

**1º SIMPÓSIO SOBRE A MARGEM CONTINENTAL  
IBÉRICA ATLÂNTICA**

**1<sup>er</sup> SIMPOSIO SOBRE EL MARGEN CONTINENTAL  
IBERICO ATLANTICO**

**1<sup>st</sup> SYMPOSIUM ON THE ATLANTIC IBERIAN  
CONTINENTAL MARGIN**



**Resumos  
Resumenes  
Abstracts**

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## **RESUMOS**

**PHENOLOGY AND SUCCESSION OF LITHOPHYLLUM INCRUSTANS (CORALLINACEAE, RHODOPHYTA) POOLS IN EXPOSED SHORES AT RÍA DE MUROS (GALICIA, NW SPAIN)**

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A study of phenological variations in midlittoral shallow pools, on granitic substrate, was carried up at Pta. Insua (Carnota, Galicia, NW Spain) during 3 years. This study allowed the observation of succession changes during this period too.

These observations allow to describe the following phenological changes:

-Winter: is remarkable the abundance of *Scytosiphon simplicissima*, mainly on the limpet shells. The biomass of *Corallina elongata* has a strong decrease because its hemiphanerophytic life form.

-Spring: there is an important increasing of Ulvaceae, mainly *Enteromorpha compressa* and *Ulva rigida*. Nearly all *E. compressa* fronds were growing on limpet shells.

-Summer: *Dictyota dichotoma* and *Codium tomentosum* are the most conspicuous species which develop in this season; the first species was found growing as pulvinate tufts.

-Autumn: *Enteromorpha compressa* rises again abundant on limpet shells.

The community is controlled through herbivores grazing, mainly by *Paracentrotus lividus*. There are large areas controlled by the grazing of *Patella aspera* and *P. depressa*; a lower grazing control is carried up by Trochidae. The establishment and posterior growth of *Corallina elongata*, allow the fixation of *Mytilus galloprovincialis*.

The community structure was maintained stable during these 3 years. The only important changes were the variations in abundance of *Mytilus galloprovincialis*. This mussel arised its greater cover degree during April-May 1994, getting a maximal cover during June 1994, with a drastic disimintion in the two following months.

**CHARACTERISATION OF THE SURFACE SEDIMENTS OF THE CONTINENTAL SHELF AND UPPER SLOPE BETWEEN ESPINHO AND AVEIRO (1)**

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The study of samples from the Portuguese continental shelf and upper slope between Espinho and Aveiro was based on sediment texture and composition, as well as on morphoscopic characteristics of particles. The sediment cover of the studied area is predominantly sandy. The sediment distribution pattern of this shelf seems to be related with paleo litorals presently found in the mid shelf and in the outer shelf, with an important present and past sediment supply by litoral drift and with the efficiency of the Aveiro lagoon as a trap for fine-grained sediment, among others. Different sedimentary deposits were detected and mapped (fig. 1), some of which are apparently connected with rocky outcrops. According to the scheme proposed by MCMANUS (1975), nearshore deposits, the muddy complex of the heads of the Porto submarine canyon and the northern shelfbreak and upper slope deposits are neoteric sediments, with a slight amphoteric tendency. Gravely deposits, the outer shelf relict deposits and the southern shelfbreak and upper slope deposits are palimpsest sediments, the gravely ones having a strong relict tendency. The Aveiro gravely sand deposits and the outer shelf sandy deposits are proteric sediments. Deposits connected with the Pontal da Cartola rocky outcrop are amphoteric sediments.

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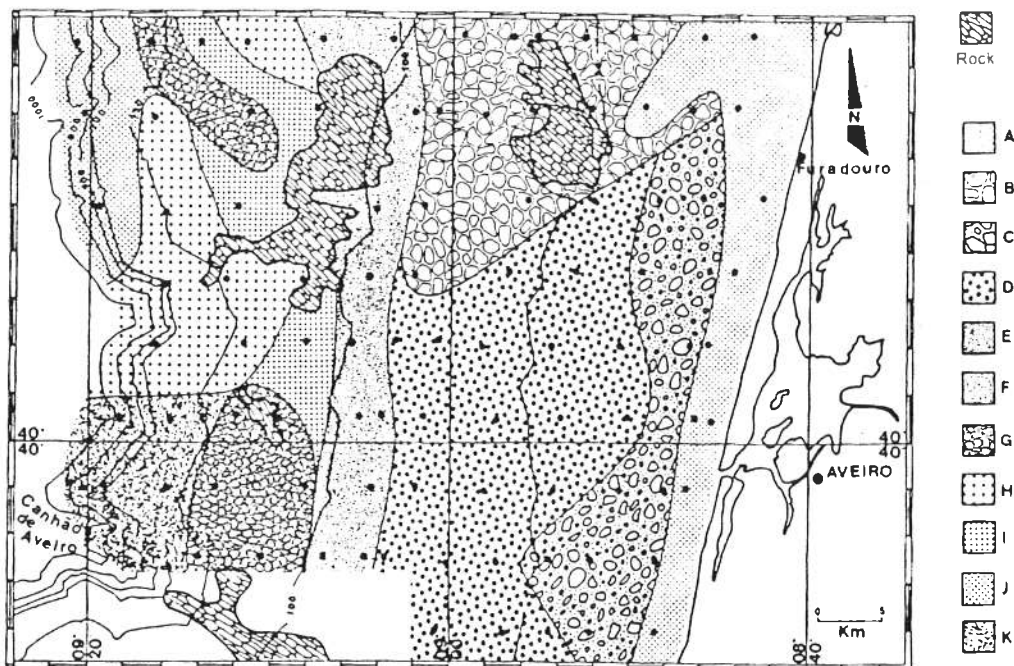


Fig. 1 - Distribution of sedimentary deposits. A - Nearshore deposits; B - Pontal da Galega gravely deposits; C - Aveiro gravely sand deposits; D - Aveiro mid shelf gravely deposits; E - Pontal da Cartola fine deposits; F - Muddy complex of the heads of the Porto submarine canyon; G - Outer shelf relict deposits; H - Pontal da Cartola ravine deposits; I - Outer shelf sandy deposits; J - Northern shelfbreak and upper slope deposits; K - Southern shelfbreak and upper slope deposits.

### RECENT PLANKTONIC FORAMINIFERA FROM THE WEST IBERIAN MARGIN: PRELIMINARY RESULTS (1)

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1) - DISEPLA Group contribution nº C100.

2) - Boleira de Mestrado - JNICT/ Museu Nacional de História Natural (Miner. e Geol.)

The paleoenvironmental studies undertaken at the Western Iberian margin are extremely important, since this can be considered a crucial area when it comes to researching polar front migrations' influence on sedimentary records, and its particular structural setting, as well as sediments distribution.

However, there is still a lack of information relating such matters, therefore additional research is required to improve the available knowledge concerning the dynamics of this area.

The Western flank of the Galicia Bank is to be taken into account, when it comes to interesting marine sedimentation study spots, suffering from a quite ineffective input of terrigenous particles of continental origin.

An important key to the study of past oceanographic conditions is the description and identification of microfossil assemblages in surface sediments, and the relation of these associations to modern water masses and current distribution.

Based on ninety samples obtained from two deep-sea cores, recovered at depths of 2220 and 3482 metres during the "NORESTLANTE III" scientific cruise (1<sup>st</sup> leg) - which was promoted by IFREMER on board the french oceanographic vessel "Jean Charcot" in 1989 -, thirty-five different species of planktonic foraminifera were identified in the fraction over 125 µm of these foram-rich deposits. From which only two specimens of *Globigerinoides primordius* are deemed to have been carried to the coring site, since they are not represented among the actual microfauna.

These organisms were grouped into three distinct assemblages, according to their distribution on the superficial sediments, so as to provide a mean of relating the species disposition with their distribution along the deposits history, as well as to stress the observed contrasts between glacial and interglacial faunas.

Therefore, a subarctic assemblage, a temperate assemblage and a cold-subtropical assemblage were defined:

- The subarctic assemblage is mainly characterized by dominance of the left coiling *Neogloboquadrina pachyderma* - accounting for 60 to 90% of the fauna - over all other species, including its own right coiling form, *Globigerina bulloides*, *Globorotalia inflata* and *Turborotalita quinqueloba*.

- The temperate assemblage includes species such as *Neogloboquadrina pachyderma*, mainly represented by its right coiling form (about 20 to 35%), *Globigerina bulloides*, *Globigerinita glutinata*, *Turborotalita quinqueloba*, *Globorotalia inflata* and *Globigerinella aequilateralis*; though in minor quantities one may also come upon less frequent species like *Globorotalia scitula*, *Globorotalia hirsuta* and *Globorotalia truncatulinoides*, as well as *Orbulina universa*.

- Few subtropical species were also identified; not only *Globigerinoides ruber*, *Globigerinoides immaturus*, *Neogloboquadrina dutertrei* and *Globigerinoides sacculifer*, but also *Globigerina rubescens*, *Globigerinoides conglobatus*, *Turborotalita humillis* and *Turborotalita cristata*, although these were scarcer than the rest.

The establishment of a biostratigraphic scale, based on the major species associations, implied a correlation, not only between their distribution - assuming that the species concerned have not changed their environmental requirements with time -, and the presence of less representative species, but also, between the carbonate content of the deposits, and the degree of dissolution presented by some shells and the existence, in some layers, of terrigenous ice-rafted particles.

On the whole, it was possible to suggest the presence of a succession of warm and cold climatic events - being the latter, usually associated with intensive dissolution, that becomes less evident during the warm periods -, roughly comparable to the isotopic stages defined with greater accuracy by numerous investigators through the analysis of  $\delta^{18}O$  and  $\delta^{13}C$  data.

**COMPARISON OF AGONISTIC BEHAVIOURS IN LEPADOGASTER LEPADOGASTER PURPUREA (BONNATERRE, 1788), GAIDROPSARUS MEDITERRANEUS (LINNAEUS, 1758) AND DIPLODUS SARGUS (LINNAEUS, 1758)**

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This work presents the preliminary results from an agonistic behaviour study in *Lepadogaster lepadogaster purpurea*, *Gaidropsarus mediterraneus*

and *Diplodus sargus*, resident species or frequent visitors of rocky shores.

The three species present different degrees of association with the substrate, *L. lepadogaster purpurea* being typically benthic fish while *D. sargus* is a more pelagic species.

The comparison of agonistic behaviours in the three species shows that the details of the concerned behavioural patterns are strongly influenced by each species anatomy and swimming patterns. Consequently, any factors affecting the relationship with the substrate also affect agonistic behaviour patterns structures.

**LIVING RESOURCES. RESEARCH AND PROTECTION IN CLOSE COOPERATION : PORTUGAL - SPAIN - E.U.**

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The communication is related with the experience of the author during more than 20 years of active research in the Iberian Margin, in the fields of hydrography, oceanography, marine biology and marine environment. The need of a more closed cooperation Portugal - Spain and E.U. in what concerns the protection of the living resources in the Iberian Margin, is the main objective of the communication. Special attention will be given to the oceanographic cooperation made before, in the aim of Portugal, Spain, EEC and OTAN joint research programs, as terms of reference, looking to a much more knowledge of the marine ecosystem on the Iberian Margin.

**RECONSTRUCTING SEDIMENT TRANSPORT MECHANISMS AND DATING SILICICLASTIC SEDIMENT INPUT IN A CORE FROM THE NORTHERN PORTUGUESE MARGIN: A STUDY WITHIN THE FRAMEWORK OF THE ENAM PROGRAMME**

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Sediment gravity cores were collected along the Portuguese continental margin in order to reconstruct sedimentary transport processes and fluxes during the Late Quaternary within the framework of the MAST II sponsored programme ENAM (European North Atlantic Margin). The initial results on the stratigraphy and sedimentology of a core from the northern Portuguese margin (41.488°N, 9.721°W) will be presented. Emphasis will be laid on the origin of silty and sandy siliciclastic beds within the core. For



this purpose, the sedimentary structures, grain size, and mineralogical composition were analysed and compared for various beds. Three bed types were distinguished, interpreted as contourites, turbidites, and beds rich in ice-rafted debris (IRD). IRD-beds lack grading, contain numerous scattered lithoclasts, and have distinct mineralogical distributions, including large amounts of terrigenous dolomite clasts. Furthermore, they are characterised by relatively high concentration of *N. pachyderma* (sin). The IRD-beds are interpreted as Heinrich event beds, signifying rapid break-up of the Laurentide ice sheet and transport of huge amounts of icebergs across the North Atlantic Ocean. Contourites often have a gradual base and top, a uniform grain size distribution and relatively low amount of fine-grained sediment. They are probably related to an increase in intensity of Mediterranean Outflow Water along the Portuguese margin. Turbidites dominantly have a sharp base with a lag deposit, and typical graded sequences of structures. They are likely to originate from the Portuguese shelf. Both contourites and turbidites lack terrigenous dolomite.

A preliminary stratigraphy was established by tuning stable isotopic and magnetic susceptibility values with nearby cores of known stratigraphy in order to establish the ages of the sand/silt beds. The analysis confirmed the presence of Heinrich event beds in the studied core. Average sedimentation rates are of the order of 6 cm/kyr.

### DISTRIBUTION AND ECOLOGY OF SIPHONARIA PECTINATA (GASTROPODA, SIPHONARIIDAE) IN GALICIA (NW SPAIN)

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*Siphonaria pectinata* (Linné, 1758) is a patelliform pulmonate, distributed along Mediterranean and near Atlantic coasts.

In the coasts of Galicia, it was only abundantly found in the shores between the localities of Baiona and A Guarda (Ría de Vigo, Pontevedra, NW Spain), with several cyclical variations in its abundance (ROLAN, 1983).

Besides this small area, there are not more records for this species in Galicia.

During the last years, some specimens were found at Ría de Pontevedra, as well as in the shores between Monte Louro and Finisterre; these localities represent its northern known distribution limit. The species is scarce at all these localities, and its presence is under strong variations, perhaps because local climatic

conditions, which allow the dispersion and establishment of its larval stage; however, the establishment of the species is highly limited. This population dynamic clearly indicates a limit of its distribution range, which delimitation is unclear.

In Galicia, *S. pectinata* is characteristically found in photophilic rocky pools, from supralittoral fringe to upper littoral. In these pools, it lives with *Patella depressa*, *P. aspera*, *Monodonta lineata*, *M. colubrina*, *Littorina saxatilis*, *L. neritoides* and *Gibbula umbilicalis*, among others. All these are herbivorous gastropods, competitors with *S. pectinata*; therefore, this could explain the lack of its permanent establishment.

### ZONACION DE LA VEGETACION BENTONICA MARINA EN LA RIA DE A CORUÑA (N.O. DE ESPAÑA)

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En las costas del noroeste de la Península Ibérica han sido estudiadas la flora y vegetación de la mayoría de las rías. De norte a sur, existe información, total o parcial, de tramos de costa como Burela (POLO *et al.*, 1979), ría del Barquero (FISCHER PIETTE & SEOANE CAMBA, 1962), ría de Cedeira (PÉREZ-CIRERA, 1975), ría de Ferrol (GRANJA, 1992), ría de A Coruña (BÁRBARA, 1993), ría de Corme-Laxe (PÉREZ-CIRERA, 1976), costa de Camelle (PÉREZ-CIRERA & MALDONADO, 1982), ría de Camariñas (FISCHER PIETTE & SEOANE CAMBA, 1963), ría de Lires (PÉREZ-CIRERA & PACHECO, 1985), ría de Muros (OTERO-SCHMITT, 1993; LÓPEZ RODRÍGUEZ, 1994), ría de Arousa (DONZE, 1968), ría de Pontevedra (MIRANDA, 1934; NIELL, 1977; LÓPEZ RODRÍGUEZ, 1994), ría de Vigo (ARDRE, 1957; SEOANE-CAMBA, 1960 y NIELL, 1977) y ría de Bayona (BESCANS, 1948). La ría de A Coruña había sido explorada únicamente desde el punto de vista florístico por LANGE (1860), SAUVAGEAU (1986, 1987) y BESCANS (1948). Actualmente disponemos de abundantes datos de su flora y vegetación, al haber sido catalogadas 340 especies, y descritas 70 comunidades de algas marinas.

La ría de A Coruña se localiza en la parte central del noroeste de la Península Ibérica, y se caracteriza por su orientación al norte, su tamaño medio con respecto a otras rías gallegas (45 km de línea costera) y por la diferenciación de materiales geológicos en los márgenes de la ría (granitos al este y esquistos al oeste). En ella se pueden distinguir dos zonas manifiestas: una de orientación norte hacia mar abierto, con gran influencia de agua oceánica, en la que predominan los acantilados rocosos expuestos al oleaje, y otra interna o de estuario en la que es menor la renovación de agua, y en la que dominan los

sustratos arenosos y fangosos. En función del grado de exposición al oleaje se pueden establecer cuatro sectores: expuesto, semiexpuesto, protegido y de estuario.

En esta comunicación, se presentan, de manera gráfica y resumida, las principales catenas o modelos de zonación de algas bentónicas marinas, existentes en la ría de A Coruña y se comparan con los descritos para otras zonas del noroeste Peninsular. La comunicación se completa con un tabla en la que aparecen reflejadas las especies más frecuentes y características de cada cintura de vegetación, en relación con su presencia o ausencia en los horizontes litorales, así como en los cuatro sectores de la ría.

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A NUMERICAL METHOD FOR RESOLUTION OF TWO-DIMENSIONAL SHALLOW-WATER EQUATIONS.

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In this communication the two dimensional shallow water equations are solved by using a numerical scheme implicit in time and finite elements of Raviart and Thomas for space discretization.

The nonlinear discretized problem is solved by duality iterative algorithm. Numerical results are presented for an application to the simulation of tidal currents in the "ría de Vigo" (Galicia. Spain).

FAUNA Y FLORA BENTONICAS DE LA RIA DE FERROL (NW DE ESPAÑA): MEIOFAUNA SUBLITORAL

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En la presente comunicación se recopilan los datos obtenidos a partir de las muestras recogidas desde Febrero de 1983 a Abril de 1985 en una estación infralitoral (12 m de profundidad) de "arena de Amphioxus" ubicada en la Ría de Ferrol. Las muestras se recogieron mensualmente durante el primer año y estacionalmente durante el segundo, con el fin de conocer su composición meiofaunística así como las variaciones producidas en la misma a lo largo del año.

Se aislaron del sedimento únicamente los invertebrados no Artrópodos, reuniéndose una colección de 3.899 individuos, pertenecientes a 12 taxones, 9 de ellos identificados a nivel específico: Esponjas (3 especies; 4 ejemplares), Cnidarios (4 especies, 35 ejemplares), Turbelarios (103 ejemplares), Nemertinos (47 ejemplares); Nematodos (916 ejemplares), Aplacóforos (12 ejemplares de la misma especie); Gasterópodos (12 especies, 769 ejemplares), Poliquetos (48 especies, 1935 ejemplares), Sipuncúlidos (9 ejemplares de una sola especie). Asimismo, se identificaron un total de 7.336 ejemplares de Foraminíferos, pertenecientes a 63 especies, si bien no se diferenciaron los individuos vivos de los caparzones.

Como consecuencia del estudio faunístico se realizan una serie de consideraciones acerca del hábitat y la distribución de las 136 especies tratadas; así, 13 de ellas se mencionan por primera vez en este tipo de sedimento (arenas conchíferas), 6 son novedad para el litoral ibérico, 21 para las costas atlánticas europeas y peninsulares, 30 para el litoral gallego y 10 presentan en nuestras costas un nuevo límite de distribución; asimismo, 2 especies se citan por primera vez fuera de sus localidades típicas.

En cuanto a la evolución temporal, los Poliquetos constituyen el grupo dominante tanto en los que se refiere a su abundancia total como mensual; estacionalmente se observa un aumento del número total de individuos en invierno.

En lo que se refiere a la distribución vertical, no parece existir una pauta de comportamiento definida, si bien la presencia de especies desciende con la profundidad. Los grupos mayoritariamente representados y la presencia constante durante todo el año, ocupan en verano y primavera las capas superficiales del sedimento, alcanzando en el invierno sus máximos valores en la capa más profunda.

#### FAUNA Y FLORA BENTONICAS DE LA RIA DE FERROL (NW DE ESPAÑA): MEIOFAUNA INTERMAREAL

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Dos proyectos de investigación (XUGA8430189 *A fauna intersticial da Ria de Ferrol* y el Convenio de Seguimiento del petrolero "Aegean Sea") soportan la financiación del estudio de la meiofauna intermareal de la Ría de Ferrol desde 1990; sus objetivos son, para el primero, el cartografiado de la meiofauna en la ría y, para el segundo, el impacto producido por la marea negra provocada por el accidente del petrolero *Aegean Sea*, así como una comparación con el estado de la ría antes del siniestro.

Para la realización de ambos proyectos se recogieron un total de 152 muestras, conseguidas en 19 localidades, visitadas en repetidas ocasiones. Del estudio de la meiofauna presente en 48 de estas muestras (6 localidades) se obtuvieron los datos que se exponen en la presente comunicación. Se trata de una colección de 9.196 ejemplares pertenecientes a 15 taxones: Foraminíferos (937 ejemplares); Cnidarios (2 ejemplares), Turbellarios (390 ejemplares), Nemertinos (11 ejemplares), Gastrotricos (27 ejemplares); Quinorrincos (1 ejemplar), Nematodos (5.852 ejemplares), Poliquetos (504 ejemplares), Sipuncúlidos (3 ejemplares), Gasterópodos (2 ejemplares), Bivalvos (2 ejemplares), Isópodos (19 ejemplares), Copépodos Harpaticóideos (1.511 ejemplares), Ostrácodos (124 ejemplares) y Acaros (11 ejemplares).

Del estudio global de estos datos, para obtener una primera información acerca de la composición faunística de las comunidades, se puede establecer que el grupo dominante son los Nematodos, que representan algo más de la mitad de la comunidad. Dos taxones ocupan los lugares segundo y tercero en la escala de dominancia: Copépodos Harpaticóideos y Foraminíferos; esta situación, para el primero de ellos, con frecuencia, mencionado por otros autores, mientras que el segundo grupo no acostumbra a ser citado en los estudios de meiofauna, probablemente por su condición de seres unicelulares. Turbellarios y Poliquetos se sitúan a continuación, con valores sensiblemente más bajos, mientras que los restantes taxones escasamente alcanzan el 1 % del total de las muestras.

#### BIOLOGICAL CHARACTERISTICS OF THE PLANKTON ASSOCIATED TO A SHELF-BREAK FRONT OFF THE GALICIAN COAST

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A large (> 900 nm<sup>2</sup>) phytoplankton-rich patch (> 200 mg Chl-a m<sup>-2</sup>) was found off the NW Galician shelf in May 1994. On the shelf side, it was limited by a density front which separated thermally stratified oceanic waters from vertically mixed coastal waters. The structure was observed for several days, having a complex topology which suggest strong influence of hydrodynamic processes. The bulk of phytoplankton biomass sank approximately 15 meters in two days, probably as a consequence of the combined effects of convergence of surface currents near the shelf break and bloom decaying. There were several indicators of the decline of the phytoplanktonic populations: high phytoplanktonic biomass and low nutrient concentrations, along with low chlorophyll-specific carbon fixation rates and shallow euphotic layers. High nutrient concentrations, particularly nitrate and nitrite, were characteristic of the layers below the chlorophyll maximum, suggesting rapid recycling of the organic matter. The phytoplankton species characteristic of the patch were chain forming diatoms, and also cyanobacteria (especially abundant at the shelf-break). The zooplankton biomass was very variable through the area, having the coastal zone the highest values, mainly because the contribution of mesozooplankton (200-1000 µm), whereas both macrozooplankton (> 2000 µm) and microzooplankton (40-200 µm) dominated the biomass distributions at the oceanic side of the front. Further studies are being made to ascertain the implications of this structure,

and similar ones reported for the NW Spanish shelf, in the regional biogeochemistry of carbon and the efficiency in the transfer of organic matter through the food-web, particularly in relation to pelagic fisheries.

### OIL SPILLAGE IN THE NORTHERN COAST OF PORTUGAL - FIRST RESULTS OF THE IMPACT ON THE INTERTIDAL ECOSYSTEM

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On October 2nd 1994 the Panamanian registered tanker Cercal collided with a rocky formation off the west pier of Leixões oil terminal (Northern coast of Portugal). About 2,000 metric tonnes of Arabian light crude were spilled into the sea. Soon after the accident the tanker was towed to deeper waters and immobilised 13 nautic miles from shore. About 48 hrs later the oil slick splitted in two, the largest portion with a surface area of 313 km<sup>2</sup>, and washed ashore. Although the slick contaminated about 45 km of rocky littoral, only two zones were severely affected, namely Lavadores beach, 2.3 km south the River Douro mouth and Leça beach, north of Leixões port. To this situation certainly contributed the development of upwelling of coastal waters induced by strong prevailing winds from land during several days. The salinity and phosphate contents increased slightly during the first ten days. Nevertheless primary productivity was reduced and coastal phytoplankton showed a high rate of chlorophyll degradation, up to 99%. Oxygen concentration decreased but CO<sub>2</sub> levels increased. The weeds community was strongly affected particularly the sea lettuce (*Ulva lactuca*), wrack (*Fucus sp.*) and kelp (*Laminaria digitata*). Despite the disadvantages of the high concentration of crude, apparently *Enteromorpha sp.*, a green algae, and *Gelidium sp.* as well as *Gigartina stellata*, both red seaweeds, were more resistant. On the other hand, scores of dead large-sized common mussel (*Mytilus edulis*) were washed ashore in the more contaminated areas. Barnacles (*Balanus sp.*) and limpets (*Patella sp.*) showed survival difficulties. Although a large stretch of the northern coast of Portugal was affected by oil spillage, after a 3-week period the entire ecosystem showed some signs of recovery. Nevertheless, accidents such the one occurred off the second large port of Portugal poses a major long-term threat.

