

# **UNIVERSITA' DEGLI STUDI DI BOLOGNA**

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## **I Foraminiferi Bentonici della Sezione "Falchi"**

**(S. Lazzaro di Savena - Bologna)**

**TESINA**

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## Abstract

The Savena torrent marks for a long stretch the boundaries between the Municipalities of Bologna and San Lazzaro di Savena, deeply carving the sedimentary Apennine succession, dominated by clays in its part ascribable to the Pliocene.

In particular, near the "Gianni Falchi" baseball stadium, as will be illustrated below, riverbed banks expose a series of sediments, including outstanding highly glauconitic clays, referable to the passage between the lower and middle Pliocene.

The micropaleontological / biostratigraphic study of this section is the subject of this work.

## Purpose

The purpose of this study is the precise definition of the lower Pliocene - Middle Pliocene limit within the examined section (Section "Falchi"), as far as can be deduced from the associations and from the distribution of numerous species of benthic foraminiferans in the samples collected according to the criteria of exposed below.

In addition, it will summarize all the deductions made possible by the peculiarities of the thanatocoenosis and washing residues of the samples.

## Methodology

In its initial phase, the sampling covered a large stretch of the river course (from the bridge of San Ruffillo, Municipality of Bologna, to Ponticella, Municipality of S. Lazzaro di Savena) encountering microfaunas referable to a chronostratigraphic interval from the Tortonian to the Quaternary (lithofacies of the "Yellow Sands") with microfaunas dominated by *Ammonia beccari papillosa*.

Subsequently, the area of interest was gradually restricted, while appropriately increasing the sampling frequency.

Finally, the section subject of the work was isolated, and its purpose was specified.

Altogether 50 samples were examined, of which 29 (2 sterile) directly interesting the work. The treatment of the samples had no particularities worthy of mention, as did the micropaleontological examination, performed with a WILD M5 stereomicroscope (max 50x).

For the biostratigraphic part, biozones are based on COLALONGO - SARTONI, "Biostratigraphic scheme for the Pliocene and the lower Pleistocene in Italy" taken from "Preliminary contributions to the realization of the neotectonic map of Italy", Publication 251 of the Finalized Geodynamic Project (1979). For taxonomy and iconography, the "Atlante dei Foraminiferi Padani" was used, in its second edition (1982).

58 species and 2 genera have been determined, and their stratigraphic distribution in the "Falchi" section is highlighted in Table 1.

## Geological framework

The section is essentially made up of clayey sediments, and there are no significant changes in competence within it. The depositional environment will be inferred from the examination of the bathymetric indicators present in the studied samples.

The sequence, from below, is as follows (for the thicknesses, see the attached column, of which this is the legend):

- **Gray-blue clays without prominent structures**, nor evident sedimentological peculiarities, pyritose and at times slightly glauconitic, bioturbated from burrows to the roof, with a thin sterile layer of clayey sands inside them.
- **Strongly glauconitic clays, bioturbated**, with scattered lamellibranch valves (dominant *Ostrea cochlear* and *Pecten spp.*)
- **Laminated sapropelitic clays**, with scarce glauconite and abundant diagenetic chemical precipitates (especially gypsum) and organic material inside them, with remains of fishes and a microslump observable within them; as a whole, attributable to stagnation episodes. Between the two recognizable sapropelitic episodes, the clays do not have significant structures, however, the millimetric lamination present in the eusinic episodes is lacking. They contain lamellibranchs of the genera already mentioned, (*Pecten* and *Ostrea*, scattered throughout the section in highly variable concentration, mentioned only where it becomes significant). Still, in the interval between the episodes mentioned, the clays are slightly (at times more markedly) glauconitic, as well as slightly sapropelitic.
- **Gray clays** follow and are not better definable follow, also due to the small outcrop.

The genetic-environmental characteristics of the sediments mentioned will be examined later. As far as tectonics is concerned, apart from the disturbance symptom constituted by the mentioned microslump, and neglecting the indication of the potential presence of a tectonic threshold bordering an eusinic basin (a clue provided by sapropelites), the series in question is to be considered undisturbed, although perhaps altogether dislocated within the complex tectonics of the Padan Apennine border. As a whole, from the point of view of sedimentary cycles, the section does not display immediately recognizable trends, for example, of textural-granulometric type. However, a drastic drop in the deposition rate (glauconite deposits) is normally connected to transgression phenomena, due to the landward regression of the coast line with the consequent removal of the terrigenous sediment sources, as well as the overall drop in relief energy. In conjunction with the general drop in bottom energy, it is not strictly necessary to hypothesize the evolution of a threshold model to justify the situation of very limited circulation and the sapropelites, although nothing allows us to exclude some contribution of the structural-tectonic factor in accentuating the stagnation at the bottom of the basin. Consequence of those premises is that the sequence - in its section between samples 38 to 40 but probably already from sample 50 (rather

glaucous) - can be defined, without too many reservations, as transgressive *sensu lato*. Irregularities in the Savena riverbed and remains of artefacts prevented the study of some stretches of the upper section. For a more complete approach to the sedimentological problems of the succession studied, see S. d'Onofrio - M. Roveri (with the collaboration of C. Brizio), "Il passaggio Pliocene Inferiore – Pliocene Medio nel pedeappennino bolognese pedeappennine della sezione «Falchi» (Torrente Savena)" published in volume 45 of the *Giornale di Geologia*, in print while I am writing.

