Ciências da Terra (UNL)	Número especial II	Lisboa	1992	pp. 37-56 fig. 0.1-3.9

EXCURSION B

MAINLY CONTINENTAL MIOCENE AND PLIOCENE DEPOSITS FROM LOWER TAGUS AND MONDEGO TERTIARY BASINS

R. P. B. PENA DOS REIS [1], P. M. R. R. PROENÇA CUNHA [1], B. P. BARBOSA [2], M. T. ANTUNES [3] & J. PAIS [3]

1 - Dept. Ciências da Terra, Faculdade de Ciências e Tecnologia , Univ. Coimbra, Centro de Geociências (INIC), P-3000 Coimbra

2 - Serviços Geológicos de Portugal., R. Academia das Ciências, 19-2º, P-1200 Lisboa

3 - Centro de Estratigrafia e Paleobiologia (INIC), Faculdade de Ciêmcias e Tecnologia, Quinta da Torre, P-2825 Monte de Caparica

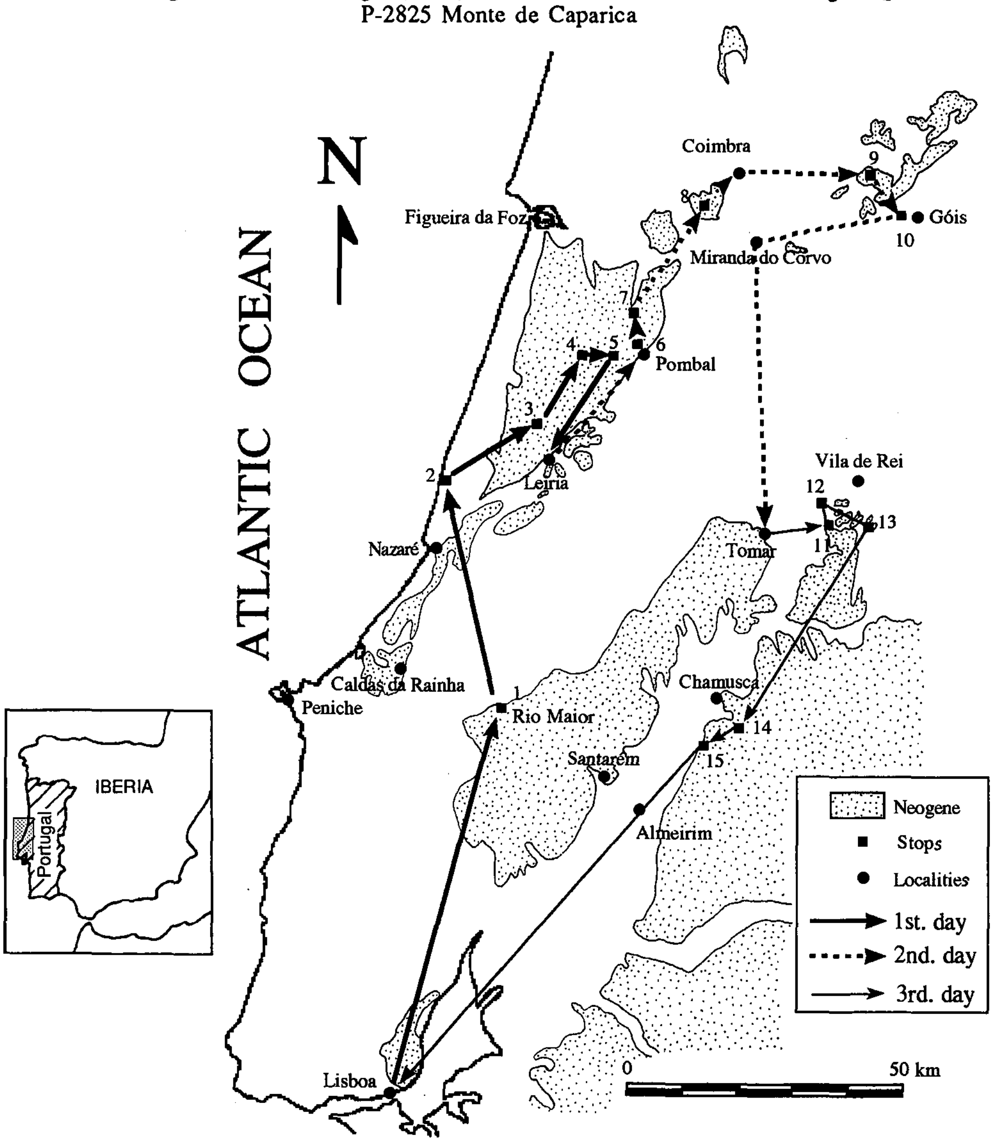


Fig. 0.1 - Tour itinerary

INTRODUCTION AND STRATIGRAPHY

This excursion is arranged to places of important interest of the stratigraphycal continental neogene infilling of the western central portuguese continental margin. The itinerary is shown on Fig. 0.1. To describe the sedimentary succession the lithostratigraphic nomenclature has been informally used in capital letters.

The mesozoic and cenozoic sedimentary record of the western Iberian margin (Lusitanian Basin) is about 4 km thick (WILSON, 1988). In the pre-upper Aptian deposits, several unconformity-bounded sequences (UBS) are defined according to Wilson (1988): UBS1) upper Triassic-upper Calovian; UBS2) middle Oxfordian-Berriasian; UBS3) Valanginian-lower Aptian.

In the post-lower Aptian record of Central Portugal, the definition of the infill episodes (ANTUNES, 1979; RIBEIRO *et al.*, 1979; CUNHA, 1987a, 1987b; ANTUNES *et al.*, 1987; WILSON, 1988; REIS & CUNHA, 1989; MOUGENOT, 1989; BARBOSA, *et al.*, 1990) led to the establishment of a recent proposal of synthesis (CUNHA, 1992) in which several unconformity-bounded sequences are distinguished: UBS4) upper Aptian-lower Campanian; UBS5) upper Campanian-Maastrichtian; UBS6) Paleocene-lower Lutetian; UBS7) upper Lutetian-Bartonian; UBS8) Priabonian-lower Chattian; UBS9) upper Chattian-upper Burdigalian; UBS10) upper Burdigalian-lower Tortonian; UBS11) upper Tortonian-lower Messianian; UBS12) upper Messianian-Zanclean; UBS13) Piacenzian.

In the Lutecian, distensive faulting related to the Pyrenaic Orogeny openned up the Lower Tagus tectonic graben, and led to the separation of the Lusitanian Basin in two tertiary basins Mondego (northern) and Lower Tagus (southern). In the onshore area, the tertiary sedimentary infill consists of main continental siliciclastic deposits; the Mondego Basin is about 370m thick and the Lower Tagus Basin the maximum thickness is about 900m.

The following paragraphs present a general caracterization, for the onshore area, of the neogenic unconformity-bound sequences (Fig. 0.2):

UBS 9 - The record exists at the vestibular area of Tagus River (Lisbon region) and in the offshore area. Not visited in this excursion.

UBS10 - The record integrates a positive fluvial succession: orange conglomeratic arkoses passing upwards to arkoses, siltstones with carbonated crusts and limestones. Smectite and kaolinite are the dominant clay minerals .

UBS11, UBS12 and UBS13 consists mainly of piedmont coarse alluvial deposits correspondent to the Portuguese Central Range, Maciço Calcário Estremenho (Estremenho Massif) and Western Mountains uplifts.

UBS11 - Greyish and reddish litharenites, greywackes, breccias and conglomerates, with clasts of metasedimentary rocks and milky quartz, alternating with siltstones. Smectite and illite are the most common clay minerals in sediments.

UBS12 - Red conglomerates, litharenites and siltstones, with calcareous concretions and clasts of milky quartz and quartzite. Illite and kaolinite, in similar proportions, are the usual clay minerals. UBS11 and UBS12 document endorreic stages of the evolution of the Mondego and Lower Tagus tertiary basins.

UBS13 - In the onshore area, the record is composed of continental (conglomerates, coarse sandstones and mudstones), transition (lignites, diatomites, "lumachelles") and shallow marine sediments (Fig. 0.3). The sediments, mainly of light yellow and white colour, are composed of quartz and quartzite clasts; the clay fraction contains mostly kaolinite, with illite and seldom vermiculite. In the Mondego and Lower Tagus tertiary basins, the continental deposits have been interpreted as alluvial fans entering rivers valleys (pre-Tagus and Erges rivers) from the north-western mountain front (Portuguese Central Range). This siliciclastic sediments caracterized the Hesperian landscape prior to its present (quaternary) fluvial dissection, culminating the marginal piedmonts in many tertiary basins. The record of UBS13 documents a exorreic stage in which eustasy was an important control on clastic deposition. The transgressive-regressive evolution can be correlated with the 3rd order eustasy cycle nº 3.6 of Haq *et al.* (1987). Near the present coast line, the UBS13 record begin with marine sediments; the UBS13 upper contact is made by disconformity, with a siliciclastic cover testifying another marine incursion correlated with the 3rd order cycle nº 3.7 of HAQ *et al.* (1987).

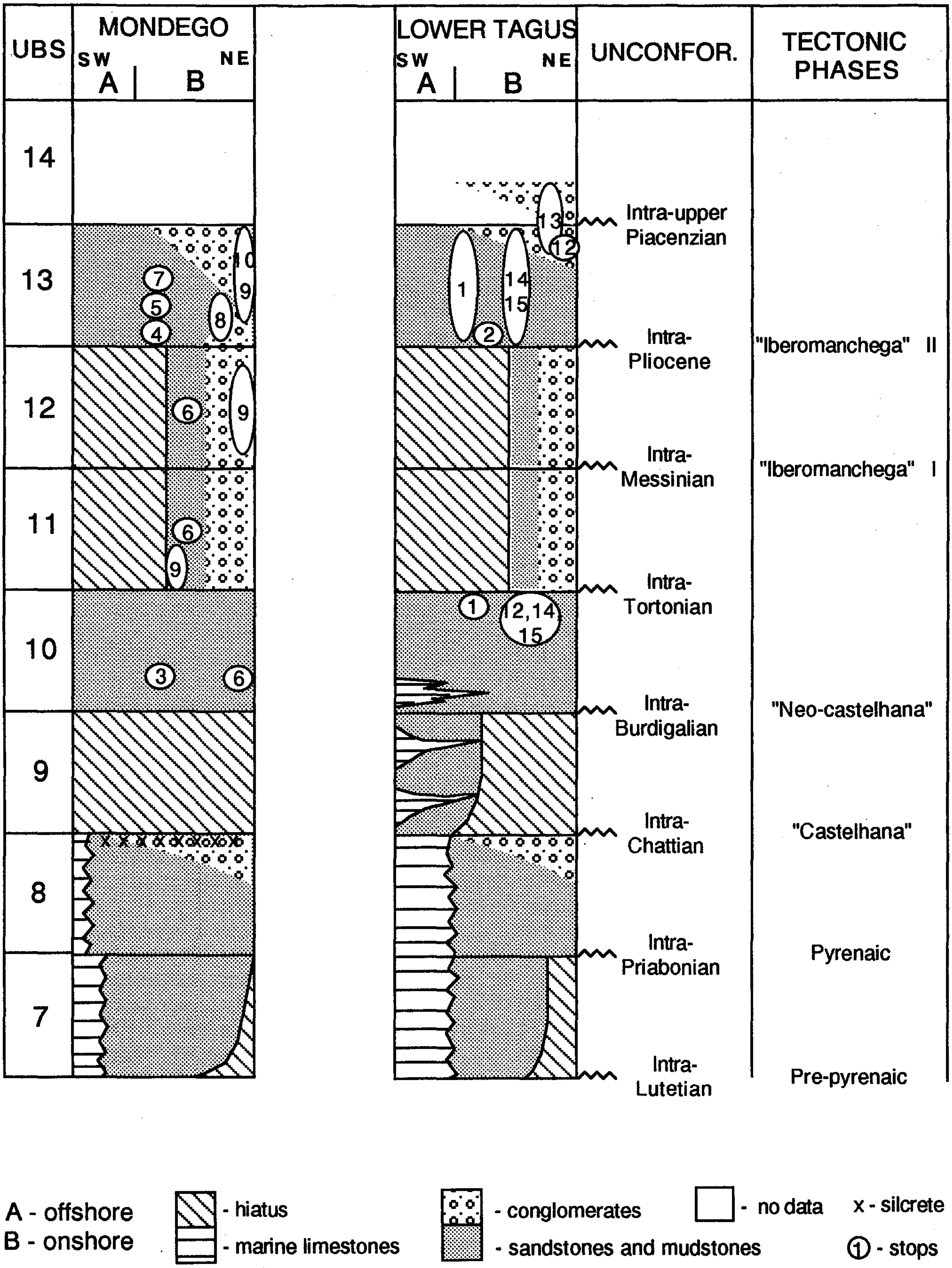


Fig. 0.2 - Tertiary unconformity-bounded sequences (UBS) of the western portuguese record (Mondego and Lower Tagus tertiary basins) and stratigraphic position of the stops.

