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SEDIMENTOLOGY AND MICROPALEONTOLOGY OF THE CORE G93-C27 (GAETA BAY, CENTRAL TYRRHENIAN SEA, ITALY) *

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RIASSUNTO - *Sedimentologia e micropaleontologia della carota G93-C27 (Golfo di Gaeta, Mar Tirreno centrale, Italia)* - Il Quaternario *Italian Journal of Quaternary Sciences,* 9(2), 1996, 687-696 - Viene presentato uno studio sedimentologico e micropaleontologico della carota G93-C27 prelevata nella piattaforma continentale del Golfo di Gaeta (Mar Tirreno centrale). I sedimenti recuperati comprendono una porzione inferiore prevalentemente siltoso-sabbiosa ed una superiore sabbioso-siltosa. Il passaggio tra le due porzioni, ubicato a 55 cm, coincide con un livello con base erosiva, particolamente ricco di bioclasti; questi ultimi tendono progressivamente a diminuire verso il top della carota. In base ai parametri sedimentologici e alle osservazioni microscopiche è stato possibile ascrivere i sedimenti più antichi a depositi marini costieri (*nearshore*), ed i più recenti a quelli di piattaforma esterna (*offshore*). Le oscillazioni di frequenza dei foraminiferi bentonici, rilevate lungo la carota, evidenziano a 55 cm dal *top* il passaggio da un intervallo inferiore, caratterizzato da specie diffuse prevalentemente nei substrati sabbiosi del piano infralitorale, ad uno superiore nel quale predominano specie tipiche dei fondi fangosi circalitorali e batiali. Tale variazione, batimetrica ed ambientale, in base ai dati sedimentologici e stratigrafici, potrebbe registrare il passaggio da una fase regressiva, verosimilmente riferita all'ultimo stazionamento basso del livello del mare (ca. 18 ky B.P.) e il successivo innalzamento eustatico.

ABSTRACT - *Sedimentology and micropaleontology of the core G93-C27 (Gaeta bay, central Tyrrhenian Sea, Italy)* - Il Quaternario *Italian Journal of Quaternary Sciences,* 9(2), 1996, 687-696 - A sedimentological and micropaleontological study was carried out on the core G93-C27 from the continental shelf of the Gaeta bay (central Tyrrhenian Sea). Grain-size analysis allowed to distinguish a lower portion, consisting of silty-sandy sediments, and an upper one consisting of sandy-silty sediments. The passage between these two parts occurs at 55 cm from the top, and coincides with a scoured base level particularly rich in bioclasts. The bioclastic content tends to decrease from this level toward the top of the core. Sedimentological parameters and optical microscopy observations allow to ascribe the older sediments to a nearshore environment and the younger sediments to an offshore setting. Frequency oscillations of benthic foraminifera indicate that the lower portion of the core (up to 55 cm from the top) is characterized by species which commonly occur on sandy bottoms of the infralittoral zone, whereas species typical of muddy bottoms of the circalittoral and bathyal zones are dominant in the upper part. This bathymetric and environmental change could record the passage from a regressive phase, which can be ascribed to the last eustatic lowstand (about 18 kyrs B.P.), to a subsequent eustatic rise.

Key words: Sedimentology, paleoecology (benthic foraminifera), Late Glacial-Holocene, Tyrrhenian Sea, Italy
Parole chiave: Sedimentologia, paleoecologia (foraminiferi bentonici), Tardiglaciale-Olocene, Mar Tirreno, Italia

1. FOREWORD

This paper presents the results of the sedimentological analysis and of the quantitative micropaleontological study (benthic foraminifera) performed on the core G93-C27 from the continental shelf of the Gaeta bay.

This research is part of a marine geology project, which is coordinated by T.S.Pescatore and funded by MURST 40%.

Studies on sequence stratigraphy, sedimentology, tephrachronology and micropaleontology, integrated with isotopic analyses are parts of the project.

In particular, in the Gaeta bay, researchers focussed on the continental shelf especially with the aim of recognizing the major eustatic fluctuations during the Late Glacial and the Holocene, through the sedimentological and micropaleontological analyses of cores and the interpretation of high resolution seismic lines, not included in this paper.

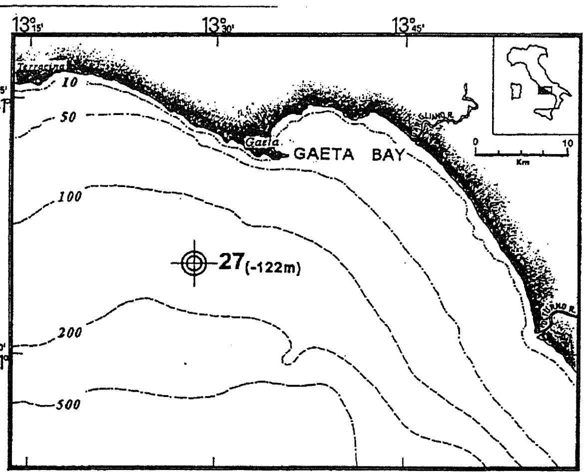


Fig.1 - Location and depth of G93-C27 core.
Ubicazione e batimetria della carota G93-C27.

