Geogr. Fis. Dinam. Quat.,
14 (1991), 201-207, 5 figg., 1 tab.

GILBERTO CALDERONI (*), OLIVIA NESCI (**) & DANIELE SAVELLI (**)

TERRACE FLUVIAL DEPOSITS FROM THE MIDDLE BASIN OF CESANO RIVER (NORTHERN MARCHE APENNINES): RECONNAISSANCE STUDY AND RADIOMETRIC CONSTRAINTS ON THEIR AGE

Abstract: CALDERONI G., NESCI O. & SAVELLI D., *Terrace fluvial deposits from the middle basin of Cesano river (Northern Marche Apennines): reconnaissance study and radiometric constraints on their age* (IT ISSN 0391-9838, 1991).

A geomorphologic and stratigraphic study dealing with the «3rd-order» terrace alluvium outcropping between the villages of S. Lorenzo in Campo and S. Michele al Fiume (middle basin of Cesano river) has been carried out. In addition five macrofragments of fossil wood, collected in three gravel-pits within the intermediate Würmian fluvial sequences laid down by braided-streams, were dated with the radiocarbon method. The obtained ^{14}C ages, ranging from 37,300 ± 2200 to 31,700 ± 1050 yr B.P., allowed a significant refining of the chronologic framework for the development of the «3rd-order» valley terraces throughout northern Marche. Despite some of the dated samples were reworked, it results that aggradation phase took place through middle Würm. Based on a tentative correlation among the deposition phases in the Cesano river valley and in the nearby Metauro and Conca river basins for a hich other ^{14}C dates are available, it is argued that sedimentation of the fluvial braided-stream alluvium commenced prior to 41,000 - 44,000 yr B.P. Further, it is noticed that although the studied alluvium is rather homogeneous as far as lithology, sedimentology and granulometry are concerned, its accumulation was recurrently affected by subordinate cut-and-fill processes which likely account for the origin of buried terraces.

KEY WORDS: Terrace alluvium, Radiocarbon dating, Würm, Marche Apennines.

Riassunto: CALDERONI G., NESCI O. & Savelli D., *Depositi fluviali terrazzati del medio bacino del fiume Cesano (Appennino nord-marchigiano): analisi conoscitiva e cronologia radiometrica.* (IT ISSN 0391-8938, 1991).

Sono state eseguite indagini geomorfologiche e stratigrafiche sulle alluvioni terrazzate del «3° ordine» della media valle del fiume Cesano, tra gli abitati di S. Lorenzo in Campo e S. Michele al Fiume. Su tre fronti di cave di ghiaia, di cui uno attivo, nella porzione intermedia delle sequenze fluviali würmiane depositate da canali multipli intrecciati a basso indice di sinuosità sono stati rinvenuti cinque campioni di legno. La cronologia radiometrica di questi materiali mediante il metodo del radiocarbonio ha consentito di affinare l'inquadramento cronologico delle fasi genetiche dei terrazzi del «3° ordine» dell'area nord-marchigiana. Sebbene alcuni dei campioni di legno analizzati mostrassero evidenze di fluitazione, le età ^{14}C ottenute, comprese tra 37.300 ± 2200 e 31.700 ± 1050 anni dal presente, hanno consentito di attribuire l'intervallo datato al Würm medio. Sulla base di una ipotesi di correlazione tra le fasi di aggradazione nella valle del F. Cesano ed in quelle vicine dei fiumi Metauro e Conca, per i quali si dispone di altre datazioni, vi è ragionevole evidenza che il corpo alluvionale iniziò ad accumularsi prima degli ultimi 41.000 - 44.000 anni. La dettagliata analisi delle sezioni ha inoltre rivelato che, contrariamente a quanto potrebbe suggerire la omogeneità litologica, sedimentologica e granulometrica, le alluvioni considerate non si sono originate per aggradazione continua. L'accumulo è stato infatti ricorrentemente interrotto da processi di reincisione, verosimilmente responsabili della formazione di terrazzi sepolti.

TERMINI CHIAVE: Alluvioni terrazzate, Età radiocarbonio, Würm, Appennino marchigiano.

INTRODUCTION

Throughout northern Marche the Apennines range shows a typical morphotectonic pattern dominated by recurrent occurrence of ridges and basins trending NW-SE («*Apennine*» direction). As a rule the ridges are made up by calcareous anticlinoria showing Mesozoic units in the core, whereas terrigenous and/or marly-calcareous Cenozoic formations outcrop in the synclinoria. Main rivers of the drainage net flow north-eastwards, thus cutting both ridges and basins almost orthogonally, this being to some extent accounted for by occurrence of «anti-*Apennine*» faults along with systems of structural fractures (BOCCALETTI & *alii*, 1884; NANNI & VIVALDA, 1987: NESCI & SAVELLI, 1991a). Terraces, ranging in age from middle Pleistocene up to Holocene, are widespread on the flanks of the main valleys according to the relative height of the terrace treeds on the valley floor, terraces are referred to four main «orders», from IV (T4, «fourth order», lowermost, most recent terraces) to I (T1, «first order», topmost, oldest terraces), see LIPPARINI, 1938; VILLA, 1942, SELLI, 1954 and references therein. Such a classification approach may lead to misinterpretations depending on the variations among the adopted low-datum planes (viz., talweg, floodplain, etc.) and, particularly concerning floodplains, on the lack of con-

