

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)

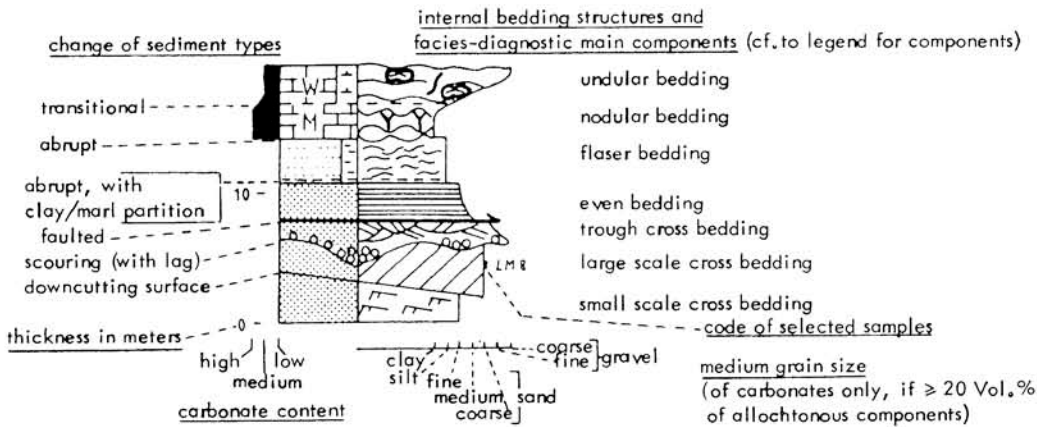
DUNHAM-lithotypes

 mudstone
 wackestone
 floatstone
 packstone
 grainstone
 rudstone
 boundstone

 clay
 marl
 silt
 sand
 conglomerate

textural alterations

 concretion
 bioturbation (general)
 Skolithos sp.
 Diplocraterion sp.
 Rhizocorallium irregulare
 Thalassinoides sp.
 birdseye (general)
 mudcrack
 early diagenetic cracks
 calichefication
 reddish colour
 intensive recent weathering



Components

○ / ○ / ○	ooids, quartz core / bioclastic core, indiffereniated / bioclastic core, e.g. echinid clast
o	peloids
⊙	vadoids
II	intraclasts
⊂	extraclasts, calcareous
q	quartz, detritic
fs	feldspar, detritic
⊞	fragments of cristalline rocks
⊕ / ⊕ _H	dasycladaceans / <i>Macroporella</i>
⌋	charophytes
⌈ / ⌈ / ⌈	<i>Marinella lugeoni</i> , fragments / rhodoliths / <i>Permocalculus</i> n.sp.
—	cyanophytes, evenly laminated
⊃ / ⊃ / ⊃	oncoids, spongiostromate or porospongiostromate/ with sessile organism / eg., with gastropod core
⊗	algal nodules, radial growth, mainly "cayeuxiid" algae
⊙	lumps
○ / ○ _E / ○ _R / ○ _A	lituolid foraminifers (in general) / <i>Everticyclammina</i> / <i>Rectocyclammina</i> / <i>Anchispirocyclina</i>
⊕ / ⊕ / ⊕ / ⊕	valulinids, textulariids / miliolids / lagenids / sessile forams
⌋ / ⌋	serpulids / bryozoans
⌋ / ⌋	ostracods / doublets
▽	brachiopods
⊕ / ⊕ _A	corals, solitary / <i>Axosmilia</i>
⌈ / ⌈	corals, branched / massive
⊕	calci sponges (incl. stromatoporoids)
⊞ / ⊞ / ⊞ / ⊞	echinoids (in general) / echinid spines / <i>Pseudocidaris</i> (spines) / crinoid ossicles
⌋	vertebrate remains
⌋	crustacean remains
⊕ / ⊕ _N	gastropods / e.g., nerineids
⊕ / ⊕	bivalves (in general) / doublets
⊕ / ⊕ _R / ⊕ _M / ⊕ _E	shallow burrowers / <i>Protocardia</i> sp. / <i>Myophorella lusitanica</i> / <i>Eomiodon securiformis</i>
⊕ / ⊕ _M	deep burrowers (e.g., doublets) / <i>Myopholas multicostata</i>
⌈ / ⌈	epifauna!-semiinfaunal: <i>Arcomytilus morrissi</i> / clusters
⌈ / ⌈ / ⌈	bakevelliids / <i>Isognomon</i> / <i>Gervillia</i> / <i>Trichites</i>
— / —	oysters / oyster patch reef
⌋	borers: <i>Lithophaga</i>
⊕	"soft bottom" - small sized bivalves
⊕	large-sized bioclasts (>2mm), e.g., bivalve clast
⊕	small-sized bioclasts (<2mm), e.g., gastropod bioclast
⊕ / ⊕	microbored bioclasts (in general): cortoids / e.g., bivalve bioclast with cortoid structure
⌋ / ⌋	vertical distribution / presumed vertical distribution (e.g., lituolids)
⊕ / ⊕ / ⊕	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 closeby 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 outwedging in neighboured 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 lugeoni*
- m10.0–11.0: intercalation of brownish, micaceous siltstones 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 fasciculate corals, *Marinella lugeoni*, echinoid 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. lugeoni* 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 ooidic envelopes, partly complex and polyooids, lumps
- m45.0–50.0: micaceous, lignitic, ooid-bearing siltstones; 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

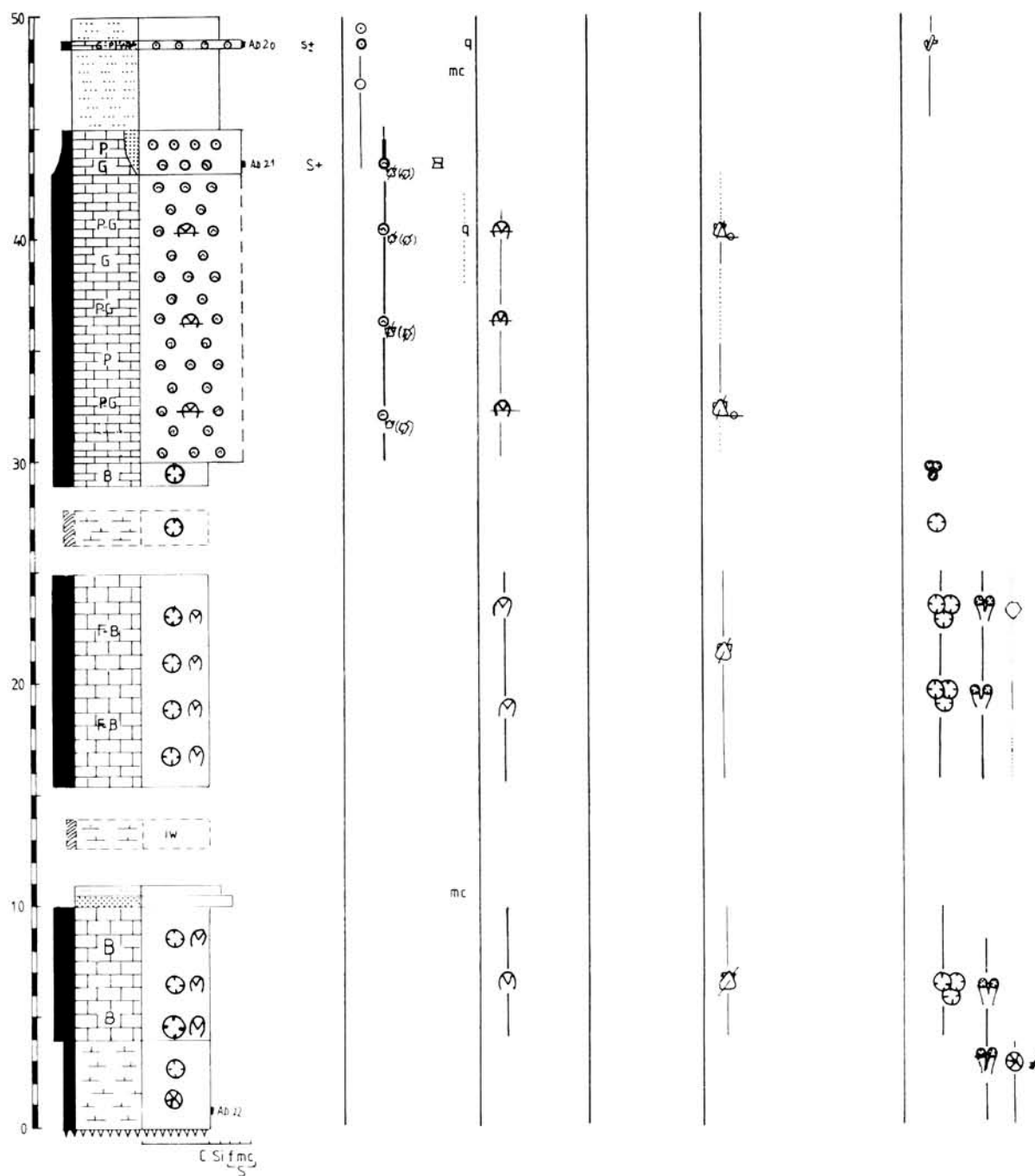
Generalities: section partly taken by zigzagging the slope to avoid major exposure gaps. Possibility of minor correlation errors. Outcrop conditions moderate, partly good (esp. upper part). Marls deeply weathered.

Special remarks: Sobral clastics almost completely outwedged (3 m silts). Corals and *M. lugeoni* already in lower part of the »Pteroceriano« fm.

Description:

- m0.0–3.0: light coloured, poorly sorted oolitic grainstones with *M. lugeoni*, cortoids, etc. (top of Amaral fm)
- m3.0–12.0: brownish-greyish, moderately sorted, sandy, micaceous and lignitic oolitic pack/greinstones. At base, free quartz (besides quartz in ooid nuclei)(transition Oólito mb/Sobral fm)
- m12.0–15.0: brownish silts with layer of *Gervillia sobralensis* (Sobral fm)
- m15.0–19.6: light grey, nodular mudstones, thin-bedded, with *Arcomytilus morrisi*, rare corals (base of »Pteroceriano« fm)

Section Adanaia 1



- m 19.6–20.0: coral bank with marly matrix. Mainly fasciculate corals («*Calamophyllia*» *flabellum*), furthermore *Axosmilia carrapateirensis* and *Ovalastrea lobata*
- m 20.0–21.0: silty marls with *Gervillia sobralensis*
- m 21.8–25.0: Light grey wacke/mudstones and marls with *A. morrissi*; abundant oysters in upper part. In middle part marly ocre-coloured macrofaunal rudstone composed of, only partially broken *Unicardium crassum*, *A. morrissi*, *Isognomon* sp., *Praeexogyra pustulosa*. Furthermore clasts of *Trichites* sp., *Pteroperna* sp., corals, *M. lugeoni*
- m 25.0–31.5: gap; most probably subcropping marls. Findings of giant *Protocardia* sp. A, *Isognomon lusitanicum* with *Nanogyra nana* overgrowth. Above it, *Praeexogyra pustulosa*/*Nanogyra nana* patch reef. Top part: *Myophorella* cf. *lusitanica*, ?*Camptonectes* sp., *Actinastrea crasso-ramosa*, *Amphiastrea piri-formis*, *Cyathophora bourgueti*, *Dermosmilia capitata*, *Axosmilia* cf. *crassa*

- m 48.7–62.0: intercalation of weathered marls and light grey to white nodular mudstones with *A. morrisi*, etc.. At base, marls with abundant oysters and large oncoids, partly with attached *N. nana*. At m 50–52 compact float-stone with small solitary and colonial corals, bored by *Lithophaga* sp.; spines of *Pseudocidaris lusitani-cus*, *M. lugeoni*, oncoids, etc.
- m 62.0–62.6: poorly sorted, well rounded intraclastic packstones with common lito-lids and verneu-linids, grading into rhodolith rudstone. Horizontal burrows on lower surface. Beds apparently outwedging on both sides
- m 63.0–65.2: grey, bioturbated marls with intercalation of thin, nodular mudstones with *A. morrisi*. *Thalassinoides* bur-rows filled with gastropod float/rudstone. *Cylindroporella* sp., etc.. On top 20 cm of light, nodular mud-stone (primarily pelmicritic?), bioturbated by *Thalassinoides suevica*, *Rhizocorallium irregulare*. Lito-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 Arranhó), 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 Buce-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 southward 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–Arranhó, Gotleis, Tesoureira–Casais da Serra.

Special remarks: very important section due to its large stratigraphic extent. Moreover, typus section of Choffat's »Freixialiano«. Holostratotypus of the here defined »Pteroceriano« fm and Freixial fm (see chap. 5.2.2.3). Somewhat unsa-tisfying exposure conditions were compensated by using outcrops in the vicinity of the above described course of the sec-tion. Furthermore, nearby sections give additional data and can be well correlated. Due to the wide lateral extent of the sec-tion, 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 Gotleis, if inter-calation of the latter is not pretended by faulting.

North of Alcubela de Baixo:

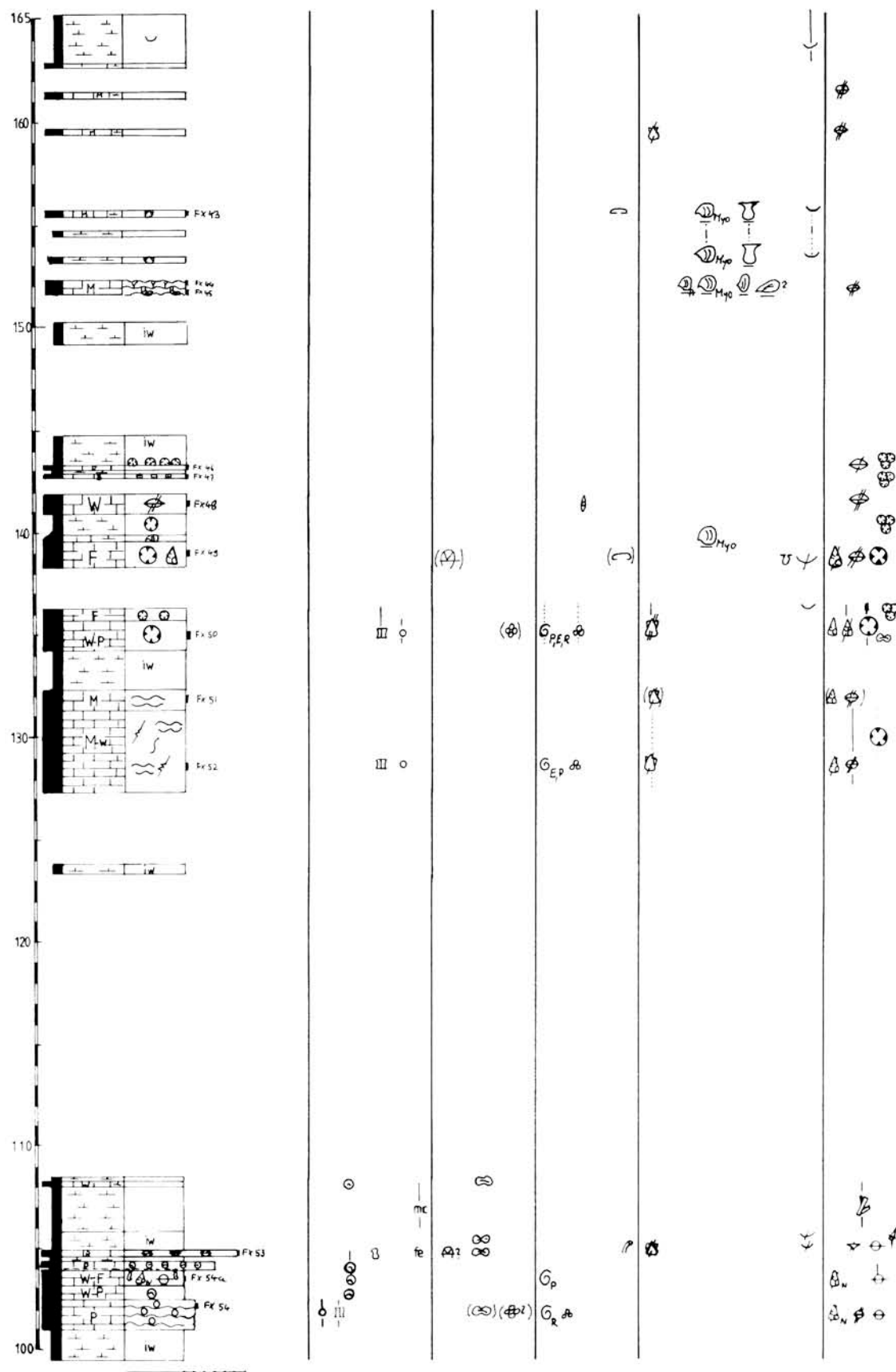
- m 0.0–0.8: brown, micaceous, lignitic sandstone, cross-bedded with foresets dipping southwards
- m 0.8–4.8: exposure gap, most probably covered marls. Fragmented parts of *Gervillia sobralensis*
- m 4.8–5.8: marls, rapidly grading into grey, thick-bedded, partly bioturbated marly mudstones with *Arcomytilus morrisi*, rare *Protocardia* sp., small bioclasts, ostracods; *Everticyclammina virguliana* and on top, *Trichi-tes* sp. and *Praeexogyra pustulosa*
- m 12.0–17.0: grey, marly, mostly nodular mudstones with *A. morrisi* and scattered small bioclasts, with distinct bur-rows of *Thalassinoides* sp..

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

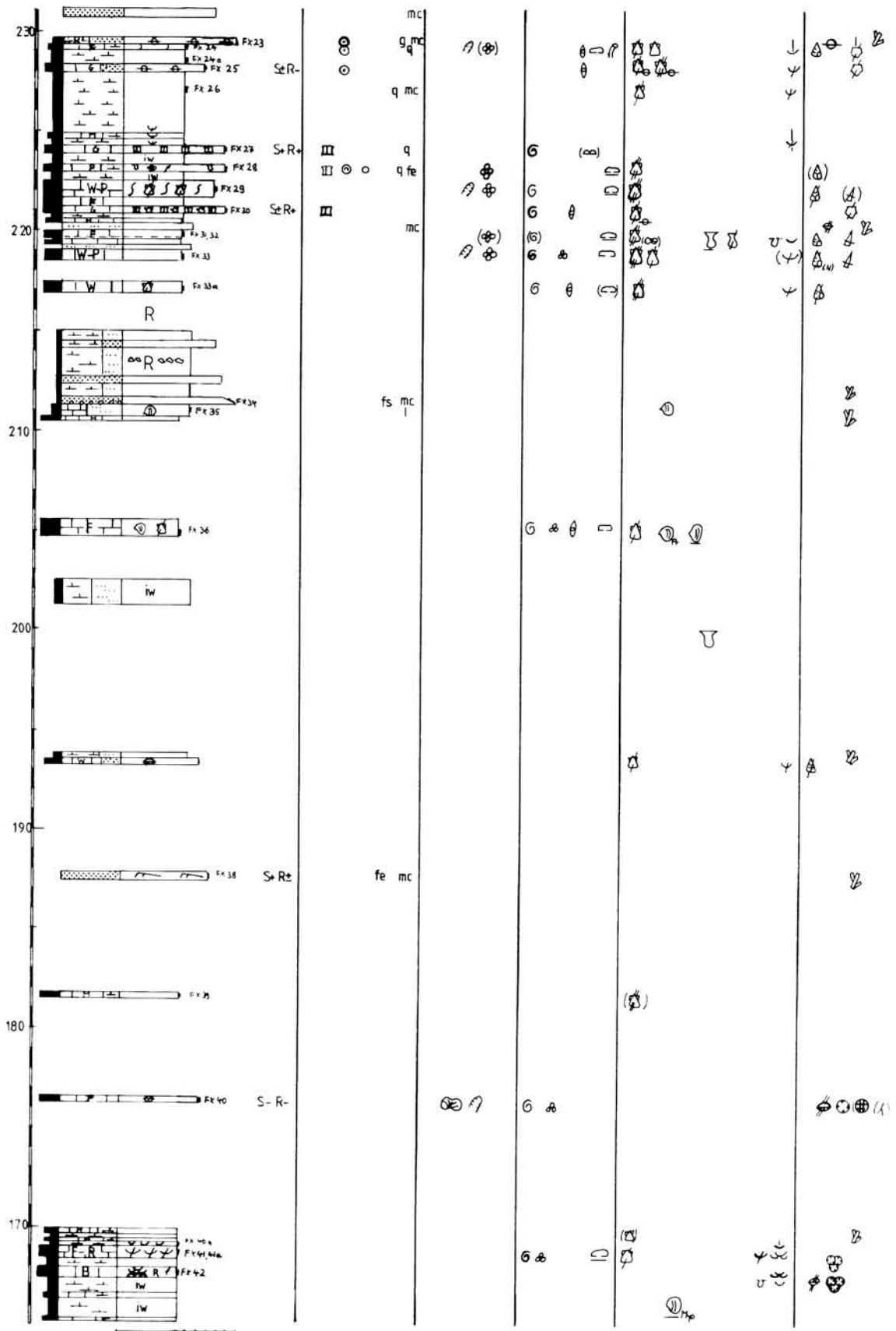
- m 21.6–23.0: grey, thick-bedded, slightly marly mudstones and wackestones with bioclasts and *A. morrisi*, *Campto-nectes* cf. *auritus*, *Protocardia* sp., *Myopholas multicosata*, *Everticyclammina virguliana*, rare verneu-linids, ostracods. On top rare *Trichites* sp.. Common early diagenetic cracks on top
- m 23.0–27.0: grey, medium-bedded, very nodular limestones with varying marl content. At m 25, marl layer with com-mon *Jurassicorbula edwardi*, *Nicaniella* sp., etc.