(*) Sedimentology: M. Pennetta, A. Valente e C. Vecchione. Micropaleontology (foraminifera): M.G. Coppa, L. Ferraro e B. Russo

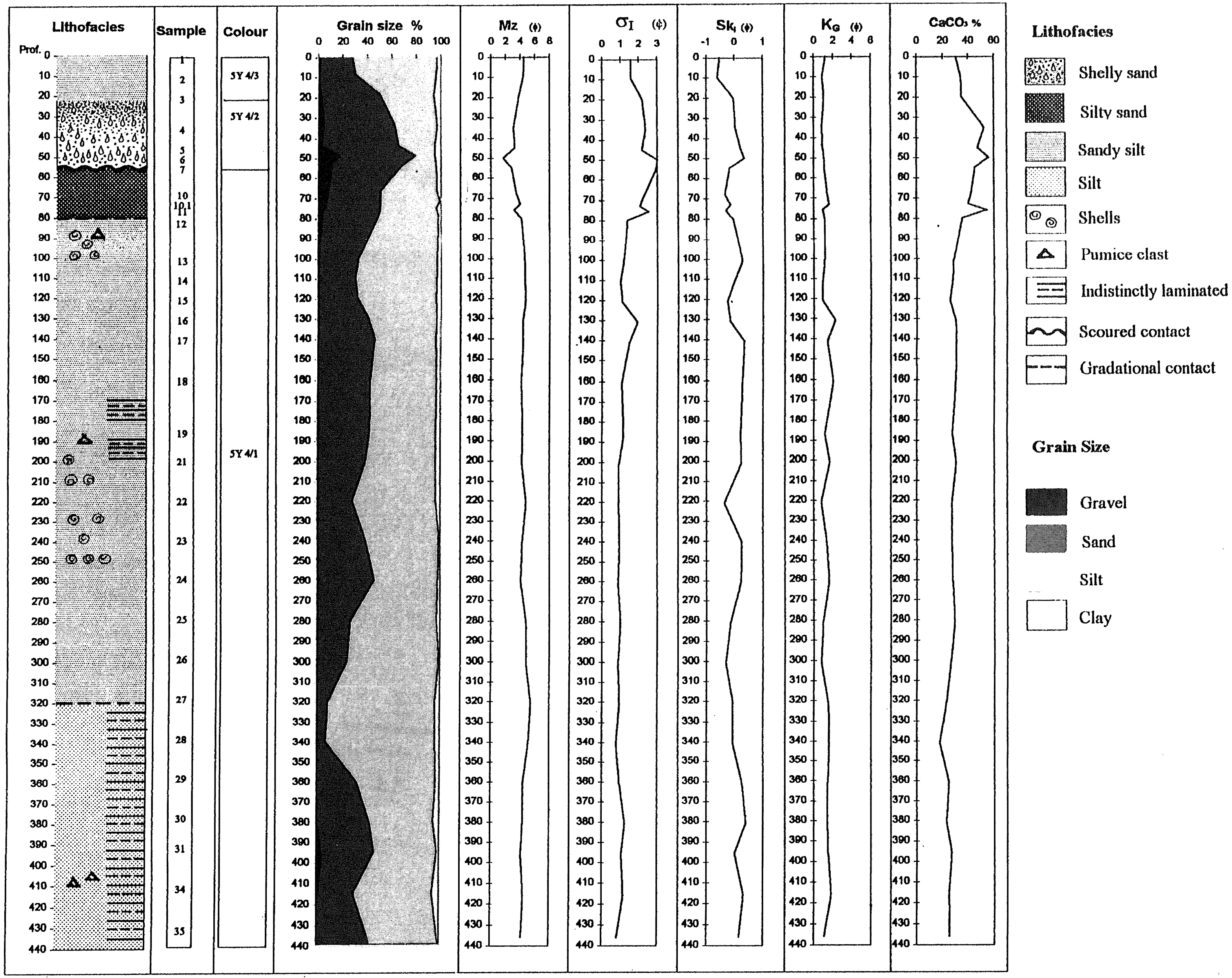


Fig. 2 - Sedimentological characteristics of the core G93-C27. The sediments from the core bottom to 55 cm are interpreted as Late Pleistocene in age (lower interval), the sediments from 55 cm to the top as Holocene in age (upper interval).

Caratteristiche sedimentologiche della carota G93-C27. I sedimenti dalla base della carota fino a 55 cm vengono attribuiti al Pleistocene superiore (intervallo inferiore), i sedimenti da 55 cm fino al top della carota all'Olocene (intervallo superiore).

2. GEOMORPHOLOGICAL SETTING

The studied core was obtained in 1993 through gravity coring at the margin of the continental shelf of the Gaeta bay (Fig. 1), during an oceanographic cruise of the *O/V Urania*. The geographical coordinates of the core are Lat. 41°05'23", Long. 13°29'08", the depth is 122 m.

Landward of this part of the continental shelf a plio-pleistocenic graben is filled with an about 900 m thick succession consisting of continental deposits passing to transitional and marine sediments, with intercalated volcanoclastic deposits of the Roccamonfina and, secondarily, of the Campi Flegrei volcanic units (Brancaccio *et al.*, 1991).

At present, the graben represents the alluvial plain of the Garigliano river and is limited to the south by the anti-apenninic structure of Mt. Massico, and to the north and east by the meso-cenozoic carbonatic massifs of the Aurunci Mts. Seaward of this plain, there is a wide continental shelf, the width of which ranges from 15 km north of Gaeta to 25 km close to the Garigliano river mouth, with a gradual shelf break at about 150 m (Segre, 1950). Data regarding an area lying immediately to the north (Marani *et al.*, 1986) indicate that the continental shelf consists of deformed deposits that in their outer portion are covered by several prograding sedimentary units. The uppermost terminations of the clinoforms of the youngest prograding unit are cut by an erosional surface covered by a thin veneer of fine-grained marine deposits.