(*) *Dipartimento di Scienze della Terra, Università di Roma I «La Sapienza», P.le A.Moro, 5 00100 Roma Italy.*
(**) *Istituto di Geologia, Università di Urbino, Via S. Chiara, 27 61029 Urbino.*
Publication no. 149 dell'Istituto di Geologia dell'Università di Urbino. Funding provided by M.P.I. (60% allotment, Research Leaders: O. Nesci & D. Savelli) and Consiglio Nazionale delle Ricerche (C.N.R.), Com. 13, Ctr. no. 90.2.04.007.

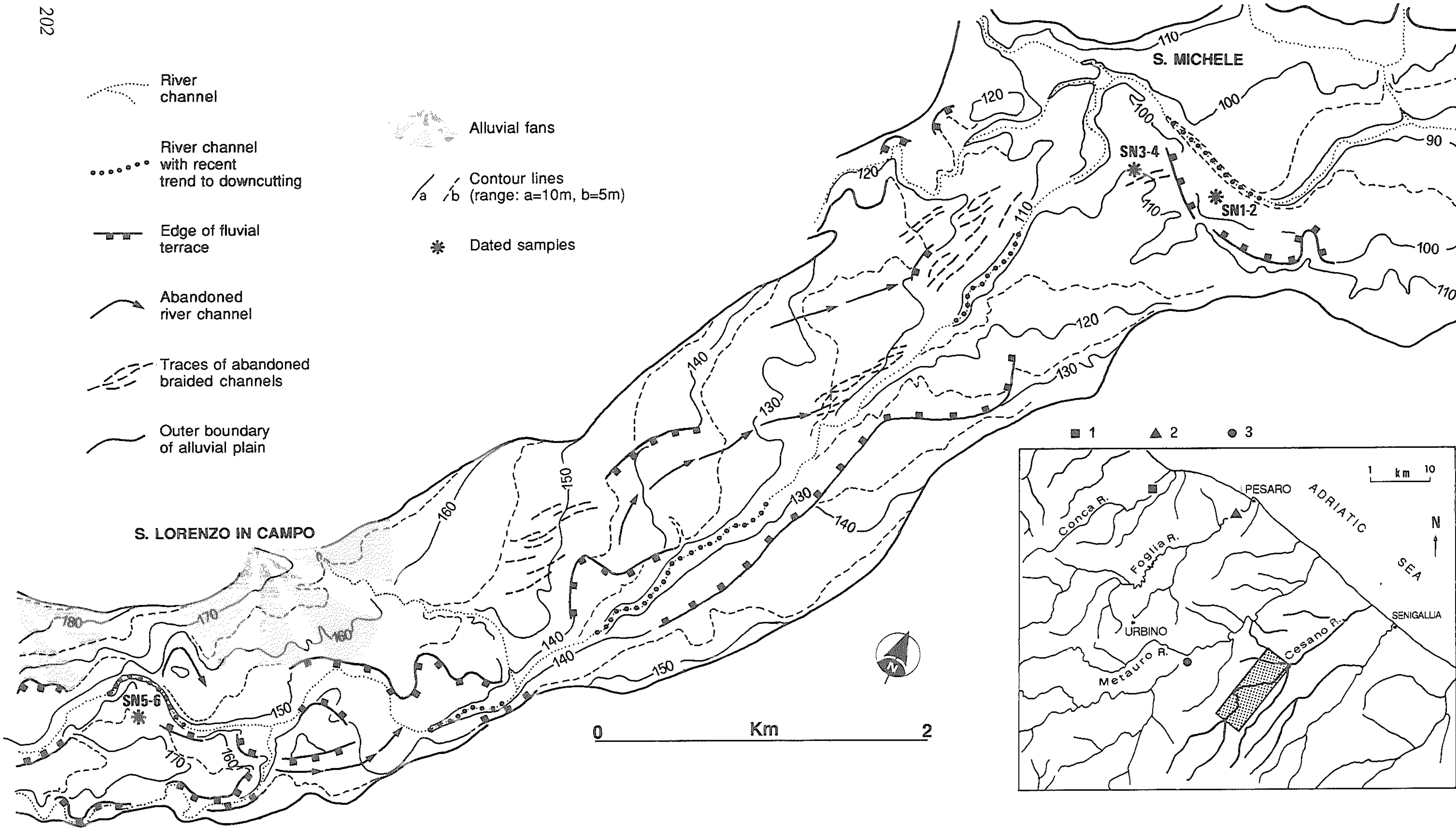

Fig. 1 - Geomorphologic map of the Cesano river plain between S. Lorenzo in Campo and S. Michele al Fiume and location of the dated samples. In the small general map, the numbers 1-3 indicate respectively the position of the dated samples from Conca R., Foglia R. and Metauro R. - Candigliano R. junction.

