8. APPENDIX: Description and Display of Lithological Sections

To serve as data bank for the present work and for future investigations, the most important lithological sections are figured here in detailed log drawings and briefly described. Given are carbonate content (qualitative), lithology, sedimentary structures, grain size (semi-quantitative) and skeletal as well as non-skeletal particles. Further informations, such as colouring, determined organisms, diagenesis, are additionally mentioned in the explanations.

Location of sections can be drawn from fig. 1. chap. 1.1, and is further concretized in the text.

Legend (for all litho-logs)

Composition and Texture

- Carbonates
  - Limestone (in general)
  - DUNHAM-lithotypes
    - Mudstone
    - Wackestone
    - Packstone
    - Grainstone
    - Radiolarite
    - Boundingstone
  - Siliciclastics
    - Clay
    - Mud
    - Silt
    - Sand
    - Conglomerate

Textural alterations

- Concretion
- Bioturbation (general)
- Skolithos sp.
- Diplomoceras sp.
- Rhabdammina rectlinea
- Thalassinoides sp.
- Bivalve (general)
- Mudcrack
- Early diagenetic cracks
- Calicheification
- Reddish colour
- Intensive recent weathering

Change of sediment types

- Transitional
- Abrupt
- Abrupt, with clay or silt partition
- Faulted
- Scouring (with lag)
- Downcutting surface

Internal bedding structures and facies-diagnostic main components (cf. to legend for components)

- Undular bedding
- Nodular bedding
- Loop bedding
- Even bedding
- Trough cross bedding
- Large scale cross bedding
- Small scale cross bedding

Thickness in meters

- High
- Low
- Medium

Carbonate content

- Clay
- Silt
- Fine sand
- Medium sand
- Coarse sand
- Conglomerate

Grain size

- Medium grain size
- (of carbonates only, if > 20 Vol. %
- of allochthonous components)
Components

- ooids, quartz core / bioclastic core, indifferenitated / bioclastic core, e.g., echinid class
- peloids
- vadoids
- intraclasts
- extracalysts, calcareous
- quartz, detritic
- feldspar, detritic
- fragments of crystalline rocks
- daycladaceans / Macroporella
- charophytes
- Marinella lugeoni, fragments / rhodoliths / Permoescalites n.sp.
  - cyanophytes, evenly laminated
- oncoids, sponge bodies or porofossilate / with sessile organism / e.g., with gastropod core
- algal nodules, radial growth, mainly "cayeuill" algae
- lumps
- Lithoid mactanites (in general) / Everticyclammina / Recticyclammina / Anchispiroclina
- Valvulinids, textulariids / miliolids / legenids / sessile forams
- serpulids / bryozoans
- astracids / doublets
- brachiopods
- corals, solitary / Axomilia
- corals, branched / massive
- calcisponges (incl. stromatoporoids)
- echinoids (in general) / echinid spines / Pseudocidaris (spines) / crinoid ossicles
- vertebrate remains
- crustacean remains
- bivalves (in general) / doublets
- shallow burrowed / Protocardia sp. / Myophorella lusitanica / Eomiodon securiformis
- deep burrowed (e.g., doublets) / Myophorula multigastata
- epifossil / semi-jilfossil / Arcaucttas morrisi / clusters
- bakkellids / Isognomon / Gervillia / Trichites
- oyster / oyster patch reef
- borers: Lithophaga
- "soft bottom" - small-sized bivalves
- large-sized bioclasts (>2mm), e.g., bivalve clast
- small-sized bioclasts (<2mm), e.g., gastropod bioclast
- microbori bioclast (in general); cortoids / e.g., bivalve bioclast with cortical structure
- vertical distribution / presumed vertical distribution (e.g., lituroids)
- frequency (e.g., gastropods): rare / occur / common / abundant
Adanaia Sections

The Adanaia sections, ranging from the Amaral fm to the lower 'Pteroceriano' fm give, together with the connected younger sequence of closely section Bom Jesus, a good impression of the development in the southeastern part of the study area.

Exceptionally, the Trancoso mb was also briefly examined due to its outwedge in neigboured sections (cf. to section Calhandriz).

Nearby sections: Bom Jesus, Calhandriz.

Section Adanaia 1

Location: geol. map, sheet Loures, NW quadrant. E Adanaia (at road between Arruda dos Vinhos and Alverca). Section extending from isolated shed up to trigon, altitude 305 m.

Stratigraphic range: Amaral fm to Sobral fm.

Generalities: outcrop conditions good; marls normally covered. Rocks covered by thick weathering crust.

Description:

m0.0–4.0: grey marls with dendroid corals (mainly cf. 'Calamophyllia' sp. and abundant crinoid stalks and ossicles: cidaroid spines (top of Abadia marls)

m4.0–10.0: massive, light coloured, thick–bedded coral boundstone (mostly bafflestone) with Marinella lugeonii

m10.0–11.0: intercalation of brownish, micaceous siltsstones and fine–grained sandstones

m11.0–15.0: exposure gap, partly strongly weathered marls outcropping

m15.0–25.0: massive, brownish, very thick–bedded coral floatstone/boundstone (baffle/framestone). Massive and fasiculate corals, Marinella lugeonii, echinod debris, etc.

m25.0–29.0: gap, in its midst poorly exposed marls with corals

m29.0–30.0: coral boundstone, full of massive coral heads

m30.0–42.5: thick–bedded oolitic grainstones (partly packstones) with abundant nodules of M. lugeonii and cortoid bivalve debris

m42.5–45.0: medium–bedded, well sorted oolitic grainstones (passing into packstones on top), with increasing amount of quartz in ooid cores. Thick oolitic envelopes, partly complex and polyoids, lumps

m45.0–50.0: micaceous, lignitic, ooid–bearing siltsstones; in upper part intercalation of 30 cm marly–sandy oolitic grain/packstone. Presumed base of Sobral fm.

End of section

Section Adanaia 2

Location: geol. map, sheet Loures, NW quadrant. 1.2 km S Adanaia 1. From hill SE Manacas up to hill crest with former, small quarry.

Stratigraphic range: Oólito mb (top), Sobral fm, lower part of 'Pteroceriano' fm

Generalities: section partly taken by zigzagging the slope to avoid major exposure gaps. Possibility of minor correlation errors. Outcrop conditions moderate, partly good (esp. upper part). Marls deeply weathered.

Special remarks: Sobral clastics almost completely outwedge (3 m silts). Corals and M. lugeonii already in lower part of the 'Pteroceriano' fm.

Description:

m0.0–3.0: light coloured, poorly sorted oolitic grainstones with M. lugeonii, cortoids, etc. (top of Amaral fm)

m3.0–12.0: brownish–greyish, moderately sorted, sandy, micaceous and lignitic oolitic pack/grainstones. At base, free quartz (besides quartz in ooid nuclei)(transition Oólito mb/Sobral fm)

m12.0–15.0: brownish silts with layer of Gerzillia sobralensis (Sobral fm)

m15.0–19.6: light grey, nodular mudstones, thin–bedded, with Arcomytilus morrisi, rare corals (base of 'Pteroceriano' no fm)
m 19.6 – 20.0: coral bank with marly matrix. Mainly fasciculate corals ("Calamophyllia" flabelatum), furthermore Axosmilia carrapateirensis and Ovalastrea lobata

m 20.0 – 21.0: silty marls with Gervillia sobriensis

m 21.8 – 25.0: Light grey wacke/mudstones and marls with A. morrisi; abundant oysters in upper part. In middle part marly ocre–coloured macrofaunal rudstone composed of, only partially broken Unicardium crassum. A. morrisi, Isognomon sp., Praeexogyra pustulosa. Furthermore clasts of Trichites sp., Pieroperna sp., corals, M. lungeoni

Section Adanaia 2

m 31.5 - 48.7: Light grey, thin-bedded, nodular limestones (mud/wackestones) with A. mornisi, rare giant Protocardiia sp. A and deep burrowing bivalves; scattered bioclasts and bituloids. Rare calcisponges in upper part. In part reconstructed by rock rubble; several gaps, with findings of Myophoebella lusitanica, Isognomon sp., and Ampullina sp. At m 36.0, 40.5 and 48.5 intercalations of very hard, ocre-coloured, thick-bedded oncotic rudstones with cyanophyte oncoids and occasional M. lugeoni in micritic matrix.
m 48.7–62.0: intercalation of weathered marls and light grey to white nodular mudstones with A. morrissi, etc. At base, marls with abundant oysters and large oncoids, partly with attached N. nana. At m 50–52 compact floatstone with small solitary and colonial corals, bored by Lithophaga sp.; spines of Pseudocidarix fusitani-
cus, M. fucatoeni, oncoids, etc.

m 62.0–62.6: poorly sorted, well rounded intraclastic packstones with common lituolids and verneuiloids, grading into rhodolithic rudstone. Horizontal burrows on lower surface. Beds apparently outwedge on both sides

m 63.0–65.2: grey, bioturbated marls with intercalation of thin, nodular mudstones with A. morrissi. Thalassinosoides burrows filled with gastropod float/rudstone. Cylindroporella sp., etc. On top 20 cm of light, nodular mudstone (primarily pelmicitic?), bioturbated by Thalassinosoides suevica, Rhizocorallium irregularare. Lituol-
lids, etc.

End of section.

Section Alcubela – Freixial

Location: geol. maps, sheet Loures, NW quadrant, and sheet Alenquer, SW quadrant. Section starting at the southern boundary of Alcubela de Baixo (1 km W Arranho), extending south along tar road (direction to Tesoureira) until narrow curve to the right. Further south on track following hill crest until northern boundary of Freixial (between Montachique and Bucel-
las).

Stratigraphic range: uppermost part of Sobral fm, «Pteroceriano» fm, Freixial fm.

Generalities: outcrop conditions rather variable. Exposure gaps very common. Marls and sandstones intensively weathered. No major faults cutting the section. Due to flat outcrop dipping of beds, section extending over more than 5 km, corresponding to a true thickness of 350 m (longest of all sections possible in the region). True thicknesses of marls and gaps often re-evaluated by apparent thicknesses, causing uncertainties in exact determination.

Nearby sections: Bemposta–Arranho, Gotelis, Tesoureira–Casais da Serra.

Special remarks: very important section due to its large stratigraphic extent. Moreover, typus section of Chofft’s «Freixialiano». Holostratotypus of the here defined «Pteroceriano» fm and Freixial fm (see chap. 5.2.2.3). Somewhat unsatis-
fying exposure conditions were compensated by using outcrops in the vicinity of the above described course of the section. Furthermore, nearby sections give additional data and can be well correlated. Due to the wide lateral extent of the section, lateral facies variations within the sequence cannot be omitted.

Description:

Base of section, lignitic sandstones of Sobral fm, in lower part intercalations of cross—bedded oolite with quartz—cored ooids (Casal de Mato), and most probably marly mudstones in «Pteroceriano» facies analogous to section Gotelis, if inter-
calation of the latter is not pretended by faulting.

North of Alcubela de Baixo:

m 0.0–0.8: brown, micaceous, lignitic sandstone, cross—bedded with foresets dipping southwards

m 0.8–4.8: exposure gap, mostly probably covered marls. Fragmented parts of Gervillia sobralensis

m 4.8–5.8: marls, rapidly grading into grey, thick—bedded, partly bioturbated marly mudstones with Arcomytilus morrissi, rare Protoceratida sp., small bioclasts, ostracods; Everticyclammina virguliana and on top, Trichites sp. and Praeexogyra pustulosa

m 12.0–17.0: grey, marly, mostly nodular mudstones with A. morrissi and scattered small bioclasts, with distinct bur-
rows of Thalassinosoides sp.

South of bifurcation to Bucelas (from former small quarry onwards):

m 21.6–23.0: grey, thick—bedded, slightly marly mudstones and wackestones with bioclasts and A. morrissi, Campto-
nectes cf. australis, Protoceratida sp., Mycholas multicoasta, Everticyclammina virguliana, rare verneuil-
lids, ostracods. On top rare Trichites sp. Common early diagenetic cracks on top

m 23.0–27.0: grey, medium—bedded, very nodular limestones with varying marl content. At m 25, marl layer with common Jurassicorbula edwardi, Nicanella sp., etc.

Heavily bioturbated, partly intraclastic limestones ranging from bioclastic mudstones to wacke/float-
stones with clusters of A. morrissi, giant Protoceratida sp. A, rare Trichites sp., oysters, serpulids, ostracods, E. virguliana, rare Recticyclammina sp., Freixialina planispiralis, Glomospira sp., etc. Early diage-
netic dissolution of valves and collapse of sediment occurring
Section Alcubela - Freixial
m 27.0—29.6: grey, very nodular, bioclastic float — to rudstones with variable marl content. Bioclast formation even in micritic rudstones only due to very intensive bioturbation which is evident by irregular distribution of clasts. Further characteristics similar to underlying beds, additionally with rhodolith fragments, spines of *Pseudocystis lusitanicus* and rare coral debris as well as *Trichites* sp. and red coloured oysters, mainly *N. nana*

m 29.6—30.2: grey marl with abundant *P. pustulosa*, also forming an intercalated, *Lithophaga*—bored patch reef which is outwedgeing within several meters

m 30.2—31.2: grey thin—bedded, bioclastic nodular floatstones with *P. lusitanicus* (spines), *Trichites* sp., corals, etc.

m 31.2—31.8: exposure gap, most probably coral—bearing marl

m 31.8—32.8: at base, grey, nodular, bioclastic limestones, followed by 60 cm of brown oncotic floatstone. Coarse clasts of bivalves (A. morrisi, oysters and others) are superficially encrusted by cyanophytes. Cortices strongly stained by iron hydroxide, bored by *Lithophaga* sp. and serpulids. Small—sized, angular bioclasts are not encrusted. Beds bioturbated by *Thalassinoides* sp. Dissolution vugs common.

(correlation bed to Arranbé—Bemposta section, m 37)

m 33.0—50.0: exposure gap, presumed soft, marly series. Findings of *Myophorella lusitanica* and *A. morrisi*

m 50.0—50.8: brownish grey floatstone with *A. morrisi*, intensively overgrown by oysters, grading into small oyster patch reeves. Additionally, minor amount of bioclasts

m 50.8—69.0: predominance of grey marls, mostly intensively weathered: rich in soft bottom fauna when better preserved (cf. to m 52 of Arranbé—Bemposta section). Intercalated are thin to very thin nodular mudstone horizons, representing diagenetically altered burrow fillings. Mudstones forming thicker bed in lower and upper part with scattered bioclasts and early diagenetic compaction cracks

m 69.0—69.2: stromatoporoid boundstone (framestone). Stromatoporoids intensively bored by *Lithophaga* sp.; attached oysters, serpulids and cyanophytes. In intraclastic pseudomass bioclasts of bivalves and echinoids, at base spines of *P. lusitanicus* as well as litouliids and *Reophax* sp. Very frequent solution vugs, covered with brownish, accicular cement

m 94.0—98.5: light brown, thick to very thick—bedded cortoid limestones, mostly with closed fabric (poorly to very poorly sorted grain—pack—, rudstones) with abundant microbored bioclasts of bivalves, nerineids, corals, calcisponges, echinoids and frequent to abundant *Haplophragmium* sp. Besides other forms. Superficial cyanoids, nodules of *Lithocodium* sp./*cayeuxid*—alga, questionable nautilid and common, large—sized nerineids also occurring in upper part

m 98.5—99.3: light grey rhodolith rudstone with abundant fragments of *Marinella lageoni* and frequent cyanoids with nuclei of bivalves, *M. lageoni*, echinoids and corals. Large bivalve clasts, serpulids and *Haplophragmium* sp. also occurring

m 99.3—101.0: poorly exposed, strongly weathered, grey marl

m 101.0—102.5: grey, medium—bedded, nodular peloid packstone (with grainstone areas) with large, floating, fragmented nerineids, abundant small—sized, partly microbored bioclasts and *Rectocyclammina* sp., *?Feurtilla frequens*, *Glosmospora* sp., rare nodules of cyanophytes and questionable debris of dasycladaceans

m 102.5—104.6: greyish—brownish, thick—bedded, bioturbated oolitic waacke— and packstones, partly with large nerineids (floatstone), common cortoids, *Haplophragmium* sp., etc., Ooids with bioclastic nuclei. Burrows in waackestones filled with oolitic packstone, originating from superimposed packstone layer. Thin oolitic marl layer on top

m 104.6—104.8: ocre—coloured, bioclastic rudstone. Coquina of thin, broken bivalve shells, exhibiting imbricated bedding. Clasts of oysters, echinoids, brachiopods. Serpulids and dark, iron hydroxide—stained coated grains and extracts occurring. Strong recrystallization effects

m 104.8—108.5: grey marls with small oncoids, ooidal spines and fragmented *Nanogysa nana*, grading into brownish—greenish, micaceous marls with lignite litter. In uppermost part intercalation of marly, oolitic wackestone with small oncoids

m 108.5—127.3: exposure gap, partly weathered marls outcropping.

In former small quarry, north of road curve:

m 127.3—132.3: light brownish grey, medium to thick—bedded, partly nodular mudstones (rarely wackestones) with scattered bivalve, gastropod and coral clasts and *Pseudocyclammina* gr. *parva*—mulchensis, *Evertocyclammina virguliana*, verneuilids, valvulids and, in part, peloids and intraclasts. Irregular cracks common (desiccation and/or early diagenetic compaction). Thin marl layers between limestone beds
m 132.3 – 134.3: brownish grey, weathered marls

m 134.3 – 136.3 and m 138.3 – 139.5: brownish grey, medium – bedded, bioclastic, coral – bearing peloidal intraclastic wacke/packstones and thick to very thick – bedded coral floatstones with large gastropods, oysters and other bivalve debris. P. gr. parvula + melurchensis, +Haplophragmium sp., E. virguliana, ?Rectocyclus sp., Freixiatina planispirata, Reophax sp. and rare dasycladaceans, M. lugeoni and ostracods. Various corals, mostly +Calamophyllia+ sp., in part superficially encrusted by cyanophytes or bored by Lithophaea sp.