3. DESCRIPTION OF THE CORE

The core G93-C27 has a total lenght of 445 cm. It was sampled at regular intervals of 20 cm, with the exception of some particularly significant levels that were more closely sampled. A total of 31 samples was taken. Lithology and colour (Munsell Soil Charts, 1975) were noted in the macroscopic description. The most common sediments are fine-grained and lack evident structures. In particular, along the core, it is possible to distinguish a lower part, consisting of silty-sandy sediments and an upper one, consisting of sandy-silty sediments, separated by a level (from 55 cm to 20 cm), where sediments are relatively coarse-grained. Shells and pumices are scattered at various levels in the core.

A dark grey colour (5Y 4/1) predominates from the bottom of the core up to 29 cm, where it changes into an olive grey colour (5Y 4/2) and finally, in the uppermost three centimeters, to olive (5Y 4/3).

4. STUDY METHODS

Grain-size analyses were performed following standard techniques (sieving for the fraction >63μ, pipette analysis for the fraction <63μ). The statistical parameters of Folk & Ward (1957) were calculated from the grain-size data. The combined use of some of these parameters allowed to define specific characters indicative of a particular sedimentary environment. The sediments were classified using Shepard's (1954) triangular plot.

In addition, calcimetry was performed to evaluate the $CaCO_3$ content and optical microscopy observations to define the percentage of skeletal grains (whole shells and fragments) and detrital grains, as well their abrasion degree.

For the micropaleontological analysis, the samples were dried at 30°C, then weighed, washed on a 90μ sieve and dried again. The quantitative study of the benthic foraminifera was carried out on sample fractions, obtained by means of a microsplitter and containing at least 300 specimens.

5. SEDIMENTOLOGY

The sedimentological study was carried out to investigate the main characteristics of deposits, with special emphasis on the changes in depositional processes occurred on the shelf during Late Pleistocene-Holocene.

5.1 Samples analysis (Fig. 2)

The sediments from the core bottom up to 320 cm commonly consist of silt (5.1ϕ≤Mz≤5.4ϕ), within which

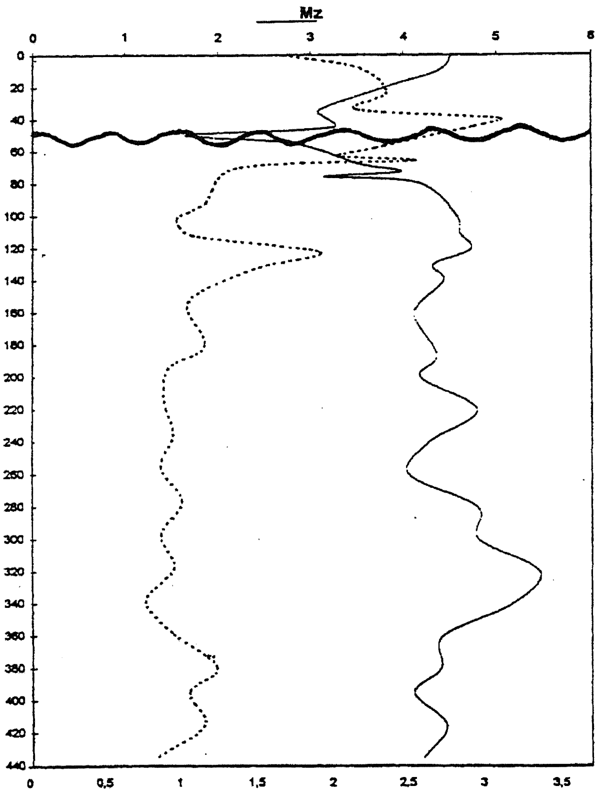


Fig. 3 - Variation with depth of Mean size and Standard deviation. Wavy line correspond to the scoured contact.

Variazione degli andamenti del Mean size *e della* Standard deviation *con la profondità. La linea ondulata indica la superficie d'erosione.*

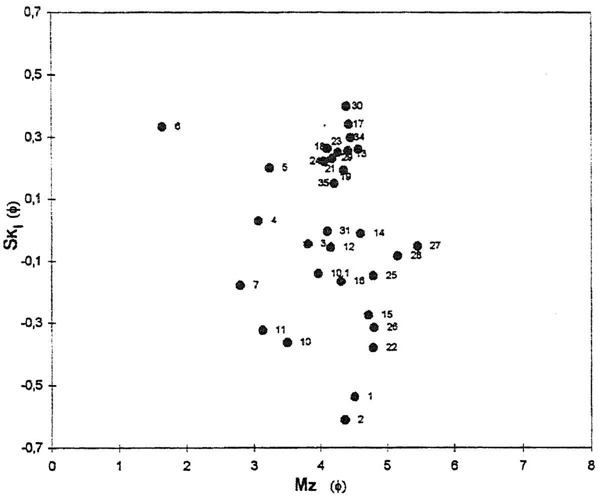


Fig. 4 - Mean size *vs.* Skewness.
Confronto tra Mean size *e* Skewness.

levels with a significative sandy fraction (near 40%) are intercalated. Grain-size frequency distributions show sediments from moderately to poorly sorted and positively skewed or unskewed, whereas the carbonate content is about 24%.