Heavily bioturbated, partly intraclastic limestones ranging from bioclastic mudstones to wacke/float-stones with clusters of *A. morrisi*, giant *Protocardia* sp. A, rare *Trichites* sp., oysters, serpulids, ostra-cods, *E. virguliana*, rare *Rectocyclammina* sp., *Freixialina planispiralis*, *Glomospira* sp., etc.. Early diage-netic dissolution of valves and collapse of sediment occurring

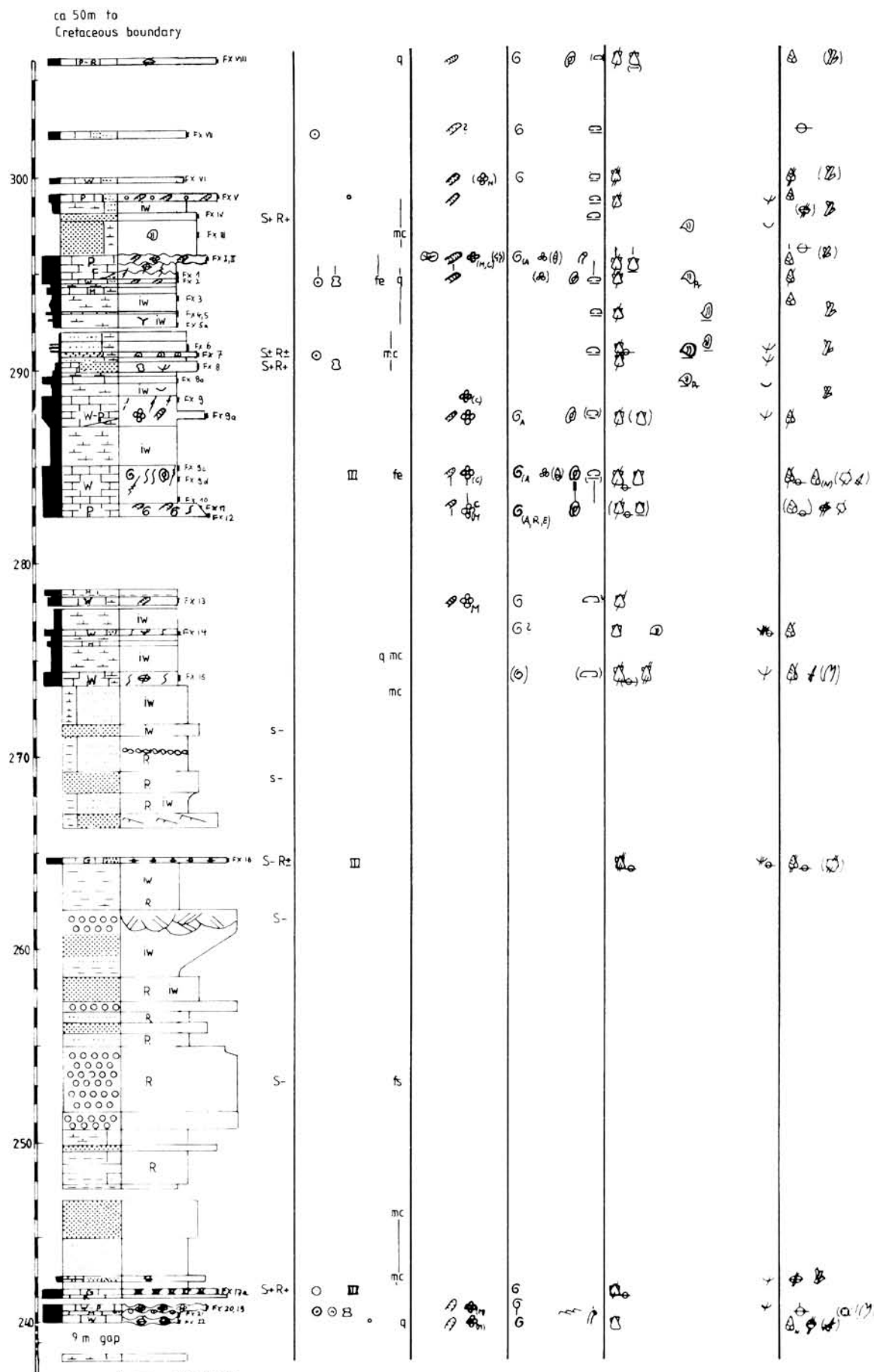
Section Alcubela - Freixial (Continuation)



Section Alcubela - Freixial (Continuation)



Section Alcubela - Freixial (Continuation)



- 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 *Pseudocidaritis 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 outwedging 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 oncolitic 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 Arranhó–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 reefs. 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 Arranhó–Bemposta section). Intercalated are thin to very thin nodular mudstone horizons, representing diagenetically altered burrow fillings. Mudstones forming thicker beds 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 pseudogroundmass bioclasts of bivalves and echinoids, at base spines of *P. lusitanicus* as well as lituolids and *Reophax* sp.. Very frequent solution vugs, covered with brownish, acicular 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, echinids and frequent to abundant »*Haplophragmium*« sp. besides other forms. Superficial cyanoids, nodules of *Lithocodium* sp./»cayeuxiid« 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 lugeoni* and frequent cyanoids with nuclei of bivalves, *M. lugeoni*, 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., ?*Feurtillia frequens*, *Glomospira* sp., rare nodules of cyanophytes and questionable debris of dasycladaceans
- m 102.5–104.6: greyish–brownish, thick–bedded, bioturbated oolitic wacke– and packstones, partly with large nerineids (floatstone), common cortoids, »*Haplophragmium*« sp., etc., Ooids with bioclastic nuclei. Burrows in wackestones 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, echinids, brachiopods. Serpulids and dark, iron hydroxide–stained coated grains and extraclasts occurring. Strong recrystallization effects
- m 104.8–108.5: grey marls with small oncoids, cidaroid spines and fragmented *Nanogyra 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. *parvula*–*muluchensis*, *Everticyclammina virguliana*, verneuiliinids, valvulinids 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–muluchensis*, »*Haplophragmium*« sp., *E. virguliana*, ?*Rectocyclammina* sp., *Freixialina planispiralis*, *Reophax* sp. and rare dasycladaceans, *M. lugeoni* and ostracods. Various corals, mostly »*Calamophyllia*« sp., in part superficially encrusted by cyanophytes or bored by *Lithophaga* sp..

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

m 139.5–151.0: at base, frequent *Myophorella lusitanica* 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 *Amphiastrea 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 *Rhizocorallium irregulare*, *Thalassinoides suevica*, *Thalassinoides* sp. and *Myophorella lusitanica*, *Protocardia* sp., *Mactromya concentrica* and questionable *Arcomytillus morrissi*

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

m 167.3–170.0: at base, coral meadow, mainly composed of *Amphiastrea piriformis*, bored by *Lithophaga* 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., *Pseudocyclammina* sp. and verneuilinids;

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 Freixial fm);

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 litiolids

m 210.5–212.5: at base, grey mudstone grading into calcareous lignitic 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 caliche 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 *Lithophaga* sp. and overgrown by *Nanogyra nana*), gastropods (partially nerineids), echinid spines, ostracods, common to abundant *Permocalculus* n.sp., damycladacean debris and litiolids. 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 oolitic packstone with mostly quartz–cored ooids. Partly leached, vadose cements covering solution vugs. In lower grainstone horizon abundant rounded, microbored bivalve clasts besides intraclasts.

m 224.3–232.0: greenish grey, weathered marl with *N. nana*, *Placunopsis suprajurensis*, gastropods, *Everticyclammina virguliana*, smooth ostracods and rare echinid spines, with the following intercalations:

at base: marly mudstone;

- at m 228.0: 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, bioturbated bioclastic floatstone. Bivalves dominating, gastropods, echinids, serpulids, ostracods occurring, *Permocalculus* 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-bedded, nodular limestone; at base, slightly sandy pelletal bioclastic wackestones with fine bivalve bioclasts, large bivalves, nerineids, rare fragmented echinoid spines, serpulids, *Macroporella espichelensis* and common litiolids. 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, *Permocalculus* n.sp. and litiolids. On top *Permocalculus* packstone with microbored bioclasts, litiolids 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 litiolids; 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, siliciclastic sequence; lower part silt-sized within intercalation of calcareous, lignitic bioclastic sandstone, upper part sand-sized
- m 247.0–264.5: predominantly red or violet coloured siliciclastics 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 thickbedded, 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 litiolids. At m 276.5, very sandy, bioturbated bioclastic wackestone with autochthonous bivalves. At m 278, bioturbated algal wackestone with common debris of *Permocalculus* n.sp., *Macroporella espichelensis* and litiolids 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 *Anchispirocyclina lusitanica* besides *Rectocyclammina* sp., *Everticyclammina virguliana*, *Nautiloculina oolithica*, or, higher, very frequent *Permocalculus* n.sp. besides *Cylindroporella* 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 *Anchispirocyclina lusitanica* besides »*Haplophragmium*« sp., *N. oolithica*, *Freixialina planispiralis*, *Lenticulina* sp. and dasycladacean debris (in part ?*Likaniella bartheli*, *Cylindroporella* cf. *arabica*), *Permocalculus* 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. bartheli*, *C. cf. arabica*) and common *Permocalculus* 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, siliciclastic 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 freixialensis* with oysters and corroids. 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 diagenetically altered horizontal burrow systems (in part *Thalassinoides* sp.), with ?*Pleuromya* 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., *?Pleuromya* sp.) and gastropods, and very common *Permocalculus* n.sp. besides ostracods, *Reophax* sp., »*Quinqueloculina*« sp., iron hydroxide-stained, quartz-cored ooids and extraclasts. In higher part, additionally, dasycladacean debris (*?Likaniella bartheli*, *Actinoporella podolica*, *Cylindroporella* cf. *arabica*, *Macroporella espichelensis*), *Solenopora cayeuxiformis* n.sp., rare charophyte gyrogonites, verneuulinids, »*Haplophragmium*« sp., *?Glomospira* sp., etc.. Early vadose influence evident by early cracks, dissolution and collapse of aragonitic shells, and internal vadose silt

m296.0–299.5: 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 grey, silty or sandy muddy limestones (wacke/pack/rudstones) with common large fragments of *Permocalculus* n.sp., ostracods, bivalves, gastropods and their clasts, »*Haplophragmium*« sp., partly »*Quinqueloculina*« sp., *?Mesoendothyra* sp., *M. espichelensis* 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 Lousa–Bucelas.

Section Alqueidão

Location: geol.map, sheet Alenquer, SW quadrant. On road from Sobral de M. Agraço direction to Sapataria via Cabeda. Section beginning 250 m SE Cabeda at the connection of two stream valleys. Extending S to hamlet Pedreira, crossing traffic road, climbing to water container, then always following top of crest, bending SE to altitudes 312 m and 333 m. Section ending 500 m NW fort ruin and trigonometric altitude Alqueidão (442 m) in well exposed outcrop of nodular limestones.

Stratigraphic range: top of Amaral fm, Sobral fm, lower part of »Pteroceriano« fm.

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.

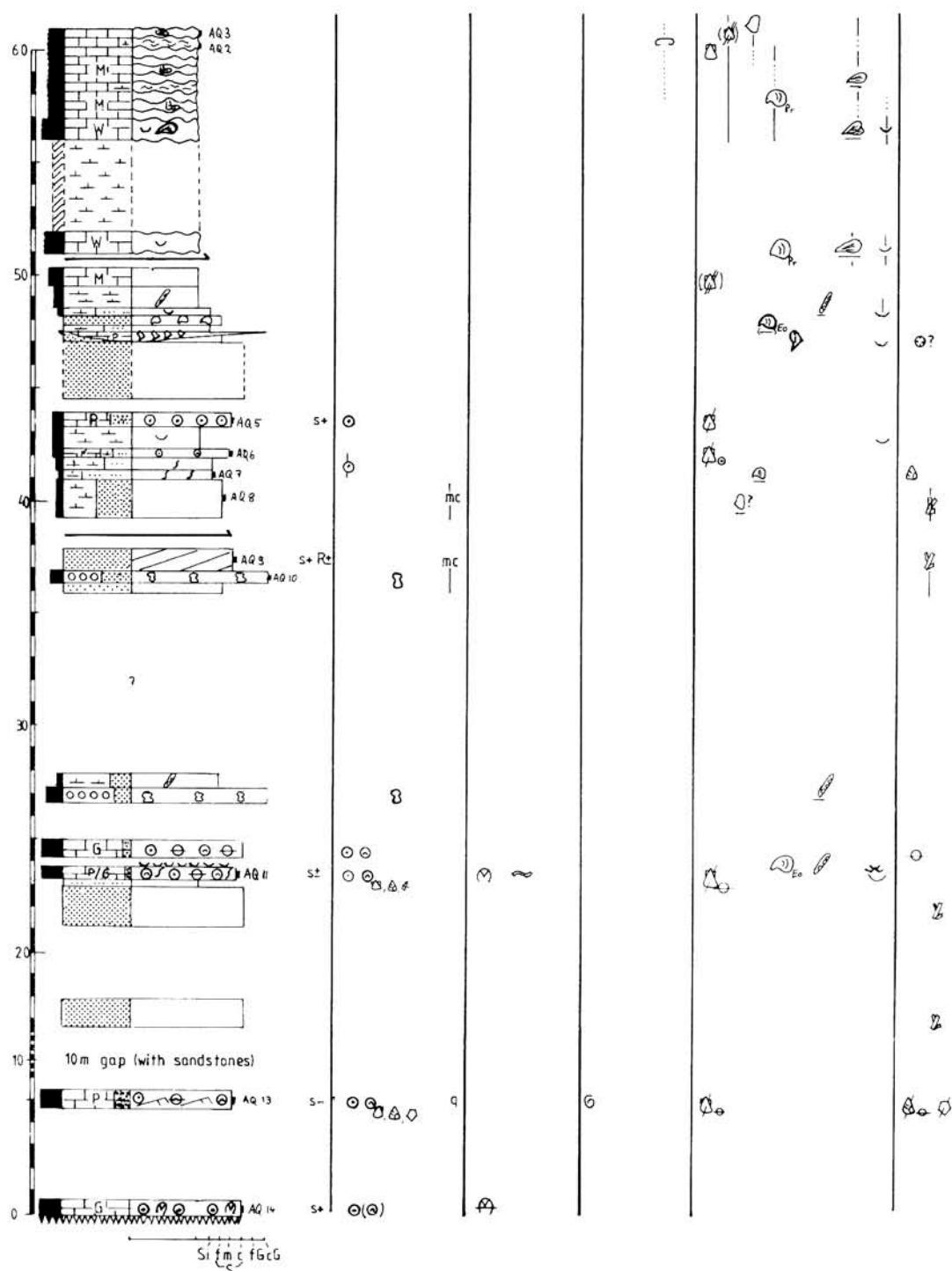
Nearby sections: Gotleis, Alcubela–Freixial, Arranhó–Bemposta, Patameira.

Special remarks: Clastic Sobral complex not interfingering with micritic »Pteroceriano« limestones as in nearby section Gotleis. Well developed limestone conglomerates (cf. to section Gotleis).

Description:

- m0.0–0.5: light, thick-bedded oolitic grainstone with *Marinella lugeoni* (top of Amaral formation?)
- m4.5–5.5: dark brown, thick-bedded, very sandy oolitic bioclastic packstone. Ooids with quartz and bioclastic cores (1:1). 20% non-encrusted detrital quartz. Bioclasts mostly microbored
- m5.5–23.2: mainly exposure gap. At base, rubble of micaceous, platy, well sorted, fine-grained and cross-bedded, medium-grained sandstones, partly burrowed. At m 16 and m 22 brown, thick to very thick-bedded, coarse-grained sandstones with lignite litter. Siltstones on top
- m23.2–25.0: (on southern side of traffic road:) at base, light brown, thick-bedded oolitic bioclastic packstone. Densely overpacked ooids, partly polyooids 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 bivalves, mostly microbored, in part algal-encrusted, floating in oolite. Above it, small gap with abundant *Placunopsis* sp. as well as *Eomiodon securiformis* and *Gervillia sobralensis*. Superimposed is oolite with similar facies as base
- m26.6–37.8: 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 *Gervillia sobralensis*. Top: fine-grained, micaceous sandstones, followed by dark 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 Alqueidão



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, lignitic 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-*

nogyra nana. Maximum thickness 50 cm, wedging out on both sides. (Note similar occurrence 300 m SE Forte Alqueidão in presumed same level with bivalved *Isognomon lusitanicum* and *Ovalastrea choffati*.) Above it, thin layers of silt and sandstone with abundant *Eomiodon securiformis*, overlain by thin horizon of silty oyster marl and 1 m of grey marl with very frequent *Gervillia sobralensis* (top of Sobral formation). Top built of 80 cm slightly marly mudstones (base of »Pteroceriano« formation), cut by minor fault

m50.8–61.0: well exposed outcrop 500 m NW Alqueidão hilltop: Medium to thick-bedded nodular mud/wacke-stones, altered to microsparites and intensively black coloured due to nearby extrusion of Alqueidão tectonite. In lower part 4 m exposure gap (presumed marls). Limestones partly marly with distinct flaser bedding. Burrows dominated by *Rhizocorallium irregulare*. Occurring fauna (partly in life position): *Arcomytilus morrissi*, giant *Protocardia* sp. A, *Protocardia intexta*, *Protocardia* sp., *Mactromya concentrica*, *Camptonectes* cf. *auritus*, *Nanogyra nana*, ostracods, etc..

End of section.

Alrota Sections

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

From road Bucelas–Arranhó, right hand bifurcation, direction to village Alrota. 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 downroad, taken in outcrops extending uphill; 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 (Alrota 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 Alrota region is also treated in chap. 6.3.2

Description:

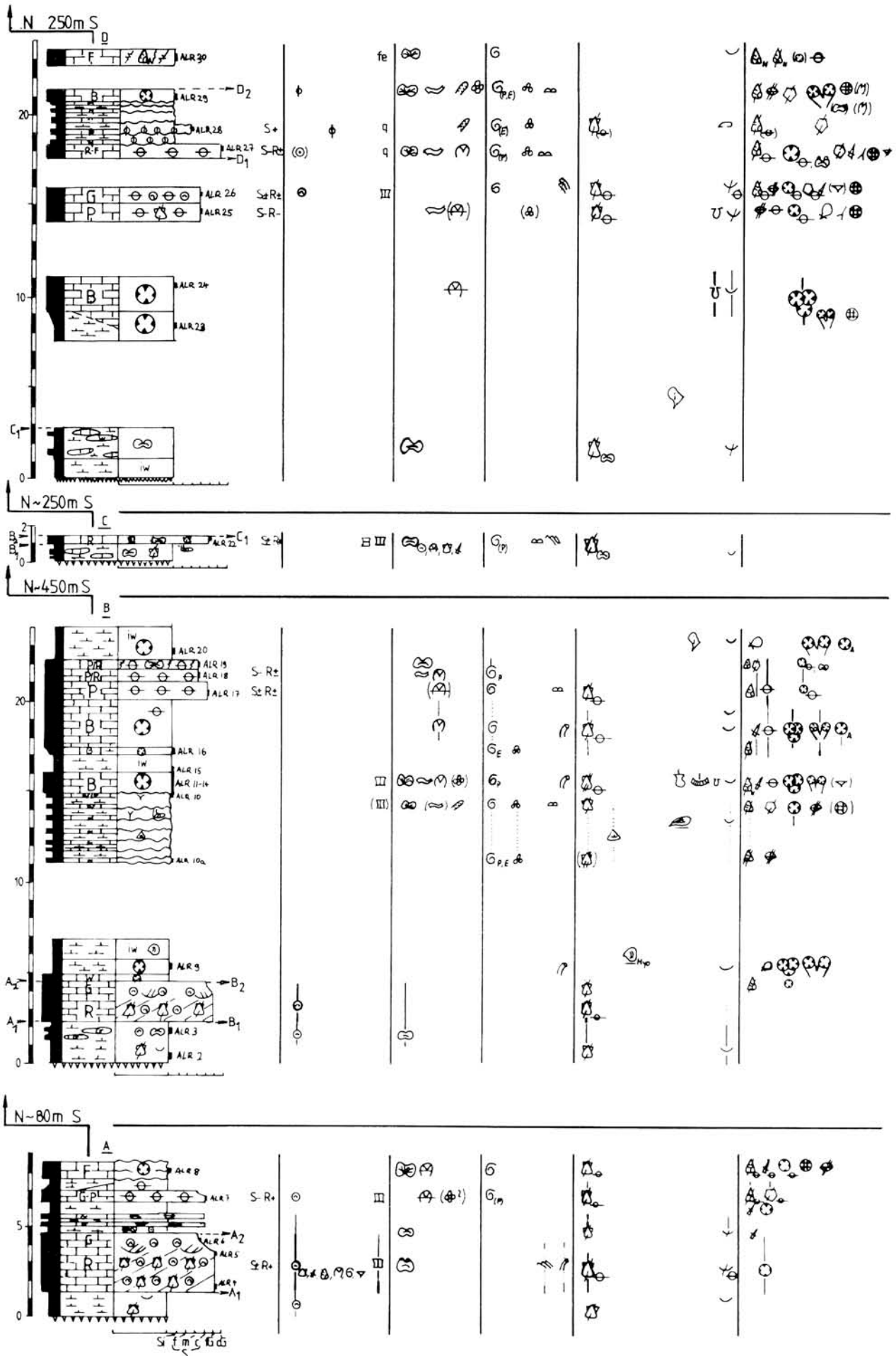
Section part A

- m0.0–1.4:** brownish grey marl with small bivalve clasts, *Nanogyra nana* and ooids
- m1.4–4.7:** 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 wavy 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 oncoids with bryozoans, rounded intraclasts (partly reworked algal bindstones) and lumps occurring. Sparitic matrix, partly with microsparitic geopetal fillings of intergranular pores (altered micrite); early vadose influence evident by leached intraclasts and oomolds, with collapse of ooid cortices after dissolution of nuclei
- m4.7–6.3:** grey marls, in lower part ooid- and oncoid-bearing, with thin intercalations of bioclastic grainstones, in upper part with some corals
- m6.3–7.6:** at base, thick bed of brownish, poorly sorted, bioclastic grainstone, with very close overpacking impeding development of intergranular pores (packstone fabric) in lowermost part. Chaotic, often vertical position of elongated bioclasts. Bed is fining upwards with increasing lime mud, then marl content. Microbored bioclasts composed of bivalves, gastropods, echinids, furthermore *M. lugeoni*, questionable dasycladaceans, *Pseudocyclammina* sp., *Nautiloculina oolithica* as well as intraclasts and rare ooids. Ghost structures very common. This »tempestite« is overlain by marl.
- m7.6–8.6:** 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 *Lithothodium* sp., »cayeuxiid« algae, *Marinella lugeoni*, *Conicospirillina basilensis*. Furthermore fine angular bioclasts and lituolids.