### THE NEOGENE & QUATERNARY STRATIGRAPHY IN CENTRAL ALGARVE A CRITICAL REVIEW AND NEW PROPOSALS

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The stratigraphy of Neogene to Quaternary deposits in Algarve received until now attention of several authors. However the positioning of stratigraphic boundaries within sedimentary series cropping out in the coastal fringe of Southern Portugal remains an open question. According to ANTUNES et al. (1990) the lowermost Tertiary unit is the Neogene, Lagos - Portimão formation lying discordantly on Mesozoic substratum. The pectenacea studies carried out by FERREIRA (1951) Lagos - Portimão formation could be attributed to Serravalian age. The studies of ANTUNES et al. (1981) indicated mostly Burdigalian age, obtained from foraminifera studies. On top of this predominantly carbonatic, bioterritic sediments the same author positioned directly suprajacent calcareous sandstones and the Olhos de Água sands in which age indicating *Charcharocles megalodon* (shark) teeth were found. Their Langhian - Serravalian age was also indirectly deduced from K - Ar dating of the overlying Oura - Galé silts (ANTUNES et al. 1984) which gave 10.1 +/- 0.25 Ma. The Neogene sedimentation in Algarve terminates according to the same author by the deposition of silts and conglomerates of Cacela Formation. Our recent studies carried in the Galé - Olhos de Água coastal segment brought new elements which place the whole Neogene sequence in narrower time span. The presence of *Chlamys scrabiscula* (Matheron) found in fossiliferous limestones in Galé is strongly in favour of Langhian/ Tortonian age of Lagos - Portimão formation and the similar opinion (Langhian / Serravalian) was supported by CACHÃO (1992). The presence of *Chlamys Varia* (Linné) in the topmost part of carbonatic sequence of São João cliff is convincing indicator that the discussed sedimentary sequence could be terminating already in Pliocene. We believe that the Tortonian age of overlying Galé - Oura silts is doubtful because of complete lack of glauconitic component observed in this sediment exposed in more than 2 km coastal segment, notwithstanding the possibility of simple disappearance of glauconites through erosion of the cliffs (in fact observed). Also the reliability of radiogenic dating applied to the glauconites younger than Oligocenic is not in favour of the existing data. These silts are overlaid in Oura by the silcarenite also observed in Olhos de Água cliff and which is rich in oysters, barnacles and contain *Palliolulum excisum*. Its foraminifera assemblage (BOSKI et al. 1993) is indicating an Upper Pliocene age, also supported by paleomagnetic studies carried out in the same profile. The presence of shark teeth like *Isurus sp* and *Carcharocles megalodon* in underlying Olhos de Água sands may not be indicative

of their age, because all fossils originate from thin gravel layer (tempestite) from below sandstone and bear traces of transport and eolisation. Besides the purely stratigraphic evidence, it must be also remembered that there is no facial transition between calcarenites and sands like suggested by Antunes & Pais (1993) but rather tectonic contact marked by disappearance of calcarenites to the East of Olhos de Água. A proposed tentative terminal Miocene - Pliocene age of these sediments is in agreement with arguments presented by CACHÃO (1992). The topmost 10 - 15m of the sedimentary sequence as observed between Galé and Olhos de Água are exposed as fluviomarine deltaic series (see article of the authors in this volume) bearing high content of ferruginous pigments which frequently are redistributed throughout the whole cliff profile by percolating ground waters. The iron oxides should be treated therefore as a significant stratigraphic feature only in relation to its original horizon.

This study was possible thanks to support of JNICT within STRIDE AMB C/31/92 Project.

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### SADO ESTUARY COASTAL WATERS: THERMOHALINE PROPERTIES AND CHEMICAL COMPOSITION

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Sado estuary coastal waters were investigated in terms of their chemical structure during the productive period, in two occasions, April and August of 1993. Based on meteorological data, thermohaline properties and chemistry no active upwelling was detected. Associated with this situation two well differentiated water masses were identified: a nutrient-poor surficial layer and a nutrient enriched water mass, which was assumed to be the upper part of the Eastern North Atlantic Central Water (ENACW).

Some impact from the estuary was noticed near the estuary mouth northwards along the coast, particularly relative to levels of phosphate, nitrate and ammonia and amounts of suspended particulate matter.

### SWELL ANALYSIS BY REMOTE SENSING ON THE PORTUGUESE COAST.

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The aim of this work is the analysis of the swell on a **Spot image**. The image covers a coastal zone of the Portuguese Coast which stretches from Ponta da Lamporeira to Lagoa de Albufeira. It shows, among other things, the Cabo da Roca, the Tagus Estuary and the sandy bars of beaches between Costa da Caparica and Lagoa de Albufeira.

We employ the **Fourier Transform** to represent all the sea surface wavelengths. By filtering the **Fourier Spectrum**, we obtain a simplified swell, more easily identifiable. We apply other image processing treatment to improve the visual appearance of the results (binarization, skeletonisation).

The figures 1 and 2 show the swell before and after the treatment.

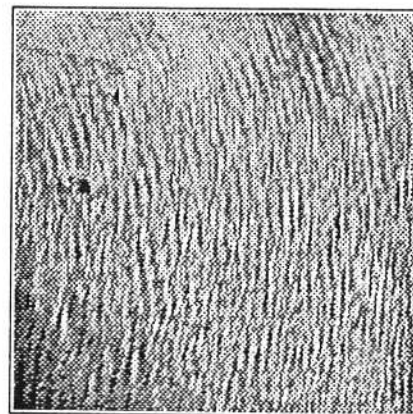


Figure 1.

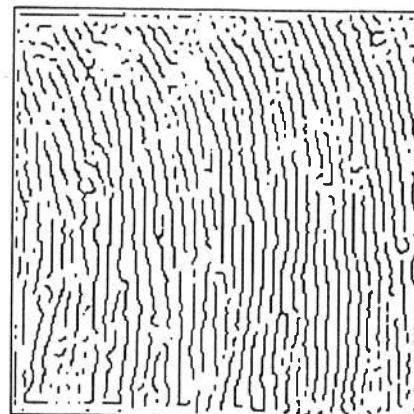


Figure 2.

Afterwards we draw the crests and the normals to the crests (Fig. 3).

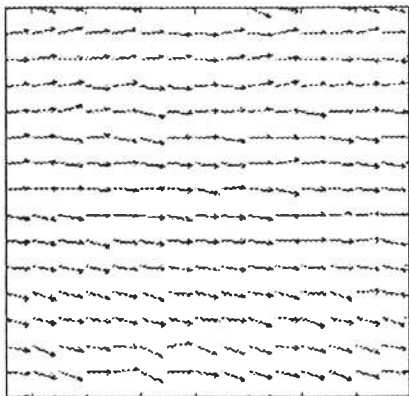


Figure 3

We compare our results with the results from a mathematical wave model.

### QUATERNARY CALCAREOUS NANNOFOSSIL ASSEMBLAGES AND TIME SERIES FROM IBERIAN OCCIDENTAL MARGIN

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Here we present preliminary results from the project JNICT nº 743/90 - "*Microfloras da margem ocidental ibérica. Implicações (paleo)climáticas e (paleo)ecológicas*" in what concerns the coccolith component of surface bottom samples from distinct sectors of portuguese occidental and meridional shelf and of two piston cores from Galicia Bank, offshore Vigo. This project aimed to give continuity to a more general endeavour which is concerned with the paleoecological and paleoenvironmental potential of nannoliths near high productive shelf areas such as occidental Iberian margin.

In a first step we studied several samples from inside Tagus estuary (*LNEC - Dep. Hidráulica*) at progressively larger inward distances from its river mouth. The results confirmed the presence of coccoliths in bottom samples also showing a more or less gradual decrease in their relative abundance towards upstream. Together with previous data retrieved from portuguese lagoonal systems, these results confirm the potential of coccoliths as natural tracers of marine influence inside transitional environments. In the future we hope to use coccoliths in paralic facies to reveal the open/close rhythms of an inlet system, to identify and/or confirm the past existence of singular destructive events such as *tsunamis* or, for larger time scales, to record sea level changes.

In a second step the coccolith content of groups of bottom samples from four distinct sectors of portuguese shelf [Charts IH 150.000 nº 1, 5, 6/7 and 7)

where determined. The obtained data matrix was subsequently studied by Factorial Analysis which R mode factor diagrams showed that was possible to distinguish between each sample cluster by means of their coccolith assemblages. This result shows first that iberian occidental margin is influenced by distinct water masses with different Coccolithophore assemblages; secondly that the coccolith content from shelf bottom samples can be used to monitor relative changes in the circulation pattern of these water masses.

From the results of this study was also possible to confirm the existence, in the southern sector, of an intense erosional process with rework of silty-clay dimensional particles (such as coccoliths in general) along an extensive sector (from at least offshore "Ria Formosa" to Portimão canyon, between -200 and -500 m depth). This erosion is ascribed to a septentrional contourite branch of the mediterranean anti-estuarine deep flow. Due to the Eocene age of a large majority of the reworked forms found in this sediments, and since no sediments of this age are expected to outcrop in the portuguese sector of the continental margin, this evidence points to an extensive transport of silty-clay sediments from Spanish meridional sectors such as the Guadalquivir bank and/or the Gibraltar strait.

72 one mile-interval samples recovered from an homogeneous bottom sediment sector of northern portuguese shelf ("*Complexo silto-argiloso a oeste do Douro*") allowed us to test the robustness of the counting procedure used in *rippled* smear slide studies, and the meaningfulness of the relative abundance countings performed on them. Together with a "natural" variability in certain coccolith percentage abundances we found unexpected and interesting behaviours in the bottom record of *Emiliania huxleyi* and *Coccolithus pelagicus* which points out to an yet not quite understood variability in oceanographic conditions which are able to selectively control some Coccolithophore species but not others.

In a third step two offshore piston cores from "*Banco da Galiza*" (42° latitude), N3KF21 ("21") and N3KF24 ("24") where studied. Although these two cores were retrieved from closed sites they revealed quite distinct sedimentary rates: core 21, with approx. 4.5 m, reached isotopic stage 11 (~400 Ky) while core 24, with approx. 3.5 m, registered only till stage 3 (~50 Ky). This fortunate circumstance allowed us to confirm and detail (the entire core 24 time series is equivalent to the topmost 30 cm of core 21) the behaviour of several Coccolithophore species during recent Quaternary. The results shows that:

- i) There was a significant decrease in coccolith abundances as well as an inversion in the small *Gephyrocapsa* / *E. huxleyi* ratio during the first phase of the last deglaciation (Termination IA);
- ii) The relative abundances for core 24, between *Gephyrocapsa oceanica* and *Gephyrocapsa muelleriae* shows an interesting behaviour during last deglaciation. While *G. oceanica* (a present day



warmer water masses indicator) keeps with low values, *G. muelleriae* reveals a first drop (from around 60-70% to 30%) during Termination IA, then recovers during *Younger Dryas event* (reaching 50%), to decrease again (Termination IB) to around 10%. Meanwhile *G. oceanica* slowly increases its abundances until it matches *G. muelleriae* abundances, for the last 5 to 6 Ky (which characterizes present day situation). Although these warm and cold water indicators follows a pattern that was expected to occur, their behaviour is more difficult to understand when extrapolated further into the past. In fact, during glacial isotope stage 8 *G. oceanica* is more represented than *G. muelleriae* which should be interpreted as a stronger influence of warm waters at our latitudes; does this reflect some sort of "Gulf stream paradox"?

iii) The relative frequencies of *Calcidiscus leptoporus* and *Coccolithus pelagicus* shows periods of both covariation and antivariation difficult to explain unless we consider that *C. pelagicus* paleobiogeographic distribution is controlled by specific oceanographic conditions, somehow related with present day downwelling NADW formation system ?

## DISTRIBUIÇÃO E ABUNDÂNCIA DE PEIXES NA COSTA PORTUGUESA

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O Instituto Português de Investigação Marítima (IPIMAR) iniciou, em 1979, um programa de cruzeiros de investigação dirigido ao estudo da abundância e da distribuição de espécies capturáveis por arrasto de fundo. No período 1990-1993, este programa foi integrado no Projecto FAR 1.203 MA.

Apresentam-se resultados para o período 1990-1992 relativos à distribuição e abundância de: Pescada (*Merluccius merluccius*), Carapau (*Trachurus trachurus*), Cavala (*Scomber japonicus*), Sarda (*Scomber scombrus*), Areeiros (*Lepidorhombus boscii* e *L. whiffiagonis*), Esparídeos (*Diplodus vulgaris*, *Dentex macropthalmus*, *Sparus aurata*, *Pagellus spp.*, *Pagrus pagrus*, *Boops boops*, *Sponyllosoma cantharus*), Verdinho (*Micromesistius poutassou*) e Apará-lápis (*Macroramphosus scolopax*).

As principais conclusões foram subdivididas em quatro tópicos - níveis médios de abundância, variações espácio-temporais da distribuição e da abundância, padrão de distribuição geográfica e padrão de distribuição batimétrica - e as espécies agrupadas de acordo com as suas características em cada um destes tópicos.

### Níveis médios de abundância

Muito elevado - rendimentos médios por cruzeiro superiores a 350 kg/hora - APARA-LÁPIS

Elevado - rendimentos médios por cruzeiro entre 20 e 90 Kg/hora - CARAPAU, VERDINHO

Médio - rendimentos médios por cruzeiro entre 5 e 15 Kg/hora - PESCADA, ESPARÍDEOS

Reduzido - rendimentos médios por cruzeiro entre 1 e 3 Kg/hora - SARDA, CAVALA

Muito reduzido - rendimentos médios por cruzeiro inferiores a 1 Kg/hora - AREEIROS

### Variações espácio-temporais da distribuição e abundância

Tendência decrescente acentuada na abundância de PESCADA (desde Outubro 1991), AREEIROS e VERDINHO (desde Outubro de 1990).

Tendência crescente na abundância de CARAPAU, CAVALA e ESPARÍDEOS (desde Julho de 1991).

Aumento muito acentuado na abundância de APARA-LÁPIS (quaduplicou entre Julho 1990 e Julho 1992).

Para PESCADA, CARAPAU, SARDA, CAVALA, AREEIROS e VERDINHO não se observam variações na distribuição geográfica.

A área de distribuição do APARA-LÁPIS expandiu-se gradualmente para norte.

### Padrão de distribuição geográfica

Distribuição ampla (recursos distribuídos ao longo de toda a costa) - PESCADA, CARAPAU, VERDINHO, AREEIROS e APARA-LÁPIS (desde 1990).

Distribuição setentrional (recursos distribuídos preferencialmente a norte do Cabo Carvoeiro) - SARDA.

Distribuição meridional (recursos distribuídos preferencialmente a sul do Cabo Carvoeiro) - ESPARÍDEOS e CAVALA.

### Padrão de distribuição batimétrica

Recursos distribuídos preferencialmente na plataforma continental - CARAPAU, SARDA, CAVALA, ESPARÍDEOS e APARA-LÁPIS.

Recursos distribuídos na plataforma continental e no talude - PESCADA, VERDINHO e AREEIROS.

## EVOLUCION DE LOS APORTES CONTINENTALES A LA PLATAFORMA EN EL NORTE DE LA PROVINCIA DE CADIZ DESDE EL PLIOCENO A LA ACTUALIDAD.

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En el litoral norte de la provincia de Cádiz, en la actualidad, depositan sus sedimentos dos importantes cauces fluviales: el Guadalquivir (cuya desembocadura se sitúa en el límite con la provincia de Huelva) y el Guadalete. Esta geografía es bastante reciente y ha estado regida por la neotectónica, la cual ha jugado un papel esencial en la configuración del litoral gaditano (Benkhelil, 1976).

Los diferentes estudios realizados en los depósitos arenosos (DRX, microscopía óptica, etc.) han puesto de manifiesto la existencia de tres tipos muy diferentes de arenas, tanto en composición como en procedencia, que han llegado a la cuenca por diferentes mecanismos:

- En el sector Jerez-Lebrija los materiales, de edad Plioceno superior, fueron aportados por un aparato deltaico que progradó hacia el sur ocupando zonas más meridionales. La composición de estas arenas está en la serie arcosa lítica-subarcosa, presenta abundantes fragmentos de rocas ígneas y metamórficas y una asociación de minerales pesados formada por andalucita, estauroлита, epidota+turmalina (And, St, Ep+Tur).

- Cauces fluviales procedentes del E y SE, originados en los relieves recientemente emergidos, transportaron las arenas silíceas de la zona Arcos-San José del Valle con una asociación de minerales pesados ultraestables: circón, turmalina y rutilo (Zrn, Tur, Rt).

- Por último, están las arenas de las terrazas del río Guadalete que tienen abundantes fragmentos de materiales subbéticos, calizas, ofitas, sílex, etc y una asociación de minerales pesados formada por epidota, granate y andalucita (Ep, Grt, And). Estos depósitos son claramente cuaternarios y tuvieron lugar una vez que el Guadalete configuró su cuenca.

Los datos aportados sobre la neotectónica de la zona (Viguiet, 1974; Benkhelil, 1976), indican la existencia de dos fases tectónicas: la fase distensiva Mio-Pliocena y la fase compresiva Fini-Pliocena. De estas dos fases la que parece que ha jugado un papel más importante en la configuración actual de la zona ha sido la fase compresiva, ligada a ella se formó la Falla del Bajo Guadalquivir y otras fracturas del mismo tipo, que dieron lugar a la formación de una nueva divisoria de aguas y a la configuración de dos cuencas independientes: la del Guadalquivir, en parte herencia

de la estructura deltaica primitiva y la nueva cuenca del Guadalete.

Los principales acontecimientos que tuvieron lugar en la zona desde el Plioceno fueron los siguientes:

- A partir del Plioceno inferior se produjo la emersión de la zona y la retirada generalizada del mar, existiendo una serie de cauces fluviales que fluían hacia el W desde los relieves recientemente emergidos, entre los depósitos producidos por ellos se encontrarían las arenas silíceas de Arcos. Así mismo, se desarrolló un aparato deltaico que progradaría hacia el S, depositó las arenas del sector Jerez-Lebrija y fue el responsable de la llegada de materiales detríticos de la Meseta a áreas actualmente ocupadas por la Bahía de Cádiz.

- Durante el Plio-Pleistoceno, en relación con la fase compresiva Fini-Pliocena (Benkhelil 1976), se produjeron una serie de estructuras que fueron determinantes para la evolución posterior de la zona y para el nuevo sistema de aportes a la plataforma. Una de ellas fue la falla del Bajo Guadalquivir (Viguiet, 1974), que afectó casi por la mitad a la estructura deltaica que se había desarrollado y en cuyo bloque hundido, situado al W, se configuró el actual estuario del Guadalquivir. Al SE una serie de fracturas de este tipo dieron lugar a una zona deprimida que supuso el nacimiento de una red fluvial independiente (el Guadalete), la cual durante su estructuración capturó antiguos cauces fluviales y depositó las arenas calcáreas y gravas que constituyen sus terrazas.

Se puede considerar que a partir del Holoceno queda configurado el actual sistema de aportes fluviales a la plataforma del Golfo de Cádiz en la zona estudiada.

### SEDIMENTARY UNCONSOLIDATED COVER OF THE ALENTEJO CONTINENTAL SHELF (FIRST RESULTS) (1)

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Galopim de (4)

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2) - Junta Nacional de Investigação Científica e Tecnológica/Museu Nacional de História Natural - Projecto DISEPLA. R. da Escola Politécnica, 58, 1294 LISBOA CODEX, PORTUGAL.

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Two sets of sediment samples from the Alentejo continental shelf were studied. One set (with 96 samples) was submitted to grain-size and coarse-fraction analyses. Heavy minerals were studied in the other (with 134 samples). Textural sediment characteristics are probably related to the absence of important rivers and to regularity in shelf's slope and exposure to wave action. The terrigenous component

of both sand and gravel is not very important. Source effect observed in the distribution of some heavy mineral species is evident only in the occurrence of clinopyroxene and brown hornblend. The circulation cell induced by oceanographic conditions near Sines cape difficult the dispersion of sediments throughout the shelf. The existence of this cell can be detected in the distributions of sand mean grain-size and of clinopyroxenes and brown hornblend. The high glauconite content in the outer shelf, shelfbreak and upper slope is related to high organic productivity in these regions, which is probably induced by coastal upwelling.

### NUMERICAL METHODS FOR HYDRODYNAMICS FLOWS BY RIEMANN SOLVERS

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In this communication we present an extension of some upwind schemes to the shallow water equations when the bottom is not flat. We use a new type of finite volume to obtain a suitable treatment of the boundary conditions. The source terms include the bottom friction, the wind stress and the Coriolis effect. We consider an implicit scheme to avoid the restriction on time step which is necessary for stability in explicit ones.

### FAUNA Y FLORA BENTONICAS DE LA RÍA DE FERROL (NW DE ESPAÑA): LISTADO FAUNISTICO Y DISTRIBUCION DE LOS PECES (VERTEBRATA)

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Se presentan los resultados obtenidos, efectuados durante dos años, en los muestreos mensuales de tres localidades de la Ría de Ferrol, mediante dos artes de pesca de enmalle diferentes: Beta y Trasmallo; paralelamente, durante el mismo periodo de tiempo, se realizaron censos visuales subacuáticos, en las mismas localidades, mediante inmersión con escafandra autónoma con una máscara AGA y una grabadora submarina.

En la presente comunicación se elabora el listado faunístico de Peces de la Ría de Ferrol, basado en los datos obtenidos en los muestreos de campo, así como de la recopilación bibliográfica de las citas existentes hasta la actualidad.

Este trabajo pertenece a un amplio proyecto de Investigación titulado "Contribución al estudio de las

pesquerías de bajura con artes de enmalle, en sustratos rocosos infralitorales de la Ría de Ferrol", subvencionado por la Dirección Xeral de Formación e Investigación Pesqueira de la Xunta de Galicia.

### MODELLING THE WIND DRIVEN FLOW OFF IBERIAN PENINSULA

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The aim of this work is to study the exchange between the shelf waters and the open ocean, in the frame of the OMEX (Ocean Margin EXchange) project. Specifically we are interested in investigate the role of the wind, bottom topography and coastal morphology as possible driving mechanisms for the coastal jets, fronts and eddies in the west coast of the Iberian Peninsula. Three different bathymetries and three different coastlines were combined to study the effects of bottom topography and coastal morphology. Several steady winds were also considered. Eight numerical experiments were released representing a successive approach to the real case, with a numerical model that solves the primitive equations using a finite differences scheme, an implicit algorithm and a vertical sigma coordinate.

The results showed well known features like, coastal jets, filaments and formation of dipole pairs of eddies composed by anticyclonic and cyclonic. In agreement with thermal wind relation, thermal structures of cyclonic eddies showed raised upper ocean isotherms in the center.

The results are in considerable agreement with other numerical experiments and with described observations.

In future, some more work is needed to investigate the formation of filaments because it is not clear what is/are the mechanism(s) behind it. The influence of the Mediterranean water should be considered at least imposing an outflow in the strait of Gibraltar. This will be done linking the present model with the existent one for the strait of Gibraltar and the regions surrounding it (Neves *et al.*, 1994). Also in our plans is the investigation of the density driven shelf edge current.

**THE RETREAT OF EASTERN QUARTEIRA CLIFFED COAST AND ITS POSSIBLE CAUSES (PRELIMINARY RESULTS)(1)**

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The cliffed coastal stretch eastward of Quarteira town (Algarve, Portugal) is subject to a fast shoreline retreat. Several authors attempted the quantification of cliff retreat rates in this area. However, obtained results present a wide range of variation due to the different methods of measurement used.

For this study, the cliff top edge on the 1958, 1969, 1976, 1983 and 1991 aerial photographs was restituted in an analytical stereoplotter linked to a computer. Mean retreat rates for each period were determined considering the Forte Novo, Trafal and Vale do Lobo sectors.

Mean retreat rates of the order of 0.5m/y were determined for the first period (1958/69), most probably representing an ubiquitous (natural?) erosion possibly due to the sea-level rise. In the following periods (1969/76 and 1976/83) mean retreat rates increased, apparently in direct response to the construction of the Quarteira groin field and Vilamoura marina jetties, in 1972/73. A maximum value of 3.1m/y was obtained for the Forte Novo sector for the period 1976/83.

Obtained data series point on a continuous process of downstream progressive erosion of the beach and nearshore zone, leading to a more direct and intense abrasion of the cliff base. This explains the progressive increase of the mean cliff edge retreat rates through the time, reaching the value of 3.5m/y in Forte Novo in the period 1983/91. However, the great increase registered in this period was also probably due to stormy events, as well as to unusually intense rainy seasons.

For the sake of better insight into the evolution of the area, a 10m grid was used to plot local retreat profiles. These diagrams point on an acceleration of the local retreat rates in the eastward and westward cliffs adjacent to the Vale do Lobo swimming pool rip-rap built in 1984/85.

**BIOLOGICAL ASPECTS OF SCROBICULARIA PLANA (DA COSTA, 1778) IN TWO COASTAL LAGOONAL SYSTEMS OF THE SW PORTUGAL**

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This communication deals with some biological aspects, mainly growth and reproduction, of the bivalve *Scrobicularia plana*, in two small estuary systems of the Odeceixe and Aljezur rivers in the SW coast of Portugal. Both systems show a similar biological pattern.

**FIRST DATA ABOUT THE DENSITY OF POLYCHAETA HEDISTE DIVERSICOLOR O.F. MULLER, 1776 (ANNELIDA, POLYCHAETA) IN SMALL RIVER OF ODECEIXE (SOUTHWEST COAST OF PORTUGAL)**

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*Hediste diversicolor* is the most widespread organism in the estuarine mud flats, reaching different densities according to the type of the substrate, the contents of organic matter, food availability and abiotic factors. during a period of 14 months (April/93 to May/94) samples were carried out in the intertidal area in two different stations located in the small river of Odeceixe (Southwest coast of Portugal). So far, it seems possible to define not only the reproductive season but also the density of adult individuals and larvae.

**FLORA Y VEGETACION BENTONICA MARINA DEL LITORAL DE LUGO (N.O. DE ESPAÑA)(1)**

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La elaboración de floras de algas marinas ha sido una actividad que comenzó a finales del siglo XVIII, y que, dada la laboriosidad que requiere una investigación de este tipo, la necesidad de infraestructura, material y bibliografía, así como de medios económicos, ha hecho que pocos países, hasta el momento, dispongan de una flora completa y actualizada que les permita conocer sus auténticos recursos. En las costas peninsulares españolas sólo existen floras parciales referidas a

tramos muy concretos, generalmente resultado de tesis doctorales, así como una lista florística de los países catalanes y una lista global, actualmente bastante incompleta.

Las costas de Galicia, como está universalmente admitido, y la costa norte de Portugal, están encuadradas en la provincia fitogeográfica Lusitana, perteneciente a la región cálido-templada del Atlántico Norte, y constituyen una frontera biogeográfica, no sólo atlántico-oriental sino también anfiatlántica, hasta donde llegan, desde el norte, elementos árticos y templado-fríos, y desde el sur elementos templado-cálidos y mediterráneos, siendo precisamente las rías de Galicia el punto de encuentro más significativo de elementos pertenecientes a floras tan diferentes. El interés de la Flora de Galicia, es pues, evidente, y más teniendo en cuenta que aún en Galicia, pueden distinguirse, por lo menos dos zonas diferentes, caracterizadas claramente por determinados elementos florísticos. Hasta el momento, sólo se han realizado en las costas de Galicia, desde finales del siglo pasado, muestreos puntuales y estudios florísticos, algunos sin publicar, que ofrecen una visión muy poco completa de la flora existente, con un desequilibrio geográfico debido a que nunca se han abarcado la totalidad de las costas, habiéndose elegido, al azar, el estudio de determinadas rías. Esta laguna de conocimiento es particularmente notoria en las costas del litoral de la provincia de Lugo; baste destacar que mientras de las provincias de A Coruña y Pontevedra se conocen más de 400 táxones diferentes, en Lugo esta lista se reduce a 112. Aparte de las bionomías generales de FISCHER PIETTE & SEOANE CAMBA (1962) en la ría de O Barqueiro y POLO *et al.* (1979) en San Cibrao de Burela, desde el punto de las algas bentónicas marinas, los trabajos referidos exclusivamente a ellas en el litoral lucense se restringían hasta la fecha a las aportaciones aisladas de SAUVAGEAU (1897), GALLARDO & MARGALET (1988) y LÓPEZ RODRÍGUEZ *et al.* (1991)

Con el desarrollo del presente proyecto de investigación se pretenden conseguir los siguientes objetivos:

- 1.- Reconocimiento y estudio de las zonas del litoral de Lugo que presenten una vegetación bentónica representativa de las diversas condiciones ecológicas.
- 2.- Elaboración de un catálogo florístico que permita conocer la riqueza real de las costas del litoral lucense y el carácter biogeográfico de las mismas.
- 3.- Estudio morfológico, anatómico, autoecológico y fenológico de todos los componentes de la flora, así como de su variabilidad. Este estudio, entre otras cosas, permitirá conocer las pautas de distribución zonal y geográfica de los mismos.
- 4.- Catalogar y caracterizar los tipos de costas del litoral lucense en función de las diversas comunidades reconocidas y su distribución zonal y geográfica.