From 320 cm to 80 cm, the sediments consist of sandy silt ($4.05\phi \leq Mz \leq 4.7\phi$) with degrees of sorting similar to the previous ones and both positive and negative skewness, with carbonate content about 27%. In gen-eral, a tendency to an increase of the sandy fraction up to 50% is observed. Very thin lamination, nodules and a large number of both whole and fragmented shells, are present.

From 80 cm to 55 cm, the sediments consist of slightly coarser sediments ($2.8\phi \leq Mz \leq 3.9\phi$) such as silty sands, with fragments of shells. This lithofacies is characterized by very poorly sorted sediments with negative skewness.

From 55 cm up to 20 cm the sediments consist of shelly, polimodal sands passing upward to silty sands (shell hash). The sorting degree is very poor and the skewness is commonly positive. In this interval the carbonate content may reach maximum values above 50%.

From 20 cm to the top of the core the sediments consist of poorly sorted sandy silt sediments ($4.3\phi \leq Mz \leq 4.5\phi$) with negative skewness. The carbonate content is about 32%.

On the whole, the sorting degree decreases in the shelly coarser sands (Fig. 3). The diagram Sk_I/Mz (Friedman, 1961) shows a slightly negative correlation between the two parameters (Fig. 4). The youngest and finer-grained sediments show negative Sk_I values. They consist of two different grain populations: the modal population is composed of terrigenous mud (5-6ϕ or 6-7ϕ) whereas the coarse tail is made of bioclasts (2-3ϕ).

Microscope observations are confirmed by the high values of the $CaCO_3$ content, though the general trend indicates a positive correlation between $CaCO_3$ contents and coarse grain size (Al-Ghadban, 1990). On the contrary, the sandy bioclastic sediments show positive skewness and an high percentage of shelf skeletal grains (coarse mode), mixed with a little terrigenous muddy sediments (fine tail).

5.2 Interpretation

Grain size distribution analysis, correlation between Folk & Ward's (1957) statistical parameters and carbonate content (Gostin *et al.*, 1984; Al-Ghadban, 1990), microscopic observations on the roundness of mineral grains as well as skeletal grains content, allowed us to interpret the older sediments (from the bottom core up to 55 cm) as nearshore deposits, with coarsening upward tendency. The more recent sediments (the uppermost 20 cm) pertain to offshore domains (Fig. 5).

The sediments comprised between 55 and 20 cm, which show a sharp, scoured contact with the underlying deposits, are the result of the sedimentation of material produced by shoreface erosion (Bruun, 1962) caused by a sea-level rise (Saito, 1991).

Consequently, it is possible to recognize, at first, a regressive phase (from the core bottom up to 55 cm) and then a transgressive phase.

Further support to this interpratation comes from the changes in the pattern of sediment input in this part of the continental shelf, where the mouth of the Garigliano river developed. In fact the older sediments (lower part of the core) show low $CaCO_3$ contents, which are typical of sea-level lowstands, *i.e.* regressive phases, when the terrigenous input is higher.

On the contrary, the sediments of the upper part of the core, where the $CaCO_3$ content is higher, were probably deposited during a transgressive phase when the fluvial discharge is smaller and most of stream load is deposited in subaerial valleys. In fact, the highstand muddy sediments having a thickness in the order of the decimetre suggest that the sampled site was barely affected by the Garigliano river sediments and was mainly affected by the action of bottom currents washing out the sediments fine grained fraction.

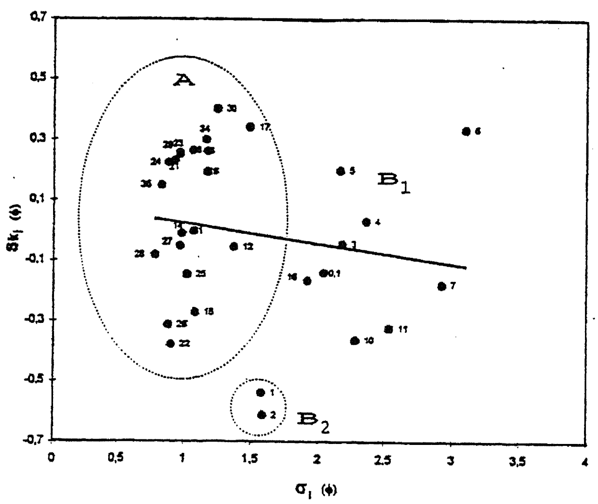


Fig. 5 - Standard deviation vs. Skewness. Note how the samples are grouped into two different sets allowing for the distinction of the field of offshore sediments (A) from that of nearshore deposits (B) (modified from Al-Ghadban, 1990)

Confronto tra Standard deviation *e* Skewness. *Notare i raggruppamenti che permettono di suddividere il campo dei sedimenti di* offshore *(A) da quelli di* nearshore *(B) (da Al-Ghadban, 1990, modificato).*

Such an evolution can also be inferred from seismic profiles (Senatore, pers.comm.) showing prograding bodies, linked to a regressive phase, which are cut by an angular unconformity veneered by thin transgressive highstand deposits.

6. MICROPALEONTOLOGY

The micropaleontological study was performed in order to recognize the paleobathymetric variations eventually recorded by the benthic foraminifera and to investigate the relations between the changes in the foraminiferal assemblages and the sedimentological changes.

