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FLUVIAL SEDIMENTATION DURING THE EARLY HOLOCENE IN THE MARCHEAN VALLEYS (CENTRAL ITALY)

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RIASSUNTO - *Sedimentazione fluviale durante l'Olocene antico nelle valli marchigiane (Italia centrale)* - Il Quaternario *Italian Journal of Quaternary Sciences*, 9(2), 1996, 459-464 - Le valli della fascia periadriatica in Italia centrale sono state interessate da un generale processo di aggradazione da parte di corsi díacqua a canali intrecciati durante la maggior parte del Pleniglaciale medio e superiore. Durante le fasi stadiali (Denekamp-Arcy, Hengelo, Kesselt, Tursac e Pre-Bølling) si avevano corsi d'acqua anastomizzati a prevalente sedimentazione fine con deposizione di livelli torbosi. La generale aggradazione pleistocenica è terminata verosimilmente già nel Tardiglaciale anche se, attualmente, non si dispongono ancora di datazioni al riguardo. Prima di 8.260 ±100 yr B.P., dopo una generale erosione dei depositi pleistocenici, ha avuto inizio, nei tratti montani dei fiumi, la deposizione di travertino fitoermale che ha in più casi sbarrato le valli producendo accumuli di sedimenti palustri o lacustri spessi fino ad alcune decine di metri. La deposizione di travertino è proseguita fino al II° millennio B.C. nel corso del quale essa è generalmente terminata. Nella media valle del fiume Potenza, in località cava Smorlesi, i depositi alluvionali risultano costituiti da alternanze di sedimenti argillosi e siltosi, suoli alluvionali e sedimenti sabbiosi a stratificazione incrociata a basso angolo. Nella sequenza sono localmente presenti sedimenti ghiaiosi a stratificazione piano parallela (barre) e incrociata (migrazione laterale di barre e di piccoli canali). A vari livelli si rinvengono focolari e carboni sparsi, gusci di molluschi e, più raramente resti di macrovertebrati. Frammenti ceramici sono stati osservati solamente nella parte medio-alta della sequenza, sia all'interno dei suoli alluvionali che nei sedimenti più fini. Un focolare ubicato a –11.0 m dalla sommità del deposito ha fornito 7,210±90 yr B.P. (ROME -508). Circa 1 km più a valle, nei pressi di Fontenoce, la sommità della medesima unità morfologica è incisa da un canale contenente due livelli insediativi eneolitici sovrapposti e separati da limi di esondazione, che hanno fornito età di 4,680±100 e 4,700±100 yr B.P. Nella media valle del fiume Tenna, sono state individuate sequenze spesse 7-8 metri con caratteristiche stratigrafiche e morfocronologiche simili. Nella cava nei pressi di San Gualtiero, alla base della sequenza alluvionale, costituita essenzialmente da sedimenti fini, è stato rinvenuto un livello a carboni la cui datazione ha fornito 7,620±80 yr B.P. (ROME 508); resti ceramici dell'Età del Bronzo e carboni, datati 3,570±70 yr B.P., sono stati rinvenuti al fondo di un canale profondo oltre 10 m, che incide l'intera sequenza, raggiungendo anche le sottostanti alluvioni del Pleistocene superiore. Queste età permettono di ipotizzare che nei tratti mediani e prossimali delle valli principali l'incisione fluviale si sia realizzata tra la fine del Tardiglaciale e 8,000 anni B.P. lungo canali singoli e sinuosi, approfondendosi talora fino a 20 m rispetto alla pianura pleistocenica. A partire dal II° millennio B.C. la deposizione di sedimenti fini aveva termine mentre tutti gli assi vallivi venivano interessati da un rapido approfondimento in alveo. Contemporaneamente, nelle aree di foce, si verificavano forti incrementi nei tassi di sedimentazione. Tali cambiamenti potrebbero essere associati ad un progressivo diradamento della copertura vegetale dei versanti ed a conseguenti diffusi processi di erosione concentrata per cause antropiche o per effetto di variazioni climatiche.