Section part B

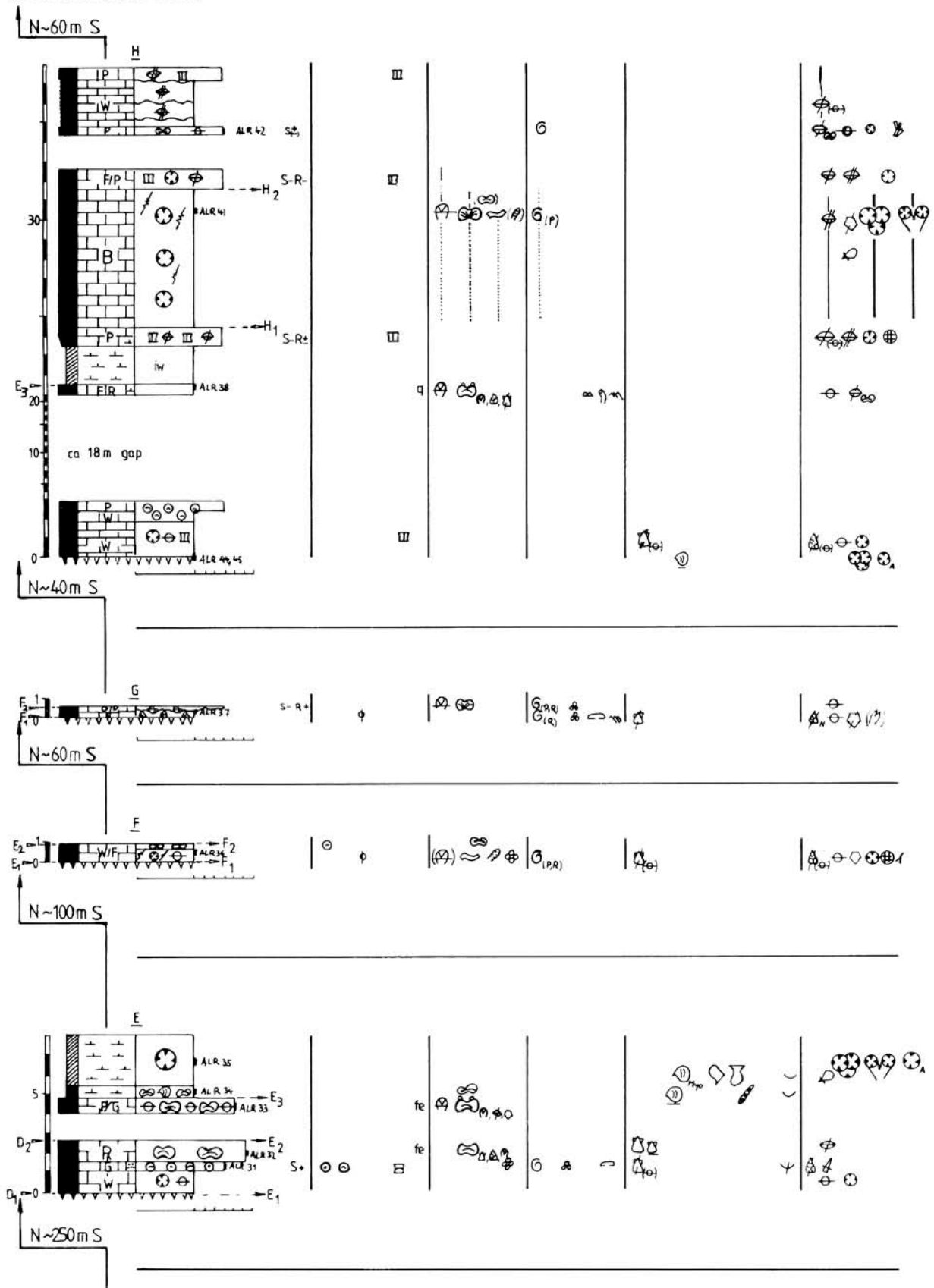
- m0.0–2.3:** brownish grey marl with small bivalve clasts, *Nanogyra nana* and, particularly on top, ooids and small oncoids. Intercalated in upper part are thin layers and lentils of oolitic grainstone

Alrota Sections



Alrota Sections (Continuation)

(to Arranhó-Bemposta Section)



- m 2.3–4.6: very thick bed of bioclastic oolitic rud/grainstone, resembling and corresponding to m 1.4–4.7 in part A. Richer in oncoïds than in part A
- m 4.6–5.0: grey bioclastic wackestone with individual corals
- m 5.0–5.8: marl with abundant corals, often in growth position (*Amphiastrea piriformis*, *Actinastrea ramulifera*, *A. crasso-ramosa*, *Cyathophora cesaredensis*, *Thamnasteria pseudarachnoides*, *Stylina (Convexastrea)* cf. *pustulosa*, cf. *Dermosmilia* sp.). Corals partly with attached serpulids and *Praeexogyra pustulosa*. Spines of *Pseudocidaritis lusitanicus* very common. Coral meadow laterally extending only over a short distance
- m 5.8–6.8: weathered, dark grey marl with *Myophorella lusitanica*
- m 11.0–14.8: thin to medium beds of nodular mud/wackestone with thick layers of weathered marls. In limestones small bioclasts, *Arcomytilus morrisi*, *P. pustulosa*, *Everticyclammina virguliana*, *Pseudocyclammina* sp. and burrows of *Thalassinoides* sp. and *Rhizocorallium irregulare*. Marls partly with rich, ?*Nicaniella* sp.-dominated, soft bottom fauna. In upper part coral debris occurring. Burrows filled with coral debris wacke/packstone with common echinoids. *Pseudocyclammina* gr. *parvula-muluchensis*, ?*Mesoendothyra* sp., *Nautiloculina oolithica*, verneulinids, bryozoans, *Cayeuxia kurdistanensis*, *Lithocodium* sp., ?*Permocalculus* n.sp., *Thaumatoporella parvovesiculifera* and rare dasycladaceans indet.. Matrix altered to microspar and neospar
- m 14.8–16.2: brownish grey, massive coral boundstone (baffle/framestone) with up to 30 m Ø measuring coral heads. Corals often bored by *Lithophaga* sp., covered by serpulids and oysters, or thickly encrusted with acicular cement A. *Trichites* sp. partly serving as substratum for coral attachment. Between coral heads diagenetically recrystallized bioclastic float/rudstone with large coral clasts besides debris of gastropods (e.g., nerineids), bivalves, echinids and rare brachiopods. Bioclasts microbored and/or superficially encrusted by spongiostromate algae, ?*Solenopora cayeuxiformis* n.sp., *Marinella lugeoni*, *Lithocodium* sp., bryozoans and serpulids. Common *Pseudocyclammina* gr. *parvula-muluchensis*. In the upper part small *Pteroperna* cf. *pygmaea* occurring, together with common *Trichites* sp.
- m 16.2–17.0: intensively weathered, poorly exposed marl
- m 17.0–20.0: brownish grey, very thick-bedded, at base marly, coral boundstone (frame/bafflestone) with up to 1 m large, in-situ heads of plocoid corals (*Stylina (Convexastrea) sexradiata*), *Axosmilia* sp. and fasciculate corals. Sediment fillings between corals analogous to coral bed described above
- m 20.0–22.2: light brown, thick-bedded pack/rudstones with intensively microbored bioclasts, developing gradually from underlying boundstone. Coral debris dominating, *M. lugeoni* and *Lithocodium* sp. occurring, common litoïds (*Pseudocyclammina* sp., *Freixialina planispiralis*), etc.. In uppermost part micritic oncoïds. Sorting moderate at base, then deteriorating (large, floating clasts). Matrix at base altered to microspar and neospar. In uppermost part circumgranular shrinkage cracks common
- m 22.2–24.0: intensively weathered, poorly exposed marls with abundant corals, dominated by *Calamophyllia (Calamoseris) flabellum* and *C. variabilis*. Besides these, *Axosmilia crassa*, *A. cf. caudata*, *A. cf. cuneata*, *Thamnasteria lobata*, *T. gracilis* and *Plagiostoma* sp., *Isognomon (Rostroperna)* sp., *Pteroperna* sp., *P. pustulosa* and modiolid bivalve.

Section part C

- m 0.0–1.0: weathered, brownish grey marl with superficial spongiostromate oncoïds, bivalve clasts, *N. nana* and intercalated lentils of oncolitic bioclastic wacke/packstone
- m 1.0–1.3: brownish bioclast-intraclast rudstone with all components being superficially encrusted. Micritic oncoïds with nuclei formed by ooids, clasts of bivalves, echinids, and *M. lugeoni*. Intraclasts representing reworked pelletal, oolitic or bioclastic facies with enclosed *N. oolithica*, *Pseudocyclammina* sp., *Conicospirillina basilensis*, bryozoans, corals, etc.. Iron hydroxide-stained microsparitic matrix. At lower surface well preserved burrows of crustaceans?. Bed corresponds to m 2.3–4.6 in section part B.

Section part D

- m 0.0–1.2: intensively weathered marls, poorly outcropping
- m 1.2–2.8: brownish grey, oncolitic, oyster-bearing marl with intercalated lentils of oncolitic bioclastic wackestone. Top corresponds to m 1.3 in section part C
- m 2.8–7.5: exposure gap with findings of *Isognomon* sp. and rare corals
- m 7.5–11.0: Coral and oyster-bearing marl, grading into very thick-bedded coral boundstone (framestone). Corals dominated by *Actinastrea* sp. (lower part) and *Amphiastrea piriformis* (up to 30 cm Ø). Common *Litho-*

phaga borings, overgrowth of oysters and calcisponges. Fan-like cement A, leaving rest-porosity. In upper part *Marinella lugeoni* occurring

- m 14.0–16.0: basal bed, light brown, poorly sorted, overpacked bioclastic packstone with all larger, poorly rounded clasts being microbored, constituted of very large, partly *Lithophaga*-bored bivalve and coral clasts, echinid debris, nodules composed of *Bacinella irregularis*/*Lithocodium* sp., *M. lugeoni*, calcisponges, sponge spiculae and rare verneuilinids. 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 echinids, calcisponges, brachiopods, bryozoans, »*Haplophragmium*« sp. and other lituolids. 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 cyanophytes, *B. irregularis*/*Lithocodium* sp., nubeculariids or microbored, consisting mainly of coral clasts besides common gastropod debris, *Lithophaga* sp. and fragments of echinids, brachiopods, calcisponges and sponge spiculae. Furthermore intact large thalli of digitiform *M. lugeoni*; *Permocalculus* n.sp., *Pseudocyclammina lituus*, *P. gr. parvula–muluchensis*, *Nautiloculina 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, echinids, crustaceans. Furthermore *P. gr. parvula–muluchensis*, *Everticyclammina virguliana*, ?*Rectocyclammina* sp., *Ammobaculites* sp., »*Haplophragmium*« sp., ?*Mesoendothyra* sp., verneuilinids and valvulinids, and *Permocalculus* n.sp.. In uppermost part, thick bed of coral boundstone (bafflestone). Corals overgrown by algae (in part *Lithocodium* sp.), nubeculariids, ?bryozoans and calcisponges. Gastropod, echinid and crustacean clasts as well as fragments of ?*Likaniella bartheli*, ?*Macroporella nisi*, ?*Actinoporella podolithica*, ?*Cylindroporella* cf. *arabica*, *Permocalculus* n.sp., »cayeuxiid« algae and *Pseudocyclammina* gr. *parvula–muluchensis*, *E. virguliana*, *Freixialina planispiralis*, ?*Mesoendothyra* sp., »*Haplophragmium*« sp., *Glomospira* sp., verneuilinids and valvulinids float in micritic/pelmicritic matrix
- m 22.7–23.5: light greyish brown, thick-bedded, partly iron hydroxide-stained nerineid floatstone with large, partly reworked nerineids which are overgrown by *Solenopora cayeuxiformis* n.sp.. Oysters, lituolids and very common microbored bio/intraclasts 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 E

- m 0.0–2.7: (corresponding to m 17.6–21.3 in section part D) at base, brownish grey, thick-bedded, bioclastic wackestone with scattered coral debris and common cortoids, overlain by medium thick bed of brownish grey, well sorted, oolitic grainstone with mature, partly polycored ooids with nuclei composed of quartz (50%) and various bioclasts. Ooid cortices with radial fibrous fabric, overprinted by diagenesis. Above it, very thick bed of iron hydroxide-stained, oncolitic rudstone with, partly superficial, spongiostromate oncoids of type SS–R and SS–C. Nuclei formed by bivalves, gastropods and *M. lugeoni*. Small double-valved bivalves and large fragments of ?*Coelastarte discus* occurring. Matrix microsparitic
- m 4.0–5.6: very thick bed of brownish, poorly sorted, bioclastic pack/grainstone with cortoids and large, floating, iron hydroxide-stained spongiostromate oncoids (type SS–R, SS–I, SS–C), frequently with nuclei of *M. lugeoni* besides other bioclasts. Often multiple oncoids with layers of bryozoans. Furthermore, moderately rounded bioclasts and *Freixialina planispiralis*, ?*Kurnubia* sp., *Lenticulina* sp.; non-encrusted *Marinella lugeoni*. Chaotic attitude of particles in microsparitic/sparitic matrix. At top, marl with *Praeexogyra pustulosa*, *Nanogyra nana*, *Gervillella aviculooides*, *Coelastarte discus* and abundant cyanophyte nodules and oncoids of different sizes, partly with attached oysters
- m 5.6–8.0: very poorly exposed, weathered marl with findings of *Comophyllia corrugata*, *Amphiastrea piriformis*, *Actinastrea trochiformis*, *Stylina* (*Convexastrea*) *sexradiata*, *S. (C.) pustulosa*, *Cyathophora bourgueti*, *Thamnasteria pseudarachnoides*, *Dermosmilia* sp., *Axosmilia crassa*, *Axosmilia* sp., and *Isognomon* (*Rostroperna*) sp., *Pteroperna* sp. (both with attached *P. pustulosa* and *N. nana*), *Myophorella lusitanica* and spines of *Pseudocidaridius lusitanicus*.

Section part F

- m 0.0–0.8: (corresponding to m 0.0–2.8 in section part E) thick bed of brownish grey, bioturbated bioclastic wacke/floatstone with large clasts of, partly microbored, corals, bivalves, gastropods, echinids and very frequent small-sized cortoids. Furthermore, calcisponges, sponge spiculae, *M. lugeoni*, ?*Lithocodium* sp., *Permocalculus* n.sp., ?*Likaniella bartheli*, ?*Actinoporella podolithica*, *Pseudocyclammina* gr. *parvula–muluchensis*, *Rectocyclammina* sp., »*Haplophragmium*« sp., *Nautiloculina oolithica*. Inhomogenous

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, *Ammobaculites* sp., »*Haplophragmium*« sp., *Rectocyclammina* sp., *Glomospira* sp., verneuulinids 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–muluchensis*, *Rectocyclammina* sp., *Freixialina planispiralis*, »*Haplophragmium*« sp., verneuulinids and valvulinids, *Cayeuxia kurdistanensis*, *M. lugeoni*, *Permocalculus* n.sp.: and questionable codiacean alga.

Section part H

At base, below first outcrop, findings of *Stylina tubulosa*, *Axosmilia crassa*, *Comoseris meandrinoides*, *Thamnasteria pseud-arachnoides* 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/rudstone with large, complex, spongiostromate oncoids, most often with *M. lugeoni* integrated in cortices and serving as core. Serpulids, nubeculariids, bryozoans and questionable bryozoans also occurring in algal cover. Oncoids intensively attacked by *Lithophaga* borings with holes later filled with internal micrite, crystal silt and cements A, B. Besides oncoids, 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 boundstone (frame/bafflestone) built of large heads of *Amphiastrea piriiformis*, fasciculate *Calamophyllia*-type corals; spines of *Pseudocidarid lusitanicus*, fine angular bioclasts, nodules of *Solenopora cayeuxiformis* n.sp. and spongiostromate cyanophytes, *M. lugeoni*, rare *Permocalculus* n.sp., *P. gr. parvula–muluchensis*, *F. planispiralis*, »*Haplophragmium*« sp.. Micritic matrix partly altered to microspar and neospar. Irregular compaction cracks common. Boundstone is embedded 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 oncoids and cortoids; occasional corals, »*Haplophragmium*« sp. and lignite litter. 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 Alrota sections: *Amphiastrea gregory*, *Meandrophyllia (La-timeandrea) helvelloides*, *M. (Meandrea) bonanomii*.

Section Arranhó – Bemposta

Location: geol. maps, sheet Alenquer, SW quadrant and sheet Loures, NW quadrant. 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 Vila Nova (short before Bemposta).

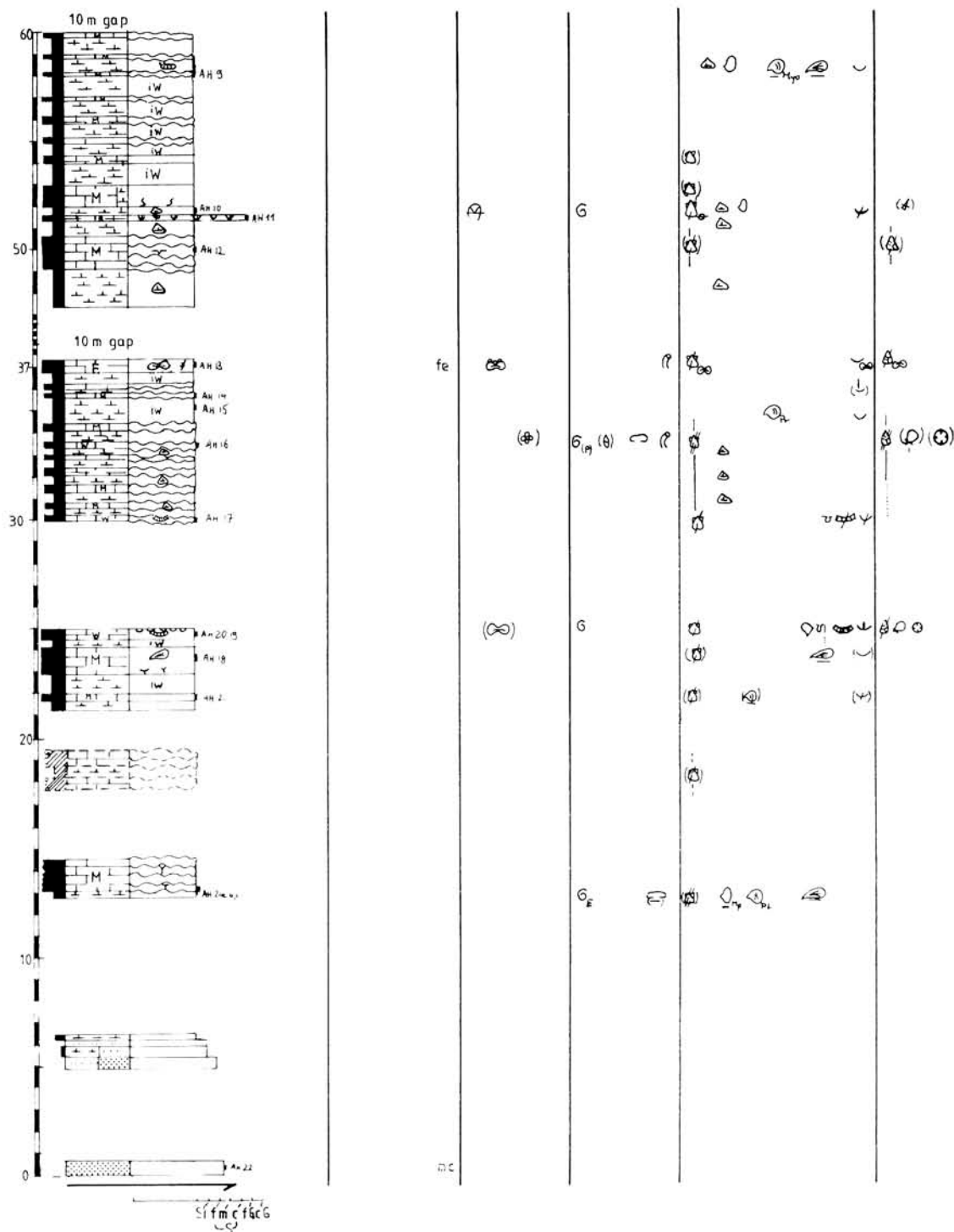
Stratigraphic range: top of Sobral formation, complete »Pteroceriano« formation.

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, S'Tiago 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

Section Arranhó – Bemposta



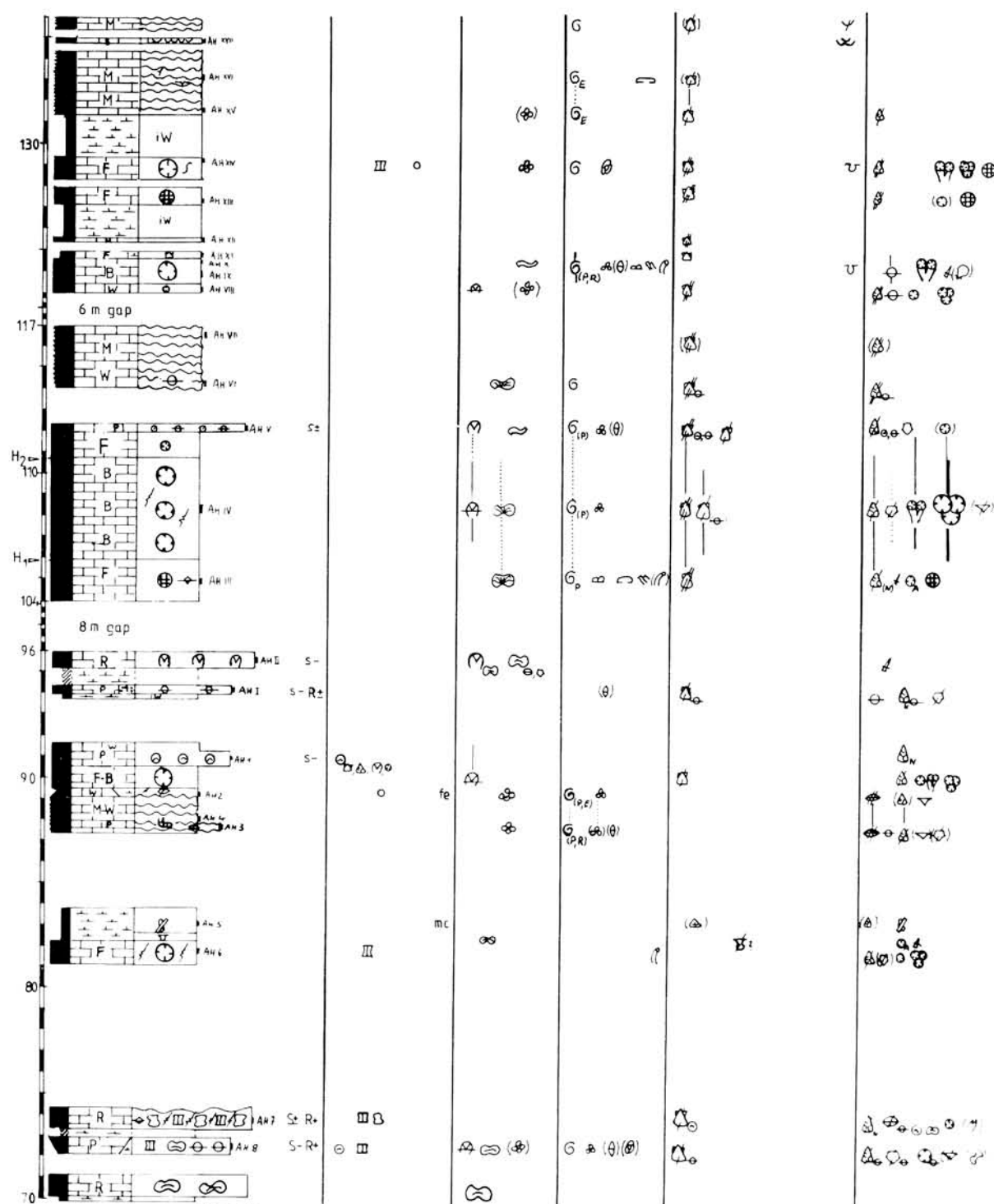
one section or the other; (b) to find out degree of small – scaled lateral facies differentiations; (c) to correlate the Alrota patch reef complex to a continuous section.

