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THE TYRRHENIAN TRANSGRESSION IN THE TARQUINIA AREA (Northern Latium, Italy) (***)

ABSTRACT: BARTOLINI C. & BOSI C., *The Tyrrhenian transgression in the Tarquinia area (Northern Latium, Italy)* (IT ISSN 0084-8948, 1983).

Between the rivers Marta and Mignone, approximately 70 km North of Rome, the presence of Tyrrhenian sediments containing *Strombus bubonius* and *Conus testudinarius* has been known for a long time. Due to swift lateral facies variations, poor exposures and intervening tectonic uplift, coastline identification has not however been straightforward.

Careful examination of morphologic features as well as of all the sections available in the area has led the authors to correlate the calcarenites of the distal area with the sands and gravels outcropping in the proximal area, directly fed by streams down the steep slopes. The coastline of maximum Tyrrhenian transgression was located from morphologic evidences between 40 and 45 meters.

Just South of the River Mignone, the Tyrrhenian coastline had been previously identified at approximately the same altitude. North of the River Marta the coastline of the same age is instead found as low as 25 m a.s.l. and, farther North, at about 15 m. The differential uplift thus evidenced is consistent with the middle Pleistocene Tectonics in the same area.

RIASSUNTO: BARTOLINI C. & BOSI C., *La trasgressione tirreniana nella zona di Tarquinia (Lazio settentrionale, Italia)*.

La presenza di sedimenti tirreniani con *Strombus bubonius* e *Conus testudinarius* nella zona compresa fra i fiumi Marta e Mignone è nota da tempo. A causa delle frequenti variazioni di facies, delle mediocri condizioni di esposizione e della successiva attività tettonica, la identificazione delle corrispondenti linee di costa è stata tuttavia oggetto di serrato dibattito.

Lo studio di dettaglio delle caratteristiche morfologiche nonché di tutte le sezioni osservabili nella zona, ha condotto gli autori a correlare le calcareniti dell'area distale con le sabbie e ghiaie che affiorano invece al piede delle colline. La linea di costa corrispondente al massimo trasgressivo tirreniano è stata identificata, su base morfologica, ad una quota di circa 40-45 m. Anche a Sud del F. Mignone la stessa linea di costa mantiene la stessa quota.

A Nord del F. Marta essa si trova invece ad appena 25 m e, ancora più a Nord, nella zona dell'Argentario, a circa 15. Il sollevamento differenziale così messo in evidenza è coerente con la Tettonica mediopleistocenica della zona, quale essa risulta dallo studio, tuttora in corso, dei terrazzi pre-tirreniani.

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TERMINI-CHIAVE: terrazzi marini; morfodinamica; Neotettonica; Tirreniano; costa medio-tirrenica.

INTRODUCTION

Geological and morphological surveys of the Pleistocenic coastlines have been carried out as part of the research promoted by the CNR « Sottoprogetto Neotettonica » of the « Progetto Finalizzato Geodinamica ».

These surveys, which are still in progress, led to results which in part contrast with data and interpretations reported in the literature.

This paper deals with the Tyrrhenian of the littoral area of Tarquinia, between Pian di Spille and the River Mignone (fig. 1).

PREVIOUS STUDIES

The first studies carried out on the Tarquinia Tyrrhenian are those of MELI (1915) and GIGNOUX (1913; 1915). The *Strombus bubonius* which was found by MELI at the Tarquinia Saline (salt works) is the first evidence of the presence of Tyrrhenian sediments in the area. GIGNOUX reports that a *Conus testudinarius* was collected near the Tarquinia railway station (collection of the Servizio Geologico d'Italia, Rome) possibly between 10 and 15 m a.s.l. He remarks that there are no suitable elements with which to identify the corresponding coastline, which he believes could be placed (on the basis of stratigraphic data collected elsewhere!) at the elevation of 15 or 35 m.

Many years later BONADONNA (1967) identified a coastline at 15-20 m a.s.l. on the basis of the outcrops distribution between the rivers Arrone and Mignone. The Tyrrhenian age of these sediments was based on the fauna mentioned by GIGNOUX and MELI and on the elevations attributed by BLANC (1936) to the Tyrrhenian between Tarquinia and other areas South of Rome (Pianura Pontina).

