations on sedimentary structures. The whole thickness of **Unit A** reaches 250-300 m. These values suggest a wide and long-lasting river alimentation for the delta system to accommodate the entire successions, although characterized by a discontinuous supply, with alternation of high river discharge and prevailing wave reworking phases. The repetition of the *facies* associations suggests a cyclic organization in depositional sequences, as the result of interaction among tectonic subsidence, sea-level variations, sediment supply and compaction. An account of the cyclicity is beyond the aims of this work, and study is still in progress. In summary, the *facies* associations of **Unit A** can be referred to a wave-dominated delta built in correspondence to one or more stable and long-lasting river mouth. This kind of fluvial system, with steady characters along a time span of at least 500 ka, inferred by biostratigraphic data, necessarily implies the hypothesis of a stable, long-lasting and wide catchment area. The present day geological setting underlines the occurrence of two past continental domains (Figs. 1A, 1B), coeval with the *Città della Pieve* delta, which can supposedly represent source areas for deltaic sediments: the South *Chiana* Valley Basin to the north, and the *Tavernelle-Pietrafitta* Basin to the east. Deposits of **Unit B** indicate the occurrence on the south-western part of *Trasimeno* hills (Figs. 1A, 1B) of a roughly organized braided river environment, characterized by a distinctive bi-parted gravel/sand fill. Fluvial environment had a discontinuous activity, with the highest gravel transport consequent to main river activity phases. Overbank is represented by prevailing sheetflood deposits, alternated with alluvial plain fine sediments and paleosoils. Stratigraphic data (Fig. 2) point out the stability of these environmental conditions for at least 500 ka, between Late Pliocene and Early Pleistocene. Besides stratigraphic data, depositional architecture of that river environment matches with the alternation of river supply and marine reworking described for *Città della Pieve* deposits. Moreover, the >200 m thickness estimated for **Unit B** deposits (BIZZARRI *et al*., 2008) is comparable to values proposed for **Unit A**. *Facies* analysis and paleontological determinations mark the occurrence, NE and N of *Città della Pieve*, of mixed marine and brackish deposits (Fig 1B, Tab. 2), easily referable to delta plain environment and transitional to braided river environment of **Unit B**. Paleocurrent pattern reconstructed for **Unit A** agree with a NW-SE proximal-distal *facies* transition. Measures indicate two main orthogonal directions (Fig. 5C); NW-SE values aligned on along-shore direction, show a symmetrical distribution and are here related to longshore currents. Across-shore, SW-NE oriented values confirm the dispersion of channel axis about a N-S direction, marking also a clear asymmetry, with a prevalence of SW-directed flows (Fig. 5C), referable to a mean mouth bar progradation in the same direction. The subordinate NE-directed set also testify for across-shore wave reworking. The *La Trincea* paleocurrent pattern, although indicative of only local flow conditions, still denotes a coherent trend compared to *Città della Pieve* (Fig. 5C), and underlines a local western or north-western provenance of flows. Gravel lithology analyses on both **Unit A** and **Unit B** sampled outcrops (Figs. 3, 5A, 5B) reveal a prevalence, or a significant amount, of limestone coming from Tuscan and Ligurid lithostratigraphic Units, although percentages vary with outcrops. Abundance of Cretaceous to Palaeogene bio-calcarenites is a feature of Tuscan and Ligurid lithostratigraphic Units, whereas they lack on Umbria-Marche western successions. Sandstone gravels become important only close to the cropping out *Macigno s.l.* formation (Figs. 1B, 5A, 5B); on the other hand, western outcrops show an absolute dominance of limestone (Figs. 1B, 5 A, 5B). The scarce sandstone occurrence can be ascribed to its low preservation potential and its rapid disaggregation during river transport; in fact, both marine and continental sands contain a large amount of quartz presumably derived from sandstone erosion. Gravel lithology agrees with a prevailing northern and western sediment supply, from sectors in which Tuscan and Ligurid lithostratigraphic Units are more represented, whereas an eastern supply, due to prevailing sandstone substratum lithology east of *Città della Pieve*, seems negligible (Figs. 1A, 1B). Indeed, both gravel lithology and paleocurrent pattern are consistent with a northern alimentation for the *Città della Pieve* delta. Basing on depositional environment, age, *facies* transition and analogous sediment supply, this feeder system can be found on South *Chiana* Valley braided rivers (**Unit B**). Nevertheless, the northern hypothesis has been essentially neglected by previous authors (VERRI, 1877; 1885; 1889; 