Continuation of section both stratigraphically downwards and upwards can be drawn from Alcubela – Freixial section.

Description :

- m0.0–0.6: yellowish brownish, micaceous sandstone (at road km 67.4)
- m5.0–6.4: marls, brownish silts and silty sandstones (top of Sobral formation)

Section Arranhó – Bemposta (Continuation)



- 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 multicostata*, 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, litooids, *Isognomon* sp. and common, very large, *Lithophaga*–bored, *Trichites* aff. *saussurei*, espe-

cially at top. Top densely covered by *Nanogyra nana* and *Praeexogyra pustulosa*; corals and spines of *Pseudocardis 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 *Neritoma* sp.. Macrofauna occurring, consisting of *Protocardia* sp., *Jurassicorbula edwardi*, *Nanogyra 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 *Pseudocardis lusitanicus*, ostracods, serpulids, lituolids, lagenids and rare dasycladaceans (*Terquemella*(?) *triangularis*, *Cylindroporella* sp.); at m 37, 60 cm of brownish, bioclastic oncolitic 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 cirum– and intragranular; solution features). (Correlation bed to Alcubela–Freixial 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, echinids, lituolids and *Marinella lugeoni*; at m 51.3, 20 cm of bioclastic rudstone; from m 58.0–59.0 (at road bifurcation to Alrota), bluish grey marls with soft bottom fauna: *Nicaniella* sp., *Mesosaccella dammariensis*, *Antiquicyprina* sp., *Protocardia* sp., ?*Anisocardia* sp., *Jurassicorbula edwardi*, ?*Pleuromya* sp., *Myopholas multicostata*. Partly clusters of *Arcomytilus morrisi*. Thin layers of marly, nodular mudstones, representing burrow fillings (e.g., *Rhizocorallium* sp.)
- m 70.0–71.2: single bed of brownish, micritic oncolitic 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 spongiostromate oncoids, *M. lugeoni*, *Cylindroporella* sp., *Freixialina planispiralis*, verneuulinids and valvulinids, *Lenticulina* sp., rare miliolids and rare vertebrate 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–bearing marls with debris of ?*Pteroperna* sp., *Axosmilia* sp. and rare cidaroid spines, passing into grey, micaceous, lignitic 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 irregulare*, debris of terebratulid brachiopods, *Everticyclammina virguliana*, *Rectocyclammina* sp., *Pseudocyclammina lituus*, *P. gr. parvula–muluchensis*, »*Haplophragmium*« sp., *F. planispiralis*, verneuulinids and valvulinids, lagenids, dasycladaceans (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 oolitic 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 Ø), 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., *Axosmilia* sp.), nerineids, »cayeuxiid« algae, sessile foraminifers, *P. lituus*, bryozoans, serpulids, ostracods, 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: *Stylina* ssp., *Amphiastrea piriformis*, ?*Cyathophora* sp., meandroid corals) besides branching types (e.g., »*Calamophyllia*« 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*, »cayeuxiid« algae, dasycladaceans, *P. lituus*, *P. gr. parvula–muluchensis*, »*Haplophragmium*« sp., *Nautiloculina oolithica*, ?*Mesoendothyra* sp., etc. (boundstone extending to Alrota section, correlation H₁, H₂).
 - 2.2 m of coral–bearing floatstone, developing from underlying framestone.

- 30 cm of cortoid packstone (microsparitic matrix), moderately sorted. Rare corals, echinoids, *M. lugeoni*; common »*Haplophragmium*« sp. besides *P. lituus*, *Lenticulina* sp., verneulinids 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, »cayeuxiid« algae and litiolids
- m 123.0–129.4: light grey to brownish coral–bearing complex, from base to top:
 - 50 cm of bioclastic wackestone with cortoids, *M. lugeoni*, *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 cyanophytes and *Conicospirillina basileensis*. In micritic to microsparitic matrix, cortoids, rare spines of *Pseudocidaris lusitanicus*, *P. gr. parvula*–*mulchensis*, *Rectocyclammina* 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 *Stylina* (*Convexastrea*) *sexradiata*), often bored by *Lithophaga* sp.. Furthermore, very common *Salpingoporella annulata*, litiolids, 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 Monfalim, Batalha hamlet. From Batalha (beginning of section) uphill in ESE direction, first along track, then crossing fields up to hilltop with the same name (trig. altitude m 322). End of section several meters below hilltop at fault.

Stratigraphic range: Amaral formation (Oórito member); »Pteroceriano« formation, lower to middle part.

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

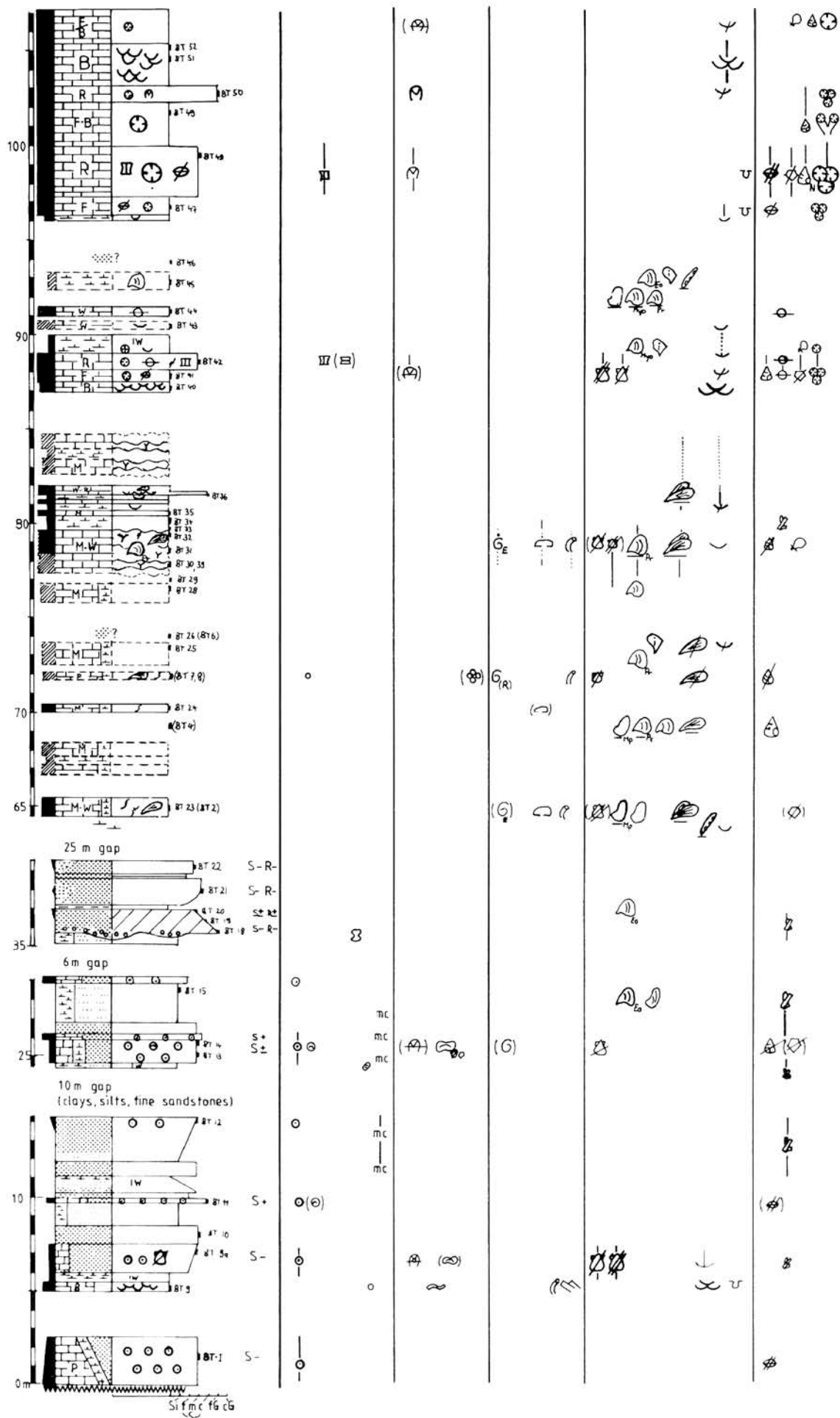
Nearby sections: Carvalha, Mata, Alqueidão, Sobral.

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 siliciclastic series with fairly large gaps. Predominantly thick–bedded, lignitic, often micaceous sandstones with poor to moderate sorting. In part cross–bedded with downcutting surfaces and gravel at base; rarely evenly laminated. Scattered *Eomiodon securiformis*. This bivalve is also occurring in marly silts together with ?*Neomiodon* sp. and rare gastropods (esp. m 28). Sandstones partly ooid–bearing, with transitions to oolites with quartz–cored ooids. Debris of *Marinella lugeoni* 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 morrissi* (in clusters), *Gervillia* sp., *Myopholas multicostata*, ?*Pleuromya* sp., *Protocardia intexta*, *Protocardia* sp., *Praeexogyra pustulosa*, ostracods (reddish impregnation), serpulids, litiolids, etc.. Findings at m 69: *A. morrissi*, giant *Protocardia* sp. A, *M.*

Section Bataiha



multicostata. At m 72.0 (correlated from nearby site): brownish grey, bioclastic, bioturbated floatstone, partly with faecal pellets. Clusters of *A. morrissi*, abundant bioclasts of bivalves and gastropods, rare lituolids (?*Everticyclammina virguliana*) and dasycladaceans. *A. morrissi* and giant *Protocardia* 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 lusitanicum* (prevailing), *Eomiodon securiformis* (common), *Antiquicyprina* sp., *Praeexogyra pustulosa*, *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 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.. Microfacies: common bivalve bioclasts with mottled distribution, oysters, ostracods, serpulids, *E. virguliana*. 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 *Nanogyra* marls), oyster wacke— to rudstone. Clusters of *A. morrissi* 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), echinids (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., *Jurassicorbula edwardi*, *Myophorella* cf. *lusitanica*, and, somewhat higher, *Isognomon lusitanicum*, *Gervillella aviculoides* 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., ?*Styline delabechii*); rudstone full of corals, bored by *Lithophaga* sp., and rhodoliths in intraspartitic, unsorted matrix. Large nerineid 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. 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.

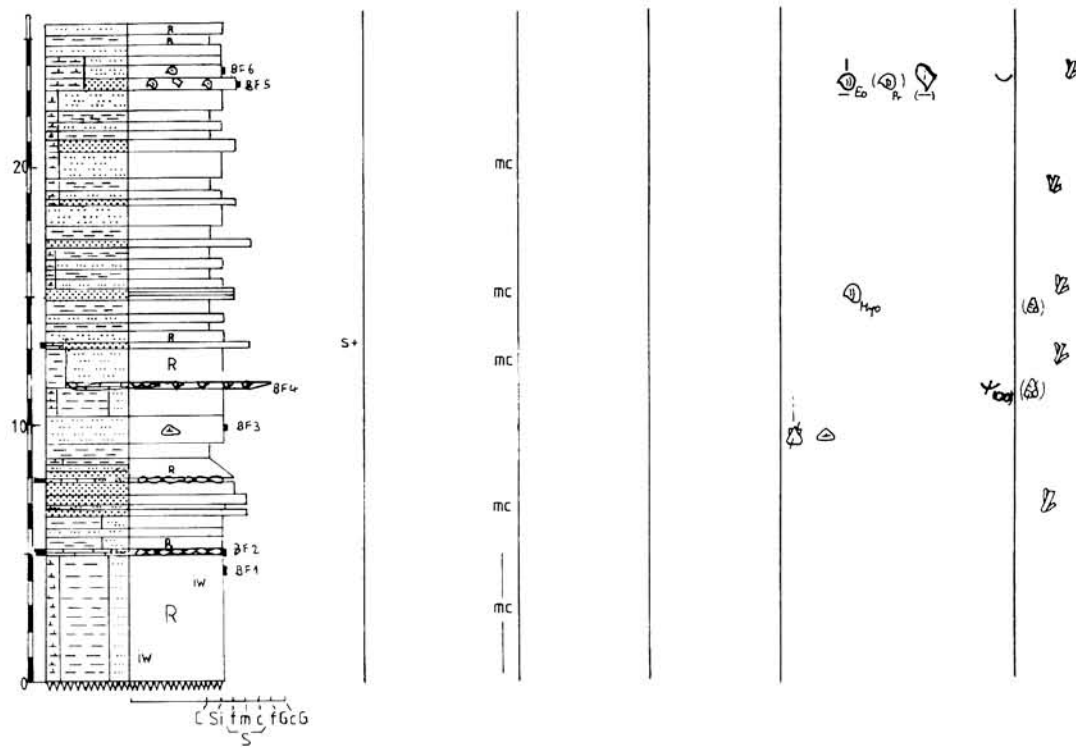
Nearby sections: Engenheiro.

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



- ster rudstone, 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 securiformis*, often in life position; above it, cluster of *Isognomon lusitanicum* with attached *Praeexogyra pustulosa*, also often in life position, together with *Eomiodon securiformis* and rare *Protocardia* sp.. At top, common, small–sized specimens of *E. securiformis*
- 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 »Corálico« outcrops (Amaral formation) up to hilltop.

Stratigraphic range : Uppermost part of Amaral formation, Sobral formation, lowermost part of »Pteroceriano« 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 morrissi* (dominating by far) and *Eomiodon securiformis*, 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.

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 lituolids (?*Everticyclammina virguliana*) and dasycladaceans. *A. morrisi* and giant *Protocardia* 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 lusitanicum* (prevailing), *Eomiodon securiformis* (common), *Antiquicyprina* sp., *Praeexogyra pustulosa*, *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 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.. Microfacies: common bivalve bioclasts with mottled distribution, oysters, ostracods, serpulids, *E. virguliana*. 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 *Nanogyra* 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), echinids (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., *Jurassicorbula edwardi*, *Myophorella* cf. *lusitanica*, and, somewhat higher, *Isognomon lusitanicum*, *Gervillella aviculoides* 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., ?*Styline delabechii*); rudstone full of corals, bored by *Lithophaga* sp., and rhodoliths in intraspartitic, unsorted matrix. Large nerineid 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. 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 (Bombaral formation).

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

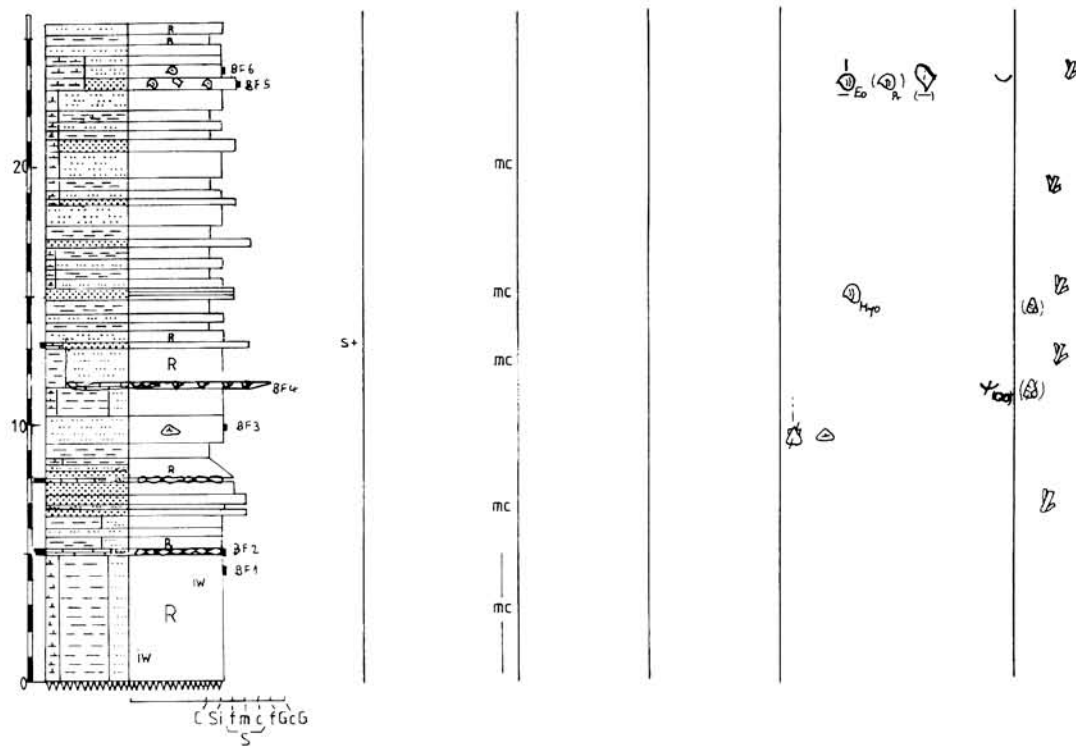
Nearby sections: Engenheiro.

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



- ster rudstone, 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 securiformis*, often in life position; above it, cluster of *Isognomon lusitanicum* with attached *Praeexogyra pustulosa*, also often in life position, together with *Eomiodon securiformis* and rare *Protocardia* sp.. At top, common, small-sized specimens of *E. securiformis*
- 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 »Corálico« outcrops (Amaral formation) up to hilltop.

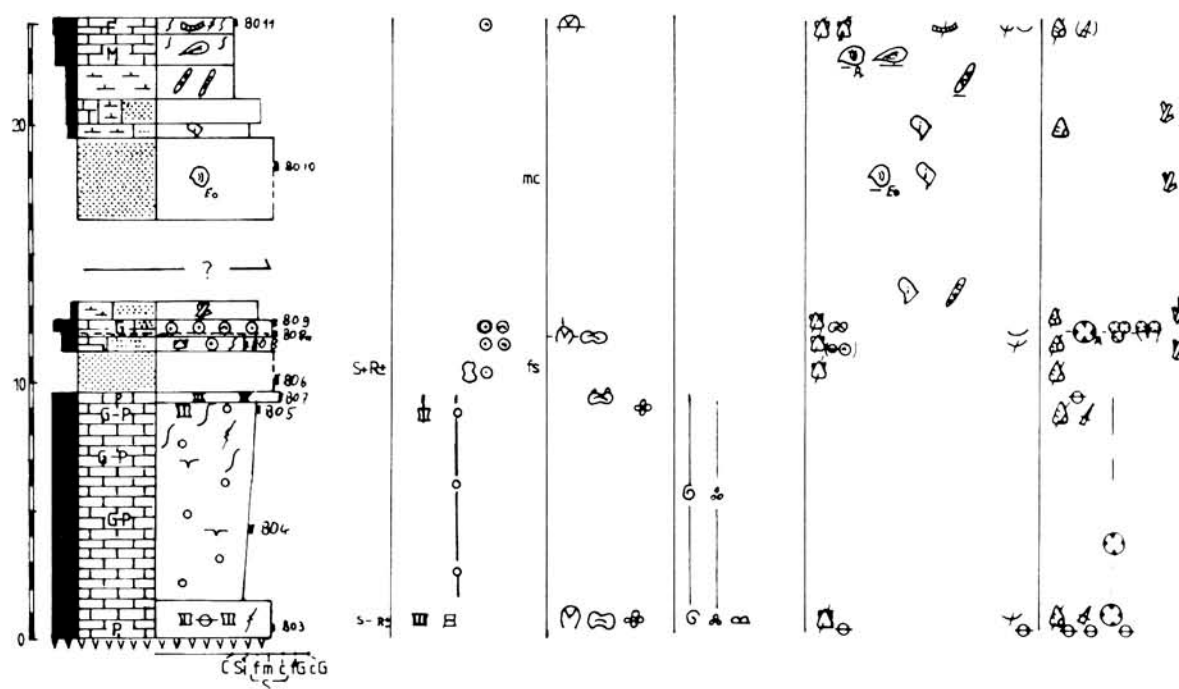
Stratigraphic range: Uppermost part of Amaral formation, Sobral formation, lowermost part of »Pteroceriano« formation.

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 morrissi* (dominating by far) and *Eomiodon securiformis*, 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.

Section Boieiro



W Boieiro, in Sobral sequence, findings of *Axosmilia* gr. *discoidea*—*caudata*, *A. caudata*, *A. crassa*, *Coelastarte discus*, *Nerinea turbinata*.

Description:

- m 0.0–1.5: light coloured, thick-bedded, poorly sorted intraclastic packstone with common cortoids of corals, echinoids, bivalves, gastropods. Furthermore, oncoids, »cayeuxiid« algae, algal lumps, *M. lugeoni*, dasycladaceans, lituolids, *Conicospirillina basilensis*, 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*, *Cyathophora 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 oncoid 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 *Eomiodon securiformis* besides *Isognomon lusitanicum*. Eventually faulting in lower part
- m 19.5–22.2: marly, sandy sequence, at base with frequent *I. lusitanicum* and *Nerinea turbinata*. At top, marl with abundant, double-valved *Gervillia sobralensis* (top of Sobral formation)
- m 22.2–23.5: grey, medium-bedded, slightly marly, bioturbated mudstone with *Arcomytilus morrissi* 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, litiolids (e.g., »*Haplophragmium*« sp., *Nautiloculina oolitica*), *Cylindroporella* sp., etc.. Above it, findings of double-valved *Myophorella lusitanica* and giant *Protocardia* sp. A, with *Praeexogyra pustulosa* overgrowth.