6.1 Samples analysis

The micropaleontological analysis of the foraminiferal content of 30 samples allowed to identify 132 benthic species and 15 planktonic species (see appendix), with dominant benthic specimens (75,2-95,4%).

Planktonic foraminifera are subordinate and, therefore, though showing frequency changes from the bottom to the top of the core, dot not give reliable indications on paleoclimatic evolution.

The changes in the percentage values of some benthic species from the bottom to the top of the core allow to subdivide the cored succession into two intervals (Fig. 6):

1) *lower interval* (from 445 cm to 55 cm) characterized by *Rosalina globularis, Asterigerinata mariae, Elphidium macellum, Elphidium punctatum, Nonion depressulum, Nonionella turgida.*

2) *upper interval* (from 55 cm to 0 cm) characterized by *Textularia calva, Bigenerina nodosaria, Amphycorina scalaris, Bulimina gibba, Uvigerina mediterranea, Hyalinea baltica, Cassidulina crassa, Hanzawaia rhodiensis.*

6.2 Interpretation

On the basis of the literature (Blanc-Vernet, 1969; Wright, 1978; Sgarrella & Barra, 1985; Sgarrella *et al.*, 1985; Sgarrella & Moncharmont-Zei, 1993; Coppa *et al.*, 1992; 1994; Coppa & Di Tuoro, 1995) it is possible to interpret the differences in the foraminiferal assemblages of the two intervals in terms of bathymetric and ecological changes.

1) *Lower interval:* it is characterized by species commonly occurring in the infralittoral and upper circalittoral zone, among which *A. mariae* and *E. punctatum,* both typical of sandy bottoms, are dominant. The assemblage is completed by epiphytic species (*R. globularis, E. macellum*), euryhaline species *(N. depressulum)* and finally by species typical of muddy bottoms (*N. turgida*).

2) *Upper interval:* this is characterized by species common both in the lower circalittoral and bathyal zones, especially on muddy bottoms (*H. baltica, A. scalaris, U. mediterranea, C. crassa*), but also on sandy ones (*H. rhodiensis*). These species are associated with others characterized by a wider bathymetric distribution and typical of sandy bottoms (*T. calva*) or of muddy bottoms (*B. nodosaria, B. gibba*).

The frequency fluctuations mark a sharp bathymetric change at 55 cm, separating the lower interval, whose paleodepth is referred to the infralittoral-upper circalittoral zone, from the upper interval with an inferred paleodepth between the lower circalittoral and the bathyal zone.

This bathymetric change is in good agreement with the different ecological significance of the lower interval, consisting prevalently of biota typical of sandy bottoms, and the upper interval, consisting mainly of biota typical of muddy bottoms.

7. CONCLUDING REMARKS

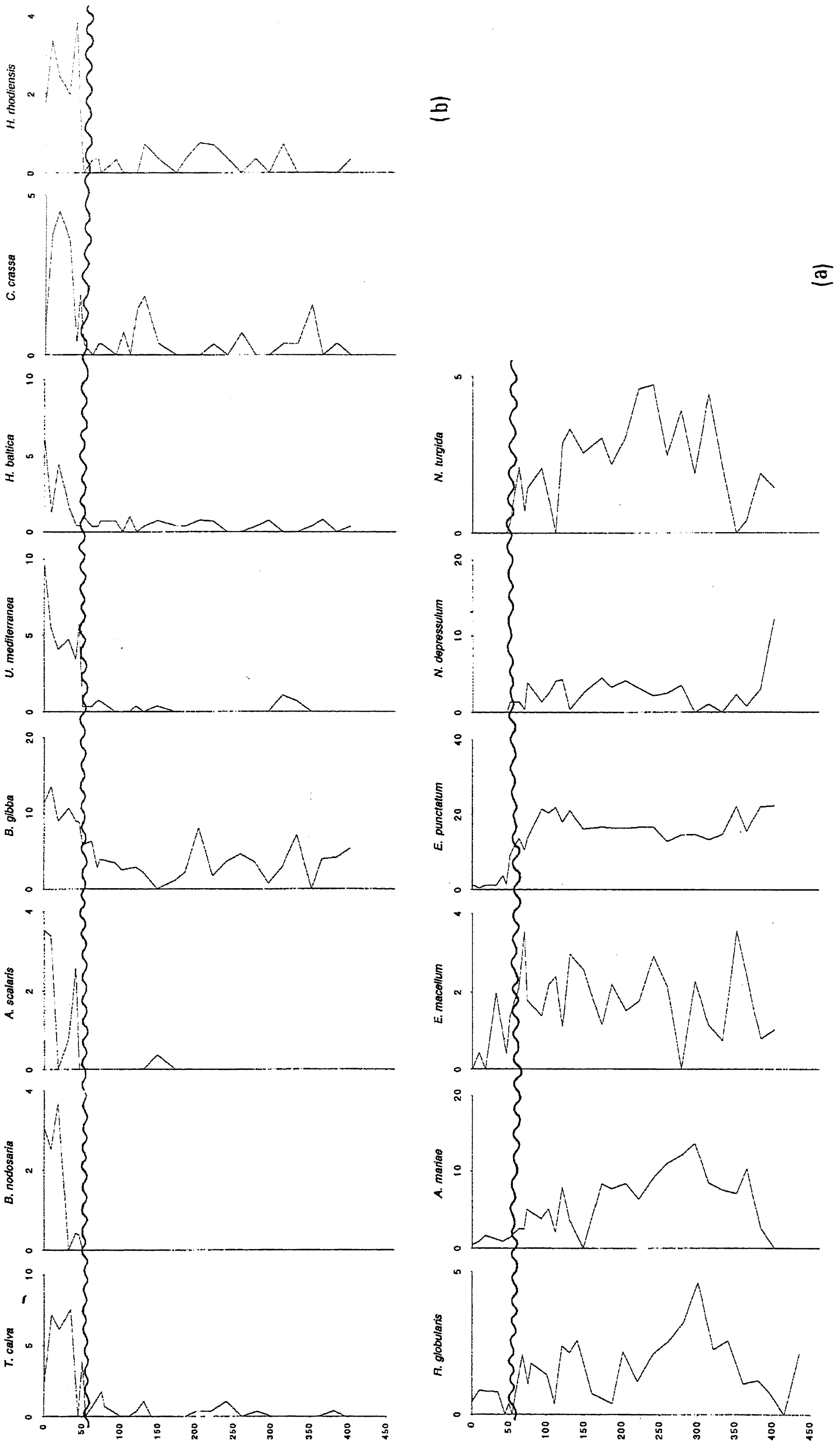
The sediments of the lower interval (from bottom core to 55 cm) of the G93-C27 core, interpreted as lowstand deposits and characterized by benthic infralittoral-upper circalittoral species, were probably deposited during the last glacial maximum (ca. 18 ka BP), when the sea level dropped to 110/120 m in the Eastern Tyrrhenian Margin (Marani *et al.*, 1988), or possibly during a previous regressive period. The upper interval (from 55 cm to 0 cm) in which the benthic lower circalittoral-bathyal species prevail, was probably deposited during the post-glacial sea level rise and could be related to the transgressive phase, marked at 55 cm by an erosional surface. Similar deposits have been identified by various authors in other areas of the Tyrrhenian and Mediterranean margin, and interpreted as marker of the *ravinament surface* (RS) by inferring that the paralic deposits, generally present at the base of this surface, were eroded (Trincardi *et al.*, 1994). The dominant muddy sediments of the upper part of the core were deposited during the sea level highstand (ca. 6 ka BP).