fidence in identifying the reference plane. Further, the apparent or actual uncostant number of terraces along a given valley, the variable detail in terrace studies along with conflicting interpretations on valley-fill phases represent additional constraints on the effectiveness of the above mentioned criteria for terrace classification (HOWARD, 1954). In this respect, data from four companion papers after NESCI & SAVELLI (1990, 1991a and 1991b) and NESCI & *alii* (1990) demonstrated that terrace classification throughout northern-Marche Apennines is unsatisfactory, its use being responsible for several biases in establishing both number and hierarchy of terrace units. In particular, for the study area NESCI & SAVELLI (1990, 1991b) pointed out that the T3 (Würm) valley terraces strictly conforms to the three previous main terrace orders (viz., T2, T1a and T1b) which, though discontinuous and dissected, are here recognizable. Thus, it is inferred that T3 terraces represent a valuable, well preserved record, effective for understanding origin and evolution of the three older, more overshadowed terrace units. In this view it is of primary importance to improve the knowledge on both erosional and depositional phases through which T3 terraces formed, by estabilishing a chronological sequence. Unfortunately, radiometric dates so far available are too few and scattered to implement a detailed time-scale for the deposition of terrace alluvium. In our knowledge the chronological data set, obtained by radiocarbon dating, includes an age of >41,000 yr B.P. (ALESSIO & *alii*, 1987), yielded by a fragment of *Pinus* cf. *sylvestris* from a sandy-silty fluvial deposit in the lowermost unit of the T3 terrace alluvium at the Metauro-Candigliano rivers junction (fig. 1). For the nearby, north-westwards Foglia basin, 4.5 km upstream from the coast (fig. 1), two ages were measured, respectively for a remnant of *Ulmus laevis* (4000 yr B.P.), found 7 m below the topographic level in the T4 alluvium, (BEDOSTI, 1983) and for a fragment of *Ulmus* sp. (10,090 yr B.P.) not far from the previous one (fig. 1), collected at 11.5 m in depth in T3 alluvial sediments that submitted to geotechnic trials revealed an history of cut-and fill processes (GORI, 1988). Further C-14 ages (spanning from 31,920 ± 1030 to >44,000 through 34,760 ± 1505 yr B.P.) were yielded by large tree-trunks from alluvial deposits that, though exposed close to the mouth of the nearby Conca river (southern Emilia-Romagna) on lithologic basis are referred to the adjacent Ventena stream, a former Conca river tributary (FORLANI, 1987). Results of palynologic analysis for the alluvium containing the trunks (BIONDI, 1983) are of some concern in that pointed to a phase of forest expansion under cold climate. Pollen assemblage for arboreal plants is dominated by *Abies alba* and *Fagus sylvatica*, likely the former being spread on the hilly areas and the latter over the plains. This areal distribution of the two arboreal taxa is consistent with the findings of only flooded remnants of abies, whereas, conversely, relics of fagus occur also *in situ*. For a site located in central Marche, south-eastwards the study area herein focused, two radiocarbon dates for a peaty level just below the top of a T3-terrace alluvium outcropping in the upper Esino basin yielded 15,250 and 14,700 yr B.P. Thus, based on chronologic and field data, the terrace deposit was assigned to a Würmian phase and it was also claimed that likely the bulk of the Marchean T3 terraces could be almost coeval (ALESSIO & *alii*, 1979). Finally, by concluding this exhaustive review of the available radiocarbon dates, we mention the ages of 30,150 and 26,800 yr B.P. measured for two wood samples from a fluviatile peaty-clayey-silty deposit lying close to the talweg in the upper Chienti basin, central-southern Marche (DAMIANI & MORETTI, 1968).

This paper is aimed to give some innovative contribution of the late-Pleistocene and Holocene erosional and depositional phases recorded by the terrace deposits spread throughout the northern Marchean Apennines. Results herein reported are based on detailed field work, interpretation of geomorphologic and lithostratigraphic data and radiocarbon dating of five samples from the «3rd-order» terrace alluvium deposits outcropping through a significant reach of the middle Cesano valley, an area so far poorly investigated.

LITHOSTRATIGRAPHIC AND GEOMORPHOLOGIC SETTING

The five wood samples submitted to radiocarbon dating were collected from *ca.* 8-10 to *ca.* 20 m above the talweg, within the alluvium referred to the «3rd-order» terrace, in three gravel-pits close to the talweg of the middle-lower basin of Cesano river, 25 to 15 km far from the sea coast, between the villages of S. Lorenzo in Campo and S. Michele al Fiume, Marche (fig. 1). According to geomorphologic analysis (fig. 1) the T3 terrace (*sensu* NESCI & SAVELLI, 1991a) here is strip-shaped, trends SW-NE and occurs from *ca.* 30 to *ca.* 20 m above the present talweg at S. Lorenzo in Campo and S. Michele al Fiume, respectively. However, its detailed recognition is constrained by the intensive remoulding affecting the primitive alluvial plain and the occurrence of two alluvial fans overlying the fluvial terrace alluvium. Because of erosion, the talweg commonly attains the Mio-Pliocene bedrocks underlying the sampled alluvium. The thickness of such polygenic deposit (NESCI & SAVELLI, 1991a), never exceeding 30 m, is characterized by significant variations which could depend either on severe remoulding or bedrock topography. However, as field survey locally revealed an almost flat basement surface, inference is made that the alluvium thickness is mostly controlled by erosion processes.

