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Neogene Palaeogeographic Evolution of Algarve Basin (Southern Portugal): a two step model. Preliminary data*

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Abstract: The proposed model considers two sedimentary cycles separated by a hiatus. The first depositional cycle (Langhian? - Middle Serravalian) is materialized by shallow marine calcareous deposits: "Lagos-Portimão" Formation and on top the "Mem Moniz - Albardeira" Formation. The hiatus (Upper Serravalian? - Middle Tortonian) marks a generalized uplift of Algarve sector, most probably related with tectonic activity along the Gibraltar arc (westward overthrust) and subsequent dextrogyre rotation of the Guadalquivir basin. During the second depositional cycle (Upper Tortonian - Pliocene) two other coastal marine to paralic terrigenous formations were deposited: "Cacela" and "Olhos de Água-Falésia" Formations.

Resumo: O presente modelo resulta da necessidade de conciliar a profusão de unidades litostratigráficas anteriormente definidas para o Neogénico algarvio com as evidências de campo e os dados paleontológicos e geocronológicos até ao momento disponíveis. O seu objectivo é contribuir para uma melhor compreensão do Neogénico algarvio, enquadrando-o no contexto da evolução paleogeográfica do Mediterrâneo ocidental / Atlântico. Este modelo, basicamente, considera a existência de dois ciclos sedimentares separados por um hiato. O primeiro ciclo (Langhiano? - Serravaliano médio) está testemunhado por duas formações carbonatadas: a Formação de "Lagos - Portimão", subjacente, e a Formação de "Mem Moniz - Albardeira", melhor representadas, em afloramento, no sector ocidental algarvio. Este ciclo está separado do seguinte por um hiato, resultante da sobrelevação da plataforma algarvia, provavelmente associada a importante actividade tectónica compressiva E-W no arco de Gibraltar. Durante este hiato (Serravaliano superior? - Tortoniano médio) ocorreu intensa erosão continental (carsificação) responsável pela reduzida expressão cartográfica da Formação de "Mem Moniz - Albardeira". O cavalgamento para oeste do arco Bético - Rifenho, o consequente desenvolvimento de espessos mantos olistostrómicos ao longo do Golfo de Cadiz e o deslocamento dos depocentros da Bacia de Guadalquivir para N e NW terão modificado a paleogeografia do sector algarvio da placa ibérica passando este a ter uma relação mais íntima com a evolução sedimentar, terrígena, distal, da bacia do Guadalquivir. O segundo ciclo sedimentar considerado neste modelo reflete este novo enquadramento geológico. É representado por duas formações: a Formação de "Cacela" (Tortoniano superior - Messiniano?) que se desenvolve para oeste através de um nível de condensação constituído por arenitos finos (Siltitos de Galé - Oura), micáceos, com glauconite e abundantes dentes de peixe e a Formação de "Olhos de Água - Falésia" (Messiniano? - Pliocénico), suprajacente, na qual se incluem a lenticula fossilífera de Olhos de Água com *Palliolum (Lissochlamys) excisum*, e, na região de Luz de Tavira, os níveis lacustres de Morgadinho com fauna de pequenos mamíferos.

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INTRODUCTION

The first geological references to Algarve's Neogene formations (Fig. 1) stretches back as far as 1850. Since then several Palaeontological (mainly concerning Cace-la fossiliferous outcrop), Vulcanological, Hydrogeological, Geomorphological and Stratigraphical works have been published (PAIS 1982).