APPENDIX

The foraminifera taxa identified are listed below in alphabetical order.

Benthic foraminifera

Adelosina elegans (Williamson) = *Serpula bicornis* Walker & Jacob var. *elegans* Williamson, 1858
Adelosina intricata (Terquem) = *Quinqueloculina intricata* Terquem, 1878
Adelosina italica (Terquem) = *Quinqueloculina italica* Terquem, 1878
Adelosina mediterranensis (LeCalvez & Le Calvez) = *Quinqueloculina mediterranensis* LeCalvez & Le Calvez, 1958
Ammodiscus planorbis Hoglund, 1947
Ammonia beccarii (Linneo) = *Nautilus beccarii* Linneo, 1758
Ammonia parkinsoniana (d'Orbigny) = *Rosalina parkinsoniana* d'Orbigny, 1839
Ammonia perlucida (Heron-Allen & Earland)= *Rotalia perlucida* Heron-Allen & Earland, 1913
Ammonia tepida (Cushman)= *Nautilus beccarii* Linneo var. *tepida* Cushman, 1926
Amphicoryna scalaris (Batsch) = *Nautilus scalaris* Batsch, 1791
Asterigerinata mamilla (Williamson) = *Rotalina mamilla* Williamson, 1858
Asterigerinata mariae Sgarrella, 1990
Bigenerina nodosaria d'Orbigny, 1826


H. rhodiensis
C. crassa
H. baltica
U. mediterranea
B. gibba
A. scalaris
B. nodosaria
T. calva
(b)
N. turgida
N. depressulum
E. punctatum
E. macellum
A. mariae
R. globularis
(a)

Biloculinella globula (Bornemann) = *Biloculina globulus* Bornemann, 1855
Biloculinella inflata (Wright) = *Biloculina inflata* Wright, 1902
Biloculinella labiata depressa Wiesner = *Biloculina labiata* Schlumberger var. *depressa* Wiesner, 1923
Bolivina aenariensis (Costa) = *Brizalina aenariensis* Costa,1856
Bolivina alata (Seguenza) = *Vulvulina alata* Seguenza, 1862
Bolivina catanensis Seguenza, 1862
Bolivina dilatata Reuss, 1850
Bolivina pseudoplicata Heron-Allen & Earland, 1930
Bolivina spathulata (Williamson) = *Textularia variabilis* Williamson var. *spathulata* Williamson, 1858
Buccella granulata (Di Napoli Alliata) = *Pulvinulina frigida* Cushman var. *granulata* Di Napoli Alliata, 1952
Bulimina costata d'Orbigny, 1852
Bulimina elongata d'Orbigny, 1846
Bulimina gibba Fornasini, 1902
Bulimina marginata d'Orbigny, 1826
Buliminella multicamera Cushman & Parker, 1938
Cassidulina carinata Silvestri = *Cassidulina laevigata* d'Orbigny var. *carinata,* Silvestri 1896
Cassidulina crassa d'Orbigny, 1839
Cibicides lobatulus (Walker & Jacob) = *Nautilus lobatulus* Walker & Jacob, 1798
Cibicides refulgens Montfort, 1808
Clavulina crustata (Cushman) = *Pseudoclavulina crustata* Cushman, 1936
Coryphostoma perforata (Di Napoli) = *Loxostomum perforatum* Di Napoli, 1952
Cribroelphidium cuvilleri (Levy) = *Elphidium cuvilleri* Levy, 1966
Cribroelphidium granosum (d'Orbigny) = *Nonionina granosa* d'Orbigny, 1846
Cribroelphidium incertum (Williamson) = *Nautilus umbilicatulus* Walker & Jacob, 1798 var. *incerta* Williamson, 1858
Discopulvinulina araucana Barker = *Rosalina araucana* d'Orbigny, 1839
Discorbinella bertheloti (d'Orbigny) = *Rosalina bertheloti* d'Orbigny, 1839
Elphidium aculeatum (d'Orbigny) = *Polystomella aculeata* d'Orbigny, 1846
Elphidium complanatum (d'Orbigny) = *Polystomella complanata* d'Orbigny, 1839
Elphidium crispum (Linneo) = *Nautilus crispus* Linneo, 1758
Elphidium macellum (Fichtel & Moll) = *Nautilus macellum* Fichtel & Moll, 1798
Elphidium pulvereum Todd, 1958
Elphidium punctatum (Terquem) = *Polystomella punctata* Terquem, 1878
Eponides repandus (Fichtel & Moll) = *Nautilus repandus* Fichtel & Moll, 1798