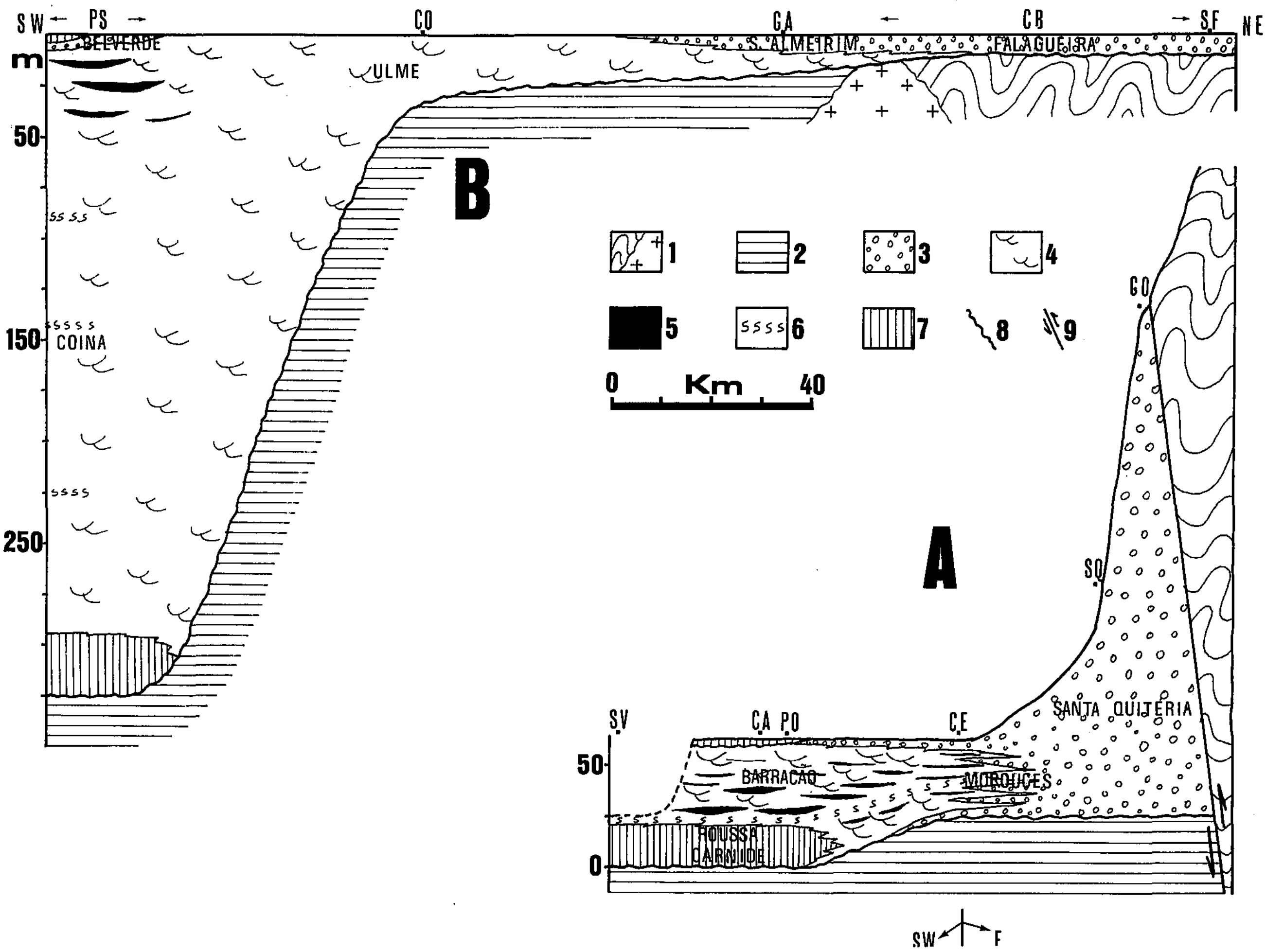


Fig. 0.3 - Schematic geological sections (SW-NE), showing the upper pliocene record in the Mondego (**A**) and Lower Tagus (**B**) tertiary basins. 1 - basement (metamorphosed / granitic); 2 - mesozoic and cenozoic substratum; 3 - alluvial conglomerates; 4 - alluvial sandstones; 5 - alluvial siltstones; 6 - marish sediments (sandstones interbeded with lignits and diatomits); 7 - marine sandstones; 8 - sedimentary discontinuity; 9 - Lousã fault; SV - Senhora da Vitória beach (S. Pedro de Muel); CA - Carnide; PO - Pombal; CE - Cernache (Coimbra); SQ - Santa Quitéria; GO - Góis (Carvalhal and Sacões sections); PS - Setúbal peninsula; CO - Coruche; GA - Gavião; CB - Castelo Branco region; SF - spanish border.

FIRST DAY

RIO MAIOR - COIMBRA REGION

In the Rio Maior - Coimbra region (Mondego tertiary basin) the neogene sedimentary succession was divided int the following major units:

1) Amor Sandstones and Clays (UBS 10 - upper Burdigalian-lower Tortonian) - generally startswith gravel deposits but is mainly composed of clayey sands deposited in a flood plain passing to lacustrine conditions to SW. The sediment has a light gray color locally reddish, it is unlithified and includes silicified levels.
2) Pombal-Redinha Sandstones and Clays - lower levels include orange coarse feldspathic sandstones and conglomerates (UBS 11 - upper Tortonian-lower Messianian); the upper levels are composed of red sandstones and conglomerates alternating with mudstones showing carbonate concretions (UBS 12 - upper Messianian-Zanclean). They correspond to deposition in alluvial fan systems related to Sicó Massif uplift.
3) Upper Pliocene terrigenous sediments (UBS 13) show important lateral variations used for the definition of the following lithostratigraphic units (Fig. 0.3 A).

3.1 - The Carnide Sandstones: a shallow marine fossiliferous unit;
3.2 - The Roussa Sandstones: a coastal unit (shorestring);
3.3 - The Barracão Clays: a rich in organic matter palustrine unit;

3.4 - The Morouços Complex, a proximal and lateral equivalent alluvial fan system of the previous units.

1st STOP

FREIRIA DE RIO MAIOR

Purposes - Observation of Almoster and Santarém Upper Vallesian limestones and marls and of the infilling of the Rio Maior graben.

Description - The old quarry of Freiria de Rio Maior shows a section of the Almoster and Santarém limestones (Fig. 1.1). There is a succession of mostly greyish lacustrine limestones with a few and thin intercalated clayey levels.

Some limestones are very compact and show structures that may be ascribed to algae and other plant remains. Other ones are rich in casts of gastropods (*Limnaea*, *Planorbis*, etc.), most of them being represented by cavities.

The clayey levels are rich in Charophyte gyrogonites and Gastropoda also. The lower one yielded further fossils: pollen and spores, Ostracoda, freshwater fishes and amphibians, besides a rhinoceras and small mammals (Perissodactyla: Cf. *Aceratherium* (*A.*) *simorrense*; Rodentia: *Rotundomys freiriensis*, *Hispanomys peralensis*, *Progonomys hispanicus*; Lagomorpha: *Prolagus crusafonti*), that point out to an Upper Vallesian, MN10 age (ANTUNES & MEIN, 1979). This gives a fairly accurate datation for this unit.

Corresponding environmental features would be the predominance of shallow lacustrine fed by an influx of limy waters from ressurgences of the nearby Calcareous massif. These were surrounded by dense forest and further away by drier savannah or steppe areas. Climate would be warm and quite dry, with contrasting seasons and arid events.

The Santarém and Almoster limestones (Upper Miocene) were subjected to intensive faulting. Some grabens were developped, the most important one being that of Rio Maior. Here, an important downthrust occurred, related to the ascension of the nearby Fonte da Bica salt dome.

The infilling of the Rio Maior graben begun with the deposition of thick accumulations of white sands of mainly eolian nature. These are actively exploited for industrial purposes. An important bye-product is the kaolin rich fraction separated through sand washing and employed as special clays in ceramics. The sands did not yield any fossils, besides a sole

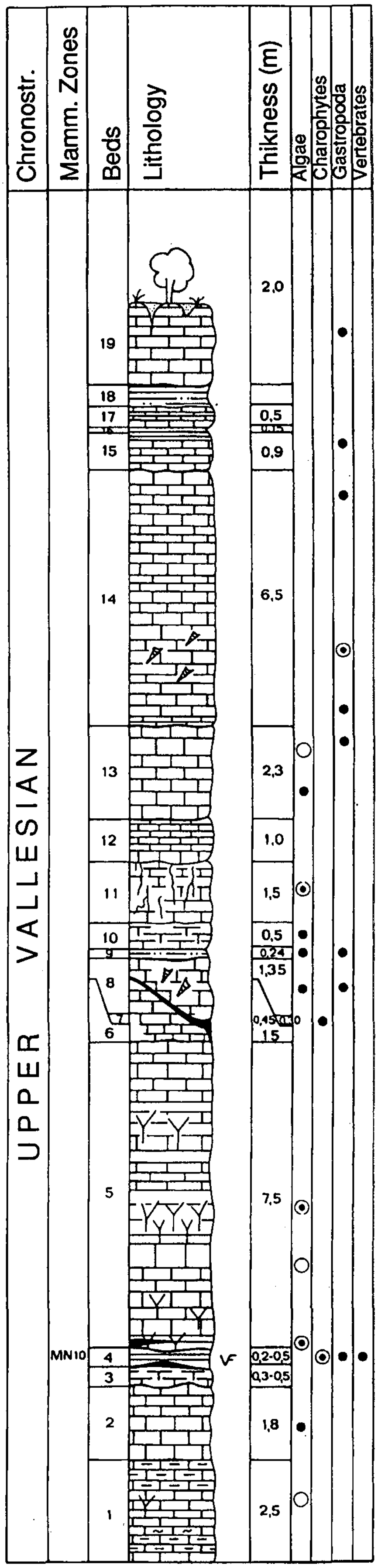


Fig. 1.1 - Freiria de Rio Maior section.

Palliolum (L.) excisum has been found in a borehole. However, the correlation with the Caldas da Rainha - Pombal Pliocene (Lower Piazencian) seems to be valid.