## Tables

To simplify the presentation of the work, and in the hope of graphically highlighting the presence of any trends, I present most of the data relating to the samples using tables, which will be examined below. They are:

- Litho-biostratigraphic column;
- Table 1) Distribution in the samples of the 60 taxa examined

The documents cited above are self-explanatory.

- Table 2) Data taken from the bathymetric indicators present in the samples;
- Table 3) Generality about residues from sieving and thanatocenoses.

On these latter tables we will talk more widely.

## Biostratigraphy and Paleocology

Recognized biostratigraphic units, according to the already cited schema by Colalongo-Sartoni 1979, are from bottom to top:

- *Uvigerina rutila* Cushman & Todd zone, whose lower limit was not recognized, while the upper limit is the LAD of *U. rutila*;
- *Anomalinoidea helycinus* (Costa) zone, ranging between the LAD of *U. rutila* and the FAD of *Bulimina marginata*.

Besides the zone markers, the examined samples also include: *Marginulina costata coarctata*, *Bulimina basispinosa*, *Discanomalina semipunctata* (infrequent species with very high intraspecific variability), for which reference is made to Plate 1.

Among the most significant species encountered, deserving mention are: *Brizalina spathulata*, *alata*, *dilatata*, *albatrossi*; *Bolivina punctata*; *Bulimina fusiformis*, *minima*, *costata*; *Cibicides lobatulus*; *Gyroidina soldanii*; *Praeglobobulimina pupoides*; *Pullenia quinqueloba*, *salisburyi*; *Stainforthia complanata*; *Sigmoilinita tenuis*; *Sigmoilopsis celata*; *Uvigerina peregrina*, *pygmaea*, *proboscidea*, *canariensis*.

Among the species mentioned, many can be used as bathymetric indicators.

In addition to these, all the others listed in Table 1 and in the annex have been identified.

The limit between the lower Pliocene and the middle Pliocene was placed in correspondence with the sample 52, containing both the LAD of *U. rutila* and the FAD of *A. helycinus*, obviously with reference to the section being examined.

With regard to paleoecology, the first significant deductions that can be drawn come from some bathymetric indicators; among the species defined and recognized in the samples the most important that were identified include:

- For eulittoral bathymetry: *Cibicides lobatulus*.
- For circalittoral bathymetry: *Valvulineria bradyana* and *Stainforthia complanata*.
- For bathyal bathymetry: the genera *Pullenia*, *Praeglobobulimina* e *Gyroidinoides*.

With regard to the depositional environment, it is perhaps not superfluous to remember that, as long as, in the majority of cases, reworking takes place towards the deepest parts of the basin, whenever the isochronous species from a given sample include conflicting bathymetry indicators, the real depositional environment is marked by the deepest-living ones. That said, it is clear from Table 2 how the deposition as a whole refers to the bathyal environment.

Fluctuations in the quantitative ratios between the different indicators can, if anything, refer to variations in distality / proximity of the depositional environment, that is to say, to fluctuations in the coast line.

However, it would be rash to induce a direct and mechanical correlation between the presence of eulittoral indicators and regressive phases. We can only note how, at times, the supply of eulittoral

species (*Cibicides lobatulus*, for example) is lacking, in other words the feeding of the deepest part of the basin by terrigenous deposits, and by deposits originating in transitional environments, is interrupted (therefore, mass transport cease), particularly in the moments in which eusinic conditions – which in fact imply poor circulation and exchange – are established.

The fact that the lack of mass transport from the eu littoral zone is linked to transgression phenomena (with the epineritic zone moving landward and the increase of distality of the deepest parts of the basin) is qualitatively probable, and indeed the drop in background energy that would ensue could justify, especially in the presence of some threshold, the establishment of more or less transitory eusinic conditions depending on the nature of the possible threshold, isostasis and eustatism. With regard to Table 2, it should be noted that many of the indicators do not have a resolving power between the circalittoral area and the bathyal area, being indifferently located in one or the other environment. It can be easily seen that these indicators have been plotted in a specific line in the table.

Important deductions regarding the conditions at the depositional interface can be drawn from a careful examination of Table 3, the most important parameters of which will be examined below, commented with the aid of the data provided by F. Ricci Lucchi in Volume 2 of his "Sedimentologia" (CLUEB, Bologna 1980).