Fig. 6 - Frequency fluctuations of characteristic benthic species along the core. The species typical of the lower interval are given in (a), those of the upper interval in (b). The percentage values are on the horizontal axis. The studied samples are evenly spaced on the vertical axis where the position of the two intervals, lower one (445-55 cm) and upper one (55-0 cm), is indicated. Wavy line corresponds to the erosive contact.

Variazione di frequenza delle specie bentoniche caratteristiche lungo la carota. Le specie caratteristiche dell'intervallo inferiore (445-55 cm) sono riportate in (a), quelle dell'intervallo superiore (55-0 cm) in (b). Sulle ascisse sono indicati i valori percentuali delle singole specie; sulle ordinate i campioni studiati, ugualmente distanziati ed i due intervalli, l'inferiore ed il superiore. La linea ondulata indica la superficie d'erosione.

Fissurina castanea (Flint) = *Lagena castanea* Flint, 1899
Fissurina orbignyana Seguenza, 1826
Fissurina pseudorbignyana Buchner, 1940
Gavelinopsis lobatulus (Parr) = *Rosalina isabelleana d'Orbigny,* 1839
Gavelinopsis praegeri (Heron Allen & Earland) = *Discorbina praegeri* Heron Allen & Earland, 1913
Glabratella torrei (Bermudez) = *Discorbis torrei* Bermudez, 1935
Globocassidulina subglobosa (Brady) = *Cassidulina subglobosa* Brady, 1881
Globulina gibba (d'Orbigny) = *Polymorphina gibba d'Orbigny,* 1826
Guttulina communis (d'Orbigny) = *Polymorphina communis* d'Orbigny, 1826
Gyroidina soldanii d'Orbigny, 1826
Gyroidina umbonata (Silvestri) = *Rotalia soldanii* d'Orbigny var. *umbonata* Silvestri, 1898
Hanzawaia rhodiensis (Terquem) = *Truncatulina rhodiensis* Terquem, 1878
Heterolepa pseudoungeriana (Cushman) = *Truncatulina pseudoungeriana* Cushman, 1922
Hoeglundina elegans (d'Orbigny) = *Rotalia elegans* d'Orbigny, 1826
Hyalinea baltica (Schroeter) = *Nautilus balthicus* Schroeter, 1783
Lagena clavata (d'Orbigny) = *Oolina clavata* d'Orbigny, 1846
Lagena laevis (Montagu) = *Vermiculum laeve* Montagu, 1803
Lagena nebulosa Cushman = *Vermiculum laeve* Montagu var. *nebulosa* Cushman, 1923
Lagena semistriata Williamson = *Vermiculum striatum* Montagu var. *semistriata* Williamson, 1848
Lagena striata (d'Orbigny) = *Oolina striata* d'Orbigny, 1839
Lenticulina crassa (d'Orbigny) = *Cristellaria crassa* d'Orbigny, 1846
Lenticulina peregrina (Schwager) = *Cristellaria peregrina* Schwager, 1866
Melonis barleanum (Williamson) = *Nonionina barleana* Williamson, 1858
Miliolinella circularis (Bornemann) = *Triloculina circularis* Bornemann, 1855
Miliolinella elongata (Kruit) = *Triloculina circularis* Bornemann var. *elongata* Kruit, 1955
Miliolinella subrotunda (Montagu) = *Vermiculum subrotundum* Montagu, 1803
Neoconorbina terquemi (Rzehak) = *Discorbina terquemi* Rzehak, 1888
Nonion depressulum (Walker & Jacob)= *Nautilus depressulus* Walker & Jacob, 1798
Nonionella turgida (Williamson) = *Rotalina turgida* Williamson, 1858
Oolina acuticosta (Reuss) = *Lagena acuticosta* Reuss, 1862
Oolina hexagona (Williamson) = *Vermiculum squamosum* Montagu var. *hexagona* Williamson, 1848
Oridorsalis umbonatus (Reuss) = *Rotalina umbonata* Reuss, 1855
Planorbulina mediterranensis d'Orbigny, 1826
Planulina ariminensis d'Orbigny, 1826
Pleurostomella alternans Schwager, 1866
Pullenia bulloides (d'Orbigny) = *Nonionina bulloides* d'Orbigny, 1846
Pullenia quinqueloba (Reuss) = *Nonionina quinqueloba* Reuss, 1855
Pyrgo depressa (d'Orbigny) = *Biloculina depressa* d'Orbigny, 1826
Pyrgo elongata (d'Orbigny) = *Biloculina elongata* d'Orbigny, 1826
Pyrgo inornata (d'Orbigny) = *Biloculina inornata* d'Orbigny, 1846
Quinqueloculina bosciana d'Orbigny, 1839
Quinqueloculina cliarensis (Heron-Allen & Earland) = *Miliolina cliarensis* Heron-Allen & Earland, 1930
Quinqueloculina contorta d'Orbigny, 1846
Quinqueloculina costata d'Orbigny, 1878
Quinqueloculina longirostra d'Orbigny, 1826
Quinqueloculina milletti (Wiesner) = *Miliolina milletti* Wiesner, 1912
Quinqueloculina oblonga (Montagu) = *Vermiculum oblonga* Montagu, 1803
Quinqueloculina padana Perconig, 1954
Quinqueloculina pulchella d'Orbigny, 1826
Quinqueloculina pygmea Reuss, 1850
Quinqueloculina seminulum (Linneo) = *Serpula seminulum* Linneo, 1758