ABSTRACT - *Fluvial sedimentation during the early Holocene in the Marchean valleys (Central Italy)* - Il Quaternario *Italian Journal of Quaternary Sciences*, 9(2), 1996, 459-464 - The periadriatic valleys of central Italy were affected by a general aggradation under braided river system conditions during most of the Middle and Upper Pleniglacial. Anastomosing rivers characterized by a fine sedimentation with peat layers, established during the interstadial phases (Denekamp-Arcy, Hengelo, Kesselt, Tursac and Pre-Bølling). The general Pleistocene aggradation seems to have ended in the Late Glacial, although further dating is necessary to framework the events more precisely. After a general downcutting of the Pleistocene deposits, slightly before 8,260±100 yr B.P. travertine deposition started in the mountain areas, with the damming of river valleys and the production of swampy-lacustrine deposits up to some 10 m thick. Travertine deposition continued until the 2nd millennium B.C., when it practically ceased. A section in a quarry in the middle Potenza river valley (Smorlesi Quarry) shows a sequence made up of fine sediments (alternating silty-clayey layers, alluvial soils and cross-bedded sandy layers). Within the sandy sediments, in the middle-upper part of the sequence, ceramic fragments were also found. A fireplace that was found at about 11 m from the top of the sequence, dates back to 7,210 ± 90 yr B.P. (ROME -508). Approximately 1 km downvalley, close to Fontenoce, a channel was identified at the top of the same sedimentary unit; this channnel contains two superimposed layers with Eneolithic industry, separated by overflood silts. The dating of these layers gave ages of 4,680±100 and 4,700±100 yr B.P. Sequences up to 7-8 m thick, showing the same stratigraphic and morphochronological characteristics, have been recognized in the middle Tenna River valley. At the San Gualtiero quarries, a charcoal layer from the base of an alluvial sequence generally composed of fine-grained sediments gave an age of 7,620±80 yr B.P. Moreover, Bronze age ceramic fragments and charcoal fragments 3,570±70 yr B.P. old were discovered at the base of a more than 10 m deep channel, which cuts the whole sequence and the underlying Upper Pleistocene alluvial deposits. These age values suggest a progressive deepening of the alluvial plain as the work of a single and sinous channel up to 20 m deep. From Late Glacial to 8,000 yr B.P., a slow aggradation process followed. After the 2nd millennium B.C., the deposition of fine sediments ended and a rapid deepening of *thalwegs* is recorded. These modifications may be attributed either to climatic changes or to the effect of Man impact after the general occupation of the slopes for agriculture and farming purposes.

Key words: Fluvial sedimentation, channel fills, Holocene, Marche, Italy
Parole chiave: Sedimentazione fluviale, riempimento di canali, Olocene, Marche, Italia

1. INTRODUCTION

Whereas many investigations have been carried out on the Pleniglacial and Late Holocene morphodynamics of the Adriatic side of Central Italy (Alessio *et al.*, 1979; Biondi & Coltorti, 1982; Nesci & Savelli, 1986; Alessio *et al.*, 1987; Gentili & Pambianchi, 1987; Coltorti *et al.*, 1994), only a few works deal with the early Holocene