Leaving westward turning tar road, following track southwards along hill crest:

m 139.5 – 151.0: at base, frequent Myophorella lusitaniae in calcareous – marly matrix; above it, grey weathered marl with coral heads, measuring up to 20 cm in diameter

m 141.0 – 142.0: dark grey, thick – bedded, bioclastic wackestone with fine debris and Lenticulina sp., at base with corals

m 142.7 – 143.5: at base, coral meadow of Amphistrea piriformis and Thamnasteria sp. followed by thin marl layer and thin bioclastic wackestone. Above it, another coral meadow

m 143.5 – 151.7: exposure gap, with two outcrops of grey, weathered marls

m 151.7 – 152.3: grey, medium – bedded, nodular mudstone with distinct burrows of Rhizocoralium irregularare, Thalassinosoides suevica, Thalassinoides sp. and Myophorella lusitaniae, Protocardia sp., Mactromya concentrica and questionable Arcumillus morrisi

m 152.3 – 167.3: outcrops of brownish grey, mostly weathered marls with Nanogyrina nana and thin, marly mudstones, separated by exposure gaps. In lower part M. lusitaniae, Pteroperna sp. and Praeexogyra pustulosa common

m 167.3 – 170.0: at base, coral meadow, mainly composed of Amphistrea piriformis, bored by Lithophaea sp. Bioclastic matrix between corals strongly recrystallized, exhibiting reddish brown colouring. Above it, thin marl layer, followed by another A. piriformis meadow which is overlain by bioclastic oyster float/rudstone with ostracods and foraminifers. Recrystallization and dolomitization. Top built by thin intercalated layers of marls and marly mudstones with N. nana, P. pustulosa, lignite litter, etc.

m 170.0 – 210.5: exposure gap with minor thin outcrops:

at m 176.5: brownish grey, poorly sorted, bioclastic packstone with angular fine bioclasts (corals among others), rare sponge spiculae, large nodules of Solenopora cayeuxiformis n.sp., Permocalculus n.sp., Pseudocyclusina sp. and vermeulindics;

at m 181.5: grey, marly mudstone with rare bivalve clasts;

at m 187.5: brown, small – scale cross – bedded, well sorted, micaceous sandstone with common fine lignite litter and relatively well rounded grains (base of Freixiat sp.);

at m 193.0: grey, sandy, bioclastic wackestone and superimposed silty marl;

at m 201.0: 1 m of very silty, weathered, brown marl, below it findings of Pteroperna sp.;

at m 205.0: 80 cm grey, thin to medium – bedded floatstones with common Protocardia sp., Mactromya concentrica, heterodonts indet., bivalves, bioclasts and lithoids

m 210.5 – 212.5: at base, grey mudstone grading into calcareous lithitic siltstone with imprints of shallow burrowing bivalves, overlain by micaceous sandstones, feldspar bearing conglomerates and greenish marls

m 212.5 – 216.8: silty and sandy marls containing feldspar grains and mica, predominantly red to violet colour, with small calcite concretions. Top part not exposed, covered by red soil

m 216.8 – 224.3: predominance of grey to brownish grey, medium – bedded, mostly bioturbated bioclastic wacke/floatstones to packstones with bivalve clasts, rare entire bivalves (e.g., Pteroperna sp., bored by Lithophaea sp. and overgrown by Nanogyrina nana), gastropods (partially nerineids), echinid spines, ostracods, common to abundant Permocalculus n.sp., damycladacean debris and lithoids. Intercalated are marls, siltstones and two horizons of moderately to well sorted intraclastic grainstones (at m 221.0 and 224.0) with excellently rounded grains which represent reworked ooctic packstone with mostly quartz – cored ooids. Partly leached, vadose cements covering solution vugs. In lower grainstone horizon abundant rounded, microbored bivalve clasts besides intraclastics.

m 224.3 – 320.0: greenish grey, weathered marl with N. nana, Placumopsis suprarensis, gastropods, Everticyclusina virguliana, smooth ostracods and rare echinid spines, with the following intercalations:

at base: marly mudstone;
brownish oolitic grainstone with superficial, quartz-cored ooids, common non-encrusted quartz, microbored bivalve clasts, rare echinoid debris and *Lenticulina* sp.;

at m 229.0:

brownish grey, marly, bioturibated bioclastic floatstone. Bivalves dominating, gastropods, echinoids, serpulids, ostracods occurring, *Permocaculites* n.sp. and *Lenticulina* sp. rare. Ooids occurring in burrows;

over it,

sparitic bivalve clast rudstone with intergranular pores filled with, mostly quartz-cored, superficial ooids, non-encrusted quartz and echinoid debris. Note glauconite; upper part poorly exposed, micaceous sandstones and silty marls rarely outcropping

m 240.0–251.6: light grey, medium-beded, nodular limestone; at base, slightly sandy pelletal bioclastic wackestones with fine bivalve bioclasts, large bivalves, nereidids, rare fragmented echinoid spines, serpulids, *Macroporella espichelensis* and common bivalves. Above it, mudstones with rare serpulids, bivalve clasts, crustacean debris and early diagenetic cracks, overlain by thin horizon of oolitic wacke/packstone with predominantly quartz-cored ooids, lumps, microbored bioclasts, rare corals, *Permocaculites* n.sp. and littoroids. On top *Permocaculites* packstone with microbored bioclasts, littoroids and *Macroporella espichelensis*

m 241.8–242.3: at base, cm-thin layer of grey, sparitic bioclastic rudstone, strongly recrystallized, with ghost structures, intraclasts and littoroids; overlain by brown, excellently sorted intraclastic grainstone. Well rounded intraclasts represent reworked oolitic packstone with radial ooid structure.

The following part of the section up to m 273 is very poorly exposed and intensively weathered:

m 242.3–247.0: brownish grey, micaceous, silicilastic sequence; lower part silt-sized within intercalation of calcareous, lithic bioclastic sandstone, upper part sand-sized

m 247.0–264.5: predominantly red or violet coloured silicilastics ranging from clays up to coarse-grained, poorly sorted, partly feldspar-bearing conglomerates; at m 261 trough cross-bedded

m 264.5–264.7: whitish, poorly sorted, very sandy, coarse bioclastic grainstone with all clasts being microbored. Common intraclasts, derived from reworked oolitic packstones

m 266.4–273.6: marly, in lower part red to violet siltstones with intercalations of thick-bedded, partly small-scale cross-bedded sandstones. At m 270 layer of nodose caliche

m 273.6–278.6: intercalation of weathered, grey, mostly micaceous marls and grey medium-bedded marly limestones; at base, marly bioclastic wackestone with clasts of bivalves and gastropods, echinoid spines, crustacean debris, rare ostracods and littoroids. At m 276.5, very sandy, bioturbated bioclastic wackestone with autochthonous bivalves. At m 278, bioturbated algal wackestone with common debris of *Permocaculites* n.sp., *Macroporella espichelensis* and littoroids as well as larger bioclasts

m 282.5–285.0: light brown, medium-bedded, strongly bioturbated, muddy microfossil limestones; partial staining by iron hydroxide. At base, microfossil packstone with large, partly microbored bioclasts, intact shells and abundant *Anchispirocyclus lusitanica* besides *Rectocyclammina* sp., *Everticyclammina virguliana*, *Nautiloculina oolithica*, or, higher, very frequent *Permocaculites* n.sp. besides *Cylindropora* cf. *arabica*, *M. espichelensis* and *Quinqueloculina*. Mud content increasing upwards, thus grading into microfossil-rich wackestone with packstone patches due to bioturbation, dominated by abundant *Quinqueloculina* and cm-large *Anchispirocyclus lusitanica* besides *Halophyllum* sp., *N. oolithica*, *Fraxinella planispiralis*, *Lenticulina* sp. and dasycladacean debris (in part ?*Likanella bartholi*, *Cylindropora cf. arabica*, *Permocaculites* n.sp. and double-valved, partly sculptured ostracods. Vadose influence evident by early cracks, dissolution vugs and recrystallization (particularly in burrows)

m 285.0–287.0: very poorly exposed, weathered marls

m 287.0–288.6: brownish grey microfossil wacke/packstones similar to those described in m 282.5 to 285.0, with abundant debris of dasycladaceans (?*L. bartholi*, C. cf. *arabica*) and common *Permocaculites* n.sp., *A. lusitanica*, *Quinqueloculina*, etc... Common desiccation cracks in upper part

m 288.6–290.0: grey, weathered, oyster-bearing marls with intercalation of mudstone exhibiting *Protocardia* sp.

m 290.0–292.0: brown, micaceous, silicilastic sequence; at base well sorted calcareous glauconitic sandstone with common limestone and bivalve clasts (mostly as ghost structures). Above it, in marly, moderately sorted, ooid-bearing sandstone: shell bed of mostly double-valved *Trigonia freixa* with oysters and corals. Top built by marly siltstones.

100 meters east of southern gate to properties of Quinta do Avelar:

m 292.3–296.0: lower part, weathered, slightly sandy marls with thin marly mudstone beds, generally representing diogenetically altered horizontal burrow systems (in part *Thalassidrillides* sp.), with ?*Pleurotyra* sp., ?*Cerio-
mya sp. and ostracods; upper part, grey, thin to medium-bedded, mostly nodular, quartz-bearing, muddy bioclastic limestones, ranging from mudstones to float/packstones, with bivalves (e.g., *Protocardia* sp., *Pleuronectes* sp.) and gastropods, and very common *Peracutus* n.sp. besides ostracods, *Reophax* sp., *Nuculoculina* sp., iron hydroxide-stained, quartz-cored ooids and extracellular. In higher part, additionally, dasyoladacean debris (?Lunulella barthlei, *Actinoporella podoficla*, *Cylindraporella* cf. *arctica*, *Macroporella espihelensis*), *Solopora* *caynixiformis* n.sp., rare charophyte gyrogonites, verneulinites, *Haplophragmium* sp., *Glycostoma* sp., etc. Early vadose influence evident by early cracks, dissolution and collapse of aragonitic shells, and internal vadose silt

m 296.0—299.5: brown, marly, micaceous sandstones, on top marls, mostly with well sorted and well rounded grains. Thick-shelled ostracods, large bioclasts and lignite litter occurring.

Outcropping south of track:
at ca. m 299,
300, 302 and 306: thin horizons of brownish gray, silty or sandy mudstone limestones (wacke/pack/rudstones) with common large fragments of *Peracutus* n.sp., ostracods, bivalves, gastropods and their clasts, *Haplophragmium* sp., partly *Nuculoculina* sp., ?*Mesoendothyra* sp., *M. espihelensis* and, in part, lignite litter, ooids and peloids.

End of section: superimposed are ca. 50 m of partly exposed, coarse siliciclastics, extending up to Cretaceous boundary situated along main road Louga – Bucelas.

**Section Alqueidão**

**Location:** geol. map, sheet Amenquer, SW quadrant. On road from Sobral de M. Agro to direction to Sapataria via Cabeça. Section beginning 250 m SE Cabeda at the connection of two stream valleys. Extending S to hamlet Pedro da, crossing traffic road, climbing to water container, then always following top of crest, bending SE to altitudes 312 m and 336 m. Section ending 500 m NW for ruin and trigoneometric altitude Alqueidão (442 m) in well exposed outcrop of nodular limestones.

**Stratigraphic range:** top of Amalric Irm, Sobral Irm, lower part of *Pterocerian* Irm.

**Generalities:** Insecurities in determining true thicknesses due to the section's lateral extension of 2 km. Twice the section is cut by faults, yet it is believed that correlation of individual section parts is correct.

Outcrop conditions are moderate to poor in lower part, in upper part good to excellent.

Nearby sections: Gotões, Alcubela – Freixial, Arranhô – Bemposta, Patameira.

**Special remarks:** Clastic Sobral complex not interfingering with micritic *Pterocerian* limestones as in nearby section Gotoes. Well developed limestone conglomerates (cf., to section Gotoes).

**Description:**

m 0.0—0.5: light, thick–bedded oolitic grainstone with *Marinella lugeoni* (top of Amaral formation?)

m 4.5—5.5: dark brown, thick–bedded, very sandy oolitic bioclastic packstone. Ooids with quartz and bioclastic cores (1:1), 20% non–encrusted detrital quartz. Bioclasts mostly micoboled

m 5.5—23.2: mainly exposure gap. At base, rubble of micaceous, platy, very well sorted, fine–grained and cross–bedded, medium–grained sandstones, partly buried. At m 16 and m 22 brown, thick to very thick–bedded, coarse–grained sandstones with lignite litter. Siltsstones on top

m 23.2—25.0: (on southern side of traffic road.) At base, light brown, thick–bedded oolitic bioclastic packstone. Densely overpacked ooids, partly polyconic with quartz (30%) and bioclastic cores. Round to elongated horizontal patches with loosely packed oolitic grainstones, assumed to be burrows, with rare rhodoliths. Ooid fraction well sorted; large clasts of bioclasts, mostly microbored, in part aulac–encrusted, floating in oolite. Above it, small gap with abundant *Placaropis* sp. as well as *Echimod disapariformis* and *Grevillo sobriensis*. Superimposed is oolite with similar facies as base

m 26.6—37.8: mainly exposure gap; presumed sandstones with *Scolithos* burrows, partly with bioclasts. Outcrops at base and top. Base: brownish, very sandy conglomeratic sandstone with limestone pebbles and rare lignite litter and bioclasts, followed by sandy marls with *Grevillos sobriensis*. Top: fine–grained, micaceous sandstones, followed by brown, micaceous, lignitic sandstones with gravel horizons. Pebbles are of micritic, partly sandy or marly limestones, grey or brownish, ranging from 3 to 40 mm in diameter. Pebbles well rounded but not spherical. Superimposed are brown, thick–bedded, well sorted, cross–bedded sandstones with common mica and lignite litter on foreset surfaces. Grains moderately rounded.
Section is cut by fault, causing only minor slip, so that continuation of section is most probably as follows:

m 39.2 – 44.0: at base, very sandy, micaceous, lenticular marls with Jurassicorbula sp., followed by dark grey, bioturbated marly siltstones with small-sized burrowing bivalves in life position. Ooids appear due to bioturbation. Above it, grey, ooidic bioclastic wackestone with quartz-cored ooids and superficially encrusted bivalve clasts, overlain by oyster-bearing marl and brown, very well sorted, oolitic packstone. Ooids with quartz cores and thick micritic cortex; complex ooids and large bivalve clasts occurring.

m 44.5 – 50.3: (close to altitude 312 m:) 2.5 m of poorly exposed, coarse sandstones, superimposed by channel-fill of mostly univalved, Isognomon lusitanicum. Valves partly overgrown by Praeexogyra pustulosa and Na-
Aloota Sections

Location: geol. map, sheet Loures, NW quadrant, west of village Aloota.

From road Bucelas–Arranhó, right hand bifurcation, direction to village Aloota. Section part A and B in outcrops north of narrow curve just before beginning of village. Section part B 450 m north of road, part A 80 m further north. Part C several meters south of mentioned curve; part D 250 m south down road, taken in outcrops extending up hill; part E 250 m north, parallel to the latter; part F, G, H respectively 100/60/40 m further NNW. From part H another 60 m NNW to corresponding beds of Arranhó–Bemposta section (see respective section).

Stratigraphic range: «Pteroceriano» formation, upper part (Aloota limestones).

Generalities: sections taken in parallel cuts to point out lateral facies variations. Correlation of section parts executed by persecuting individual, weathering—resistant beds in the field. Outcrop conditions good, except for poorly exposed marls.

Nearby section: Arranhó–Bemposta.

Special remarks: only brief description given here, since the Aloota region is also treated in chap. 6.3.2

Description:

Section part A

m 0.0–1.4: brownish grey marl with small bivalve clasts, Nanogyna nana and ooids

m 1.4–4.7: very thick bed of brownish, moderately sorted, bioclastic oolitic rudstone, passing into oolitic grainstone on top. Low angle, predominantly north—dipping, cross—bedding, partly with waving foreset surfaces and trough cross—bedding. Bioclastic ooid nuclei very variable (e.g., Lenticulina sp., Marinella lugeoni). Large bioclasts, mostly microbored (in part ghost structures), mainly of bivalves and echinoids. Corals, large spongiostromate ooids with byssozoans, rounded intraclasts (partly reworked algal bindstones) and lumps occurring. Sparitic matrix, partly with microporiferous peopel flints of intergranular pores (altered micrite); early vadose influence evident by leached intraclasts and oomolds, with collapse of ooid cortices after dissolution of nuclei

m 4.7–6.3: grey marls, in lower part ooid— and oncoc—bearing, with thin intercalmations of bioclastic grainstones, in upper part with some corals

m 6.3–7.6: at base, thick bed of brownish, poorly sorted, bioclastic grainstone, with very close overpacking implying development of intergranular pores (packstone fabric) in lowermost part. Chaotic, often vertical position of elongated bioclasts. Beds fining upwards with increasing lime mud, then marl content. Microbored bioclasts composed of bivalves, gastropods, echinoids, furthermore M. lugeoni, questionable dasycladaceans, Pseudocyclemmina sp., Nautiloculina oolithica as well as intraclasts and rare ooids. Ghost structures very common. This «tempestite» is overlain by marl

m 7.6–8.6: light grey, medium—bedded, nodular bioclastic floatstone (partly very poorly sorted micritic rudstone) with large clasts of corals, calcisponges, bioclasts and gastropods, microbored or/and encrusted by Lithocodium sp., «cay euxid» algae, Marinella lugeoni, Conicospirillina basilensis. Furthermore fine angular bioclasts and lithoids.

Section part B

m 0.0–2.3: brownish grey marl with small bivalve clasts. Nanogyra nana and, particularly on top, ooids and small oncois. Intercalated in upper part are thin layers and lentils of oolitic grainstone.
Alrota Sections

N 250m S

N-250m S

N-450m S

N-800m S
m23−4.6: very thick bed of bioclastic oolitic rud/grainstone, resembling and corresponding to m 1.4−4.7 in part A. Richer in oncocoids than in part A

m4.6−5.0: grey bioclastic wackestone with individual corals

m5.0−5.8: marl with abundant corals, often in growth position (Amphistrea pinniformis, Actinastrea ramulifera, A. crasso−rama, Cyathophora cesareodensis, Thamnasteria pseudarachnioides, Stylophora (Convexastra) cf. pustulosa, cf. Dermosmilia sp.), Corals partly with attached serpulids and Paeaeogrypha pustulosa. Spines of Pseudocidaris lustianicus very common. Coral meadow laterally extending only over a short distance

m5.8−6.8: weathered, dark marl with Myophorella lustiana


m14.8−16.2: brownish grey, massive coral boundstone (baffle/framestone) with up to 30 m Q measuring coral heads. Corals often bored by Lithophaga sp., covered by serpulids and oysters, or thickly encrusted with aulacian cement A. Trichites sp. partly serving as substratum for coral attachment. Between coral heads diagnostically recrystallized bioclastic float/rudstone with large coral clasts besides debris of gastropods (e.g., nerineids), bivalves, echinoids and rare brachiopods. Bioclasts microbored and/or superficially encrusted by spongiostome algae, ?Solenopora haygiformis, Marrella ligeonii, Lithocodium sp., byrhozoans and serpulids. Common Pseudocyclostoma sp., parvula−mulchens. In upper part small Pteropera cf. Pygmaea occurring, together with common Trichites sp.

m16.2−17.0: intensively weathered, poorly exposed marl

m17.0−20.0: brownish grey, very thick−bedded, at base marly, coral boundstone (frame/bafflestone) with up to 1 m Q large, in situ heads of ooidic corals (Stylophora (Convexastra) sexradiata, Axosmilia sp. and fasciculate corals. Sediment fillings between corals analogous to corals described above

m20.0−22.2: light brown, thick−bedded pack/rudstones with intensively microbored bioclasts, developing gradually from underlying boundstone. Coral debris dominating, M. ligeonii and Lithocodium sp. occurring, common lithoids (Pseudocyclostoma sp., Frenkelina planispiralis), etc. In uppermost part micritic oncocoids. Sorting moderate at base, then deteriorating (large, floating clasts). Matrix at base altered to microspar and neospar. In uppermost part circumgranular shrinkage cracks common

m22.2−24.0: intensively weathered, poorly exposed marls with abundant corals, dominated by Calamophyllia (Calamosina) filabellum and C. variabilis. Besides these, Axosmilia crassa, A. cf. caudata, A. cf. cuneata, Thamnasteria lobata, T. gracilis and Pliostoma sp., Isognomon (Rostero) sp., Pteropera sp., P. pustulosa and modiolid bivalve.

Section part C

m0.0−1.0: weathered, brownish grey marl with superficial spongiostome oncocoids, bivalve clasts, N. nana and intercalated lentils of oncolitic bioclastic wacke/packstone

m1.0−1.3: brownish bioclast−intraclast rudstone with all components being superficially encrusted. Micritic oncocoids with nuclei formed by ooids, clasts of bivalves, echinoids, and M. ligeonii. Intraclasts representing reworked pellets, collocl or bioclastic facies with enclosed N. obtecta, Pseudocyclostoma sp., Conocyphonina basilensis, byrhozoans, corals, etc., iron hydroxide−stained microporous matrix. At lower surface well preserved burrows of crustaceans?. Bed corresponds to m 2.3 − 4.6 in section part B.

Section part D

m0.0−1.2: intensively weathered marls, poorly outcropping

m1.2−2.8: brownish grey, oncolitic, oyster−bearing marl with intercalated lentils of oncolitic bioclastic wacke/packstone. Top corresponds to m 1.3 in section part C

m2.8−7.5: exposure gap with findings of Isognomon sp. and rare corals

m7.5−11.0: Coral and oyster−bearing marl, grading into very thick−bedded coral boundstone (framestone). Corals dominated by Actinastrea sp. (lower part) and Amphistrea pinniformis (up to 30 cm Q). Common Litho−
**Section part E**

**m 14.0 – 16.0:** basal bed, light brown, poorly sorted, overpacked bioclastic packstone with all large, poorly rounded clasts being microbored, composed of very large, partly Lithophaga-bored bivalve and coral clasts, echinoid debris, nodules composed of *Bacinella irregularis/Lithocodium* sp., *M. lugeoni*, calcisponges, sponge spiculae and rare verneuilidids. Upper bed, brown, well to moderately sorted, bioclastic oolitic grainstone with bioclasts being microbored and/or with superficial ooid cortices. Determinable bioclasts consist of mollusks, corals, common echinoids, calcisponges, brachiopods, bryozoans, *Haplophragmium* sp. and other lithoids. Chaotic distribution of components with vertically oriented shells and overpack features. Cortices of ooids often detached and fragmented.