Quinqueloculina stalkeri Loeblich & Tappan, 1953
Quinqueloculina stelligera Schlumberger, 1893
Quinqueloculina viennensis Le Calvez & Le Calvez, 1958
Reussella spinulosa (Reuss) = *Verneulina spinulosa* Reuss, 1850
Robertina traslucens Cushman & Parker, 1936
Rosalina bradyi (Cushman) = *Rosalina globularis* d'Orbigny var. *bradyi* Cushman, 1915
Rosalina concinna (Brady) = *Discorbina concinna* Brady, 1884
Rosalina globularis d'Orbigny, 1826
Rosalina obtusa d'Orbigny, 1846
Sigmoilina tenuis (Czjzek) = *Quinqueloculina tenuis* Czjzek, 1848
Sigmoilina tricosta (Cushman & Todd) = *Spiroloculina tricosta* Cushman & Todd, 1944
Sigmoilopsis celata (Costa) = *Spiroloculina celata* Costa, 1855
Sigmoilopsis schlumbergeri (Silvestri) = *Sigmoilina schlumbergeri* Silvestri, 1904
Siphonina reticulata Czjzek = *Rotalina reticulata* Czjzek, 1848
Siphotextularia concava (Karrer) = *Plecanium concavum* Karrer, 1868
Sphaeroidina bulloides d'Orbigny, 1826
Spiroloculina depressa d'Orbigny, 1826
Spiroloculina excavata d'Orbigny, 1846
Spiroloculina grata Terquem, 1878
Spiroloculina limbata d'Orbigny, 1826
Spiroloculina rostrata Reuss, 1850
Spiroplectinella sagittula (d'Orbigny) = *Textularia sagittula* d'Orbigny, 1839
Spiroplectinella wrighti (Silvestri) = *Spiroplecta wrighti* Silvestri, 1903
Stainforthia complanata (Egger) = *Virgulina schreibersiana* Czjzek var. *complanata* Egger, 1893
Textularia calva Lalicker, 1935
Textularia conica d'Orbigny, 1839
Textularia pala Czjzek, 1848
Trifarina angulosa (Williamson) = *Uvigerina angulosa* Williamson, 1858
Triloculina austriaca d'Orbigny, 1846
Triloculina gibba d'Orbigny, 1826
Triloculina plicata Terquem, 1878
Triloculina tricarinata d'Orbigny, 1826
Uvigerina mediterranea Hofker, 1932
Valvulineria bradyana (Fornasini) = *Discorbina bradyana* Fornasini, 1900
Valvulineria minuta Parker, 1954

Planktonic foraminifera:

Globigerina bulloides d'Orbigny, 1826
Globigerina rubescens Hofker, 1956
Globigerinoides elongatus (d'Orbigny) = *Globigerina elongata* d'Orbigny, 1826
Globigerinoides gomitulus (Seguenza) = *Globigerina gomitulus* Seguenza, 1880
Globigerinoides ruber (d'Orbigny) = *Globigerina rubra* d'Orbigny, 1839
Globigerinoides sacculifer (Brady) = *Globigerina sacculifera* Brady, 1877
Globigerinoides tenellus Parker, 1858
Globigerinoides trilobus (Reuss) = *Globigerina triloba* Reuss, 1850
Globorotalia inflata (d'Orbigny) = *Globigerina inflata* d'Orbigny, 1839
Globorotalia scitula (Brady) = *Pulvinulina scitula* Brady, 1882
Globorotalia truncatulinoides (d'Orbigny) = *Rotalia truncatulinoides* d'Orbigny, 1839
Neogloboquadrina dutertrei (d'Orbigny) = *Globigerina dutertrei d'Orbigny, 1839*
Neogloboquadrina pachyderma (Ehrenberg) = *Aristerospira pachyderma* Ehrenberg, 1861
Orbulina universa d'Orbigny, 1839
Turborotalita quinqueloba (Natland) = *Globigerina quinqueloba* Natland, 1938

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