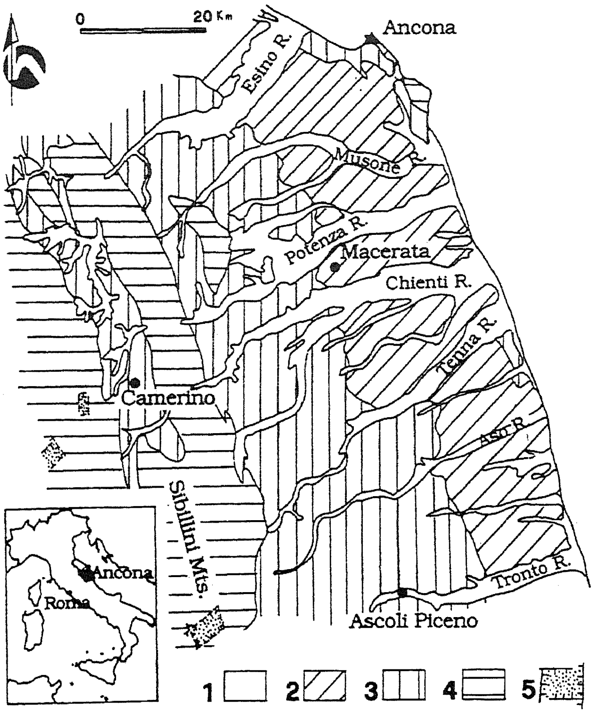

Fig. 1 - Morphostructural scheme of the Marche region: 1 - Pleistocene and Holocene continental and littoral deposits; 2 - Pliocene-Lower Pleistocene clays and sands (marine and littoral deposits); 3 - Miocene turbidites; 4 - Limestones and marly limestones; 5 - Continental deposits of the intermontane tectonic depressions.

Schema morfostrutturale della regione marchigiana: 1 - Depositi continentali del Pleistocene e dell'Olocene e deposti litoranei; 2 - Argille e sabbie del Pleistocene inferiore-Pliocene (depositi marini e litoranei); 3 - Torbiditi mioceniche; 4 - Calcari e marne calcaree; 5 - Depositi continentali delle depressioni intermontane.

geomorphological evolution of this area (Coltorti, 1991; Calderoni *et al.*, 1991a & b; Cilla *et al.*, 1994; Calderoni *et al.*, in press). The stratigraphic analyses of alluvial fine-grained sediments outcropping in numerous sections, allow for a better understanding of the early Holocene fluvial dynamics in the area. In particular, ^{14}C ages obtained on wooden remains from alluvial sequences seem to explain both time and mode of Holocene fluvial dynamics, and to indicate significant environmental changes in the area.

2. PRESENT KNOWLEDGE ON LATE GLACIAL AND HOLOCENE FLUVIAL DYNAMICS

Almost all the Marche rivers originate from the Umbro-Marchean Apennine chain and, crossing the Peri-Adriatic hilly belt with a SW-NE trending course, reach the Adriatic Sea (Fig. 1). Their Quaternary geomorphological evolution was greatly influenced by the interaction between climatic changes and regional uplift, which has affected the Apennines since Lower Pliocene and the Periadritic Basin since the late Lower Pleistocene (Cantalamessa *et al.*, 1986; Coltorti *et al.*, 1991; Dramis, 1992). As a consequence, alluvial terraces formed at progressively higher elevations above the valley floors.

In the Upper Esino Basin, the Late Pleistocene fluvial evolution was characterized by a general aggradation under braidplain conditions during the stadial phases of the Upper Pleniglacial (Calderoni *et al.*, 1991a). The deposits are generally made of several meters thick horizontal gravel bars (the "Gm facies" of Miall, 1985) and less frequent gravelly channel fills (Gt). In connection with the Denekamp-Arcy, Hengelo, Kesselt, Tursac and Pre-Bölling Interstadials, a certain stability of the rivers was attained, with development of anastomosing channels and deposition of fine-grained sediments locally containing peat layers (Alessio *et al.*, 1979; Calderoni *et al.*, 1991a). Similar dynamics have been recognized in some fluvial systems of Central Europe (Starkel, 1983; Mol, 1995). Fluvial sedimentation was greatly influenced by the production of debris on slopes from outcropping bedrock formations, which had easily been affected by frost-shattering (Coltorti & Dramis, 1995). During the Late Glacial, the debris production ended and the progressive re-colonization of slopes by forest vegetation started. This caused a marked reduction of debris feeding to the river network and the downcutting of river channels in the alluvial plain. Analogous events have also been recognized in several valleys of Central Europe (Rose *et al.*, 1980; Vanderberghe *et al.*, 1987; Van Huissteden & Vanderberghe, 1988; Vanderberghe, 1992). In fact, large meander loops have been identified along the middle part of many Marchean rivers, which slightly cut into the Late-Plestocene alluvial deposits. The presence of meander terraces, also at elevations close to the present-day *thalweg,* indicates that, until Roman Times, the Marchean rivers had been affected by a general downcutting under a meander course (Coltorti, 1991). During this period, and especially after the Middle Age, the middle-lower reaches of the valley underwent aggradation under braided courses to which a strong seaward advance of the coastline was connected. These phenomena continued till the end of the last century (Gentili & Pambianchi, 1987). Subsequently, reclaiming of water courses, the creation of artificial levees along river banks, the land use changes occurred after the unification of Italy and an intensive quarrying activity along river beds during the 1940-60s induced a general downcutting along single irregular channels (Biondi & Coltorti, 1982; Conti *et al.*, 1983; Gentili & Pambianchi, 1987; Coltorti *et al.*, 1991; Coltorti, in press).