In the upper part of Rio Maior sands, some small intercalations of diatomites are present. Later, the graben has been filled by a sucession of essentially lacustrine beds, mostly diatomites and lignites, that were both commercially exploited in the past. These beds are particularly rich in well preserved plant macroremains, as well as pollen and spores (DINIS, 1984; PAIS, 1987). This succession ends with some algal (*Botryococcus* sp.) coal levels that overlie positive sequences [fine sand → clays rich in gastropods with some small mammals either of Uppermost Pliocene or Lower Pleistocene age (now under study) →boghead coal; both clays and coal are gypsum rich].

Quaternary coarse sands and gravels overlie both the diatomite-lignite series and the Rio Maior sands, through erosion surfaces.

2nd STOP

PAREDES DE VITORIA BEACH (12 km North from Nazaré)

Purposes - Observation of pliocene marine micaceous sandstones (UBS 13) overlying jurassic limestones.

Description - This section 25 m thick, described by CACHÃO (1989) on the northern limit of Paredes de Vitória beach is one of the most westerly pliocene outcrops of the Lusitanian basin (Fig. 1.2 and 0.4A) Over a pre-pliocene paleokarst surface with lithofagic invertebrate perforations, were deposited a micaceous fossiliferous sandstone, similar to the most frequent facies of the Carnide Sandstones. The upper part of the section presents sandstone facies refered as Arenitos de Paredes equivalent to Roussa Sandstones (Pombal region).

3rd STOP

ROAD MONTE REAL-LEIRIA (1km North from Amor)

Purposes - Observation of the langhian lacustrine Amor Sandstones and Clays (UBS 10) presenting frequent vertebrate remains.

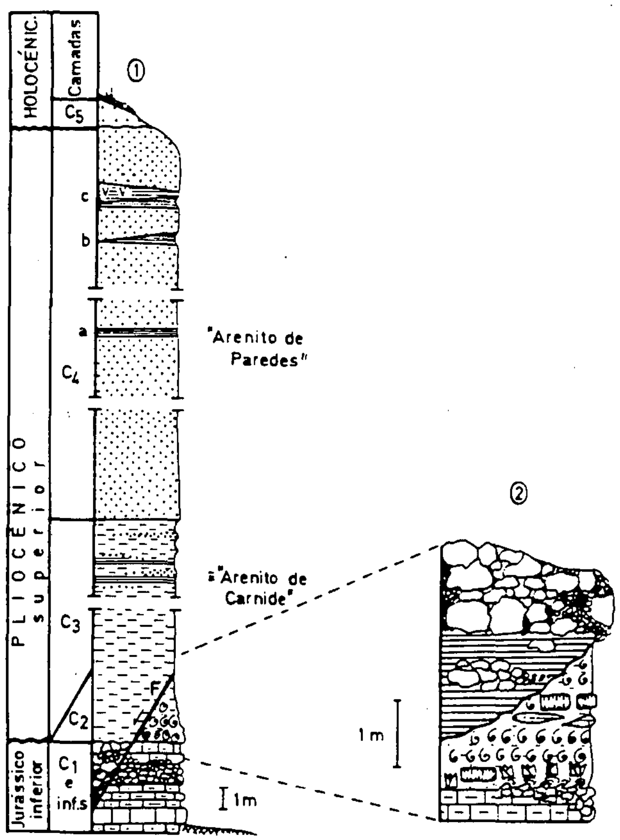


Fig. 1.2 - (1) Paredes de Vitória section. (2) Detail of the basal beds of the pliocene fossiliferous sediments (CACHÃO, 1989).

Description - This outcrop with poor observation conditions, evidences clay feldspathic sandstones rich in smectite, palygorskite and carbonate concretions. These vertebrate remains, were described by (ANTUNES & MEIN, 1981).

4th STOP

CARNIDE (12 km WSW from Pombal)

Purposes - Observation of the fossiliferous upper pliocene Carnide sandstones (UBS 13) overlying middle miocene mudstones (Amor Sandstones and Clays).

Description - This outcrop shows a section of the Carnide Sandstones (8 - 12 m). From the base to the top it comprises a lenticular fossiliferous conglomerate (mainly Mollusca and Bryzoa), fine yellowish micaceous sandstones

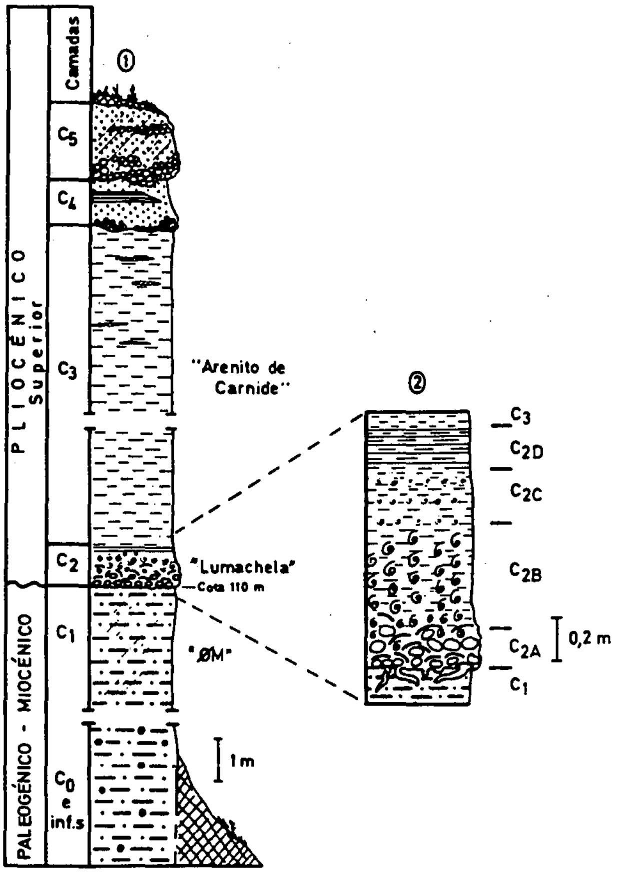


Fig. 1.3 - (1) Carnide section. (2) Detail of the basal beds of the pliocene fossiliferous sediments (CACHÃO, 1989).

with well rounded gravel cobble lag intercalations and reddish coarse sandstones and conglomerates with crossbedding structures (Fig. 1.3 and 0.4A). The basal conglomerate contains a nannofossil assemblage (*Discoaster tamalis, D. surculus, D. variabilis, D. brouweri*) indicative CN12a Zone of Okada & Bukry (lower NN16 zone of Martini) (CACHÃO, 1990). The fauna (molluscs, in particular) occuring in the base of the Carnide Sandstones indicate a shallow marine environment not deeper than 30 m with waters of near normal salinity and relatively warm temperature condition (CACHÃO & SILVA, 1990).

5th STOP

ROUSSA DE CIMA
(9 km West from Pombal)

Purposes - Observation of the Roussa Sandstones unit (UBS 13).

Description - This unit includes white kaolinitic coarse sandstones (15 m), showing gentle (< 10°) planar crossbedding structures (Fig. 1.4 and 0.4)) overlying by conformity,the Carnide Sandstones. On the top the Roussa Sandstones contact conformably the Barracão Clays composed of coarse sandstones with lenticular greyish mudstone intercalations (BARBOSA, 1983).

SECOND DAY

6th STOP

EN1 - EN237 CROSS - ROADS
(Pombal-Ansião)

Purposes - Observation of the Amor and Pombal-Redinha units (UBS 10 -11-12).

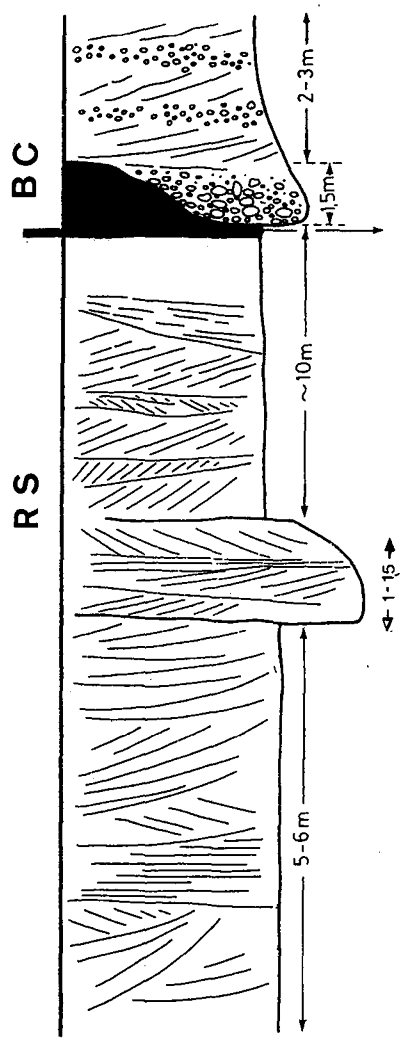


Fig. 1.4 - Roussa section (SOARES, 1984).
RS - Roussa Sandstones; BC - Barracão Clays.

Description - The Amor unit overlays paleogene sediments and is composed of arkoses with silicified pedogenetic crusts rich in paligorskite. Pombal-Redinha unit contacts, by angular unconformity, the older units. At the bottom includes orange coarse feldspathic sandstones and conglomerates; the upper levels are composed of red sandstones and conglomerates alternating with mudstones showing carbonate concretions.

7th STOP

REDINHA
(10 km North from Pombal)

Purposes - Observation of the Barracão Clays (UBS 13).

Description - The pliocene sediments overlaies the Pombal-Redinha unit. The Barracão Clays (Fig. 0.3A) include a negative aluvial sucession: greyish mudstones pass up to coarse yellowish quartz arenites and redish heterometric conglomerates on the top.

8th STOP

CERNACHE AERODROME
(about 5 km South from Coimbra)

Purposes - Observation of the pliocene Cruz de Morouços Complex (UBS 13).

Description - This outcrop is located over an important NS vertical fault (Pombal - Cernache fault) which separates upper cretaceous mudstones (Taveiro Claystones and Sands) in the western block from lower cretaceous sandstones and conglomerates (Belasian Sandstones) in the eastern block. These sediments are overlaid in disconformity by the Cruz de Morouços Complex, showing conglomerates with sandy lenses interpreted as pliocene alluvial fan deposits. They are considered to be the distal equivalents of Santa Quitéria Conglomerates (CUNHA & REIS, 1991; CUNHA, 1992) (Fig. 0.3).

EAST OF COIMBRA REGION

In the Coimbra eastern region the post - Paleocene sedimentary succession (Mondego Tertiary Basin) has been divided into several major units (DAVEAU *et al.*, 1985-1986; CUNHA, 1992), separated by regional descontinuities (Fig. 2.1 and 2.2):

1) Côja Arkoses - arkoses and gravel conglomerates rich in smectite, related to a gravel fluvial system (UBS7 and UBS8 - upper Lutetian-lower Chattian).
2) Lobão Arkoses - coarse arkosic sandstones deposited in a proximal portion of a gravel fluvial system (UBS10 - upper Burdigalian-lower Tortonian). This neogene unit is not seen in this excursion.
3) Sacões Grup - consisting of alternating shale and quartzitic conglomerates and massive siltstones. Includes piedmont accumulations correspondent to the Portuguese Central Range and Western Mountains uplifts.
   3.1) Campelo Formation (UBS11- Upper Tortonian-Lower Messianian). This formation can be subdivided in two members; the Arroça Member greyisch or yellow clayey deposits are the distal equivalent of the Folques Member conglomeratic facies.
   3.2) Telhada Conglomerates (UBS12 - upper Messianian-Zanclean) - red conglomerates with slate and vein quartz clasts.
   3.3) Santa Quitéria Conglomerates (UBS13 - Piacenzian) - coarse ocre conglomerates mainly with quartzitic clasts.