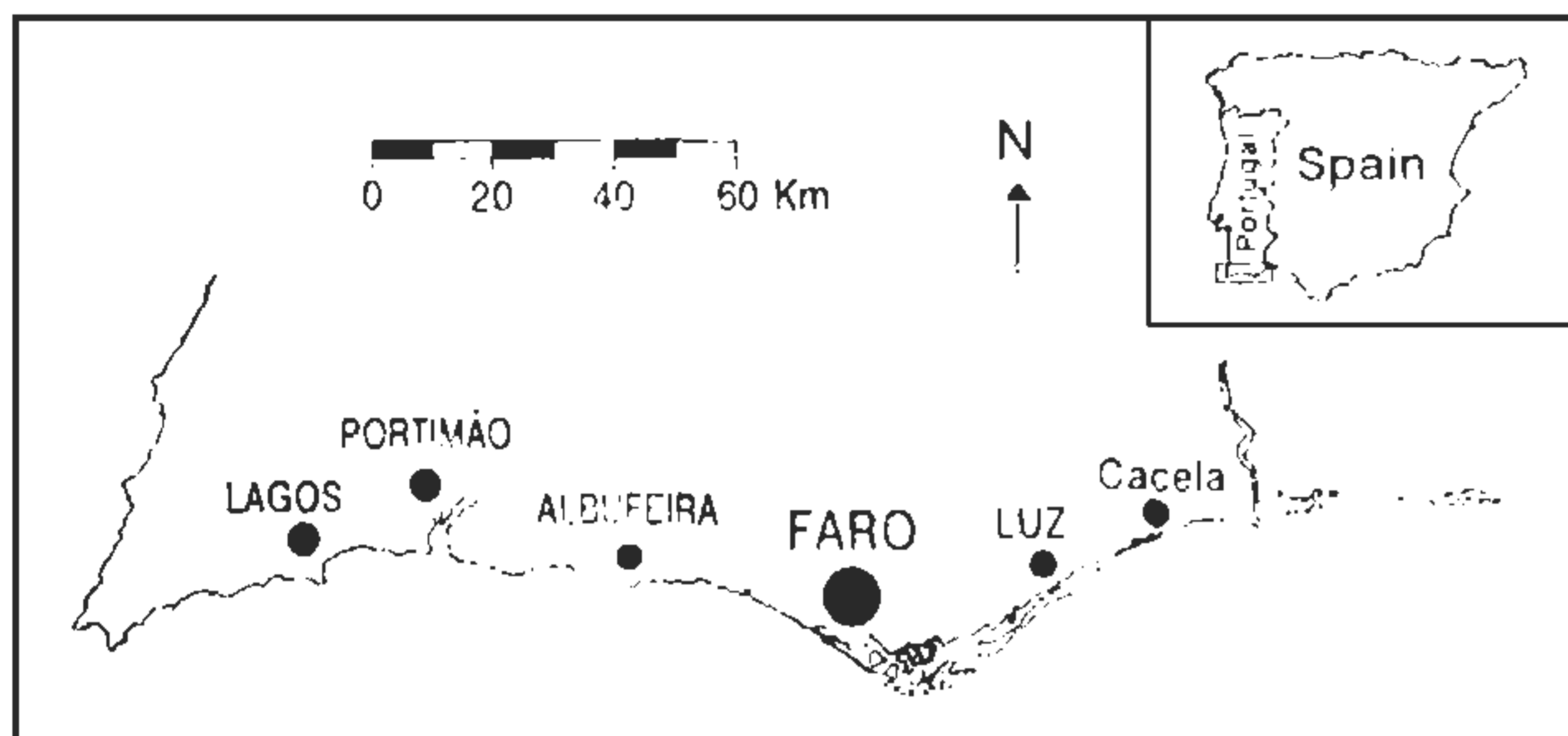


Fig. 1 - Location map of the referred main sites

More recently, geological mapping carried out by the Portuguese Geological Survey and "Universidade Nova de Lisboa" brought in a considerable amount of new biostratigraphic and chronological data. However, several questions still remain unanswered: the stratigraphic position of Mem Moniz outcrop in relation to other Miocene formations, the relationship between Neogene formations west and east of Faro (ANTUNES *et al.* 1990), and the relationship of the Algarve basin with the geological evolution of the overall neogene basins of the Betic - Rif arc, Alboran Sea and Golf of Cadiz.

Giving continuity to studies carried out in Algarve by the "Faculdade de Ciências da Universidade de Lisboa" Geological Department the preliminary model now presented combines field observations with new biostratigraphic data (based upon Calcareous Nannofossils). This model was born from the need to conciliate the multitude of lithostratigraphic units previously created with field, palaeontological and geochronological evidences (both new and previously published data). Its purpose is to contribute to a better understanding of Algarve's Neogene within the context of Western Mediterranean / Atlantic Neogene palaeogeographic evolution.

THE TWO STEP MODEL

Basically, this new model considers two sedimentary cycles separated by a hiatus (Fig. 2).