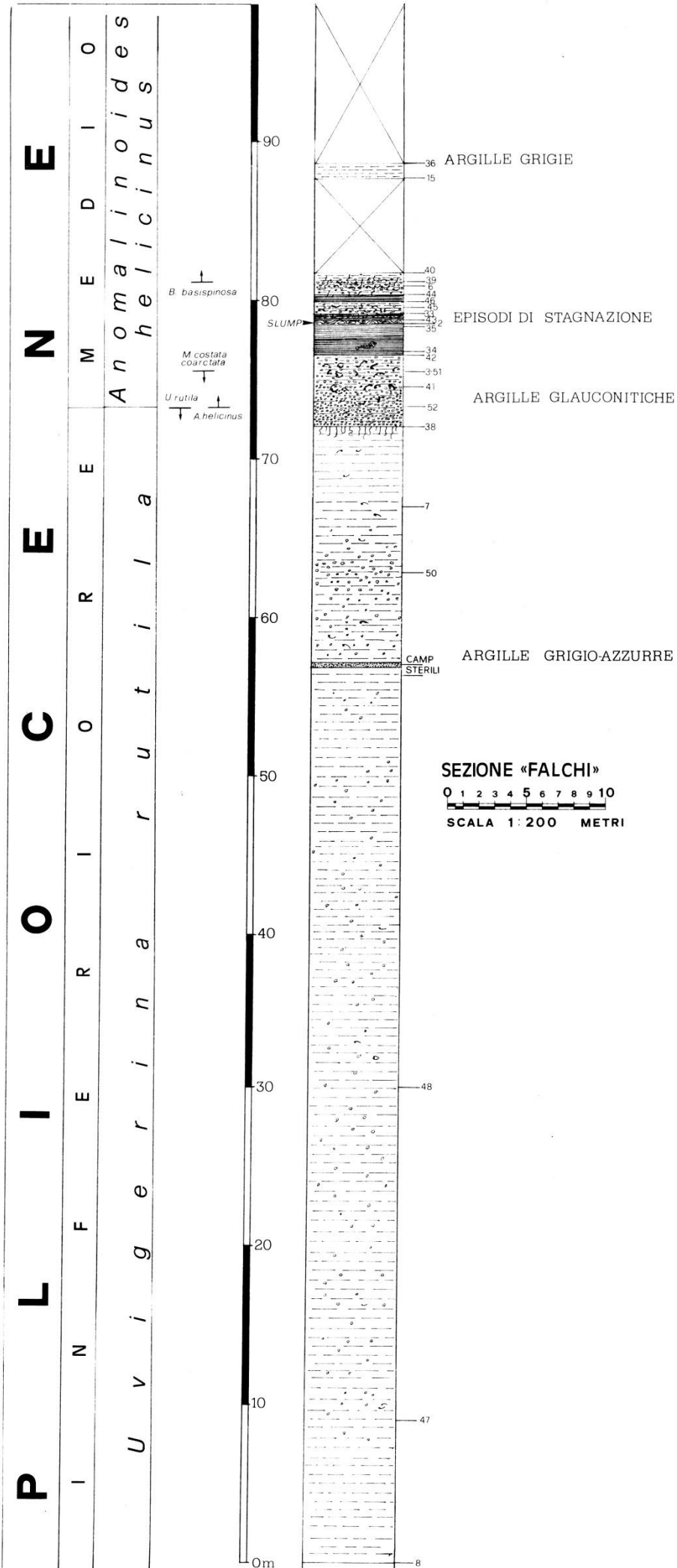
From top to bottom, Table 3 cites:

- **Abundant insoluble residue:** is an indication of the amount of diagenetic chemical precipitates in the sample: it's almost constantly related with ...
- **Gypsum in crystal aggregates,** which therefore is one of the most important among the mineralogical indicators, showing that a good part of the diagenetic history of the sediment took place on this side of the sulphates / sulphides limit, that is, for slightly alkaline conditions, at an Eh greater than -0.25.
- **Mica leaflets:** index of relative distality of the deposit, the mica settles slowly due to its lamellar structure, and therefore is deposited with relative delay with respect to the granules of smaller specific surface; among other things, it is one of the "mother materials" of ...
- **Glauconite:** it is deposited under slight alkaline conditions (pH around 8), in presence of organic substance, mica or clayey minerals rich in Fe as mother materials, depth between 19 and 730 meters, LOW OR NULL SEDIMENTATION RATE. Its confinement in microenvironments is very evident in this series from the fact that the glauconite globules are in their entirety internal models of foraminifera or diagenized faecal pellets.
- **Pyrite:** in partial contrast to the presence of gypsum (and, as per theoretical forecasts, almost always in antithesis to the presence of glauconite), pyrite testifies to a strongly reducing environment (for slightly alkaline conditions, Eh less than -0.25) and is therefore can very probably

be referred to a subsequent phase of diagenesis with respect to gypsum, for example a deeper departure of the sediment from the depositional interface, with the consequent increase in -Eh.

- **Vegetal frustules:** since it is not possible to refer them to definable species of plants, they are to be considered simple indications of conservation of organic matter, and of contributions from the photic area (they could be fragments of algae) or more simply of the presence of floating wood which, after drenching, sank to the bottom.
- **Fish vertebrae and other organic matter:** their conservation confirms that the Eh was less than zero even above the bottom, and that the conditions above the depositional interface (at least from sample 34 onwards) have tended to be asphyctic, more or less accentuated as can be understood from other indicators. It deserves reporting the presence in several samples (for example 43, 33, 6) of a blackish colouring of various plasmostraca and bioclasts, also attributable to reducing conditions s.l. .
- **State of conservation of fossils:** A poor state of conservation can testify to alterations, high energy (currents) on the bottom and above all a low or zero sedimentation rate with biosomes exposed for a long time on the bottom. However, it is in no case a reliable indicator: it is however worth noting that oligotypic, sapropelitic, asphyctic and stagnant conditions samples, that is, the low energy ones, normally have a good conservation status of fossils.
- **Oligotypy:** itself an indicator of environmental stress, it coincides with the presence of sapropelites and with the explosive and exclusive development of species of known resistance to asphyctic conditions, for example *Brizalina*, *Bolivina*, *Stainforthia spp.*. Those factors qualify the environment represented by the samples as reducing *sensu lato*, which corresponds very well with the data deductible from the other Eh indicators. For a quantitative definition of oligotypy and poly-specificity, see Table 1.
- **Radiolarians and diatoms:** silica is preserved for a pH lower than 7.8, which should exclude the possibility of finding it in alkaline conditions. A certain correlation with a scarcity of glauconite (which instead requires some alkalinity) is actually found. The presence of diatoms and radiolarians in the "asphyctic" samples is not a problem, however, and for our purposes it can be used to emphasize the low energy of the environment and the scarcity or lack of oxygen at the bottom, favourable conditions for the conservation of diatoms.