9th STOP

SERRA DE SANTA QUITÉRIA
(about 22,5 km East from Coimbra)

Purposes - Campelo Formation, Telhada Conglomerates, Santa Quitéria Conglomerates observations and also a geomorphological scenery (UBS 11-12 -13).

Description - In a open pit located near the Arroça village outcrops the base of the Arroça Member (Campelo Formation). Lutites alternating with lenticular beds of small slate and quartz vein pebbles are seen (SQ-Norte column of figure 2.2 and 2.1). Here this unit overlays the Buçaco Group.

At about 350 m of altitude the Telhada unit contacts, by disconformity, the Campelo Formation. Along the road badly exposed red conglomerates outcrops, showing alternating massive unsorted cobble and boulder gravel, with few parallel-laminated coarse sands.

The contact with the Santa Quitéria Conglomerates overlying unit is a disconformity located near the chapell at about 400m of altitude. They integrate clast-supported boulder conglomerates, with some lenses of sandstones (Fig. 0.3A).

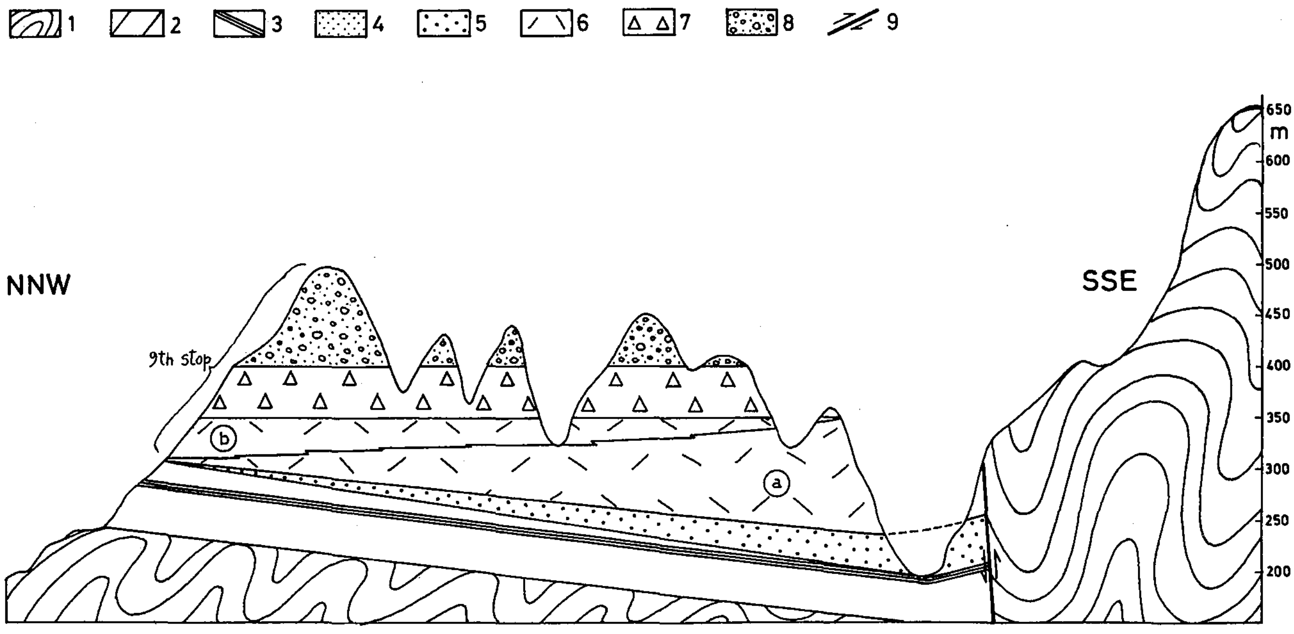


Fig. 2.1 - Geological section of the Santa Quitéria - Góis region). 1 - metamorphic basement (slates); 2 - metamorphic basement (quartzites); 3 - Buçaco Group (Cretaceous); 4 - Buçaqueiro Sandstones (Upper Cretaceous); 5 - Côja Arkoses; 6 - Campelo Formation (a - Folques Member; b - Arroça Member); 7 - Telhada Conglomerates; 8 - Santa Quitéria Conglomerates; 9 - Lousã fault (CUNHA, 1992).

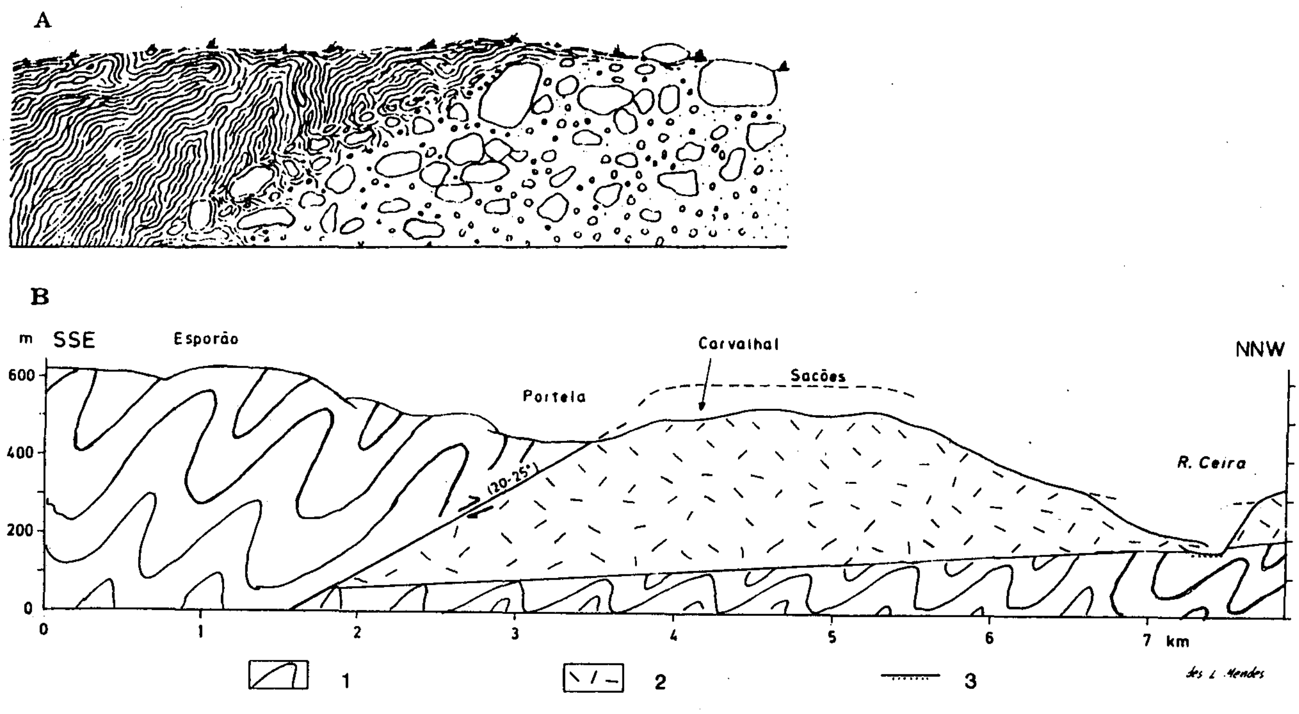


Fig. 2.3 - The overthrust of Portela de Góis. A - after DELGADO (1895-98); B - after DAVEAU *et al.*, 1985-1986. 1 - basement; 2 - cretaceous and cenozoic sediments; 3 - alluvium.

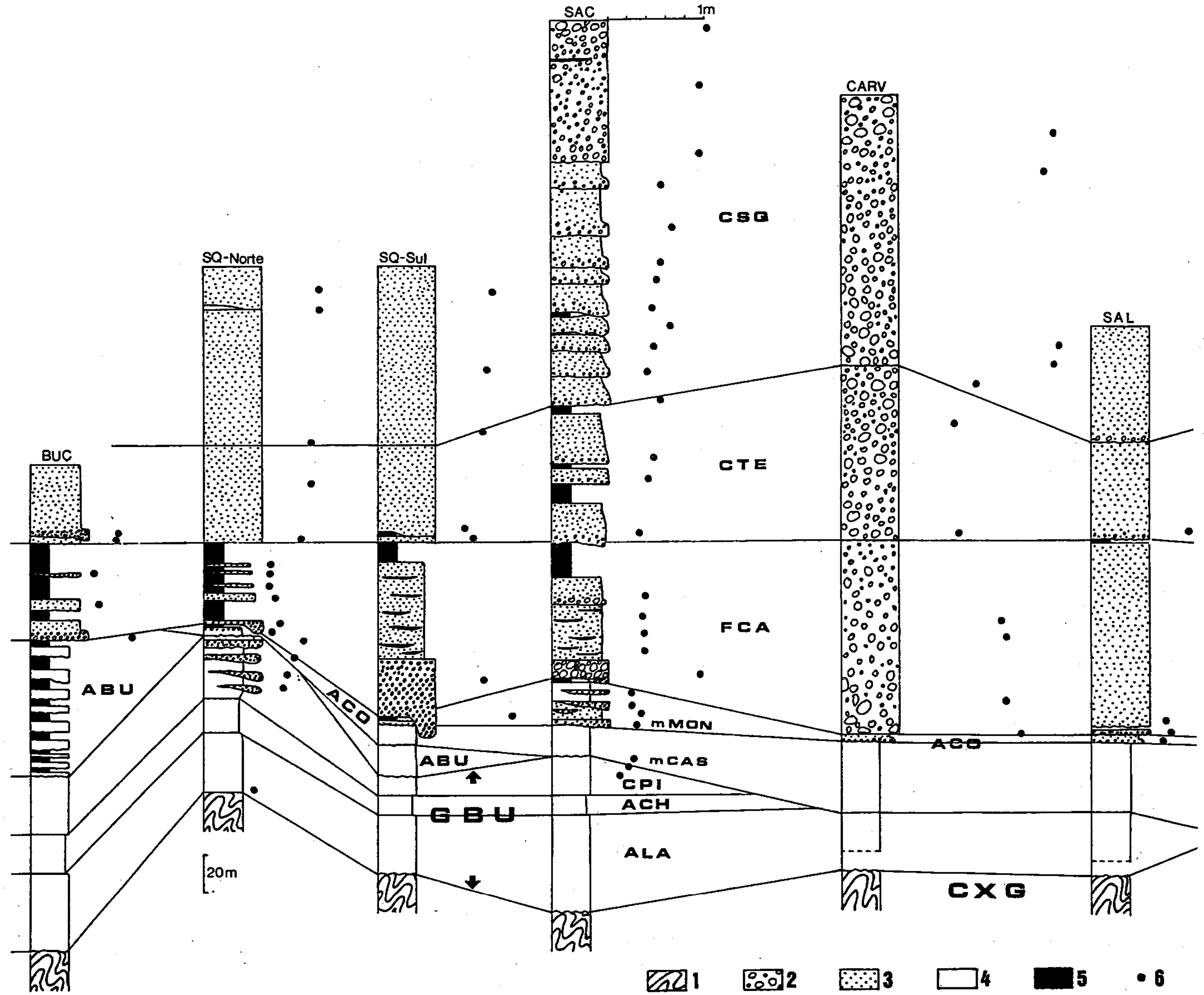


Fig. 2.2.- Stratigrafic columns of the Coimbra eastern region. 1 - basement; 2 - horizontally bedded clast-supported conglomerates; 3 - muddy matrix-supported conglomerates; 4 - sandstones; 5 - siltstones; 6 - maximum particle size (mean); CXG - "Xisto-Grauváquico" Complex GBU - Buçaco Group; ALA, ACH and CPI - Buçaco Group formations; ABU - Buçaqueiro Sandstones; ACO - Côja Arkoses; mCAS - Casalinho de Cima Member; mMON - Monteira Member; FCA - Campelo Formation; CTE - Telhada Conglomerates; CSQ - Santa Quitéria Conglomerates (Cunha, 1992).