In the mountain areas, after a general downcutting phase, the rivers had been affected by travertine deposition from some time before 8,260±100 yr B.P. up to about 3,500 yr B.P. (Cilla *et al.*, 1994; Calderoni *et al.*, in press). After this period, the travertine deposition ended and a new phase of downcutting started, producing up to 10 m deep channels, which locally contain archaeological industry of the Bronze Age.

3. THE EARLY HOLOCENE DEPOSITS

Along the Tenna River, between Servigliano and "Molino di Monte S. Martino" (Fig. 2a), geomorphological-stratigraphic observations on gravel quarries (Fig. 3) indi-

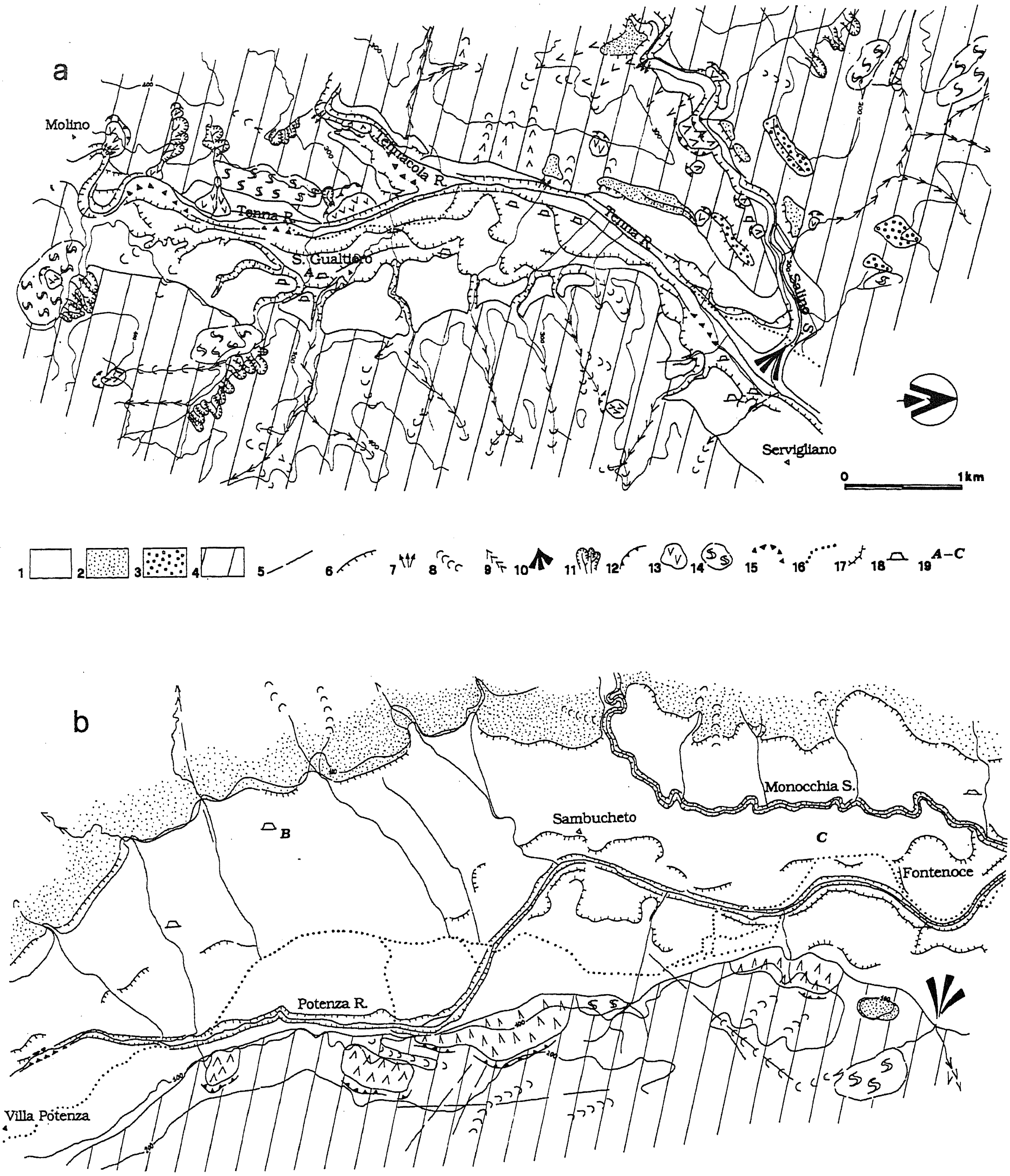

Fig. 2 - Geomorphological scheme of the Tenna river valley (**a**) and Potenza river valley (**b**) in their middle part: 1 - Present-day and terraced alluvial deposits (Holocene); 2 - Terraced alluvial deposits of Upper Pleistocene; 3 - Terraced alluvial deposits of late Middle Pleistocene; 4 - Siltites and sands with intercalated arenaceous and conglomeratic bodies (Pliocene - Lower Pleistocene); 5 - Faults; 6 - Fluvial erosion escarpment; 7 - Intense lateral erosion; 