5.- Confección de un herbario completo de la flora del litoral de Lugo que se depositará en un herbario oficial, como testimonio real, accesible y contrastable.

En la presente comunicación se expone el cronograma, plan de trabajo y metodología seguida en el desarrollo del presente proyecto de investigación, así como se resumen los resultados más sobresalientes obtenidos hasta la fecha.

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### GROWTH OF THE COMMON PRAWN, *PALAEMON SERRATUS* (PENNANT) AND THE COMMON SHRIMP, *CRANGON CRANGON* (L.) IN THE ST. ANDRÉ LAGOON (SW PORTUGAL)

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St. André (SW coast of Portugal) is an enclosed coastal brackish lagoon, connected to the sea only during a short period (less than 1 month in Spring, as a rule) through a man made channel. As a consequence, a colonization by marine species takes place, providing a sudden and rich Spring recruitment. Due to this, the studies of the growth of some species after its settlement in the lagoon are facilitated because of the lack of generations overlap.

This is the case of a number of Fish and Decapod Crustacean species, such as the Common Prawn, *Palaemon serratus* (Pennant) and the Common Shrimp, *Crangon crangon* (L.). This work deals with the growth of these two species based on samples obtained during an annual cycle in the lagoonal environment of St. André.

Length of cephalothorax without rostrum (C) was the measure taken for the estimates of the growth, and the following growth curves (Von Bertalanffy, t - time in months) were obtained :

*Palaemon serratus* ( $C_{10} \approx 0.15$  cm) :

$$C_t = 2.499 - 2.349 e^{-0.105t}, \quad C_t \infty = 2.499 \text{ cm.}$$

*Crangon crangon* ( $C_{10} \approx 0.102 \text{ cm}$ ):

$$C_t = 1.3904 - 1.2884 e^{-0.249t}, C_t \infty = 1.3904 \text{ cm.}$$

The observed growth values for *P. serratus* agree with others obtained for animals reared under optimal conditions, indicating that the lagoonal environment of St. André could be good for the extensive rearing of crustacean species.

### FAUNA Y FLORA BENTONICAS DE LA RIA DE FERROL (NW DE ESPAÑA): DISTRIBUCION DE PORIFEROS DE SUSTRATOS BLANDOS

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Se estudian las esponjas procedentes de 81 muestras de sedimento recogidas en 78 estaciones infralitorales de la Ría de Ferrol (Galicia, NW de España), comprendidas entre los 1,5 y 35 metros de profundidad y que han sido obtenidas mediante una draga rectangular de naturalista.

Se han encontrado poríferos en el 27% de las estaciones muestreadas. La mayor diversidad corresponde a los sedimentos gruesos de tipo cascajo, en donde las esponjas pueden fijarse a pequeños elementos sólidos. En fondos fangosos son muy pocos los ejemplares encontrados, referidos a unas pocas especies, desapareciendo prácticamente en las estaciones de arenas finas y medias.

Se identifican las especies recolectadas y se relacionan con el tipo de sedimento sobre el que se asientan.

Las esponjas se reparten en 6 Ordenes Hadromerida, Axinellida, Poecilosclerida, Halichondrida, Haplosclerida, y Dictyoceratida. Desde el punto de vista cualitativo el mejor representado es Poecilosclerida, sin embargo en cuanto al número de ejemplares el Orden mejor representado ha sido Hadromerida, ello se debe en parte a la alta frecuencia de aparición de *Ficulina ficus*.

### EVALUATION OF POLLUTION-INDUCED DEGRADATION IN CADIZ BAY, USING THE SEDIMENT QUALITY TRIAD APPROACH

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For determining cause-effects relationships resulting from mixtures of chemical contaminants found in studied sediments an integrative assessment has been

used: The Sediment Quality Triad Approach (Long & Chapman, 1985; Chapman, 1990). This report shows the first results obtained in the application of the SQT in littoral ecosystems of Cadiz Bay

The results showed: a) Sediment pollution was not general in the Cadiz area, b) sediment pollution was restricted to the vicinity of point source discharges and c) cessation of point source discharges should be result in decreased sediment pollution through natural capping (waves-swell and tides).

### MARINE PALYNOLOGY OF THE IBERIAN OCCIDENTAL MARGIN - PRELIMINARY RESULTS.

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The study of bottom surface samples and cores within the ambit of project JNICT nº 743/90 "Microfloras da Margem Ocidental Ibérica. Implicações (paleo)climáticas e (paleo)ecológicas" aims at identifying micropaleontological (pollen/spores and coccoliths) from the Iberian continental margin; understanding the means of marine transport and characterising the paleo-ecological and paleo-climatic aspects.

This work, unpublished in Portugal, will enable comparisons to be made from micro-paleontological records from the West-Iberian shelf, an important zone between the Mediterranean and Atlantic areas.

Palynology - in their widest context palynological studies favour the continent/ocean relationships which are essential to the study of climatic mechanisms.

The preliminary results presented here refer to the pollen analysis of bottom surface marine sediment samples distributed along the continental shelf. They enable an assessment to be made as to the value of pollen and spores contents in relation to the nature of sediments, bathymetry and topography; detect the distribution patterns of the different taxones and estimate marine flow transport.

The detailed study of pollen and spores assemblages present in the surface sediments is both useful and necessary to the interpretation of palynological marine cores.

Muddy sediments predominate on the Algarve shelf (Sagres to Vila Real de Santo António - chart IH 1/150.000 nº 7/8) and the pollen spectra relative to the surface samples situated between -200m and -500 show great consistency. The dominant elements are *Pinus*, *Ericaceae* and *Asteraceae*. *Isoetes* indicate considerable fluvial transport which lessens from west to east. The sub-Mediterranean stage (*Quercus*, *Ericaceae*) is well represented and the herbaceous component is significant. These characteristics fit perfectly into the series of diagrams of surface samples



of marine sediment in the Mediterranean basin and strengthen the idea of floristic continuity.

On the northern shelf between Cávado and Douro at a depth of 70 and 80 metres the sediments are sandier, which is reflected in the pollen contents which are rich in minerals. The microflora is poorer and more monotonous. *Pinus* is overrepresented which causes spectrum disturbances which mask the vegetation image. However the presence of *Betula*, a medium altitude element, should be emphasised and that of *Pinus Sylvestris*.

Thanks to the methodology used it has been possible to get a global perspective which integrates various micro-organisms (pollen and spores, foraminifera, dinoflagellates), organic matter and mineral component.

Comments are also presented on the pollen spectra of the core located on the northern shelf, 40 km offshore, at a depth of 100m. Radiocarbon age at the bottom 1.400±70 BP.

### LA VASIERE OUEST-DOURO ET LE PIEGEAGE DES SEDIMENTS ESTUARIENS RÉCENTS (1)

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The muddy body detected near the submarine Porto's canyon in the northern portuguese shelf at depths of 65m to 130m, has a surface of approximately 503km<sup>2</sup>.

The study of this important mud body was based on the analysis of high resolution seismic profiles and of sediments samples (grab samples and one core 3.10m long) in order to evaluate its importance as a trap for fine-grained sediments.

The study of the seismic profiles allowed us to conclude that the muddy body is located in a tectonic depression limited by reliefs (with an amplitude of 10 to 30m) and is characterised by a 5m average thickness. These reliefs form a barrier which protect

the muddy body from the NW predominant incident waves and, consequently, they seem to control its morphology and, most probably, its installation.

The sedimentological study allowed us to conclude that the body is constituted by continental materials arranged in three main facies: silt (in the center), silty sand and sandy silt (in the border).

The determination of C<sup>14</sup> and Pb<sup>210</sup> contents has given an age of 1400 years B.P. at 3.10m depth and an accumulation rate of 5.7mm/year.

The mass of mud is 1787.5 x 10<sup>6</sup> tons. Assuming that the Douro river is the main source of fine sediments (with a transport of 2.25 x 10<sup>6</sup> tons of solide charge per year, in a natural regime) (OLIVEIRA *et al.*, 1982), we can conclude that the muddy body traps around 34% of this sedimentary charge.

Presently, the mass transported by the Douro river is reduced to 312x10<sup>3</sup> tons/year, *i.e.*, approximately 14% of its earlier debit. The existence of dams, wich have been built since 1930, is the main cause for such decrease.

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### HOW SOUTHWARD MIGRATED THE POLAR FRONT, ALONG THE WEST IBERIAN MARGIN, AT 17,800 YEARS BP? (1)

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Three deep-sea piston cores collected at the West Iberian Margin were used to compare planktonic foraminifera biostratigraphic data and isotopic stratigraphy obtained from δ<sup>18</sup>O record of benthic foraminifera.

A lag between the last glacial maximum, recorded by δ<sup>18</sup>O, and the cold bioclimatic zone II was found in all cores. We observed that bioclimatic zone II occurs near to the end of the isotopic stage 2 and is followed by the presence of ice rafted sediments. During the last glacial maximum (at 17,800 years BP), sea surface temperatures in this region were aproximately as warm as today. These data probably mean that the bioclimatic zone II is related with the penetration of icebergs and cold melt waters in this region during the last deglaciation.

We suggest that: 1) at the West Iberian Margin the bioclimatic zone II records the first phase of the

isotopic stage 2 deglaciation, the Termination IA (14,500 - 12,500 years BP); 2) during the last glaciation the polar front didn't migrate south of 42°N at this region.

### THE BIOCLASTIC COMPONENT OF THE INNER SHELF SURFICIAL SEDIMENTS IN THE ASTURIAN CENTRAL AREA (NW SPAIN, BAY OF BISCAY)

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Three surficial sedimentary facies of the inner continental shelf in the nearby area of Gijón (Asturian central coast, southwestern Bay of Biscay, NW Spain) can be distinguished: siliciclastic sands (shallow prism with the pocket beaches included), bioclastic gravels (relict sediments) and bioclastic coarse sands (palimpsest sediments), both of them distributed at greater depths.

The carbonate content of these sediments (exclusively biogenic) constitutes an essential mineralogic component versus siliciclastic one which is supplied by the own marine environment (chiefly from the coast), and it represents the youngest component.

From the carbonate bioclastic percent, the sedimentary sheet can be distributed in two sedimentary belts from the shoreline: 1) siliciclastic sandy prism, and 2) bioclastic gravel and coarse sands. The average of carbonate percent of the siliciclastic sandy prism is 18.94% (n=41), decreasing seaward and with the depths (inner: 21.87%, intermediate: 19.18%, and outer: 15.61 %). Bioclastic gravels and coarse sands have high carbonate content (83.82%, n=15; 81.85%, n=21; respectively).

The biologic variety is represented by several groups of organisms: bivalves, gastropods, echinoderms, barnacles and, occasionally, calcareous algae. Microscopic organisms: foraminifers, bryozoans and sponges are poorly represented, being more important in the siliciclastic sandy prism and when settling sedimentation is prevailing (shadow coastal areas and outer deeper belt). The cliff/abrasion -platform system is the main coastal environment contributing with the bioclasts to the entire sediment, followed by sandy subtidal beaches, estuaries and continental shelf.

The surfaces of bioclasts are chiefly unchanged or lustrous (abrasion action of waves), especially in the siliciclastic sands. Those of bioclastic gravels contain high percents of corroded (due to the subaerial exposition) and bored surfaces, and encrusting organisms are frequent. Variable proportions of corroded and lustrous surfaces are in bioclastic coarse

sands, and even a lot of mineral bioclasts develop both properties over a same grain.

The surficial distribution of these sedimentary facies, and the described sedimentologic patterns (carbonate percent, biologic variety and surficial texture of bioclasts) allow to propose a first hypothesis about the sedimentary origin of these inner shelf deposits. Bioclastic gravels, probably the older deposits, generated during the Würmian regression (Late Pleistocene) as beach barriers and/or barrier islands. Falling sea level until the maximum glacial left these sediments under a subaerial exposition, corroding the carbonate surfaces. The posterior rising sea level reworked those bioclastic gravels, generating a new deposits (smoothly finer) landward, and acquiring the bioclasts lustrous surfaces. During the highstand phase (from the last Flandrian transgression) to present, the siliciclastic sandy prism developed in the shallow coastal belt.

### SEDIMENTOLOGIC AND DYNAMIC PATTERNS OF THE SILICICLASTIC INNER SHELF IN THE ASTURIAN CENTRAL AREA (NW SPAIN, BAY OF BISCAY)

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In the nearby area of Gijón (Asturian central coast, southwestern Bay of Biscay, NW Spain) the siliciclastic sandy prism extends from the coast, including the pocket beaches, through variable depths (10-50 m). This prism has a sedimentary continuity from the beaches in the Carranques-Aboño sector and San Lorenzo beach, outcropping an isolated narrow sedimentary belt (NE-SW) in the western area. It is best developed in front of the coastal river mouths and when the coastal current approaches to the coast, promoting local upwellings (Flor, 1977). The main sedimentary sandy volumes come from the Nalón river, situated about 32 km to the W.

Prevailing winds blow from the NW. Tides are semidiurnal and ranges vary from 4.2 to 1.0 m (mesotidal). Main wave fetches come from the NW (the most important) and NE, and this continental shelf can be included as a wave-dominated shelf.

According to the longshore and seaward components of the sedimentary transport, textural characteristics and the mineralogy of the surficial sediments allow to separate several coastal sectors: Carranques-Aboño (high sedimentary volume), Musel harbour (shadow dynamic zone and scarce sedimentation), San Lorenzo beach (high sedimentary volume), and eastern area (strong wave exposition and scarce sedimentation: by-passing area).

Longshore transport is characterized by decreasing mean grain size, better sorting, curves more leptokurtic and less bioclastic carbonate percent downcurrent; there is a general transition from the W to the E. The narrow upper foreshore contains the biggest mean size and the highest carbonate percent (the most energetic area). Also, the sedimentary dynamic from the shoreline to the outer shelf is similar to those sedimentologic tendencies, excepting the case of the sorting which in some depths shows an intermediate step of worse sorting.

The situation and distribution of the siliciclastic prism in shallow areas, the size of sediment, the low bioclastic content induce its former fluvial origin so as the coastal drift from the NW, but partially can be supplied by washing of the finer fractions of the deeper bioclastic relict and palimpsest sediments during the last transgressive cycle.

The Torres cape is a natural wall which acts on the shallow area (nearshore); so in the stoss side, between the Carranques-Aboño sector, the sedimentation is relatively high, and in the lee side, the Musel harbor, the area is shadow with a low sedimentation. Towards the E, the San Lorenzo bay represents a high sedimentation area.

### PRODUCTIVITY OF THE TAGUS ESTUARY AN APPLICATION OF THE ECOWIN ECOLOGICAL MODEL

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This work discusses the application of an ecological model to the calculation of planktonic primary productivity and nutrient uptake within the Tagus Estuary. The model has been implemented using an object-oriented approach.

Results from the EcoWin model are presented herein for phytoplankton standing stock, primary production and turnover for different areas of the estuary, and an analysis is carried out on the effects of a potential clean-up of the Trancão River on estuarine productivity as a whole, and on the Cala do Norte in particular.

### BEACH EROSION INDUCED BY STORMS A TENTATIVE PREVISION FOR THE NORTHWEST PORTUGUESE COAST<sup>(1)</sup>

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The need of predictive methods for beach erosion associated to extreme events on the Portuguese west coast is great since this events are associated to strong

shoreline retreat, dune destruction, and to the damage of coastal defenses, houses, and roads. In this work beach erosion previsions given by two simple methods were tested against actual erosion on the coastal area between Aveiro and Cape Mondego.

The Vellinga method proved to be ineffective to the study area while the Balsillie method gave good results for the storm of 24-27 February 1989. Using the Balsillie method for different storm characteristics a global prevision of beach erosion for the extreme events that normally occur in the study shore was calculated. The necessary sand amount at the beach/dune system to prevent overwashes or building damages can be computed using this tentative prevision.

### MATHEMATICAL MODELLING OF THE SEDIMENT DYNAMICS IN THE MOUTH OF ESTUARIES. THE CASE OF THE TAGUS OUTER ESTUARY

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Mouths of estuaries are the most complex natural systems in what concerns sediment dynamics. There, the movement of the sediments depends, simultaneously, on the oceanic tide, on the tidal currents generated in the estuary and on the wave propagation and breaking. The modelling of the evolution of the bottom shape, supported on the understanding of the mechanisms of sediment transport, must be made considering the evolutive tendencies defined for small time scales, which are characteristic of meteorological episodes. The complexity of the morphological modelling problem arises from the necessity of knowing how to extend those tendencies for larger time scales, characteristic of the bottom morphology evolution.

Numerical simulation is a modelling method of great utility for the understanding of sediment dynamics, since it makes it possible to study separately or jointly, the processes involved in that dynamics.

In this paper, some aspects of the study and preliminary results are presented concerning the characterization of the sediment dynamics in the area of Tagus mouth. These results show the great complexity of the phenomena involved. The study is mainly directed towards the understanding of the mechanisms of sediment transport phenomena in the study area, and the setting up of the relative importance of each conditioning factor. The analysis of the tendencial evolution of the shoals known as "Cachopo Sul" as a consequence of significative perturbations in the natural sediment balance, is an important aspect to be analysed.

The computational system MIKE21 is being used as a tool for this study, with its modules of hydrodynamics, nearshore wave propagation and non-cohesive sediment transport. The modules of the system are formulated in a very consistent way and have been validated by worldwide applications.

### CARACTERIZACIÓN MICROPALAEONTOLÓGICA DE SEDIMENTOS CUATERNARIOS EN ZONAS COSTERAS DE GALICIA (NW DE ESPAÑA)

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La caracterización de sedimentos costeros en Galicia, debido a la frecuente ausencia de restos fósiles, se hace basándose en datos parciales (altura respecto al nivel del mar actual, granulometría, naturaleza del sedimento, contenido o materia orgánica etc.). La costa gallega de rias bajas con numerosos entrantes del mar hace bastante común la interferencia entre medios terrígenos y marinos mixtos tanto en las zonas de fondo de ria como en las de mar abierto. El examen "de visu" de los sedimentos correspondientes no permite distinguir, por ejemplo, entre un depósito de lagoon y un suelo orgánico. En estos casos el único criterio decisivo para su correcta identificación ha demostrado ser el estudio micropaleontológico: (polen, diatomeas, foraminíferos). Esto permite definir con precisión, p.e., salinidad, profundidad de las aguas, etc. Por lo general la identificación de los sedimentos costeros de Galicia se ha limitado a su estudio sedimentológico. En otros, los estudios micropaleontológicos han introducido graves errores de método (datación o estudio de perfiles polínicos correspondientes a sedimentos removidos y/o contaminados por la acción de insectos, raíces o cualquier tipo de remoción o polución). Todo esto ha hecho que el conocimiento actual de los depósitos costeros gallegos no sea completo, ni exista conexión entre los distintos afloramientos descritos hasta el momento, y lo que es más importante que se hayan interpretado en algunos casos como marinos sedimentos continentales y viceversa.

Se han seleccionado cuatro afloramientos de la costa gallega. Uno situado actualmente a unos 200 m de profundidad y los otros 3 en zonas litorales y emergidas en la actualidad. La literatura previa lo había interpretado como de origen marino atribuyéndolos genéricamente a medios de tipo lagoon, correspondientes a oscilaciones eustáticas positivas o negativas del mar. Sin embargo los datos micropaleontológicos han probado concluyentemente su origen.

Fonferrón: Interpretado como un sedimento marino de edad holocena por su situación sobre un nivel de cantos rodados y al nivel actual del mar. Estudiado su

contenido en microfósiles ha resultado corresponder a un suelo orgánico fósil.

Corrubedo: Interpretado inicialmente como un nivel marino fósil de edad holocena (el único nivel datado en toda la costa gallega, hasta la actualidad), ha resultado ser un suelo interdunar sin relación alguna con las oscilaciones eustáticas del Holoceno.

Seselle: Interpretado inicialmente como un nivel de bosque fósil de edad holocena ha resultado tratarse de un episodio marino transgresivo inundando un bosque desarrollado en la parte interna de un lagoon litoral.

Finisterre sur: Interpretado inicialmente como un nivel marino de plataforma, ha resultado tratarse de un depósito de influencia continental relacionado con el máximo episodio marino transgresivo del Pleistoceno (-200 m) conservado en la plataforma continental gallega.

### DINAMICA DE NUTRIENTES EN LA BAHIA DE CADIZ

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The exchange of nutrients with tides across a section that separates the inner and outer zones of Cadiz bay has been quantified. From November 1989 to March 1993 have been carried out 36 sampling and  $\text{NH}_4^+$ ,  $\text{NO}_2^-$ ,  $\text{NO}_3^-$ ,  $\text{HPO}_4^{2-}$ ,  $\text{SiO}_2$ , dissolved organic and inorganic concentrations, primary productivity and phytoplanktonic pigments have been determined in the inputs and outputs of the bay.

The results indicate the existence of nutrients exportation (to exception  $\text{NO}_3^-$ ), dissolved inorganic and organic carbon and possibly particulate organic carbon. Different experimental evidences suggest that nutrient benthic regeneration is the main factor of nutrient dynamic in Cadiz bay.

### UNUSUAL CO - OCCURRENCE OF SERPULIDS AND BRYOZOA IN A LAGOONAL SYSTEM (ALBUFEIRA COASTAL LAGOON - PORTUGAL)

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Here we report the unusual co-occurrence of two invertebrate groups - Bryozoa and Serpulids - in a

brackish environment located on the portuguese western (Atlantic) coast - Albufeira lagoon. In February 1990, during a survey on the physical properties of the lagoonal waters, a singular assemblage and abundance of this two taxa was registered, covering almost completely pebbles and other rigid substrata including trees, bushes, bottles and plastic fragments; particularly evident was the extraordinary development of Serpulids on the *Phragmites* sp. tips while Bryozoa dominate flat surfaces.

This event is related with an unusually high lagoonal water level, due to an extremely pluviometric winter, coincident with an inlet closed stage. Bryozoans and Serpulids were mainly confined to the 3m-4m upper section of the water column in which salinity was about 6.5‰-9‰, the temperature registered during the day range between 14°C and 18°C and the pH fluctuated between 8.0-8.2 in the inner part of the lagoon and 8.5-8.7 in the main water mass.

Only two *taxa* dominated the assemblages: the Briozoan species *Membranipora savarti* ((Audouin, 1826) and the Polichaeta Serpulid species *Ficopomatus enigmaticus* (Fauvel, 1923), displaying a typical opportunistic development. We could also recognize the minor presence of a few fragments of another Bryozoan - *Conopeum* sp. - as well as small Cirripeds. To our knowledge, this is the first time this occurrence is reported in similar portuguese environments.

Due to the carbonate nature of the Bryozoa and Serpulid species exoskeletons, this opportunistic occurrence can be registered in the fossil record which allows us to use them as a potential brackish proxy in paleoenvironmental reconstructions.

### RETURN PERIODS OF EXTREME SEA LEVELS IN PORTUGAL.<sup>(1)</sup>

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1) - Contribution C105 of DISEPLA Group (Project CALMA-JNICT PEAM/C/CNT/56/91)

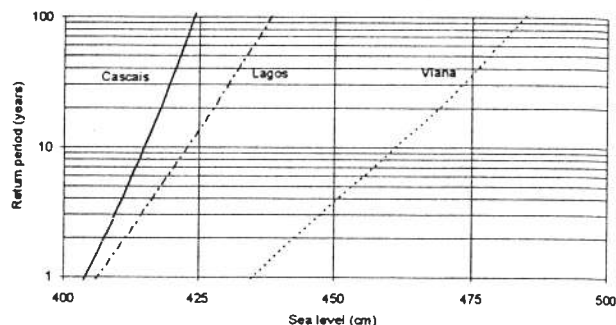
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This communication presents the probability of occurrence of extreme sea levels and their respective return periods for three tide gauges station (Viana do Castelo, Cascais and Lagos). The main objective is to provide a first analysis of the extreme sea levels in Portugal, and to contribute to studies dealing with littoral sedimentary dynamics, as well as to a better shoreline management. The method of extreme sea levels analysis as developed by Pugh and Vassie (1978) was used. This method consist of deriving the probability of occurrence of extreme sea levels by combining the probability functions of surge and tide.

The method was applied to hourly values of predicted tide levels (five years) and storm surge levels (two years). Return periods for the tree station were calculated (fig. 1). Results obtained with this study points out the fact that significantly high values are associated with relatively short return periods. For instance, sea levels with return periods of 10 years are 461 cm in Viana do Castelo, 415 cm in Cascais and 423 cm in Lagos, that is, respectively 54 cm, 28 cm and 41 cm above the maximum level reached by the predicted tide. These results confirm the effectiveness of the storm surge in the Portuguese coast.



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### MONTHLY VARIATION ON SANDY SEDIMENTS IN RIA DE ARES-BETANZOS (NW IBERIAN PENINSULA)

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The Ría de Ares-Betanzos is in the NW of Iberian Peninsula. The bottom is mostly sandy.

With this study we want to observe the variability of those sandy bottoms during an annual period. So, three stations (called W,X & T) among 11 & 16 meters depth were selected from the central part of this Ría.

Sampels were taken monthly between August 1988 and July 1989. A Box-Corer Reineck (Bowman) grab. A 20 cm depth sedyment samples were obtained this way. Eh and pH were measured at 4 cm depth in the sample on board; the grain size, organic matter and carbon percentage were measure in the laboratory afterwards.

The grain size distribution shows diferences among the three stations. Stations X & Z keep the same along the whole period. Station X is the innerst of the three ones and the fine sand is the dominant fraction. Station Z is in the southern coast of the Ría and the very fine sand is the dominat fraction.

In station W, located in the northern coast, not any fraction is dominant. Fine sand, very fine sand and medium sand are the greater fraction. The grain size distribution variation could be caused by the stream dynamics, with the out fluxe throught the northern coast.

The organic content in the sediment is very low in the three stations; the organic carbon is always below 0,65% and the organic matter is never greater than 2,5%.

### MORPHOLOGICAL DIFFERENCES ON THE NAZARÉ CANYON AND AVALANCHE PROCESSES ALONG ITS THALWEG

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The Nazaré canyon is considered the biggest accident that cuts the portuguese continental shelf. Since the beggining of this century that it's being study by several scientists, namely, french scientists. Various cruises were performed wich resulted in a great volume of new information: bathymetry, reflective and refraction seismic, dredgings and examples of collected rock. Such acumulation of information allow new interpretations about the morphology and evolution

of the canyon and confirmed the total submission of the morphological creation to the tectonics of the margin, in particular to the replay of the late-hercynian accidents.

From the analysis made of the Bathymetric Map of the Nazaré canyon and using some technics of morphological analysis , morphological differences were established between the margins and between the different courses of the canyon. The highes slopes of the canyon walls is a factor that propurcionates the occurance of mass movements that, when arriving at the bed of the canyon, they move in avalanche. This movement is also facilitated thanks to the significant slope of its thalweg.

With a medium slope of 2,7 %, the longitudinal profile of the Nazaré canyon (see figure 1) is quite differenciaded on its parts. The higher and medium courses contain an high slope, medium rate of 3,5%, whereas the lower course has a much smoother slope, medium rate of 0,9%. Regardless of this medium rate, one notices that in the superior segments, the slope are frequently higher than 5%, wich in some way can induce the accelaration on the movgements of liquid and solid loads that move around the canyon bed.