**m 17.6 – 21.3:** at base, brownish, poorly sorted, micritic rud/floatstone. Main components are superficially encrusted by cyanotheces, *B. irregularis/Lithocodium* sp., nubecularids or microbored, consisting mainly of coral clasts besides common gastropod debris, *Lithophaga* sp. and fragments of echinoids, brachiopods, calcisponges and sponge spiculae. Furthermore inexact large thall of digitiform *M. lugeoni*, *Permocalcites* n.sp., *Pseudocyclammina itius*, P. gr. *parvalva – muluchensis*, *Nautilculina oolithica*, *?Mesoendothyra* sp., *?Haplophragmium* sp.; rare quartz grains and quartz-cored ooids. Superimposed is intercalation of marls and nodular, slightly sandy limestones in mudstone or well sorted pelletal packstone facies, with large clasts of bivalves, gastropods, echinoids, crustaceans. Furthermore, P. gr. *parvalva – muluchensis*, *Eretricyclammina virulansa*, *?Rectocyclus sp.*. *Ammobaculites* sp., *?Haplophragmium* sp., *?Mesoendothyra* sp., *P. virulansa* and *P. virulansa* and *Permocalcites* n.sp. In uppermost part, thick bed of coral boundstone (bafflestone), Corals overgrown by algae (in *Lithocodium* sp.), nubecularids, *?bryozoans* and calcisponges. Gastropod, echinoid and crustacean clasts as well as fragments of *?Lithocyclus nasi*, *?Actinoporella podolithic*, *?Cylindroporita cr. arabica*, *Permocalcites* n.sp., *?Actinoporella cr. arabica*. *Pseudocyclammina gr. parvalva – muluchensis*, E. *virulansa*, *Freixia sp.* planispirals, *?Mesoendothyra* sp., *?Haplophragmium* sp., *Glosorhiza* sp., *P. virulansa* and *P. virulansa* flake in micritic/pelmicritic matrix.

**m 22.7 – 23.5:** light greyish brown, thick-bedded, partly iron hydroxide-stained nereid floatstone with large, partly reworked nereids which are overgrown by *Solenopora cuphea* sp. Oysters, lithoids and very common microbored bio/infraclast form pack/grainstone fabric in bioturbation burrows. Early desiccation cracks, spar-filled solutional vugs and cement A and B in leached gastropod shells point out early vadose influence.

**Section part F**

**m 0.0 – 2.7:** (corresponding to m 17.6 – 21.3 in section D) at base, brownish grey, thick-bedded, bioclastic wackestone with scattered coral debris and common corticles, overlain by medium thick bed of brownish grey, well sorted, oolitic grainstone with mature, partly polycrystalline ooids with nuclei composed of quartz (60%) and various bioclasts. Ooid cortices with radial fibrous fabric, overprinted by diagenesis. Above it, very thick bed of iron hydroxide-stained, onciferal floatstone with partly superficial, spongiostromate oncoes of type SS – R and SS – C. Nuclei formed by bivalves, gastropods and *M. lugeoni*. Small double-valved bivalves and large fragments of *Coelastaria* sp. occurring. Matrix microsparitic.

**m 4.9 – 5.6:** very thick bed of brownish, poorly sorted, bioclastic pack/grainstone with corticles and large, large, floating, iron hydroxide-stained spongiostromate oncoes (type SS – R, SS – I, SS – C), frequently with nuclei of *M. lugeoni* besides other bioclasts. Often multiple oncoes with layers of *bryozoans*. Furthermore, moderately rounded bioclasts and *Freixia sp.* planispirals. *?Kunubia* sp., *Lenticula* sp.; non-encrusted *Marniella lugeoni*. Chaotic attitude of particles in microsparitic/sparitic matrix. At top, marl with Pseudocyclus *pustulosa*, *Nanogyna nova*, *Gervillea avulcoides*, *Coelastaria* sp. and abundant cyanophyte nodules and oncoes of different sizes, partly with attached oysters.

**m 5.6 – 8.0:** very poorly exposed, weathered marl with findings of *Comophylla corugata*, *Amphiastrea profundis*, *Actinastera trochiformis*, *Stylina (Convexastery) sexradiata*, S. (C.) *pustulosa*, *Cyathophora bourgueti*, *Thamnasteria pseudarachnoidea*, *Dermamilla* sp., *Axosmilia crassa*, *Axosmilia* sp., and *Isogromon* (Rostroperra) sp., *Petroperna* sp. (both with attached *P. pustulosa* and *N. nova*), *Myophorella lusitanica* and spines of *Pseudocidaris lusitanica*.

**m 0.0 – 0.8:** (corresponding to m 0.0 – 2.8 in section D) thick bed of brownish grey, bioturbated bioclastic wacke/floatstone with large clasts of, partly microbored, corals, bivalves, gastropods, echinoids and very frequent small-sized corticles. Furthermore, calcisponges, sponge spiculae, *M. lugeoni*, *Lithocodium* sp., *Permocalcites* n.sp., *?Lithocyclus nasi*, *?Actinoporella podolithic*, *Pseudocyclammina gr. parvalva – muluchensis*, *Rectocyclus sp.*. *Haplophragmium* sp., *Nautilculina oolithica*, *Inhomogenus*
matrix, partly pelmicritic or microsparitic. Common circumgranular desiccation cracks; cement A in leached biomolds. At top, thin bed of oncolitic oolitic wacke/floatstone.

Section part G

m 0.0 - 0.5:
(corresponding to section part F) single bed of grey, partly pelletal, gastropod floatstone with large, corroded nerineids, cortoids, crustacean? debris, Ammodoculites sp., "Haplophragmium" sp., Rectocyclammina sp., Gomospira sp., vermeulinids and valvulinids, ostracods, bryozoans; common solutional vugs filled with cements A, B. Superimposed, by an erosional, very irregular, component and fissure cutting disconformity, is a thin bed of poorly sorted grain/packstone with abundant well rounded cortoids and P. gr. parvula - multichensis, Rectocyclammina sp., Freixialina planispiralis, "Haplophragmium" sp., vermeulinids and valvulinids, Cayeuxia kurdistanensis, M. lugeoni, Permoaulax n.sp.; and questionable codiacean alga.

Section part H

At base, below first outcrop, findings of Stylinia tubulosa, Axospilia crassa, Comoseris meandrinoidea, Thamnasteria pseudarachnoides and, deeper, Coelastarte discus.

m 0.0 - 3.0:
light grey, medium to thick-bedded, bioclastic intraclastic wackestone with corals and cortoids, passing into oolitic wackestone, then packstone

m 20.0 - 20.5:
single bed of brown, microsparitic oolitic float/nudstone with large, complex, sponge/marine oncocysts, most often with M. lugeoni integrated in cortices and serving as core. Serpulids, tubularians, bryozoans and questionable bryozoans also occurring in algal cover. Oncoids intensified attacked by Lithophaga borings with holes later filled with internal micae, crystal silt and cements A, B. Besides oncocysts, common non-encrusted fragments of M. lugeoni, cortoids and rare detrital quartz. Upper surface of bed corresponds to m 5.0 in section part E

m 20.5 - 22.5:
intensively weathered, mostly soil - covered marl

m 22.5 - 32.5:
grey, very thick-bedded coral (frame/bafflestone) built of large heads of Amphiastrea periformis, fasciculate Calamophyilla-type corals, spines of Pseudocidaris lusitanica, fine angular bioclasts, nodules of Solenopora carpeiformis n.sp. and spongo/biolast type cyanothems, M. lugeoni, rare Permoaulax n.sp., P. gr. parvula - multichensis, F. planispiralis, "Haplophragmium" sp. Micritic matrix partly altered to microspar and neospar. Irregular compaction cracks common. Boundstone is embossed into, partly marly, poorly sorted, bioclastic intraclastic float/packstone at base and top. Boundstone between m 23.5 - 31.5 corresponds to boundstone between m 105.0 - 110.5 in Arranhó - Bemposta section

m 34.5 - 37.8:
grey, medium-bedded limestones; at base, moderately sorted packstone with superficial oncocysts and cortoids; occasional corals, "Haplophragmium" sp. and igneous tuff. Above it, nodular bioclastic wackestone, partly with cortoids. At top, bioclastic intraclastic packstone.

End of sections.

Additional, not yet mentioned, corals from the surroundings of Alrote sections: Amphiastrea gregory, Meandrophyilla (Latimamisareo) helvettoides, M. (Meandrorea) bonanomil.

Section Arranhó - Bemposta

Location: geol. maps, sheet Alierque, SW quadrat and sheet Loures, NW quadrat. Section taken along traffic road between Sobral de M. Agraço and Bucelas. Base of section 1 km S Arranhó (at bifurcation to Ajuda and Arruda); top at end of Villa Nova (short before Bemposta).

Stratigraphic range: top of Sobral formation, complete "Pteroceriano" formation.

Generalities: on the average, exposure conditions good, though gaps are common. One of the few sections where marls, though strongly weathered, are also outcropping. Section extends over more than 4 km along the road (due to flat morphology and only gentle southward dipping of beds), certainly summarizing lateral differentiations which should be taken into consideration. Often, apparent thicknesses had to be measured (especially in gaps) and re-evaluated to true thicknesses using strike and dip readings.

Nearby sections: Alcubela - Freixial, Alverca, STIago dos Velhos.

Special remarks: Section Alcubela - Freixial is very nearby. The present section is nevertheless taken (a) to complete information of Alcubela - Freixial section, particularly to eliminate informational gaps due to lacking outcrops in either
one section or the other; (b) to find out degree of small-scaled lateral facies differentiations; (c) to correlate the Aробat shelf complex to a continuous section.

Continuation of section both stratigraphically downwards and upwards can be drawn from Albufeira–Freixal section.

**Description:**

m 0.0 – 0.6: yellowish brownish, micaceous sandstone (at road km 67.4)

m 5.0 – 6.4: marls, brownish silts and silty sandstones (top of Sobral Formation)
m 12.6 - 14.5: grey marls, grading into dark grey, nodular mudstone. Partly distinct Thalassinoides burrows; occasionally Arcomytilus morrisi (in life position), Protocardia sp., Myopholas multicosata, ostracods, Everticyclammina virguliana, etc.

m 14.5 - 21.2: gap with vaguely outcropping nodular mudstones and marls

m 21.2 - 25.0: weathered marls and slightly marly, greyish to brownish mudstones, in part bioturbated (e.g., Thalassinoides sp.), with Arcomytilus morrisi (in life position). In upper part bioclastic wackestone with rare oncolids, litoleds, Isognomon sp. and common, very large, Lithophaga-bored, Trichites aff. saussurei, espe-
cially at top. Top densely covered by Nanogya nana and Praeexogyra pusulosa; corals and spines of Pseudoecidans lusitanicus also occurring (hardground). (Described features can be seen best on loose block at km 68.0)

m 30.0 – 60.0:
- grey marls (dominating) and nodular limestones. Marls with fauna (if not disguised by recent weathering): soft bottom fauna dominated by ?Nicaniella sp. and Mesosaccella dammariensis and Neriiform sp. Macraulina occurring, consisting of Protocardia sp., Jurassiocorulla edwardii, Nanogya nana and cidaroid spines. Grey, nodular limestones (mostly mudstones), bioclastic, poor in components. At base, nodular wackestone with common oysters and common, Lithophaga—bored Trichites sp.; at m 33.5, bioclastic wackestone with rare corals, spines of Pseudoecidans lusitanicus, oestracods, serpulids, lithoids, lagenids and rare dasycladaceae (? Terquemella (?) triangulans, Cylindroporella sp.). At m 37.6, 60 cm of brownish, bioclastic oncotic floatstone with oncoids (mostly superficially encrusted oysters with sessile foraminifers, serpulids, bryozoans) which are intensively impregnated with iron hydroxide. Heavy vadose influence (common cracks, partly circum- and intragravelan; solution features). (Correlation bed to Alcubola—Freixiel section, m 33). From m 37.4 – 47.4 exposure gap; at m 50.0 indistinct mud cracks in mudstone with microbored clasts of oysters and other bivalves, echinoids, lithoids and?Marcellina lugeoni; at m 51.3, 20 cm of bioclastic rudstone; from m 58.0 – 59.0 (at road bifurcation to Alcorta), bluish grey marls with soft bottom fauna: Nicaniella sp., Mesosaccella dammariensis, Antiquipora sp., Protocardia sp., ?Aniscocorulla, Jurassiocorulla edwardii, ?Pleurocyclus, Myophora multicostata. Partly clusters of Arctomytilus mornisi. Thin layers of marly, nodular mudstones, representing burrow fillings (e.g., Rhizocorallium sp.)

m 70.0 – 71.2:
- single bed of brownish, micritic oncotic rudstone

m 72.0 – 74.5:
- (500 m south of house, ?Caralinda?) at base, thick bed of poorly sorted, bioclastic intraclastic packstone with cortoids (partly corals, brachiopods), ooids, micritic and spongiosomatous oncoids, ?Lugeoni, Cylindroporella sp., Freixialuna planispiralis, verneuillids and valvulinids, Lenticulina sp., rare miliolids and rare vermetid fragments. At top (eventually separated by thin marl layer), thick bed of lithoclastic rudstone, with strong vadose alterations

m 81.0 – 82.2:
- light grey, thick-bedded coral floatstone with debris of solitary and colonial corals (e.g., Cyathophora bourgueti), large gastropods, etc. Primary micritic matrix partly altered to neospar. Common compaction cracks

m 82.2 – 83.8:
- brownish, oncoid-beariing marls with debris of ?Pteroperna sp., Axosimilia sp. and rare cidaroid spines, passing into grey, micaceous, lignite marls with rare imprints of gastropods and small-sized bivalves

m 87.3 – 89.5:
- grey, partly iron hydroxide-stained, medium-bedded, bioclastic nodular mud/wackestones, partly packstone. Rhizocorallium irregularare, debris of terebratulid brachiopods, Erythroclammina virgulana, Rectocyclamina sp., Pseudocyclamina ltau, P. gr. parvula—inulchensis, ?Haplophragmium sp., F. planispiralis, verneuillids and valvulinids, lagenids, dasycladaceae (e.g., Salpingoporella annulata)

m 89.5 – 90.5:
- single bed of light brown coral float/boundstone (bafflestone); corals with different growth forms; M. lugeoni

m 90.5 – 91.6:
- brownish, poorly sorted oolithic packstone, at base sparitic, grading into ooid—bearing wackestone. Bioclasts of corals, bivalves, gastropods and M. lugeoni form ooid nuclei. Large nerineids occurring

m 93.7 – 96.0:
- above weathered marls, bioclastic packstone with cortoids and considerable amount of medium—grained, detrital quartz. Gastropods, esp. nerineids, common, often heavily reworked. Superimposed are marls, mostly covered by soil, and thick bed of rhodolith rudstone with large rhodoliths (up to 1 cm), mostly with superficial overgrowth of cyanophytes. Extremely poor sorting; micritic to microsparitic matrix

m 104.0 – 112.3:
- greyish brown, coral—bearing complex, from base to top:
  - 2 m of bioclastic floatstone with calcisponges, corals (e.g., Axosimilia sp.), nerineids, ?Cayuexuid? algae, sessile foraminifers, ?Litiinus, bryozoans, serpulids, oestracods, etc. cm—large vugs with micritic internal filling.
  - 4.8 m of massive coral boundstone (mostly framestone), composed mainly of large coral heads (field determination: Styliina sp., Amphiastrea piniformis, ?Cyathophora sp., meandroid corals) besides branching types (e.g., <Catanophyllia> sp.). Between coral heads, bioclastic pack/rudstone (micritic—microsparitic) with poorly sorted and rounded, often microbored fragments of bivalves, gastropods, brachiopods, echinoids, and M. lugeoni, ?Cayuexuid algae, dasycladaceae, ?Litiinus, P. gr. parsura—inulchensis, ?Haplophragmium sp., Neutilulina oolithica, ?Mesoendothyra sp., etc. (boundstone extending to Alcorta section, correlation H, H.)
  - 2.2 m of coral—bearing floatstone, developing from underlying framestone.
- 30 cm of cortoid packstone (microsparitic matrix), moderately sorted. Rare corals, echinoids, *M. lugoei*; common *Haplophragmium* sp. besides *P. litus*, *Lenticulina* sp., verneuilids and valvulinids, *Bacinella irregularis*, *Solenopora* sp.

**m 114.0 — 117.0:** grey, medium-bedded, nodular, though compact, mud/wackestone. Bioclasts at base microbored; also with calcisponges, «calcereid» algae and litooids

**m 123.0 — 129.4:** light grey to brownish coral-bearing complex, from base to top:

- 50 cm of bioclastic wackestone with cortoids, *M. lugoei*, *Campbelliella striata* and corals (e.g., *Actinastrea* sp.).
- 80 cm of coral boundstone (bafflestone), mostly constructed by fasciculate *Calamophyllia* flabellum, often bored by *Lithophaga* sp. and encrusted by cyano phytes and Conicospiroliana basinsp. In micritic to microsparitic matrix, cortoids, rare spines of *Pseudocaidaris lusitanica*, *P. gr. pavula — mulchensis*, *Rectocyclolamina* sp., *?Mesoendothyra* sp., *Lenticulina* sp., serpulids, bryozoans, etc.
- 2.5 m of medium-bedded, bioclastic mud/floatstones and weathered marls.
- 2.5 m of thick-bedded, bioclastic floatstone with calcisponges and, esp. at top, corals (dominated by massive, digitiform *Styliola* (*Convexastrea*) *sexradiata*, often bored by *Lithophaga* sp. Furthermore, very common *Salpingoporella annulata*, litooids, miliolids, etc. Matrix micritic, apparently composed of compacted peloids (in Vila Nova, along NE — SW striking section of road)

**m 129.4 — 131.3:** grey, weathered marls

**m 131.3 — 136.0:** grey, medium-bedded, nodular mudstone, partly with indistinct mud cracks, *E. virguliana* common, ostracods and oysters occurring. In filled burrows bioclastic wacke/packstone with often only slightly disarticulated valves of clams. At m 135.0, thin layer of oyster patch reef, built by *Praeexogyra pustulosa* and *Nanogyra nana*.

End of section (southern boundary of Vila Nova).

**Section Batalha**

**Location:** geol. map, sheet Alenquer, SW quadrant, 4 km W Arruda dos Vinhos; from Arruda, direction to Sobral de M. Agraço, at Pontes bifurcation to Montafim, Batalha hamlet. From Batalha (beginning of section) uphill in ESE direction, first along track, then crossing fields uphill to hilltop with the same name (trig. altitude m 322). End of section several meters below hilltop at fault.

**Stratigraphic range:** Amaral formation (Oitilo member) «Pteroceriano» formation, lower to middle part

**Generalities:** soft sequences and possibly sandstones underrepresented; parts of section reconstructed by loose rock rubble.

**Nearby sections:** Carvalha, Mata, Alqueidão, Sobral.

**Special remarks:** Sobral formation forming continuous series of about 55 m thickness, yet isolated sandstone horizons also seem to appear in higher parts (cf. to Carvalha and Mata sections). Important finding site for giant *Protocardia* sp. A.