In the Explanatory Notes of sheets 136 and 142 of the Geological Map of Italy (ALBERTI & *al.*, 1970), the

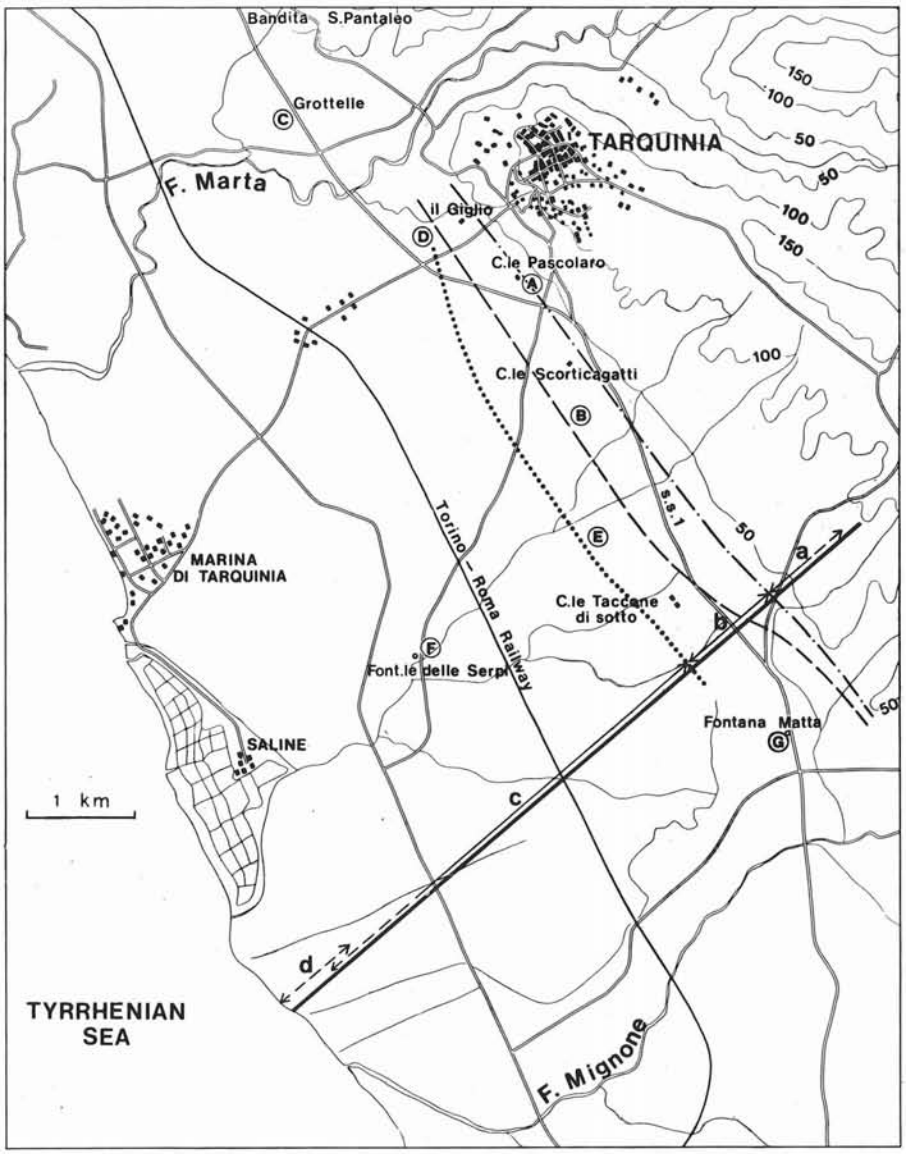

FIG. 1. - Sketch map of the studied area. *Circled letters*: location of the sections cited in the text. A) Casale Pascolaro; B) Casale Scorticagatti; C) Grottelle; D) Giglio; E) Taccone; F) Fontanile delle Serpi; C) Fontana Matta. *Dashed line*: landward limit of the Tyrrhenian « Giglio sands and gravels ». *Dotted-dashed line*: Tyrrhenian coastline. Approximately corresponding to the limit between morphological units a) and b). *Dotted line*: limit between units b) and c). *Double line*: track of the topographic profile shown in fig. 2.

authors do not pay much attention to Tyrrhenian features. FAZZINI & *al.* (1972) accept BONADONNA's data for the marine Quaternary and particularly for the Tyrrhenian.