During the first depositional cycle two sedimentary units were formed: a high-energy coastal macrofossiliferous calcareous sandstone - "Formação carbonatada de Lagos - Portimão" - (ANTUNES *et al.*, 1981a) and on the top a microfossiliferous shallow low-energy micritic limestone - "Formação carbonatada micrítica de Mem Moniz - Albardeira" (CACHÃO 1992). The age interval proposed for this first cycle ranges from Langhian ? to Middle Serravalian. Since the lowermost "Lagos - Portimão" Formation is restricted inshore to outcrops in the vicinity of present day coast line and the "Mem Moniz" outcrop is located approximately 10 km north of Albufeira, this sedimentary sequence clearly reflects a progressive coast line withdrawn northward, during a positive eustatic movement over a stable margin (Fig. 3).

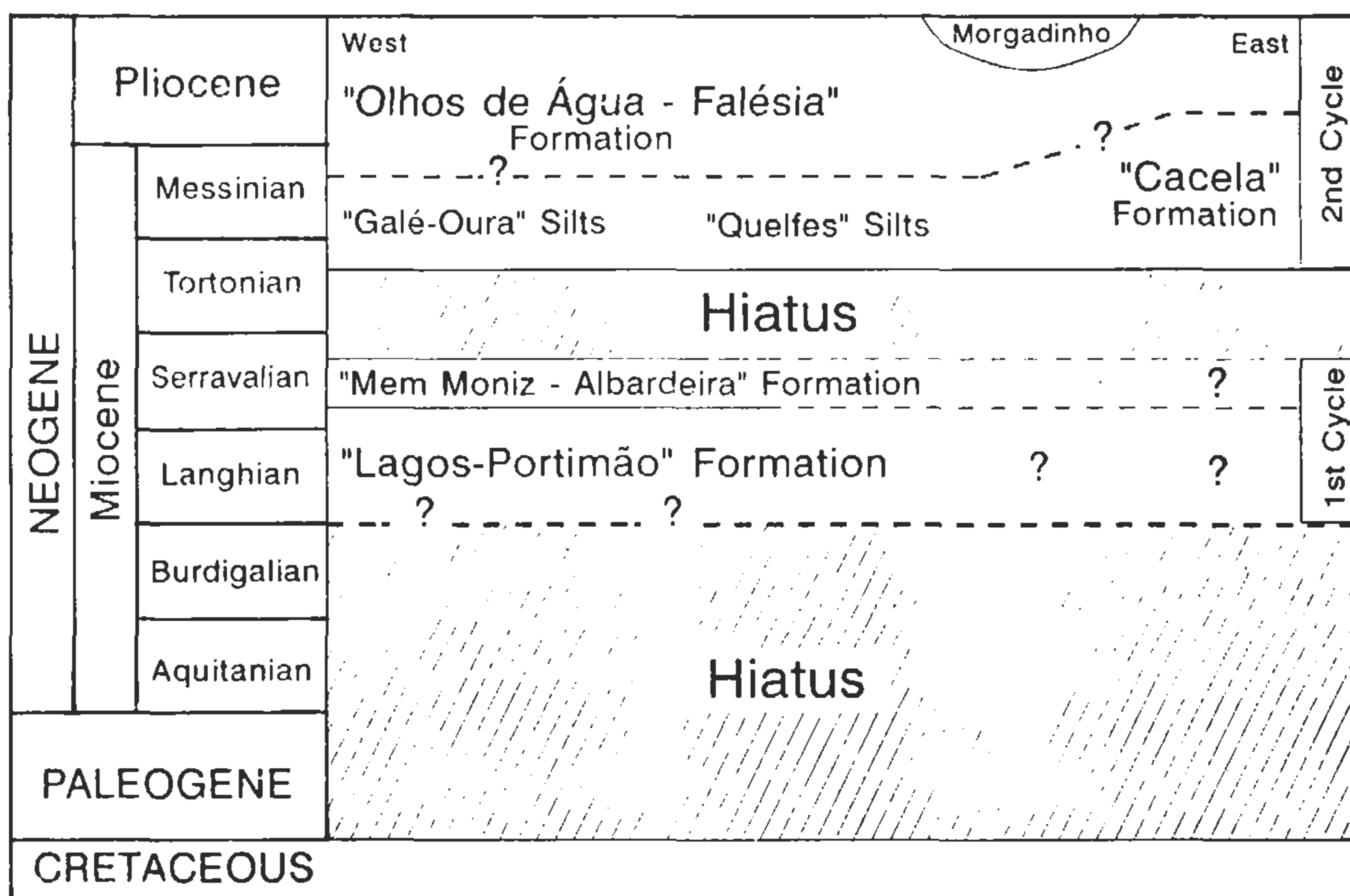


Fig. 2 - Litological units considered in this model and its stratigraphical correlation