1892; 1918; LOTTI, 1899; 1900; MERLA, 1944; CATTUTO *et al*., 1983; 1992; AMBROSETTI *et al*., 1987; 1989), and an eastern alimentation, throughout the *Tavernelle-Pietrafitta* Basin, as well as subordinated relations with Tiber Basin, was chosen. The lack of lithologies referable to the Umbria-Marche stratigraphic Units both among **Unit A** and **B** gravel, which should be documented on deposits of a large river, with a hydrographical basin of several hundred square kilometres, sharply contrasts with the hypothesis of a Paleo-Tiber delta (VERRI, 1877; 1885; 1889; 1892; 1918; LOTTI, 1899; 1900; MERLA, 1944). A local eastern supply hypothesis (Paleo-*Nestore*: CATTUTO *et al*., 1983; 1992; AMBROSETTI *et al*., 1987; 1989) denotes some incongruence with the previously explained data. First of all, pre-Pliocene substratum all around the *Tavernelle-Pietrafitta* Basin, both on the *Paciano-Panicale* lineage and the northern termination of *M. Peglia* range, is today represented by Oligo-Miocene turbiditic sandstones (*Macigno s.l. Auct.*), whereas limestone Units are not widely diffused and mainly confined on a far, south-western portion (Fig. 1A). This lithological homogeneity reflects on gravel, almost exclusively arenitic and with less than 10% of limestone, on all the outcrops of the basin (PAZZAGLIA, 2007). The depositional context appears even more in contrast: the *Tavernelle-Pietrafitta* Basin was characterized, during Late Villafranchian, by a lacustrine-swampy rather than by a fluvial environment, and was widely bounded, also toward Città della Pieve, by a large thickness of piedmont deposits (Figs. 1B, 2). The *Tavernelle-Pietrafitta* Basin shows, indeed, a centripetal and prevailing eastward river drainage at least during Early Pleistocene, not consistent with the alimentation of the *Città della Pieve* delta. Thus, the hypotheses involving eastern supply and temporary communication with the paleo-sea between Late Pliocene and Early Pleistocene, still not rejectable, are not satisfactory for a comprehensive interpretation of the collected data. Another possibility to evaluate is an origin from deposits far (both in time and space) from their final sedimentation area. From this point of view, the reworking of previous deposits, a sort of "cannibalization", related to a different environment and/or a previous basin must been considered. The hypothesis of reworked gravel, with the *Città della Pieve* delta representing only the last depositional environment, still leads to a northern or north-western supply. The limestone-dominated deposits can result from substratum erosion at the Miocene-Pliocene boundary or during Early Pliocene; that substratum, tectonically-dislocated and buried under about 400 m thick Plio-Pleistocene deposits, is now only inferred from seismic sections under *Trasimeno* Lake (BARCHI *et al*., 2007; BIZZARRI *et al*., 2008). In fact, the small substratum occurrences in the wide *Trasimeno* hill area (Fig. 1A) are characterized by Ligurids *Auct.* (*C. del Lago, Sanfatucchio, Paciano*), *Scaglia Toscana s.l.* (*Isola Minore*) and *Macigno s.l.* (*Isola Maggiore, Isola Polvese*), and only partially reflect the composition of substratum on the eastern side of present-day *Trasimeno* Lake. On the other hand, material origin can be somehow put in relation with thick gravel deposits, with prevailing bio-calcarenitic Tuscan/Ligurid clasts, deposited during Early-Middle Pliocene on *Rapolano-Cetona* range western side (*Conglomerati de La Foce*: PASSERINI, 1965; JACOBACCI *et al*., 1967; 1969; COSTANTINI & DRINGOLI, 2002), interpreted as northern river fan delta deposits into the *Radicofani* Basin (COSTANTINI & DRINGOLI, 2002). At the emersion of *Radicofani* Basin area, from Middle-Late Pliocene onward (BARBERI *et al*., 1994), the hypothesis of reworking, due to South Chiana Valley rivers must be considered: the southward shift of river systems led to deposition on the *Città della Pieve* area between Late Pliocene and Early Pleistocene.

6. CONCLUSIONS

Sedimentological and stratigraphic data here proposed, still supporting the deltaic origin for *Città della Pieve* coastal marine deposits, which shed new light on both age of deposits and river supply source. Depositional and paleoenvironmental contiguity, gravel lithology and stratigraphic position mark a clear lateral SW continuity between these deposits and the South *Chiana* Valley gravel river systems; indeed, they represent the transition to open marine environment. From this point of view, the Plio-Pleistocene *Città della Pieve* deltaic deposits belong to the South Chiana Valley Basin and can be related to a 3rd order Late Pliocene-Early Pleistocene depositional cycle, only partially corresponding to "Argille e Sabbie del Chiani-Tevere" cycle of AMBROSETTI *et al*. (1977; 1987) and comparable to the *Chiani-Tevere* Unit described in the Orvieto area (GIROTTI & MANCINI 2003; MANCINI *et al*., 2004).

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