The dated third-order terrace alluvium is dominantly made up by gravels and, subordinately, fine-grained, mostly sandy-silty-clayey lenses and horizons locally exceeding 5 and 100 m in thickness and lateral extension, respectively. Though as a whole the deposits may be referred to gravel of braided-stream environments (*Fb sequences* after NESCI & SAVELLI, 1990), results of detailed analysis point to more complicated depositional models for some of the occurring facies (NESCI & SAVELLI, 1991b). The topmost part of terrace deposits is re-incised by gradually deepening sinousmeandering streams, responsible for laying down thin alluvium levels (*Fs sequences*, after SAVELLI & *alii*, 1984; NESCI & SAVELLI, 1991b) overlying unconformably the braided-stream sequences. Finally, it is noticed that locally the lowermost part of the alluvial suite is dominated by silty-sandy facies, also more than 7-8 m thick, previously reported for other sites and assigned to a widespread deposition phase preceeding the aggradation of the braided-stream, gravelly bodies (ALESSIO & *alii*, 1979; NESCI & SAVELLI, 1991b; CALDERONI & *alii*, unpublished).

1 - S. Lorenzo in Campo site. The alluvial suite is exposed on a *ca.* 150 m long section produced by past quarry workings on the left bank of Cesano river, just upstream the Nevola creek confluence and the village of S. Lorenzo in Campo (fig. 1). Here the medium-upper part of the «3rd-order» terrace alluvium, from *ca.* 15 m above the talweg up to 2-3 m below the terrace level is shown (fig. 2). At the bottom, fluvial gravels, showing channel-through and festoon-like cross stratification resulting from braided-stream deposition occur. Upwards a *ca.* 2 m thick sandy-silty level, characterized by horizontal lamination and/or thin stratification (flood-plain deposits?) is exposed along the upstream half of the section. This latter layer (viz., *fb*, fig. 2), overlain and locally cut by gravels, resembles the previous one, and exhibits, respectively upstream and downstream, a puzzling thin horizontal stratification and a typical point-bar epsilon cross-stratigrafication. Such features suggest that the level could represent, at least in part, the *Fs sequence* (fig. 2).

The lower pebbly layer frequently includes small clayey-silty-sandy lenses, two of which provided the dated wood

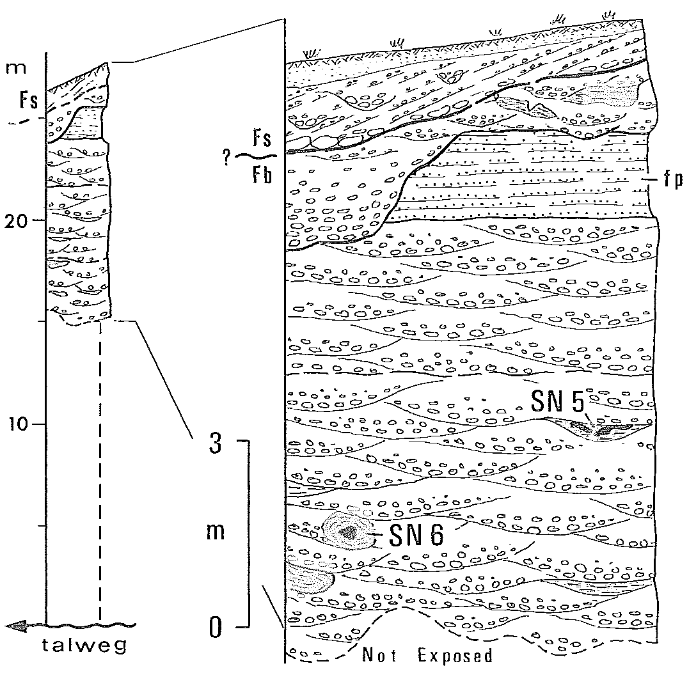

FIG. 2 - S. Lorenzo in Campo site: lithostratigraphic setting of the dated wood samples. The horizontal distances on the left column are arbitrary. Comprehensive explanation is given in the text.

samples SN#5 and SN#6. Only in a few instances, however, such lenses are *in situ*, whereas most of them, featuring irregular shape, deformed and/or randomly cut lamination (fig. 2) and sub-spheric shape of the fine-grained bodies, likely are remnants of eroded fine-grained layers transported by stream during flood stages. Concerning the two dated wood samples, SN#5 (Rome-111: 31,700 ± 1050 yr B.P.), the most upstream, was contained in a lens reasonably judged *in situ*, whereas SN#6 (Rome-112: 37,300 ± 2000 yr B.P.), the most downstream, was found in a silty-sandy, round-shaped transported «mud ball» *ca.* 2 m below the previous one.