A curious morphological aspect is related with the existence of some depressions wich make the profile irregular. From the bathymetric analysis, we noticed 15 accidents of this type on the whole canyon, finding 7 on the upper course, 5 on the m□dium course and 3 on the lower course. Most of these depressions are shown on figure 3, some of them assumig pronounced forms.

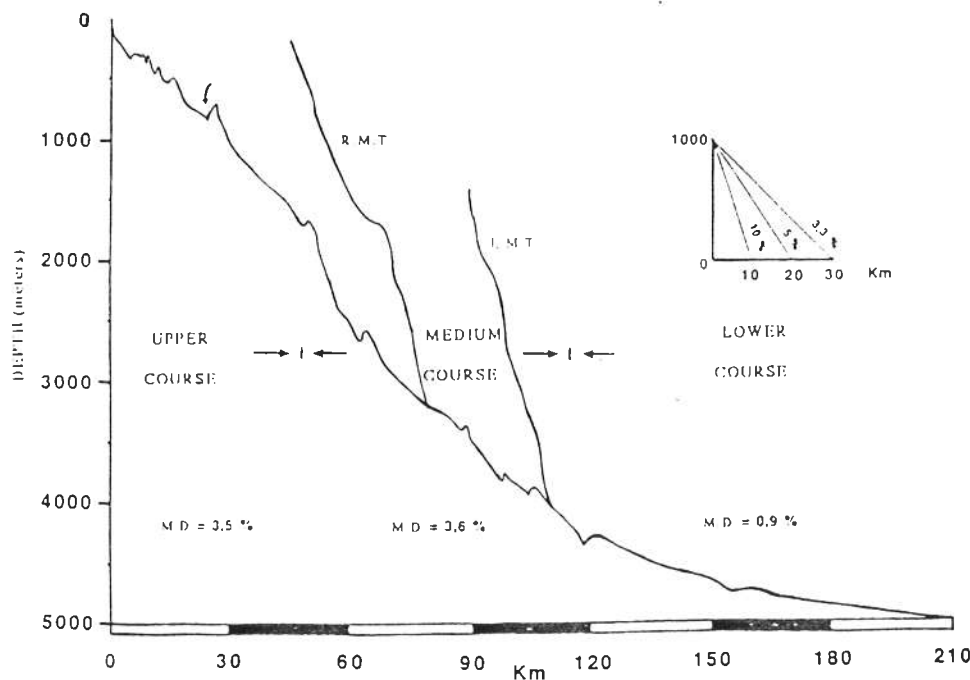


Figure 1 - Longitudinal profile of Nazaré canyon. M.D - medium declivity. R.M.T. - right margin tributary. L.M.T. - left margin tributary.



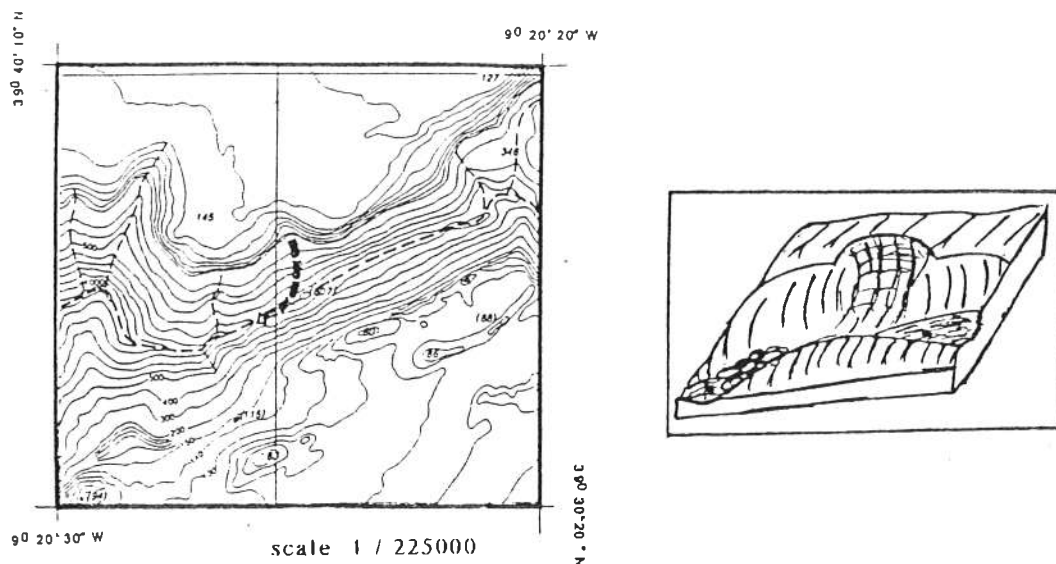


Figure 2 - Sketch of a slope mass movement that originates a depression on the bottom of the canyon.

Similar depressions located on the longitudinal profile have also been pointed out on the Mediterranean canyons and it was verified (by submersible surveys) that these accidents were originated by avalanches that occurred throughout the thalweg. These avalanches allow the deposition of enormous masses of material (certain rocky blocks with more than 60 meters of height) at the bottom of the canyons, especially in certain areas where the bed becomes wider and the slope of the longitudinal profile becomes smoother. As soon as these enormous blocks become immobilized, they function as a sedimentary traffic trap, thus producing a depressed area upstream, more or less important, depending the height of this wall of the blocks and sediment trapped.

It's possible that an identical phenomenon exists on the Nazaré canyon, resulting of the 15 accidents of the same type that occur throughout its profile.

The depression that can be very well detected along the longitudinal view (marked with an arrow in figure 2), occurs when on the upper course, the canyon depth reaches 700/800 meters. This is a good example of the process already described.

On this part of the profile it was probably verified the immobilization of enormous blocks which served as a barrier towards the sedimentary traffic, namely, the turbidity currents, thus, producing an important depression upstream. The origin of these blocks can be very far, because there appears to be a significant scar of a gravitational collapse on the north slope upstream, formed by the re-entry curve levels.

## PRESENT STAGE OF THE MINERALOGICAL AND GEOCHEMICAL STUDIES OF CENOZOIC SEDIMENTS FROM THE AVEIRO LAGOON AND ADJACENT LITTORAL AREAS

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In the Aveiro region (littoral NW of Portugal) mineralogical and geochemical studies of the clay fraction have been carried out on samples of both sediments and sedimentary rocks either for lithostratigraphical discrimination or paleoenvironmental reconstruction of the ancient sedimentary deposits as well as for the characterization of the recent surficial and near-surficial sediments of the "Ria de Aveiro" lagoon. This paper presents the "state of the art" of the studies developed by the authors during the last six years based, particularly, on clay mineralogy and geochemistry. Infra-Cretaceous and Cretaceous units have been discriminated on the basis of clay mineralogy and geochemistry. On the other hand, the post-Cretaceous units are characterized, in general terms, by the dominance of Illite and Kaolinite. Kaolinite is more abundant in some layers of the "Areias de Esgueira" and "Terraços/Depósitos de praias antigas" units, whereas Illite is predominant in the other layers and units. On the other hand, Tertiary units contain small amounts of fibrous clay minerals, more developed in the basal units. Chlorite and irregular 10-14 Å interstratifications are ubiquitous but, in general, have low expression. Vermiculite is present, as a rule, only in the upper units. The analytical results obtained so far provided also information on the environmental conditions prevailing at the time of the deposition of the different units. In the case of the recent sediments of the lagoon, the studies carried out did show the distribution

patterns of clay minerals in the surficial and near surficial sediments of the Aveiro lagoon. Those clay minerals are essentially of continental origin and of inherited type. Kaolinite, Illite, Smectite, Vermiculite, Chlorite and 10-14 Å interstratifications are the clay minerals which have been identified. The qualitative and semi-quantitative variation of the clay minerals along sedimentary columns, represented by vibrocores, allow the establishment of both rhythmicity and periodicity of the more distinctive climatic episodes which did occur in the region during the last 500 years BP, approximately. In surficial sediments of the Aveiro lagoon, collected both in channels and in interflaves, concentrations of heavy metals, such as: Cu, Ni, Co, Zn, Cd, Hg, As, Pb, Mn and Cr were determined. Extraordinarily high contents of heavy metals were found in the sediments. The heavy metals are not uniformly distributed in the lagoon sediments, higher concentrations being found in the channels and in north and northwest regions in relation with the higher concentration of industrial plants, particularly chemical and metallurgic, whose effluents discharge into those regions. Relationships between heavy metal concentrations with clay content and clay mineral species in the sediments were established.

### IMPACTO AMBIENTAL DE VERTIDOS URBANOS EN UNA MARISMA LITORAL DEL GOLFO DE CADIZ

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Levels of contamination were determined in a channel close to Cadiz Bay. Contamination was due to undepurated urban effluents from a population ca. 100.000 inhabitants. This channel provides seawater to saltmarshes, 5.500 Ha in extension, used for extensive marine aquaculture. Chemistry analysis indicated that the highest contamination was found in the central part of the channel, nearby to location of urban sewage effluents. Mean levels of nutrients in this zone was highest than 35, 4, 6 and 6  $\mu\text{M}$ , respectively for  $\text{NH}_4^-$ ,  $\text{NO}_2^-$ ,  $\text{NO}_3^-$  and  $\text{HPO}_4^{2-}$ .

### A PRELIMINARY STUDY ABOUT THE POPULATION GROWTH OF MICROALGAE IN MONOSPECIFIC CULTURE AND THEIRS RELATED BACTERIA.

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Interactions between microalgae and bacteria populations are few known. In this preliminary study, the evolution of growth in culture of several microalgae species and the bacterial flora associated was determined. Among the microalgal species studied (*Tetraselmis suecica*, *Dunaliella salina*, *Isochrysis galbana*, *Monochrysis lutheri*, *Chaetoceros calcitrans*, *Chaetoceros gracilis* and *Porphyridium cruentum*), there is an evident parallelism about the growth of the bacterial and microalgal population.

In the same way, the rate of biomass between both populations was measured during the growth, using the usual culture methods. Finally, we have isolated the heterotrophic bacterial strains from each specie of cultured microalgae, with the aim to identify them and check the specificity level between the bacteria and the microalgae.

### COMPORTAMIENTO DEL ALQUILBENCENO LINEAL SULFONATO EN SISTEMAS COSTEROS

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This study addresses the fate of LAS in the Bay of Cádiz (SW, SPAIN), specially considering the adsorption process onto suspended solid and sediment.

The measured values in suspended solids are one thousand higher than those found in seawater. This results indicate that the principal cause of LAS removal of the water column is adsorption onto the particulate matter and subsequent sedimentation of the particles.

The existence of biodegradation metabolites of LAS (SPCs) in seawater samples, shows that the biodegradation is also involved in surfactant removal of the water column.

Both processes, adsorption and biodegradation, are responsible that distribution of LAS homologs in water and marine sediments is not the same of comercial LAS.

The proportions of C<sub>12</sub> and C<sub>13</sub> LAS in the sediment were higher than those in water, because of their high adsorption and scarce biodegradation in this compartment. This fate of LAS has a lot of ecological implications because LAS toxicity increases with length chain (Kimerle y Swisher, 1977).

Kimerle, R.A., Swisher, R.D. (1977). *Water Research*, 11(1): 31-37.

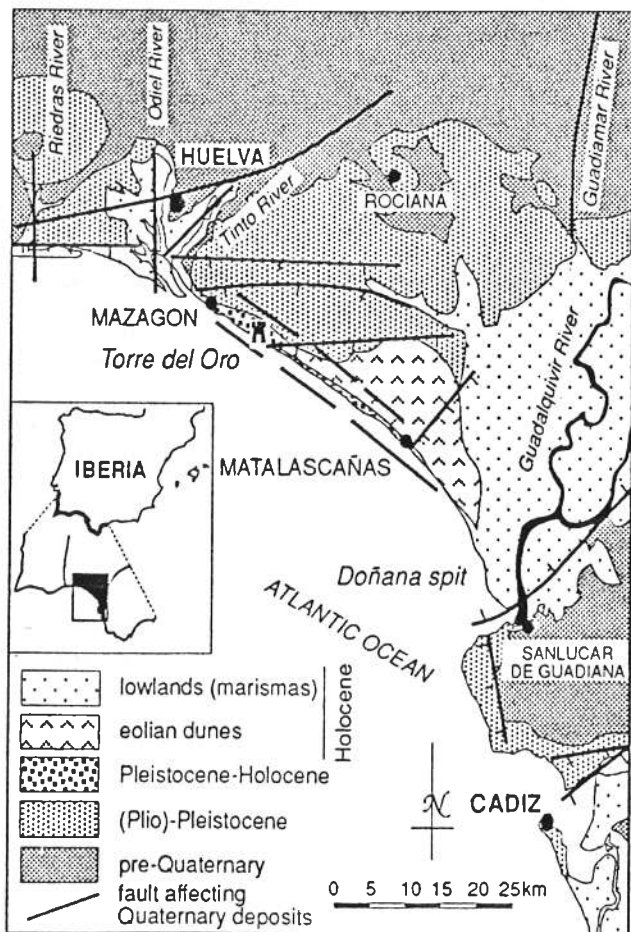
### FAULT-CONTROLLED SHIFTING SHORELINES IN THE GULF OF CADIZ SINCE 20 KY. BP

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A multidisciplinary study of the Pliocene to Present sediments along the coast of Huelva, between the Guadiana and Guadalquivir rivers is under way since the middle 1770's.

Studies include detailed geomorphological mapping, field sedimentology, drill-core analysis and 14C dating.



There is evidence that the present-day coastal morphology is the result of successive shifting of the coastline that were induced by repeated reactivation of E-W, N-S, AND NW-SE trending fault systems that extend from the mainland into the inner shelf.

Particularly-prominent movements occurred during the last 20 Ky between the Tinto and Guadalquivir estuaries. These faults are referred to, and pictured on a map, for the first time in this paper.

Fault movements were mostly vertical, with typically down- thrown southern blocks.

Nevertheless, variable tilting of the moving fault-blocks generated surfaces inclined not only to the south but towards other directions as well (relative tilting of blocks not always facing to the south).

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### TOWARDS A COASTAL MORPHODYNAMIC MODEL OF THE BAY OF CADIZ (SOUTHATLANTIC SPANISH MARGIN): METHODOLOGICAL APPROACH

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The work deals with the methodology proposed for studying the coastal morphodynamics of the Bay of Cádiz (Southatlantic spanish margin). The Bay of Cádiz was formed during the upper Pliocene, by the means of a tectonic sinking. Since then it has suffered a progressive sedimentation in marshland environments, being separated from the open sea by extensive and still growing spits. The methodology proposal consists on four main working phases:

1) Physical processes.- A continuous pursuit of the incident wave dynamics is done (starting from data collected by an offshore buoy), as well as an almost daily visual estimation of the characteristics of breaking waves at several points of the coast.

2) Sedimentological analysis.- Consist on sistematic sampling, granulometric analysis,

mineralogical determination textural classification of the beach sediments.

3) Geomorphological study.- Includes monthly transverse beach profiling (with teodolite) and a longitudinal study through the elaboration of a detailed geomorpho-dynamic map.

4) Historical study.- By the means of a compilation of ancient historical and recent maps, aerial photographs and other images, for establishing velocities of coastal morphological change.

All these data will help to elaborate a mathematic model of the morphodynamic behaviour of the coast, as well as a predictive model, taking into account the historical impact associated to ancient and recent human activities.

### BEACHED BIRD SURVEYS IN PORTUGAL, 1990-1994

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In winter, vast numbers of seabirds from several species occur in Portuguese waters, using them as overwintering grounds or in their migration to more southern areas. During this period these birds can be affected by severe weather conditions, which may represent a major cause of mortality, especially to juveniles and other vulnerable groups. Some human activities can also result in increased seabird mortality and the best documented examples include the widespread use of gill-nets (resulting in massive drowning of diving birds) and oil transportation in tankers cruising near the shore leading to chronic pollution or accidental contamination of coastal waters.

Beached Bird Surveys have been carried out in Portugal since 1982, in order to monitor winter mortality of seabirds there. Standard methods involve walking sandy beaches along the shore from October to March and recording the numbers of birds and the species involved. Causes of mortality and the physical condition of corpses are also recorded, enabling the temporal and geographical pattern of the casualties to be further analyzed. Information is also collected on the levels of oil contamination of the coastal stretches examined and from the birds found dead there.

The results obtained between 1990 and 1994 show that most strandings occur between Peniche and Nazaré, especially on sectors facing dominant NW winds. The density of corpses (expressed as the number of seabirds found dead per Km walked) were fairly constant between October and January each year, with a peak value in December, and then decreasing markedly in February and March. Most casualties involved Razorbills *Alca torda*, Gannets *Sula bassana* and Gulls *Larus spp.*, usually juvenile or immature forms.

The incidence of oil contamination is generally low especially when compared with results obtained on northern european countries. Confirmed situations of mortality due to gill-net entanglement are now also rather scarce, although they can be locally relevant particularly near some fishing settlements.

Since 1991 this monitoring program was integrated into an european network (following international standard methods). This as provided updated scientific information on seabird ecology and also on their use as monitors of the effects of human activities on the marine environment.

### FAUNA Y FLORA BENTONICAS DE LA RIA DE FERROL (NW DE ESPAÑA): PATRONES DE ZONACION Y VEGETACION BENTONICA

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INTRODUCCION.- El presente trabajo es resultado del estudio de la flora y vegetación bentónica marina de la Ría de Ferrol, llevado a cabo entre agosto de 1989 y marzo de 1991, y de la recopilación de la información existente sobre ella. De dicha ría ya fue ofrecido anteriormente su catálogo florístico (Granja et al., 1992).

MATERIAL Y MÉTODOS.- Para la elaboración del presente trabajo han sido estudiadas muestras procedentes de un total de veinte localidades intermareales, de las que seis fueron visitadas periódicamente y catorce visitadas esporádicamente. Para realizar el estudio de las comunidades de la zona intermareal, con la intención de caracterizar los principales tipos de vegetación bentónica presentes en la Ría de Ferrol, se escogieron seis localidades representativas de los diferentes tipos de vegetación de la Ría. Para dividir y describir las franjas litorales se ha seguido la clasificación de Womersley & Edwards (1952), adaptada para las costas ibéricas por Seoane-Camba (1969).

RESULTADOS.- De cada una de las seis localidades características se ofrece un esquema de las principales cinturas de vegetación y de la zonación de las principales comunidades. Se presenta también su catálogo florístico, indicando, para cada taxon, en qué comunidades puede ser encontrado.

CONCLUSIONES.- En general, la vegetación bentónica marina de la Ría de Ferrol es similar a la estudiada por autores anteriores en otras rías gallegas [Pérez-Cirera, J.L., (1976), Pérez-Cirera, J.L. & Maldonado (1982), Pérez-Cirera, J.L. & Pacheco, J., (1985)]. Los datos que se ofrecen en este trabajo podrán ser muy útiles para evaluar los efectos y la regeneración de las

comunidades bentónicas de esta ría, después de la reciente marea negra provocada por el buque "Aegean Sea" que la afectó gravemente.

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**MODÉLISATION DES MARAIS SALÉS, DÉVELOPPEMENT DANS L'ESTUAIRE DU RIO MIRA**

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A model is developed with data from the Rio Mira in order to simulate the biomasses of the halophytic grass *Spartina maritima* with a differentiation between the dead and live parts.

**ALGUNOS ASPECTOS SOBRE LA BIOLOGÍA Y PESCA DE LA ACEDÍA (*DICOLOGLOSSA CUNEATA*, MOREAU, 1881) EN LA REGIÓN SURATLÁNTICA ESPAÑOLA (GOLFO DE CÁDIZ)**

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La acedía (*Dicologlossa cuneata*, MOREAU, 1881) es un soleido de elevado interés comercial en el área de estudio, pudiéndose considerar como una de las especies objetivo de las pesquerías demersales de la región.

La pesca de la acedía cobra mayor relevancia en la provincia de Cádiz, realizándose los desembarcos mas importantes en Sanlúcar de Barrameda y Puerto de Santa María (34 y 33 % del total desembarcado en la

región respectivamente), siendo la flota de arrastre la principal responsable de su explotación pesquera (aproximadamente el 90 % de las descargas totales de la especie). El análisis de la serie histórica de desembarcos realizados entre 1984 y 1993 indica la existencia de una marcada estacionalidad en la pesquería, siendo ésta típicamente invernal. Los mayores desembarcos tienen lugar durante el periodo de noviembre a marzo, destacando los meses de enero y diciembre.

En cuanto a la biología de esta especie, el rango de tallas muestreado ha oscilado entre 13 y 23 cm para los machos y entre 13 y 26 cm para las hembras. La presencia de hembras maduras (estados III, IV y V) en los meses de mayo de 1993 y durante el periodo comprendido entre septiembre de 1993 y mayo de 1994, pone de manifiesto la existencia de un amplio ciclo reproductor, centrándose el periodo de reposo sexual durante los meses estivales. Así lo confirman tanto las evoluciones mensuales del Índice Gonadosomático como del Factor neto de condición estimados. Estos datos son totalmente opuestos a los aportados por Forest (1973, 1975) y Lagardère (1982) para la acedía del Golfo de Gascuña, la cual presenta un periodo reproductivo típicamente estival.

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**POLEWARD LARGE-SCALE TRANSPORT ALONG THE IBERIAN-MORROCCAN SLOPE ON THE BASE OF HYDROGRAPHICAL AND BIOLOGICAL DATA**

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The poleward undercurrents of NE-Atlantic Eastern Boundary Current upwelling systems were anticipated to be interconnected, and to coincide with the intermediate salinity minimum layer. This hypothesis

was tested by 3 seasonal, multidisciplinary surveys along the Iberian and Moroccan slope by long-term current meter moorings, CTD casts and biological sampling.

The selected biological tracer was the preadult resting stage (copepodite C5) of *Calanoides carinatus*, basically a pseudo-oceanic South Atlantic copepod species, abundant also in the tropical African upwelling areas. This stage, resting generally at 400 - 800 m depth, drifted northwards along the Moroccan slope in the intermediate salinity minimum (of some NACW-characteristics).

Off the Iberian Peninsula, the affinity to the same, but vertically less extended salinity minimum was seemingly (though perhaps falsely) inconsistent. A decrease in abundance (and a deeper relative vertical distribution of the few remaining specimens) occurred in the Gulf of Cadiz with the intrusion of Mediterranean Water into the normal depth range of C5, particularly when Mediterranean Water off southern Portugal had a shallow upper boundary in autumn 1991. It is concluded that at that time the undercurrent had been displaced westwards by the Mediterranean Outflow, and that the autumn transect off Portugal did actually not sample the core of the population.

The structure of the winter population 3 months later suggested, that the autumn mode of C5 had in the meantime displaced northwards towards central Portugal, and that the population was maturing. Coinciding with a somewhat deeper upper boundary of Mediterranean Water, the distribution of C5 was meridionally uninterrupted and its vertical distribution closer to normal. However, adult *C. carinatus* were less abundant at stations in the Mediterranean Outflow.

Reproduction had already taken place in spring 1991, when most of the population off southern Portugal belonged to the new generation, but overwintering C5 (at slope stations as well as along a cross-slope transect off northern Portugal) again displayed an affinity to the salinity minimum. These latter CTD-data and most slope moorings between Casablanca and Cape Finisterre indicate northward flow also above the Mediterranean Water at some 400 to 600 m depth.

It is concluded that summer stocks of *C. carinatus* reported from off the British Isles are maintained by C5-stages originating from more southerly upwelling regimes. They are entrained by the poleward undercurrent, which is consistent in space and time from tropical latitudes to at least the British Isles, and crossing the Mediterranean Outflow off the Gulf of Cadiz.

## A STUDY OF THE MONTHLY FIXATION OF FOULING ORGANISMS IN THE PORT OF VIGO OVER JANUARY-DECEMBER OF 1993

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The main objective of this work is to study the monthly fixation of fouling organisms in the port of Vigo during twelve months, from January to December of 1994, and to establish the maximal and minimal fixation periods of encrusting organisms.

An experimental float anchored in the port of Vigo was used, in order to carry out the study. The PVC plates, 15 cm x 20 cm in size, were fixed to stainless-steel supports, which were introduced vertically in the float. These, submerged the surfaces to be studied to depths of 20 cm and 80 cm. Two plates corresponding to both experimental depths were extracting monthly and replaced by two clean plates. In this way, "monthly plates" were available to take to the laboratory, where the study of a central square of 100 cm<sup>2</sup> was carried out. The study consisted in identifying the species present in each sampled square and assigning a covering index for each one of the species.

During the first five months of the study (January, February, March, April and May) a minimal fixation of animal fouling was observed, though, algal cover was considerable. However, the plates which were in place during June were extensively colonized by barnacles (*Balanus* spp.). The plates of the two following months (July and August) presented a great algal cover, which was replaced by an important settlement of Hydrozoans in September. During the last three months of the study (October, November and December) a minimal fixation period was observed again, in which, the plates presented a slime constituting by Bacteria, Protozoa and Microalgae.

## BASIN-FILL MODELS AND TURBIDITE EMPLACEMENT ON THE HORSESHOE AND TAGUS ABYSSAL PLAINS (IBERIAN MARGIN)

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The Horseshoe (HAP) and Tagus (TAP) abyssal plains are located on the Iberian margin, south of the Tore



seamount, and confined within topographic elevations. As no flow can escape, all the incoming sediment remains trapped in the plains. They are built by an alternation of turbidites and pelagites. The major sources of terrigenous material are the submarine canyons which incise the Portuguese shelf: the Tagus and Sado canyon system feeds the TAP whereas the São Vicente canyon feeds the HAP. A minor source of sediments are the surrounding seamounts. An intensive study of 14 piston cores, based on visual observation (colour and thickness), relative stratigraphic position of units, magnetic susceptibility and P-wave velocity logs, calcium carbonate content and mineralogy of bases of turbidites, was carried out aiming to correlate each single turbiditic unit.

The two abyssal plains possess a different geometry and particular sources of sediments leading to distinct depositional models. The HAP is characterised by laterally continuous units from both giant and smaller flows arriving from the canyon and covering the entire plain. On the other hand, the TAP shows a more complex structure, with multiple sources and laterally discontinuous units. Detailed grain size analysis performed in the four thickest turbidites of the HAP allowed examination of their vertical and lateral variation, and inference of the position of the sediment entry points, the transport paths and the hydrodynamic characteristics of the flows.

In addition, foraminiferal counts in the intervening pelagic units of the TAP and HAP were performed aiming tie them into glacial/interglacial climatic episodes and an age model. This permitted estimation of the time and frequency of emplacement of turbidites and, then, inference of whether the triggering causes are climatic or tectonic.

### LATE QUATERNARY PALEOCEANOGRAPHY OFF IBERIA: TORE SEAMOUNT (39°N, 12°W).

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The study of the Tore seamount contributes to a wider knowledge of the pelagic sedimentation off the Iberian margin. Its record can be used as a litho and chronostratigraphic template for the pelagic components of deep cores collected in the surrounding areas.