**SEZIONE «FALCHI»**

Foraminiferi      Bentonici

DISTRIBUZIONE NEI CAMPIONI

8 474850 7 385241 51 423435 2 4333454644 6 394015 36

	8	47	48	50	7	38	52	41	51	42	34	35	2	43	33	45	46	44	6	39	40	15	36	
Amphicoryna sublineata (Brady) .....																								
Bigenerina nodosaria d'Orbigny .....																								
Brizalina spp. ....																								
Cibicides lobatulus (Walker & Jacob) .....																								
Dentalina leguminiformis (Batsch) .....																								
Gyroidina soldanii d'Orbigny .....																								
Heterolepa bellincioni (Giannini & Tavani) .....																								
" " floridana (Cushman) .....																								
Lenticulina cultrata (de Montfort) .....																								
" " rotulata (Lamarck) .....																								
Planulina ariminensis d'Orbigny .....																								
Praeglobbulimina ovata (d'Orbigny) .....																								
Rectuvigerina gaudryinoides (Lipparini) .....																								
" " siphogenerinoides (Lipparini) .....																								
Saracenaria italica DeFrance .....																								
Siphonina reticulata (Czjzek) .....																								
Stainforthia complanata (Egger) .....																								
Trifarina bradyi Cushman .....																								
Uvigerina pygmaea d'Orbigny .....																								
Valvulineria bradyana (Fornasini) .....																								
Bulimina costata d'Orbigny .....																								
" " minima Tedeschi & Zanmatti .....																								
Cancris oblongus (Williamson) .....																								
Cassidulina neocarinata (Thalman) .....																								
Cibicidoides pachyderma (Rzehak) .....																								
Florilus boueanum (d'Orbigny) .....																								
Globocassidulina oblonga (Reuss) .....																								
Hopkinsina bononiensis (Fornasini) .....																								
Karrerella bradyi (Cushman) .....																								
Lenticulina peregrina (Schwager) .....																								
Plectofrondicularia raricosta (Karrer) .....																								
Sphaeroidina bulloides d'Orbigny .....																								
Uvigerina peregrina Cushman .....																								
" " proboscidea Schwager .....																								
Vulvulina pennatula (Batsch) .....																								
Bolivina spp. ....																								
Bulimina fusiformis Williamson sensu Fornasini .....																								
Globobulimina pyrula (d'Orbigny) .....																								
Viscanomalina semipunctata (Bailey) .....																								
Hoeglundina elegans (d'Orbigny) .....																								
Marginulina costata (Batsch) .....																								
Martinottiella communis (d'Orbigny) .....																								
Melonis padanum (Perconig) .....																								
" " soldanii (d'Orbigny) .....																								
Remulina globulifera Brady .....																								
Uvigerina rutila Cushman & Todd .....																								
Valvulineria complanata (Cushman) .....																								
Bulimina inflata Seguenza .....																								
Pullenia bulloides (d'Orbigny) .....																								
Spiroplectammina wrighti (Silvestri) .....																								
Planulina wuellerstorfi (Schwager) .....																								
Sigmoilopsis celata (Costa) .....																								
Vaginulinopsis carinata (Silvestri) .....																								
Sigmoillinita tenuis (Czjzek) .....																								
Anomalinoidea helycinus (Costa) .....																								
Marginulina costata (Batsch) var. coarctata Silvestri .....																								
Pullenia salisburyi R.E. & K.C. Stewart .....																								
Pullenia quinqueloba (Reuss) .....																								
Lenticulina gibba (d'Orbigny) .....																								
Bulimina basispinosa Tedeschi & Zanmatti .....																								

**2 DATI DESUNTI DAGLI INDICATORI BATIMETRICI PRESENTI NEI CAMPIONI**

AMBIENTE DI SEDIMENTAZIONE	CAMPIONI ▶	8	47	48	50	7	38	52	41	3/51	42	34	35	2	43	33	45	46	44	6	39	40	15	36
EULITTORALE		1		○	1	1		1	1	1					1	○	○			1	1			1
CIRCALITTORALE		○	○		○			1	○	○	1	1	1	1	○		○	1	○	1			○	1
CIRCALITTORALE ○ BATIALE		○	○	○	○	○	1	○	○	○	○		1	○	○	○	○	1	○	○	○	○	○	○
BATIALE		○	○	○	○	○	○	○	○	○	○	1	○	○	○	○	○	○	○	○	○	○	○	○

AMBIENTE RAPPRESENTATO  
 DALLA MAGGIORANZA(=○)  
 DA CIRCA IL 50% (○) DEGLI INDICATORI  
 DA UNA MINORANZA (=○) (1=DA UN UNICO INDICATORE)