DAI PRA (1978) and CONATO & DAI PRA (1980), locate the Tyrrhenian (Eutyrrhenian) coastline between the rivers Marta and Mignone at 60-65 m a.s.l. mainly on the basis of the elevation of the sediments ascribed to this cycle, without, however, a correlative series of morphological observations. DAI PRA also quotes the finding of two specimens of *Strombus bubonius* at 25 m a.s.l. near Monna Felice, South of the Mignone River. The corresponding coastline there can easily be located at the foot of a cliff at 35-40 m.

MORPHOLOGY

The topographic profile of fig. 2 shows that the following morphological units can be distinguished in the studied area:

a) a moderately steep slope above the elevation of 45 m;

b) a mildly concave surface joining slope a) with the underlying unit c);

c) a flat surface running between the elevations 33 and 5÷10 m (dip less than 1% towards the sea) terraced by the Marta and Mignone rivers; its lower limit terminates locally in a small scarp which is part of the next unit; at most places this limit is hardly defined (and therefore not shown in fig. 1) because of subsequent erosional and depositional events;

d) present coastal plain.

This morphologic profile fits the entire area except for the deep cuts of the Marta and Mignone rivers and of their tributaries and also, in the central part of the area, for the small valleys of minor streams such as the Scolo dei Prati and the Scolo dei Giardini.

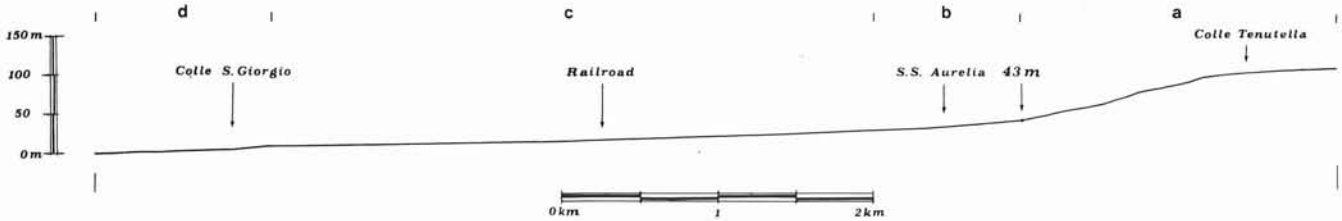

FIG. 2. - Topographic profile showing four morphologic units. Unit c) is the Tyrrhenian terrace.

STRATIGRAPHY

The stratigraphic elements relevant for this study can be described separately for each of the four morphologic units a), b), c) and d) mentioned above.

Unit a - The slope is cut in sediments of various ages. The oldest outcropping units are Pliocene clays and biogenic calcarenites (« Macco ») southward from the River Marta and « Pietraforte » and « Tolfa Flysch » of Cretaceous age (FAZZINI & *al.*, 1972) northward of the same river. These sediments are in places covered by Pleistocenic, terraced marine deposits, some of which have been described by CONATO & DAI PRA (1980) and, in the lowermost section of the slope, by tuffites of both marine and continental facies. These sediments are well exposed at Bandita San Pantaleo (near km 96 800 of the Aurelia motorway) and at Tarquinia below the elevation of about 80 m.

At Bandita San Pantaleo the stratigraphic succession is composed of marine deposits containing abundant *Glycymeris* covered by fine-grained tuffites and volcanic sands including small Pulmonate Gasteropods (see BONADONNA, 1967). In Tarquinia, a cut downslope of the former Aurelia motorway near km 91 800 (MAGRI, pers. comm.) shows a stratigraphic succession similar to that of Bandita San Pantaleo.

At its foot the slope is usually covered by a silty-sandy colluvial deposit also extending over a large part of morphologic unit b.

Unit b - The unit is a most erosional surface, cut in the tuffites described for unit a) or, directly, in the Pliocenic clays. This situation is shown in a section near *Casale Pascolaro* (foundation cut 500 m on the WSW of *Casale* at an elevation of about 45 m). The section is formed of layers of tuffites, including rare (reworked?) marine fossils and a few large fragments of biogenic calcarenites (« Macco »), overlain by colluvial deposits.