**Description:**

**m 0.0 — 2.5:** light grey, thick to medium-bedded, partly marly, poorly sorted oolitic packstone with quartz-cored ooids. Increasing amount of detrital quartz in upper part. Small bioclasts. (top of Amaral fm)

**m 5.0 — 6.0:** *Praeexogyra pustulosa*/*Nanogyra nana* patch reef, bored by *Lithophaga* sp. and encrusted by bryozoans, serpulids and algae. Above it, oyster-bearing marl

**m 6.0 — 65.5:** brownish siliclastic series with fairly large gaps. Predominantly thick-bedded, lenticular, often micaceous sandstones with poor to moderate sorting. In part cross-bedded with downcutting surfaces and gravel at base; rarely evenly laminated. Scattered *Eomioidea secundiformis*. This bivalve is also occurring in marly silts together with *?Neomioidea* sp. and rare gastropods (esp. m 28), Sandstones partly ooid-bearing, with transitions to oolites with quartz-cored ooids. Debris of *Bacinella lugoei* as well as oncoids and bioclasts occurring in oolites at m 7 and 25. No outcrops within the 25 uppermost meters (possibly silts and marls) (top of Sobral formation)

**m 64.5 — 73.8:** medium grey, partly bioturbated, marly mudstones, in part floatstones, with several exposure gaps (marls and very marly limestones?). At base, *Arcomytilus morrisi* (in clusters), *Gervilia* sp., *Myopholas multicoastata*, *?Pleuromya* sp., *Protocardia texta*, *Protocardia* sp., *Praeexogyra pustulosa*, ostracods (reddish impregnation), serpulids, litooids, etc. Findings at m 69: *A. morrisi*, giant *Protocardia* sp. A, M.
**multicostata.** At m 72.0 (correlated from nearby site): brownish grey, bioclastic, bioturbated floatstone, partly with faecal pellets. Clusters of *A. morrisi*, abundant bioclasts of bivalves and gastropods, rare lithoids (?Evelethyclammina virgulina) and dasycladaceans. *A. morrisi* and giant Protocardiida sp. A are the most common faunal elements in this segment.

**m 74.0:** horizon with abundant loose fauna to pick up, extending over several hundreds of meters. Hostrock (not exposed), micaceous silt— to sandstone, as can be seen from the fillings of fossils. Most probably macrofossil coquina with *Isognomon lusitanicus* (prevailing), *Eomiodon securiformis* (common), *Antiquicyprea* sp., *Praeexogyra pustulosa*, *Nanogryra nana*.

**m 75.8—84.8:** grey marls, marly mudstones and nodular mud/wackestones (base and top reconstructed by loose rock rubble, middle part well exposed, former small quarry). Nodular mud/wackestones in lower part with common, large-sized fauna (in decreasing order of frequency): giant *Protocardia* sp. A with attached *N. nana*, *P. intexta*, *Protocardia* sp., *Pleuromya* sp., *Pleuromya* sp. Microfacies: common bivalve bioclasts with mottled distribution, oysters, ostracods, serpulids, *E. virgulina*. Early diagenetic compaction cracks and vadose solution features. Above it, marls with giant *Protocardia* sp. A, partly full of *N. nana*. At m 81.5 (above *Nanogryra marls*), oyster wacke— to rudstone, Clusters of *A. morrisi* also common. At base, weathered burrows of *Thalassinoides* sp., covered with oysters on upper side. Oysters in part encrusted by serpulids.

**m 87.0—87.6:** patch reef built of *P. pustulosa* and rare *N. nana*. Rare small corals.

**m 87.6—90.0:** light brown, bioclastic floatstone grading into bioclastic—intraclastic rudstone with massive corals, debris of bivalves and gastropods (often microbored), echinoids (spines of *Pseudocidaris lusitanicus*), *M. lugeoni*, etc. At top, 1 m of weathered, bluish grey marls at base with common *N. nana* besides small coral heads and spines of *P. lusitanicus*. Above it, *Myophorella* sp. and *Isognomon* sp.

**m 90.0—94.5:** very poorly exposed. Thin outcrops, from base to top: dark grey, bioclastic wacke/packstone with abundant oysters. Brownish grey bioclastic wackestone with cortoids; micritic envelopes of clasts with reddish brown impregnation. In upper part, presumed marls with *Protocardia* sp., *Jurassicita gaudrii* or *Jurassicita lusitanica*, *Myophorella* cf. *lusitanica*, and, somewhat higher, *Isognomon lusitanicus*, *Gervilla lata* variegata and *Eomiodon securiformis*. Here also findings of sandstone rubble.

**m 96.0—100.0:** at base, thin layer of marl with *N. nana*, superimposed by brownish, thick—bedded, coral and coral debris—bearing floatstone, grading into rudstone. Floatstone with coral heads (partly in life position), measuring up to 15 cm (e.g., *Stylinella delabechii*); rudstone full of corals, bored by *Lithophaga* sp., and rhodoliths in intrasparites, unsorted matrix. Large neritoid occurring. Solution features common.

**m 100.0—103.0:** Light grey, thick—bedded float/boundstone (ballestone) with, partly autochthonous, corals (esp. fasciculate corals), etc., passing into multicoloured rudstone with abundant debris of corals, *M. lugeoni*, gastropods, oysters, etc.

**m 103.0—105.4:** massive patch reef of *P. pustulosa* and *N. nana*.

**m 105.4—107.0:** coral boundstone; corals directly overgrowing oyster reef. Spines of *P. lusitanicus*.

**End of section.**

**Section Benfica**

**Location:** geol. map, sheet Torres Vedras, NE quadrant, 4.3 km W Torres Vedras, at road to Ericeira. Section along short road cut from bifurcation at main road to cemetery of Benfica.

**Stratigraphic range:** Santa Cruz member (Bombarral formation).

**Generalities:** Mostly well exposed section, though partially soil—covered.

**Nearby sections:** Engenheiro.

**Special remarks:** Siliciclastic series, substituting «Pteroceriano» facies in the western part of the study area, i.e., no limestone development, yet similar fauna (e.g., *Myophorella lusitanica*), intercalated in terrestrial facies with caliche horizons.

**Description:**

**m 0.0—5.2:** weathered, red, silty—marly, micaceous clays, at top thin horizons of reddish greenish caliche (10 cm)

**m 5.2—8.6:** green to red mottled, silty clays, silts and medium—grained, micaceous, lignitic sandstones; in upper part with intensively coloured caliche horizon (red—green—brown)

**m 8.6—11.6:** grey to green, marly clays and siltstones, partly with common, poorly preserved bivalves. At top, thin oy-
Section Benfica

Sterrudstone, exhibiting very dense packing or shells, forming narrow channel filling. Oyster clasts in part superficially encrusted by cyanophytes.

m 11.6–13.6: mostly red coloured siltstones, with intercalation of pale, well sorted, medium grained calcareous sandstone.

m 13.6–23.0: intercalation of brownish greyish greenish clays, siltstones and fine-grained sandstones, often micaceous, lignitic, in higher part very poorly exposed. In lower part, below evenly laminated sandstone, findings of Myophorella lusitanica fragments.

m 23.0–24.0: in brownish, marly-sandy, micaceous, lignitic matrix, very common, large-sized Eomiodon secundiformis, often in life position; above it, cluster of Isognomon lusitanicum with attached Praeexogyra putulosa, also often in life position, together with Eomiodon secundiformis and rare Protocardia sp. At top, common, small-sized specimens of E. secundiformis.

m 24.0–25.5: red coloured clays and siltstones.

End of section.

Section Boieiro

Location: geol. map, sheet Alerquer, SW quadrant. 2500 m SW Arruda dos Vinhos, on southern flank of elevation Boieiro, trig. altitude m 378. Section from top of distinct »Coralico« outcrops (Amaral formation) up to hilltop.

Stratigraphic range: Uppermost part of Amaral formation, Sobral formation, lowermost part of »Pterocerino« formation.

Generalities: Exposure conditions for a continuous section are very poor. Only thin outcrops, rest of log interpreted from loose rock rubble. Reconstructed true thickness of log is very low, due to apparent gentle southward dipping of beds; yet, exact determination is impossible, so that given thicknesses are only approximate (eventually thicker). Faults, causing notable slips are frequent in the Boieiro region. Section is eventually also faulted in middle part.

Special remarks: Sobral sequence is very thin, eventually confined by fault (see above).

Worth noting is a coquina built of entire, uni- and double-valved, oyster-covered Arcomytilus maris (dominating by far) and Eomiodon secundiformis, with lentils of oyster patch reefs. Site is in western slope of Boieiro, several meters below top, in Sobral formation. Due to track construction, patch reef was almost completely destroyed in 1983.
multicostate. At m 72.0 (correlated from nearby site): brownish grey, bioclastic, bioturbated floatstone, partly with faecal pellets. Clusters of *A. morrisi*, abundant bioclasts of bivalves and gastropods, rare *Oxylloxys* (Silicea elongata, *Pleurostoma virgulata*) and dasyycladaceans. *A. morrisi* and giant Protocardiida sp. A are the most common faunal elements in this segment.

m 74.0: horizon with abundant loose fauna to pick up, extending over several hundreds of meters. Hostrock (not exposed), micaceous silt—sandstone, as can be seen from the filling of fossils. Most probably macrofossil coquina with *I. lusitanianum* (prevailing), *L. securiformis* (common), *A. trigonina* sp., Praeaxogyra pusulosa, Nanogyra nana.

m 75.8—84.8: grey marls, marly mudstones and nodular mud/wackestones (base and top reconstructed by loose rock rubble, middle part still exposed, former small quarry): Nodular mud/wackestones in lower part with common, large-sized fauna (in decreasing order of frequency): giant Protocardiida sp. A with attached *N. nana*, *P. securiformis*, *P. trigonina*, *A. virgulata*. Microfossils: common bivalve bioclasts with mollusk distribution, oysters, ostracods, serpulids. E. virgulata. Early diagenetic compaction cracks and vadose solution features. Above it, marls with giant Protocardiida sp. A, partly full of *N. nana*. At m 81.5 (above Nanogyra marks), oyster wacke—rudstone. Clusters of *A. morrisi* also common. At base, weathered burrows of *Thalassinoides* sp., covered with oysters on upper side. Oysters in part encrusted by serpulids.

m 87.0—87.6: patch reef built of *P. pusulosa* and rare *N. nana*. Rare small corals.

m 87.6—90.0: light brown, bioclastic floatstone grading into bioclastic—intraclastic rudstone with massive corals, debris of bivalves and gastropods (often bioturbated), echinoids (spines of *Pseudocidaris lusitanicus*), *M. luyoensis*, etc. At top, 1 m of weathered, bluish grey marls at base with common *N. nana* besides small coral heads and spines of *P. lusitanicus*; above it, *Myophorea* sp. and *I. securiformis*.

m 90.0—94.5: very poorly exposed. Thin outcrops, from base to top: dark grey, bioclastic wacke/packstone with abundant oysters. Brownish grey bioclastic wackestone with coroids; micritic envelopes of clasts with reddish brown impregnation. In upper part, presumed marls with *Protocardiida* sp., *Jurassicituba* sp., *Myophorea* sp., *I. lusitanicus*, and somewhat higher, *I. securiformis*; *Gavrillevella* sp., *Lithophaga* sp., and *I. lusitanicus*. Here also finds of sandstone rubble.

m 96.0—100.0: at base, thin layer of marl with *N. nana*, superimposed by brownish, thick—bedded, coral and coral debris—bearing floatstone, grading into rudstone. Floatstone with coral heads (partly in life position), measuring up to 15 cm (e.g., *Stylus delabedechi*); rudstone full of corals, bored by *Lithophaga* sp., and rhodoliths in intraclastic, unsorted matrix. Large reniform occurring. Solution features common.

m 100.0—103.0: Light grey, thick—bedded float/boundstone (bafflestone) with partly autochthonous, corals (esp. fasciculate corals), etc., passing into multicoloured rudstone with abundant debris of corals, *M. luyoensis*, gastropods, oysters, etc.

m 103.0—105.4: massive patch reef of *P. pusulosa* and *N. nana*.

m 105.4—107.0: coral boundstone; corals directly overgrowing oyster reef. Spines of *P. lusitanicus*.

End of section.

Section Benfica

Location: geol. map, sheet Torres Vedras, NE quadrant, 4.3 km W Torres Vedras, at road to Eiréneia. Section along short road cut from bifurcation at main road to cemetery of Benfica.

Stratigraphic range: Santa Cruz member (Bombarral formation).

Generalities: Mostly well exposed section, though partially soil—covered.

Nearby sections: Engenheiro.

Special remarks: Siliciclastic series, substituting *Pterocerianos* facies in the western part of the study area, i.e., no limestone development, yet similar fauna (e.g., *Myophorea lusitanica*), intercalated in terrestrial facies with caliche horizons.

Description:

m 0.0—5.2: weathered, red, silty—marly, micaceous clays, at top thin horizons of reddish greenish caliche (10 cm)

m 5.2—8.6: green to red mottled, silty clays, silt and medium—grained, micaceous, lignitic sandstones; in upper part with intensively coloured caliche horizon (red—green—brown)

m 8.6—11.6: grey to green, marly clays and siltstones, partly with common, poorly preserved bivalves. At top, thin oyster.
Section Benfica

ster rudstone, exhibiting very dense packing of shells, forming narrow channel filling. Oyster clasts in part superfi-"ci ally encrusted by cyanophytes

m 11.6–13.5: mostly red coloured siltstones, with intercalation of pale, well sorted, medium grained calcareous sandstone

m 13.6–23.0: intercalation of brownish greyish greenish clays, siltstones and fine-grained sandstones, often micaceous, lignitic, in higher part very poorly exposed. In lower part, below evenly laminated sandstone, findings of Myophorella lusitanica fragments

m 23.0–24.0: in brownish, marly-sandy, micaceous, lignitic matrix, very common, large-sized Eomiodon secu"niformis, often in life position; above it, cluster of Isognomon lusitanicum with attached Praeexogyra pustulosa, also often in life position, together with Eomiodon secu"niformis and rare Protocorda sp. At top, common, small-sized specimens of E. secu"niformis

m 24.0–25.5: red coloured clays and siltstones.

End of section.

Section Boieiro

Location: geol. map, sheet Alenquer, SW quadrant. 2500 m SW Arruda dos Vinhos, on southern flank of elevation Boieiro, trig. altitude m 378. Section from top of distinct «Coralico» outcrops (Amaral formation) up to hilltop.

Stratigraphic range: Uppermost part of Amaral formation, Sobral formation, lowermost part of «Pteroceriana» formation.

Generalities: Exposure conditions for a continuous section are very poor. Only thin outcrops, rest of log interpreted from loose rock rubble. Reconstructed true thickness of log is very low, due to apparent gentle southward dipping of beds; yet, exact determination is impossible, so that given thicknesses are only approximate (eventually thicker). Faults, causing notable slips are frequent in the Boieiro region. Section is eventually also faulted in middle part.

Special remarks: Sobral sequence is very thin, eventually confined by fault (see above).

Worth noting is a coquina built of entire, uni- and double-valved, oyster-covered Arcomytilus monroi (dominating by far) and Eomiodon secu"niformis, with lentils of oyster patch reefs. Site is in western slope of Boieiro, several meters below top, in Sobral formation. Due to track construction, patch reef was almost completely destroyed in 1983.

**Description:**

**m 0.0–1.5:** light coloured, thick–bedded, poorly sorted intraclastic packstone with common cortoids of corals, echinoids, bivalves, gastropods. Furthermore, oncoids, *cayeuxid* algae, algal lumps, *M. lugeoni*, dasycladaceans, lituolids, *Conicospirotina basileensis*, etc.; Micritic matrix partly recrystallized; common circumgranular desiccation cracks and solutional vugs

**m 0.5–9.5:** light, thick–bedded peloid grain/packstones, coarsening upwards, with coral debris, lituolids, etc.; in upper part grading into intraclastic packstone with oncoids and dasycladacean fragments, top bioturbated. Common desiccation cracks and solutional vugs (top of Amaral formation, in lagoonal facies)

**m 9.5–11.5:** (poorly exposed) brown to grey siliciclastics, with extraclasts, ooids, detrital feldspar, lignite litter and, particularly at top, abundant bioclasts, partly superficially coated by algae

**m 11.5–12.0:** not exposed (presumed marl), findings of *Axosmilia caudata*, *A. corallina*, *Actinastrea crasso–ramosa*, *Cyanthophora bourgueti*. Corals partly with attached Praeexogyra pustulosa and *Nanogyra nana*. Nodules of *M. lugeoni* and cyanophytes also occurring

**m 12.0–12.5:** light grey, oolitic grainstone. Mature ooids, 75% quartz–cored, rest bioclast–cored. Furthermore, bivalve clasts (among them, oysters), most often microbored or with superficial oncid coating, rare gastropods, echinid spines; common rounded large rhodoliths (*M. lugeoni*), rare lignite litter

**m 12.5–19.5:** poorly exposed, brown, medium to thick–bedded, micaceous, lignitic siliciclastics, often with *Fomiodon secundiformis* besides *Isognomon lusitanicum*. Eventually faulting in lower part

**m 19.5–22.2:** marly, sandy sequence, at base with frequent *I. lusitanicum* and *Nereia turbinata*. At top, marl with abundant, double–valved *Gervilla sobraliensis* (top of Sobral formation)

**m 22.2–23.5:** grey, medium–bedded, slightly marly, bioturbated mudstone with *Arcomytilus marisi* and *Protocardia* sp.

**m 23.5–24.2:** light grey, thick–bedded, bioclastic floatstone, with coarse, angular bioclasts, *Trichites* sp., *Nanogyra nana*, rare echinid spines, rhodolith fragments and ooids.

End of section.
Section Bom Jesus

Location: geol. map, sheet Loures, NE quadrant. 2300 m W Alhandra, in quarries of «Cimentejo» west of main road between Alverca and Alhandra (road sign to «Pedreiras do Bom Jesus»). Section taken in main quarry (under active exploitation in 1982/1983), where big store depot is situated. Due to progressive work, exposure condition will alter continuously. In any case, stable element should be plane in front of (east of) depot, corresponding to upper surface of bed JO at m 41.3 of section.

Stratigraphic range: «Pteroceriano» formation, lower part

Generalities: The only section in the area where a major part of the «Pteroceriano» formation is exposed in a quarry under work. Important section, especially because marls are outcropping. However, recently blown up, dangerously steep and unstable quarry walls are difficult to reach out to. This is especially valid for the lower part of section (below m 40), where only an overall picture can be outlined.

Nearby sections: Adanaia.

Special remarks: According to the management of the quarry, rare ammonites have been found.

Description:

(In the north, outside quarries, 10 m below beginning of section.)

Light grey, nodular bioclastic wackestones (partly mudstones) with very fine bioclasts, rare large gastropod and bivalve clasts, lutiloids (e.g., «Haplophragmium» sp., Nautilolona coiltica), Cylindroporella sp., etc. Above it, findings of double-valved Myophorella lusitana and giant Protocardia sp. A, with Praeexogyra pustulosa overgrowth.