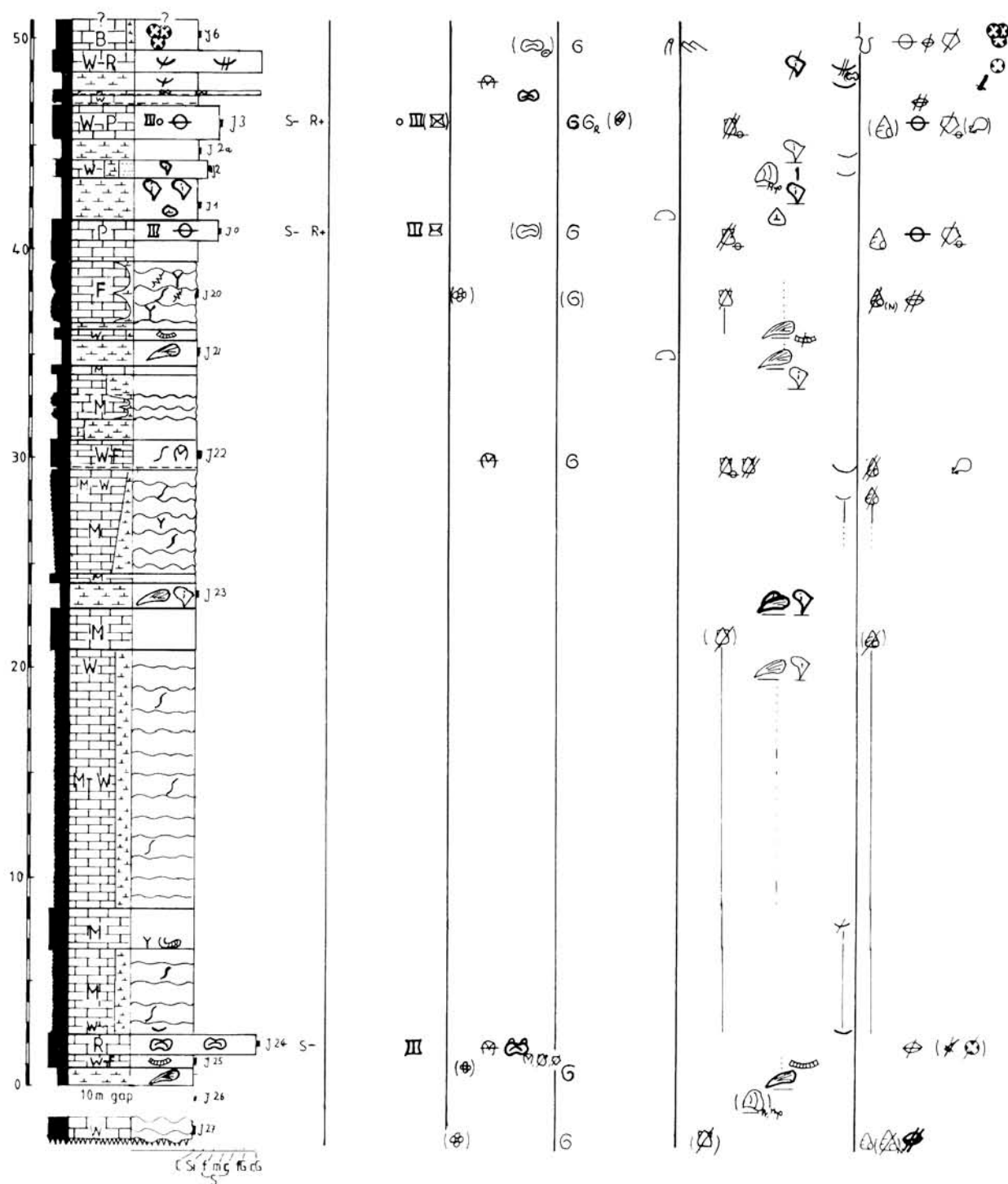
In quarries: quarry walls SW store depot:

- 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 litiolids (mainly *Everticyclammina virguliana*), *Terquemella* 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 irregulare* 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 dammeriensis* (a), *Jurassicorbula edwardi* (c), *Protocardia* sp. (c), *Pteroperna pygmaea* (c), ?*Pleuromya* 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 *Pseudocidaris lusitanicus*, litiolids, 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 *Corbulomima suprajurensis*, *Mesosaccella dammeriensis*, *Jurassicorbula edwardi*, *Nicaniella* sp., *Protocardia* sp., *Placunopsis suprajurensis* 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 litiolids, *Cylindroporella* sp., etc.. Top inaccessible.

Quarry wall south of store depot:

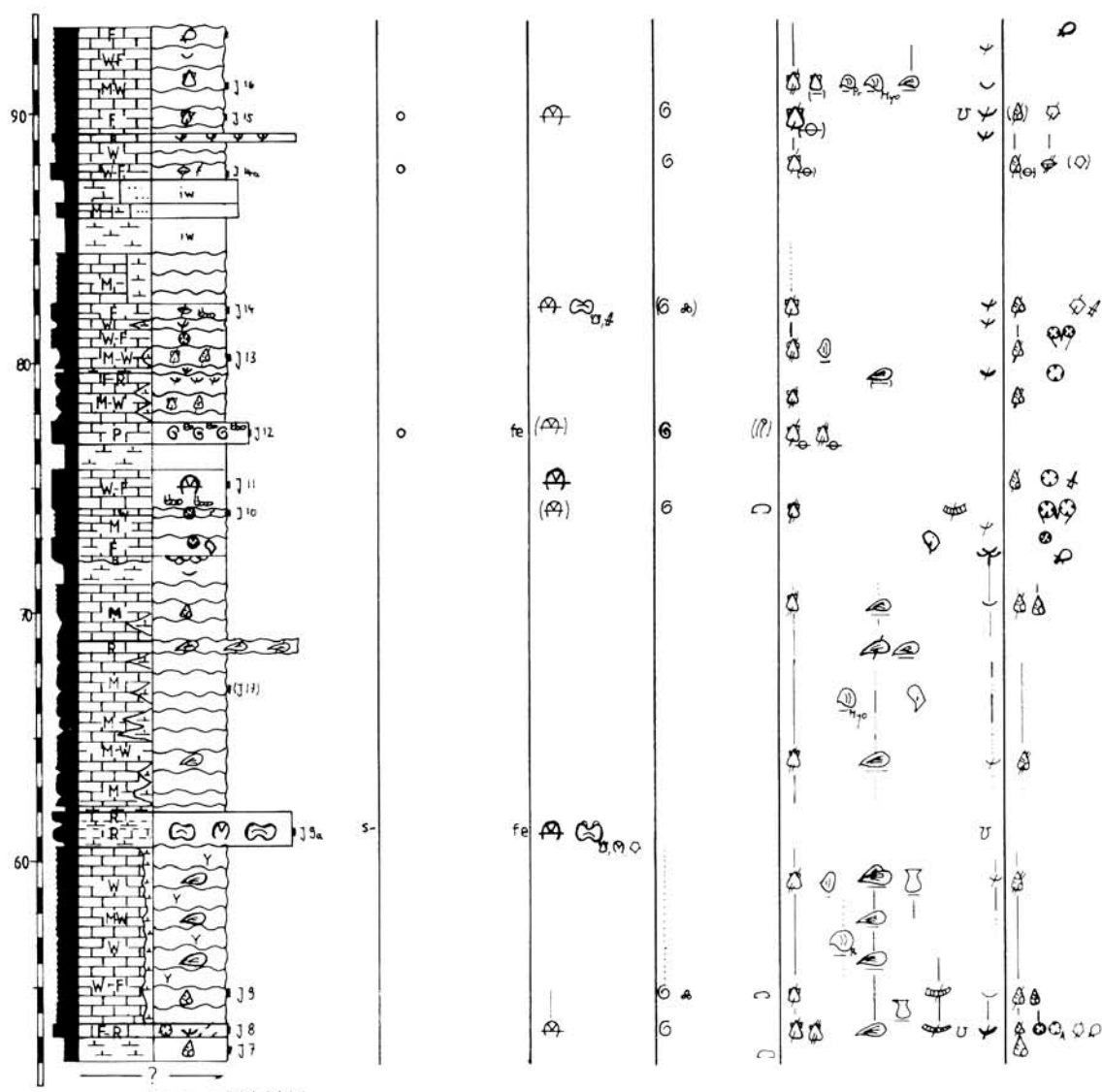
- m 40.5–41.5: light brown, bioclastic intraclastic packstone, poorly sorted; roundness of grains moderate to good. Small bioclasts microbored. Echinoids, oncoids and lumps occurring, litiolids common. Rare large bivalve clasts and nerineids. Dense packing of grains; matrix mostly sparitic

Section Bom Jesus



- m 41.5–45.2: grey marls with rich fauna: *Mesosaccella dammariensis* (a), *Corbulomima suprajurensis* (a), *Isocyprina* sp., *Pteroperna pygmaea*, *Jurassicorbula edwardi*, *Plicatula* sp., echinid spines; abundant ostracods (*Cytherella suprajurassica*, *Asciocythere* sp., *Cytheropteron* sp., aff. *Theriosynoecum* sp. (non wyomingense)), verneulinids, *Everticyclammina virguliana*; lignite litter, authigenous quartz (c). Shell bed of *Isognomon* sp. occurring in midst of 80 cm of silty marly, bioclastic wackestone with *Nanogyra nana*, *Myophorella lusitanica*
- m 45.2–46.8: light coloured, thick-bedded, bioclastic intraclastic peloidal wacke/packstone. Bioclasts and intraclasts normally microbored; lumps, large gastropods, spines of *Pseudocidaris lusitanicus*, very frequent lituolids (mostly *Pseudocyclammina* sp., *P. lituus*, »*Haplophragmium*« sp., *Rectocyclammina* sp., *Nautiloculina oolithica*), very rare miliolids, etc.

Section B o m J e s u s (Continuation)



- m 46.8–47.5: thin beds of intercalated marls, bioclastic wackestone and oncolitic 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 frame builders, 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 is 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: *Placunopsis suprajurensis* (a), *J. edwardi* (c), *C. suprajurensis* (o), *Modiolus* sp. (r); common ostracods (forms see m 41)
- m 53.0–53.5: grey, bioclastic, partly bioturbated float/rudstone, with coarse clasts of corals (partly *Axosmilia* sp.; corals bored by *Lithophaga* sp.), oysters and other bivalves (e.g., *A. morrisi*, *Trichites* sp.), echinids, *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

(in part oysters) common, in lower part additionally corals, *Trichites* sp. (bored by *Lithophaga* sp.), *Pteroperna* sp., pectinid bivalve, litiolids and ostracods. In upper part additionally giant *Protocardia* sp. A, *Mactromya concentrica*

- m 60.5–62.0: brownish, iron hydroxide–stained, thick–bedded, poorly sorted, oncolitic rudstone. Irregular shaped, *Lithophaga*–bored oncoids built of cyanophytes, *M. lugeoni* and sessile foraminifers; partly polycored (clasts of bivalves, echinoids). Groundmass microsparitic to sparitic (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 *Arcomylus morrissi* (forming a coquina at m 68.5) and rare *Myophorella lusitanica*, *Isognomon* cf. *flambarti*, 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 litiolids. Spines of *Pseudocidaris lusitanicus* and *Isognomon* sp. in lower, *Trichites* sp. in middle and frequent *Marinella lugeoni* in upper part. Excellently preserved burrows of *Rhizocorallium irregulare* on lower surfaces
- m 75.8–76.8: grey marls
- m 76.8–77.6: light brown, iron hydroxide–stained, litiolid peloidal packstone. Abundant litiolids, small, mostly micro-bored bivalve clasts, rare serpulids and *M. lugeoni*, in pelmicritic matrix with densely compacted peloids. *Rhizocorallium irregulare* on upper surface
- m 77.6–82.5: grey, medium–bedded, partly marly, nodular bioclastic limestone (mud–, wacke–, floatstones), often coral–bearing, with *A. morrissi*, *Jurassicorbula edwardi*, common oysters (partly forming rudstone in middle), etc.. At top, oncoid–bearing, with echinid debris, *M. lugeoni* and rare foraminifers. Intensively bioturbated by *Rhizocorallium irregulare*. 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: grey, medium to thick–bedded, nodular bioclastic wacke/floatstones (rarely mudstones), bioclasts occasionally microbored. Oysters very frequent in lower part, also forming thin bioclastic rudstone horizon. Bivalve fauna: *A. morrissi*, further *Eopecten* sp., *Coelastarte discus*, *Myophorella* cf. *lusitanica*, *Protocardia* sp., *Jurassicorbula edwardi*, *Inoperna* sp., *Praeexogyra pustulosa*, *Nanogyra nana*, heterodonts indet.. At top, abundant spines of *Pseudocidaris lusitanicus*. Litiolids and *M. lugeoni* occurring. Matrix partly pelmicritic.

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.

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

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

Nearby sections: Adanaia, Bom Jesus, S'Tiago dos Velhos, Chão da Vinha.

Special remarks: Sobral formation outwedging. Lower part of »Pteroceriano« formation with corals and red algae.

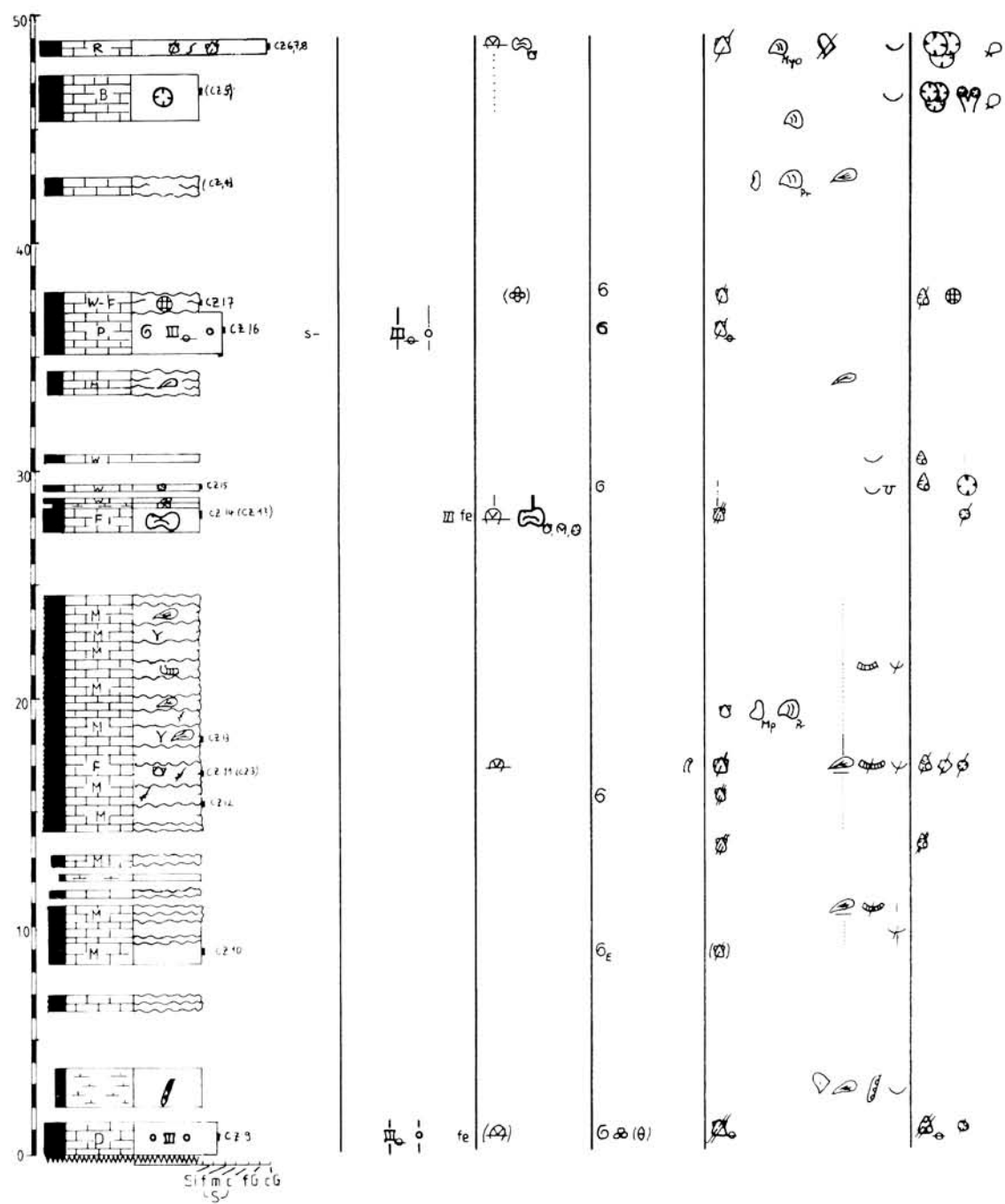
Description:

(a) **Base of section** (from the road to Calhandriz, climbing across covered Abadia beds up to first outcrops): 10 m Amaral 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), 6 m coral floatstones (partly boundstones with thick coral heads) and oolitic grainstones with bioclast–cored ooids and *M. lugeoni* (nodules up to 10 cm Ø). Above it, gap (ca. 2 m), then 50 cm yellowish, micaceous, fine–grained sandstone with common lignite pieces (up to 3 cm in size), superimposed by horizon with *Isognomon lusitanicum* (Sobral formation). *Isognomon* horizon possibly corresponding to *Gervillia* 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, intraclastic peloidal packstone with fine bioclasts, coral fragments, *M. lugeoni* and litiolids (top of Amaral formation)

Section Calhandriz



- m 2.0–3.8: dark grey marls with *Gervillia sobralensis*, *Arcomytilus 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 irregulare* 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. lugeoni*
- m 27.2–28.8: greyish oncolitic floatstones with an intercalation of oncolitic marl. Iron hydroxide-stained oncoids; on-coid nuclei built of bivalve clasts, *M. lugeoni* and, partly, corals. Non-encrusted *M. lugeoni* also common in intraclast-bearing matrix
- m 29.2–30.8: light grey gastropod wackestone (two small horizons, divided by gap). Biobored 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 intraclastic peloidal packstone with frequent litiolids, etc.. Components mostly microbored
- m 37.0–38.0: grey, nodular calcisponge wacke/floatstone with additional gastropods, bioclasts, *Salpingoporella annulata*
- m 38.0–45.3: gap, with small outcrop of nodular mudstone with *A. morrisi*, giant *Protocardia* sp. A and *Mactromya concentrica*
- m 45.3–47.3: light, thick–bedded, coral boundstone (bafflestone) with *Amphiastrea piriformis*, *Cyathophora cesareensis*, *Actinastrea ramulifera*, *A. crasso–ramosa*; *Praeexogyra pustulosa*, spines of *Pseudocidaris lusitanicus*, *M. lugeoni*, etc.
- m 48.9–49.0: yellowish, medium–bedded, nodular bioclastic rudstone with oncoids (partly superficial). *Isognomon (Rostroperna)* sp., *P. pustulosa*, *Placunopsis suprajurensis*, *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 serpentine 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, Batalha, Boieiro.

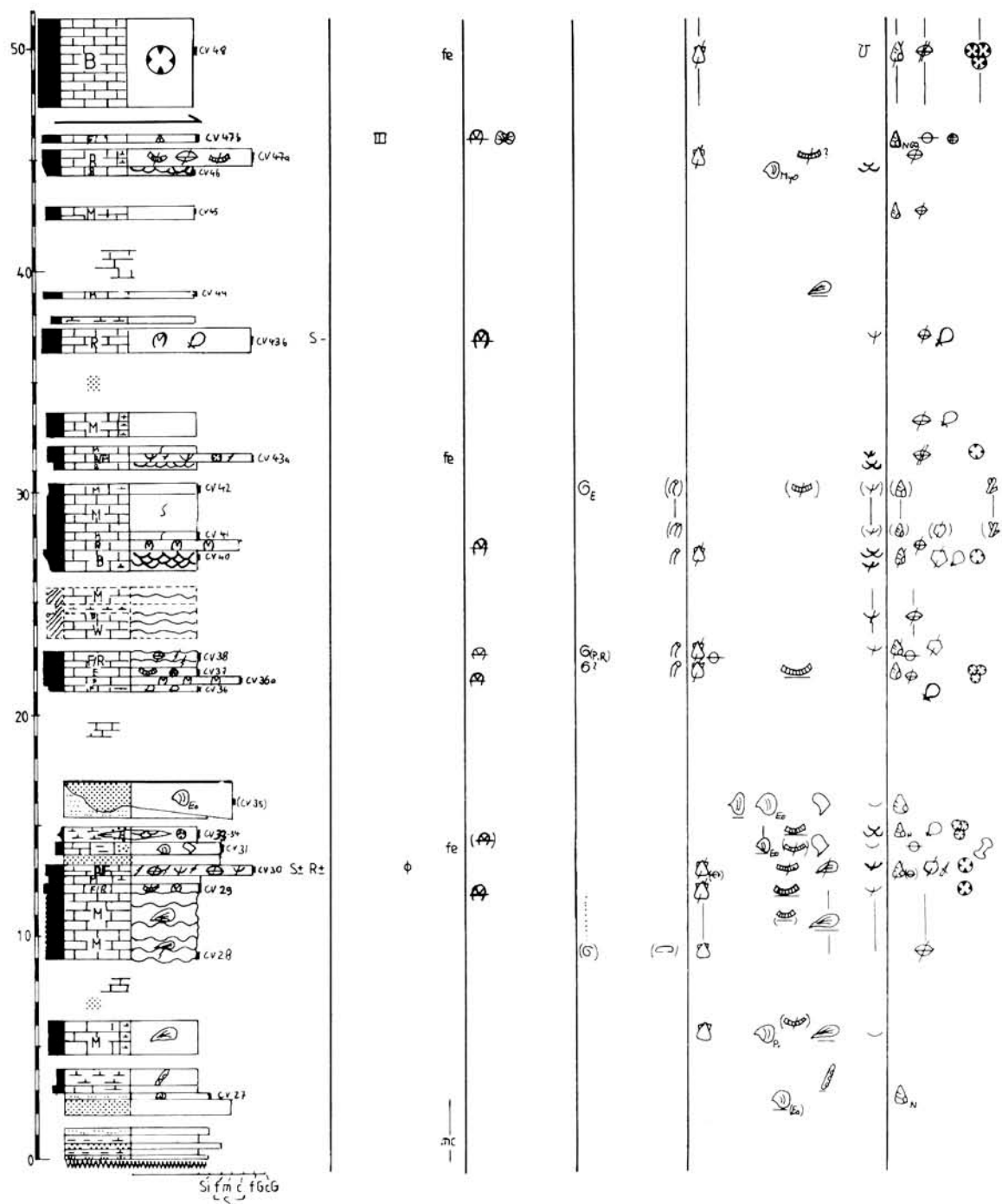
Special remarks: To point out outwedging intercalations of Sobral sandstones within the »Pteroceriano« formation, two parallel sections were taken. Note frequency of coralline algae and corals in siliciclastics. The sections are the direct continuation of the Mata section.