From the top (492 m of altitude), a geomorphological scenery can be seen over the cretaceous and tertiary sediments, and palaeozoic basement. Looking eastwards is a palaeozoic quartzite relief. Looking southwards, the southern tectonic block (Portuguese Central Range horst) is seen.

10th STOP

PORTELA DE GOIS

Purposes - Observation of the Portela de Góis overthrust.

Description - This stop shows the Shale-Greywacke Complex (Precamb.-Camb.) overthrusting the Santa Quitéria Conglomerates (UBS 13) (Fig. 2.3 and 0.4A). The heterometric quartzitc pebbles and blocs of caotic fabric came from the Penedos de Góis quartzitic ridge. This overthrust proves that after the deposition of the Santa Quitéria Conglomerates (considered of piacenzian age) occurred another compressional stage of the Lousã fault.

THIRD DAY

VILA DE REI REGION

The neogene continental deposits situated at Vila de Rei region are located close to ordovician quartzite ridges of the Amêndoa-Envendos syncline, in Central Portugal. They include main continental siliciclastic sediments of the Lower Tagus Basin northeastern border. In the region they are controled by a complex fault system related to the uplift of the southern border of the Hesperic Massif, mainly during the neogene final stages (Fig. 3.1).

The neogene column presents six lithostratigraphic units, from bottom to top:

1) Monsanto Sandstones (UBS8 - Priabonian-lower Chattian) - an alluvial conglomeratic sandstones;
2) Ota Sandstones and Tomar Claystones (UBS10 - upper Burdigalian-lower Tortonian) - fluvial sandstones grading up to claystones and lacustrine limestones;
3) Ulme Sandstones and Serra de Almeirim Conglomerates (UBS13 - Piacenzian) - a prograding alluvial sucession (BARBOSA & REIS, 1989) and (Fig. 0.3);
4) Vila de Rei Conglomerates (UBS14) - a quaternary border alluvial fan conglomerates (BARBOSA & REIS, 1991a).

11th STOP

MATAGOSA
(6,5 km SSW from Vila de Rei)

Purposes - Geomorphological panoramic view of neogene sediments overlying palaeozoic basement.

Description - Northward view of the neogene pediment gently tilted up towards the quartzite ridges on the horizon. The sediment thickness covering the palaeozoic quartzites and schists is afected by a complex faulty blocky system. Looking southwards, pliocene pediplain is a little raised compared with the northern by a WNW-ESE trending fault parallel to the Codes stream. Eastward the neogene basin limit by the palaeozoic quartzite relief is seen.

Old open pits (possibly old Roman gold works) and huge dump of rounded boulder quartzites, can be seen looking towards NE, over the quartzites, on the opposite river margin. Serra de Almeirim Conglomerates is the main collector unit, although some quaternary terraces of Codes stream, seen from here, have been exploited too. This great scars and dumps are geographically named "conheiras".

12th STOP

MACIEIRA TO VILAR ROAD
(6 Kms SW from Vila de Rei)

Purposes - Observation of a tertiary complete section, integrating four lithostratigraphic units, named from base to top: Monsanto Sandstones (UBS8), Ota Sandstones.and Tomar Claystones.(UBS10); Serra de Almeirim Conglomerates (UBS13). Only the upper four units are neogene.

Description - Here the Monsanto Sandstones (UBS8) contact the palaeozoic slates by fault. It is a whitish coarse sandstone with reddish to pink subvertical stains, columnar structure and local carbonate crusts. Palygorskite is the dominant clay mineral. The contact with the upper unit is not well exposed.

Ota Sandstones and Tomar Claystones (UBS10) correspond to a positive miocene megasequence, integrating coarse to fine reddish arkosic microconglomerate sandstones grading up to fine sandstones and mudstones. The upper part is a speckled reddish (marmorized) massive mudstone belonging to Tomar Claystones. An unconformity separates the Tomar Claystones from the following unit.

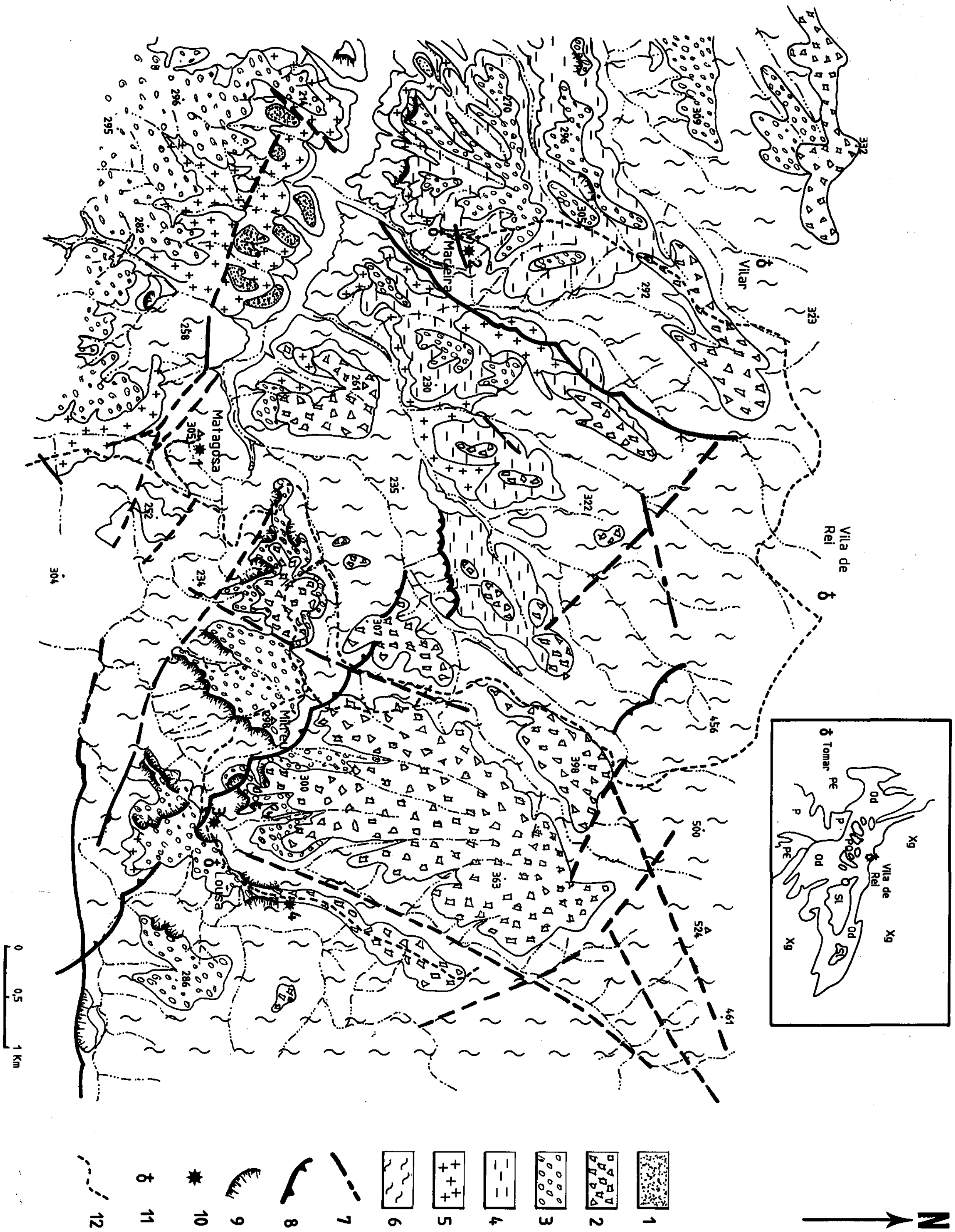


Fig. 3.1. - Geological sketch of the Lower-Tagus Basin norther border in the Vila de Rei area and stop locations. 1 - Terrace deposits; 2 - Vila de Rei Conglomerates (Quaternary); 3 - Serra de Almeirim Conglomerates (Piacenzian); 4 - Ota Sandstones and Tomar Claystones (Miocene); 5 - Monsanto Sandstones (Paleogene); 6 - Shales and quartzites (Palaeozoic basement); 7 - Normal fault; 8 - Reverse / thrust fault; 9 - Old open pit; 10 - 11 th, 12 th and 13 th A.M. stops; 11 - Villages; 12 - Way to the stops; PQ - Plio-quaternary; P - Pliocene conglomerates Sl - Silurian schists; Od - Ordovician shales and quartzites; Xg - Ante-ordovician "Xisto-Grauváquico" Complex PC - Precambrian gneisses.

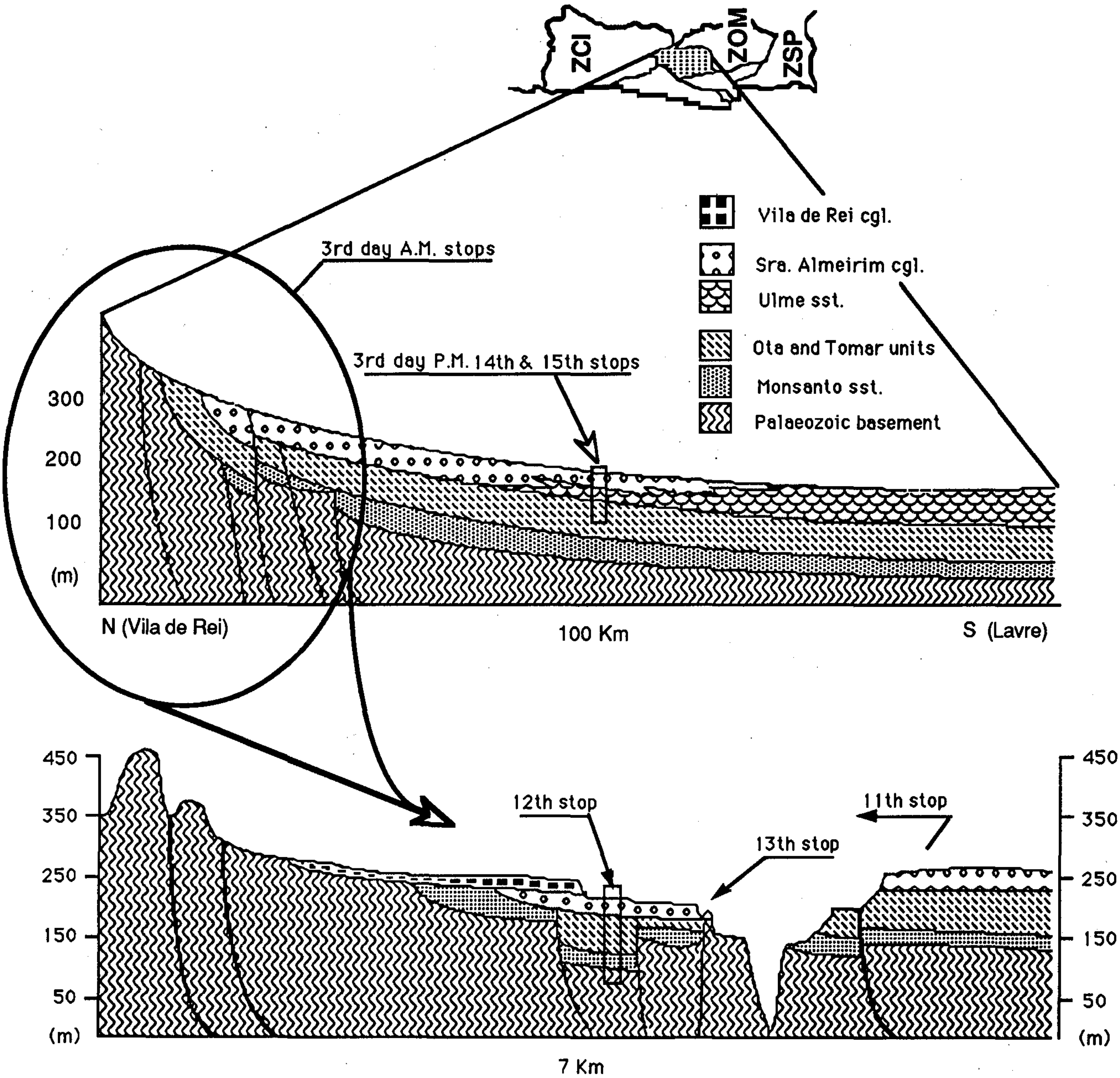


Fig. 3.2. - Stops and geological profile location of the continental siliciclastic sediments and tectonic scketch of the Lower Tagus Basin northern border (modified from BARBOSA & REIS, 1991b).