Core D11957P provides a continuous pelagic record unaffected either by turbidity currents or chemical dissolution, as the core site lies at 3547 m, well above the position of the Carbonate Compensation Depth in the North Atlantic Ocean. A strong relationship exists

between colour, calcium carbonate content and oxygen isotope values showing the sequence of glacial/interglacial climate changes back to isotope stage 7 (225 Kyr). The rate of sedimentation estimated for this area is 3.58 cm/kyrs. Paleotemperatures estimated using the CLIMAP FA20 equation give the lowest values for glacial stage 4, Termination I, and interstadial 3.2 while glacial stage 6 shows less severe temperatures. The magnetic susceptibility record plotted on a carbonate free basis, used to infer changes in the composition of detrital components, is consistently lower during glacials. Thus the occurrence of particularly high values is noticeable during cold events 3.2 (HL 4) and 5.2, and to a lesser extent 5.4.

The Heinrich events, ice-rafting pulses, recognised further North and off Labrador, are also represented here. This southernmost point has not previously been regarded as being within the path of icebergs which drifted according to the North Atlantic surface pattern circulation. The supporting distribution of the polar foraminifera species *Nq. pachyderma* (s) and the subpolar species such as "P-D intergrade" and *Ga. quinqueloba* leads one to suggest the transport of icebergs within the southern boundary of the North Atlantic Drift, thence southwards merging into the Canary Current. Heinrich layer (HL) 3, as in other cores in the North Atlantic lacks in dolomite and it is not recognisable by magnetic susceptibility, but on the other hand does not decrease in the incidence of foraminifera shells. The origin of reddish feldspars in Heinrich layers, must also be explained by ice-rafting. Their most probable provenance is the Carboniferous and Triassic red beds of the Maritime Provinces of Canada. Icebergs from this source would have been entrained in the southern side of the eastern flowing current of the subtropical gyre. Some of them arrived at the Tore Seamount in the ancestor of the Canary current, but during the warmer period early in isotope stage 3 all the icebergs yielding HL 5 elsewhere had melted before they could get to 39°N, 12°W. At Tore Seamount, despite the peculiar differences of HL 3, Heinrich layers 1, 2, 3, 4 and 6 could all have the same provenance.

The palaeoproductivity history of this site was inferred looking at the traditional proxies, namely organic carbon, planktic and benthic productivity-associated foraminifers and the  $\delta^{13}\text{C}$  record of *Globigerinoides ruber*. All the proxies considered confirm an enhancement of productivity from stage 5 to stage 2, with a minimum during stage 4.



## SEDIMENTARY PROCESSES CHARACTERIZATION IN FUNCTION OF ECO-CHARACTER DISTRIBUTION IN THE CADIZ ATLANTIC CONTINENTAL SHELF

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The acoustic character determination by means of high resolution seismic profiles of 3.5 kHz has been applied in the Atlantic Continental Margin over the shelf and slope of Cádiz. 17 echo types have been defined which are classified in 7 echo class: 1) *transparent*; 2) *weak to little transparent*; 3) *opaque with high reflectivity*; 4) *irregular*; 5) *hyperbolae*; 6) *wavy*; and 7) *others*. The microphysiography, lithofacies and sedimentary processes (depositional, erosive and gravitational) have been determined in function of the seismic characteristics of each echo type and their regional distribution. In the infralittoral domain, in the septentrional sector prevails the fluvial-deltaic depositional processes in relation with the Guadalquivir River mouth. Moreover in the central and meridional sectors prevail the infralittoral depositional processes and the development of discontinuous sandwaves fields. In front of the Bay of Cádiz coexistent the depositional processes of sedimentary input of the inner bay and the erosional processes due to a strong tidal stream. In the continental shelf domain three sectors have been differentiated: a) a septentrional sector where the fluvio-deltaic depositional processes prevail in relation with the Guadalquivir River input determined a sedimentary dynamics towards the SE in relation to the North Atlantic Surficial Water; b) a central sector with the presence of large sands bodies (sand-waves and megaripples) over a shallow abrasion shelf at 25-30 meters depth, and 3) a meridional sector where coexistent the fluvio-deltaic depositional processes in relation with the Barbate River input and the erosive processes due to the interactions of a water flow towards the N-NW. In the shelf break predominates the progradational depositional processes in the septentrional and central sector and the combined processes (neotectonic and depositional) in the southern sector. In the Upper slope predominates the depositional processes which produce the slope aggradation and progradation, gravitational and erosive processes due to the interaction of a Superficial Atlantic Water Flow with the sea floor. In the middle slope prevails the erosion processes in relation to the interaction of the Mediterranean Outflow (toward NW) with the sea floor, and the combined processes (erosive, gravitational and depositional) in relation to the through and submarine canyons occurred.

The echo-character analysis is a useful methodology of interpretation of recent sedimentary processes over the

slope and continental shelf. The acoustic character classification proposed is a function of the response of the seismic waves below the sea floor by means of high resolution seismic profiles of 3.5 KHz, determining the seismic lithofacies and the sedimentary processes. Moreover, in relation to the surficial sediment samples distribution we have noted that some echo types show a vertical seismic lithofacies without correlation with the surficial sedimentary facies. So, the sedimentary processes determined by echo-character are a important information about the vertical deposits sequence, but the surficial sedimentary processes are determined by means of classical method of marine sedimentology, currents analysis, temperature measurements, salinity measurements, etc..

## VARIABILIDAD DE LA MORTALIDAD CELULAR EN *ENTEROMORPHA PROLIFERA* (O.F. MÜLLER) J. AGARDH (ULVACEAE, CHLOROPHYTA) SOMETIDA A CONDICIONES DE CONTAMINACION

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Como una posible medida del impacto ambiental sobre individuos de algas sometidos a ambientes contaminados, se ha utilizado la proporción de células muertas en los talos de *Enteromorpha prolifera*.

La tasa de mortandad celular en un individuo se obtiene mediante recuento celular directo al microscopio, previa tinción con colorantes vitales (rojo neutro).

El supuesto efecto ambiental resulta poco apreciable sobre la variabilidad individual, pese a ser significativo estadísticamente. Mediante un análisis detallado de cada muestra, considerando el mes en que se efectuó la recolección, se observa que hay diferencias, aunque los resultados varían según los individuos y el momento de su recolección.

La mayor mortalidad celular parece depender del momento en que se realiza la recogida de muestras, al variar en el tiempo las concentraciones de tóxicos y no ser éstos los únicos responsables de tal mortandad.

Los datos, por tanto, no permiten afirmar concluyentemente la existencia de una mayor mortandad celular en la localidad contaminada, aunque sí aportan fuertes indicios causales.

**ESTUDIO DE LA COLONIZACION Y  
SUCESION DE LA COMUNIDAD DE  
*FUCUS SPIRALIS* (LINNAEUS)  
(FUCACEAE, PHAEOPHYTA) EN LAS  
CERCANIAS DE UN COLECTOR DE  
AGUAS RESIDUALES**

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En la ría de Pontevedra (N.O. de la Península Ibérica)  
se ubica un complejo industrial dedicado a la  
fabricación de pasta de papel y cloro-sosa.

En las cercanías del colector de aguas residuales de  
dicho complejo, se ha realizado (durante un período de  
20 meses), un estudio de la colonización y sucesión  
(mensual) de una superficie esterilizada y colonizada  
inicialmente por *Fucus spiralis*.

Al igual que HUVÉ (1969), se han observado cuatro  
fases diferentes, según los grupos algales que se van  
sucediendo (o reemplazando) en el tiempo.

Se ha observado, igualmente, una capacidad de  
recuperación de la comunidad climácica, de sólo un  
año, aproximadamente, que depende de la época en  
que se halla realizado la esterilización de la superficie  
muestreada.

**MODELO DEL EFECTO DE LA  
CONTAMINACION INDUSTRIAL  
SOBRE LA COLONIZACION Y  
SUCESION DE COMUNIDADES  
ALGALES DE LA RIA DE  
PONTEVEDRA (N.O. DE LA  
PENINSULA IBERICA)**

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Se seleccionaron superficies semejantes en dos  
localidades de dos rías gallegas: Muros-Noia (no  
contaminada) y Pontevedra (contaminada por aguas  
residuales de industrias dedicadas a la fabricación de  
celulosa y cloro-sosa).

Tras la esterilización de superficies colonizadas  
inicialmente por la comunidad de *Fucus vesiculosus*, y  
la observación mensual del proceso de colonización y  
sucesión, en sustratos, se han detectado las siguientes  
diferencias entre las dos localidades:

- Una colonización más rápida en la localidad  
contaminada.

- Una mayor permanencia de las clorofíceas  
durante la colonización en la localidad no  
contaminada.

- Un tiempo de recuperación de la comunidad  
climácica superior a dos años en la localidad no  
contaminada, e inferior a un año en la sometida a  
contaminación.

Fundamentándose en estas observaciones, se propone  
un modelo del efecto de la contaminación en el que se  
determina que, las variaciones temporales de la  
colonización y sucesión de las comunidades son  
consecuencia de las condiciones ambientales en que se  
desarrollan.

**DIVA 1: DIVING ON THE MID-  
ATLANTIC RIDGE BETWEEN 37°17'N  
AND 38°20'N (SEGMENTS - LUCKY  
STRIKE, MENEZ GWEN AND  
38°20')(1)**

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The authors participated in the DIVA 1 cruise, and  
dived to the Lucky Strike and Menez Gwen sites. Here  
we provide information to support a poster  
presentation, previously published by the DIVA 1  
scientific team (Fouquet et al and Charlou et. al., EOS,  
in press, 1994).

The DIVA 1 (Diving in Vents at Azores) cruise was  
promoted by IFREMER and had the co-participation  
of the University of Lisbon and Woods Hole  
Oceanographic Institution. The mission took place a  
board of the Nadir, in May 5 to 29, 1994. The main  
objectives of the cruise were to dive using the Nautile  
submersible on three previously selected areas WSW  
of the Azores Islands, on the Mid-Atlantic Ridge  
(MAR): Lucky Strike (37°17'N), Menez Gwen  
(37°50'N) and 38°20'N segments, in order to study the  
hydrothermal systems and their relations with the  
volcanic and tectonic processes.

For the first time during the DIVA 1 mission,  
combined analyses of CH<sub>4</sub> (methane) and H<sub>2</sub>S  
(sulphide) tracers made on board immediately after each  
dive, were used to detect evidence of hydrothermal  
plumes. This method proved to be effective and was  
the most important towards the discovery of the new  
Menez Gwen hydrothermal field.

One of the most striking results of the cruise was the  
discovery of two lava lakes, located on the Lucky  
Strike and Menez Gwen zones. These are very recent  
features, characterized by successions of fresh basalt  
piles supporting lobated roofs, and had never been  
observed before on a slow spreading ridge as the  
MAR. The Lucky Strike lava lake lies in a depression  
situated at a depth of 1700m, between three volcanic  
cones that mark the summit of a major volcanic

structure. The several new vents that were discovered here during the cruise, as well as the previously known ones, are all around the lava lake. The Menez Gwen lava lake, situated in the southern part of a wide graben, does not display any evidence of active hydrothermalism.

Very young sheet flows of "pahoehoe" lava type were observed in the Lucky Strike and Menez Gwen segments. This is another important observation that had never been made on the Atlantic rift. In the Lucky Strike zone this kind of highly fluid lavas were observed on the bottom of the inner valley at a depth of 2100m, thus marking the neovolcanic axis in this area. The sheet flows in Menez Gwen are associated with its lava lake and cover the central part of the graben.

The 38°20'N segment is the shallower zone studied (500m) and has less importance when compared with the other two regions. No hydrothermal activity was found, although there are some data that indicate the possibility of low temperature hydrothermal circulation.

### PHYSICAL AND BIOGEOCHEMICAL ASPECTS OF RESUSPENSION

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This study aims to investigate how resuspension (*in vitro*) affects the dynamics of inorganic dissolved reactive phosphorus (DRP) pool in shallow water sediments which are being exposed to a decrease in P loading from land. Emphasis is given on the combined physical (e. g. bed erosion) and biogeochemical (e. g. DRP and O<sub>2</sub> pools) aspects of resuspension.

### NUMERICAL MODELLING OF WATER MASS EXCHANGES THROUGH THE STRAIT OF GIBRALTAR

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The simulation of water fluxes through the Strait of Gibraltar and of the Alboran Sea dynamics is carried out. In this sea, two different water layers can be distinguished: the outgoing deep mediterranean water and the incoming surface atlantic water. Therefore to deal with this stratified structure a multilayer shallow water model is used. The shallow water hypothesis are considered in each layer and then coupled with an appropriate term of interface. To solve

this coupled system discretization are used. Some numerical results are presented.

### GLAUCONITE CHARACTERISTICS AND DISTRIBUTION IN THE SAND FRACTION OF THE RECENT SEDIMENTS OF THE CONTINENTAL SHELF NEXT TO CADIZ (SPAIN).

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The analysis of the content and distribution of glauconite in the sand fraction of the recent sediments of the continental shelf near to Cádiz (Spain) reveals, firstly, that the content of this mineral is not superior to 3 % and, secondly, that the highest contents are placed in two distant and good differentiated sectors under an environmental point of view. One of them in the N of the zone and related with the mouth of Guadalquivir river, in the inner shelf. Another, farthest, at SW of Cádiz, in outer shelf areas, at depth higher than 100 m. Glauconite grains present a size between 60 and 500 microns, and basically two kinds of morphologies: lobated grains and internal tests of benthonic foraminifera, and in both, dark green colour.

The use of Multivariant Statistic Analysis applied to the data from glauconite contents in the sediment, together with siliciclastics (quartz, mica, rock fragments, heavy minerals) and carbonated components (benthonic and planktonic foraminifera, mollusc, bryozoans, equinoderms, spicules, ostracods, etc.) and the depth, has permitted to determine that the glauconite present in this zone appears with two different shapes and origins. One of them related with the detrital components of the sand fraction, and with the depth. The other, associated with the benthonic and planktonic foraminifera, is well correlated with the depth.

It may be concluded that: a) The dark green colour of the grains indicates a fully-developed state in the glauconitization process, that appears frequently in the fine and medium sand sizes (60 to 500 microns), although it can not be excluded its presence in the more fine fractions of the sediment; b) the grain shape and size are limited by the foraminifers tests and the lobated granular shapes may, at least partly, proceed from the reworking of previous shapes.

Glauconite origin presents a clear authigenic origin, specially in the internal moulds of the foraminifers tests. These can appear "in situ", specially in outer shelf zones, whereas, in the shelf edge and the upper part of the slope, it can be found non-autoctonous shapes produced by gravitational removal, currents, etc.

In litoral zones, glauconite appears to have a detritic origin due to reworking of authigenic shapes previously generated.

Its origin appears to be related, firstly, with the presence of foraminifers in the sediment and secondly, with the clay minerals content, of the same kind that serves as substrate to the benthonic foraminifers in which inner part is present the glauconite.

Lobated grains appear to have an authigenic origin, from the clay minerals transformation and clearly related with the depth of the water column and the lower sedimentation rate.

### MORPHOSTRUCTURAL CONTROLS ON THE COASTAL SEDIMENTARY DYNAMICS IN THE SOUTH ATLANTIC SPANISH MARGIN (PROVINCE OF CADIZ, SPAIN)

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The coastal sedimentary dynamics and the transfer of sediments to the continental shelf is controlled, despite other factors, by the structural morphology of the coast and adjacent continental margin. The present work deals with the influence of structural lineations upon the coastal sedimentary dynamics in the Gulf of Cádiz, between the Guadalquivir river mouth and the Cape Trafalgar.

The orientation and morphology of the coast is controlled by several fault and joint families, prevailing the NNW-SSE and NE-SW directions in the faults and the WNW-ESE and N-S to NNE-SSW directions in the joints. The jointing direction WNW-ESE is the most important one and, in addition to other minor faults, lead to small E-W coastal portions. This structural scheme is responsible for the stepped coastal morphology of the coast, and for the existence of wide bays opened to the SW.

The morphostructural control upon the coastal sedimentation is reflected by the orientation of lineaments in the adjacent continent, especially river valleys, with two prevailing directions: NE-SW and NW-SE, in coincidence with the orientation of coastal straight segments. This also controls the location of river mouths at the North side of the bay, which favours the transport and accumulation of sediments along the shore.

The transfer of fine suspended sediments onto the shelf takes place directly from the river mouths, by the means of ebb tides and by the general coastal streams systems towards the SE. The transfer of coarser sediments (sands) is done through the erosion of coastal deposits (mainly beaches) and their transport to the continental shelf during storms.

### ESTABLISHMENT OF THE TRACE OF A OUTFLOW FROM THE BAY OF CADIZ TO THE ADJACENT CONTINENTAL SHELF.

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The general movements of the water masses and the associated sedimentary dynamics of the continental margin of the Gulf of Cadiz are known (Madelian, 1970; Melieres, 1974; Palanques et al., 1987; Nelson et al., 1993). However, the hydrodynamics aspects as well as the sedimentary exchange with the adjacent continental shelf are unknown in the bay of Cadiz. This paper shows the results of a granulometric and mineralogical study of sediments in this area. The statistic treatment allows us to establish the trajectory of a flow from the inner sector of the bay toward open sea, able of transporting fine sediments, and shows the existence of a hydrodynamic and sedimentary exchange among the bay and the adjacent continental shelf.

They are three different areas: 1) a coastal area with quartz-rich sands; 2) a muddy north area, extended from the estuary of the Guadalquivir river until the continental slope; and 3) a southern area, among the bay of Cadiz and the cape of Trafalgar, with sand and muddy sand (Segado et al., 1984; Gutiérrez-Más, 1992). In the clay fraction the most abundant mineral is illite, followed by kaolinite and smectites. Other minerals are interstratified illite-smectite, illite-chlorite, vermiculite and chlorite. The dominant mineralogical association, established by mean of factorial analysis (Q mode) is made up of illite and kaolinite.

As illite is the main clay mineral in all sector, the determination of possible source areas and transport trajectories must be based in associations among other minerals. For this reason, it has been used the Multivariate Factor Analysis (R mode). Factor 1 is controlled by interstratified illite-smectite (I-S1 and I-S2) and presents a great significance in the continental shelf, in front of the Bay of Cadiz and in the Bay itself. It is configured as a trace or transport trail that, from the bay and with different orientation in successive sectors, reaches deeper areas of the adjacent continental shelf. Factor 2 is meaningful to the N of the area, close to the estuary of the Guadalquivir river, and includes with high positive values (0.9) the interstratified illite-chlorite, indicating the trajectory of the sediment transport from this estuary toward the SE, following the general hydrodynamic system.

Bernal (1986) and Guillemot (1987), by mean of satellite images, show that in certain conditions water fluxes with particulate matter go through the bay limit and suggest three out flow linked with tidal reflux

flows: the first one, the most important, takes place through the main channel, by the center of the bay mouth, and is guided toward the S and SE by effect of the coastal drift. The second goes by the N of the bay, toward the WNW, between the estuary of the Guadalete river and Rota, reaching open sea. The last one takes place by the Caño of Sancti Petri, to the S of the bay. The emptied of the inner part of the bay is initiated once established the low-water situation in the waters of the outer part of the bay, so that the increase of sea level auspicious the flow toward open sea.

Consequently it is possible to think that the detected trace corresponds to the flux that, originated by the Guadalete river, goes by the northern margin of the bay, transporting sediments of this and other of smaller entity rivers. This flow transports particulate sediments from the bay to the continental shelf, where they are accumulated. In a first sector it is geared toward the W or SW and, in deeper waters (among 30-50m) it is guided toward the NW, where the atlantic flow (NASW) goes by the continental shelf with SE direction, being responsible of the transport of the fine sediments drifted by the Guadalquivir river, together with the coastal current of this same way.

The establishment and intensity of this flow depends on the interacción of several factors: a) existence of exceptional amplitude tides, generating important reflux currents; b) source areas and drifting of the rivers fluxing toward the bay of Cadiz in swelling moments; c) currents generated by east winds and west surge, and d) the action of the Coriolis force that produces the deflection of the flow toward the NW.

## O PROJECTO IAM: A ESTRUTURA PROFUNDA DA MARGEM IBERO-ATLÂNTICA

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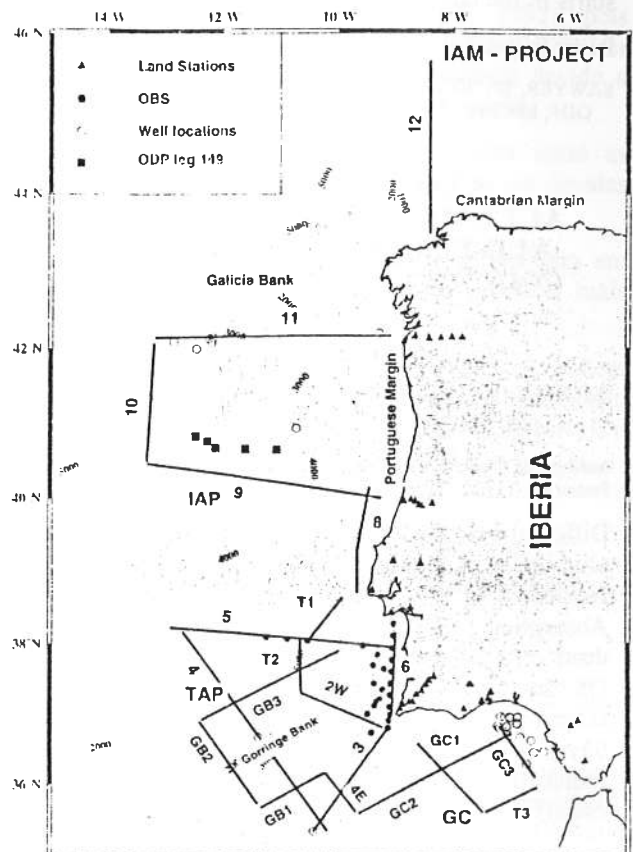
O projecto *Iberian Atlantic Margins Project* (IAM) financiado pela Comunidade Europeia no âmbito do programa JOULE foi elaborado para promover o estudo da crosta profunda continental e oceânica em áreas seleccionadas das Margens Atlântica da Peínsula Ibérica e melhorar a compreensão dos processos da respectiva formação.

Foram executados cerca de 20 perfis de reflexão profundos quase vertical num total de 3800 quilómetros, cobrindo a margem cantábrica, as Planícies Abissais Ibérica e do Tejo, a região do Banco de Gorringe e o Golfo de Cadiz. Foram ainda obtidos dados de refração e reflexão de grande ângulo em estações terrestres referentes a 11 dos perfis acima

mencionados. Por outro lado e assegurada a colaboração do Prof. H. Shimamura da Universidade de Hokaido, foram colocados no fundo do mar 25 "Ocean Bottom Seismographs" (OBS) que registaram também os sinais referentes aos perfis 2W, 3, 5 e 6.

Os perfis foram activados com um dispositivo de "airguns" (BOLT) constituído por 36 canhões distribuídos por 6 arranjos e arrastado a 10 metros de profundidade. A separação entre os disparos feitos à pressão nominal de 2000 psi foi, em geral, de 75 metros com uma janela de registo de 25 segundos. O "streamer" constituído por 192 canais distribuídos por 4.8 quilómetros e organizado em grupos de 25 metros foi rebocado a 15 metros de profundidade.

A partir do processamento comercial já efectuado é possível observar excelentes imagens de reflexão profundas na crosta continental e oceânica, o tectonismo no "basement" do Golfo de Cadiz, a estrutura diferenciada nos flancos do Banco de Gorringe e a extensão do olistostroma a SW do Cabo S. Vicente.





**PLEISTOCENE AND PLIOCENE  
SEDIMENTARY RECORD ON THE  
IBERIA ABYSSAL PLAIN - RESULTS  
OF ODP LEG 149**

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Leg 149 of the Ocean Drilling Program drilled a transect of holes (Sites 897 to 901) across the rifted continental margin off the west coast of Portugal (SAWYER, WITHMARSH, KLAUS et al., 1994). We discovered the history of turbidite sedimentation on the Iberia Abyssal Plain (IAP). Pleistocene-Pliocene sedimentation on the IAP consist of thin terrigenous turbidites (10 to 100 cm thick) separated by pelagic clay, marl and ooze. Most of the turbidites consist of ungraded massive silts and clays, occasionally with coarser bases. A huge number of turbidites were deposited in the last million years, on average 1 turbidite per 3200 years at Site 898A. Terrigenous turbidite sedimentation on the Iberia Abyssal Plain starts in the late Pliocene.

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**COMPARATIVE COPPER  
ACCUMULATION BY DEAD AND  
ALIVE MARINE MICROALGAE  
(*NANNOCHLOROPSIS GADITANA*  
LUBIÁN).**

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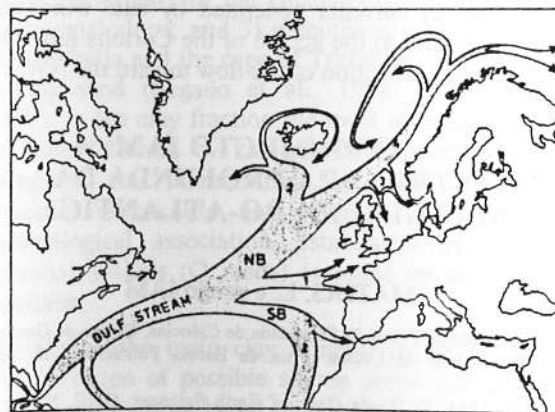
Different amounts of accumulated copper by dead and alive cells of *Nannochloropsis gaditana* Lubián are studied. The analysis of the samples, using Atomic Absorption Espectrophotometry techniques, shows that dead cells accumulate more copper than living cells. On the other hand, it can be appreciated that the largest amount of the accumulated copper ( about 95%) is easily removed with EDTA (that appears to indicate the extracellular situation of the most of the metal).

**OCEAN CIRCULATION, SEA LEVEL  
AND CLIMATE IN THE IBERIAN  
PENINSULA AND NORTHWEST  
AFRICAN REGION**

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The Gulf Stream is a gigantic circulation system that redistributes energy and water masses over the entire North Atlantic region. It consists of a northern branch leading up to high latitudes, an intermediate branch towards the Bay of Biscay and a southern branch towards the Gibraltar region and the Canary Islands. This is, of course, not a stationary system. The total input of warm equatorial surface water varies with time. Similarly, the distribution of water masses along the northern and southern branches varies on a compensational basis. Any imbalance in the distribution of water masses must be compensated by changes in the differential rotation of the Earth. Therefore, there exists a delicate feedback coupling between ocean circulation changes and interchange of angular momentum between the solid Earth and the hydrosphere (as first proposed by me in 1984 and followed up in greater details in a number of subsequent papers). This is observable (i.e. testable) in our records.



During the 20 Ka glaciation maximum, the polar front was displaced down to about Lat. 40° N with all the Gulf Stream circulation concentrated to its southern branch. This imposed quite peculiar paleoenvironmental conditions in the Gibraltar and Canary Islands region. A similar southward displacement of the Kuroshio Current took place in the Pacific.

During the Younger Dryas cold phase, the polar front was displaced down to Scotland-Ireland. Severe climatic conditions occurred in the whole of Europe and the North Atlantic. In the Gibraltar region, however, quite warm and humid conditions occurred as recorded by soils and peat along the coasts of southwestern Spain and Portugal. Also in the Pacific, the Kuroshio

Current bend southward allowing the cold Oyashio Current to penetrate southwards.

During the Holocene, we see similar opposed trends in northern Europe and in the Gibraltar region because of changes in the distribution of water along the different branches of the Gulf Stream.

New data indicate that changes in the balance between water transport along the Gulf Stream branches and the cold arctic water from the north plays a major controlling role also for the short climatic events of the Medieval Optimum and the Little Ice Ages. Hence, these events seem to have an oceanographic rather than solar origin.