Unit c - On the entire southwestern sector of the area forming this unit (on the SW of the railway) the Geology is basically that described by GIGNOUX (1913) and, with more detail, by DAI PRA (1978) and CONATO & DAI PRA (1980). The stratigraphic succession is mainly formed by a Pliocene clayey or sandy bedrock unconformably overlain by bioclastic calcarenite transgressive layers (« panchina ») considered to be of Tyrrhenian age (see ahead).

The northeastern part of the studied area (on the NE of the railway) is geologically more complex. The general lineaments are those outlined in the following sections.

Casale Scorticagatti section (foundation cut 300 m on the SSE of Casale at an elevation of about 41 m). Pedogenic clays (vertisols, FERRARI, 1968) probably rest over grey pliocenic clays.

Grottelle section (Scarp on the W of the Aurelia motorway at km 94 000 at an elevation of about 30 m, fig. 3). A southward dipping Pliocenic sandy and silty bedrock with *Flabellipecten flabelliformis* and a layer of clays are unconformably covered by reworked, thinly laminated sand-grained volcanites which gently dip southwestward (fig. 3). These horizons are transgressively covered by *Ostrea* bearing sands and by sands and gravels including violet pumice fragments of up to 20 cm in diameter. The sandy-gravelly layer (level 5, fig. 3) contains a rich fauna including many *Spisula subtruncata* (DA COSTA) specimens and

Striarca lactea (LINNEO)
Mytilus galloprovincialis LAMARCK
Glycymeris glycymeris LINNEO
Naytiopsis granum (LAMARCK)
Naytiopsis reticulata (LINNEO)
Ocenebra erinacea (LINNEO)
Mitra fusca SOWERBY

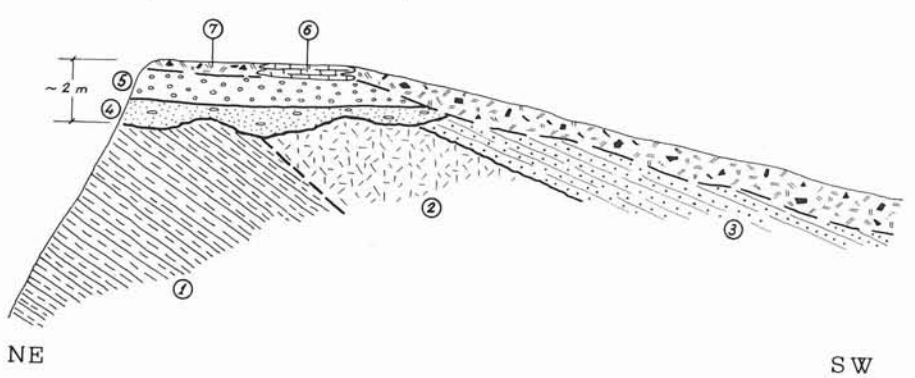

FIG. 3. - Grottelle section (C in fig. 1). 1) sands and silts with *Flabellipecten flabelliformis* (Pliocene); 2) clays (lower Pleistocene?); 3) tuffites (middle Pleistocene); 4) sand and gravels with *Ostrea* sp. (middle Pleistocene); 5) sand with quartz gravels and a few pumix pebbles containing *Spisula subtruncata* (Tyrrhenian); 6) algal limestones (Tyrrhenian); 7) soil.

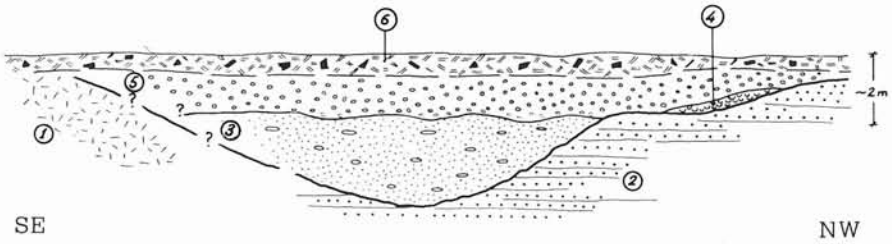

FIG. 4. - *Giglio section* (D in fig. 1). 1) clays (Pliocene); 2) whitish pumices (middle Pleistocene); 3) sands and pebbles rich in marine Mollusca (Tyrrhenian?); 4) poorly cemented, coarse grained sandstones with *Spisula subtruncata* (Tyrrhenian); 5) brownish loam with both sedimentary and volcanic derived gravels and a few *Glycymeris* sp. (Tyrrhenian); 6) Plowed soil.