Description:

Section East

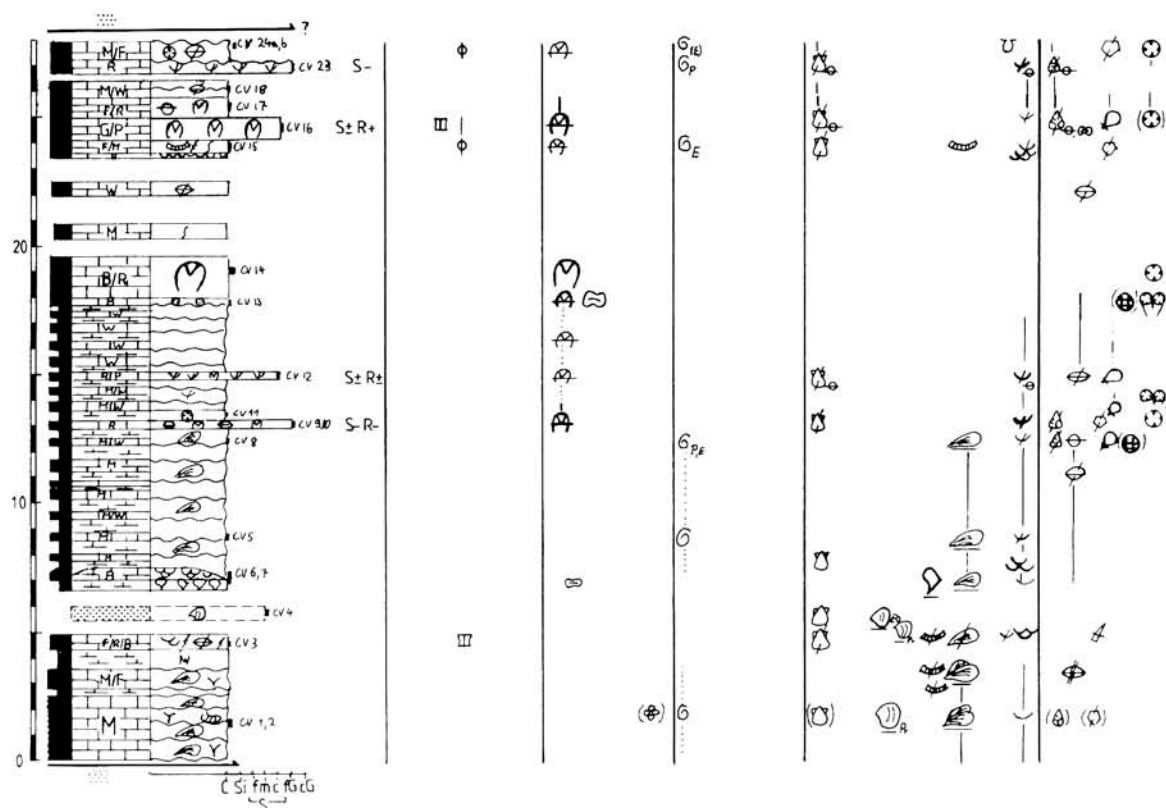
- m 0.0–4.0: (in stream valley) brown, micaceous siliciclastics with *Eomiodon securiformis*, *Antiquicyprina* sp., *Nerinea turbinata*, superimposed by medium bed of grey calcareous marl and grey marl with *Gervillia sobralensis* (top of Sobral formation)
- m 4.7–5.2: grey, medium to thick–bedded, marly mudstone with scattered *Arcomytilus morrisi*, *Camptonectes* cf. *auritus*, *Praeexogyra pustulosa* 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. morrisi*, pectinids, *Trichites* sp., litiolids, 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*, *Eomiodon securiformis*, clasts of *Trichites* sp., vertebrate tooth and *M. lugeoni*. Superimposed is sandy marl with *E. securiformis*, *Trichites* aff. *saussurei*, *Praeexogyra pustulosa*, nerineids (in part *Nerinea turbinata*), *Pseudocidaris lusitanicus* (spines), *Amphiastrea piriformis*, *Actinastrea crasso–ramosa*, *Ovalastrea* cf. *plicatula*. *P. pustulosa* forms oyster patch reef, outwedging over a few meters
- m 15.2–17.0: brown siltstone with *Isognomon* sp., *Unicardium crassum*, *Coelastarte discus*, *P. pustulosa*, nerineids, ampullinid gastropod, *P. lusitanicus* (spines), and brown sandstone with *E. securiformis*. Sandstone apparently interfingering with siltstones and outwedging over a short distance. Top of sandstone cut by NW–SE striking fault
- m 21.0–22.8: brownish grey, mostly nodular floatstones and pack/rudstones with *M. lugeoni*, bioclasts (partly microbored), frequent spines of *P. lusitanicus*, *T. aff. saussurei*, oysters, serpulids and litiolids (*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

Section Carvalha East



- m 26.5–30.5: at base, brownish, marly oyster rudstone, rapidly passing into *P. pustulosa* boundstone with *Amphistrea piriformis*, 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 virguliana* 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 Carvalho 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 cayeuxiformis* n.sp., *M. lugeoni* and intraclasts. Section is cut by fault

m 47.5–51.3: (on hilltop Carvalho) brownish, iron hydroxide–stained, very thick–bedded to massive coral boundstone (framestone), dominated by, often *Lithophaga*–bored, *Amphiastrea piriformis*. 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*, *Rhizocorallium irregulare*, and *A. morrisi*, giant *Protocardia* sp. A, *Protocardia* cf. *intexta*, *Praeexogyra pustulosa*, *Camptonectes* cf. *auritus*, *Trichites* sp. (in upper part), echinoid and other debris; rare liliolids (?*Everticyclammina virguliana*), *Cylindroporella* cf. *arabica*. In upper part marls, oyster rudstone and oyster boundstone intercalated. Compaction cracks and intensive recrystallization in higher part

m 5.0–7.5: at base, gap, with sandstone rubble and common, large *Eomiodon 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 *Pseudocidaris lusitanicus*

m 7.5–17.5: medium to thick–bedded limestones with intercalation of marl: grey mudstones with *A. morrisi*, oysters and *E. virguliana* 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 micritic *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 (coniatolitic?) 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 echinoid debris, *Marinella lugeoni*, *Everticyclammina virguliana*. Spar-filled solutional vugs and autoclast formation
 - dark grey, thick, moderately sorted rhodolith grain/packstone with *M. lugeoni*, spines of *Pseudocidaris lusitanicus* (often enriched in layers), rare corals, cortoids, intraclasts, peloids, etc.. Groundmass formed of neospar; ghost structures common
 - bioclastic rhodolith float/rudstone with similar characteristics
 - nodular mud/wackestone
 - slightly marly, micritic oyster rudstone with additional gastropods, microbored corals, *Pseudocyclammina* sp., »*Haplophragmium*« sp.
 - nodular mud/floatstone with fasciculate corals, partly bored by *Lithophaga* sp., *M. lugeoni*, *Cylindroporella* 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 lusitanicum*, *Coelastarte discus*, corals, overlain by mudstone with *Arcomytilus morrisi*, rare oysters, corals and liliolids, with common compaction cracks.

Section Chão de Vinha

Location: geol. map, sheet Alenquer, SW quadrant, 4 km S Arruda dos Vinhos. From Trancoso 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.

Generalities: survey section. Only hard beds outcropping. Parts of section reconstructed by loose rock rubble.

Nearby sections: Calhandriz, Boieiro.

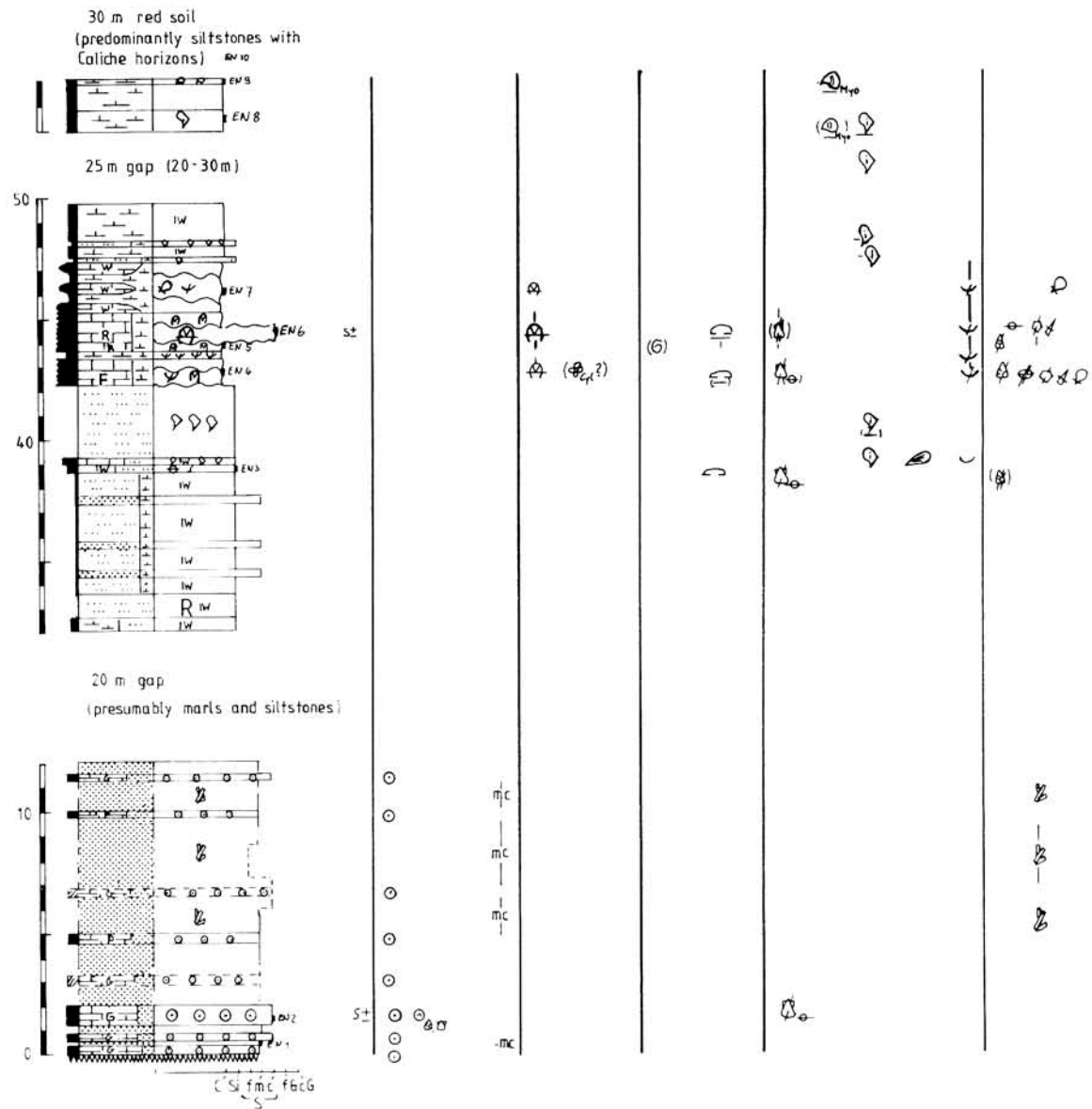
Special remarks: Sobral clastics about 30 m in thickness.

Description:

- m 0.0–1.2: bioclastic wacke/floatstones with *M. lugeoni*, 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 (Oólito member of Amaral formation)
- m 3.0–30.5: mostly gap, with common loose blocks of brownish sandstones and rare outcrops of silt- and sandstones, partly evenly laminated, with occasional oyster layers and *Eomiodon securiformis* (Sobral formation)
- m 34.5–51.6: poorly exposed nodular limestones (mainly mudstones) with *Arcomytilus morrisi*, oysters, etc., and *Trichites* sp. in some levels. Note marl layer at m 45.0 (extending to old windmill) with *Gervillia sobralensis*, *Isognomon* cf. *lusitanicum*, *A. morrisi*, *Praeexogyra pustulosa*, and superimposed, iron hydroxide-stained, bioclastic float/packstone with inconstant thickness, bearing abundant oysters besides other bioclasts, e.g., corals, *Pseudocidaris lusitanicus* (spines), *M. lugeoni*. On hilltop, floatstone with *Trichites* sp., *Myopholas multicostata*, *A. morrisi*, *P. lusitanicus* (spines), *Everticyclammina virguliana*, dasycladaceans, etc..

End of section.

Section Engenheiro



Description:

- m 0.0–2.0: predominance of brown, medium-bedded, oolitic grainstones with quartz-cored ooids; bioclast-cored ooids and cortoids occur. Brown, micaceous sandstones form minor intercalations (upper part of Amaral formation)
- m 2.0–12.0: (partly poorly exposed) brown, medium to thick-bedded, mostly micaceous and lignitic sandstones, with thin intercalations of oolitic packstones and grainstones
- m 12.0–32.5: exposure gap with presumed marls and siltstones subcropping
- m 32.5–33.5: weathered, red to violet-coloured silts
- m 33.5–42.2: 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 *Isognomon lusitanicus*, *Arcomylus morrissi*, *Praeexogyra pustulosa* and *Nanogyra nana*. At m 41.0 another coquinoïd layer of, partly double-valved, *I. lusitanicus*
- m 42.2–45.2: dark grey to brownish, nodular float- and rudstones (micritic), with abundant oysters and very common clasts of *M. lugeoni*. 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*
- m 45.2–50.0: 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-

ceriano« formation). At m 47.5 *I. lusitanicum* in siltstone; at m 48.0 thin coquinoïd layer of same species (beginning of Santa Cruz member, Bombarral formation)

m 50.0–75.0: exposure gap with rare findings of *I. lusitanicum*

m 75.0–77.0: grey marls, in lower part with *I. lusitanicum* and rare *Myophorella lusitanica*. At top, coquinoïd layer composed of *M. lusitanica*.

Above it, beginning of red to violet colour soil, corresponding to a true thickness of eventually 30 m of subcropping siltstones with caliche horizons (Bombarral formation s.str.).

End of section.

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 Casal da Quinta Grande, 1125 m SSW Enxara hilltop.

Stratigraphic range: »Pteroceriano« formation, lower part with siliciclastic 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, aggravated by 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, Gotleis.

Special remarks: though above described difficulties complicate interpretation, section is important due to its situation at the western boundary of main »Pteroceriano« distribution. Remarkable is the intertonguing of siliciclastics with coral-bearing limestones and marls (»Pteroceriano« facies interfingering 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 *I. lusitanicum*. At m 2.0 bioclastic rudstone (micritic) with abundant oyster debris, *M. lugeoni*, rare *Pseudocidaris* spines, etc., At m 9.0 abundant small-sized *Myophorella* cf. *lusitanica* (presumed same horizon at closeby site contains additionally *Isognomon* sp. and *Amphiastrea piriformis*)

m 11.7–14.8: brownish, thick-bedded, bioclastic floatstone with coral debris (mostly »*Calamophyllia*« sp.), *M. lugeoni*, etc.

m 17.8–19.0: patch reef of *Praeexogyra pustulosa*/*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 *Pseudocidaris lusitanicus*

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

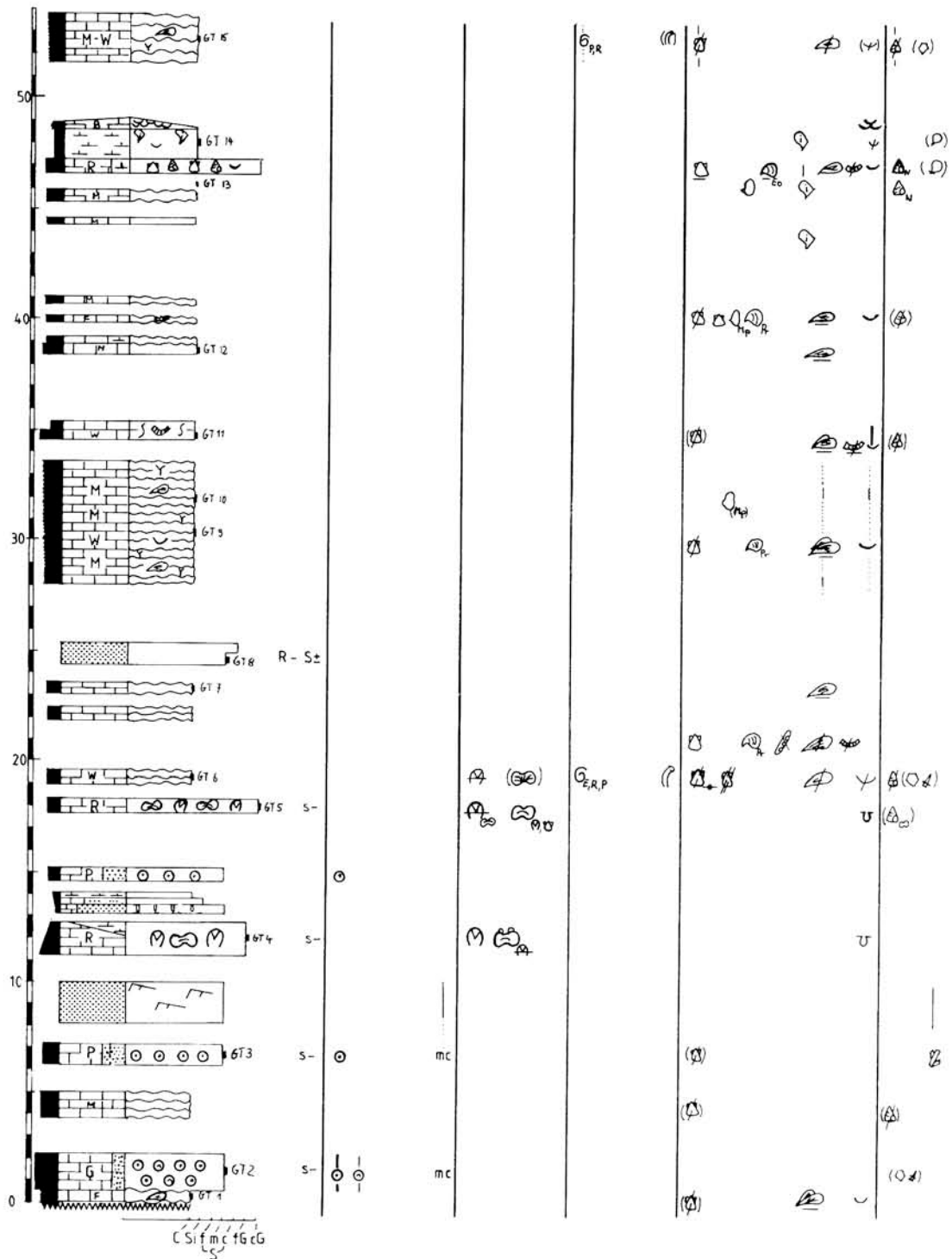
m 36.0–41.0: at base, clusters of, mostly univalved, *Eomiodon securiformis*, *I. lusitanicum* and *M. lusitanica* with rare corals in silty matrix. Superimposed are sandstones and brown, sandy, moderately sorted, bioclastic packstones. Bioclasts well rounded and microbored. At top, increase of sand 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 ?*Amphiastrea piriformis*, silts with small patch reefs of *P. pustulosa*/*N. nana* and abundant *I. 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 microbored oyster debris, very frequent *Everticyclammina virguliana*, etc..

End of section.

Section Gottleis



- m 0.5–2.2: grey oolitic grainstone. Ooids mainly with quartz cores; partly polyooids and pitting contacts. Ooid cortices largely varying in thickness.
- m 3.8–5.0: grey nodular mudstone
- m 6.3–7.2: dark grey, micaceous, oolitic packstone
- m 8.0–10.0: ocre-coloured, medium-grained, small-scale cross-bedded sandstone with lignite litter
- m 11.2–12.7: one bed of brownish grey, micritic oncolitic rudstone with abundant *Marinella lugeoni*, partly encrusted by cyanophytes and sessile foraminifers. Oncoids 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 correlatable position) calcareous sandstone with abundant *Scolithos* 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, oncoids 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 wackestone (partly packstone) with cortoids, *A. morrisi*, echinid spines, *M. lugeoni*, *Everticyclammina virgulianna*, *Rectocyclammina* sp., *Pseudocyclammina* sp., etc.. In upper part findings of *A. morrisi*, *Trichites* sp., *Gervillia* sp., *Camptonectes* cf. *auritus*, *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 Oólito member, Sobral formation and lower part of the »Pteroceriano« formation)
- m 28.0–41.1: grey, thin-bedded, nodular mud/wackestones (partly floatstones), with larger exposure gaps. *A. morrisi* as well as *Praeexogyra pustulosa* and *Nanogyra nana* common. In some horizons *Trichites* sp., *Camptonectes* sp., *Protocardia* sp., *Myopholas multicostata*, etc.. Partly distinct burrows of *Thalassinoides suevica* and *Rhizocorallium irregulare*
- 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. Dominating are *P. pustulosa*, *N. nana*, *Eomiodon securiformis*, *Nerinea turbinata*, besides *A. morrisi*, *Unicardium crassum*, *Coelastarte discus*, *I. lusitanicum*, *Trichites* sp., *Pseudocidaridius lusitanicus* (spines). Partly only composed of *E. securiformis* and *N. turbinata*
- 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), encrusted 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 *Rectocyclammina* sp. and *Pseudocyclammina* 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, Oólito member (both of Amaral formation), Sobral formation, lowermost part of »Pteroceriano« formation

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

Nearby sections: Carvalha, Boieiro.

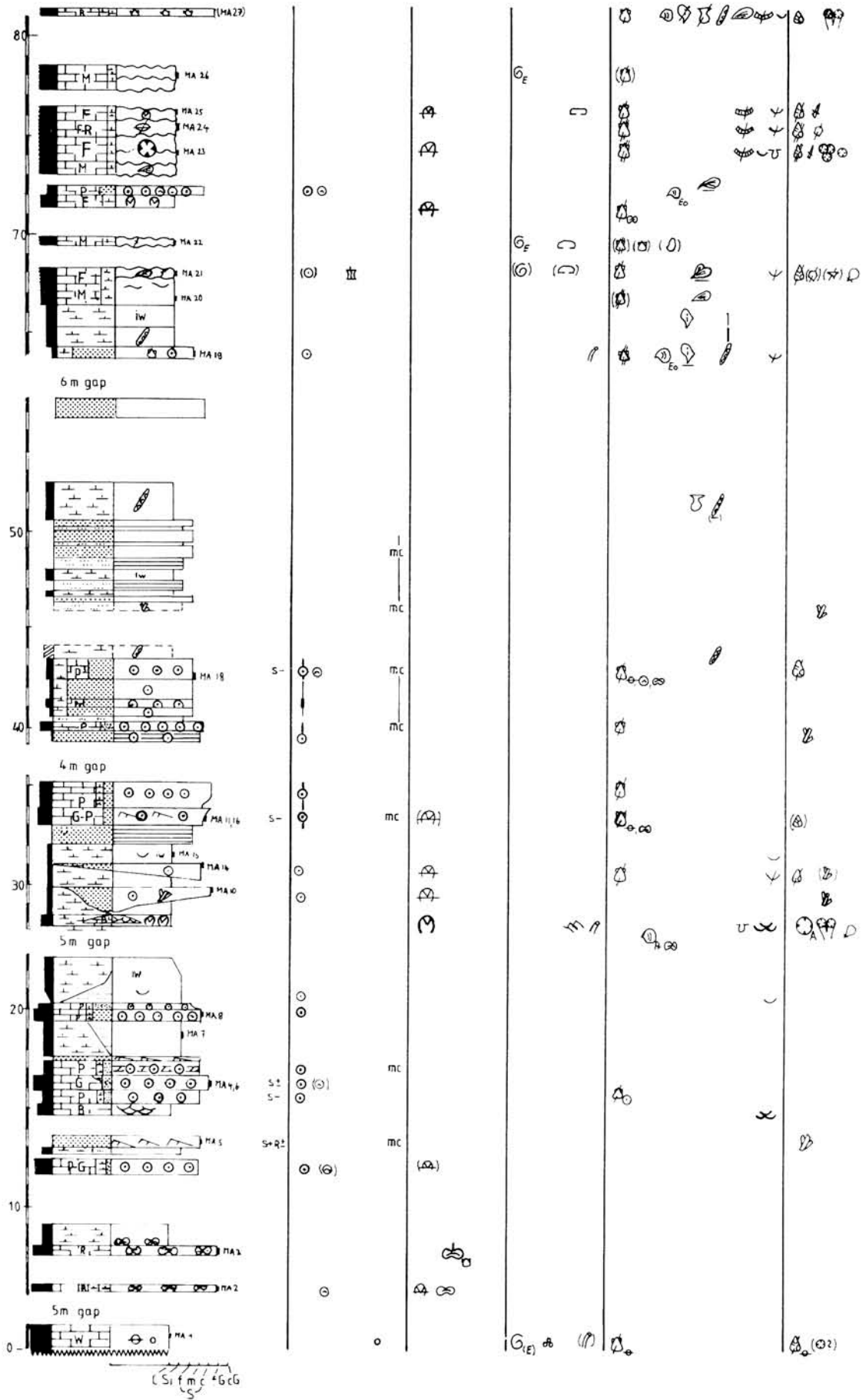
Special remarks: section exhibits small-scaled facies variations in clastic sequence. Note coral fauna appearing in siliciclastic facies at m 28. Carvalha sections form direct continuation of present section.