In quarries: quarry walls SW store depot:

m 0.0 – 0.8: grey marls with very frequent Arcomytilus morrisi

m 0.8 – 1.3: grey, bioturbated bioclastic wacke/floatstone with Trichites sp., common lutiloids (mainly Everticyclamina virguliana), Tenquemella sp., etc.

m 1.3 – 2.3: dark grey, oncolitic intraclastic rudstone. Oncoids often polycored, with sessile foraminifers. Nuclei often built of Marinella lugeoni, otherwise of bivalve and echinoid clasts. Algal cortices often with intra- and circumgranular shrinkage cracks and attached oysters. Further components: abundant tiny, angular intraclasts, common debris of M. lugeoni, bioclasts of echinoids, corals and others. Groundmass formed by fine-grained sparite, most probably recrystallized micrite

m 2.3 – 22.8: uniform sequence of grey, medium-bedded, nodular, marly mudstones and wackestones. Intercalation of massive, non-marly mudstones in middle and upper part, the first with distinct burrows of Thalassinoides sp. and Rhizocorallium irregularare on lower surface. Arcomytilus morrisi, oysters, bivalve and gastropod clasts occurring; in upper part Isognomon sp. Partially pyrite aggregates

m 22.8 – 29.0: dark grey marl with very rich, though low diverse bivalve fauna: Mesosaccella dammarenensis (a), Jurassicbulla edwardi (c), Protocardia sp. (c), Protoperina pygmaea (c), ?Pleiromya sp. (r). At base, coquina horizon of A. morrisi and Isognomon sp.

m 29.0 – 29.7: medium bed of grey mudstone, overlain by medium-bedded, nodular, marly mudstones with decreasing marl content towards top. Scattered bioclasts of oysters and gastropods. At top, thin marl layer

m 29.7 – 31.0: light grey, bioclastic wacke/floatstone, with common rhodolith fragments (M. lugeoni), bivalve clasts (partly microbored), especially oysters, gastropod clasts, spines of Pseudocidarina lusitanica, lutiloids, etc.

m 31.0 – 34.5: grey, medium-bedded mudstones, mostly nodular and very marly (calcareous marl at base). Isognomon sp., etc.

m 34.5 – 35.7: grey marl with large A. morrisi and very tiny Corbulonima suprajurienensis, Mesosaccella dammarenensis, Jurassicbulla edwardi, Nicainella sp., Protocardia sp., Placopristis suprajurienensis and ostracods

m 35.7 – 40.5: grey, medium-bedded, marly, nodular bioclastic floatstones (partly wackestones) with intercalation of 30 cm Arcomytilus morrisi-bearing marl in lower part. Bioclasts of limestones dominated by gastropods (partly nerineids). Rare lutiloids, Cylindroporella sp., etc. Top inaccessible.

Quarry wall south of store depot:

m 40.5 – 41.5: light brown, bioclastic intraclastic packstone, poorly sorted; roundness of grains moderate to good. Small bioclasts microbored. Echinoids, oncocid and lumps occurring, lutiloids common. Rare large bivalve clasts and nerineids. Dense packing of grains; matrix mostly spartite
m 41.5-45.2: grey marls with rich fauna: Mesosaccella dammariensis (a), Corbulomima suprajuresis (a), Isocyprina sp., Pteroparnia pygmaea, Juracarbula edwardi, Plicatula sp., echinid spines; abundant ostracods (Cytherella suprajurassica, Asciocythere sp., Cytheropteron sp., aff. Thecosomocome sp. [nominogen]). Stroma, verneuillids. Eventicyclammina virgulans, light tinter, authigenous quartz (c). Shell bed of Isognomon sp. occurring in midst of 80 cm of silty marly, bioclastic wackestone with Namagyrna nana, Myophorella lusitanica.

m 45.2-46.8: light coloured, thick-bedded, bioclastic intraclastic peloidal wacke/packstone. Bioclasts and intraclasts normally micropelled; lumps, large gastropods, spines of Pseudocollaris lusitanica, very frequent litoleds (mostly Pseudocyclusina sp., P. litus, «Haplophragmium» sp., Rectocyclusina sp., Nautiloculina oolithica), very rare mioloids, etc.
m 46.8–47.5: thin beds of intercalated marls, bioclastic wackestone and oncoidal rudstone
m 47.5–48.5: grey marl with frequent Praeexogyra pustulosa and cidaroid spines, encrusted by Marinella lugeoni
m 48.5–49.5: light, bioclastic wackestone with floatstone and rudstone areas. Mainly oyster debris, partly superficially algal encrusted. At top, small corals
m 49.5–51.0: dark grey, marly calcisponge boundstone (frame/bafflestone) with stromatoporoids and corals, bored by Lithophaga sp. (also in groundmass), encrusted by serpulids, sessile foraminifers, oysters. Groundmass between frambuilders, wacke/packstone with coarse, angular bioclasts.

Continuation of section at quarry wall N store depot. Divided by minor fault from rest of section. Fault—caused gap or eventual overlap unclear; most likely minor gap, since similar coral facies can be found at base of quarry wall in question:

m 52.0–53.0: dark grey marl with poor fauna: Placopora suprabejrensis (a), J. edwardi (c), C. superbrensis (o), Modiolus sp. (f); common ostracods (forms see m 41)

m 53.0–53.5: grey, bioclastic, partly bioturbated float/rudstone, with coarse clasts of corals (partly Axosmina sp.; corals bored by Lithophaga sp.), oysters and other bivalves (e.g., A. morrisi, Trichites sp.), echinoids, M. lugeoni, frequent lituolids

m 53.5–60.5: grey, medium–bedded, marly nodular limestones (mainly mud/wackestones, in part floatstones). Often distinct burrows of Thalassinoides sp., A. morrisi, partly in clusters, and clasts of gastropods and bivalves

m 60.5–62.0:
brownish, iron hydroxide-stained, thick-bedded, poorly sorted, oncoiditic rudstone. Irregular shaped, *Lithophaga*—bored oncoids built of cyanophytes, *M. lugeoni* and sessile foraminifers, partly polycrystalline (clasts of bivalves, echinoids). Groundmass microsparitic to spartic (implying a partially primary micritic matrix), or marly (at base, in middle and at top).

m 62.0–71.2:
grey, medium-bedded, partly marly, nodular mudstones (in part wackestones) with *Arcomytilus morrisi* (forming a coquina at m 68.5) and rare *Myophorella lustiana*, *Isoognomon* cf. *flabelliforme*, gastropods, etc.

m 71.2–72.8:
grey marls with abundant *Praeexogyra pustulosa* and *Nanogyra nana* which form thin oyster patch reef with irregular lower and upper surface at top.

m 72.8–75.8:
grey, thick-bedded, wacke/floatstones, with intercalated, thin-bedded, nodular mudstones. Wacke and floatstones bear corals and lithoids. Spines of *Pseudociadis lusitanicus* and *Isoognomon* sp. in lower, *Trichites* sp. in middle and frequent *Marinella lugeoni* in upper part. Excellently preserved burrows of *Rhizocorallium irregular* on lower surfaces.

m 75.8–76.8:
grey marls

m 76.8–77.6:

m 77.6–82.5:
grey, medium-bedded, partly marly, nodular bioclastic limestone (mud—wacke—floatstones), often coral-bearing, with *A. morrisi*, *Jurassiccula edwardii*, common corals (partly forming rudstone in middle), etc. At top, oncoid-bearing, with echinoderm debris, *M. lugeoni* and rare foraminifers. Intensively bioturbated by *Rhizocorallium irregularum*. Early desiccation cracks occurring.

m 82.5–87.5:
grey, thin-bedded, very marly nodular mudstones and thick, weathered marls, both very silty in upper part.

m 87.5–93.5:

End of section.

Section Calhandriz

Location: geol. map, sheet Loures, NE quadrant, SSE Calhandriz. Section taken uphill, from the first outcrops up to trig. altitude mark on hilltop.


Generalities: Normally only hard beds outcropping, it was also attempted to use information from outcrops nearby to avoid major gaps within the section.


Special remarks: Sobral formation outcaved. Lower part of *Pteroceriano* formation with corals and red algae.

Description:

(a) Base of section (from the road to Calhandriz, climbing across covered Abadia beds up to first outcrops): 10 m Amoral formation, i.e. 4 m brownish yellowish, large-scale cross-bedded, medium to coarse-grained, moderately sorted, oolitic grainstone, partly bioturbated (*Scolithos* sp.). Mostly detrital quartz serving as ooid nuclei. Above it (laterally displaced), 6m coral floatstones (partly boundstones with thick beds) and oolitic grainstones with bioclast—cored ooids and *M. lugeoni* (nodules up to 10 cm φ). Above it, gap (ca. 2.5 m), then 50 cm yellowish, micaceous, finely-grained sandstone with common calcite pieces (up to 3 cm in size), superimposed by horizon with *Isoognomon lusitanicum* (Sobral formation), *Isoognomon* horizon possibly corresponding to Gervilka marls at base of Calhandriz section.

(b) Detailed section (cf. to section chart), located 200 m west of part (a): m 0.0–1.3:
brownish, iron hydroxide-stained, intracrustal peloidal packstone with fine bioclasts, coral fragments, *M. lugeoni* and lithoids (top of Amoral formation)
m 2.0 – 3.8: dark grey marls with *Gervillia sobralensis*, *Arconytilus morrisi*, *Isognomon cf. lusitanicum* and *Praeexogyra pustulosa* (Sobral formation)

m 6.0 – 24.5: light grey, nodular mudstones (partly floatstones) with minor exposure gaps. Thin–bedded, though compact. *Thalassinoides suevica* and *Rhizocorallium irregular* partly well visible on lower surfaces. Rare *A. morrisi* and small–sized bioclasts typical, occasionally *Trichites* sp., giant *Protocardia* sp. A, *Myopholas multicostata*, echinoid fragments, corals (very rare) and *M. fugeoni*

m 27.2 – 28.8: greyish oncitic floatstones with an intercalation of oncitic marl. Iron hydroxide–stained ooids; oncoid nuclei built of bivalve clasts, *M. fugeoni* and, partly, corals. Non–encrusted *M. fugeoni* also common in intraclast–bearing matrix

m 29.2 – 30.8: light grey gastropod wackestone (two small horizons, divided by gap). Bicbored corals may be common

m 30.8 – 35.0: gap, in upper part outcrop of nodular mudstones with *A. morrisi*
m 35.0–37.0: very thick-bedded intraclassic peloidal packstone with frequent litooids, etc. Components mostly microborred

m 37.0–38.0: grey, nodular calcisponge wacke/floating stone with additional gastropods, bioclasts, Salpingoporella annulata

m 38.0–45.3: gap, with small outcrop of nodular mudstone with A. mornisi, giant Protocardia sp. A and Mactromya concentrica

m 45.3–47.3: light, thick-bedded, coral boundstone (bafflestone) with Amphistrea piniformis, Cyathophora cesareodensis, Actinastrea ranulifera, A. crasso-ramosa, Praeexogyra pulsulosa, spines of Pseudocidaris lusitanicus, M. lugeoni, etc.

m 48.9–49.0: yellowish, medium-bedded, nodular bioclastic rudstone with oncoids (partly superficial), Isognomon (Rostroperina) sp., P. pulsulosa, Placunopsis surraeensis, Myophorella cf. lusitanica, meandroid corals, spines of Pseudocidaris lusitanicus, etc.

End of section.

Carvalha Sections

Location: geol. map, sheet Alenquer, SW quadrant. From Arruda dos Vinhos to Mata and further direction to Arranhó. For Section East climb down from edge of curve following serpentinite curve to stream valley. Here beginning of section, extending NNW up to trig. altitude Carvalha. Section West starts at road km 5, extending N up to high tension pole below Carvalha hilltop.

Stratigraphic range: uppermost part of Sobral formation (only Section East), lower part of »Pteroceriano« formation.

Generalities: hard beds with good outcrops. Area intensively faulted, yet with minor displacement.

Nearby sections: Mata, Batuha, Boiçote.

Special remarks: To point out outcruushing of Sobral sandstones within the »Pteroceriano« formation, two parallel section were taken. Note frequency of coralline algae and corals in siliciclastics. The sections are the direct continuation of the Mata section.

Description:

Section East

m 0.0–4.0: (in stream valley) brown, micaceous siliciclastics with Eomidotod secundiformis, Aniquagyprina sp., Nerineae turbinate, superimposed by medium bed of grey calcareous marl and grey marl with Gervilla sobralensis (top of Sobral formation)

m 4.7–5.2: grey, medium to thick-bedded, marly mudstone with scattered Arcamylitus mornisi, Camptonectes cf. australis, Praeexogyra pulsulosa and, in upper part, rare fragments of Trichites sp.

m 5.2–9.0: exposure gap, in soil rubble sandstone and mudstone fragments

m 9.0–13.2: grey, medium-bedded, nodular mudstones with A. mornisi, pectinids, Trichites sp., litooids, ostracods, with intercalations of bioclastic float/rudstones with Marinella lugeoni, corals, echinids. At top, common compaction cracks

m 13.2–15.0: brown sandstone, overlain by iron hydroxide-stained, very sandy, marly floatstone with Isognomon lusitanicum, Eomidotod secundiformis, clasts of Trichites sp., vertebrate tooth and M. lugeoni. Superimposed is sandy marl with E. secundiformis, Trichites aff. saussurei, Praeexogyra pulsulosa, nerineids (in part Nerineae turbinate), Pseudocidaris lusitanicus (spines), Amphistrea piniformis, Actinastrea crassoro-ramosa, Ovalastrea cf. plicatula, P. pulsulosa forms oyster patch reef, outwending over a few meters

m 15.2–17.0: brown siltstone with Isognomon sp., Unicardium crassum, Coelastarte discus, P. pulsulosa, nerineids, ampullolid gastropod, P. lusitanicus (spines), and brown sandstone with E. secundiformis. Sandstone apparently interfingerling with siltstones and outwending over a short distance. Top of sandstone cut by NW–SE striking fault

m 21.0–22.9: brownish grey, mostly nodular floatstones and pack/rudstones with M. lugeoni, bioclasts (partly microborred), frequent spines of P. lusitanicus, T. aff. saussurei, oysters, serpulids and litooids (Pseudocyclammina sp., Rectocyclammina sp., Freixialina planispiralis). At top, common cracks and leaching features

m 23.3–26.0: soil rubble implies subcropping nodular mudstone with rare oysters and other bioclasts
m 26.5–30.5: at base, brownish, marly oyster rudstone, rapidly passing into *P. pustulosa* boundstone with *Amphistaerea piniformis*, spines of *P. lusitanicus* and other echinids, serpulids. Above it, horizon of *M. lugeoni* rudstone, followed by grey, medium to thick—bedded mudstone with rare oyster clasts, gastropods, serpulids, lignite litter and, at top, *Everticyclammina virgulana* and *Trichites* sp.

m 31.0–33.6: at base, thin oyster boundstone, overlain by brown, iron hydroxide—stained oyster rud/floatstone with corals and other bioclasts. At top, marly mudstone with rare bioclasts and spines of *P. lusitanicus*

m 33.6–36.2: exposure gap with sandstone rubble

m 36.2–37.2: greenish brown, poorly sorted, micritic bioclastic rudstone (one bed) with coarse fragments of *P. lusitanicus* (spines), *M. lugeoni*, oysters and other bioclasts

m 37.2–44.2: exposure gap with minor outcrops of marl and *A. morrisi*—bearing mudstones
Section Carvalha West

m 44.2 – 46.2: at base, marly patch reef of *P. pustulosa*, with overgrown valves of *Myophorella lusitanica*; overlain by brownish, marly, bioclastic rudstone with abundant debris of *?Coelastarte discus*. At top, brownish grey nerineid floatstone with cortoids, calcisponges, nodules of *Solenopora cayeuiformis* n. sp., *M. lugeoni* and intraclasts. Section is cut by fault

m 47.5 – 51.3: (on hilltop Carvalha) brownish, iron hydroxide–stained, very thick–bedded to massive coral boundstone (framestone), dominated by, often *Lithophaga*–bored, *Amphistrea piniiformis*. Heavy recrystallization is disguising further structures.

End of Section East.

Section West (brief description)

Base of section is formed by major fault (also cutting top of Mata Section); below it, sandstone rubble.

m 0.0 – 5.0: grey, nodular mud/floatstone with burrows of *Thalassinoides suevica*, *Rhisocorallium irregularare*, and *A. morrisi*, giant *Protocardia* sp. A, *Protocardia* cf. *intexta*, *Praexogyra pustulosa*, *Camptorectes* cf. *auritus*, *Trichtes* sp. (in upper part), echinoid and other debris; rare liuolids (*?Everticyclammina virguliana*), *Cylindroporella* cf. *arabica*. In upper part marls, oyster rudstone and oyster boundstone intercalated. Comaction cracks and intensive recrystallization in higher part

m 5.0 – 7.5: at base, gap, with sandstone rubble and common, large *Eomidona securiformis*, *Coelastarte discus*. Above it, cluster of *Isognomon lusitanicum* with rare *A. morrisi*. Bivalves densely covered with *P. pustulosa*, with transition to oyster patch reef with incorporated *A. morrisi* and spines of *Pseudocidaridus lusitanicus*

m 7.5 – 17.5: medium to thick–bedded limestones with intercalation of marls: grey mudstones with *A. morrisi*, oysters and *E. virgulana* dominating in lower part; brownish bioclastic wackestones with corals (e.g., *Axosmilia* cf. *discoidea*), *M. lugeoni*, spines of *P. lusitanicus* in upper part. Here also intercalations of micrite *M. lugeoni* rudstones with abundant oyster debris, etc.

m 17.5 – 19.6: at base, brown, medium bed of slightly marly coral boundstone (framestone), with additional calcisponges, *M. lugeoni*, fine bioclasts. Micritic (conlalotitic?) crust on top of bed. Strongly recrystallized, with spar–filled solutional vugs. Superimposed is thick–bedded rhodolith bound/rudstone (micritic), almost exclusively formed of *M. lugeoni*
m 19.6–23.5: exposure gap, with outcrops of grey, bioturbated mudstones and bioclastic wackestones

m 25.5–28.0: from base to top:
- thin oyster patch reef
- grey, bioturbated bioclastic peloidal floatstone with Trichites sp., oyster and echnoid debris, Marinella lugeonii, Everticicyclamina virguliana. Spar-filled solutional vugs and autodidact formation
- dark grey, thick, moderately sorted rhodolith grain/packstone with M. lugeonii, spines of Pseudocicatris lusitanicus (often enriched in layers), rare corals, cortoids, intraclasts, peloids, etc. Groundmass formed of neospa; ghost structures common
- bioclastic rhodolith float/rudstone with similar characteristics
- nodular mud/wackestone
- slightly marly, micritic oyster rudstone with additional gastropods, microbored corals, Pseudocyclamina sp., Haplophragmium sp.
- nodular mud/floatstone with fasciculate corals, partly bored by Lithophaga sp., M. lugeonii, Cylindropora cf. arabica, E. virguliana, ?Mesoendothyra sp., Partly recrystallized, with irregular cracks, often reddish, mottled colouring.

Section most probably cut by fault (at high tension pole).

End of section; sandstone outcropping in superimposed part, with Eopecten cf. velatus, Isognomon lusitanicus, Caelaster discus, corals, overlain by mudstone with Arctomytus morrisi, rare oysters, corals and litooids, with common compaction cracks.

Section Chão de Vinha

Location: geol. map, sheet Alenquer, SW quadrant, 4 km S Arruda dos Vinhos. From Francisco do Meio up to trig. altitude Chão da Vinha. Section extending from top of well exposed «Corálico» outcrops up to hilltop.

Stratigraphic range: uppermost Amaral formation, Sobral formation, »Pteroceriano« formation, lower part.


Nearby sections: Calhandriz, Boieiro.

Special remarks: Sobral clastics about 30 m in thickness.

Description:

m 0.0–1.2: bioclastic wackestone/floatstones with M. lugeonii, enrichments of P. lusitanicus spines, rare corals, etc. (Trancoso member of Amaral formation, upper part)

m 1.8–3.0: ocre-coloured, sandy oolitic grainstone, partly packstone. In middle part 5 cm of oyster boundstone. Oolite bioturbated, with ooid-filled burrows extending to underlying mudstone (Oolite member of Amaral formation)

m 3.0–30.5: mostly gap, with common loose blocks of brownish sandstones and rare outcrops of silt—sandstones, partly even laminated, with occasional oyster layers and Eomiodon secundiformis (Sobral formation)

m 34.5–51.6: poorly exposed nodular limestones (mainly mudstones) with Arctomytus morrisi, oysters, etc., and Trichites sp. in some levels. Note marl layer at m 45.0 (extending to old windmill) with Gervilia sobralensis, Isognomon cf. lusitanicus, A. morrisi, Praeexogyra pustulosa, and superimposed, iron hydroxide-stained, bioclastic float/packstone with inconstant thickness, bearing abundant oysters besides other bioclasts, e.g., corals, Pseudocicatris lusitanicus (spines), M. lugeonii. On hilltop, floatstone with Trichites sp., Myophras multicoastata, A. morrisi, P. lusitanicus (spines), Everticicyclamina virguliana, dasycladaeous, etc.