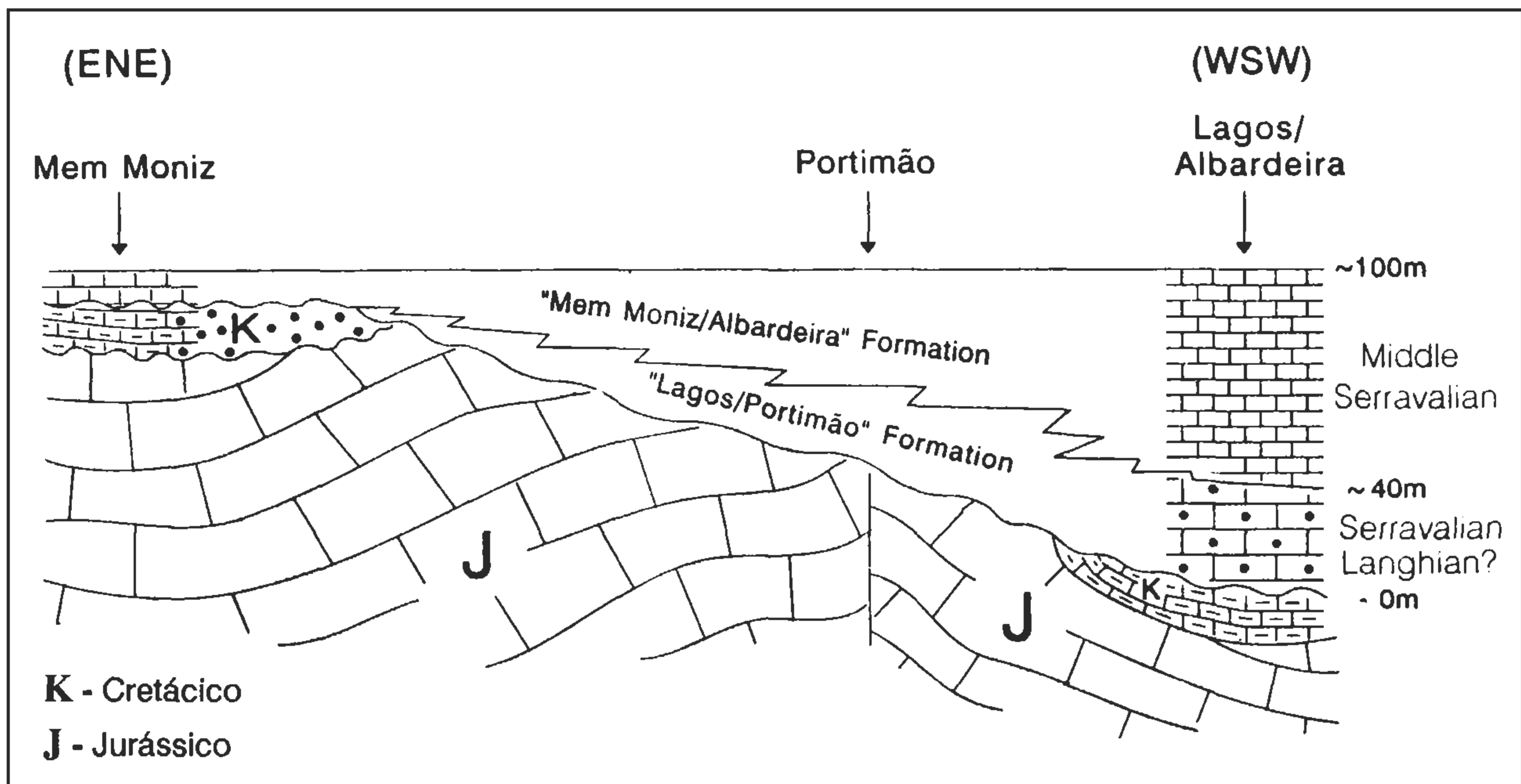


Fig. 3 - Schematic cross-section of the two units related with the first sedimentary cycle.