3 GENERALITÀ DEI RESIDUI DI LAVAGGIO E CARATTERISTICHE DELLE TANATOCENOSI

CAMPIONI	8	47	48	50	7	38	52	41	3/51	42	34	35	2	43	33	45	46	44	6	39	40	15	36	
ABBONDANTE RESIDUO INSOLUBILE					▲					▲	▲	▲	▲	▲	▲	▲	▲	▲	▲					▲
GESSO IN AGGREGATI CRISTALLINI	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
MICA IN LAMELLE	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
CLAUCONITE	S	A																						
PIRITE	S	A																						
FRUSTOLI VEGETALI	S	A																						
FOSSILI IN PREVALENZA BEN CONSERVATI																								
" " " " DANNEGGIATI		▲	▲																					
OLIGOTIPICO *	N	M																						
«POLISPECIFICO»	M	N																						
VERTEBRE DI PESCE E RESTI ANALOGHI																								
BOLIVINA spp.+BRIZALINA spp. DOMINANTI																								
RADIOLARI																								
DIATOMEE																								

\*VEDI TAB.1 S=SCARSA/I A=ABBONDANTE/E N=NETTAMENTE M=MODERATAMENTE

## CONCLUSIONS

From a concise summary of the data in my availability for the section studied, at the Lower Pliocene - Middle Pliocene boundary particular environmental conditions emerge: within a rather condensed succession (as evidenced by the presence of glauconite), an interval with almost zero deposition rate (decidedly glauconitic deposits) is followed by a drastically reduction in circulation (deposit of laminated sapropelitic clays, increasingly oligospecific Benthic Foraminifera associations), all those phenomena taking place within a probable transgressive trend.

This trend, no longer observable in the uppermost part of the section, is proved not by textural variations but by purely sedimentological / ecological considerations, such as the indications of progressive (then drastic) drop in the background energy and the establishment of the already cited asphyctic conditions. From a superficial examination of mineralogical and non-mineralogical indicators in the context of the lithofacies of the laminated sapropelite clays, the existence of particular chemical-physical conditions has been ascertained, with a decidedly reducing and neutral / slightly alkaline character of the environment at the depositional interface.

Finally, the first goal of this study was reached, namely the biostratigraphic definition of the lower Pliocene - middle Pliocene limit based on the benthic Foraminifera. In full awareness of the innate limits of Datum Planes based on the benthic species, it was placed in correspondence with the sample 52, that contains both the LAD of *Uvigerina rutila* Cushman & Todd and the FAD of *Anomalinoidea helicinus* (Costa) referring to this section.

The influence from environmental conditions on the distribution of the determined species was noteworthy, as was the number of information obtainable from the careful evaluation of the characters of the sieving/washing residues.

It can be said without particular doubts that the benthic foraminiferans observed prove that the deposition of the sediments studied took place at bathyal depths.

## ANNEX - LIST OF SPECIES PRESENT IN THE SAMPLES NOT REPORTED IN THE TABLE

**Note:** This list does is not meant to exhaust the content of benthic foraminiferans in the different samples, but simply to present the most clearly determinable and most significant of the species encountered during the research.

### SAMPLE 8

*Brizalina dilatata* (Heuss)  
*spathulata* (Williamson)  
*Marginulina crebricosta* Seguenza  
*glabra* d'Orbigny  
*Orthomorphina tenuicostata* Costa  
*Stilostomella monilis* (Silvestri)  
*Vaginulinopsis sulcata* (Costa)

### SAMPLE 47

*Bulimina elongata* d'Orbigny  
*Brizalina alata* (Seguenza)  
*dilatata* (Reuss)  
*spathulata* (Williamson)  
*Bulimina aculeata* d'Orbigny  
*Criboelphidium decipiens* (Costa)  
*Fissurina orbignyana* Seguenza  
*Fursenkoina schreibersiana* (Czjzek)  
*Lagena striata* (d'Orbigny)  
*Praeglobobulimina affinis* (d'Orbigny)  
*pupoides* (d'Orbigny)  
*Siphonodosaria sp.*

### SAMPLE 48

*Bolivina punctata* d'Orbigny  
*Chilostomella oolina* Schwager  
*Lagena laevis* (Montagu)  
*Lagena spp.*  
*Lenticulina curvisepta* (Seguenza)  
*inornata* (d'Orbigny)  
*spinulosa* (Costa)  
*vortex* (Fichtel & Moll)  
*Pandaglandulina dinapolii* Loeblich & Tappan  
*Marginulina glabra* d'Orbigny  
*Nodosaria sp.*  
*Orthomorphina sp.*  
*Stilostomella hispida* (d'Orbigny)

### SAMPLE 50

*Amphicoryna scalaris* (Batsch)  
*Bolivina punctata* d'Orbigny  
*Brizalina aenariensis* Costa  
*alata* (Seguenza)  
*dilatata* (Reuss)  
*spathulata* (Williamson)

*Bulimina aculeata* d'Orbigny  
*Lenticulina curvisepta* (Seguenza)  
*inornata* (d'Orbigny)  
*Nodosaria pentecostata* Costa  
*Praeglobobulimina affinis* (d'Orbigny)  
*pupoides* (d'Orbigny)  
*Stilostomella hispida* (d'Orbigny)  
*Stilostomella sp.*

#### SAMPLE 7

*Lenticulina orbicularis* (d'Orbigny)  
*Marginulina hirsuta* d'Orbigny  
*Stilostomella hispida* (d'Orbigny)  
*monilis* (Silvestri)

#### SAMPLE 38

*Brizalina aenariensis* Costa  
*alata* (Seguenza)  
*catanensis* (Seguenza)  
*dilatata* (Reuss)

*Lagena spp.*

#### SAMPLE 52

*Brizalina dilatata* (Reuss)  
*spathulata* (Williamson)