8 - Through-floored small valley; 9 - V-shaped small valley; 10 - Alluvial fan; 11 - Badlands; 12 - Landslide scarp edge; 13 - Landslide scree-tongue; 14 - Plastic deformations; 15 - Artificial levees; 16 - Artificially cut channel; 17 - Artificial embankments; 18 - Quarry; 19 - Study section (localities: A - San Gualtiero; B - Smorlesi; C - Fontenoce).

*Schema geomorfologico della valle del fiume Tenna (**a**) e della valle del fiume Potenza (**b**): 1 - Depositi alluvionali attuali e terrazzati dell'Olocene; 2 - Depositi alluvionali terrazzati del Pleistocene superiore; 3 - Depositi alluvionali terrazzati del Pleistocene medio finale; 4 - Peliti e sabbie con intercalazioni di corpi arenacei e conglomeratici; 5 - Faglie; 6 - Scarpata d'erosione fluviale; 7 - Intensa erosione laterale; 8 - Vallecola a fondo concavo; 9 - Vallecola a V; 10 - Conoide alluvionale; 11 - Calanchi; 12 - Scarpata di frana; 13 - Corpo di frana; 14 - Deformazioni plastiche; 15 - Argini artificiali; 16 - Canale artificiale; 17 - Terrapieni; 18 - Cava; 19 - Ubicazione delle sezioni studiate (localita: A - San Gualtiero; B - Smorlesi; C - Fontenoce).*