End of section.
Section Chão da Vinha

Section Engenheiro

Location: geol. map, sheet Torres Vedras, NE quadrant, 3.5 km S Torres Vedras. From trig. altitude Engenheiro southwards direction to Carvalhal, after ca. 750 m bending southwestwards towards Quinta de Viscondessa.

Stratigraphic range: Amaral formation, Sobral formation, «Pteroceriano» formation, Santa Cruz member (Bombarral formation), Bombarral formation s.str.

Generalities: At base of section, beds strongly inclined with dips of 70° S, flattening towards south, i.e., towards higher part of section, leading to difficulties in determining exact thicknesses (esp. extent of exposure gaps). Exposure condition moderate to good, yet major gaps.

Nearby sections: Bemposta, Enxara do Bispo.

Special remarks: Westernmost section of large extent. Dominating faunal elements are Isognomon lusitanicum and oysters. Note red terrestrial facies already in lower part of section.
Description:

m0.0–2.0: Predominance of brown, medium-bedded, oolitic grainstones with quartz-cored ooids; bioclastic-cored ooids and cortoids occur. Brown, micaceous sandstones form minor intercalations (upper part of Amaral formation).

m2.0–12.0: (Partly poorly exposed) brown, medium to thick-bedded, mostly micaceous and lignitic sandstones, with thin intercalations of oolitic packstones and grainstones.

m12.0–32.5: Exposure gap with presumed marls and siltstones subcropping.

m32.5–33.5: Weathered, red to violet-coloured silts.

m33.5–42.2: Weathered, brownish, mostly marly siltstones with thin sandstone horizons. At m 38.6 thin intercalation of very silty, bioclastic wackestone (grading into packstone) with bioclasts and ostracods; above it, macrofossil coquina, composed of weathered *Isoagmomon lusitanicum*, *Arcomytilus marris*, *Praeexogyra pustulosa* and *Nanogyra nana*. At m 41.0 another coquinaloid layer of partly double-valved, *I. lusitanicum*.

m42.2–45.2: Dark grey to brownish, nodular float- and rudstones (m/critic), with abundant oysters and very common clasts of *M. luteoni*. Apart from this, echinoids (e.g., *Pseudocidaris* spines), cortoids, ostracods, rare li-tuolids and questionable *Cylindroporella* sp. At m 43.5 marl horizon with abundant *N. nana*.

m45.2–50.0: Dominance of grey marls, at base with very common spines of *Pseudocidaris lusitanicus* and *N. nana*. Here also intercalations of nodular wackestones with features similar to above described (top of "Ptero-"
Section Enxara do Bispo

Location: geol. map, sheet Alenquer, SW quadrant. Beginning of section 600 m WNW of cemetery of Enxara dos Cavaleiros (E Enxara do Bispo), in stream valley, extending W and SW in the fields south of trig. altitude Enxara. End of section at windmill next to Casa da Quinta Grande, 1125 m SSW Enxara hilltop.

Stratigraphic range: Pierocerian - formation, lower part with silicilastic intercalations of the Santa Cruz member.

Generalities: due to very poor exposure conditions and unconnected individual outcrops, sequence of recorded section is somewhat hypothetical. Correlation of individual horizons was worked out in the field, from among the flat position of beds. Dashed parts of presented chart are reconstructed by interpreting soil composition of bare cereal fields. Thicknesses are largely subject of interpretation.

Nearby sections: Moinhos do J. Miguel, Patameira, Alqueidão, Goteis.

Special remarks: though above described difficulties complicate interpretation, section is important due to its situation at the western boundary of main Pierocerian - distribution. Remarkable is the interfingering of silicilastics with coral-bearing limestones and marls (Pierocerian facies interfingerig with Santa Cruz facies). Stratigraphic continuation of section is section Moinhos do J. Miguel.

Description:

m 0.0 - 1.0: findings of Isognomon lusitanicum and rare corals

m 1.0 - 10.0: presumed marls, partly coral-bearing (e.g., Axosmilia sp.), partly with common l. lusitanicum. At m 2.0 bioclastic rudstone (micritic) with abundant oyster debris, M. fugoni, rare Pseudocidarina spines, etc., at m 9.0 abundant small-sized Myophorella cf. lusitanica (presumed same horizon as closeby site contains additionally Isognomon sp. and Amphistephanus pinniformis)

m 11.7 - 14.8: brownish, thick-bedded, bioclastic floatstone with coral debris (mostly Calamophyllia sp.), M. fugoni, etc.

m 17.8 - 19.0: patch reef of Praeexogyra pustulosar/Nanogyra nana, partly with corals, rapidly outwedging, overlain by bioclastic wackestone with gastropods

at m 18: presumed sandstones subcropping

at m 24: marly, silty, coral wackestone with spines of Pseudocidarina lusitanica

m 24.0 - 34.0: no outcrops, but presumed subcropping intercalation of sandstones and coral-bearing marls

m 35.0 - 36.0: presumed bioclastic wackestone with corals

m 36.0 - 41.0: at base, clusters of, mostly univalved, Eoiodon securiformis, l. lusitanicum and M. lusitanica with rare corals in silty matrix. Superimposed are sandstones and brown, sandy, moderately sorted, bioclastic packstones. Bioclasts well rounded and microborered. At top, increase of sand content and occurrence of ooids, lumps and intraclasts; overlain by brown, micaceous, lignitic sandstone

m 42.0 - 49.0: exposure gap, subcrops reconstructed by loose rock rubble: horizons of (from base to top) coral floatstone with Amphistephanus pinniformis, silt with small patch reefs of P. pustulosar/N. nana and abundant l. lusitanicum of gigantic size (up to 21 cm), marls with clusters of, mostly double-valved, M. lusitanica and micaceous, lignitic sandstones

m 49.8 - 50.6: brownish, nodular bioclastic packstone (rarely wackestone) with abundant microborered oyster debris, very frequent Eventicyclammina virgulata, etc.

End of section.
Section Enxarado do Bispo

Location: geol. map, sheet Alenquer, SW quadrant, 1.5 km SE Sapataria. Section from stream valley uphill to hilltop (altitude 299 m).

Stratigraphic range: Oólito member, Sobral formation, »Pterocerano« formation, lower part

Generalities: soft series underrepresented, otherwise good exposure conditions, sometimes beds slightly displaced by gravitational gliding.


Special remarks: Interlacing of oolites, sandstones and micritic limestones led to the separation of an isolated lithological unit in the official geol. map (J3-4). Sandy limestone conglomerates are well developed in nearby sites, though they do not outcrop in the section.

Description:

m0.0-0.5: light grey, nodular, bioclastic floatstone with common Arcaemytillus marisi
m0.5–2.2: grey oolitic grainstone. Ooids mainly with quartz cores; partly polyooids and pitting contacts. Ooid cortices largely varying in thickness.

m3.0–5.0: grey nodular mudstone

m6.3–7.2: dark grey, micaceous, oolitic packstone

m8.0–10.0: ochre-coloured, medium-grained, small-scale cross-bedded sandstone with lignite litter

m11.2–12.7: one bed of brownish grey, micritic oncotic rudstone with abundant *Marnella lugeoni*, partly encrusted by cyanophytes and sessile foraminifers. Ooids partly bored by *Lithophaga* sp. and very poorly sorted. Marly matrix in upper part
m 13.0–14.0: (on opposite slope of stream valley, in correlative position) calcareous sandstone with abundant Sco- 
lithos burrows, grading into silts and marls
m 14.6–15.2: grey, sandy, oolitic packstone; detrital quartz serving as ooid nuclei
m 17.7–18.3: one bed of brownish grey, very poorly sorted oncolitic rudstone analogous to above. Clasts of M. lugeoni up to 2 mm, oncocysts up to 3 cm Ø
m 18.8–23.6: gap with occasional outcrops of thin—bedded, nodular mudstone with A. morrisi. At base, bioclastic wack- 
estone (partly packstone) with cortoids, A. morrisi, echinod spines, M. lugeoni, Everticyclammina virguliana, Rectocyclus sp., Eucyclus sp., Cretaceous cl. aurius, Protocardia sp.

m 24.4–25.4: ocre—coloured, medium to coarse—grained, moderately sorted sandstone. Roundness of grains poor (top of intertonguing sequence with beds attributable to the top of the Oölito member, Sobral formation and lower part of the ″Pteroecerano″ formation)

m 28.0–41.1: grey, thin—bedded, nodular mud/wackestones (partly floatstones), with larger exposure gaps. A. morrisi as well as Praeoxypyrha pustulosa and Nanogyra nana common. In some horizons Trichites sp., Camptonectes sp., Protocardia sp., Myopholas multistata, etc. Partly distinct burrows of Thalassinoides suezica and Aribicocoralium irregularare

m 43.0–46.7: thin, partly nodular mudstones, with exposure gaps. In gaps findings of Isognomon lusitanicum (eventually 
fallen down from m 49.0) and ?Pleuromya sp.

m 46.7–47.3: ocre—coloured, densely packed macrofossil coquina with marly matrix. Fossils partly fragmented. Do- 
minating are P. pustulosa, N. nana, Eompholites secundifera, Nereis nana, besides A. morrisi, Unicardium crassum, Coelastarte discus, I. lusitanicum, Trichites sp., Pseudocidaraius lusitanicus (spines). Partly only composed of E. secundifera and N. nana

m 47.3–49.0: marls with common N. nana, rare P. lusitanicus (spines) and rare ampullinid gastropods. At top, layer with very common I. lusitanicum (mostly univalved), encrustled by oysters, passing into small P. pustulosa/N. nana patch reef

m 51.5–53.8: grey, thin—bedded, nodular bioclastic mud— and wackestones, with Rectocyclus sp. and Pseu- 
docyclammina sp.

End of section.

Section Mata

Location: geol. map, sheet Alenquer, SE quadrant. From Arruda dos Vinhos SW to Mata (on road to S.Tiago dos Velhos). Section starting 1 km S Mata center (last houses on road), more or less following southern side of road, partly also using outcrops on slope. Top of section 150 m before road crossing below Casal da Vila Nova (fault).

Stratigraphic range: uppermost Trancoso member, Oölito member (both of Amaral formation), Sobral forma- 
tion, lowermost part of ″Pteroecerano″ formation

Generalities: exposure conditions rather satisfying for normally poorly exposed Sobral formation. Since all out- 
crops available were used for section, small correlation errors might be possible.

Nearby sections: Carvalha, Beleiro.

Special remarks: section exhibits small—scaled facies variations in elastic sequence. Note coral fauna appearing in siliclastic facies at m 28. Carvalha sections form direct continuation of present section.

Proposed type section for Sobral formation.

Description:

m 0.0–1.0: peloidal wackestone with common cortoids (esp. gastropods), rare corals, lituloids (e.g., Everticyclam- 
mina virguliana), venneulitids, etc. (top of Trancoso member, in lagoonal facies)

m 5.7–6.0: dark grey, oolitic rudstone with slightly marly matrix, ooids, rare Marinella lugeoni (at southernmost house along road from Mata and in stream under road bridge)

m 7.5–9.0: 40 cm of dark grey, micritic oolitic rudstone, overlain by marls with abundant oncocysts at base (mean Ø 5 mm)

m 11.6–23.0: sequence of thin to medium—bedded, partly cross—stratified oolites (light grey, marly packstone and light brown grainstone, both with mostly mature, quartz—cored ooids, Oölito member) and superim- 
posed silty marls, in part with Nanogyra nana, also with oolite layers and intercalation of brown, cross-
—stratified sandstone with mica and lignite enrichment on forest surfaces. At m 15 Praequoxygra _pustrulosa/Nanogyna nanapatch reef

m 27.7—28.4: densely packed rhodoliths up to 5 cm Ø _M. lugeon_ in marly matrix. Often borings of Lithophaga sp.. Intercalated is oyster patch reef, overgrowing corals and in part bivalves are heavily encrusted by algae, serpulids and bryozoa. Coral meadow and oyster patch reef outwedge within a few meters, so that in lateral equivalents only oyster and coral debris can be found. Determined fauna: P. _pustrulosa_ N. _nana_, «Lophha» sp., giant Protoceratia sp. A, _Pseudocidaris lusitanicus_ (spines), _Axosmilia crassa, A. carapaterensis_, A. _cornuta, Actinostrea crassa —ramosa

m 28.4—35.2: brown, bioclastic siliciclastics, often with quartz—cored ooids, debris of _M. lugeon_ and other bioclasts, lignite litter. Often outwedge or downcutting into intercalated marls with _N. nana_. At top, laminated sandstones, oolitic pack/grainstones (in part cross—bedded). Submature quartz—cored ooids, common coarse bioclasts, rare _M. lugeon_, etc.

m 35.2—39.0: exposure gap (in serpentine curve of road)

m 39.0—44.2: brownish, marly, micaceous sandstones with ooids and, in part, lignite litter, intercalating with marly, sandy, oolitic packstones with coarse carbonates. At top, weathered marls with common _Gervilla sobralensis_ and _Pteroperna_ sp.

m 46.0—52.5: sequence of densely intercalated, thin to medium—bedded, micaceous marls, siltstones and fine—grained sandstones. At top, thick layer of marl with common _Gervilla sobralensis_(partly double—valved) and _Pteroperna_ sp.

m 52.5—64.0: exposure gap, with thick—bedded, brown sandstone outcropping in lower part

m 64.0—66.5: at base, marly, ooid—bearing sandstone with common oysters, _Isognomon lusitanicus, Gervilla sobralensis, Eomodion securiformis_, clasts of other bioclasts, serpulids. Above it, weathered marls with G. _sobralensis_ and rare _I. lusitanicus_(top of Sobral formation)

m 66.5—70.0: grey, medium—bedded, nodular (except base) mudstones with clusters of _Arctoytis morrisi, Camptorectes_ cl. _auritus_, deep—burrowing bivalves, bivalve clasts, ostracods, _Evertinidammina virgulina_, partly grading into nodular floatstones with additional oysters, gastropods, _e.g._, _Pseudocidaris lusitanicus_ (spines), rare quartz—cored ooids and intraclasts, very strongly bioturbated. Sequence showing distinct signs of early vadose diagenesis (early cracks, bioturbation, partly collapsed and/or filling of crystal silt)

m 71.5—72.5: light grey, _M. lugeon_ floatstone with fragmented rhodoliths, cortoids; overlain by brown, sandy, oolitic packstone with _E. securiformis_

m 73.0—78.5: grey, marly nodular limestones, at base, mudstone with _A. morrisi_, turning into floatstones (partly micritic rudstone) with _Trichites_ sp., debris of _M. lugeon_, common angular clasts of bivalves, gastropods, echinoids, etc. Frequent corals at m 74: thin coral meadow mainly of _Amphistrea parriformis_, bored by _Lithophaga_ sp. and encrusted by oysters. At top, mudstones with _E. virgulina_

m 81.0—81.3: greyish brown coquina (rudstone in marly matrix) of, partly fragmented, _Unicardium crassum_, _A. morrisi, Gervilla_ sp., _I. lusitanicus, Pteroperna_ sp., _Trichites_ sp., gastropods and rare corals (in similar bed at close—by site determinable as _A. axosmilia_, _Ovalifastrea_ cl. _lobata_, with _Praequoxygra pustrulosa overgrowth_)

End of section.

Section Moinhos do J. Miguel

Location: geol. map, sheet Alencar, SW quadrant, between Enxara do Bispo and Senhora do Socorro. From Enxara do Bispo along traffic road direction to Sapatara. After about 1 km turn to short—cut to S. Sebastião (track). Section starts at bridge over stream valley, extending NNE to elevation 181 m (370 m S Moinhos do J. Miguel). End of section on hilltop.

Stratigraphic range: _Pterocerano_ formation, lower part of Bombarral formation.

Generalities: section is most likely continuation of section Enxara do Bispo. Extent of gap between both unknown, presumably 10—20 m. Outcrop conditions poor, but most probably undisturbed sequence.

Near by sections: Enxara do Bispo, Pataimeira, Alqueidão

Special remarks: see remarks for section Enxara do Bispo.

Description:

m 0.0—11.2: (poor exposure conditions, mostly reconstructed by loose rock rubble) intercalation of grey marls and grey nodular mud/wackestones with common _A. morrisi_ and oysters (mostly _Nanogyna nana_), further-
more findings of Protocystis sp., Jania echioides, Cidarocystis fulva corona, poor preservation, etc.

mass occurrence of Ammonites (early double-valved) superimposed by Muralyra and bound rud-
very frequent *I. lusitanicum*, also with *Coelastarte discus*. At top, *M. lusitanica*

m26.0–51.0: exposure gap, findings of *M. lusitanica* and *I. lusitanicum*, both with overgrowth of *Praeexogyra pustulosa*, *Nanogyra nana* and serpulids

m51.0–54.3: from base to top:

- thin layer or silty marl with abundant spines of *P. lusitanicus*
- thick bed of coral boundstone (framestone), almost entirely built of big heads of *Amphastrea piniformis*, bored by *Lithophaga* sp. and encrusted by oysters. Additionally, solitary corals and spines of *P. lusitanicus* in small micritic pockets between coral heads.
- thick bed of marly oyster rudstone, at base with *Myophorella lusitanica* and frequent spines of *P. lusitanicus*
- intensively weathered marl

m56.0–62.2: from base to top (with small gaps between outcrops):

- brown, medium–bedded, slightly nodular, bioclastic wackestone with gastropods, corals, etc., Bioclasts partly microborred
- slightly nodular, bioclastic rudstone (micritic). Abundant rounded fragments of *Marinella lugeoni* and oysters besides echinoid spines
- patch reef of *Praeexogyra pustulosa*/*Nanogyra nana*, partly bored by *Lithophaga* sp. and encrusted by sessile foraminifers (?). Greenish marly filling of interstices

m66.0–67.0: brown, thick–bedded, well sorted, micaceous sandstone with rare oyster debris

m67.0–91.0: exposure gap, with findings of oyster bearing marls (at m 70), *M. lusitanica* (at about m 69 and 87), *Amphastrea piniformis* (at m 72), *Axensmila sp.* (at m 87), *Isognomon lusitanicum*, *Pteroperna* sp. and *?Gerviella aviculoides*

m91.0–93.0: at hilltop m 181) light brown, evenly laminated, moderately to well sorted sandstone with rare oyster debris.

End of section (another presumed 5 m of true thickness until change to strongly red coloured soil: boundary between Santa Cruz member and Bombarral formation s.str.).

**Section Oerca**

**Location**: geol. map, sheet Alenquer, NE quadrant. From main road Alenquer direction to Olhalvo turn left at Estalagem (direction to Sobral), then immediately left again: here base of section, extending along road in direction to brig, altitude Oerca.

**Stratigraphic range**: top of Oolito member, Sobral formation.

**Generalities**: outcrop conditions moderate to good, yet fine–grained beds are deeply weathered.

**Nearby sections**: S. Quitéria, Sobral.

**Special remarks**: very monotonous section, exemplary for Oolito/Sobral development in this area. Stratigraphic continuation is S. Quitéria section.

**Description**:

m0.0–2.5: light brown, thick–bedded, well sorted, in part marly, oolitic grain/packstone. Mature ooids; nuclei of ooids 80% detrital quartz, 20% bioclasts. Larger cortoids, constituting of oysters and other bivalves, and gastropods. At top, passing into poorly sorted, oolitic grainstone with non–encrusted detrital quartz

m2.5–7.0: weathered siltstones and silty marls, in part with oysters

m7.0–8.3: brownish grey, thick–bedded, oncolitic limestones, ranging from dunal, sandy, ooid–bearing grainstones to, predominating floatstone and rudstones. Superficial oncolids, in part with sessile foraminifers. Nuclear composed of oysters, gastropods, bivalves, echinoids and corals (in decreasing frequency). Furthermore, *Geyseriidae* algae, *M. lugeoni*, etc.

m11.2–12.7: brownish, medium–bedded, very sandy, oolitic–oncolitic rudstone (micritic), overlain by thin oolitic packstone and medium–bedded, very sandy wacke/packstone with frequent gastropods, ooids, *Marinella lugeoni*, *dasyoladaceans* (?), *Haplophragnum* sp., *Verticyclammina virgulina*, etc. (top? of Oolito member)
Section Oerca

m 12.7 – 21.0: weathed, ooid-bearing, marly siltstones with thin intercalations of marly, ooid-bearing gastropod wackestones and oolitic grainstones

m 21.0 – 30.5: poorly exposed sequence of marly siltstones, partly with oysters

m 30.5 – 36.0: medium to thick-bedded, sub-mature sandstones with rare lignite litter. Thin intercalations of oolitic grainstones exhibiting quartz-cored ooids.