*Bulimina echinata* d'Orbigny  
*Criboelphidium semistriatum* (d'Orbigny)  
*Dentalina inflexa* (Reuss)  
*Fissurina apiculata* (Reuss)  
*quadricostulata* (Reuss)  
*seguenziana* (Fornasini)

*Gyroidinoides laevigatus* (d'Orbigny)  
*neosoldanii* (Brotzen)

*Lagena cf. L. apiopleura* (Loeblich & Tappan)  
*Lenticulina orbicularis* (d'Orbigny)  
*Marginulina glabra* d'Orbigny  
*Oolina hexagona* (Williamson)  
*Pullenia compressiuscula* Reuss var. *quadriloba* Reuss  
*Pseudonodosaria aequalis* (Reuss)

#### SAMPLE 41

*Amphicorina scalaris* (Batsch)

*Bolivina cistina* Cushman  
*subspinescens* Cushman

*Brizalina alata* (Seguenza)  
*catanensis* (Seguenza)  
*dilatata* (Reuss)  
*spathulata* (Williamson)

*Bulimina aculeata* d'Orbigny  
*echinata* d'Orbigny .  
*lappa* Cushman & Parker  
*marginata* d'Orbigny

*Dentalina inflexa* (Reuss)

*Dimorphina tuberosa* d'Orbigny emend. Selli  
*Hanzawaia boueana* (d'Orbigny)  
*Oolina hexagona* (Williamson)  
*Pullenia compressiuscula* Reuss var. *quadriloba* Reuss  
*Stilostomella hispida* (d'Orbigny)  
*Textularia ponderosa* Fornasini  
*Trifarina angulosa* (Williamson)  
*Uvigerina canariensis* d'Orbigny

### SAMPLE 3/51

*Amphicoryna scalaris* (Batsch)  
*Amphicoryna* sp.  
*Anomalinooides flinti* (Cushman)  
*Brizalina* *alata* (Seguenza)  
*dilatata* (Reuss)  
*spathulata* (Williamson)  
*Bulimina* *aculeata* d'Orbigny  
*elongata* d'Orbigny  
*Coryphostoma pseudodigitalis* (di Napoli)  
*Dentalina inflexa* (Reuss)  
*Dimorphina tuberosa* d'Orbigny emend. Selli  
*Fissurina* *apiculata* (Reuss)  
*longirostris* Seguenza  
*marginata* (Walker & Jacob)  
*seguenziana* (Fornasini)  
*Fissurina* sp.  
*Glandulina glans* d'Orbigny  
*Gyroidinooides longispira* (Tedeschi & Zanmatti)  
*neosoldanii* (Brotzen)  
*Lagena* cf. *L. apiopleura* Loeblich & Tappan  
*clavata* (d'Orbigny)  
*striata* (d'Orbigny)  
*Marginulina crebricosta* Seguenza  
*Nodosaria* sp.  
*Oolina hexagona* (Williamson)  
*Pandaglandulina dinapolii* Loeblich & Tappan  
*Pleurostomella alternans* Schwager  
*Pullenia compressiuscula* Reuss var. *quadriloba* Reuss  
*Spiroloculina depressa* d'Orbigny  
*Trifarina fornasinii* (Selli)  
*Uvigerina canariensis* d'Orbigny

### SAMPLE 42

*Amphicoryna scalaris* (Batsch)  
*Bolivina punctata* d'Orbigny  
*Brizalina* *alata* (Seguenza)  
*aenariensis* Costa  
*dentellata* (Tavani)  
*dilatata* (Reuss)  
*spathulata* (Williamson)  
*Bulimina elongata* d'Orbigny  
*Fissurina* *castanea* (Flint)



*seguenziana* (Fornasinii)

*Nodosaria raphanus* (Linné)

#### **SAMPLE 34**

*Brizalina* *aenariensis* Costa  
*alata* (Seguenza)  
aff. *B. alata* (Seguenza)  
*catanensis* (Seguenza)

#### **SAMPLE 35**

*Brizalina* *aenariensis* Costa  
*alata* (Seguenza)  
aff. *B. alata* (Seguenza)  
*catanensis* (Seguenza)

*Fissurina castanea* (Flint)

#### **SAMPLE 2**

*Amphicoryna proxima* (Silvestri)

*Brizalina* *aenariensis* Costa  
*alata* (Seguenza)  
*catanensis* (Seguenza)  
*spathulata* (Williamson)

*Bulimina corsiniana* Perconig

*Fissurina castanea* (Flint)

*Lagena laevis* (Montagu)

#### **SAMPLE 43**

*Bolivina albatrossi* Cushman

*Brizalina* *aenariensis* Costa  
*dilatata* (Reuss)  
*spathulata* (Williamson)

*Bulimina elongata* d'Orbigny

*Fissurina* *castanea* (Flint)  
*seguenziana* (Fornasini)

*Gyroidinoides laevigatus* (d'Orbigny)  
*neosoldanii* (Brotzen)

*Hanzawaia boueana* (d'Orbigny)

*Lagena* cf. *L. apiopleura* (Loeblich & Tappan)

*Stilostomella monilis* (Silvestri)

*Trifarina fornasinii* (Selli)

*Tristix excavata* (Reuss)

#### **SAMPLE 33**

*Brizalina* *alata* (Seguenza)  
*spathulata* (Williamson)

*Dentalina* sp.