Afterwards, a sedimentation hiatus occurred (Upper Serravalian? - Middle Tortonian), probably related to the Serravalian - Tortonian Gibraltar arc overthrust (JABALOY *et al.* 1992) and the Middle Tortonian dextral rotation of the Guadalquivir Basin (SIERRO *et al.* 1990). During this time interval the previously occupied coastal platform emerged (tectonic movements along Faro's and Tavira's faulting systems took place and subsequently it's oriental blocs uplifted, defining a horst structure. More to the west, the small "Praia da Vigia - Arrifão" bloc uplift was probably due to the same E-W induced compressional efforts during this time interval. From a tectonic point of view it's also interesting to recognize the similarity between this model and the main tectonic phases described by C. MONTENANT (1977 - *vide* PAIS 1982) for the oriental extreme of the Betic foredeep.

During this emersion interval intense continental erosion of the "Mem Moniz - Albardeira" Formation occurs followed by carsification of the "Lagos - Portimão" Formation.

The beginning of the second sedimentary cycle was marked by the marine abrasion of a new coastal platform indiscriminately cutting off Paleozoic, Mesozoic and earlier deposited Miocene sediments. Near Cacula ("Ribeira de Cacula" and "Forte de S. João da Barra" outcrops), in the eastern side of this platform, the section begins with an Upper Tortonian (CN9a OKADA & BUKRY, Calcareous Nannofossils biozone) discordant fossiliferous conglomeratic sandstone (overlying Triassic and Jurassic sediments) followed by a thick fine micaceous sandstone sequence with highly bioturbated silty-clay levels on top - "Praia Verde" outcrop, Upper

Member of Cacula Formation - (ANTUNES *et al.* 1981a). This last unit discloses, by intense ferruginous diagenesis, fine examples of the relationship between *Thalassinoides* and *Gyrolithes* ichnogenera (F. MAYORAL, pers. comunic.).

During this time interval (Upper Tortonian to Messinian?), from Faro to Lagos, a micaceous silty layer measuring a few meters thick was being deposited over a more or less well delineated abrasion surface, defining an important condensation level. Typically, this level (here denominated "Galé - Oura silts") passes laterally to glauconitic sands and, between Albufeira and Oura sea cliffs, shows a high concentration of shark teeth and other fish remains (ANTUNES *et al.* 1981b).

Absolute age determinations made in these glauconitic sands (always in the same lithostratigraphic position), range from 10.1 to 6.19 Ma. (ANTUNES *et al.* 1984, 1986b). Instead of being considered as several overlaying levels this age interval may reflect a considerable time compression within these silts (the 10.1 Ma. value obtained from the glauconitic levels of Praia da Galé is probably too high, and it is possibly due to alteration). Such time compression increasing from east to west, is a typical feature of the Guadalquivir basin which reflects its fill-in dynamics (SIERRO *et al.* 1990).

Locally, the overlaying thick sandstone Formation of "Olhos de Água - Falésia" (ROMARIZ *et al.* 1979; ANTUNES *et al.* 1981a) was deposited in continuity with these silts. More frequently this contact shows strong erosional surfaces and/or fossiliferous (mainly Ostreids, Pectinids and Barnacles) paleocanals like those observed on Oura beach cliffs. Because of both its

lithostratigraphic upper position and the presence of *Palliolum (Lissochlamys) excisum* found in a fossiliferous paleocanal near the top of this unit (ANTUNES *et al.* 1990), this Formation may already be of Pliocene age. If so, it may be closely related to the Pliocene "Arenas de Bonares" Formation, outcropping near Huelva. Near the top of "Olhos de Água - Falésia" Formation iron pisolites may be found. This feature, also occurs in the conglomeratic sands overlaying the Cacula Upper Member, as well as in several Pliocene outcrops of Huelva region (J. VIDAL, pers. comunic.). In a lateral equivalent of the "Olhos de Água - Falésia" Formation, near Luz de Tavira (Morgadinho's lacustrine deposits), small mammal teeth indicative of MN17/MN20 MEIN (Upper Pliocene - Lower Pleistocene) were found (ANTUNES *et al.* 1986a).

The sedimentation vector in the Algarve basin, probably due to the westward development of the Betic - Rif arc, the subsequent emplacement of thick olistostroms on the Gulf of Cadiz and the Guadalquivir basin dextrogyre rotation, changed from S - N to NE/ENE - SW/WSW reflecting a clearer relationship with the Upper Tortonian to Pliocene sedimentary evolution of the Guadalquivir basin.

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