The region including the Atlantic Iberian coasts, the Gibraltar water exchange area, the coasts of northwestern Africa and the Atlantic islands (the Azores, Madeira, the Canary Island ) occupies a perfect test area for the oceanographic, eustatic and climatic changes during the last 150,000 years, or so. It constitutes an ideal multi-disciplinary EC-project between relevant specialist from the areas in question and synthesizing theoreticians.

### LUDO FORMATION - A NEW LITHOSTRATIGRAPHIC UNIT IN QUATERNARY OF CENTRAL ALGARVE

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The non consolidated, mostly sandy posits of Central Algarve, loosely termed Faro-Quarteira sands, were lacking a stratigraphic setting. In order to permit a more objective approach to mapping of Upper Neogene and Post Neogene sedimentary series in this area, a new lithostratigraphic unit is proposed - The Ludo formation. The exact chronostratigraphic position of Ludo formation is still matter of discussion but existing data are pointing on Terminal Pliocene - Pleistocene age.

This study was possible thanks to support of JNICT within STRIDE AMB C/31/92 Project.

### ALIMENTAÇÃO DO CARAPAU NA COSTA PORTUGUESA

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O presente trabalho teve por objectivo caracterizar qualitativa e quantitativamente a alimentação do Carapau, *Trachurus trachurus* (Linnaeus, 1758) na costa portuguesa e a sua variação ao longo do crescimento dos indivíduos.

Este estudo poderá no futuro contribuir para o desenvolvimento e implementação de métodos multiespecíficos na gestão de pescas, ou ainda fornecer possíveis explicações para diversos fenómenos relativos à dinâmica da espécie (nomeadamente deslocações e distribuição sazonal das várias classes etárias pela costa portuguesa).

Foram analisados 1877 conteúdos estomacais de Carapau, recolhidos em animais capturados por arrasto de fundo ao longo da costa portuguesa entre as batimétricas dos 20 e dos 500 metros.

As presas presentes nos conteúdos estomacais foram identificadas até à espécie sempre que o seu estado de digestão o permitiu e foi determinado o peso total de cada espécie em cada conteúdo.

Foi posteriormente usada uma técnica de análise multivariada (cluster analysis) para agrupar amostras relativamente homogêneas, do que resultaram três classes de comprimento dentro das quais os carapaus têm uma alimentação semelhante.

Os resultados obtidos só poderão ser considerados válidos para o período em que foi feita a amostragem (entre Julho de 1990 e Fevereiro de 1992), pois noutras alturas a alimentação do Carapau poderá ser significativamente diferente, nomeadamente devido a alterações nas abundâncias das espécies-presa.

As diferenças na alimentação, verificadas entre as diferentes classes de comprimentos podem ser devidas a dois factores:

- A capacidade que os animais maiores têm em capturar presas de maiores dimensões e mais rentáveis do ponto de vista energético.
- Mudanças nos seus hábitos, que se podem traduzir na permanência em habitats onde têm acesso a presas diferentes das que estão acessíveis a animais de outras dimensões.

### SIBLING SPECIES OF ARTEMIA POPULATIONS OF PORTUGAL

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The brine shrimp *Artemia* sp. is a crustacean branchiopod widely distributed throughout the world. Several species have been identified in the Old and New World. Through morphological characteristics, mode of reproduction and cross-breeding experiments we identified two species in Portugal, *Artemia parthenogenetica* and *A. franciscana*. Unfortunately, the bisexual autochthonous species *A. tunisiana* is no more present in Portugal.



**GEOGRAPHICAL VARIATION OF LIFE  
CYCLE TYPE OF THE SHRIMP  
*PENAEUS KERATHURUS*  
(CRUSTACEA, DECAPODA) IN THE  
COASTAL WATERS OF PORTUGAL**

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Four life cycle types are commonly accepted for marine penaeid shrimps, ranging from entirely estuarine species (Type 1) to exclusively oceanic ones (Type 4). Most of the species of the genus *Penaeus* have Type 2 life cycles. Spawning takes place offshore and the planktonic stages migrate inshore towards the end of the larval development, when the postlarvae settle in the estuaries or estuarine-like environments. In this way, it is commonly thought that those species never have entirely estuarine life cycles. However, field observations along the coastal waters of Portugal point out that *Penaeus kerathurus* has two different types of life cycle according to geographical location. In the estuarine-like Ria Formosa, and in the Mira and Tejo estuaries *Penaeus kerathurus* behave like a Type 2 species, while in the Sado estuary it has an entirely estuarine life cycle (Type 1). Capture of mature and ripe females or males were regularly observed for the last three years during the reproductive season in different locations within that estuary. Strong current fields of the northward flow of the shallow water mass of Mediterranean origin along the western coast of Portugal in the area close to the Sado estuary and the particular pattern of the general circulation within the estuary, are suggested as responsible for that uncommon type of a *Penaeus* species life cycle.

**THE VOLCANICS OF AYAMONTE AT  
THE ATLANTIC MARGIN OF HUELVA**

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The volcanic successions of the Triassic-Jurassic limit at the easternmost part of the Algarve Basin are studied, using stratigraphical, geochemical and structural techniques. Volcanic rocks come from the reactivation of an anomalous sub-continental lithospheric mantle. The activity of tectonic faults post-dating the volcanism involve a SSW-directed extension, evolving with time to a SE-directed extension.

**HUMAN ACTIVITIES IN CONFLICT IN  
THE COASTAL ZONE: STUDY CASE  
OF FIGUEIRA DA FOZ**

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This work makes a very short reference to the evolution of the mouth of the Mondego river in the last hundred and eighty eight years emphasising the important morphological changes on the coastline induced by the transforming action of man. Besides this short reference there was made a observation work of the shoreline since December 1993 until February 1994. Some interesting photographs were taken that revealed the occupation and anthropic action that somehow interfered with the coastline high dynamism.

**HEAVY METALS BEHAVIOUR IN THE  
RECENT SEDIMENTOLOGICAL  
RECORD OF ENSENADA DE SAN  
SIMON, INNER RIA DE VIGO  
(GALICIA, NW SPAIN) (1)**

NOMBELA, M. A.; VILAS, F.; ALEJO, I.; GARCÍA-GIL, S.; GARCÍA-GIL, E.; RUBIO, B. & PAZOS, O.

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The Ensenada de San Simon constitutes the inner part of the Ria de Vigo. The study area is a sheltered mesotidal coastal embayment connected with the main Ria through the Estrecho de Rande (600 m wide).

The ensenada constitutes a 4-5 km wide marked geomorphological feature that extends 7 km along a N-S direction. It comprises an area of 19.4 km<sup>2</sup> of which 4 km<sup>2</sup> fall dry at low water. Its depth exceeds 30 m in the Estrecho de Rande rapidly shallowing landwards to 10-15 m, but it is less than 5 m in most places.

The northern half of the ensenada is occupied by an intertidal fluvio-tidal deltaic complex. Seawards, the inner subaqueous areas mainly consist of sands covered with a dense carpet of *Zostera marina*. These sands which are stratified and rich in *Cerastoderma edulis* forms the inner ensenada. They pass seawards into diffusely stratified muds, depleted of skeletal debris and rich in organic matter (5-6%).

Eight vertical box-corers were collected in the muddy subaqueous area of the ensenada. One plastic tube corer of 6 cm in diameter was then extracted from each one of the box-corers. Corers lengths ranged between 25 and 37 cm and were re-sampled in 1 cm intervals for analytical work.

Quantitative determination of 7 elements (Al, Zn, Cu, Pb, Co, Cr and Ni) for each centimeter in depth was

then carried out on an inductively coupled plasma atomic emission spectrometer (I.C.P.A.E.S.) in order to evaluate the vertical variability of the heavy metals distribution in the recent sedimentological record. Preliminary results has allowed us to differentiate two groups of elements showing a consistently different pattern distribution:

**Group A:** including Zn, Cu and Pb. They show a noticeable upward increase from 25-11 cm deep to the top.

**Group B:** including Co, Cr and Ni. They show distinct behavioural patterns. Whilst some corers show constant values, others show a gently upwards decrease tendency.

### FAUNA Y FLORA BENTONICAS DE LA RIA DE FERROL (NW DE ESPAÑA): ESTUDIO DE LAS POBLACIONES DE CRUSTACEOS DE LA ENSENADA DO BAÑO Y SU RELACION CON LOS PARAMETROS FISICO-QUIMICOS

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En el presente trabajo, se hace un estudio de la Ensenada do Baño, localizada en la margen sur de la Ría de Ferrol que presenta un gran interés por su amplia diversidad faunística debido a los diversos tipos sedimentológicos que presenta.

Se obtienen 548 individuos pertenecientes a 55 especies haciéndose un estudio de las poblaciones de crustaceos de fondos infralitorales e intermareales relacionándolo con los principales parámetros fisico-químicos (área de exposición, profundidad, materia orgánica y tipo de sedimento).

Los programas estadísticos utilizados fueron TWINSPAN y CANOCO. El primero de ellos, construye una clasificación de las muestras y usa después esta clasificación para obtener una clasificación de las especies, permitiendo la identificación de las que caracterizan cada división en la clasificación. A través del CANOCO obtenemos el análisis de correspondencias donde se relacionan las localidades y especies con los diferentes factores fisico-químicos.

### CHARACTERISATION OF THE RIVER PLUMES CONNECTED WITH THE RIVERS OF NORTHERN PORTUGAL (MINHO, LIMA, CÁVADO, AVE AND DOURO) (1)

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1) - Contribution No.107 from the DISEPLA Group ("Dinâmica Sedimentar da Plataforma e Vertente Continental Ibérica" - JNICT/PCMT/C/MAR/692/90).

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3) - Algarve University, Portugal.

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The turbid plumes connected with the rivers from Northern Portugal were studied during three cruises promoted by the Hydrographic Institute in summer (13-19 September 1990) and winter (11-20 March 1991 and 14-19 January 1992) conditions. A total of 57 stations on the continental shelf was sampled including 13 cross-shelf transects.

A nephelometric transect in the continental shelf near the river Cávado in summer and winter conditions confirms the presence of two preferential means of material transfer from the estuaries to the shelf. The first involves an estuarine surficial turbid plume. The second is a bottom turbid layer with values that are higher than those measured in surficial waters. The amounts of suspended matter ranged between 1.6 and 13 mg/l.

On the basis of concentration and location we can generally distinguish three water types that were also detected elsewhere, for example off Gironde estuary: a surface nepheloid layer, which is more important in summer; a bottom nepheloid layer that is more intense in winter conditions and clear waters. The study of the grain-size of suspended matter has allowed the confirmation of the origin of the material present in the water types: the estuarine suspended matter, biogenic and shelf deposit contribution.

The estuarine suspended matter has normally a uni-bimodal character with a 4.8  $\phi$  mode in summer but more difficult to define at winter (5.4-7.3 $\phi$ ). There was a biogenic contribution identified seaward from the outer part of the river's inlet corresponding to a mode at 3-3.5 $\phi$ . In addition, there was also a fine-grained inorganic contribution from the shelf deposits (3 $\phi$ ) to the benthic nepheloid layer.

## MODELIZACION DEL COMPORTAMIENTO DE NUTRIENTES Y GASES DISUELTOS EN ESTUARIOS MEDIANTE TECNICAS DE SIMULACION

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To evaluate the fate of nutrients and dissolved gases in estuaries, a dynamic mixing simulator were developed. The assay conditions performed shows a non-conservative behaviour of  $\text{SiO}_2$  and  $\text{HPO}_4^{2-}$  species, but in different sense. The first one shows a gain in dissolved phase and the second one a loss. On the other hand, the simulation of alkalinity behaviour permits a feasible modelization of carbonic acid speciation versus salinity.

## BIOCOENOSIS OF POOLS AT EXPOSED ROCKY SHORES IN THE RIA DE MUROS (GALICIA, NW SPAIN)

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The biocoenosis of rocky exposed shores pools were studied, and their zonation drawn out. Attention was given to pools with high cover of *Lithophyllum incrustans*, at the locality of Punta Insua (Carnota, Galicia, NW Spain).

The characterization of the communities of these pools was defined through monthly inventories in 30 pools, using the Bran-Blanquet 6 point cover-abundance scale.

The accurate characterization of the different kinds of pools means a depth knowledge of their floristic and faunistic composition. However, the inventories carried up until now indicate some trends about the composition of their biocoenosis; so, the following pools are accounted:

I. Midlittoral shallow pools. *Lithophyllum incrustans* is the species with greater cover; *Paracentrotus lividus* is typically found in these pools. Here, 2 different kinds of pools can be distinguished, based upon the abundance of *Anemonia viridis*.

II. The deep pools of *Lithophyllum incrustans* have some small belts of vegetation because the illumination gradient; besides, their colonizable surface is much bigger. The patterns of variation in their biocoenosis seem to be dependent on the wave

exposition and, in a similar degree, on the presence of sandy and rocky sediments. There can be distinguished 4 main kinds:

1) Some, partially filled with big boulders, where *Gibbula umbilicalis* and *Grateloupia dichotoma* are typically found.

2) Sciophilic pools, with bottom covered with pebbles: the most remarkable communities is that of *Pterocladia capillacea* and *Haliptylon squamatum*.

3) Other more photophilic pools, without pebbles, are those with greater herbivores abundance.

4) There are, finally, a few large and deep pools, with sciophilic walls, which are mainly covered with animals; *Cryptomenia lomation* and *Corinactys viridis* are the most representative species.

## FAUNA Y FLORA BENTONICAS DE LA RIA DE FERROL (NW DE ESPAÑA): *ABYSSONINOE HIBERNICA* (MCINTOSH, 1903) (POLYCHAETA, LUMBRINERIDAE) A VALID SPECIES FROM THE NORTHEAST ATLANTIC

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From material collected in the Ría de Ferrol (Feb. and Oct. 1987), Ría de Ares-Betanzos (Nov. 1986) (NW Spain); Galway Bay (May 1975 and 1976) (SW Ireland) and Iris Sea, this paper reviews the taxonomic status of *Abyssoninoe hibernica* (McIntosh, 1903 as *Lumbriconeris*) which is recorded for the first time from the Peninsula Ibérica and represents the most southern record of the species.

Its inclusion in the genus *Abyssoninoe* Orensanz, 1990 and its relation with the other members of this recently erected genus, characterized by the shape of the maxilla IV, the antero-posterior variation of the hooded hooks and morphology of the parapodia, are discussed.

*Lumbrineris pseudo-fragilis* Amoureux, 1977; *Lumbrineris scopa scopa*, Fauchald 1974 and *L.scopa aequilobata*, Winsnes, 1981 are included as junior synonyms. The morphological differences between this taxon and *Lumbrineris impatiens* (Claparède, 1868) and *Lumbrineris fragilis* (Müller, 1776), two species commonly confused with *A.hibernica* are also provided.

The geographical distribution, and ecological preferences of the species are presented.

**FAUNA Y FLORA BENTONICAS DE LA RIA DE FERROL (NW DE ESPAÑA): RELATIONS BETWEEN BENTHIC POLYCHAETOUS ANNELIDS AND ENVIROMENTAL FACTORS IN ENSENADA DO BAÑO.**

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Biological zonation in intertidal and shallow water marine habitats are usually related to the gradients of several physical and chemical factors. In this paper, species composition and distribution of the polychaetous annelid community in subtidal, soft and rocky intertidal habitats located in the Ensenada do Baño (Ría de Ferrol, NW Spain) have been analyzed.

Ninetyone species were identified as components of the benthic polychaete fauna, mainly composed by infaunal sedentary subsurface deposit-feeders (Maldanidae), tentaculate semierrant surface deposit-feeders (Cirratulidae, Terebellidae) and errant (Polynoidae) and semierrant (Glyceridae, Lumbrineridae) carnivores. Species richness, diversity and density were analyzed for each particular habitat and feeding guild. Carnivorous (*Lumbrineris gracilis*, *Glycera unicornis*) and subsurface deposit-feeders (*Notomastus latericeus*) were more abundant in subtidal samples, whereas herbivorous (*Platynereis dumerilii*, *Nereis pelagica*) dominated in intertidal areas.

Species distribution and its relationships with environmental factors (aerial exposure, depth, organic matter, and carbonate, nitrate and mud content of the sediment) were analyzed by correspondence analyses. There were major differences in community structure between habitats, due mainly to effect of aerial exposure and depth, and to the grain size in soft areas.

**RESPONSE OF BULIMINA ELONGATA SUBULATA (FORAMINIFERA) TO THE ANTHROPOGENIC CHANGES IN THE BILBAO ESTUARY**

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The benthic foraminifera in the Bilbao estuary were studied in this article in order to determine the human-originated pollution in this area.

In this study 96 species of benthic foraminifera have been differentiated 34 of which did not present living

individuals at the time of sampling. Upstream, the benthic foraminifera became scarce. In accordance with the distribution of a dominant assemblage in the Abra estuary a series of typical zones stand out. The zone 1 extends along the left bank of the estuary from Ciñrvana to the Punta Lucero breakwater. In this zone the dominant assemblage is composed by the species *Bulimina elongata subulata* Cushman and Parker, 1937, (97% of the total of individuals extracted in every sample) and the index  $nF$  presents the highest richness (27.000 indiv./g.).

The Zone 2 covers the right bank characterized by the species: *Quinqueloculina seminulum*, *Cibicides lobatulus*, *Elphidium crispum* and *Rosalina irregularis*. The Zone 3, situated at the outlet of the estuary (Nervion river), is characterized by *Haynesina depressula*, *Triloculina oblonga* and *Ammonia beccarii*. This last area is defined by one sample although it seems to be the remains of something much longer which was found up stream when conditions for life were much better.

A comparison with the results obtained from other estuaries in the Bay of Biscay with less grades of contamination (Pascual, 1992), have shown abnormally large concentration of *Bulimina elongata subulata* in Zone 1, as you go upstream this microfauna disappears.

By relating the physico-chemical factors of the analysed environment with the distribution of benthic foraminifera, the great influence of the salinity, nutrients and dissolved oxygen is shown, as well as the role it plays in the disappearance of the studied microfauna, the acidity of the environment and the high concentrations of heavy metals.

The high concentrations of heavy metals registered in the occidental area of the estuary near the breakwater, represent an essential element of the contamination of this area. It is probable that this establishment of microfauna with species such *Bulimina elongata subulata*, could be a consequence of the construction of the said breakwater which modified the movement of the water in this part of the Abra estuary, causing active sedimentation of fine elements that produced a trap for heavy metals.

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**COASTAL DUNE DEVELOPING  
AND CLIMATIC AND SEA-LEVEL  
CHANGES GALICIA (NW SPAIN)  
DURING THE HOLOCENE (1)**

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Do Trece beach, is one of the most splendid examples of climbing dunes in Galicia. In it, the dunes are situated in a very high slope of even 65° and reaching near 100 meters height. The construction of a track in this dunefield show two very good sections of two ancient aeolian sequences. one of these sequences, sited around 40 meters over the sea level is formed by three sand bodies corresponding with three ancient dunes. Two of these dunes are cemented by iron oxides, whilst the other one is very rich in organic material. Lack of carbonate remains have inhibited accurate dating of the sands, however, from the geometry of the contacts between different dunes can be established a relative chronology. Besides, granulometric and morphometric parameters of the sands could be used to perform a statistical multivariate test (MANOVA). The results obtained, lead us to interpret the differences in the granulometric curves between the three dunes in terms of changes in the sedimentological environment.

In this location, and at the level of the actual beach, can be seen small rests of ancient dunes iron oxides cemented, very probably coeval with the oldest ancient dune in the slope. Along the Galicia coastline, are common the ancient beach deposits, with similar iron oxide cement and sequence, they constitute an ancient coastline. Their age falls around the maximum climate in the holocene (Pazos et al. 1994). The study of these and other younger coastal deposits indicate a complex history of the sea level changes in the last 6.000 years, controlled by eustatism (responsible of quickly oscillations in the sea level) and tectonicism (controlling the tendency in long periods).

During the holocene, stability stages and relative falls of the sea level supply amounts of sand that could be transported by winds landwards. During relative sea level rises, erosion of beaches periods of scarcity in sediment supply. Falls of the sea-level coincide with climatic deteriorates whilst sea level rises coincide with rises of temperature.

Although there are not quantitative studies about the present aeolian sediment supply in the coastal areas, it is notorious that many of these dunes are actually inactive, and some of them are been clearly eroded (Flor, G., 1992). Specifically, the climbing dunes, presents in several points of the Galicia coastline are all of them in one of both stages, either inactively (completely colonized by plants) or under erosion.

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**THE HOLOCENE SEA LEVEL  
STABILIZATION. EVIDENCES ON THE  
COAST NEAR  
ARMAÇÃO DE PERA (ALGARVE)**

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The research on Holocene sea level variations are at the beginning in Portugal. Recent progresses have been achieved by the studies developed on the continental shelf (see J. ALVEIRINHO DIAS and A. RAMOS PEREIRA, 1993) and on the estuaries. Data is insufficient until now and is from different geographical context, namely in different morphotectonic environments. So the correlation between existent data is a very difficult task. This note is a single contribution to this problem.

The western and central coast of Algarve has a switch of cliffs and small sandy regular bays. Such bays have preserved several features of the Holocene coastal evolution. Among others, the evolution undergone by the cliffed coast until the sea reached its present stand is preserved (see A. RAMOS PEREIRA et al, 1994).

The coast near Armação de Pera is an example of such bays, where two rivers have their mouth. The estuaries of these rivers are today completely silted up and closed by a beach-dune system.

We have recorded a similar inherited system, with a beach-rock and an aeolianite under the present beach-dune system. As the genesis of a beach-dune system is a function of the sea level stand and, as in this case, the present and the inherited beach-dune system are in the same position, we assumed they were built up with the same sea level.

The <sup>14</sup>C data obtained from the beach rock and from the aeolinites are discussed in this paper (see also A. MONGE SOARES, 1993). The radiocarbon data show that the present sea level was not only reached at ca 3 300 BP, but that it was standing at this level the time needed to built up the beach dune system.

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## CLIFFS OF THE SOUTHWEST COAST OF PORTUGAL. PRESENT RESEARCH (1)

### AUTOMATIC SYSTEM FOR TAGGED SAND DETECTION(1)

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Fluorescent sand tracer experiments performed in order to obtain qualitative or quantitative information on sand transport in beaches have proven to be very useful. Tagged sands are commonly injected into the surf zone and sampled afterwards at the beach face during low tide. Fluorescent tagged sand concentrations are almost universally obtained by hand-counting these grains under ultraviolet light. Work performed during this kind of experiments revealed to be extremely tedious and very expensive in person-hours. Furthermore, the morosity of the hand-counting process severely limits the number of stations that can be occupied during the low tide period, what imposes an extreme reduction of the monitored area or a great expansion of the sampling grid. Also, the detection of the tagged grains during the day requires the transport of a big dark chamber large enough to cover one or two operators.

In order to reduce these limitations, an Automatic System for Tagged Sand Detection was developed. This automatic device will allow a faster determination of the tagged sand grains along a previous defined sampling grid, providing the chance of having a broader analysed area, greatly diminishing the field experiment costs and almost eliminating the tedious work. Moreover, the system can be used both night and day.

The developed system uses an ATV (All Terrain Vehicle) equipped with an image acquisition device connected to a Personal Computer. The small computer has installed a "video blaster" frame grabber for which the software was developed. A specific counting algorithm is used. A software application was developed under Windows 3.1 system which provides image display, storage and processing capabilities either upon a live video window or a stored image window.

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The southwest coast of Portugal is a typical coast of a negative accumulation-erosion rate. The continental shelf is very narrow, sometimes less than 10km, with high slopes, but sometimes is not well defined, and in both cases having a deficit in sediments. In fact, the lack of important rivers that could provide the sediments is the main reason for the cliff coast dominance. The significative waves have 2m high with 9s period, in winter, but waves higher than 15m have been registred at Sines, during the 1989's big storm.

The cliffs have always a structural control and their vulnerability is related to the type of rock cut in cliff, its structure and degree of tectonisation.

In the southwest it is possible to define 5 degrees of vulnerability based on that factor (fig.1: Pereira, 1993). The most vulnerable are the cliffs near the mouth of the small estuaries (on the W coast) because they are all related to faults, and consequently the cliffs are cut in very broken rocks. In these estuaries, turned to NW, part of the cliffs are cut in aeolinites, also tectonized. The estuary of the Ribeira de Aljezur is a good example. Another vulnerable cliffs are those cut in deposits of Pleistocene beach sands and alluvial fans deposits. Generally, they have a low degree of consolidation and therefore are very vulnerable to the swash. The cliffs on the north of Vila Nova de Milfontes are illustrative of such case.

But there are other factors envolved in the cliffs evolution. For this prurpose we are using an instrument conceived to mesure the wave force and also the pebble impact. This sensor, created by Dr. Guto Roberts, is bolted to the rock abrasion platform, and its computer program is able to register data of every high tides for a certain given period. We are testing this equipment and hope to have the first results next year.

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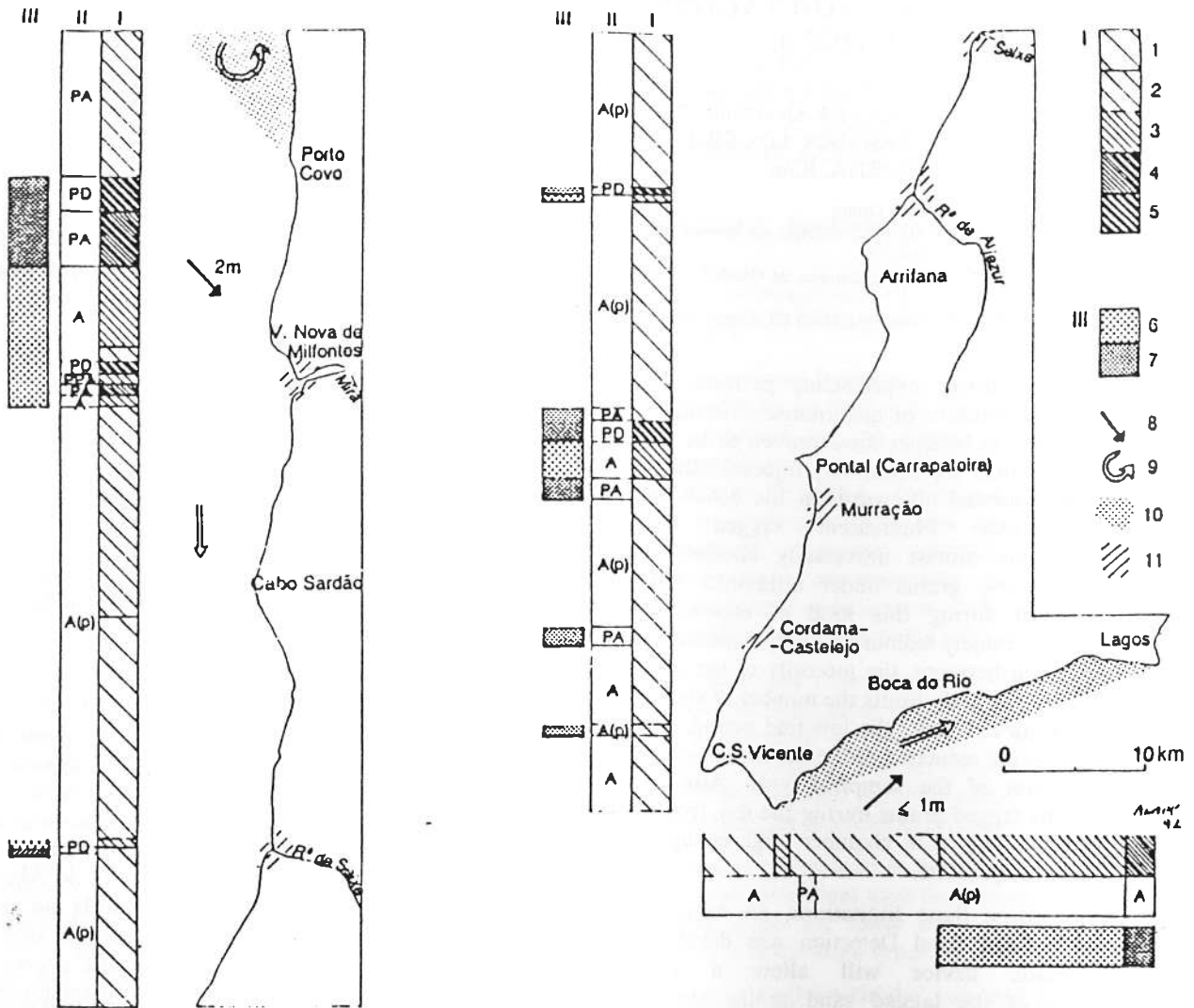


Figure 1 - Degrees of vulnerability to erosion on the southwest coast. I - Rocks cut in cliff, from the most (1) to less compact rocks (5): 1 - Turbidites from the Brejeira Formation and Carrapateira Group (Carboniferous) and compact limestones (Jurassic); 2 - Turbidites from Mira Formation (Carboniferous) and carbonated rocks (Jurassic); 3 - Carbonated and detrital rocks (Cretaceous), "Grés de Silves" (Triassic) and aeolianites (Quaternary); 4 - Detrital limestones (Miocene) and sandstones (Plio-Pleistocene); 5 - Sands (Holocene). II - Coastal system: PA - Beach / Cliff; PD - Beach / Dune; A - Cliff; A(p) - Cliff with narrow beach in summer. III - Degrees of vulnerability: 6 - Strong; 7 - Medium; IV: 8 - Dominant swell with narrow beach in summer; 9 - Direction and sense of coastal drift; Sheltered coast; 11 - Area of tectonized rocks.