Proposed type section for Sobral formation.

Description:

- m 0.0–1.0: peloidal wackestone with common cortoids (esp. gastropods), rare corals, litooids (e.g., *Everticyclammina virgulianna*), verneulinids, etc. (top of Trancoso member, in lagoonal facies)
- m 5.7–6.0: dark grey, oncolitic 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 oncolitic rudstone, overlain by marls with abundant oncoids 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, Oólito member) and superimposed silty marls, in part with *Nanogyra nana*, also with oolite layers and intercalation of brown, cross-

Section M a t a



—stratified sandstone with mica and lignite enrichment on foreset surfaces. At m 15 *Praexogyra pustulosa*/*Nanogyra nana* patch reef

- m 27.7–28.4: densely packed rhodoliths up to 5 cm Ø (*M. lugeoni*) in marly matrix. Often borings of *Lithophaga* sp.. Intercalated is oyster patch reef, overgrowing corals and in part bivalves which are heavily encrusted by algae, serpulids and bryozoans. Coral meadow and oyster patch reef outwedging within a few meters, so that in lateral equivalents only oyster and coral debris can be found. Determined fauna: *P. pustulosa*, *N. nana*, »*Lopha*« sp., giant *Protocardia* sp. A, *Pseudocardis lusitanicus* (spines), *Axosmilia crassa*, *A. carapateirensis*, *A. cf. corallina*, *Actinastrea crasso-ramosa*
- m 28.4–35.2: brown, bioclastic siliciclastics, often with quartz—cored ooids, debris of *M. lugeoni* and other bioclasts, lignite litter. Often outwedging 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. lugeoni*, 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 cortoids. At top, weathered marls with common *Gervillia sobralensis*
- 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 *Gervillia 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 lusitanicum*, *Gervillia sobralensis*, *Eomiodon securiformis*, clasts of other bivalves, serpulids. Above it, weathered marls with *G. sobralensis* and rare *I. lusitanicum* (top of Sobral formation)
- m 66.5–70.0: grey, medium—bedded, nodular (except base) mudstones with clusters of *Arcomytilus morrissi*, *Camptonectes* cf. *auritus*, deep—burrowing bivalves, bivalve clasts, ostracods, *Everticyclammina virguliana*, partly grading into nodular floatstones with additional oysters, gastropods, terebratulids (rare), echinids, e.g., *Pseudocardis lusitanicus* (spines), rare quartz—cored ooids and intraclasts; very strongly bioturbated. Sequence showing distinct signs of early vadose diagenesis (early cracks, biomolds, partly collapsed and/or filling of crystal silt)
- m 71.5–72.5: light grey, *M. lugeoni* 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. morrissi*, turning into floatstones (partly micritic rudstone) with *Trichites* sp., debris of *M. lugeoni*, common angular clasts of bivalves, gastropods, echinids, etc.. Frequent corals at m 74: thin coral meadow mainly of ?*Amphiastrea piriformis*, bored by *Lithophaga* sp. and encrusted by oysters. At top, mudstones with *E. virguliana*
- m 81.0–81.3: greyish brown coquina (rudstone in marly matrix) of, partly fragmented, *Unicardium crassum*, *A. morrissi*, *Gervillia* sp., *I. lusitanicum*, *Pteroperna* sp., *Trichites* sp., gastropods and rare corals (in similar bed at close-by site determinable as ?*Axosmilia* sp., *Ovalastrea* cf. *lobata*, with *Praexogyra pustulosa* overgrowth).

End of section.

Section Moinhos do J. Miguel

Location: geol. map, sheet Alenquer, SW quadrant, between Enxara do Bispo and Senhora do Socorro. From Enxara do Bispo along traffic road direction to Sapataria. 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: »Pteroceriano« 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.

Nearby sections: Enxara do Bispo, Patameira, 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. morrissi* and oysters (mostly *Nanogyra nana*), further—

Section Moinhos do J. Miguel



more findings of *Protocardia* sp., *Jurassicorbula edwardi*, cidaroid echinid (entire corona, poor preservation), etc.

m 11.2–20.5: exposure gap, findings of *A. morrissi* and *Myophorella lusitanica*

m 20.5–21.2: mass occurrence of *I. lusitanicum* (partly double-valved), superimposed by *Nanogyra nana* bound/rudstone with marly matrix, with spines of *Pseudocidaris lusitanicus*

m 21.5–26.0: presumed marls and nodular mud/wackestones with burrows of *Thalassinoides suevica*. In middle part

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 *Amphiastrea piriformis*, 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 microbored
- slightly nodular, bioclastic rudstone (micritic). Abundant rounded fragments of *Marinella lugeoni* and oysters besides echinid 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), *Amphiastrea piriformis* (at m 72), *Axosmilia* sp. (at m 87), *Isognomon lusitanicum*, *Pteroperna* sp. and ?*Ger-villella 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 trig. altitude Oerca.

Stratigraphic range: top of Oólito 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 Oólito/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 basal, sandy, ooid–bearing grainstones to, predominating floatstone and rudstones. Superficial oncoids, in part with sessile foraminifers. Nuclei composed of oysters, gastropods, bivalves, echinids and corals (in decreasing frequency). Furthermore, »cayeuxiid« 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*, dasycladaceans(?), »*Haplophragmium*« sp., *Everticyclammina virguliana*, etc. (top? of Oólito member)

well sorted, in part cross-bedded 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-bedded, 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 »Pteroceriano« equivalents (mainly Santa Cruz member): soil contains fragments of marls and siltstones; marly, silty, bioturbated mudstones are rare (»Pteroceriano« 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, foraminiferal limestones are derived from Cretaceous outcrops at Marquita). 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 quadrant. 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, »Pteroceriano« 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 Oerca, though overlap is assumed. Top of Amaral formation supposed to be situated 10–15 m below base of present section.

Nearby sections: Oerca.

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

Description:

- m 0.0–5.5:** intercalation of brownish sandstones (dominating) mostly with feldspar, mica and lignite litter, and thin horizons of brownish marls, silts and siliciclastic conglomerates, the latter with reworked caliche nodules. *Eomiodon securiformis* occurring in sandstone
- m 5.5–7.5:** greyish brownish, thick-bedded, very sandy, peloid packstone with large bioclasts, mostly biomicro-bored or with superficial oncolite coating, ooids (50% with quartz cores), small cortoids, rare *M. lugeoni*, »*Haplophragmium*« sp., rare ostracods, etc.. Distinct early diagenetic vadose influence. Above it (divided by thin marl layer with gastropods and ostracods), thick-bedded, bioturbated sandstone with abundant bioclasts, esp. oysters, frequent quartz-cored ooids, *M. lugeoni*, common lignite litter, gravels of sandy limestones and reworked caliche and mud pebbles
- m 7.5–14.0:** 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. lugeoni*, litiolids, verneulinids and rare serpulids. Findings of ?*Gervillia* sp.
- m 14.0–49.0:** gap of uncertain extent (here presumed 35 m), with common caliche concretions in soil, esp. in upper part
- m 49.0–56.2:** (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 bioclasts, mostly preserved as ghost structures. Gravels of quartz, feldspar, *M. lugeoni* (top of Sobral formation)
- m 56.2–56.8:** thick bed of greyish brown, poorly sorted algal packstone (at base marly mud/wackestone) with abundant, well rounded debris of *M. lugeoni*, cortoids (also of echinoids), litiolids, valvulinids. Very sandy at base, quartz content decreasing towards top. Partly chaotic, imbricated bedding of components, mostly due to bioturbation?. Partly strongly recrystallized. Note *Arcomytilus morrisi* and frequent, partly double valved *Trichites* aff. *saussurei* in upper part (vestige of »Pteroceriano« formation)
- m 57.3–59.5:** at base, pale, lignitic, feldspar-bearing sandstones with gravel and caliche horizons, above it, sandy, oolitic pack/grainstone with cortoids, rare litiolids, fragments of *M. lugeoni* and detrital feldspar grains

Section São Tiago dos Velhos

Location: geol. map, sheet Loures, NW quadrant. Section starting 1200 m S S'Tiago 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 south-west of Moinhos dos Toja's up to hilltop.

Stratigraphic range: »Pteroceriano« formation, upper part; Freixial 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 this part of the sequence. Information in upper part derives from both the slopes W Moinhos dos Toja's and SW southern hilltop, also causing difficulties in correct correlation.

Nearby sections: Alrota, 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 S'Tiago's primary school (northern border of village), in a road curve (fossil site is now destroyed due to construction of a new house):

Stylina (Convexastrea) sexradiata, *S. girodi*, *Cyathophora bourgueti*, ?*Thamnasteria pseudarachnoides*, *Microphyllia davidsoni*, ?*Amphiastrea piriformis*, *Axosmilia crassa*, *A. cf. caudata*, *A. carrapateirensis*, *A. cf. corallina*; *Myophorella lusitanica* with overgrowth of *Nanogyra nana*/*Praeexogyra pustulosa*, *Gervillella aviculoides*, *Isognomon (Rostroperna) sp.*, *Pteroperna sp.*, calcisponges.

At road further north (300 m N A. dos Eiros) in fields:

(additional forms only) *Cyathophora cesaredensis*, ?*Comophyllia corrugata*, *Isognomon lusitanicum*, serpulids.

Description:

m0.0–0.5: brown, iron hydroxide—stained, thick—bedded, oncolitic rudstone. Spongiostromate oncoids, mostly of type SS—R, small SS—C and superficial oncoids also common. Clasts of bivalves, gastropods, echinids, *Marinella lugeoni* and ?*Permocalculus* n.sp. serving as nuclei. Furthermore, *Pseudocyclammina* gr. *parvula—muluchensis*, »*Haplophragmium*« sp., *Freixialina planispiralis* and *Lenticulina* sp.. Microsparitic to neosparitic groundmass

m0.5–5.0: poorly exposed, weathered marls, partly with corals and common *Mesosaccella dammariensis*, *Corbulomima suprajurensis*, *Nicaniella* sp., cerithiid gastropods, common smooth ostracods and rare foraminifers

m5.0–6.0: at base, brownish, moderately sorted, oolitic grain/packstone with large cortoids, double—valved bivalves, algal lumps, *M. lugeoni*, *Pseudocyclammina* gr. *parvula—muluchensis*, *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 oncolitic envelopes.

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

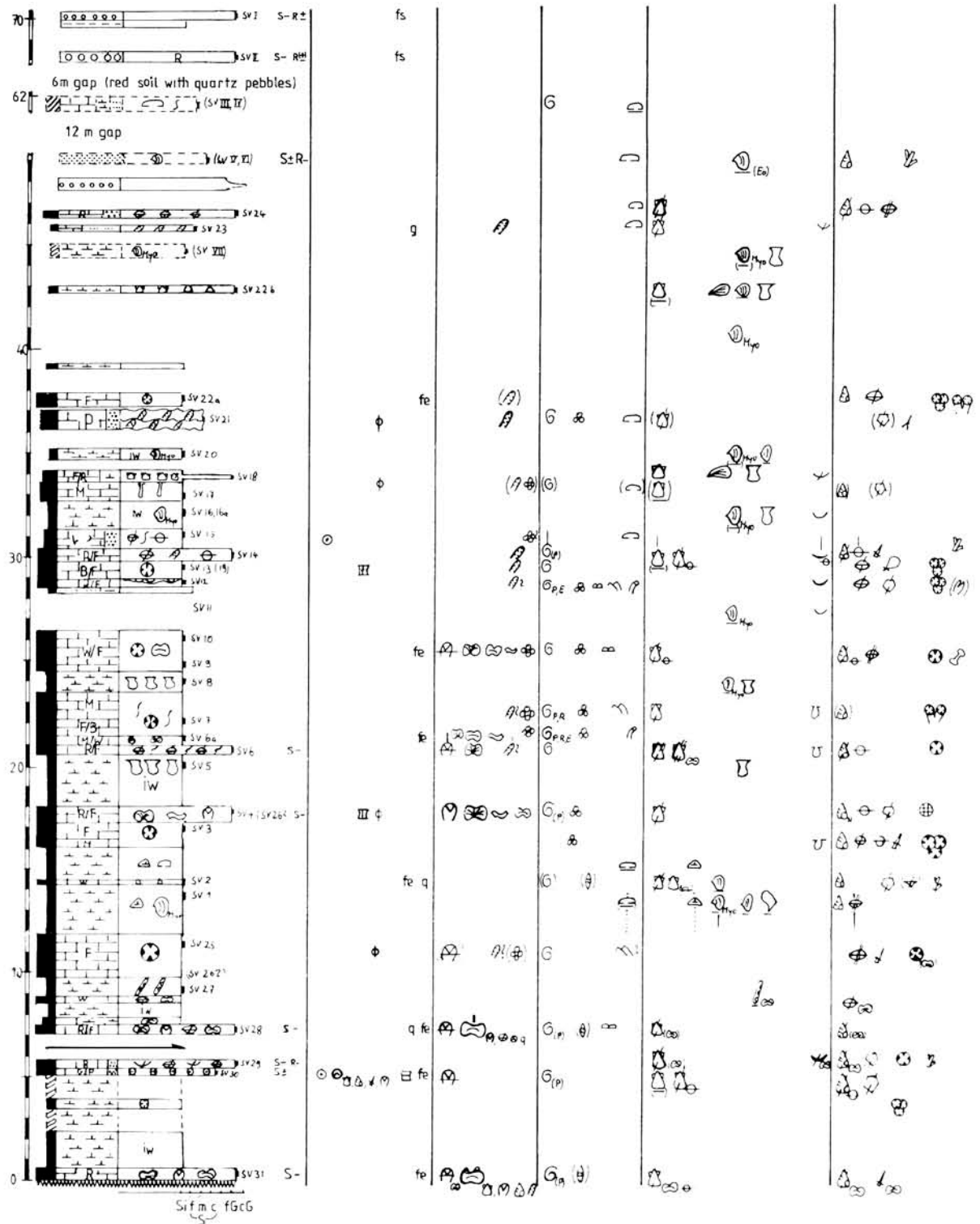
m7.0–8.0: brown, iron hydroxide—stained, thick—bedded, bioclastic oncolitic rudstone with large spongiostromate oncoids (SS—R, C), often with *M. lugeoni* serving as nuclei or incorporated in algal envelope. Bivalve and gastropod clasts partly with only superficial envelope. Rare ooids and detrital quartz, both in oncoid cores or embedded in algal layers. *M. lugeoni* also common as non—encrusted fragments, furthermore algal clasts of *Girvanella minuta*, echinid spines, *P. gr. parvula—muluchensis*, *Nautiloculina oolithica*, ?*Mesoendothyra* sp., *Ammobaculites* sp., *Lenticulina* sp., *Conicospirillina basilensis*. Micro— to neosparitic groundmass with common ghost structures. Rudstone becoming marly towards top, grading into marl with common oncoids

m8.0–9.8: weathered marls, with intercalation of thin, marly, bioclastic oncolitic wackestone and layer with *Gervillella aviculoides*, partly algal encrusted, in upper part

m9.8–12.0: (possibly parautochthonous large block) light brown coral floatstone with large coral clasts and abundant fine, angular bioclastic debris. Internal sediment in occurring gastropods is pelmiritic, implying the same pre—diagenetic matrix structure for the entire rock. Thin algal— foraminifer encrustations around large clasts. Rare occurrence of *Marinella lugeoni*, *Permocalculus* n.sp., ?*Salpingoporella annulata*, ?*Campbelliella striata*, ?*Mesoendothyra* sp., lituolids indet. and ?bryozoans. Rubble of rhodolitic *Lithocodium* facies in this level most probably derived from outcrop at m 18

m12.0–16.2: predominance of dark grey, partly bituminous marls with ostracods and soft bottom fauna of the *Jurassicorbulina edwardi* association, *Myophorella lusitanica*, *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



pois, echinoid and brachiopod clasts, rare lilioids, *Lenticulina* sp. and lignite litter

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. lugeoni*, verneuilinids and valvulinids, etc.. At top, thick bed of light brown, oncolitic intraclastic rud/floatstone with common rhodoliths of *M. lugeoni*, *Solenopora cayeuxiformis* n.sp., *Lithocodium* sp., besides calcisponges, clasts of echinids, bivalves and nerineids, *Pseudocyclammina* gr. *parvula*-muluchensis, *P. lituus*, *Freixialina planispiralis*, ?*Mesoendothyra* sp., *Nautiloculina oolithica*, »*Haplophragmium*« sp., verneuilinids and valvulinids as well as small SS-C oncoids, common intraclasts and peloids

- m 18.0–20.6: weathered marls, at top with shell bed of *Pteroperna* sp.
- m 20.6–23.3: at base, brown bioclastic rud/floatstone with large clasts of gastropods, bivalves and corals, small, superficially encrusted clasts and *M. lugeoni*, *Solenopora cayeuxiformis* n.sp., *Solenopora* sp., *?Permocalculus* n.sp. and litiolids; passing into bioclastic mud/wackestone with bioclasts, serpulid/*Lithocodium* sp. nodules, *M. lugeoni*, *S. cayeuxiformis*, *?Cylindroporella* cf. *arabica*, *?Permocalculus* n.sp., *Girvanella* sp., *P. gr. parvula–muluchensis*, *Rectocyclammina* sp., *Everticyclammina virguliana*, *?Feurtillia frequens*, »*Haplophragmium*« sp., and locally with large coral debris (floatstone) or entire in-situ coral colonies (bafflestone). Bioturbated, with partly spar-filled burrows
- m 23.3–24.5: weathered marl with shell bed of *Pteroperna* sp. and *Myophorella lusitanica*
- m 24.5–26.3: light grey, medium to thick-bedded, bioclastic oncolitic wacke/floatstone, with large, microbored bioclasts of corals, bivalves, gastropods; iron hydroxide-stained oncoids (SS–R), common small-sized bioclasts and *M. lugeoni*, *S. cayeuxiformis* n.sp., *Solenopora* sp., *?Lithocodium* sp., *?Petrascula bursiformis*, small litiolids, *Ammobaculites* sp., nubeculariids, verneuilinids and valvulinids, and fragment of vertebrate bone
- m 26.3–28.2: exposure gap, with finding of *M. lusitanica* and oysters
- m 28.2–31.3: from base to top:
- thin horizon of marly siltstone
 - brown coral float/rudstone with coral heads, bioclasts, *P. gr. parvula–muluchensis*, *?Permocalculus* n.sp., bryozoans, *?crustacean* debris, and local hardground with attached oysters
 - brown coral bound/floatstone with *Lithophaga*-bored *Amphiastrea piriformis*, angular bioclasts, spines of *Pseudocidaris lusitanicus*, *Permocalculus* n.sp., litiolids and autoclasts
 - 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–muluchensis*, *?Mesoendothyra* sp., *Freixialina planispiralis* and »*Haplophragmium*« sp.
 - brown, very sandy, bioturbated, bioclastic wacke/packstone with cortoids, quartz-cored superficial ooids, dasycladaceans indet, ostracods, litiolids and lignite litter
- m 31.3–32.7: weathered marl with *M. lusitanica*, *Pteroperna* sp., both covered with *Praeexogyra pustulosa* and *Nanogyra nana*
- m 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–muluchensis*, *E. virguliana*. Bioturbated, with bitumen-stained faecal pellets in *Planolites*-like burrows. At top, coquinoid bed: *Pteroperna* sp., *Arcomytilus morrissi*, 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 lusitanica* and *?Pleuromya* sp.
- m 36.2–38.0: at base, brownish grey, medium-bedded, very sandy, nodular *Permocalculus* packstone. Besides *Permocalculus* n.sp., common sponge spiculae, ostracods, litiolids, etc.. At top, brown, iron hydroxide-stained coral floatstone with *Amphiastrea piriformis* m 38.0–49.0: exposure gap, with minor outcrops:
- at m 39.0, marl; above it, findings of *M. lusitanica*
 - at m 42.0, coquinoid layer with *Pteroperna* sp., *A. morrissi*, *Antiquicyprina* sp., *Camptonectes* cf. *auritus*, cerithiid gastropod, in marly matrix
 - at m 45.0, common findings of *M. lusitanica* and *Pteroperna* sp. (presumed top of »Pteroceriano« 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 planorbids, ostracods and lignite litter
- at m 62.0: brown, bioturbated, calcareous siltstone with ostracods and lignite litter
- at m 69.0: red coloured, poorly sorted arkose/subarkose with poorly to moderately rounded pebbles

at m 70.0: (below Moinhos dos Tojais) marly clay, superimposed by coarse, feldspar-bearing quartz conglomerate.

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 Folgados) 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 southward slope.

Stratigraphic range: uppermost Amaral 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, Oerca.