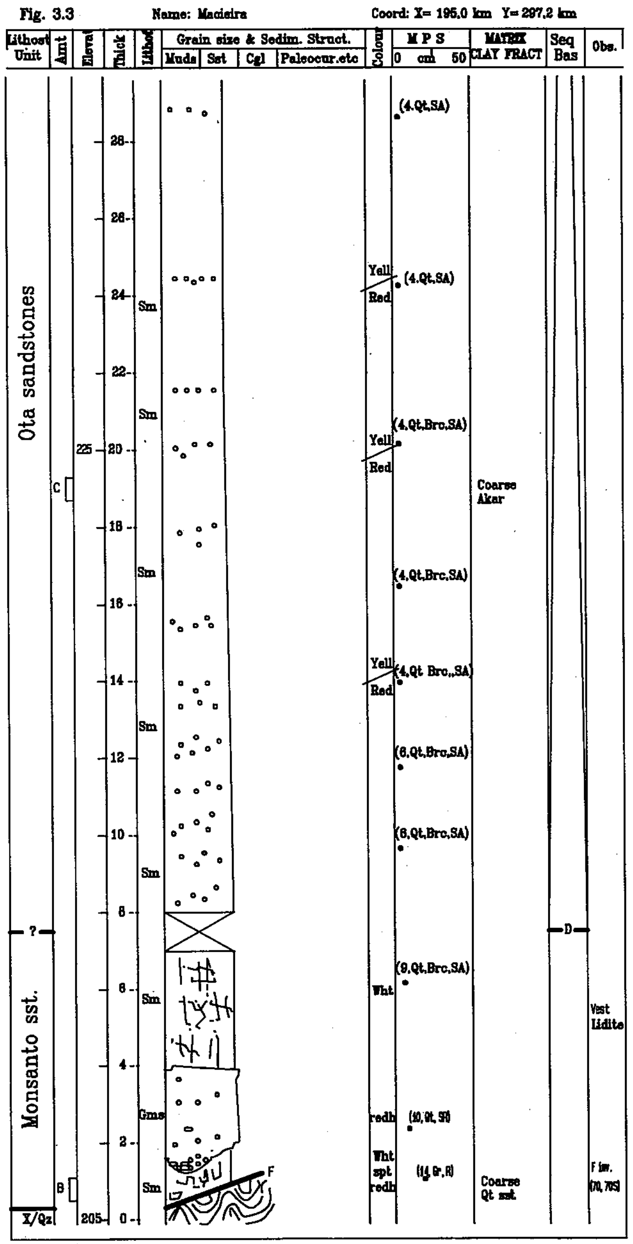
Serra de Almeirim Conglomerates (UBS13) are highly rounded quartzite conglomerates, matrix supported, with MPS=35 cm.

13th STOP

LOUSA VILLAGE
(6,5 kms ESE from Vila de Rei)

Purposes - Lousa thrust, "Conheiras" and profiles (Fig. 3.4).

Description - Palaeozoic slates thrust, towards north, over Serra de Almeirim Conglomerates is visible in the Lousa wall road. In front, the other side of the Codogoso stream, another big "conheira" can be seen. Some meters ahead, Lousa "conheira" is crossed by the road, starting up a positive macrosequence: from the massive quartzite boulders conglomerates of MPS=50 cm passing up to conglomerates barforms with MPS = 20 cm quartzites clast supported, interbbeded with planar crossbedded sandstones. The third part of the profile ends



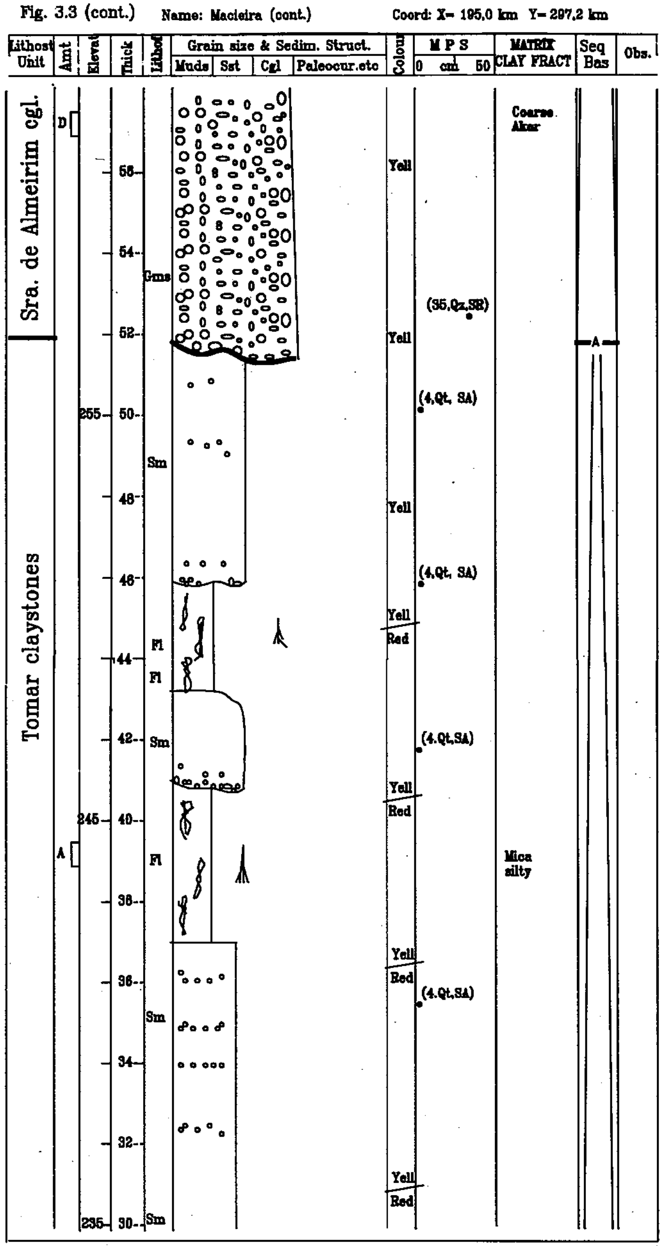


Fig. 3.3. - Macieira profile.

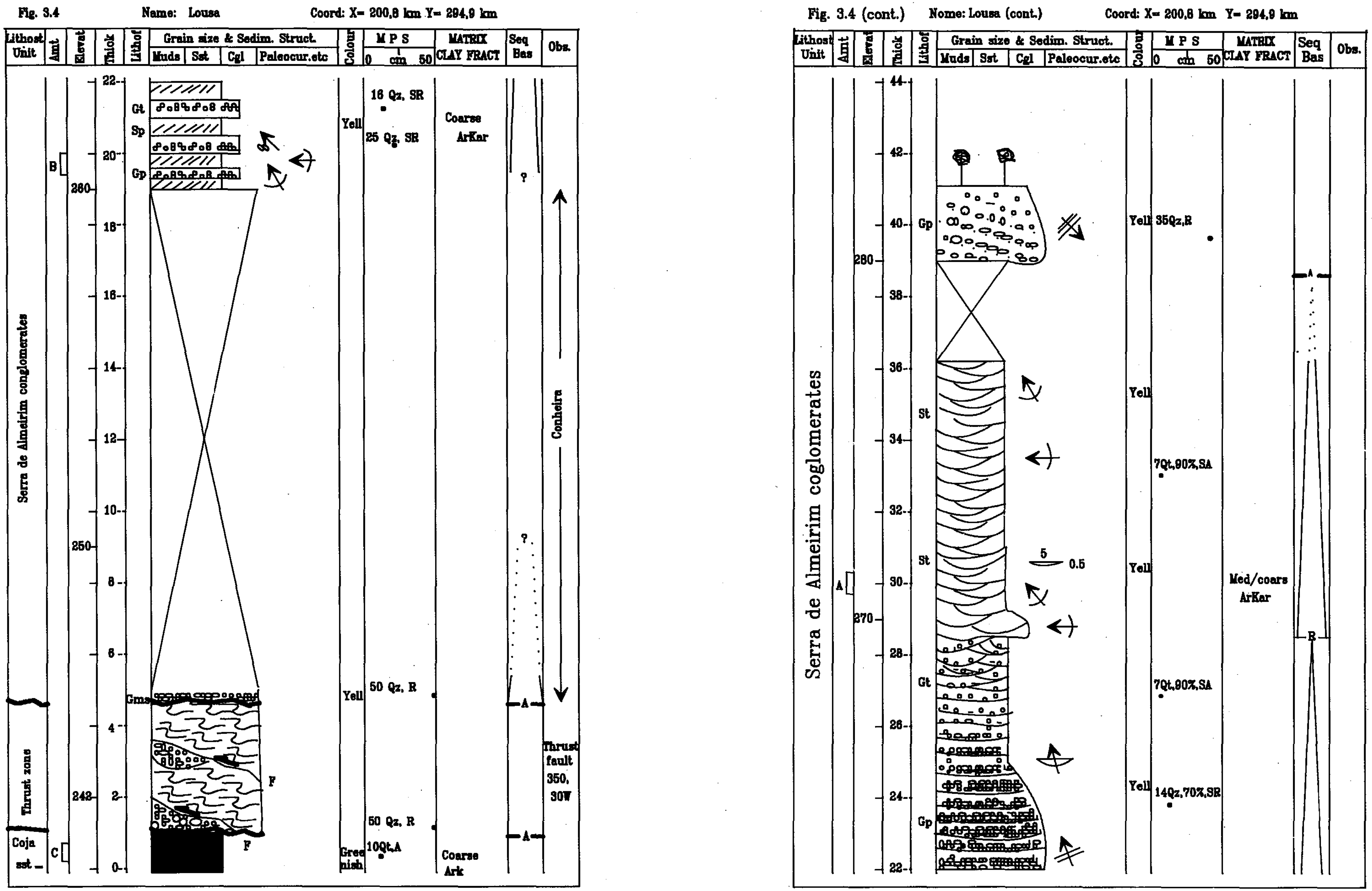


Fig. 3.4 - Lousa 1 profile.

with trough crossbedding sandstones with few lag conglomerates. The paleocurrents trend to WNW.