*Fissurina seguenziana* (Fornasini)

*Lagena* cf. *L. apiopleura* (Loeblich & Tappan)  
*clavata* (d'Orbigny)

*Marginulina crebricosta* Seguenza  
*glabra* d'Orbigny

*Oolina hexagona* (Williamson)

*Pullenia compressiuscula* Reuss var. *quadriloba* Reuss  
*Uvigerina canariensis* d'Orbigny  
*Vaginulina legumen* (Linné) var. *margaritifera* (Batsch)

#### SAMPLE 45

*Bolivina italica* Cushman  
*Brizalina* *alata* (Seguenza)  
*catanensis* (Seguenza)  
*spathulata* (Williamson)  
*Chrysalogonium obliquatum* (Batsch)  
*Dentalina inflexa* (Reuss)  
*Fissurina* *longirostris* Seguenza  
*seguenziana* (Fornasini)  
*Gyroidinoides laevigatus* (d'Orbigny)  
*neosoldanii* (Brotzen)  
*Hanzawaia boueana* (d'Orbigny)  
*Lagena* cf. *L. apiopleura* (Loeblich & Tappan)  
*Marginulina hirsuta* d'Orbigny  
*Spiroloculina canaliculata* d'Orbigny  
*depressa* d'Orbigny  
*Textularia ponderosa* Fornasini  
*Trifarina* *fornasinii* (Selli)  
*angulosa* (Williamson)

#### SAMPLE 46

*Brizalina* *alata* (Seguenza)  
*aenariensis* Costa  
*catanensis* (Seguenza)  
*dentellata* (Taviani)  
*spathulata* (Williamson)  
*Lagena laevis* (Montagu)

#### SAMPLE 44

*Bolivina italica* Cushman  
*Brizalina* *alata* (Seguenza)  
*dentellata* (Tavani)  
*spathulata* (Williamson)  
*Bulimina elongata* d'Orbigny  
*Fissurina castanea* (Flint)  
*Hanzawaia boueana* (d'Orbigny)  
*Lagena* cf. *L. apiopleura* (Loeblich & Tappan)  
*Lenticulina inornata* (d'Orbigny)  
*Nodosaria radricula* (Linné)  
*Vaginulina* sp.

#### SAMPLE 6

*Brizalina spathulata* (Williamson)  
*Fissurina* *bradyana* (Fornasini)  
*castanea* (Flint)  
*Gyroidinoides laevigatus* (d'Orbigny)  
*Lagena* cf. *L. apiopleura* (Loeblich & Tappan)  
*Marginulina crebricosta* Seguenza  
*Nodosaria radricula* (Linné)

*Quinqueloculina vulgaris* d'Orbigny  
*Siphotextularia affinis* (Fornasini)  
*Spiroloculina canaliculata* d'Orbigny  
*Stilostomella hispida* (d'Orbigny)  
*Trifarina angulosa* (Williamson)

#### **SAMPLE 39**

*Bolivina subspinescens* Cushman  
*Cribrorbulina serpens* (Seguenza) emend. Selli  
*Lagena* cf. *L. apiopleura* (Loeblich & Tappan)  
*Marginulina crebricosta* Seguenza  
*Spiroloculina depressa* d'Orbigny  
*Sigmoilopsis schlumbergeri* (Silvestri)  
*Vaginulinopsis sulcata* (Costa)

#### **SAMPLE 40**

*Bolivina punctata* d'Orbigny  
*Brizalina* *aenariensis* Costa  
*alata* (Seguenza)  
*catanensis* (Seguenza)  
*Fissurina castanea* (Flint)  
*Oolina hexagona* (Williamson)  
*Uvigerina canariensis* d'Orbigny

#### **SAMPLE 15**

*Fissurina quadricostulata* (Reuss)  
*Lagena gracillima* (Seguenza)  
*Lenticulina calcar* (Linné)  
*Neocombina orbicularis* (Terquem)  
*Quinqueloculina vulgaris* d'Orbigny  
*Siphotextularia affinis* (Fornasini)  
*Stilostomella hispida* (d'Orbigny)  
*Triloculina gibba* d'Orbigny

#### **SAMPLE 36**

*Dentalina aciculata* (d'Orbigny)  
*Lagena* cf. *L. apiopleura* (Loeblich & Tappan)  
*Lenticulina echinata* (d'Orbigny)  
*Lingulina seminuda* Hantken  
*Oolina hexagona* (Williamson)  
*Quinqueloculina* sp.  
*Spiroloculina* *canaliculata* d'Orbigny  
*depressa* d'Orbigny  
*Uvigerina canariensis* d'Orbigny

## DESCRIPTION OF THE PLATES

### PLATE 1

- 1 a,b - *Discanomalina semipunctata* (Bailey), 60X, Sample 15
- 2 *Anomalinoides helycinus* (Costa), 90X, Sample 52, ventral side, sinistral specimen
- 3 *Anomalinoides helycinus* (Costa), 90X, Sample 41, dorsal side, dextral specimen
- 4 *Bulimina basispinosa* Tedeschi & Zanmatti, 90X, Sample 15
- 5 *Uvigerina rutila* Cushman & Todd, 50X, Sample 52
- 6 *Marginulina costata* (Batsch) var. *coarctata* Silvestri, 40X, Sample 52