**PRELIMINARY RESULTS OF  
HOLOCENIC SEDIMENT  
PALAEOFACIES STUDY IN  
TERMINAL RIVER SEGMENTS OF  
CENTRAL ALGARVE<sup>(1)</sup>**

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The progressive sea-level rise during post Weichselian deglaciation reached its maximum, at approximately 5000 years B.P. corresponding to average higher than 5m the present day level (FAIRBRIDGE, 1961). The study of foraminifers suggests that the influx of Atlantic waters to the western Mediterranean Sea increased during periods of deglaciation and decreased during periods of climate degradation. This global scale (eustatic) sea level change combined with regional crustal movements are responsible for very pronounced modifications of coast line in S Portugal during last 10 ky. The direct consequence of sea level stabilization or rise is the infilling of existing coastal fluvial valleys, as is the case of Central Algarve near shore drainage system. One example is the S. Lourenço river (W of Faro), which is referred in historic documents from 13-14 century as a estuary with a fishing harbor at Quinta do Ludo zone. Later on, this harbor (16 century) was abandoned because of the sediment infilling, and at present the area is a supra tidal coastal flat (GUILLEMOT, 1978).

The present study embraces 4 Holocene plains that from W to E are Quarteira river (Vilamoura), Fonte Santa river (W from Quarteira), Vale de Fontes (Ancão) and S. Lourenço river, and is aiming the establishment of the improved time scale of the most recent transgression as well as the study of distribution of estuarine paleofacies during last +/- 10 ky. The choice of the area was dictated by unsuitability of main lagoon (Ria Formosa) area where thickness (>23m in central part) of sediments and their homogeneity makes the observation technically difficult. With exception of Quarteira river, where peat layer was sampled for datation, all the study sites are situated in the river mouth proximity.

For the holocene sediments study borings were done in grid-like pattern, by means of hand drill. Samples were taken accordingly to lithological changes, and at the present moment are analysed for C and S content and dated by <sup>14</sup>C method.

In Fonte Santa estuary, the sediments are interpreted to represent from bottom to top: Initial intrusion of marine waters reflected by a basal sand level. Progressive estuary infilling in a low energy system associated with a low flow of terrestrial water which permitted the accumulation of mud. This regime is reflected by gray clay with plant remains which alternates with shells and gastropods levels and sand intercalation's. Tidal wetland sediment follow and consist mainly of peat derived from salt-marsh

vegetation. This organic-rich superficial sediment covers all the older deposits.

The data obtained in this area witness a progressive estuary infilling in the regime of the sea-level rise and the slow stream of the river. The estuarine area extended to the north near Fonte Santa village, as the low energy coast permitted the accumulation of fine grain sediment.

In São Lourenço river valley the lateral variability of facies is very conspicuous. There are frequent sand levels representing channel / gully facies, marked also by the presence of fossil fauna typical for these hydrodynamic conditions. The channels cut clay horizons deposited in reducing conditions which could be brackish (dark grey clays, void of fossils) or marine tidal (dark grey clays, with fauna) identical to the present lagoon. This lagoonal series is covered by almost constant level of sand with shells which is interpreted as an tempestite event. The topmost horizon of bluish grey clays with frequent shell beds corresponds most probably to lagoon environment set by closing of the barrier system in XIX century (ANDRADE, 1990)

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**FAUNA Y FLORA BENTONICAS DE LA  
RIA DE FERROL (NW DE  
ESPAÑA): FORAMINIFEROS**

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Los foraminíferos son un grupo de organismos eucariotas unicelulares que poseen un amplio registro fósil; probablemente por ello han sido estudiados clásicamente por geólogos, quienes los utilizan como una herramienta de trabajo fundamentalmente por su alto valor para datar sedimentos y como indicadores de condiciones ambientales pretéritas. Como consecuencia es muy difícil encontrar datos acerca de su hábitat y quizá también ello explique el elevado número de trabajos realizados en las costas americanas, en su mayoría orientados a la búsqueda de condiciones paleoecológicas denunciadas de yacimientos pretolíferos; explicaría también el hecho de que todos los trabajos están realizados en la zona sublitoral.

En cambio, no es hasta finales del siglo XIX que se considera a los Foraminíferos como organismos vivos, iniciándose el estudio de sus ciclos vitales y poniendo a punto técnicas de tinción, con Rosa de Bengala o Sudán Negro B, para diferenciar biocenosis y tanatocenosis.

Las aportaciones acerca de los Foraminíferos Ibéricos son poco abundantes; además, casi no existen investigaciones sobre el modo de vida de estos organismos, siendo escasos los datos referidos a ejemplares vivos. Otro aspecto a tener en cuenta es que la mayor parte de los trabajos están realizados en la zona infralitoral, en detrimento de la intermareal, prácticamente desconocida.

Todo lo expuesto nos condujo a realizar un estudio sobre los Foraminíferos que habitan los sustratos blandos de la zona intermareal de la Ría de Ferrol, diferenciando los individuos vivos de los capturados vacíos, con un total de 41 estaciones de muestreo (16 localidades), reuniendo una colección de 27.889 ejemplares (3.058 individuos vivos y 24.831 caparazones) pertenecientes a 146 especies.

Los datos relativos a este material, junto con su distribución en la ría y las aportaciones que se producen con relación a las distintas especies son objeto de esta comunicación. En cuanto al hábitat, 4 especies se citan por primera vez en sedimentos, 1 de ellas en fondos de fango y 39 se mencionan por primera vez para la zona intermareal. En lo que se refiere a su distribución geográfica, 4 especies son primera cita para el Océano Atlántico, 10 para la Península Ibérica, 9 para las aguas Atlánticas peninsulares, 1 para el Atlántico español y 13 para Galicia. Asimismo, 8 especies presentan en nuestras costas un nuevo límite en su distribución hacia el norte, 2 hacia el sur y otras dos hacia el oeste.

### NERITIC DISTRIBUTION OF THE LARVAE OF THE ESTUARINE CRAB *CARCINUS MAENAS* (L.) AND MEGALOPAL INPUT TO RIA DE AVEIRO: PUTATIVE MECHANISM FOR CROSS-SHELF TRANSPORT

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A zooplankton survey of an area off Northern Portugal (40°04' N to 41°20' N, from the shore to 10°32' W) was conducted between April 2 and April 10, 1991. The 79 sampling stations, organized into six cross-shore transects, were sampled with a multi-sampling net, from a maximum depth of 200 m up to the surface. Individual samples from the same haul were obtained from four 30 m deep strata, down to 120 m, and from 120 to 200 m. The number of strata was adjusted in the shallower stations according to bottom depth. CTD data were recorded at the same stations. Currents were measured with three current meters

moored from March 19 to April 13 at 40, 71 and 98 m (40°47.23' N, 9°6.10' W). *Carcinus maenas* larvae were virtually absent below 60 m. The first two zoeal stages were concentrated (ca. 90%) in the top 30 m of water. Older stages seem to move deeper as they grow, with increasingly higher proportions of successive stages in the 30-60 m stratum, the megalopa being equally distributed between the 0-30 m and the 30-60 m strata. Horizontally, the first zoea were more abundant near the shore, close to the inlets of estuaries. Older zoeae were distributed further offshore, with a variable number of maxima along a line ca. 15 miles from the coast. Evidence for onshore transport was found for the megalopa, consistent with the current meter data that show a net onshore component at 40 m, during the period of study.

The input of megalopae to Ria de Aveiro was monitored at weekly intervals from April 13 to July 19 of the same year, at a station inside the Ria. The average concentration in 18 samples, integrated over the span of the two daily flood tides and depth, was used as a measure of the relative numbers of megalopae entering the Ria during each sampling date. A wind time-series, obtained at Cabo Carvoeiro, was used to find the direction of the best non-parametric correlation between the megalopal inflow and wind stress. One-day average wind stress components were computed for 22.5° intervals and correlated, with 0 to 7 d time-lags, with the megalopa data series. High concentrations of megalopae during flood tides were detected in April 13 and 22 and, again, in July 12 and 19. A significant positive correlation ( $p < 0.05$ ) was found between megalopal inflow and 2-d lag 45.0°-ward wind stress. Negative significant correlations ( $p < 0.05$ ) were found with 67.5°- and 90.0°-ward wind stresses, with time-lags of 1 and 2 d.

A tentative explanation for the observed correlations between wind stress and the input of megalopa to Ria de Aveiro is that an onshore wind stress could result in a coast-ward transport of megalopae in the surface layer. The negative correlations with offshore wind stress can be explained assuming that, during these wind events, a shore-ward undercurrent, below a surface layer with an offshore direction, will carry the deeper living megalopae, making them available for estuarine up-take.

## DISTRIBUCIÓN Y ABUNDANCIA DE ESCUALOS DEMERSALES EN LA PLATAFORMA Y PORCIÓN SUPERIOR DEL TALUD CONTINENTAL DEL GOLFO DE CÁDIZ

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Durante el período comprendido entre marzo de 1993 y marzo de 1994 se han realizado tres campañas de evaluación de recursos demersales con arte de arrastre (ARSA 0393, ARSA 1093 y ARSA 0394) a bordo del B/O Cornide de Saavedra. En estas campañas se prospectaron los fondos de la plataforma y talud continental del Golfo de Cádiz comprendidos entre las isóbatas de los 15 y 650 metros.

Para un total de 93 lances válidos se capturaron 6536 escualos demersales, pertenecientes a las especies *Heptanchias perlo* (Hexanchidae), *Galeus melastomus*, *Scyliorhinus canicula* (Scyliorhinidae), *Galeorhinus galeus* (Triakidae), *Centrophorus granulosus*, *Deania calcea*, *Etmopterus spinax*, *Somniosus rostratus*, *Squalus acanthias* (Squalidae) y *Dalatias licha* (Dalatidae). En términos de abundancia destacaron *S. canicula*, *G. melastomus* y *E. spinax*, presentando la primera de ellas una amplia distribución en el gradiente batimétrico, siendo la especie dominante en los fondos de la plataforma. El resto de especies quedan relegadas a los fondos batiales del talud.

En el presente trabajo se describen los patrones de distribución y abundancia en el gradiente batimétrico, analizándose la posible existencia de fenómenos de segregación sexual y/o por tallas en dicho gradiente, relacionados con las pautas reproductivas de las especies. Los patrones resultantes son discutidos y contrastados con los aportados por diversos autores.

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## FAUNA Y FLORA BENTONICAS DE LA RIA DE FERROL (NW DE ESPAÑA): LOS CRUSTACEOS DE LA ENSENADO DO BAÑO

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La ensenada de O Baño está situada en la margen sur de la Ría de Ferrol, entre la Punta do Faro da Palma (43°07'02"N; 08°06'49"W) y Punta Piteira (43°27'57"N; 8°15'37"W), posee una extensión aproximada de 0,5 Km<sup>2</sup> y una profundidad máxima de 20 metros. La elección de la mencionada ensenada se ha debido al interés que presenta dada su posición, régimen hidrodinámico y gran diversidad de tipos de sustratos, así como por presentar una fuerte gradación de exposición al oleaje.

Las muestras infralitorales se han tomado a lo largo de 12 transectos perpendiculares a la costa y con una separación entre ellos de 100 m, recogiendo una muestra en cada tipo de sustrato, de lo cual han resultado 35 estaciones muestreadas.

Para el muestreo intermareal se han fijado un total de 46 estaciones en ambos márgenes de la ensenada, anotando en cada una de ellas el nivel intermareal, el tipo de sustrato y la cobertura algal que presentaban.

De esta forma se han obtenido un total de 584 ejemplares de Crustáceos repartidos en 55 especies de los cuales 24 representan 2 táxones de Tanaidáceos, 361 corresponden a 27 especies de Decápodos, 178 individuos pertenecen a 15 especies de Anfípodos y 21 ejemplares representa 11 táxones de Isópodos.

En el presente trabajo se expone la composición faunística total de Crustáceos de la ensenada, así como su abundancia y diversidad en conjunto.

Se analizan, así mismo, las diferencias existentes entre el nivel intermareal y submareal y, dentro de éstos, las variaciones asociadas al tipo de sustrato y vegetación.

## CHAOTIC DISTRIBUTION OF RAVINES IN THE ARRÁBIDA REGION: IMPLICATION FOR RECENT TECTONICS<sup>(1)</sup>

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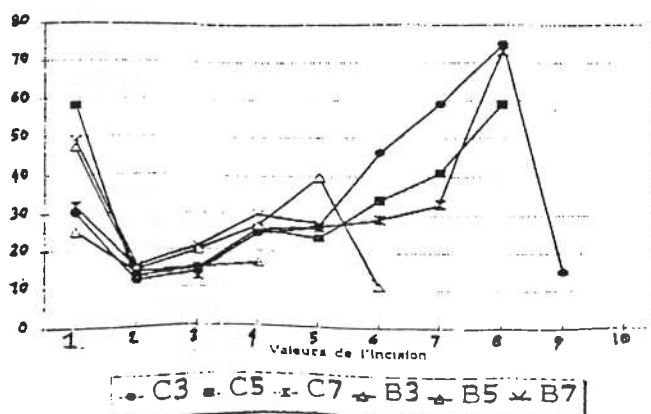
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The Arrábida mountain, in the center of Portugal, is a marginal relief on a passive margin. It has been uplifted since the Tortonian and a planation surface is now 110m above sea level. During the same time span coastal erosion has been active and the former coastline was some 5km more to the South. Uplift and coastal retreat, during various phases of sea level mobility may be correlated. As the base level changes, the geometry of ravines has to change also. A D.E.M. was realised and, after the execution of some mathematical morphology routines, a model for ravine evolution was tested. The model implies that the evolution of ravine incision is non linear and chaotic, at least at a meso scale level.

Field work, performed from 1990 to 1994, with the help of the Luso French commission for marine Geosciences, has proven effective for calculating present day rate of retreat, and producing some evidences (but not quantified) for neotectonics. Any attempt to extrapolate in a linear way from present day measurements into the past are in total contradiction with geological data. So we are, once more, confronted with a non linear evolution.

This paper is an attempt to correlate the chaotic evolution of the drainage system with the non linear evolution of the coastal retreat. Main forcing factors are eustatic, tectonics, as expected. The important point is that their respective role is scale dependant. Though sea level has changed a lot, the most efficient forcing factor is the steepness of the slope system. In their very peculiar way, this part of the continental passive margin is behaving like a very active slope system.

Equation de la carte logistique  
Variation de A



## TECTONIC STRESS PATTERN IN PORTUGAL MAINLAND AND THE ADJACENT ATLANTIC REGION (WEST IBERIA)

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The Portuguese mainland territory is located close to a recognized plate boundary (the Azores-Gibraltar fault-zone), in a tectonic setting responsible for significant neotectonic and seismic activities. However, few data concerning the present regional lithospheric stress field were available, as testified by recently published maps of stress indicators for Europe and the Mediterranean region (Muller *et al.*, 1992 and Rebai *et al.*, 1992). One of the authors already presented a synthesis on this subject (Cabral, 1993), where geological and geophysical stress indicators were considered. In this presentation we update that previous work by introducing totally new information, mainly a considerable amount of borehole breakout data (mostly located at the western Portuguese continental margin), so that the stress indicators now presented for the Portuguese mainland include 17 data from wellbore breakouts (well ovalization), 10 data from geological fault slip (neotectonic data), and 5 data from earthquakes focal mechanisms (seismological data). The complete regional data set available is reviewed using the criteria defined for the World Stress Map (Zoback, 1992). Finally, the obtained results are discussed in view of the regional geodynamical setting, namely in what concerns the West-Iberian continental margin.

## DEFORMABLE PLATE TECTONICS OF THE AZORES - GIBRALTAR BOUNDARY - WHERE THE NEXT 1755 EARTHQUAKE WILL STRIKE AGAIN ?

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The Azores - Gibraltar plate boundary (AGPB) is complex and some authors doubt that intraoceanic subduction occur at the Goring Bank, considered traditionally the source zone of the 1755/11/01 earthquake, Lisbon.

Numerical (Cloetingh *et al.*, 1989; Gregersen, 1993) and physical (Shemenda, 1992) modelling can be combined as a theoretical framework for initiation of subduction. Uniform shortening of oceanic lithosphere (Ribeiro, 1994), must be followed by buckling, enhanced by crustal faulting, and finally whole failure will occur, leading to subduction.

We favour the following model for the AGPB:

In Miocene colliding of Eurasia and Africa creates the Betic-Rif chain and intraplate pop-up structures (Atlas and Cordillera Central). The coeval shortening of oceanic lithosphere proceeds by buckling, giving sea-mounts (Hirondelle, Ampère, Gorringe) above intervening abyssal plains; the structures and oriented ENE-WSW, subperpendicular to the plate convergence vector. Finally subduction will start later, in the southern margin of Gorringe Bank (in the Pliocene?).

Continued convergence of Eurasia and Africa in Quaternary proceeds by lateral expulsion of the whole Iberian plate, delineated by historical and instrumental seismicity (Cabral, 1993); this will produce E-W convergence in the west Iberia margin. The anisotropy of previous buckled oceanic lithosphere will resist further convergence because the shortening is subparallel to axial direction of the buckles. The present stress field will produce N-S structures that we see in the margin: uplift crustal faults in the North, buckling in the Estremadura Spur and whole failure and incipient subduction in the south (Ribeiro et al., this meeting). West of the previous buckled sea-mounts oceanic lithosphere respond by NNE-SSW present buckling in the Tore-Madeira Rise.

In the deformable plate theory (Ribeiro, 1994) oceanic lithosphere is weaker than "average" continental lithosphere. So subduction can initiate in intraoceanic context by changing plate movement from transform to convergence, eventually in different places; this is the case of the Gorringe Bank intraoceanic subduction.

But subduction can also start at former passive margin if adjacent oceanic lithosphere is old, and already deformed (strain-hardened); this is the case the West-Iberia margin. What are the signs of ongoing subduction?

One is the occurrence great plate boundary earthquakes, with rupture areas of  $1-2 \times 10^5$  Km<sup>2</sup> and displacements of  $1-2 \times 10$  m. This is surely the case of the Lisbon Earthquake of 1755/11/01, with Richter magnitude above 8.5; we still don't know of the source area of this exceptional event; there are three possibilities:

- a) - Rupture in the Gorringe Bank, by analogy with/the/1969/02/28 event, that caused thrusting to south and minor tsunami (Martins & Mendes Victor, 1990).
- b) - Rupture along the West-Iberia margin, only possible in the southern sector where whole lithosphere failure could have been attained.
- c) - Simultaneous rupture in the two source areas (Oliveira, 1979).

The source mechanism of this event is being studied by Mendes-Victor team (U. Lisbon, Geophysics) in the Gitec project of EC. Reflexion seismics proceed in the I A M project. Seismotectonics studies in the margin will continue. Physical modelling will give insights on this problem. So we hope that in the near future we will know where the 1755 earthquake will strike again. When is another, "weak chaos", problem. But

we should consider that if the 1755 event ruptured only the West-Iberia margin the next candidate area will be nearer to Lisbon than we have considered up to now.

#### ACKNOWLEDGMENTS

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### ACTIVE DEFORMATION IN THE WEST-IBERIA MARGIN<sup>(1)</sup>

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1) - Contribution to Project "Seismotectonics of West-Iberia margin", JNICT.

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We studied active tectonics and seismicity of the northern sector of the West-Iberia margin, between the Minho River and the Nazaré Canyon, using bathymetry, "sparker", side-scan sonar and a Remote Operating Vehicle.

The margin is in a transition state from passive to active, more advanced as we proceed to the South. In the Southern sector subduction has already started; in the central sector the lithosphere is buckled and diffuse seismicity occurs. In the northern sector seismotectonic activity occurs in the boundary between normal and thinned continental crust of the Galicia Bank; the state of lithosphere buckling is not yet approached but is being prepared by reactivation of crustal faults, clearly expressed by the "Ramp Valley" of Beiral de Viana.

### SLOPE INSTABILITY: AN EXAMPLE FROM THE NORTHERN PORTUGUESE CONTINENTAL MARGIN<sup>(1)</sup>

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This communication will present a case study of downslope mass movement and slope failure in the Porto Submarine Canyon (northern Iberian continental margin), based on the analysis of two core samples retrieved from two distinct muddy areas, located below the 500m bathymetric curve. Applying the marine-slope stability nomogram and slope failure predictive curves to these samples, it was concluded that the area located in the canyon axis is under metastable

conditions, with only 0.02g being necessary to produce slope failure.

Knowing the Quaternary behaviour of the West Iberian Margin, these areas have high probability of slope failure. In fact, either a local seismic event of magnitude 3.5 located 20 Km apart or a high seismic event Magnitude of 6.5 located at a distance of 100 Km of the refereed area, would produce a horizontal ground acceleration that will trigger slope failures in this environment. On the other hand, the second area, located in the northern slope of the canyon is more stable being necessary a much higher or closer seismic event to start downslope movement.

Given the neotectonic activity of the West Iberian Margin, it can be concluded that seismic events producing horizontal ground accelerations and slope failure (in particular where slope angles are greater) are relatively frequent. Therefore downslope mass movements are one of the main processes of sediment transfer to deeper domains.

### DISTRIBUIÇÃO SEDIMENTAR DA PLATAFORMA CONTINENTAL PORTUGUESA ENTRE SINES E ERICEIRA

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A cobertura sedimentar da plataforma continental entre o cabo de Sines e a Ericeira foi estudada sob o ponto de vista granulométrica, e composicional.

A referida cobertura é condicionada pelas características específicas deste sector da plataforma continental, substancialmente diferentes dos outros sectores da plataforma continental portuguesa, quer devido ao número de vales e canhões submarinos que aí provocam profundas incisões na morfologia submarina, quer pelo desenvolvimento do delta submarino do rio Tejo; parcialmente abrigado da agitação marítima de NW, nomeadamente pelo complexo intruso de Sintra que se prolonga para a plataforma continental, este corpo deltaico apresenta-se muito desenvolvido apresentando espessuras superiores a 30 mseg (t.d.) aos 30m de profundidade.

Assim, a cobertura sedimentar poder-se-á considerar dividida em 3 zonas distintas e que são:

- Sines até ao Canhão de Setúbal, onde a cobertura sedimentar é predominantemente arenosa, dominando a componente terrígena na plataforma interna e média;
- a zona intermédia compreende o canhão submarino de Setúbal e o grande delta submarino do rio Tejo em que a cobertura é essencialmente lodosa;

- e a zona a norte do cabo Raso onde a cobertura é essencialmente grosseira, dominando as areias cascalhentas.

Com o propósito de melhor conhecer e esclarecer algumas destas particularidades foram analisados perfis de reflexão sísmica de alta resolução (tipo Sparker) e de sonar de pesquisa lateral, obtidos na região entre os cabos Raso e Espichel. Tal análise permitiu efectuar o reconhecimento e quantificação da cobertura sedimentar superficial e a análise de estruturas sedimentares. Esta análise permitiu reconhecer vestígios de um paleo-litoral, situado à profundidade aproximada de 130 m e representada por um cordão de sedimentos grosseiros, a existência de vários movimentos de massa junto ao bordo da plataforma e a colmatação de paleo-vales tributários dos principais canhões submarinos da região.

### A NUMERICAL MODEL FOR THE FLOW ACROSS THE STRAIT OF GIBRALTAR

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The Mediterranean Water marks its presence along the Iberian Atlantic Margin. Its existence is conditioned by several processes which depend a lot on the budget across the Strait of Gibraltar. The modelling of the Strait is one of the tools that can conduct to a better understanding and quantification of this budget.

The Strait of Gibraltar is a narrow and shallow connection between the Atlantic Ocean and the Mediterranean Sea, where in average the salty Mediterranean Water flows below inflowing Atlantic Water, establishing a dominant oceanographic feature of a two-layer circulation.

The aim of this work, conducted in the frame of the project EUROMODEL (The hydrodynamics of the Western Mediterranean Sea) is the development of a tri-dimensional numerical model for the flow through the Strait of Gibraltar. This includes the tidal propagation, the density flow as well as the interaction between both.

Several tests were conducted using schematic and real bathymetry. In order to resolve processes with different spatial scales, a refined grid was used in the region of the strait, characterised by stronger gradients.

The barotropic simulation of the tidal effects were conducted in a real bathymetry domain spanning the Gulf of Cadiz to the Alboran Sea. The four most significant tidal harmonics (M2, S2, K1 and O1) were imposed at the western boundary of this domain. The results of a simulation that took 40 days, showed well agreement with observations.



To simulate the baroclinic effects, a schematic bathymetry, representing the Strait of Gibraltar was used. The flow was initially at rest. In the Atlantic Ocean the Levitus profile was applied while in the Mediterranean side a constant salinity value of 39.77 ppt was considered. This baroclinic simulation was accomplished by the realisation of several numerical tests that included simple and double sigma coordinate as well as several parameterizations of vertical diffusion.

### **CARACTERIZATION OF SOME HABITATS OF RIA FORMOSA (PORTUGAL) USING BENTHIC FAUNA STUDIES**

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Benthic studies (macrofauna and meiofauna) have proved to be the most adequate to evaluation and monitoring of coastal habitats, because of the differentiated sensibility species show to environmental stress (in different time scales for macro and meiofauna), and because organisms burrow into the sediments.