Cerithium sp.
Monodonta tessulata (BORN) (= *M. turbinata*)
Truncolariopsis trunculus (LINNEO)
Euspira catena DA COSTA
Cladocora coespitosa D'ORBIGNY.

Sand and gravels are overlaid with algal limestones.

Giglio section (artificial scarp 400 m on the ESE of the homonymous country-house at an elevation of about 28 m, fig. 4). A Pliocene clayey bedrock is unconformably covered by layers of whitish pumices (average dimension: 1 cm) without any interstitial sediment. The layers are cut by an erosional surface covered by:

— pebbly sands bearing an abundant Molluscan fauna;
— poorly cemented, coarse grained sandstones;
— brownish loam with gravels of both sedimentary and volcanic origin and with a few pumix pebbles.

The following taxa have been identified in the pebbly sands layer (level 3 of fig. 4):

Mytilus sp.
Donax trunculus LINNEO
Dosinia exoleta LINNEO
Venus verrucosa LINNEO
Glycymeris glycymeris LINNEO
Mactra corallina LINNEO
Purpura haemastoma LINNEO

A poorly preserved specimen of *Thericium* aff. *varicosum* (BROCCHI), which was also found, is probably reworked from the underlying Pliocenic clays.

The coarse grained, poorly cemented sandstones contain at places several *Spisula subtruncata* specimens.

The silty brownish clays contain a few large *Glycymeris* sp.

Taccone section - (Little pool 1 km on the NW of Casale Taccone, below the elevation of 33 m). It is formed by a Pliocenic clayey bedrock covered by a transgressive yellowish calcarenitic layer which underlies a yellowish silty-clayey horizon with calcareous nodules. The calcarenitic layer can be correlated to the analogous *Strombus* bearing layers found on the SW of the railway.

Fontanile delle Serpi section - (Side road cut at 3.7 km SW from Tarquinia). It is formed of calcarenites and yellowish gravels and sands. It is very similar to other sections on the SW of the railway. It is however important because here an imprint of *Strombus bubonius* was collected, during a field trip made with the authors, by CONTI M. A. and a *Strombus* shell was found by PAOLINI (1979).

Fontana Matta section - (A scarp at km 85 800 of the Aurelia motorway, fig. 5).

The bedrock is made of Pliocene clays unconformably overlain by tuffites with a few fragments of marine Pelecypods. A sharp contact, corresponding to the Tyrrhenian transgression, marks the limit between the middle Pleistocene fine-grained grey tuffites and the overlying well-sorted and laminated beach sands. These also contain some gravels of both sedimentary and volcanic (lavic) origin. The scarce fauna is characterized by the presence of *Spisula subtruncata*. The beach sands are covered by fine grained sands and silts containing a few scattered *Cerastoderma* sp. and *Cladocora* sp.

On the basis of the relationships between the units outcropping on the sections described, two transgressive lithostratigraphic units have been identified overlying the Pliocene sediments:

i) Tuffitic complex. It can be divided into two different sequences. The lower sequence includes the layers rich in *Glycymeris violacescens* described by Bo-

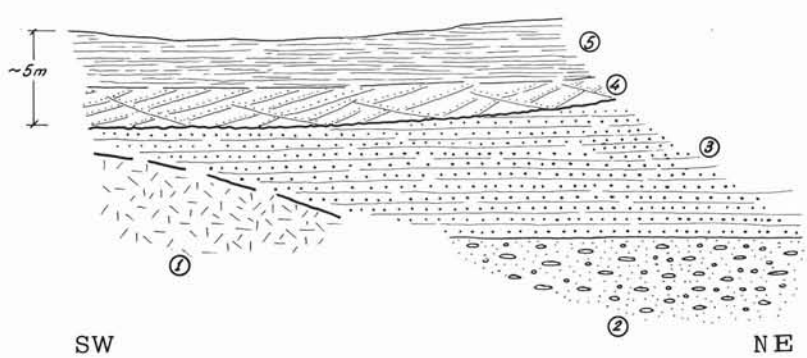

FIG. 5. - Fontana Matta section (G in fig. 1). 1) clays (Pliocene); 2) marine sands and gravels (middle Pleistocene); 3) tuffites with fragments of marine Pelecypods (middle Pleistocene); 4) laminated beach sands (Tyrrhenian); 5) fine grained sands and silts with *Cerastoderma* sp. and *Cladocora* sp. (Tyrrhenian).