2 - S. Michele al Fiume (C. Mengaroni site). Here the sampled section (fig. 3), *ca.* 100 m long and NNE-SSW oriented, is exposed on the walls of an active quarry pit near to the left bank of Cesano river, inside the meander at the confluence of Maggio stream (fig. 1). A sequence of terrace alluvium *ca.* 10 m thick, made up by gravels and, subordinately, clayey-silty lenses and/or coarse fragments («mud-balls») is shown. Here the festoon-like sedimentary structures, suggestive of braided-stream deposition, occur bottomwards and through the mid of the section are quite subordinate. Such structures may be cut by channel throughs, from 2 to 3 m deep, which are filled up by gravels showing high angle (30-40°), NNE dipping tabular cross-stratification. Despite detailed analysis of the upper portion of the outcrop was precluded by quarry workings, atop the terrace alluvium pebbly fluvial sequences including a pebbly level, showing epsilon cross-stratification frequently interrupted by coarse chute deposits, underlying a sandy layer, has been reliably recognized. Geomorphologic, sedimentologic and lithostratigraphic features exhibited by both such topmost levels strongly suggest they can be referred to the *Fs sequence* (fig. 3).

Wood sample SN#4 (Rome-110; 32,500 ± 1200 yr B.P.) was collected at the bottom of the section in a laterally discontinuous, grey-blue, clayey-silty-sandy layer containing also scattered charcoal bits. Further small bits of fossil wood were also collected (sample SN#3); their weight, however, was too scant for radiocarbon dating.

3 - S. Michele al Fiume (S. Isidoro site). Past quarry working near to the left bank of Cesano river, *ca* 500 m downstream C. Mengaroni site, exposed a 200 m long, E-W trending section. Here the terrace alluvium rests on the Pliocene clayey-marly bedrock and bottomwards shows a silty-sandy sequence (fig. 4) resembling that previously reported by ALESSIO & *alii* (1987) from the Metauro-Condigliano rivers confluence. Upwards the suite is significantly eroded and overlain by pebbly- and pebbly-sandy-alluvium exhibiting festoon-like cross-stratification typical of braided-stream environment. In the upper portion of the outcropping a fine-grained (clay, silt and fine sand) level occurs. Here were collected the wood samples SN#1 and SN#2 (Rome-108 and Rome-109, dated at 35,600 ± 1800 and 37,300 ± 2200 yr B.P., respectively). Such level, is cut atop by a rather irregular erosional surface, is overlain, bottom to top by a pebbly-sandy and a sandy layer. The topmost portion of this latter strongly resembles the *Fs sequence*.

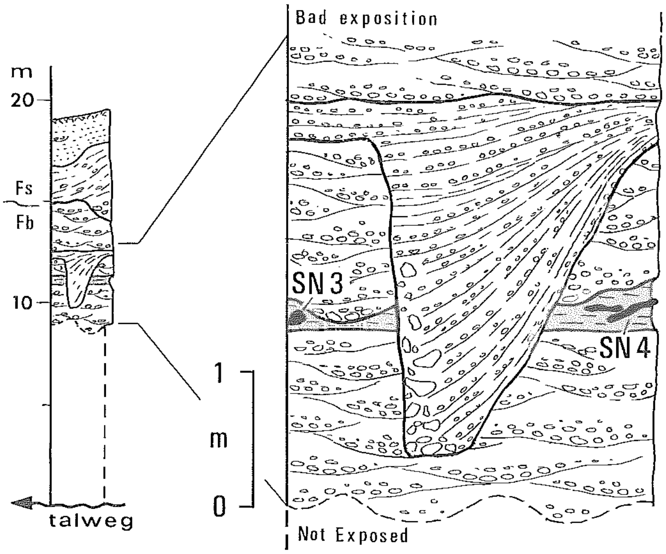

FIG. 3 - S. Michele al Fiume (C. Mengaroni site): lithostratigraphic setting of the wood samples. Arbitrary vertical exaggeration on the left column. Detailed information in the text.

RADIOCARBON DATING OF THE WOOD SAMPLES

The samples were abundant and, due to favourable preserving conditions, scarcely affected by diagenetic alteration. Concerning their realiability, it is noticed that examination under stereomicroscope did not detect any potential source of contamination, *e.g.*, rootlets and/or estraneous organic debris. In addition, as the samples were collected in clayey terranes, significant contamination by allochthonous organic matter carried by groundwater is reasonably ruled out. Prior to radiocarbon activity measurement, wood remnants were submitted to the routine mechanical and chemical pretreatment. Briefly, following cutting into small chips, samples were boiled *ca.* 30 min with 6 N HCl, then, as the trial for extractable humic matter was negative, washed with distilled water until chloride ion deseapparance and oven-dried overnight at 110°C. Samples was then converted into benzene, by combustion in oxygen stream (this yelding purified carbon dioxide), conversion of carbon dioxide into lithium carbide (performed at 800°C with melted Li), hydrolysis of lithium carbide (this yielding acetylene). Finally, by means of Cr (VI) activated catalyst, acetylene was converted into benzene. Two weeks later (to allow the virtual complete decay of the short-life β^- radioisotopes produced through the decay chains of Rn^{216}, Rn^{218}, Rn^{220} and Rn^{222}), benzene was counted for C-14 activity in 2-g geometry, following addition of scintillation cocktail (butyl-PBD and bis-MSB, 15 and 1.3 mg · ml^{-1} benzene, respectively) and transferring into low-K vial immediately flame-sealed. The β-activity of ^{14}C was measured by means of a low level liquid scintillation counter Packard 2260XL. The counting window, selected by means of Spectragraph software, yielded an efficiency better than 70%; «oxalic acid I», supplied by NBS, was used as «modern carbon» standard and coke as background. Storage of counting data was performed, on line, by means of a dedicated PC; statistics and age calculation were run with a customized software (CALDERONI & VENANZI, 1990). Final results are reported according to the recommendations after STUIVER & POLACH (1977) and ages were calculated with an overall uncertainty (that is taking into consideration the error for all the steps involved in dating) corresponding to $\pm 1\sigma$. Conventional radiocarbon age and location for the analysed samples are listed in table 1.