On the top, the Vila de Rei Conglomerates outcrop along the road, showing planar accretion surfaces towards SW, overlying the Serra de Almeirim Conglomerates over which the highest topographic (270 m) conheiras are built (Fig. 3.5). Vila de Rei Conglomerates,with MPS = 35 cm, are matrix supported massive conglomerates of angular quartzite clasts interbbeded with red coloured mudstones, showing prismatic soil disjunction and iron cementations. They represent debris flows / mud flows alluvial fans controled by the tectonic uplift of the neighbouring quartzites (BARBOSA & REIS, 1991a).

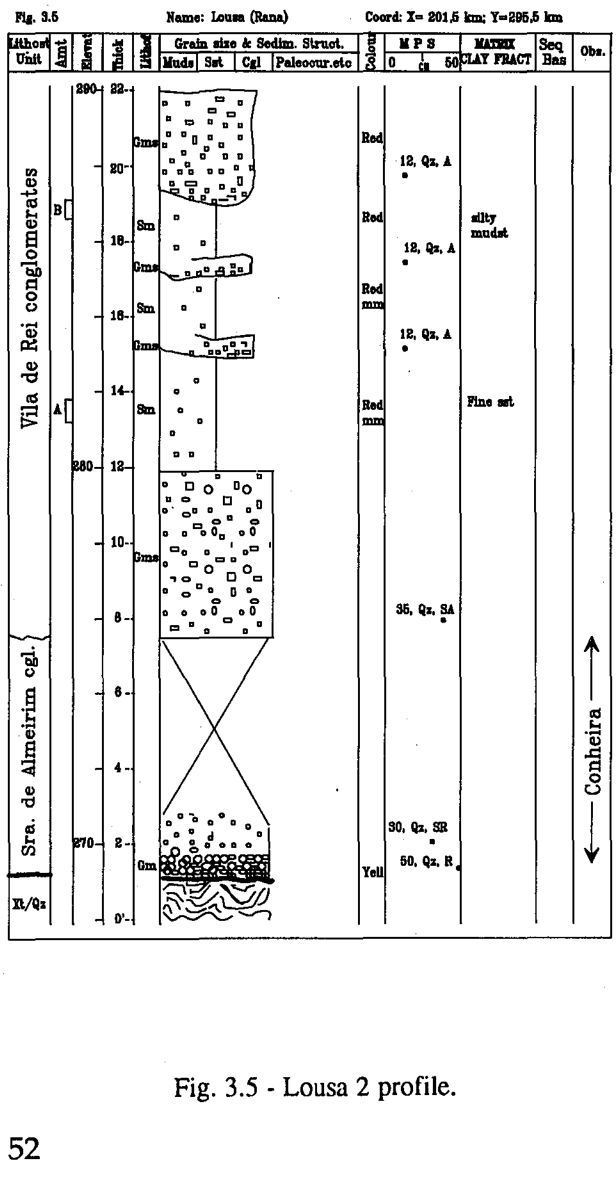


Fig. 3.5 - Lousa 2 profile.

14th STOP

ULME VILLAGE
(7 km SE from Chamusca)

Purposes - Ulme Sandstones and Serra de Almeirim Conglomerates observations.

Description - The observation starts on the Miocene Tomar Claystones (Fig.3.6). They are normally reddish brown massive mudstones, sometimes with carbonate concretions and Fe-Mn nodules. Some calcrete horizons may occur. The Ulme Sandstones overlie unconformably this unit.

The Ulme Sandstones correspond to multistory bodies of trough crossbedded yellowish and reddish feldspathic medium to coarse sandstones. They include quartz extraclasts and mudstones intraclasts underlining limits of the sets. Ulme Sandstones defines with Serra de Almeirim Conglomerates a negative macrosequence.

The Ulme lateral outcrop, close the top of the profile (Fig.3.7A), show a section subparallel to the palaeoflow. Ten diferent lithosomes integrating conglomerates and sandstones can be separated, corresponding to accretion barforms towards SW. At the outcrop base, Ulme Sandstones passing up to Serra de Almeirim Conglomerates shows reactivation surfaces. Quartzite clast supported fabric, and a(t) and b(t) imbrications, has been used for palaeoflow determinations (see panel A of Fig. 3.7). Quartzite clast MPS is 16 cm rising to 20 cm to the top.

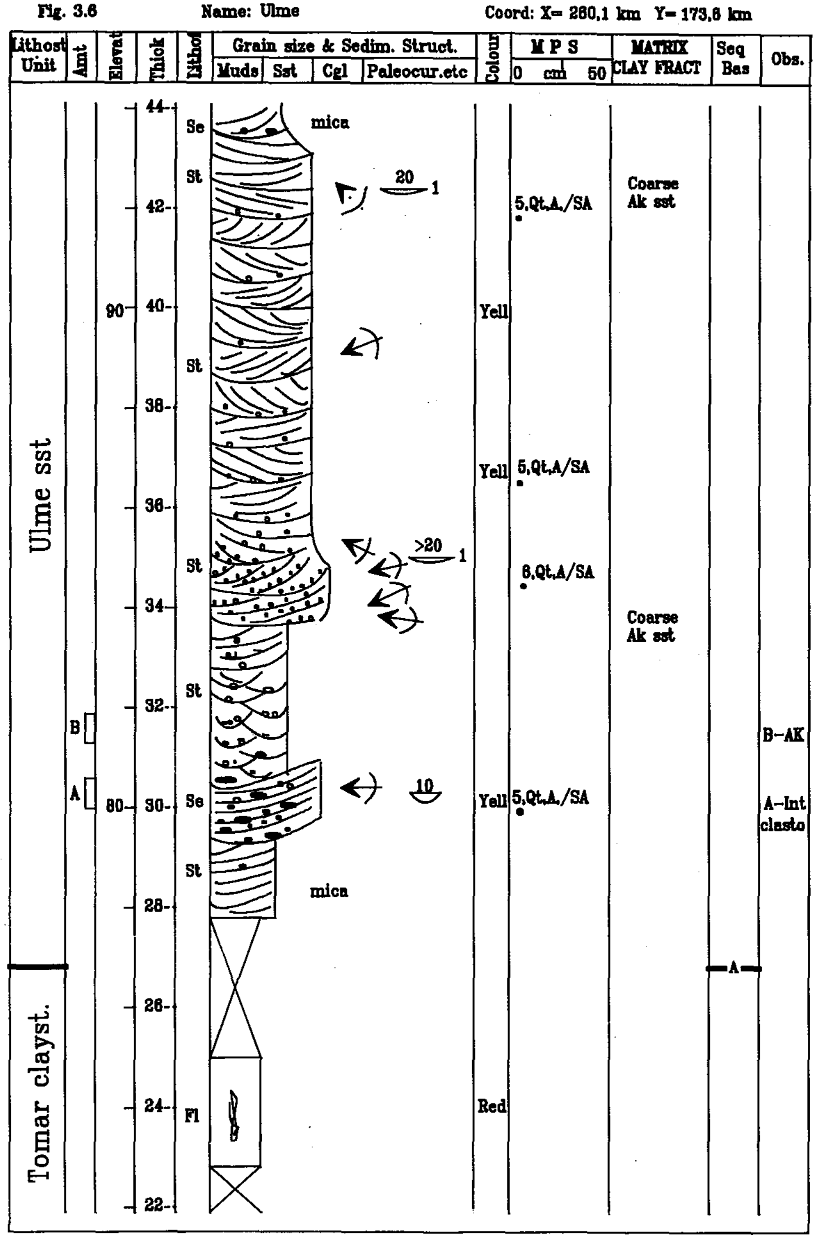
15th STOP

VALE DE CAVALOS VILLAGE
(13 km NE from Almeirim)

Purposes - Vale de Cavalos profile and extensive road section.

Description - This outcrop show the same stratigraphic units (Tomar Claystones and Ulme Sandstones) of the previous stop (Fig. 3.8).

In the Vale de Cavalos outcrop (Fig. 3.7B), the observation is normal to the deduced palaeoflow which trends to WSW. Six main bodies showing trough bedforms of conglomerates and sandstones (quartzite MPS = 16 cm) are separated by erosion concave surfaces.



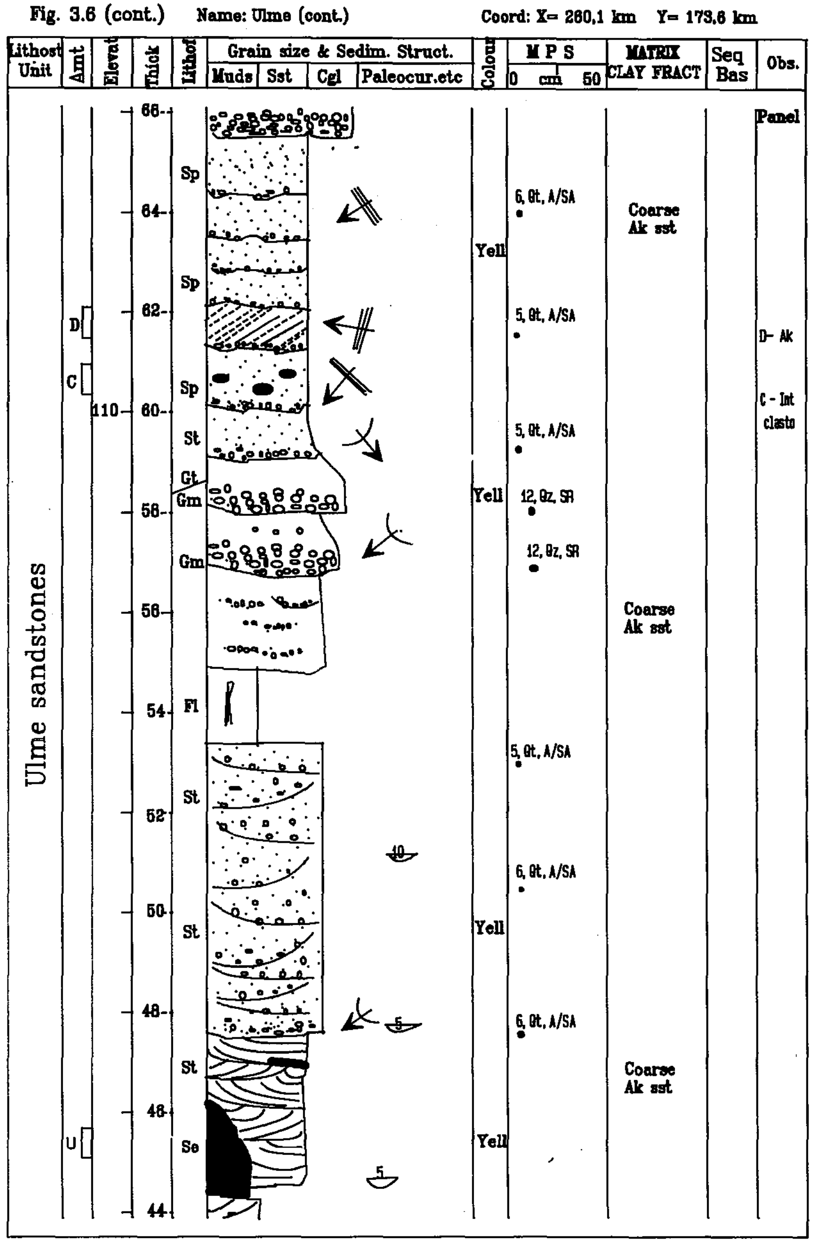


Fig. 3.6 - Ulme profile.