End of section. Clastic sequence extending up to Oerca hilltop: siltstones and sandstones with thin intercalations of oolites (quartz-cored ooids) and rare, thin oyster beds. In upper part, eventually intercalations of thin marly bioclastic wackestones (loose rock rubble).

Section Patameira (without section chart)

Location: geol. map, sheet Alenquer, SW quadrant. From Gosundeira (between Sapataria and Dois Portos) to Patameira and further to Marquita (trig. altitude m 342) (details below).

Stratigraphic range: Amaral formation, Sobral formation, «Pteroceriano» formation, Frexial formation, Bombaral formation (including Santa Cruz member).

Special remarks: Apart from basal part no outcrops. Information drawn from soil composition and loose rock rubble. Nevertheless, bare fields assure for not having overlooked eventually existing hard rocks, especially limestones. No detailed description and thicknesses can be given. Note subordinate development of «Pteroceriano» and Frexial formations. Fault, cutting section according to geol. map, apparently plays minor role, possibly, however, accounting for the very minor distribution of the «Pteroceriano» formation.

Description: hills W village Gosundeira. Several tens of meters of Amaral formation: oolitic pack/stone, often
well sorted, in part cross-beded and bioturbated, with detrital quartz serving as ooid nuclei. Small intercalations of bioturbated marls, with ooid-filled burrows. Oolites extending up to new road below hilltop Patameira. East of road rare outcrops of brownish, thick-beded, micaceous sandstones. Below hilltop, marl with oysters, summit built of oyster patch reefs (25 m of true thickness, from top of oolites up to here; Sobral formation).

Continuation along pathway from hamlet Patameira de Cima to Casal Monte Deixa (ruin): first 800 m crossing «Pterocerian» equivalents (mainly Santa Cruz member): soil contains fragments of marls and siltstones; marly, silty, bioturbated mudstones are rare («Pterocerian» formation). Then change to intensively red soil colour, with large quartz pebbles. Rare fragments of marly limestones (Freixial formation/Bombarral formation). (Occurring rubble of dense, foraminiferous limestones are derived from Cretaceous outcrops at Marquina). At ruin, outcrop of coarse quartz conglomerates and violet marls with caliche concretions. True thickness: several hundreds of meters??

End of section.

Section Santa Quitéria

Location: geol. map, sheet Alenquer, NE quadr. From main road Alenquer direction to Olhalvo. Section starting 500 m after Estalagem (at bifurcation to Sobral) along road cut, then climbing north uphill to hilltop (altitude m 141, 500 m SW Meca), south of distinct mountain Sta. Quitéria.

Stratigraphic range: upper part of Sobral formation, «Pterocerian» formation, Bombarral formation, lower part.

Generalities: apart from road cut (until m 14 of section) and small quarry within red clastics (m 86–92), only moderate outcrop conditions. Parts of sections reconstructed by loose rock rubble. Present section is stratigraphic continuation of section Oeira, though overlap is assumed. Top of Amolar formation supposed to be situated 10–15 m below base of present section.

Nearby sections: Oeira.

Special remarks: very important section, because of (a) northernmost outcrop of «Pterocerian» facies (Trichites limestones, nodular limestones), outwedges here; (b) main occurrence of the Alenquer oncolite (cf. to LEINFELDER 1985).

Description:

m0.0–5.5: intercalation of brownish sandstones (dominating) mostly with feldspar, mica and ignite litter, and thin horizons of brownish marls, silts and siliciclastic conglomerates, the latter with reworked caliche nodules. *Comidotan sexiformis* occurring in sandstone

m5.5–7.5: greyish brownish, thick-beded, very sandy, peloid packstone with large bioclastics, mostly biomicroliths with superficial oncoid coating, ooids (50% with quartz cores), small cortoids, rare *M. lugeoani, Haplophragmium* sp., rare ostracods, etc. Distinct early diagenetic vadose influence. Above it (divided by thin marl layer with gastropods and ostracods), thick-beded, bioturbated sandstone with abundant bioclastics, esp. oysters, frequent quartz-cored ooids, *M. lugeoani*, common ignite litter, gravels of sandy limestones and reworked caliche and mud pebbles

m7.5–14.0: marly–silty sequence with thin intercalations of sandstones and very sandy, bioclastic rudstones (micritic), partly bioturbated and with debris of oysters, other bivalves and gastropods, mostly as cortoids. At m 12.5, in very sandy oyster packstone, small fragments of *M. lugeoani*, lituolids, verneulids and rare serpulid. Findings of *Gervilka* sp.

m14.0–49.0: gap of uncertain extent (here presumed 35 m), with common caliche concretions in soil, esp. in upper part

m49.0–56.2: (upper part reconstructed by loose rock rubble) red to violet coloured sequence (except for base), composed of feldspar–bearing siliciclastics (partly quartz conglomerates with lime pebbles) and multicoloured marls with caliche concretions. Possible intercalation of red coloured (rubefaction?) oolitic bioclastic grainstone with mature, quartz-cored ooids and bioclastics, mostly preserved as ghost structures. Gravels of quartz, feldspar, *M. lugeoani* (top of Sobral formation)

m56.2–56.8: thick bed of greyish brown, poorly sorted algal packstone (at base marly mud/wackestone) with abundant, well rounded debris of *M. lugeoani*, cortoids (also of echinoids), lituolids, valvulinids. Very sandy at base, quartz content decreasing towards top. Partly chaotic, imbricated bedding of components, mostly due to bioturbation?, Partly strongly recrystallized. Note *Arctomythus morrisi* and frequent, partly double valved *Trichites* aff. *saussurei* in upper part (vestige of «Pterocerian» formation)

m57.3–59.5: at base, pale, lignitic, feldspar–bearing sandstones with gravel and caliche horizons, above it, sandy, oolitic pack/grainstone with cortoids, rare lituolids, fragments of *M. lugeoani* and detrital feldspar grains
Section Santa Quitéria

gap, with presumed extent of 20 m. In higher part common caliche concretions (rock rubble). At top, red to violet marls

thick-bedded, poorly sorted quartz conglomerate, exhibiting trough crossbedding and fining upwards of individual strata. Pebbles almost exclusively milky quartz (moderately rounded), rarely feldspar. Red marly matrix

red to violet, bioturbated silts and silty clay, with thin intercalations of fine sandstones and, at top, conglomerates

at base, weathered marl with poorly preserved, rare ostracods, cerithid and planorbis gastropods; followed by two sets of sandy oncolites, separated by weathered marls and silts. At top, nodular mudstone with rare ampullinid gastropods and birdseyes (second vestige of Pteroceriano formation). (This sequence is treated in detail in LEINFELDER 1985)

red clastics, mostly coarse-grained, with thin clay layers; conglomerates with a high amount of feldspar and metamorphic pebbles (Bombarral formation).

End of section, at hilltop south of elevation Sta. Quitéria.
Section São Tiago dos Velhos

Location: geol. map, sheet Loures, NW quadrant. Section starting 1200 m S of Tiaos dos Velhos (reference point church), at road to Bucelas; at m 6 of section turning east along a curved track up to windmill ruin, then further uphill southwest of Monhós dos Toijias up hilltop.

Stratigraphic range: Pterocerinion formation, upper part; Freixal formation, lower part.

Generalities: moderate to good outcrop conditions in lower part (up to ruin). Minor faults are cutting the section, thus changing attitude of bed sand causing some insecurities in correct correlation of beds. Upper part very poorly exposed, thus loose rock rubble had to be used to reconstructing the part of the sequence. Information in upper part derives from both the slopes W of Monhós dos Toijias and SW of southern hilltop, also causing difficulties in correct correlation.

Nearby sections: Aivotas, Arranhô—Bemposta, Calhandriz.

Special remarks: section is important because of its faunal richness. In the surroundings, additional rich fauna could be detected, e.g., in former field W of Tiaos' primary school (northern border of village), on a road (fossil site is now destroyed due to construction of a new house).

Stylina (Convexastrea) sexradiata, S. giroli, Cystophora bourguetii, ?Thannantheria pseudarchaenoides, Microphylla davidsoni, ?Amphiastrea pinformis, Arximia crassa, A. caudata, A. carrapaterensis, A. cl. corallina; Myophorella lusitania with overgrowth of Nanogyra nana/Praeexogyra pustulosa, Gervillia aviculoides, Isognomon (Rostraperna) sp., Pedapperna sp., calcisponges.

At road further north (300 m N of dos Eiros) in fields: (additional forms only) Cystophora cesaredensis, ?Cystophylla corrugata, Isognomon lusitanicum, serpulids.

Description:

m 0.0 - 0.5: brown, iron hydroxide—stained, thick—bedded, oncotic rudstone. Spongiostromate oncocids, mostly of type SS—R, small SS—C and superficial oncocids also common. Clasts of bivalves, gastropods, echinoids, Micranella lugeoni and ?Pseudocampanella gr. parva—mulunchens. ?Haplophragmium sp., Freixalina planispina and Lenticulina sp., microsparitic neosparitic groundmass

m 0.5 - 5.0: poorly exposed, weathered marls, partly with corals and common Mesosaccella damianensis, Corbulomina suprajurassensi, Niciellia sp., cerithid gastropods, common smooth oysters and rare foraminifers

m 5.0 - 6.0: at base, brownish, moderately sorted, oolitic grain/packstone with large coroids, double—valved bivalves, algal lumps, M. lugeoni, Pseudocampanella gr. parva—mulunchens, Ammobaculites sp. Ooids with thin, radial fibrous cortices, half with quartz, half with bioclastic nuclei. Microsparitic to neosparitic groundmass. Above it, slightly sandy, micritic oysters rudstone with additional gastropods, corals, echinoids. All clasts with superficial oncotic envelopes.

Between road and fundament of windmill ruin, separated from former part by minor fault:

m 7.0 - 8.0: brown, iron hydroxide—stained, thick—bedded, bioclastic oncotic rudstone with large spongiostromate oncocids (SS—R, C), often with M. lugeoni serving as nuclei or incorporated in algal envelope. Bivalve and gastropod clasts partly with only superficial envelope. Rare ooids and detrital quartz, both in oncoid cores or embedded in algal layers. M. lugeoni also common as non—encrusted fragments. Furthermore, algal clasts of Gervillia aviculoides, echinoid spines, P. gr. parva—mulunchens, Nautilinina oolithica, ?Mesoendothyra sp., Ammobaculites sp., Lenticulina sp., Conchospinitha basitensis. Micro—nego—sparitic groundmass with common ghost structures. Rudstone becoming marly towards top, grading into marl with common coroids

m 8.0 - 9.8: weathered marls, with intercalation of thin, marly, bioclastic oncotic wackestone and layer with Gervillia aviculoides, partly algal encrusted, in upper part

m 9.8 - 12.0: (possibly parautochthonous large block) light brown coral floatstone with large coral clasts and abundant fine, angular bioclastic debris. Internal sediment in occurring gastropods is pelmimitic, implying the same pre—diagenetic matrix structure for the entire rock. Thin algal—foraminifer encrustations around large clasts. Rare occurrence of Micranella lugeoni, Pseudocampanella m. sp., ?Salpingoporella annulata, ?Campbellella stiata, ?Mesoendothyra sp., litooids indet. and ?bryozoa. Rubble of rhodolith Lithocodium facies in this level most probably derived from outcrop at m 18

m 12.0 - 16.2: predominance of dark grey, partly bituminous marls with ostracods and soft bottom fauna of the Jurassic corbula edwardi association. Myophorella lusitania, Isognomon lusitanicum, gastropods, etc., with intercalation of dark brown, sandy, bioclastic wackestone with entire shells and clasts of bivalves, gastro
Section São Tiago dos Velhos

m 16.2 – 18.0:
light grey, medium to thick–bedded mudstones and coral floatstones, with isolated, partly tumbled, Lithophaga–bored coral heads. Furthermore, angular bioclasts, M. jugeonii, verneuilids and valvulids, etc. At top, thick bed of light brown, oncologic intraclastic rud/floatstone with common rhodoliths of M. jugeonii, Solenopora cayeuxiformis n.sp., Lithocodium sp., besides calcisponges, clasts of echinids, bivalves and nerineids, Pseudocyrtammina gr. parvula–mulcensis, P. litius, Freixalina planispiralis, ?Mesoendothyra sp., Nautilolina polithica, –Haplophragmium– sp., verneuilids and valvulids as well as small SS–C oncooids, common intraclasts and peloids.
Page 180-20.6:
Weathered marls, at top with shell bed of Pteropera sp.

Page 20.6-23.3:

Page 23.3-24.5:
Weathered marl with shell bed of Pteropera sp. and Myophorella lusitania.

Page 24.5-26.3:
Light grey, medium to thick—bedded, bioclastic oncoidal wacke/floatstone, with large, microbore bioclasts of corals, bivalves, gastropods; iron hydroxide—stained oncoids (SS—R), common small—sized bioclasts and M. lugeoni, S. cay euxiformis n.sp., Solenopora sp., »Lithocodium« sp., ?Petra sacula bursiformis, small lithoids, Ammobaculites sp., nubecularids, verneuillinds and valvulinids, and fragment of vertebrate bone.

Page 26.3-28.2:
Exposure gap, with finding of M. lusitania and oysters.

Page 28.2-31.3:
From base to top:
- Thin horizon of marly siltstone
- Brown coral float/rudstone with coral heads, bioclasts, P. gr. parvula—mulchens, ?Permocalculus n.sp., bryozoans, ?crustacean debris, and local hardground with attached oysters
- Brown coral bound/floatstone with Lithophaga—bored Amphiastera priformis, angular bioclasts, spines of Pseudocornea lusitania, Permocalculus n.sp., lithoids and autoids
- Light, though partially bitumen—stained, bioclastic rud/floatstone with large, mostly microbored shells and clasts of bivalves, gastropods, echinoids and very frequent Permocalculus n.sp., partly preserved with entire thallus, besides P. gr. parvula—mulchens, ?Mesoodothyra sp., Freixinella planispiralis and »Haplophragmium« sp.
- Brown, very sandy, bioturbated, bioclastic wacke/packstone with cortoids, quartz—cored superficial ooids, dasycladaceans indet, ostracods, lithoids and lignite litter

Page 31.3-32.7:
Weathered marl with M. lusitania, Pteropera sp., both covered with Praeexogyra pustulosa and Nanogyra nana.

Page 32.7-34.2:
At base, brownish grey, bioturbated mudstone with rare double—valved bivalves, gastropods, bioclasts, ostracods, Permocalculus n.sp., dasycladaceans, P. gr. parvula—mulchens, E. virgolana. Bioturbated, with bitumen—stained faecal pellets in Pianolites—like burrows. At top, coquinoiid bed: Pteropera sp., Archimylitus morrisi, oysters and other bivalves in marly matrix. (Windmill ruin standing on the latter.)

On hill slope:
At m 35.0:
Intensively weathered marl with common Myophorella lusitania and ?Pleuromya sp.

Page 36.2-38.0:
At base, brownish grey, medium—bedded, very sandy, nodular Permocalculus packstone. Besides Permocalculus n.sp., common sponge spiculae, ostracods, lithoids, etc. At top, brown, iron hydroxide—stained coral floatstone with Amphiastera priformis m 38.0—49.0: exposure gap, with minor outcrops:
- At m 39.0, marl; above it, findings of M. lusitania
- At m 42.0, coquinooid layer with Pteropera sp., A. morrisi, Antiocyprina sp., Camptonectes cf. auf i tus, centrid gastropod, in marly matrix
- At m 45.0, common findings of M. lusitania and Pteropera sp. (presumed top of »Pteroceratina« formation
- At m 46.0, very sandy, glauconitic Permocalculus wackestone
- At m 46.5, micritic sandy, bioclastic rudstone with large bivalve shells, ostracods and small bioclasts. Sheltered pores below convex shells with cement A, B
- At m 48.0, quartz conglomerate
- At m 49.0, moderately sorted, calcareous sandstone with large, thick bivalve shells, partly double—valved, gastropods, among these planolids, ostracods and lignite litter

At 62.0:
Brown, bioturbated, calcareous siltstone with ostracods and lignite litter

At 69.0:
Red coloured, poorly sorted arkose/subarkose with poorly to moderately rounded pebbles
End of section.

Sobral Sections

Location: geol. map, sheet Alenquer, SW, NW quadrants, E Sobral de M. Agraço.

Subsection A (Chã-Montijo): from below Moinho do Chã (2 km ESE Sobral, 800 m E Folgadão) northwards, mostly along path, passing football ground, up to trig. altitude Montijo (m 335). From here continuation towards west up to altitude m 294.

Subsection B (Maceira): from altitude m 291 (600 m WNW Freiria) northwards, up to trig. altitude Maceira (m 261).

Subsection C (Sobral northern exit): along traffic road Sobral-Freiria, section situated behind last houses of Sobral.

Subsection D (Moinho do Sobral): along road from Sobral to Dois Portos until exit of Sobral. Opposite night—club beginning of section, climbing southwards up to windmill and castle. Further samples from southwest slope.

Stratigraphic range: uppermost Amoral formation (A), Sobral formation (A, B, C), lower part of »Pteroceriano« formation (A, C, D).

Generalities: outcrop conditions for limestones good, for siliciclastics poor, with exceptions. Large gaps; estimation of extent matter of interpretation. Due to intruded basaltic dyke in part D, it is also difficult to measure total thickness.

Nearby sections: Batalha, Alqueidão, Oeiras.

Special remarks: subsection A is the southern equivalent of subsection B; subsections C and D are situated further west, with C being lower and D upper part of sequence.

Description:

Subsection A (Chã-Montijo)

at base, 20 m or tan—coloured, massive to very thick—bedded Amoral formation

m 0.0–1.0: light brown, slightly marly, micaceous, well sorted, oolitic pack/grainstone with mature, quartz—cored ooids and lignite litter

m 1.0–26.0: mostly exposure gap, with sandy soil and sandstone rubble. In upper part outcrops of brown, marly, micaceous, wavy laminated siltstones, fine—grained sandstones and very thick—bedded, lignitic, coarse—

m 26.0–30.0: (nearby football ground) thin to very thin—bedded, very micaceous, lignitic siltstones and fine—grained sandstones, with intercalations of ooid—bearing coquina with Eomodiodon secundiformis, Isognomon lusitanicum, Arcymytilus morisii, coated bioclasts and Marinella luteoni, and oolitic packstone with quartz—

m 30.0–54.5: exposure gap with scree and blocks of micaceous sandstones, partly with oysters and Scolithos burrows

m 54.5–57.5: (around Montijo hilltop) outcrops from base to top:

— brown, micaceous, very calcareous sandstone, partly with open fabric, containing lignite litter and rare bioclasts (esp. oysters, serpulids)

— brown, lignitic sandstone and bioclastic rudstone with all bivalve clasts oriented in convex upward position; intergranular pores filled with spar—cemented sand. Rare ooids, mica, glauconite and lime clasts (mostly reworked caliche). Here also findings of Gavillia sobralensis

— bioclastic oolitic grain/packstone, black coloured due to nearby dolerite dyke. Well sorted, mature, quartz—cored ooids, bioclasts and common entire bivalve shells, small gastropods; mica, glauconite

m 60.0–65.5: below altitude m 294) lower part, thick—bedded to massive Praexogryra pustulosa/Nanogryra nana patch reef, bored by Lithophaga sp., with spines of Pseudocardis lusitanicus and common Amphistreon piniformis. Marly groundmass at base, grading into pelletal—micritic matrix. Upper part, grey, marly, medium—bedded, nodular mudstone with Protocardia sp., rare bioclasts (also of echinoids), ostracods and Evertycliculmina virguliana (base of »Pteroceriano« formation). At top, thin, apparently rapidly outwedgeing P. pustulosa/N. nana patch reef with spines of P. lusitanicus.
Sobral Sections

A: Chã - Montijo

B: Maceira

c. 50 m marls, siltstones, sandstones
C: Sobral northern exit

D: Moinho do Sobral
Subsection B (Maceira)

m 0.0–2.5: (altitude m 291): brown, micaceous, silicilastic sequence, large and small-scaled cross-stratified (planar and trough cross-bedding) with foresets dipping predominantly south. Common climbing ripples, etc.

m 2.5–53.0: marls and siliciclastics, poorly exposed, with large exposure gaps

m 53.0–63.0: (on Maceira hilltop) from base to top:
- grey, very sandy, micritic bioclastic oyster rudstone; all shells microbored, rare echinoid debris and \textit{Marinella lungei}
- marly siltstone
- brownish, oncitic pack/grainstone. Besides dominating quartz-cored ooids, also small bioclasts serving as nuclei. Larger bioclasts microbored
- minor gap with mudstone rubble (eventually from above?)
- thin-bedded marls, silt, and sandstones with findings of \textit{Gervilia sobralensis}
- 6 m of grey, nodular mudstone (rarely wackestones), at base very sandy, with \textit{Arcomytilus morrisi}, rare \textit{Protocardia} sp., \textit{Trichites} sp., \textit{Camptopithecus} cf. \textit{autius}, oysters and other bioclasts. In middle part intercalation of \textit{Praegyptorcula gilus} patch reef with corals (base of "Pteroceratina" formation).