TABLE 1 - Conventional radiocarbon ages for the analysed wood samples

Sample Lab code	Sample I.D.	Radiocarbon age (yr. BP)	Location site
Rome-108	SN#1	35,600 ± 1800	
Rome-109	SN#2	37,300 ± 2200	S. Michele
Rome-110	SN#4	32,500 ± 1200	Fiume
Rome-111	SN#5	31,700 ± 1050	S. Lorenzo in
Rome-112	SN#6	37,300 ± 2200	Campo

DISCUSSION

Radiocarbon dating of five wood fragments collected in the intermediate 10 m of the up to 30 m thick «3rd-order» terrace alluvium from the middle basin of Cesano river has been performed. The measured ^{14}C ages bracket a time-span ranging from 31,700 to 37,300 yr B.P. and, despite the uncertainty depending on sample reworking, assign the main aggradation phases to the middle Würm.

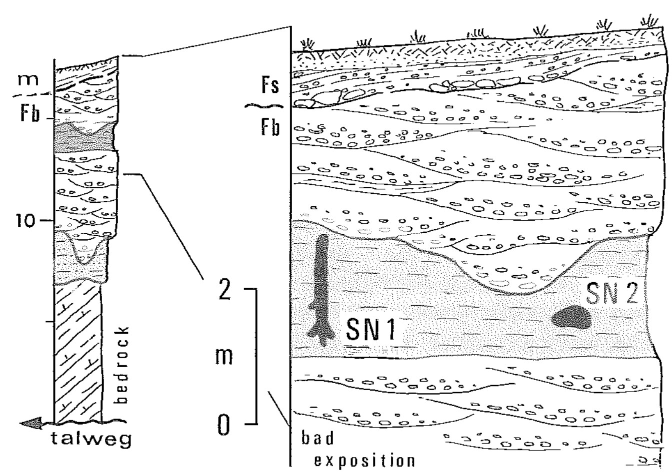

FIG. 4 - S. Michele al Fiume (S. Isidoro site): lithostratigraphic setting of the dated wood samples. Horizontal distances shown on the left column are exaggerated. A comprehensive account of the outcropping is given in the text.

In turn, chronologic data so far available for various basins nearby that of Cesano river (this paper, see Introduction) show a wider scattering, e.g., from 30,000 to >44,000 yr B.P. It is likely that the younger ages (those ranging from 15,250 to 4000 yr B.P.) are accounted for by re-incision (*Fs sequences*), cut-and-fill phases close to stream-mouths (NESCI & SAVELLI, 1991b) and/or complex-response by subordinate terraces (SCHUMM, 1977). Unfortunately, a proper evaluation of this letter pool of ^{14}C dates is hampered by the lack of comprehensive sedimentologic and lithostratigraphic accounts, this ruling out any further arguing.

Recent studies on terrace deposits from many valleys in northern Marche Apennines (NESCI & SAVELLI, 1986, 1990, 1991b) led to identify four main orders (T1a, T1b, T2 and T3), each referred to a cycle of erosion and deposition. Each cycle, in turn, includes a variable number of recurrent erosive and aggrading phases, the main of which are recognizable through the intermediate reaches of the studied valleys. On this basis it has been inferred that the mechanisms of terracement and aggradation, climate-dependent and active under an overall tectonic context of vertical uplift, were common for the bulk of the studied valleys. It was also claimed that the *Fb sequences* (sequences of braided-stream gravels after NESCI & SAVELLI, 1990) in the fluvial terrace alluvium are almost coeval throughout the northern Marche valleys. The deposition of Würmian alluvial fans, frequently coalescing and superimposed to the braided-stream fluvial terrace alluvium, caused enhanced aggradation over some reaches of the northern Marche valleys, mainly at the piedmont of the carbonate belt. Also Cesano river valley experienced the process, this being particularly well recorded a few km upstream S. Lorenzo in Campo (NESCI & SAVELLI, 1990 and 1991b). Throughout the middle reach of the main northern Marche valleys the alluvial fans underlie stratified slope-waste deposits (*eboulis ordonnès* type) referred to the end of the cold climate emi-cycle (NESCI & SAVELLI, 1986 and 1990).