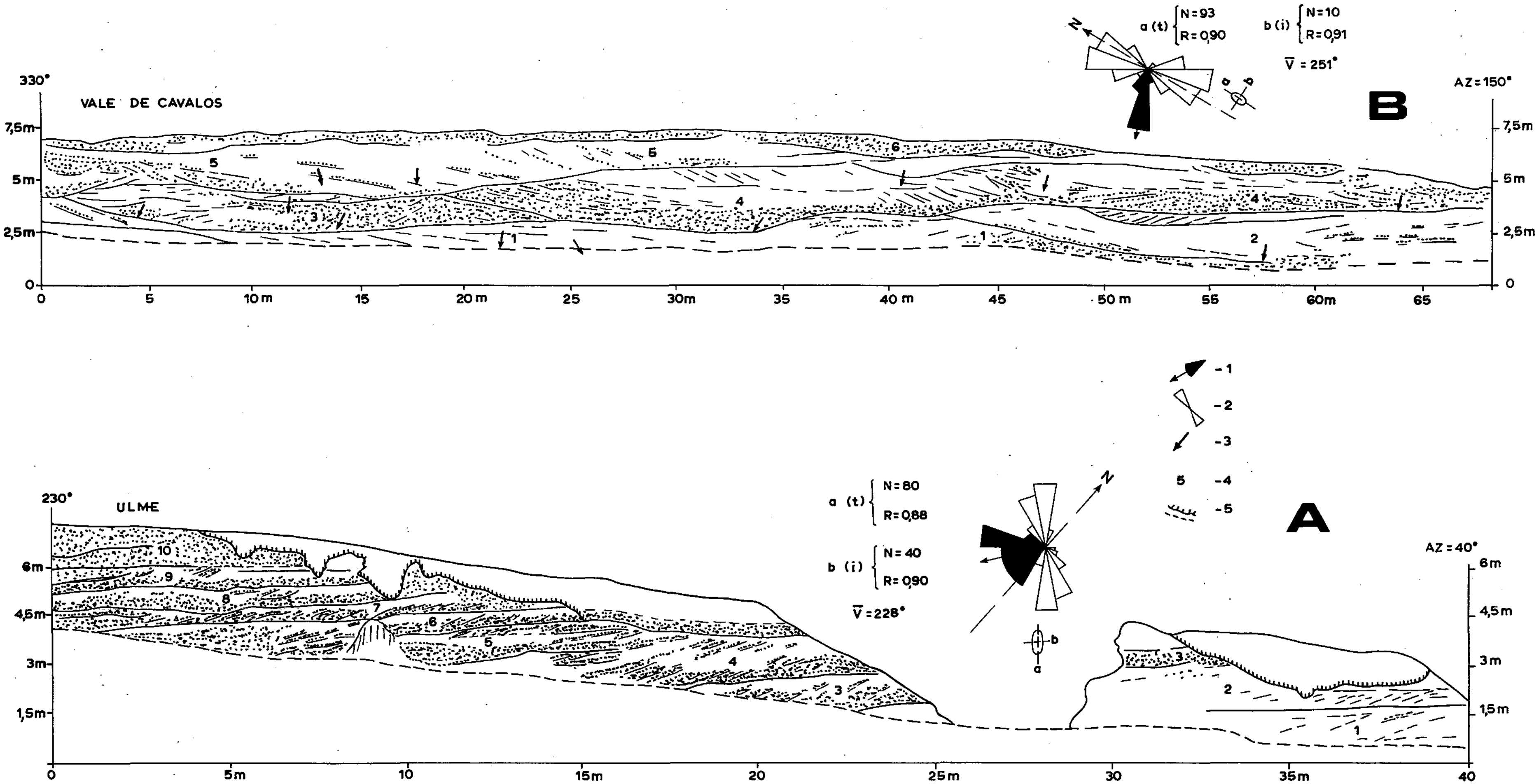


Fig. 3.7. - Ulme panel (A) and Vale de Cavalos panel (B). 1- Vector mean for clast imbrications, b (i); 2 - Clast major axis orientation, a (t); 3 - Paleocurrent trends; 4 - Conglomerate and sandstone sedimentary lithosomes; 5 - Outcrop limits.

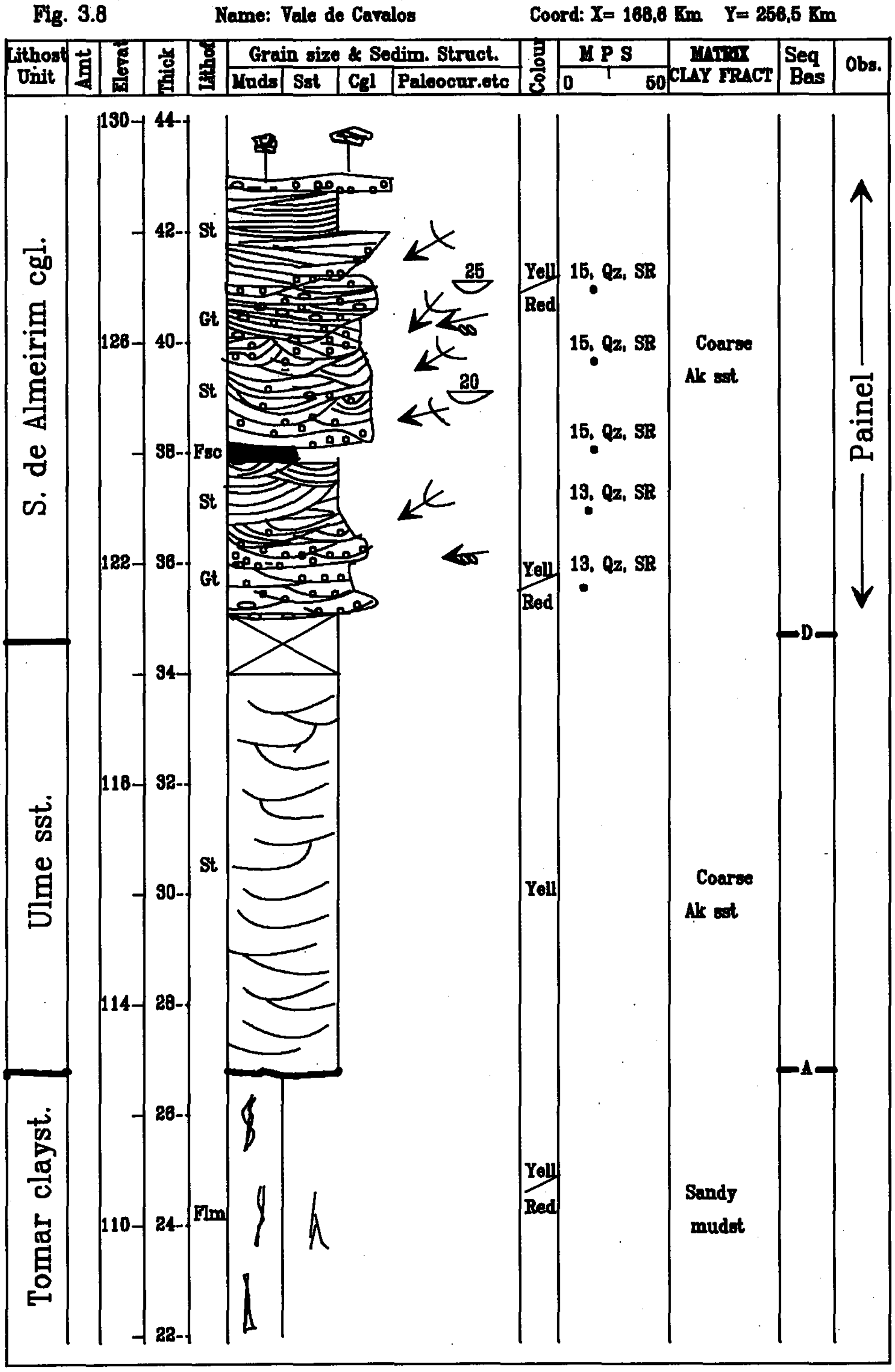


Fig. 3.8 - Vale de Cavalos profile.

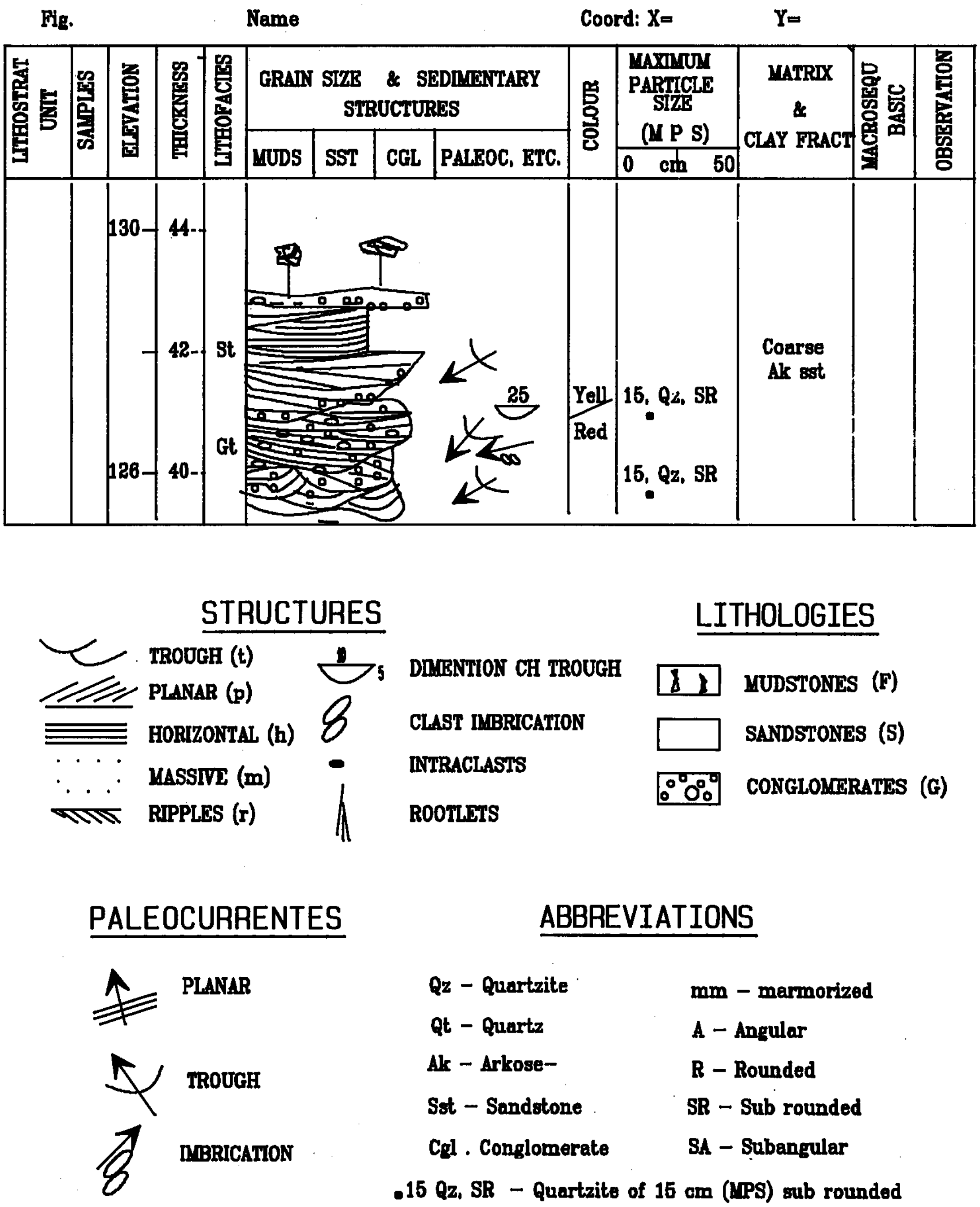


Fig.3.9 - Sections legend.

REFERENCES

See page 67.