Subsection C (Sobral northern exit)

m 0.0–3.2: brown, thick to very thick-bedded, poorly to moderately sorted, micaceous, lignitic, coarse-grained sandstones and conglomerates with scattered bivalve clasts and lime pebbles at m 2.0

m 3.2–7.0: dark grey to black marls and brownish siltstones, with intercalations of outwedgeing, cross-bedded sandstones. Marls with rare, poorly preserved soft bottom fauna (mainly \textit{Jurassicicula edwardsi}) and sand-filled \textit{Scolithos} burrows (the latter also in silts)

m 7.0–10.0: poorly exposed marls, partly red coloured, with rubble of reddish calcare mudstone

m 13.0–14.0: grey, medium-bedded, marly, bioturbated mudstone with \textit{Protocardia} sp.

m 14.0–15.5: dark grey, micaeous marls, partly strongly weathered, in lower part with oysters and \textit{Gervilia sobralensis}; above it, with soft bottom fauna (\textit{Jurassicicula edwardsi}, c; \textit{Corbulomma spraguei}; c; \textit{Phacopus spraguei}; s, c; \textit{Pygeum pygmaeum}; r, \textit{Myochlamys multicornis}, c) and imprint of crab carapax. At top, thin intercalations of fine-grained sandstones.

Subsection D (Moinho do Sobral)

m 0.0–18.0(?): grey to black (due to dolerite), marly, nodular mudstone, with astonishing paucity of components. At base, floatstone with \textit{Arcomytilus morrisi}, \textit{Protocardia} sp., oysters, gastropods, spines of \textit{Pseudoceratina lusitanicus}, rare serpulids, \textit{Evertickella virgulana}, etc.

m 18.0–21.0: exposure gap, with findings of \textit{Isognomon lusitanicum}

m 21.0–22.3: brownish grey, very marly, partly reworked \textit{Nanogyra nana} patch reef, overlain by grey, nodular mudstone with scattered \textit{A. morrisi}, \textit{Protocardia} sp., rare bioclasts of \textit{Trichites} sp., gastropods, echinoids, corals; also with rare \textit{Marinella lungei}, \textit{Evertickella auriculata virgulana}, etc.

m 22.3–23.6: grey marl with small bioclasts and very abundant spines of \textit{Pseudoceratina lusitanicus}.

End of sections.

Section Tesoureira - Cassis da Serra

Location and Generalities: geol. map, sheet Loures, NW quadrant. This is a composite section, based on individual subsections, all situated in the vicinity of traffic road Casais da Serra - Sobreira - Tesoureira.

From base to top:

Part Tesoureira (sample abbrev. TS): from western border of village, crossing stream, then southwards uphill through well exposed, thick-bedded limestones up to hilltop 600 m E hamlet Cartacharia (upper part poorly exposed).

Part Arranhó hill (sample abbrev. BA): 500 m E Sobreira, from farm Casal da Fonte da Pêra southeast upwards, crossing fields up to hilltop Arranhó (not to confuse with village Arranhó, several km further NE). Exposure condition of this part very poor, with only narrow outcrops, improving towards top. On hilltop small quarry.
Part Casais da Serra (sample abbrev. CA): from southern border of village Semieira (pg–st) along traffic road further south, crossing Casais da Serra, up to main road Montachique–Bueelas. Outcrop conditions very poor, yet an additional section from Perinheiro (300 m W Casais da Serra) northeastwards up to windmills (sample abbrev. CM) gave additional data.

Nearby sections: Alcubela–Freixal, Goteis.

Stratigraphic range: upper part of ‘Piterceriano’ formation, Freixial formation.

Special remarks: upper part of section (part Casais da Serra) is already briefly described in RAMALHO (1971: 89–92). For the purpose of this work it was attempted to obtain a continuous, long-distance section. Though determination or estimation of thicknesses, esp. of exposure gaps, is difficult, correlation of individual section parts, however, is based on extensive field studies, so that parts Tesoureira and Arranhô hill, as well as parts Casais da Serra and Perinheiro–Casais Moinhos are combined to two individual logs. Correlation between these is somewhat interpretative.

Description:

A: Lower Part: Subsection Tesoureira–Hill Arranhô

m 0.0–5.5: brownish grey, iron hydroxide–stained, partly spartic, bioclastic rud/packstone. Very thick, vaguely cross–stratified beds, within some meters laterally passing into nodular, medium beds with Thalassinoides burrows. Very poorly sorted and rounded components consist mainly of bivalve (e.g., oyster) bioclasts, bored by serpulids and clionids?, and frequent echinid and crinoid debris with enrichments of Pseudocidaridus kusitanicus spines. Furthermore, terebratulids (partly double–valved), debris of calci-
sponges and corals, serpulids, bryozoans, Marinella lugeoni, Solenopora cayeuxiformis n.sp., Lithocodium sp., Pseudocyclammina gr. parvula – mutchensis, Evertycyclammina virguliana, Nautiloculina oolithica, Haplophragmium – sp., verneulinids and lithoids, as well as, partly only superficial, spongiosostome oncocysts (SS – R) with incorporated nubecularids and bryozoans and, in lower part, ooids with radial fibrous cortices. Except for base, matrix mostly micritic (at top with floatstone areas); in internal sediment, filling shells, a primary pelmicritic structure is obvious. Early vadose influence indicated by common, mostly circumgranular desiccation cracks, solution and dolomite growth in solutional vugs and fissures.

m 5.5 – 22.0: exposure gap, with findings of coral fragments, most probably derived from coral-bearing marls
m 22.0–30.2: outcrops of brownish, medium beds in varying facies: at base, oncoidal—bearing marl, grading into oncoidal
rudstone with *M. lugeoni* or nereid—coiled spongiosicord/bryozoan oncoids (SS–R. 1). Oncoids of very variable size. Large irregular oncoids composed of irregularly shaped bioclastic cores, overgrown by *Lithocodium* sp., followed by thick layer of *M. lugeoni* and thin layer of cyanophytes. Rare
litoidss, *Coniothyris basilensis* and fine—grained bioclasts occurring. Note common desiccation cracks and crystal silt in solutional vugs. Above it, coral marl and thin boundstone, composed almost exclusively of
*Amphistrea piniformis*, with *M. lugeoni*. Following is a, extremely recrystallized, bioclastic pelletal packstone with oncoids, *M. lugeoni, Ammobaculites* sp., *Haplophragmium* sp., *Racketocyclammina* sp., verneuilids and valvulinids; superimposed by oolitic grainstone and pelletal packstone with large, burrowing bivalves. At top, completely recrystallized and calcichieved bed, most probably
former oncoidal bioclastic packstone with oysters, litoidss, etc.

m 30.2–32.8: brownish, thick—bedded, slightly marly, coral boundstone (framestone), almost exclusively built of
*Amphistrea piniformis*, with common spines of *Pseudocidaris lusitanicus*

at m 34: medium bed of dark brown, well sorted, bioclastic packstone with well rounded coroids, *M. lugeoni* and
questionable crustaceous debris

m 35.5–38.8: light grey, thick—bedded coral floatstone with pocillo and fasiculate corals, partly in situ, grading into
bioclastic wackestone with fine bioclast, gastropods, echinoid spines, calccespines, *P. gr. parvula—mulu-
chenensis, ?Mesoendothyra* sp., *Nautiloculina carthaca*, valvulinids and verneuilids, *Lenticulina* sp.,
*cayuxid*—algae, rare dasycladaceae indet., *Terquemella*? *triangulares* and questionable *Permocalle-
culus* n.sp.

m 39.2–42.0: brownish grey, medium beds, divided by small exposure gap. At base, rhodolithic pelletal packstone
with corals, calccespines, oncoids and fragments of *M. lugeoni*

m 42.0–52.0: exposure gap, with findings of fragments of *Arcomylius morrisi, Isognomon* sp. and ampullifid gastropod

m 52.0–54.0: at base, marl with *Naugyra nana*, grading into marly oyster rudstone and micritic bioclastic rudstone with
large coroids, abundant *Permocculus* n.sp., *Haplophragmium* sp. and rare ostracods. At top, brown, micaceous, lignitic sandstone (vestige of Santa Cruz member or beginning of Freixial formation)?

m 54.0–64.5: exposure gap, with rubble of sandstone

m 64.5–65.8: reddish, sandy marls, overlain by dark grey, bioturbated, sandy mudstone with packstone—filled bur-
rows. Scattered bioclasts, ostracods and *Everticyclammina virguliana* occurring

at m 67.0: rubble of multicoloured, predominantly reddish, sandy caliche mudstone (Freixial formation)

at m 69.0: weathered marl with *Peeexygra pusillosa*

at m 70.0: light grey, partly heavily recrystallized litoid wackestone with *Pseudocyclus* sp. *Parvula—mulu-
chenensis, Ricketocyclammina* sp., verneuilids and valvulinids, *Quinqueloculina* sp., rare *Permocalle-
culus* n.sp., etc.

m 90.0–92.0: reddish marl, overlain by light coloured, pelletal *Permocculus* wacke/packstone with abundant *Per-
occulus* n.sp. and common *P. gr. parvula—muluchenesis, P. litius, Ricketcocyclammina* sp., *Mesoendoth-
thyra* sp., verneuilids and valvulinids, rare *Lenticulina* sp. and *Quinqueloculina* sp., *Terquemella*?
*triangulares*, questionable *Campbellellia striata* and large bivalve and gastropod clasts. Intercalated is thin
layer of fine—grained sandstone

m 102.0–104.0: light grey, medium—bedded, nodular bioclastic wacke/packstone with partly micorbored clasts of neri-
neids, oysters and other bivalves, occasionally entire bivalves, and *Permocculus* n.sp., *C. striata, Sal-
pingoporella annulata, Terquemella*? *triangulares*, litoidss and ostracods. Common desiccation cracks. Large
areas recrystallized (end of section part Tesoureira).

at m 112.0: dark brown, moderately sorted, oolitic bioclastic lithoclastic grainstone with superficial oncoid. Strongly
recrystallized (end of section part Tesoureira).

m 122.0–123.4: intensively weathered marls, superimposed by light coloured, bioturbated bioclastic wacke/packstone
with various sized bioclasts and very common large *P. gr. parvula—muluchenesis* (late form), rare *Everti-
cyclammina virguliana, Ricketocyclammina* sp., *Mesoendothyra* sp., *Lenticulina* sp., *S. annulata, ques-
tionable *C. striata* and rare ostracods. Very frequent desiccation cracks, leading to autochlast formation

at m 125.0: weathered marls

m 125.5–128.5: lower part, exposure gap with sandstone rubble, in upper part siliciclastic conglomerate outcropping

m 130.0–132.2: grey marl, superimposed by light grey, medium—bedded, nodular bioclastic wackestone with fine bio-
clasts and common *Permococcus* n.sp., *S. annulata, Cylindroporella cf. arabica, Actinoporella* podol-
thica, Terquemella? triangularis and other dasycladacean debris, as well as small lituolids and valvulids

m 133.0 – 135.3: dark grey, medium–bedded, nodular bioclastic wacke/floatstone with micritic oyster rudstone layer at base, strongly attacked by vadose diagenesis. Besides bioclasts of oysters, other bivalves and gastropods appear, as well as serpulids, ostracods, Permocalanus n.sp., Rectocyclusina sp. and E. virgulina.

m 138.0 – 140.0: marl, overlain by light grey, marly–sandy, nodular bioclastic wacke/packstone, developing from calcareous sandstone. Bioclasts consist of, partly microbored, bivalves, gastropods and echinoids; furthermore Permocalanus n.sp., Macroporella espichelesis, E. virgulina, valvulids and vermeuloids, ostracods. Common early leaching of shells with formation of autoclasts and internal crystal silt

m 140.0 – 156.0: exposure gap, with several outcrops in lower part; at base, finding of Trigonia freixialesis; above it, poorly sorted, silicilastic conglomerate with poorly rounded gravel, measuring up to 3.5 cm ø; above it, rubble of sandstone, multicoloured, reddish calciche mudstone and violet marls

m 156.0 – 159.2: light greyish brownish, medium–bedded, marly, fine bioclastic nodular mud/wackestones and pelletal pack/grainstones. Small bioclasts, mainly of bivalves and gastropods; furthermore Permocalanus n.sp., M. espichelesis, A. podolitica, E. virgulina, Rectocyclusina sp., Anchiromycolina lusitanica (first appearance), Freixialina planispiralis, «Quinqueloculina» sp. and ostracods (end of section part Hill Arranhô).

End of subsection Tesoureira—Hill Arranhô.

B: Upper Part: Composite Subsection Casais da Serra/Casais, Moinhos

m 0.0 – 1.0: light, brownish grey, medium–bedded, nodular bioclastic pack/rudstone (at base) and wackestone with large, partly microbored, bioclasts of gastropods, oysters and other bivalves; ostracods, rare serpulids and lignite litters, and very common to abundant Anchiromycolina lusitanica, «Quinqueloculina» sp., Selpingia annulata and other indet. dasycladacean fragments, most probably of Likanella bartheli and Cylindroporella cf. arabica. Fragment of embryonic cephalopod. Early compaction cracks and mollified iron hydroxide staining.

at m 19.0: brownish grey, medium–bedded, very sandy, bioclastic wackestone with cortoids, A. lusitanica and questionable Permocalanus n.sp.

at m 28.0: light, brownish grey, quartz–silt–bearing, pelletal packstone with Protocardia sp., fine bioclasts, ostracods, A. lusitanica, Rectocyclusina sp., «Haplophragmium» sp., Freixialina planispiralis, vermeuloids and valvulids, «Quinqueloculina» sp., Permocalanus n.sp. and dasycladaceans indet. Bioturbation by Thalassinoides sp. with incorporated quartz–cored ooids in burrows

m 31.0 – 40.2: at base, lignite marls with intercalations of silty mudstones, passing into grey, nodular bioclastic mudstones and wacke/packstones. At top, densely packed, microsparitic oyster rudstone. Bioclasts often microbored; occurring organisms: serpulids, ostracods, A. lusitanica (c–a), Rectocyclusina sp., E. virgulina, Nautiloloculina oolithica, ?Mesoendothyra sp., «Quinqueloculina» sp. (large, c–a), Permocalanus n.sp. (c), Macroporella espichelesis, C. cf. arabica, S. annulata, questionable Actinoporella podolithica and other indet. dasycladaceans or forms of uncertain designation (?Likanella bartheli, ?Actinoporella maslevi, Chyopsis? solkan). Upper part with deltal detrital quartz and ooids incorporated by bioturbation. Compaction cracks, related autoclast formation and leaching of aragonitic shells common. In top part, gap with findings of Trigonia freixialesis

m 41.2 – 43.3: grey, nodular mudstone with scattered bioclasts, ostracods, Permocalanus n.sp. and A. lusitanica

m 44.0 – 50.0: silicilastic sequence, in lower part with ocre–coloured, moderately sorted, micaceous sandstone with clay pebbles and ?oysters. Medium part intensively red coloured, with multicoloured calciche mudstones. In upper part, light grey, moderately sorted, lignitic, micaceous, carbonaceous sandstone with A. lusitanica


m 54.2 – 134.0: mostly exposure gap, with outcrops of, often coarse, silicilastics, particularly in middle part.

End of section at Cretaceous boundary.
Section Zibreira

Location: geol. map, sheet Alenquer, NW quadrant. Beginning of section on bee-line between Matacães (church) and Carvoeira (church), 1750 m away from Matacães. Course of section towards SE, crossing traffic road and stream, ending 350 m NE Zibreira (church).

Stratigraphic range: Amaral formation, Sobral formation, "Pteroceriano" formation, Bombarral formation (including Santa Cruz member).

Generalities: section taken crossing bare fields. Thus, exposure conditions poor, except for rise S traffic road, where field terraces are under construction. Otherwise section reconstructed by paraautochtonous thin outcrops and loose rock rubble.

Nearby sections: Engenheiro, Sobral.

Description:

m 0.0 - 1.0: light brown, thick-bedded, oolitic pack/grainstones; ooid cores almost exclusively built of detrital quartz (top of Amaral formation)

m 1.0 - 13.0: mostly exposure gap, with thin outcrops of light, strongly micaceous, partly lithic, ooid-bearing sandstones with rare bioclasts and Eomioodon securiformis. At top, bioturbated oolitic packstone with oysters and gastropods; surface encrusted by Nanogyrina nana

m 18.0 - 19.0: brown, very poorly sorted conglomeratic sandstones with common lime pebbles (mostly reworked caliche micrites) and very rare oysters, overlain by micaceous, partly dark red sandstone.

Continuation of section S traffic road:

m 25.0 - 32.0: 1 m of light coloured, thick-bedded, strongly micaceous, bioturbated sandstones with debris of Gervilla sp. and lignite litter, superimposed by greenish grey and reddish violet marls (top of Sobral formation)

m 32.0 - 41.6: predominance of marls with tiny soft bottom fauna, with coquroid clusters of Isognomon lusitanicum and thin horizons of sandstones in lower part. At base and in upper part, intercalation of grey, marly mudstone with oysters. Note esp. bioturbated bioclastic wackestone at m 38.0 with frequent debris of oysters besides fragments of echinoids, Pseudocyclammina sp., Rectocyclammina sp., verneulinids and valvulinids, lagenids, serpulids, ostracods, etc. ("Pteroceriano" formation)

m 41.6 - 72.0: exposure gap with reconstructed outcrops: light coloured, micaceous, partly lignitic and bioturbated sandstones and marls. Note conglomeratic sandstone, patch reef of Praeexogyra postulosa/Nanogyrina nana, growing on valves of I. lusitanicum; marly packstone with oyster debris, horizons of common I. lusitanicum and Myophorella lusitanica, partly overgrown by N. nana

m 72.0 - 80.4: exposure gap, with enrichments of I. lusitanicum valves in middle and top part, in the latter case overlain by thin, laminated sandstones with rare oysters (m 41.6 - 80.4 Santa Cruz member of Bombarral formation)

m 80.4 - 92.0: at base, brown, sandy, nodular caliche mudstone, overlain by thin micaceous sandstone. Above it, intensively dark red coloured sequence with caliche nodules. Top built of coarse-grained quartz conglomerates (pebble Ø - 5 cm) with black basaltic pebbles (lower part of Bombarral formation s.str.).

End of section due to faulting.