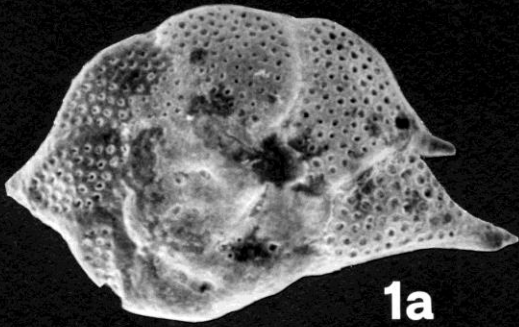
### PLATE 2

- 7 Sample 2, sieving/washing residue

### PLATE 3

- 8 Sample 34, sieving/washing residue, strongly oligotypical thanatocenosis with dominant *Brizalina* spp.

tav. 1



1a



1b



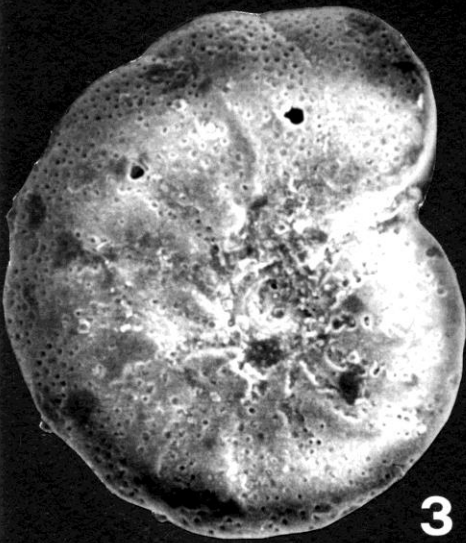
2



4



6



3



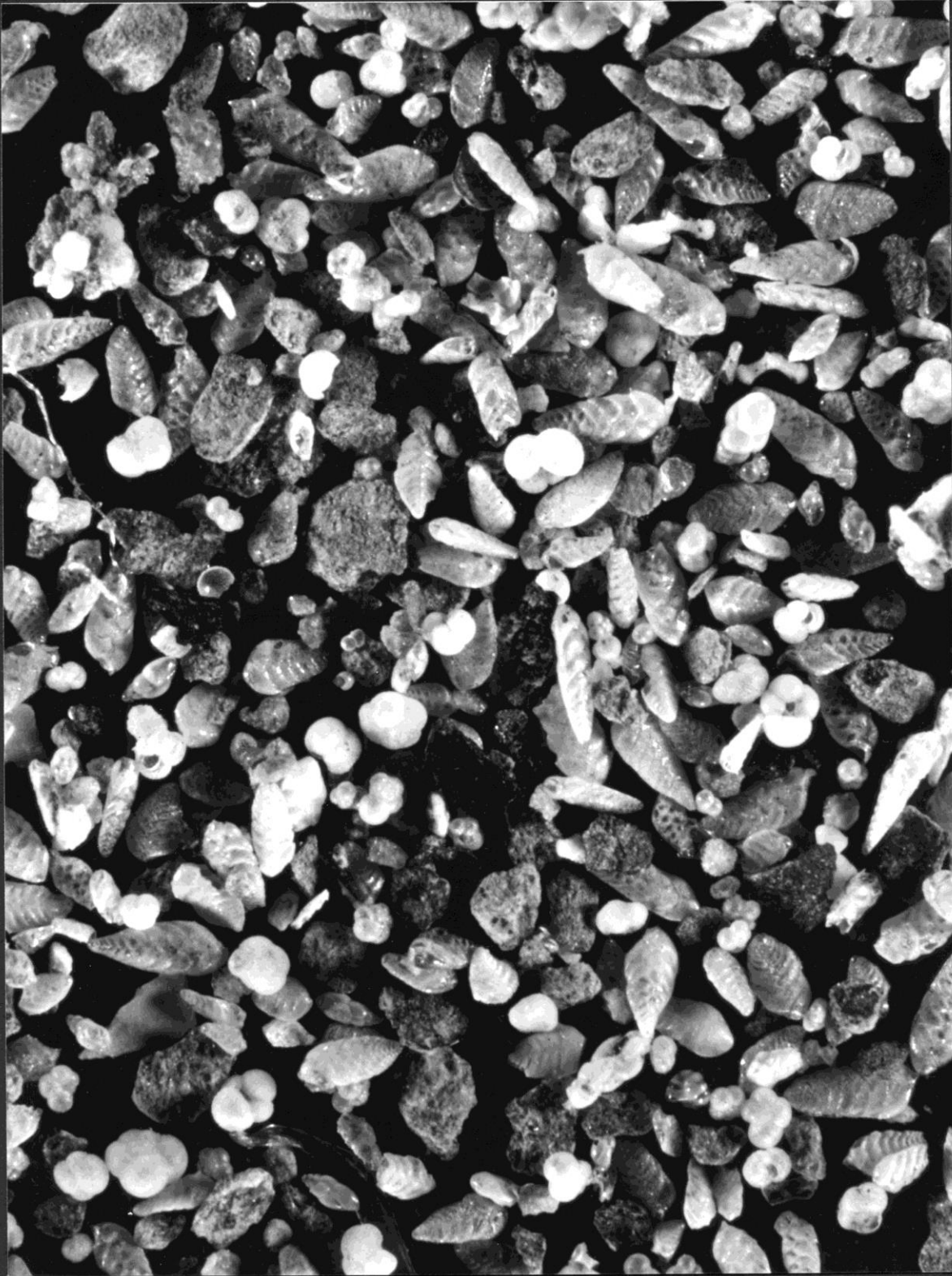
5

tav.2



7

tav. 3



8