Let us consider that the deposition of the fluvial sequence did last significantly more then the younger age of 31,700 yr B.P. yielded by sample SN # 5, as this latter is overlain by further 10 m of fluvial sediments. By supposing that the accumulation rate of alluvium was steady and unaffected by cut-and-fill processes it results that the fluvial aggradation could have continue over additional 4000 - 6000 yr following the deposition of sample SN # 5. A consequence of the above arguing is that the Main Würm climate, responsible for triggering the deposition of both alluvial fans and slope-waste sequences on the study area, acted very effectively through over a short time. Data so far available, however, are not enough to depict a reliable model. An ongoing research including ^{14}C dating and detailed survey of the Marchean reaches of Cesano and nearby basins as well as selected river valleys in Molise likely will provide a deeper insight on the origin of the Würmian terrace alluvium.

Concerning the studied reach of Cesano river, three out of the five dated wood samples were stream-transported, only SN # 4 and SN # 5, represented by big-size tree roots, were likely *in situ* or negligibly reworked. Among the transported samples SN # 1 appears the less reworked, whereas the severe abrasions shown by SN # 2 and SN # 6 (the latter from a relic of a silty layer eroded and flooded in part as «mud-balls», fig. 2) are consistent with significant reworking. Dealing with reworked samples, thus not necessarely syngenetic with the sediment, implies several constraints on data evaluation. First, ^{14}C ages are to be regarded as «maximum ages» for the sampled level and, second, wood fragments from the same level, but recruited through different reworking pathways, may yield ^{14}C ages also significantly dissimilar, this affecting to unpredictable extent the relationship age vs. height on the talweg. In this respect it is noticed that samples SN # 1 and SN # 2, both from the same clayey-silty layer (fig. 5), were dated at 35,600 and 37,300 yr B.P., respectively. The between-age discrepancy is likely accounted for by the samples origin, the older one being the most reworked and, conversely, the younger age being yielded by a fragment of tree-trunk holding remants of branches, devoided of abrasions and showing only fresh cracks. In addition to reworking, the observed chronostratigraphic reversal could depend on the preferential linear erosion operated by cut-and-fill processes which gave rise to bodies that though adjacent are not coeval. However, the above interpretation lacks field evidence because the identification of cut-and-fill events, subordinate sedimentary bodies, erosion surfaces and buried terraces is intriguing, depending on the small size of the outcroppings as well as the enhanced sedimentologic and lithologic homogeneity of the sediments.

Both chronostratigraphic consistency and lack or scant reworking lend support to the inference that the ages, respectively of 32,500 and 31,700 yr B.P., for samples SN # 4 and SN # 5 (from 10 and 20 m above the talweg, respectively) are the most representative for the intermediate portion of the «3rd-order» terrace alluvium of Cesano valley. Older samples likely belong to limbs of buried terraces and/or were recruited by alluvium through erosion of pre-existing levels. Therefore, if the deposits of Cesano, Conca and Metauro basins are considered as almost coeval, lacking of ^{14}C ages older than those measured could suggest that the bottom of the alluvial suite escaped erosion or, most trivial, that so far were not found wood remnants. The heavy reworking shown by some of the analysed samples is likely accounted for by repeated cut-and-fill processes which affected the terrace alluvium aggradation during the main Würmian cycle.

FINAL REMARKS

Five new radiocarbon dates for wood fragments collected from the intermediate portion of the terrace alluvium outcropping in the middle Cesano river basin have been measured. Ages bracket the time-span from 37,300 ± 2200 to 31,700 ± 1050 yr B.P. and despite same samples were

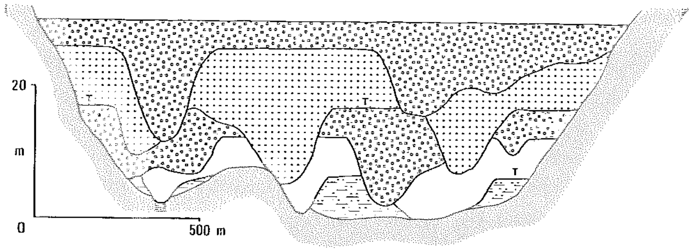

FIG. 5 - Interpretative sketch, based on field data and ^{14}C dates, showing the style of the Würm alluvial aggradation throughout the middle Cesano river valley. Both number and extension of fill and cut stages are arbitrary. For discussion see the text.

reworked, it has been possible to assign the dated alluvium to the middle Würm. If the hypothesis that aggradation was almost coeval both on the study area and the nearby Conca and Metauro basins is sound, then the deposition of «3rd-order» terrace alluvium commenced prior to 41,000 - 44,000 yr B.P. Based on ^{14}C ages and stratigraphic relationships among fluvial sequences, alluvial-fan sequences and stratified slope-waste deposits (NESCI & SAVELLI, 1986, 1990 and 1991b), it is inferred that the main peak of Würmian cold climate lasted over a short time, this being in fair agreement with the findings after FLIRI (1988) for the Eastern Alps. Finally, it is noticed that contrasting with the overall lithologic and sedimentologic homogeneity, the braided-stream terrace alluvium did not originate through a continuous process, its aggradation having been interrupted by recurrent cut-and-fill processes recorded by the buried terraces.