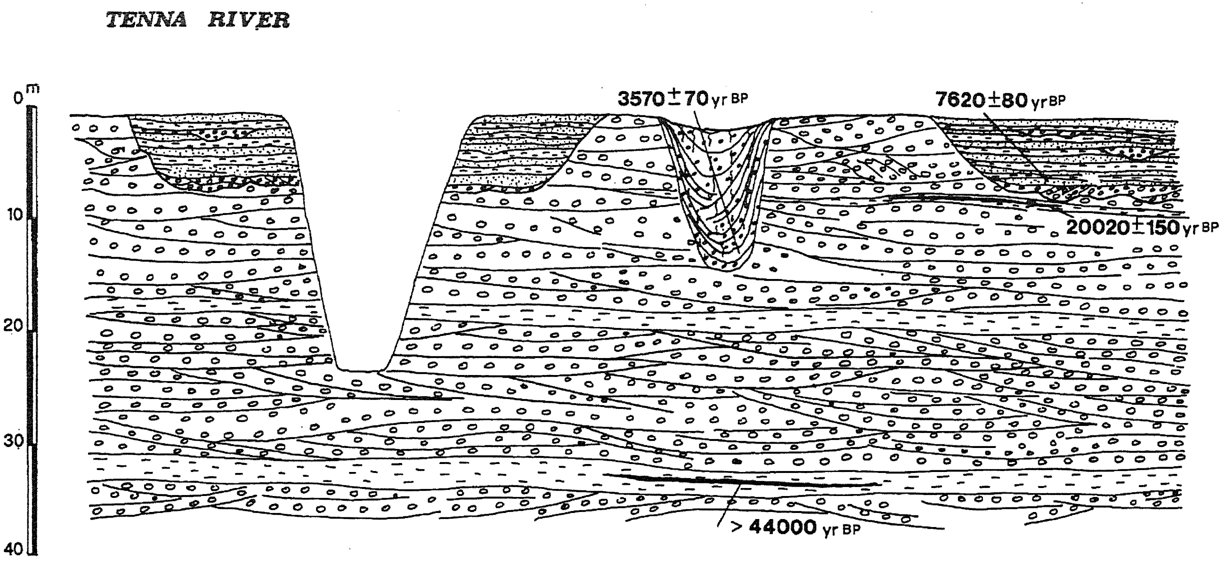

Fig. 3 - Composite sequence of fluvial deposits of the Upper Pleistocene and Holocene in the San Gualtiero quarries area, along the Tenna River with indications of the ages of outcropping sediments.

Sequenza composta dei depositi fluviali del Pleistocene superiore e dell'Olocene presenti nelle cave di San Gualtiero, lungo la valle del fiume Tenna, con indicazione delle età ottenute sui sedimenti affioranti.

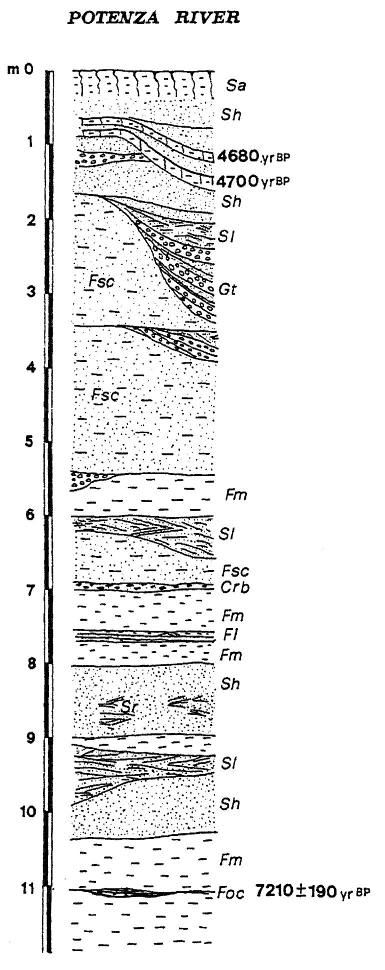

Fig.4 - Composite sequence of fluvial deposits of the Upper Pleistocene and Holocene in the Smorlesi quarry (lower part of the section) and at Fontenoce (upper part of the section) along the Potenza River.

Sequenza composta dei depositi fluviali del Pleistocene superiore e dell'Olocene presenti nella cava Smorlesi (parte basale della sezione) e a Fontenoce (parte sommitale della sezione) lungo la valle del fiume Potenza.

cated that Upper Pleistocene fluvial sediments have the same characteristics as those of the Upper Esino River. Layers of fine-grained sediment intercalated with peat and organic deposits, which are interfingered with gravel sediments, gave ages older than 44,000 yr B.P. (BETA-87663) and 20,020±150 yr B.P. (BETA-87662). In these sections, the thickness of Pleniglacial gravel deposits is reduced, due to Late Glacial-early Holocene erosional processes. The aforementioned sediments are incised by flat-floored channels, filled with alluvial sediments which show at their base coarse gravels bars (channel lag). Silty and sandy sediments, 6-7 m thick, with horizontal parallel bedding (Sh, Fl, and Fm of Miall, 1985), sometimes containing also land snails (Fcf), indicate low energy sedimentary processes. Charcoals close to the base of these sediments gave an age of 7,620±80 yr B.P. (BETA-87661). The top surface of this deposits has been incised by a channel more than 10 m deep, which was subsequently abandoned. At the bottom of the channel, Bronze age ceramic fragments, buried by colluvial sediments were found. Charcoals associated with these materials were dated at 3,570±70 yr B.P. (BETA-87660).