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:

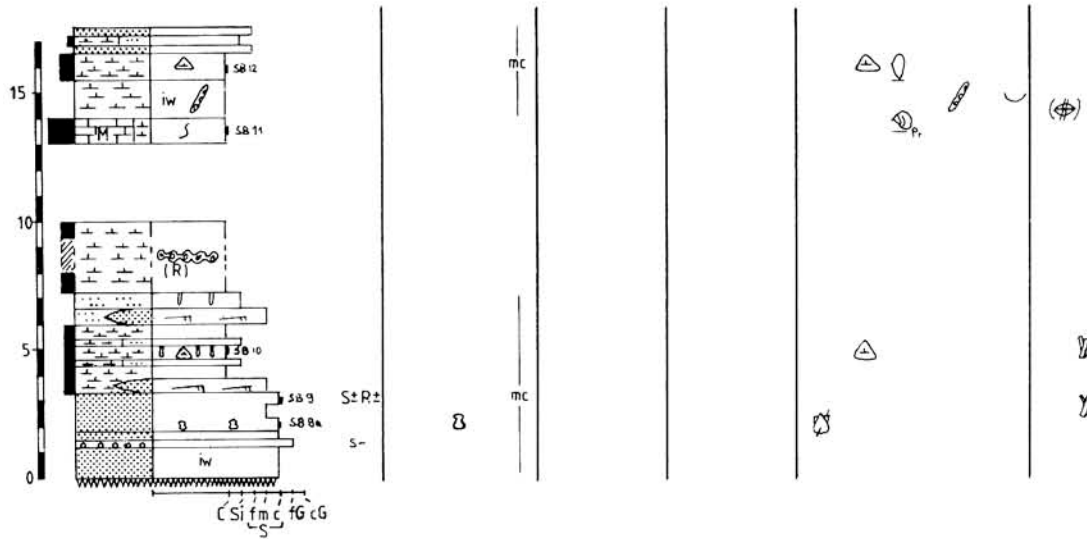
Subsection A (Chã – Montijo)

at base, 20 m or tan-coloured, massive to very thick-bedded Amaral formation

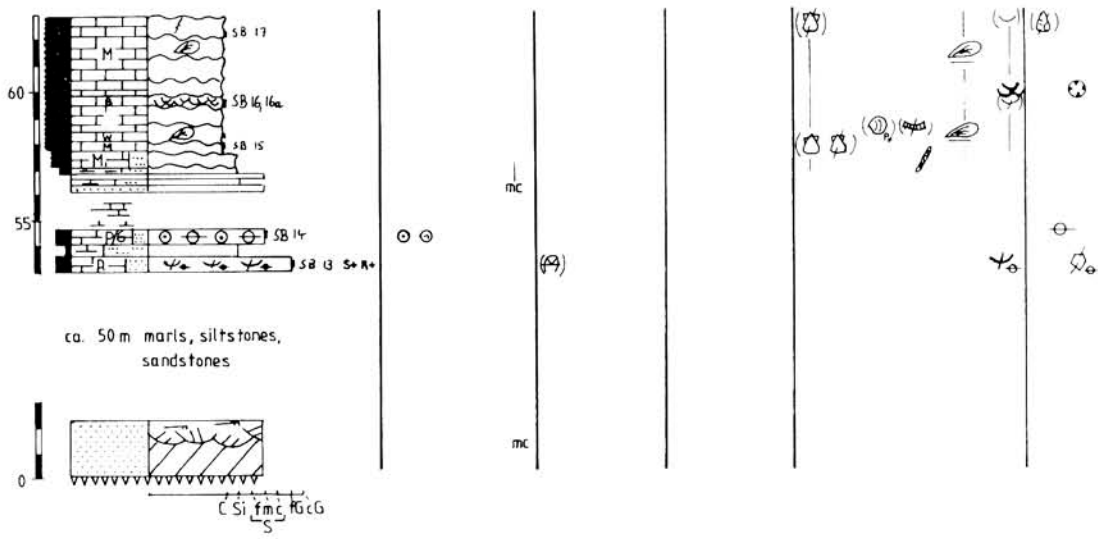
- m 0.0–1.0: light brown, slightly marly, micaceous, well sorted, oolitic pack/grainstone with mature, quartz-cored ooids and lignite litter
- m 1.0–26.0: mostly exposure gap, with sandy soil and sandstone rubble. In upper part outcrops of brown, marly, micaceous, wavy laminated siltstones, fine-grained sandstones and very thick-bedded, lignitic, coarse-grained sandstones
- 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 *Eomiodon securiformis*, *Isognomon lusitanicus*, *Arcomytilus morrissi*, coated bioclasts and *Marinella lugeoni*, and oolitic packstone with quartz-cored ooids
- 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 *Gervillia 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 *Praeexogyra pustulosa*/*Nanogyra nana* patch reef, bored by *Lithophaga* sp., with spines of *Pseudocidaris lusitanicus* and common *Amphiastrea piriformis*. 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 *Everticyclammina virguliana* (base of »Pteroceriano« formation). At top, thin, apparently rapidly outwedging *P. pustulosa*/*N. nana* patch reef with spines of *P. lusitanicus*.

Sobral Sections

A: Chã – Montijo



B: Maceira



Subsection B (Maceira)

- m 0.0–2.5:** (altitude m 291): brown, micaceous, siliciclastic 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 *Marinella lugeoni*
 - marly siltstone
 - brownish, oncolitic 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 *Gervillia sobralensis*
 - 6 m of grey, nodular mudstone (rarely wackestones), at base very sandy, with *Arcomylus morrissi*, rare *Protocardia* sp., *Trichites* sp., *Camptonectes* cf. *auritus*, oysters and other bioclasts. In middle part intercalation of *Praeexogyra pustulosa* patch reef with corals (base of »Pteroceriano« 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 outwedging, cross—bedded sandstones. Marls with rare, poorly preserved soft bottom fauna (mainly *Jurassicorbula edwardi*) and sand—filled *Scolithos* burrows (the latter also in silts)
- m 7.0–10.0:** poorly exposed marls, partly red coloured, with rubble of reddish caliche mudstone
- m 13.0–14.0:** grey, medium—bedded, marly, bioturbated mudstone with *Protocardia* sp.
- m 14.0–15.5:** dark grey, micaceous marls, partly strongly weathered, in lower part with oysters and *Gervillia sobralensis*; above it, with soft bottom fauna (*Jurassicorbula edwardi*, c; *Corbulomima suprajurensis*, c; *Placunopsis suprajurensis*, o; *Pteroperna pygmaea*, r; *Myopholas multicostata*, o) 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 *Arcomylus morrissi*, *Protocardia* sp., oysters, gastropods, spines of *Pseudocardis lusitanicus*, rare serpulids, *Everticyclammina virguliana*, etc.
- m 18.0–21.0:** exposure gap, with findings of *Isognomon lusitanicum*
- m 21.0–22.3:** brownish grey, very marly, partly reworked *Nanogyra nana* patch reef, overlain by grey, nodular mudstone with scattered *A. morrissi*, *Protocardia* sp., rare bioclasts of *Trichites* sp., gastropods, echinoids, corals; also with rare *Marinella lugeoni*, *Everticyclammina virguliana*, etc.
- m 22.3–23.6:** grey marl with small bioclasts and very abundant spines of *Pseudocardis lusitanicus*.

End of sections.

Section Tesoureira – Cassis da Serra

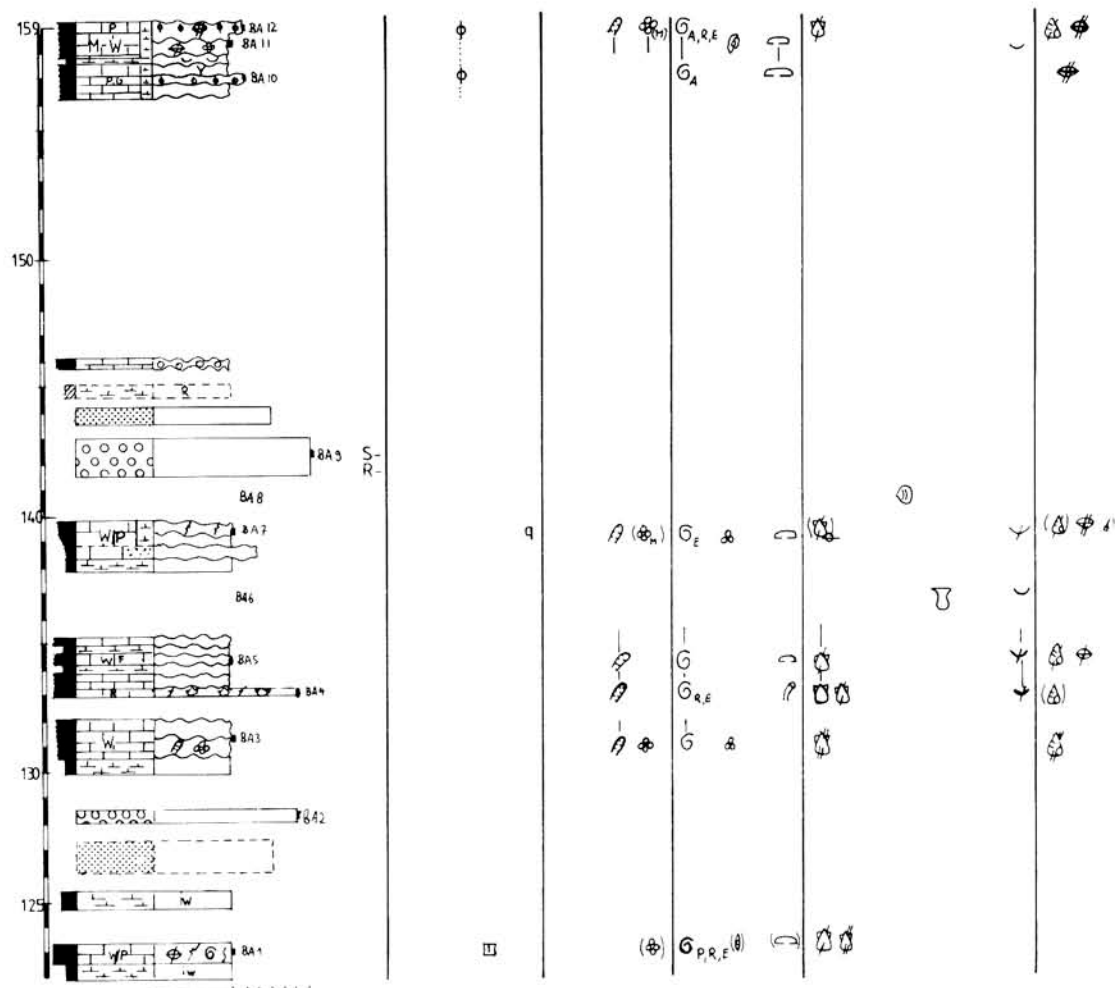
Location and Generalities: geol. map, sheet Loures, NW quadrant. This is a composite section, based on individual subsections, all situated in the vicinity of traffic road Casais da Serra—Sobreira—Tesoureira.

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 Pipa 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.

Section Tesoureira – Casais da Serra
Lower Part: Subsection Tesoureira – Hill Arranhó
(Continuation)



Part Casais da Serra (sample abbrev. CA): from southern border of village Semieira (pig-sty) along traffic road further south, crossing Casais da Serra, up to main road Montachique–Bucelas. Outcrop conditions very poor, yet an additional section from Percinheira (300 m W Casais da Serra) northeastwards up to windmills (sample abbrev. CM) gave additional data.

Nearby sections: Alcubela–Freixial, Gotleis.

Stratigraphic range: upper part of »Pteroceriano« 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 Arranhó hill, as well as parts Casais da Serra and Percinheira–Casais Moinhos are combined to two individual logs. Correlation between these is somewhat interpretative.

Description:

A: Lower Part: Subsection Tesoureira – Hill Arranhó

m0.0–5.5: brownish grey, iron hydroxide-stained, partly sparitic, 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 *Pseudocidaris lusitanicus* spines. Furthermore, terebratulids (partly double-valved), debris of calci-

- m 22.0–30.2: outcrops of brownish, medium beds in varying facies: at base, oncoloid-bearing marl, grading into oncolitic rud/floatstone with *M. lugeoni* or nerineid-cored spongiostromate/bryozoan oncoloids (SS–R, I). Oncoids of very variable size. Large irregular oncoloids composed of irregularly shaped bioclastic cores, overgrown by *Lithocodium* sp., followed by thick layer of *M. lugeoni* and thin layer of cyanophytes. Rare lituolids, *Coniospirillina 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 *Amphiastrea piriformis*, with *M. lugeoni*. Following is a, extremely recrystallized, intrabioclastic pelletal packstone with oncoloids, *M. lugeoni*, *Ammobaculites* sp., »*Haplophragmium*« sp., *Rectocyclammina* sp., verneulinids and valvulinids; superimposed by oolitic grainstone and pelletal packstone with large, burrowing bivalves: At top, completely recrystallized and calichefied bed, most probably former oncolitic bioclastic pack/rudstone with oysters, lituolids, etc.
- m 30.2–32.8: brownish, thick-bedded, slightly marly, coral boundstone (framestone), almost exclusively built of *Amphiastrea piriformis*, with common spines of *Pseudocidaritis lusitanicus*
- at m 34: medium bed of dark brown, well sorted, bioclastic packstone with well rounded cortoids, *M. lugeoni* and questionable crustacean debris
- m 35.5–38.4: light grey, thick-bedded coral floatstone with plocoid and fasciculate corals, partly in-situ, grading into bioclastic wackestone with fine bioclast, gastropods, echinid spines, calcisponges, *P. gr. parvula–muluchensis*, ?*Mesoendothyra* sp., *Nautiloculina oolithica*, valvulinids and verneulinids, *Lenticulina* sp., »cayeuxiid« algae, rare dasycladeceans indet., *Terquemella? triangularis* and questionable *Permocalculus* n.sp.
- m 39.2–42.0: brownish grey, medium beds, divided by small exposure gap. At base, rhodolitic pelletal packstone with corals, calcisponges, oncoloids and fragments of *M. lugeoni*
- m 42.0–52.0: exposure gap, with findings of fragments of *Arcomytilus morrisi*, *Isognomon* sp. and ampullinid gastropod
- m 52.0–54.0: at base, marl with *Nanogyra nana*, grading into marly oyster rudstone and micritic bioclastic rudstone with large cortoids, abundant *Permocalculus* 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 burrows. 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 *Praeexogyra pustulosa*
- at m 70.0: light grey, partly heavily recrystallized lituolid wackestone with *Pseudocyclammina* gr. *parvula–muluchensis*, *Rectocyclammina* sp., verneulinids and valvulinids, »*Quinqueloculina*« sp., rare *Permocalculus* n.sp., etc.
- m 90.0–92.0: reddish marl, overlain by light coloured, pelletal *Permocalculus* wacke/packstone with abundant *Permocalculus* n.sp. and common *P. gr. parvula–muluchensis*, *P. lituus*, *Rectocyclammina* sp., ?*Mesoendothyra* sp., verneulinids and valvulinids, rare *Lenticulina* sp. and »*Quinqueloculina*« sp., *Terquemella? triangularis*, questionable *Campbelliella 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 nerineids, oysters and other bivalves, occasionally entire bivalves, and *Permocalculus* n.sp., *C. striata*, *Salpingoporella annulata*, *Terquemella? triangularis*, lituolids and ostracods. Common desiccation cracks. Large areas recrystallized
- at m 112.0: dark brown, moderately sorted, oolitic bioclastic lithoclastic grainstone with superficial oncoloid. 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–muluchensis* (late form), rare *Everticyclammina virguliana*, *Rectocyclammina* sp., ?*Mesoendothyra* sp., *Lenticulina* sp., *S. annulata*, questionable *C. striata* and rare ostracods. Very frequent desiccation cracks, leading to autoclast 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 bioclasts and common *Permocalculus* n.sp., *S. annulata*, *Cylindroporella* cf. *arabica*, *Actinoporella podoli-*

thica, *Terquemella? triangularis* and other dasycladacean debris, as well as small litiolids and valvulinids

- 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, *Permocalculus* n.sp., *Rectocyclammina* sp. and *E. virguliana*
- 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 *Permocalculus* n.sp., *Macroporella espichelensis*, *E. virguliana*, valvulinids and verneulinids, 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 freixialensis*; above it, poorly sorted, siliciclastic conglomerate with poorly rounded gravel, measuring up to 3.5 cm Ø; above it, rubble of sandstone, multicoloured, reddish caliche 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 *Permocalculus* n.sp., *M. espichelensis*, *A. podolithica*, *E. virguliana*, *Rectocyclammina* sp., *Anchispirocyclina lusitanica* (first appearance), *Freixialina planispiralis*, »*Quinqueloculina*« sp. and ostracods (end of section part Hill Arranhó).

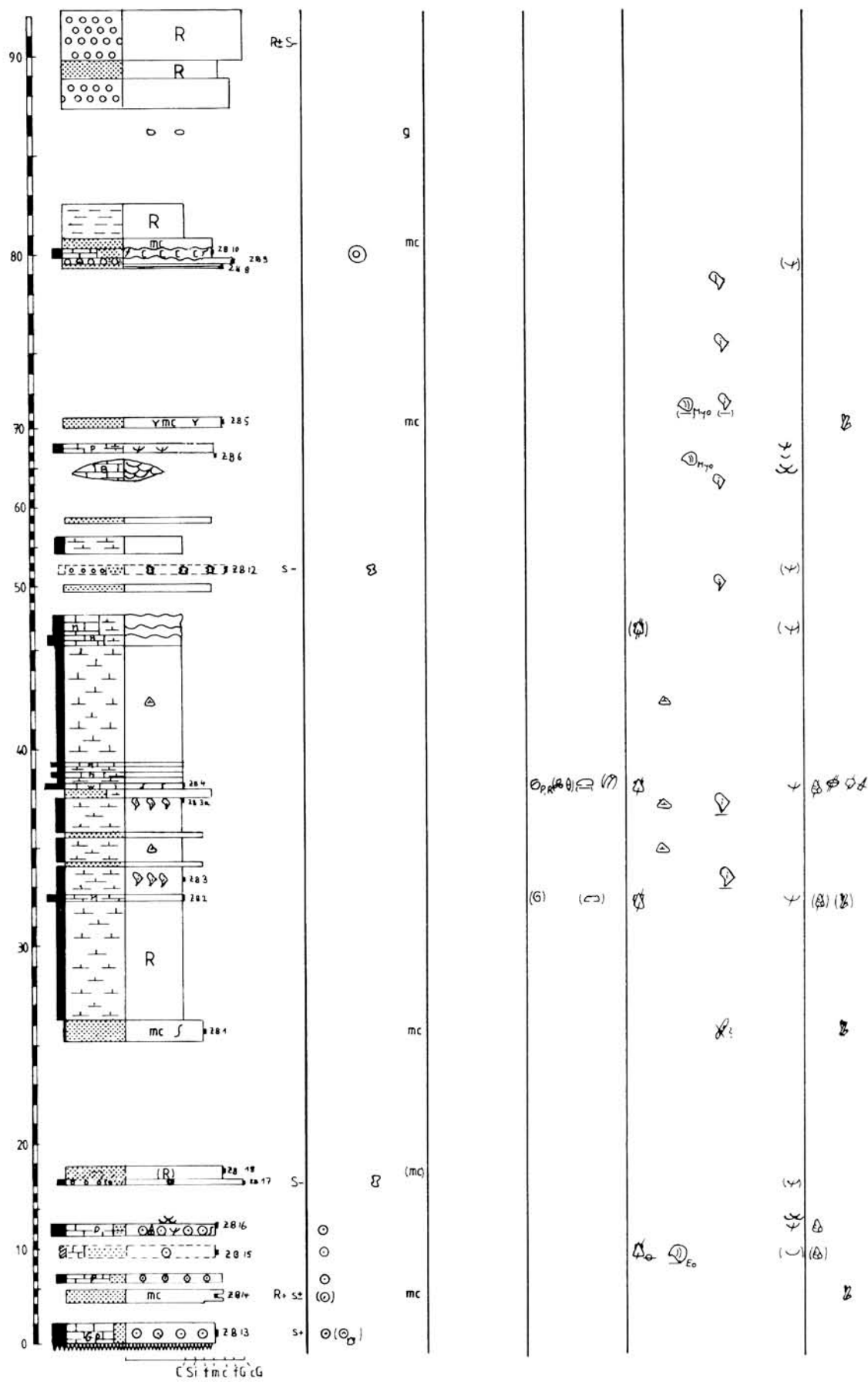
End of subsection Tesoureira–Hill Arranhó.

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 litter, and very common to abundant *Anchispirocyclina lusitanica*, »*Quinqueloculina*« sp., *Salpingoporella annulata* and other indet. dasycladacean fragments, most probably of *Likaniella bartheli* and *Cylindroporella* cf. *arabica*. Fragment of embryonic cephalopod. Early compaction cracks and mottled iron hydroxide staining.
- at m 19.0: brownish grey, medium–bedded, very sandy, bioclastic wackestone with cortoids, *A. lusitanica* and questionable *Permocalculus* n.sp.
- at m 28.0: light, brownish grey, quartz–silt–bearing, pelletal packstone with ?*Protocardia* sp., fine bioclasts, ostracods, *A. lusitanica*, *Rectocyclammina* sp., »*Haplophragmium*« sp., *Freixialina planispiralis*, verneulinids and valvulinids, »*Quinqueloculina*« sp., *Permocalculus* n.sp. and dasycladaceans indet.. Bioturbation by *Thalassinoides* sp., with incorporated quartz–cored ooids in burrows
- m 31.0–40.2: at base, lignitic 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), *Rectocyclammina* sp., *E. virguliana*, *Nautiloculina oolithica*, ?*Mesoendothyra* sp., »*Quinqueloculina*« sp. (large, c–a), *Permocalculus* n.sp. (c), *Macroporella espichelensis*, *C. cf. arabica*, *S. annulata*, questionable *Actinoporella podolithica* and other indet. dasycladaceans or forms of uncertain designation (?*Likaniella bartheli*, ?*Actinoporella maslovi*, *Clypeina? solkani*). Upper part with 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 freixialensis*
- m 41.2–43.3: grey, nodular mudstone with scattered bioclasts, ostracods, *Permocalculus* n.sp. and *A. lusitanica*
- m 44.0–50.0: siliciclastic sequence, in lower part with ocre–coloured, moderately sorted, micaceous sandstone with clay pebbles and ?oysters. Medium part intensively red coloured, with multicoloured caliche mudstones. In upper part, light grey, moderately sorted, lignitic, micaceous, carbonaceous sandstone with *A. lusitanica*
- m 50.0–54.2: brownish, partly bitumen–stained, medium–bedded, partly sandy to very sandy, nodular bioclastic mudstones and wacke/packstones with thin sandstone and marl layers. Primary pelletal fabric often visible in fillings of gastropods. Organisms: bioclasts, partly microbored, of bivalves and gastropods, ostracods, *A. lusitanica*, »*Haplophragmium*« sp., »*Quinqueloculina*« sp., *Permocalculus* n.sp., *Terquemella? triangularis*, dasycladacean debris. Beginning dolomitization
- m 54.2–134.0: mostly exposure gap, with outcrops of, often coarse, siliciclastics, particularly in middle part.

End of section at Cretaceous boundary.

Section Zibreira



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 parautochthonous 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 lignitic, ooid-bearing sandstones with rare bioclasts and *Eomiodon securiformis*. At top, bioturbated oolitic packstone with oysters and gastropods; surface encrusted by *Nanogyra 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 *Gervillia* 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 coquinoïd 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 echinids, *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 pustulosa*/*Nanogyra 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.