NADONNA (1967, p. 126, fig. 7), the layers outcropping at km 91 800 of the Aurelia motorway and those of the Casale Pascolaro section as well.

The upper sequence is formed by layers with Gasteropods Pulmonates of San Pantaleo (BONADONNA, 1967), by the tuffitic layers outcropping in the lower part of the town of Tarquinia and also by the layers which overlie the Pliocene clays in the Grottelle and Giglio sections.

ii) *Grottelle sands and gravels.* This unit includes the transgressive marine sediments covering the tuffitic complex and, locally, the Pliocene bedrock as in the Grottelle, Giglio and Fontana Matta sections (figg. 3, 4 & 5).

This unit can be correlated with the transgressive calcarenites of the Casale Taccone section as well as with the calcarenites described by DAI PRA (1978) for the entire zone on the SW of the railway, because all these are genetically linked to the flat surface described as morphologic unit c. As a matter of fact, the surface can be interpreted as produced by a marine transgression which, after having scraped off the bedrock (Pliocene clays and tuffitic complex) deposited a thin veneer of sediments made up of bioclastic calcarenites (« panchina ») in the distal belt and of Grottelle sands and gravels in the proximal area. Near the coastline of maximum transgression, as at Casale Scorticagatti, the sedimentary cover is missing.

Unit d - This morphologic unit is the present coastal plain and its landward limit: a low scarp where the Tyrrhenian calcarenites (« panchina ») described by DAI PRA (1978) and CONATO & DAI PRA (1980) overlying the Pliocene sandstones, outcrop.

THE TYRRHENIAN TRANSGRESSION

As already mentioned, the presence of Tyrrhenian deposits containing *Strombus* had long since been recognized in the Tarquinia area. However, the location of the coastline of maximum transgression was a matter of dispute by the authors. Actually it was identified at 15-20 m a.s.l. by BONADONNA (1967) and at 60-65 m by DAI PRA (1978) and CONATO & DAI PRA (1980) mainly on the basis of the outcrop elevations of the sediments attributed to the Tyrrhenian cycle.

According to our interpretation, which is based upon both stratigraphic and morphologic data, the Tyrrhenian coastline is slightly lower than the limit between morphologic units a) and b) lying at 40-45 m above present sea level. The position of the Tyrrhenian coastline at this elevation instead of 65 m as reported by DAI PRA (cit. ref.) is suggested by morphologic evidence (fig. 2) as well as by the fact that the Quaternary sediments outcropping between 40 and 65 m (grouped in the tuffitic complex) are not coeval with the Tyrrhenian sediments but on the contrary constitutes their bedrock (figg. 3, 4 & 5).

TECTONIC IMPLICATIONS

In the regions surrounding the Tarquinia area, the Tyrrhenian coastline has been located at different elevations. South of the Mignone River the coastline runs, as already mentioned, at an elevation of 35-40 m, close to that found between the rivers Mignone and Marta (present paper).

North of the Marta River, about 10 km NW of Tarquinia near Riva dei Tarquini, AMBROSETTI & *al.* (1981) identified the Tyrrhenian coastline at about 25 m.

Further northward, in the Argentario area, some 50 km on the NW of Tarquinia, the Tyrrhenian coastline is located around 15 m above present sea level (BARTOLINI & BOSI, 1982).

Such results, if interpreted on the basis of the data quoted by SHACKLETON & UPDIKE (1973) who state that the maximum Tyrrhenian eustatic level was approximately 18 m higher than today, lead to an inferred post-Tyrrhenian uplift of 20-25 m in the area between the rivers Marta and Mignone. An uplift of about the same extent would have also occurred to the South of the River Mignone. Northwestward, the uplift would have progressively decreased to nearly nil in the Mt. Argentario zone.

Whatever the Tyrrhenian eustatic level had been, the upper Pleistocene uplift rate in the area appears remarkable if compared with the known data on Northern and Central Italy Tyrrhenian coastlines, which rarely exceed 20 m of altitude.