In many tributary valleys of the Tenna River, as well as in other minor valleys of the peri-Adriatic belt, thick alluvial sequences of fine-grained sediments, sometimes also containing organic materials, have been recognized in deep channels cutting the Upper Pleistocene alluvial deposits.

Palaeochannels of tributary valleys, containing archaeological remains of Neo-Eneolithic and Bronze Age have been recognized also near Cerreto d'Esi (upper Esino River), and near Castello di Lanciano, in the middle valley of the Potenza River. Along the Chienti river, close to Borgiano, a thick sequence of alluvial fan deposits was emplaced after the beginning of the 1st millennium B.C. (Calderoni *et al.*, 1989). Along the Monte D'Oro Stream, a tributary of the Cesano River, at the contact with the bedrock, Iron Age ceramic fragments were discoverd, under several meters of alluvial materials (Coltorti, 1991).

In the middle part of the Potenza River, between Villa Potenza and Fontenoce, some fluvial terraces hanging at progressive elevations over the valley floor have been recognized (Calderoni *et al.*, in press) (Fig. 2b). A sequence more than 12 m thick, mostly made of fine sediments outcrops at Smorlesi Quarry (Fig. 4). Massive and cross-bedded sands (Sh and St facies of Miall, 1985), sometimes associated with shallow channels filled with gravels (Gt facies), are interlayered with massive clays and silts, sometimes with land snails (Fm, Fl , Fsc, Fcf). At 11.7 m from the surface, fireplace charcoals with no archaeological remains, gave an age of 7,210±90 yr B.P. At the top of the sequence, within sandy layers (Sh facies of Miall, 1985), Eneolithic ceramic fragments were found (Farabollini, 1995; Calderoni *et al.*, in press). Also a few kilometers downstream, near Fontenoce (Fig. 2b), archaeological excavations showed Eneolithic layers dated to 4,680 yr B.P. and 4,700 yr B.P. (Silvestrini *et al.*, 1994). These layers were separated by a few decimeter thick massive overflood sands and silts (Sh and Fsc facies of Miall, 1985).

In many other alluvial terraces of the Marche area, referable to the same stratigraphic and morphochronological unit, boreholes and excavations showed the presence of the aforementioned fine-grained sediments, sometimes more than 10 m thick. Similar sequences have been described by Cremaschi (1979) and Marabini *et al.* (1987) along the river valleys of the Emilia-Romagna Apennines.

4. DISCUSSION

Age determinations of organic layers and wood remains inside palaeochannels, together with the discovery of archæological materials, allowed us to reconstruct the sequence of geomorphological events which characterized the middle parts of the Marche alluvial plains. An important phase of valley downcutting involving the upper Pleistocene alluvial sediments, occurred during the Late Glacial-early Holocene, between 14,700 (Alessio *et al.*, 1979) and 7,620-7,210 yr B.P. (age of the sediments at the bottom of Holocene channels in the Potenza and Tenna River basins). Between 7,620-7,210 yr B.P. and 4,700 yr B.P., the river channels were filled up with fine materials.

Between 4,700 and 3,570 yr B.P. downcutting processes started, which locally produced more than 30 m deep channels into the earlier alluvial plain. These processes affected the whole hydrographic network in few thousand years. Contemporaneously, the deposition of travertines in the mountain area ended (Cilla *et al.*, 1994). In the coastal area, in times younger than 4,000 years B.P. the bays at the river mouths, became to be dammed and trasformed into swamps and coastal lagoons by the creation of barrier beaches (Coltorti, 1991; in press).

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