REFERENCES

ALESSIO M., ALLEGRI L., COLTORTI M., CORTESI C., DEIANA G., DRAMIS F., IMPROTA S. & PETRONE V. (1979) - *Depositi tardo-würmiani nell'alto bacino dell'Esino (Appennino Marchigiano) - Datazione con il ^{14}C.* Geogr. Fis. Dinam. Quat., *2*, 203-205.

ALESSIO M., ALLEGRI L., AZZI C., CALDERONI G., CORTESI C., IMPROTA S., NESCI O., PETRONE V. & SAVELLI D. (1987) - *Successioni alluvionali terrazzate nel medio bacino del Metauro (Appennino Marchigiano) - Datazione con il ^{14}C.* Geogr. Fis. Dinam. Quat., *10*, 307-312.

BEDOSTI B. (1983) - *Guida al Museo Scientifico L. Guidi.* Suppl. Boll. Sismico, 4-9.

BIONDI E. (1983) - *I macrofossili vegetali del Torrente Conca.* In: AA.VV., «Le più antiche tracce dell'uomo nel territorio Forlivese e Faentino», Grafiche M.D.M., Forlì, 44-48.

BOCCALETTI M., CALAMITA F., CENTAMORE E., DEIANA G. & DRAMIS F. (1984) - *The Umbria-Marche Apennines: an example of thrust and wrenching Tectonics in a model of ensialic Neogenic-Quaternary deformation.* Boll. Soc. Geol. It., *102*, 581-592.

CALDERONI G. & VENANZI G. (1990) - *Implementation of a software package of the statistical treatment of counting data from a β- spectrometer and calculation of conventional radiocarbon ages.* Internal Report, Dept. Earth Sci. Univ. of Rome.

DAMIANI A.V. & MORETTI A. (1969) - *Segnalazione di un episodio würmiano nell'alta valle del Chienti (Marche).* Boll. Soc. Geol. It., *87*, 171-181.

FLIRI F. (1988) - *An outline of the Middle and Main Würm chronology of the Eastern Alps.* Geogr. Fis. Dinam. Quater., *11*, 117-118.

FORLANI E. (1987) - *Studio idrogeologico della conoide e fattibilità di un canale deviatore della diga sul F. Conca.* Cons. Potenziam. Acquedotto, Comuni di Cattolica, Misano, Riccione (dati inediti).

GORI U. (1988) - *Contributo alla conoscenza della sedimentazione delle alluvioni quaternarie del Fiume Foglia (Marche).* Geogr. Fis. Dinam. Quat., *11*, 121-122.

HOWARD P. (1959) - *Numerical system of terrace nomenclature. A critique.* Journ. Geol., *67*, 239-243.

LIPPARINI T. (1939) - *I terrazzi fluviali delle Marche.* Giorn. Geol., ser. 1, *13*, 5-22.

NANNI T. & VIVALDA F. (1987) - *Influenza della tettonica trasversale sulla morfologia delle pianure alluvionali marchigiane.* Geogr. Fis. Dinam. Quat., *10*, 180-192.

NESCI O. & SAVELLI D. (1986) - *Cicli continentali tardo-quaternari lungo i tratti vallivi mediani delle Marche settentrionali.* Geogr. Fis. Dinam. Quat., *9*, 192-211.

NESCI O. & SAVELLI D. (1990) - *Valley terraces in the Northern Marche Apennines (Central Italy): cyclic deposition and erosion.* Giorn. Geol., *52*, Ser. *3*, 189-195.

NESCI O. & SAVELLI D. (1991a) - *Lineamenti geomorfologici del terrazzo fluviale del «3° ordine» del bacino del Metauro (Marche Settentrionali).* Geogr. Fis. Dinam. Quat., 14, in press.

NESCI O. & SAVELLI D. (1991b) - *Successioni alluvionali terrazzate nell'Appennino nord-marchigiano.* Geogr. Fis. Dinam. Quat., *14*, 149-162.

NESCI O., SAVELLI D. & MENGARELLI D.(1990) - *I terrazzi vallivi del I ordine nei bacini dei Fiumi Metauro e Foglia (Appennino Marchigiano).* Geogr. Fis. Dinam. Quat., *13*, 63-73.

SAVELLI D., BARTOLE R. & MORETTI E. (1984) - *Caratteristiche litostratigrafiche con l'ausilio del sismografo di un terrazzo alluvionale del F. Metauro a Fossombrone (Marche settentrionali).* L'Ateneo Parmense, Acta Nat., *20*, 63-79.

SELLI R. (1954) - *Il bacino del Metauro*, Giorn. Geol., ser. I, *24*, 187-209.

SCHUMM S.A. (1977) - *The fluvial system*, J. Wiley & Sons, N.Y., 388 pp.

STUIVER M. & POLACH H. (1972) - *Reporting of ^{14}C data.* Radiocarbon, *19*, 355-363.

VILLA G.M. (1942) - *Nuove ricerche sui terrazzi fluviali delle Marche.* Giorn. Geol., Ser. I, *16*, 5-75.