The increasing rate of uplift from Mt. Argentario to the River Mignone during the upper Pleistocene is consistent with the middle Pleistocene evolution of the same area, where three terraces appear scattered at altitudes which are stepwise increasing southward (BARTOLINI & BOSI, 1982).

NOTE - While this paper was under completion we received a typescript of a study dealing with the radiometric ages of the middle-upper Pleistocene sediments outcropping in the area North of the River Mignone (RADTKE & *al.*, 1982). The E.S.R. and Th/U ages of the « Grottelle sands and gravels » (four sample locations) and of the calcarenites described by DAI PRA (one sample location) range between 83 000 and 119 000 yr. B.P., with an estimated error of 15 %.

CITED REFERENCES

ALBERTI A., BERTINI M., DEL BONO G. L., NAPPI G. & SALVATI L. (1970) - *Note illustrative Carta Geologica d'Italia. F. 136 «Tuscania» e F. 142 «Civitavecchia»*, pp. 1-141. Poligrafica e Cartevalori, Ercolano (Napoli).

AMBROSETTI P., BARTOLINI C. & BOSI C. (1981) - *L'evoluzione geologica e morfologica quaternaria dell'area adiacente la bassa valle del Fiume Fiora.* Geogr. Fis. Dinam. Quat., *4*, 104-134.

BARTOLINI C. & BOSI C. (1982) - *Middle-upper Pleistocene shorelines of the Tyrrhenian coast between Tarquinia and Mt. Argentario (Italy)*, Abstract 11th INQUA Congr., Moscow, 1982.

BLANC A. C. (1937) - *Una spiaggia pleistocenica a «Strombus*

bubonius» presso Palidoro (*Roma*). Rend. Acc. Lincei, ser. 6, *23*, 200-204.

BONADONNA, F. P. (1967) - *Studi sul Pleistocene del Lazio. III - Linee di costa lungo il litorale di Tarquinia* (*Lazio settentrionale*). Geologica Romana, *6*, 121-135.

CONATO V. & DAI PRA G. (1980) - *Livelli marini pleistocenici e Neotettonica fra Civitavecchia e Tarquinia* (*Italia Centrale*). Geologica Romana, *19*, 181-194.

DAI PRA G. (1978) - *Le linee di costa tirreniane del litorale laziale dal Fiume Tevere a Tarquinia.* Geol. Appl. Idrogeol., *13*, 1-10.

FAZZINI P., GELMINI R., MANTOVANI M. P. & PELLEGRINI M. (1972) - *Geologia dei Monti della Tolfa* (*Lazio settentrionale; provincia di Viterbo e Roma*). Mem. Soc. Geol. It., *11*, 65-144.

FERRARI G. A. (1968) - *Studio pedologico dei dintorni di Tarquinia.* Ann. Acc. Sc. Forestali, *17*, 487-541.

GIGNOUX M. (1913) - *Les formations marines pliocènes et quaternaires de l'Italie du Sud et de la Sicile.* Ann. Univ. Lyon, n. s., *36*, 693 pp.

GIGNOUX M. (1915) - *Le couches à Strombes (Quaternaire marin) dans la province de Roma et sur la côte orientale de la Corse.* C. R. Soc. Géol. France, *13*, 111-112.

MELI R. (1915) - *Sopra un lembo di argille plioceniche affioranti presso la salina di Corneto-Tarquinia in provincia di Roma.* Boll. Soc. Geol. It., *34*, 321-342.

PAOLINI P. L. (ined.) - *Le linee di riva tirreniane del litorale laziale a Nord di Roma.* Unpublished thesis, Università di Roma.

RADTKE V., HENNIG G. J. & MANGINI A. (1982) - *Untersuchungen zur Chronostratigraphie mariner Terrassen in Mittelitalien. Th^{230}/U^{234} und E.S.R. Datierungen an fossilen Mollusken.* Eiszeitalter und Gegenwart, *32*, 49-55.

SHACKLETON N. J. & OPDYKE N. D. (1973) - *Oxygen isotope and palaeomagnetic Stratigraphy of equatorial Pacific core 28-238: Oxygen isotope temperatures and ice volumes on a 10^3 year and 10^6 year scale.* Quaternary Research, *3*, 39-55.