The littoral zones are one of UICN's major aims for the Conservation of Nature, because of their ecosystem's balance and fragility.

Regarding their economical importance (in terms of commercial species production), and the environmental impact of human pressure (being suitable places for harbours and industries), a study has been conducted in Ria Formosa to access and monitor the consequences of environmental problems in the benthic fauna. In order to provide a better knowledge of the Ria, concerning human interests, some maps have been elaborated showing the location (according to this study) of species used for human uses, as food, fishing bait, pollution indicators, that may conduct to a more useful view of benthic studies.

As conclusion, it is stated that, in most areas, the summer impact of human population on holidays is washed and minimized in the winter, but in some areas (the immediate vicinity of sewage outfalls) the benthic populations did not recover.

### **LA PRESENCIA MASIVA OCASIONAL DE LARVAS ADULTOS DE CAPROS APER (LINNAEUS, 1758) (PISCES) EN EL GOLFO DE CÁDIZ Y MAR DE ALBORÁN.**

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Data on boar fish (adult and eggs/larvae), as found in the South of the Iberian Peninsula, are provided while the likelihood of major quantities of eggs and larvae thereof being conveyed from the continental shelf of the Gulf of Cadiz to the Alboran Sea is considered.

Adults of this species, which are of no commercial interest, occasionally appear in large quantities in subject area, in which case a phenomonic exclusion of other pelagic fish species occurs, thereby causing significant financial losses to the fishing fleet.

### **METABOLISMO BENTONICO EN LA ENSENADA DE SAN SIMON, (RIA DE VIGO, N.O. DE ESPAÑA)**

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In this paper, the first *in situ* measurements of the oxygen, alkalinity and nutrients benthic fluxes in the Ria of Vigo (N.W. Spain) are shown. The measurements were carried out during July and September of 1993. Mean fluxes show important supply of nutrients at the sampling station located nearby to the mussels farming area. Sampling stations closed to the mouth of Oitaben river show lower benthic fluxes in comparison with the mean values established for the studied area, reaching even negatives values for  $HPO_4^{2-}$ .

### **VEÍCULO SUBMARINO DE CONTROLO REMOTO - ROV**

**APLICAÇÕES NO CONHECIMENTO DA PLATAFORMA PORTUGUESA (1)**

SALDANHA, Miguel (2)

1) - texto de apoio à exibição de um filme de video

2) - Instituto Hidrográfico - Lisboa.

Em 1988, o Instituto Hidrográfico adquiriu um sistema ROV, sigla para Remote Operated Vehicle, que em português significa: Veículo Submarino de Controlo Remoto.

Os custos da sua aquisição foram comparticipados pela Junta Nacional de Investigação Científica e Tecnológica.

O sistema ROV, consiste num equipamento que permite obter imagens e outros dados do meio subaquático, a partir da superfície, evitando desta forma, o recurso à intervenção de mergulhadores, em trabalhos de simples observação.

Por outro lado, pode atingir maiores profundidades, não ficando limitado o seu tempo de permanência no fundo.

O equipamento é composto por uma consola de comando à superfície, um cabo umbilical e um veículo submarino.

Na consola situam-se os comandos do sistema, nomeadamente: um sistema de *Joy-sticks* que accionam os quatro motores do veículo, permitindo a sua evolução em todas as direcções; um monitor que permite seguir a imagem e no qual também se encontram as informações relativas à data, à hora, direcção, profundidade do veículo e número de voltas do cabo umbilical; um receptor da imagem do sonar, susceptível de ser operado em diferentes escalas e que fornece informações relativas a eventuais ecos existentes no horizonte (360 °) em torno do veículo; um sistema de posicionamento que permite conhecer em tempo real a localização do veículo no fundo; um computador que procede à ligação de toda a informação.

O Cabo umbilical constituído por condutores, estabelece a ligação entre a consola de comando e o veículo submarino.

No veículo situam-se diversos sensores, tais como: uma câmara de video a cores; uma câmara de video de alta resolução - CIT; uma câmara fotográfica e respectivo flash; um emissor \ receptor do sistema de posicionamento; 4 motores (dois de propulsão horizontal e dois de propulsão vertical); um transductor rotativo do sonar; diversos outros sensores que se encontram alojados no interior do veículo (agulha magnética, sensor de pressão, contador de voltas); dois projectores para iluminação.

Uma garra que pode ser acoplada ao veículo, permitindo delicadas operações de manuseamento e recolha de objectos.

O ROV dispõe de um sistema de posicionamento constituído por um comando na consola à superfície, um hidrofone (que se prende ao bordo da embarcação onde se está a operar) e um receptor \ emissor no veículo.

Através de uma ligação ao sistema de posicionamento GPS existente a bordo, é possível determinar com rigor e em tempo real, as coordenadas do veículo em imersão.

Até à presente data, o sistema existente no Instituto Hidrográfico, tem intervindo em diversas áreas de actividade:

- Sedimentologia;
- Estudo da Vida Marinha;
- Geotectónica;
- Controlo de Obras de Engenharia Costeira,
- Localização de Objectos no fundo;
- Apoio à acção de Mergulhadores.

#### Sedimentologia

Um dos diversos campos da actividade científica onde o ROV pode ser empregue é o da sedimentologia, permitindo a captação de imagens relativas à natureza do fundo.

A imagem do sonar do sistema, permite avaliar duma forma quantitativa as estruturas sedimentares que se nos deparam. Pode-se calcular, com alguma precisão, as dimensões dos corpos, extensões dos relevos, direcção de alinhamentos, etc.

Em estruturas de menor dimensão, uma escala (cuja extremidade mede 10 cm) acoplada ao veículo, permite melhorar a noção das dimensões dos objectos imersos.

#### Observação da vida marinha

O Veículo submarino proporciona a observação de espécies marinhas (animais e vegetais), por vezes a escalas de grande pormenor.

Tem, sobre os mergulhadores, a grande vantagem de poder permanecer completamente imóvel, viabilizando a observação de determinados comportamentos animais, que de outra forma não seria possível.

O ROV pode facilmente operar em profundidades inacessíveis ao escafandro autónomo a ar comprimido, para além de não estar sujeito a periodos de descompressão.

#### Geotectónica

Outra das áreas onde este equipamento tem aplicabilidade é o da Geotectónica.

Já em diversas ocasiões foi solicitada a intervenção do ROV, em operações de estudo das estruturas tectónicas activas da plataforma continental portuguesa.

Nessas intervenções, obtiveram-se imagens das estruturas morfológicas dos fundos, que vieram confirmar os dados batimétricos e de sísmica de reflexão, anteriormente recolhidos.

Mais uma vez, a imagem do sistema de sonar do ROV, demonstrou constituir um precioso auxiliar na compreensão da geometria daquelas formações.

Estas operações contribuíram com importantes informações relativas à evolução tectono-sedimentar da margem continental portuguesa.

### Controlo de obras de engenharia costeira

Esta é sem dúvida, a área onde mais é solicitada a intervenção do ROV.

Em operações desta índole, o veículo pode operar sem as limitações inerentes à acção de mergulhadores, i.e., pode operar sem limitações de tempo de imersão, podendo actuar em águas poluídas sem perigo para a saúde de quem observa e evoluir em meios mais profundos.

Neste âmbito o ROV já realizou diversos trabalhos de inspecção em zonas de implantação de emissários submarinos, em túneis de descarga de estaleiros, no interior de portos e em molhes portuários.

### Localização de estruturas perdidas e apoio a mergulhadores

O veículo submarino de controlo remoto é também usado na investigação de causas de acidentes com navios ou obras portuárias.

Nesta área já interveio busca e localização de um sensor de ondulação (ondografo de fundo) em Sines; na inspecção do navio afundado "River Gurara" (C. Espichel); na inspecção da área do emissário submarino acidentado em Vila Nova de Gaia ; nas operações de inspecção do navio afundado "Bolama" (Barra de Lisboa).

Em trabalhos que requeiram a acção de mergulhadores, o ROV pode apoiar e complementar a acção daqueles: um mergulhador que se encontre a operar debaixo de água, poder-se-á sentir mais "menos só", se estiver um ROV a acompanhá-lo; o veículo submarino poderá servir para levar e trazer ferramentas ou outras peças à superfície, poupando assim, aos mergulhadores que se encontram a trabalhar no fundo, a perda de tempo em trânsitos e os inconvenientes decorrentes das descompressões.

### ESTUDIO DEL DEPOSITO DE PUERTA REAL. UN EPISODIO REGRESIVO HOLOCENO EN LA RIA DE CORUÑA.

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El depósito de Puerta Real (A Coruña) representa parte de una secuencia sedimentaria de fondo de ría constituida por sedimentos rítmicos muy bien clasificados con laminaciones de espesor medio 0,5cm./unidad. La potencia total de los sedimentos estudiados es de 1,5m., apoyándose sobre una base rocosa granítica muy alterada. A techo, en discordancia erosiva culminan en un nivel conchífero de unos 20cm. de espesor.

El estudio a la lupa binocular estereoscópica de luz reflejada revela un alto contenido en bioclastos formados por espículas, y conchas de moluscos bivalvos y gasterópodos, en mayor proporción, y subordinadamente, foraminíferos (no aparecen aglutinantes y muy pocos calcáreo-porcelanáceos), calcáreo-hialinos.

Las asociaciones microfaunísticas presentes en el sedimento estudiado corresponden a distintos ambientes dentro de un medio bentónico de carácter regresivo que se sitúa tentativamente dentro del Holoceno.

### LONGSHORE CURRENT PREDICTIONS IN THE REGION OF FARO-OLHÃO

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It is presented a 1D model to evaluate the cross-shore profile of the longshore current velocity due to irregular breaking waves. The main components of this model are the wave height transformation across the shoaling and surf zones, the computation of the wave induced current driving forces and the longshore current modelling.

The wave height computation is based on the integration of the wave energy equation. The wave induced set-up/set-down of the mean water level is obtained from the cross-shore component of the momentum equation. These equations are simultaneously solved numerically using an iterative procedure by means of a finite-difference method.

The longshore current velocity profile comes from the resolution of the alongshore component of the momentum equation, based in the model of Longuet-Higgins (1970), where the driving force is computed using the radiation stress concept. The numerical solution of this equation is obtained with a finite-difference scheme.

The model results are compared with laboratory and field data. The model is used in the prediction of the longshore current velocity induced by regular and irregular waves, propagating over plane and bar-through beach profiles.

The model is used in the prediction of the longshore current velocity induced by irregular waves, propagating over a beach profile in the region of Faro-Olhão.

## DISTRIBUTION OF THE COMMON DOLPHIN *DELPHINUS DELPHIS* IN PORTUGAL

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Being the commonest odontocete in Portugal, *D. delphis* is known to occur along the portuguese coast on a very regular basis throughout the year. Its presence has been reported at least since the XIXth century, and regular monitoring initiated in 1977 has confirmed the common dolphin as the most common species in Portuguese coastal waters.

Strandings and sightings at sea have been reported all along the coast, with higher frequencies recorded between Cabo da Roca and Sines. This area is of great importance considering the amounts of nutrients coming from the Tejo and Sado river systems, thus allowing for the presence of a rich marine fauna.

A considerable amount of the overall dolphin mortality recorded there may be directly related to fishing activities, specially those involving gillnets. As the effort to survey strandings and to obtain sightings at sea was increased along the coastline, increasing numbers of dolphins are now reported caught in gillnets, thus highlighting the need for an accurate assessment of this problem and its possible solutions.

### HOW IMPORTANT IS RIVER RUNOFF TO THE VERTICAL STRUCTURE OF THE WESTERN IBERIAN SHELF WATER?

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Variations found in the upper ocean structure off the west coast of the Iberian Peninsula may be attributed to the erosion of the upper (subtropical) branch of the Eastern North Atlantic Central Water (ENACW) as it propagates north. Over the shelf, clear differences may additionally be observed above the seasonal pycnocline, with a reduced salinity near surface lens present over the whole shelf off the northern west coast (Figure 1) but usually absent off the southern west coast. The lens appears to develop after the change of wind regime from *shifting westerlies*, in winter, to *pulsating northerlies*, responsible for coastal upwelling, in spring and summer. Since most of the freshwater discharge occurs north of Figueira da Foz (ca. 40°N), it is tempting to attribute the reduced salinity to the combined effect of river runoff and the offshore Ekman transport induced by the northerly winds.

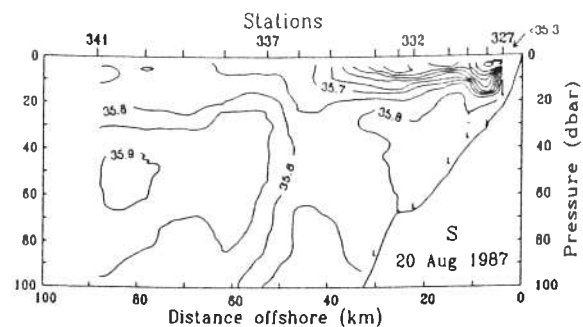


Figure 1. Salinity off Espinho in August 1987. The shelf edge is located at about 55 km from the coastline.

As a check of the relative importance of river runoff in the development of the near surface lens, an extremely simple conceptual model was devised making use of the present knowledge of the vertical structure over the shelf and calling upon the local freshwater balance. The effect of upwelling is taken into account as an input of saline water within one internal Rossby radius of the coast (7 km), occurring from April to September. This counteracts with the freshwater input, which is assumed to mix (completely and instantaneously, at 1 month time scale) within the surface layer, which is assumed to be maintained mainly through surface heating and wind mixing. As the interface is allowed to rise, the salt deficit below it is assumed to be compensated through removal from the upper layer. Upwelling is suppressed from October to March, and the mixing of freshwater is decreased in autumn and completely suppressed in winter, when a freshwater plume is assumed to flow close to the coast with no horizontal dimensions. The only mixing allowed during winter is, therefore, due to deep convection.

Precipitation and evaporation values drawn from the literature were seasonally distributed over the area 40°-43°N and added to average monthly runoff values in the area 41°-42°N only, which allows for a 20 percent loss. A consistent annual cycle of average salinity in the upper and lower layers was generated, where the near surface lens of reduced salinity showed up clearly from April to September. However, a reduction of the runoff during the summer months to half the average values for that season destroyed the salinity lens after June. This suggests that, although the lens may be justified on the basis of the local freshwater balance, the magnitude of the runoff may be critical for its maintenance.

## MAGNETIC COMPILATION OF THE WEST IBERIAN CONTINENTAL MARGIN

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The available interpretations of the structure of the West Iberian Margin, and in particular the study of the correlation between the geological features from both margins of the North Atlantic area are partially based on the magnetic signature interpretation of the Portuguese margin (Lefort *et al.*, 1981; Lefort *et al.*, 1979; Lefort *et al.*, 1978). However, these interpretations were based in several no related surveys, made at different epochs and heights and some of them never published.

The aim of this work is the compilation of the magnetic data for the Portuguese margin, from 3 different surveys (Aeromagnetic Survey of Portugal, 1980; Aeromagnetic Survey Offshore Portugal, 1969 and magnetic profiles extracted from the GEODAS-NGDC (GEOphysical Data System for Marine Geophysical Data-National Geophysical Data Center)). The data covers an area between 15°W to 6°W, and 36°N to 44°N; the final grid is composed by equal spaced meshes of 0.005 degrees, which has been transformed by analytical continuation to a 3000 m level.

The amplitude of the magnetic anomalies is usually correlated with the depth of the magnetic basement; the magnetic lows follow well the marginal basins along the Portuguese coast (Galicia Interior Basin, Porto Basin, Lusitanian Basin, Alentejo Basin) and the magnetic highs correspond to basement ridges (e.g. Berlengas Ridge) and to the sub-volcanic structures of Sintra-Monchique alignment.

The interpretation of the magnetic effects generated by the margin built up, allows a comparison between the onshore and offshore magnetic anomalies and the study of the prolongation of the hercynian structures to the west.

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## WAVEMOD PROJECT : PROBABILISTIC MODELS FOR COASTAL SITE INVESTIGATIONS

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The WAVEMOD Project is funded by the MAST program which has 11 participating institutions from 6 countries and is being managed by IST. This is a three year project involving a budget of about 2 Million ECU, which aims at improving existing probabilistic models of the wave environment and at developing a methodology for the best use of different type of data in describing coastal wave condition. This paper will present a brief overview of the project including its aims and some of the results already archived.

## STOCHASTIC MODELLING OF SEA WAVE PROCESS

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Modelling the variability of the sea surface elevation is of major interest to many engineering studies both offshore and in the coastal zone. Stochastic processes are adequate tools to represent the time variation of the various parameters related with sea waves.

This paper will present a brief overview of the different approaches adopted to model the variability of the wave environment in a short medium and long term time scale and will cover both time dependent and time independent models.

## CALIBRATION OF A WIND MODEL USED FOR WAVE HINDCAST

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A wind model has been developed to provide the input wind fields to a wave prediction program, based on information about pressure distributions.

The model has been applied to different storms in the Portuguese coast and the predicted wave fields have been compared with measurements. A good qualitative

agreement has been obtained but some numerical differences were still observed.

This paper will report on the work developed to calibrate the wind model by adjusting some of the empirical coefficients so that the quantitative comparison with the measurements is improved.

### DISTRIBUCION Y ABUNDANCIA DE LA GAMBA BLANCA (*PARAPENAEUS LONGIROSTRIS* LUCAS, 1846) EN LA REGION SURATLANTICA ESPAÑOLA (GOLFO DE CADIZ).

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La gamba blanca (*Parapenaeus longirostris*, Lucas, 1846) es un crustáceo decápodo perteneciente a la familia de los Peneidos que presenta una amplia distribución geográfica, encontrándose en el Atlántico oriental desde las costas portuguesas hasta Angola, así como a lo largo de todo el Mediterráneo (Pérez-Farfante, 1982).

En aguas españolas del golfo Cádiz se desarrolla una pesquería de arrastre en la que la gamba blanca constituye una de las principales especies objetivo.

Durante el periodo comprendido entre octubre de 1992 a marzo de 1994 se han realizado cuatro campañas de evaluación de los recursos demersales en el área de estudio, a bordo de los buques B/O Cornide de Sampedra y B/O Fco. de P. Navarro, las cuales han permitido conocer ciertos aspectos bioecológicos de la especie.

La distribución batimétrica de la gamba blanca en el Golfo de Cádiz está comprendida en los 40 y 650 m de profundidad, ampliándose el rango aportado por Massuti (1959) para esta misma área. Esta distribución está más de acorde con la registrada por diversos autores en el Mediterráneo (Tom et al., 1988, entre 20-750 m; Ardizzone, 1990, entre 100-500 m). Sin embargo, en aguas atlánticas africanas la especie presenta un rango batimétrico más restringido. Así, en el Golfo de Guinea, Sobrino y Fernandez (1991) la citan entre 20-400 m; Crosnier et al. (1970) en el Congo entre 50-500 m, al igual que en el resto de Africa tropical (Crosnier y Forest 1973) mientras que Sobrino y Cárdenas (1991) en aguas de Angola no la encuentra a más de 400 m de profundidad.

La distribución espacial de la gamba blanca ha sido analizada en cada campaña mediante técnicas de análisis geostadístico. (Clark, 1979; Conan, 1985; Matheron, 1971).

En el presente estudio se han diferenciado entre ejemplares menores y mayores de 17 mm, talla en la que comienzan los procesos de maduración de las

hembras (Sobrino y Garcia, 1993), al objeto de diferenciar las áreas de reclutamiento frente al resto de la población.

Para la obtención de los mapas de densidades se han usado técnicas de kriging ordinario, en nuestro caso por bloques, realizando la estimación sobre una trama de 5 x 5 km, cubriendo la zona prospectada en las campañas.

Referente al cartografiado de los reclutas se observa en las cuatro campañas que éstos se concentran en un área restringida, bien al oeste o al este de la zona prospectada. Sin embargo los adultos se distribuyen más homogéneamente, con excepción de la campaña realizada en marzo de 1993. No se detecta una segregación latitudinal clara entre ambas fracciones de la población.

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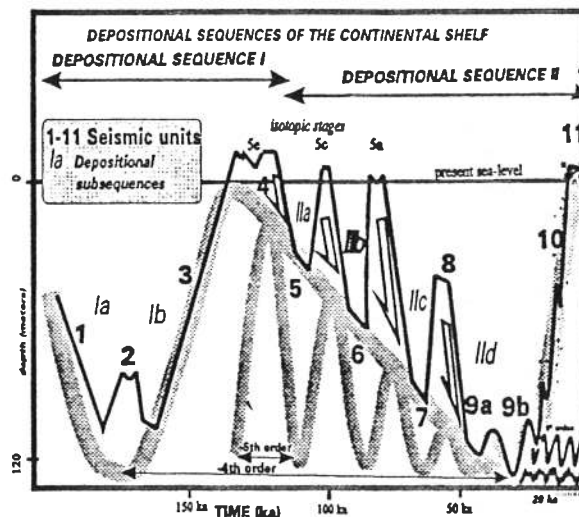
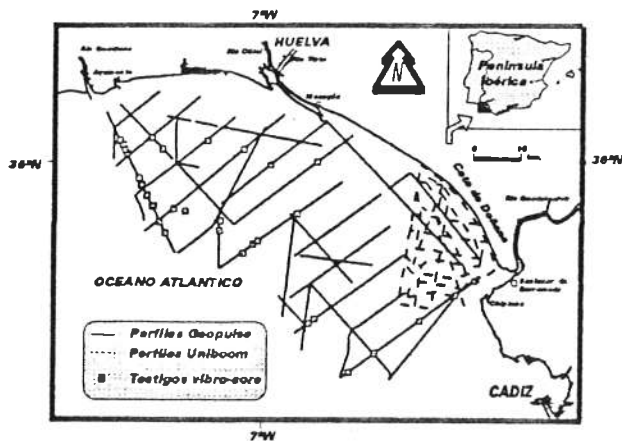
## MORPHO-DEPOSITIONAL EVOLUTION OF THE CADIZ GULF CONTINENTAL SHELF: GOLCA PROJECT

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The morpho-sedimentary architecture of the Cadiz Gulf continental shelf (SW Spain) was analyzed using single-channel very high resolution reflection seismics. Single channel seismic source used was Geopulse (300 Joules) carrying out a grid of narrow-spaced profiles (800 kms length) through the continental shelf of the Cadiz Gulf (fig. 1) during the cruises GOLCA 93 and 94 on board of the Oceanographic Spanish Institute vessel "Odon de Buen". The very high vertical resolution of this system (from 1 to 0.5 meters) allows the definition of the geometrical features of sedimentary bodies. Lithological information was obtained with 32 vibrocores (4 to 5 meters) picking up the main sedimentary bodies for isotopic dating. The interpretations of the seismic units has been based taking into account all the seismic lines, what allows the establishment of the three-dimensional geometry of the sedimentary bodies. The seismic lines presented on this paper are representative of geometry of the stratal architecture of areas with different subsidence and sediment rates dependents of local factors. The length of these seismic lines has permitted the reconstruction of the sequences in detail with great lateral continuity.

An evolutionary scheme of depositional sequences governed by the Late Pleistocene-Holocene sea-level fluctuations is proposed (fig 2). The stratigraphical analysis allows the definition of eleven seismic units making up the continental margin, that are configured into two major type 2 depositional sequences related to 4th order eustatic sea-level changes (100-110 k.y.). Within these sequences, it has possible to recognize minor depositional sequences related to higher, 5th order eustatic cycles (22-23 k.y.), superimposed and modulating the regressive trends of 4th-order cycles. In 5th-order depositional sequences, lowstand deposits are volumetrically predominant. They cause the main progradation of the margin so that they form the margin structure almost entirely. In 4th-order depositional sequences, highstand and transgressive deposits are predominant.



**TECTONIC CAUSES OF UNCONFORMITIES IN THE MESOCENOZOIC SEDIMENTARY RECORD OF THE PORTUGUESE CONTINENTAL MARGIN (ALGARVE AND LUSITANIAN BASINS)**

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Unconformities between sedimentary packages are important because they represent time gaps, eustatic and/or tectonic events and are helpful in mapping. It is often difficult to tell what was the cause of an unconformity and/or distinguish between unconformities due to compressional or extensional tectonic regimes.

Unconformities in the Mesozoic sedimentary record of the Algarve and Lusitanian Basins have been interpreted as caused by rifting or eustatic sea level variations. On the other hand, unconformities in the Cenozoic sediments have usually been interpreted as caused by inversion due to the Betic compressional phase as well as by eustatic sea level variations.

This paper presents examples from field mapping and study of seismic reflection profiles of:

- i) the above mentioned types of unconformities, i.e. due to the Mesozoic extension or Cenozoic compression
- ii) unconformities of Jurassic and Cretaceous age, that are due to compression and probably to Mesozoic basin inversion events
- iii) Cenozoic unconformities, which have been caused by thin skinned extensional tectonics and gravitational collapse
- iv) unconformities associated with diapirism.

**FAUNA Y FLORA BENTONICAS DE LA RIA DE FERROL (NW DE ESPAÑA): DISTRIBUCIÓN DE LOS MOLUSCOS POLIPLACOFOROS**

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Se presenta el catálogo de los Moluscos Polioplacóforos de la Ría de Ferrol, en el que se incluyen todas las

especies que habitan en los fondos intermareales e infralitorales de los diferentes sustratos de la ría.

Para la elaboración del inventario se han considerado todas las especies de Polioplacóforos que existen en las colecciones del Departamento de Biología Animal de la Universidade de Santiago de Compostela y las que han sido mencionadas en la bibliografía concerniente al área estudiada.

Se catalogan un total de 8 especies (*Leptochiton asellus*, *Leptochiton cancellatus*, *Callochiton septemvalvis*, *Lepidochitona cinerea*, *Lepidochitona iberica*, *Chaetopleura angulata*, *Acanthochitona fascicularis* y *Acanthochitona crinita*) que componen una colección de aproximadamente 1.566 individuos.

Para cada especie se especifican las localidades en las que fueron recolectadas, el topónimo, las coordenadas geográficas. Además, se describen y discuten las condiciones del hábitat en el que fueron recolectadas y se elaboran los mapas de distribución de las especies en la ría.

**FAUNA Y FLORA BENTONICAS DE LA RIA DE FERROL (NW DE ESPAÑA): DISTRIBUCIÓN DE LA FAMILIA TURRIDAE (MOLLUSCA, GASTROPODA)**

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Se presenta el catálogo de los Moluscos Gasterópodos pertenecientes a la familia Turridae de la Ría de Ferrol, en el que se incluyen todas las especies que habitan en los fondos intermareales e infralitorales de los diferentes sustratos de la ría.

Para la elaboración del inventario se han considerado todas las especies de Turridos que existen en las colecciones del Departamento de Biología Animal de la Universidade de Santiago de Compostela y las que han sido mencionadas en la bibliografía concerniente al área estudiada.

Se catalogan un total de 12 especies (*Haedopleura septangularis*, *Mangelia nebula*, *Mangelia brachystoma*, *Mangelia attenuata*, *Cythereella smithi*, *Cythereella coarctata*, *Cythereella costata*, *Comarmondia gracilis*, *Raphitoma linearis*, *Raphitoma purpurea*, *Raphitoma asperrima*, *Raphitoma leufroyi*) que componen una colección de 726 individuos.

Para cada especie se especifican las localidades en las que fueron recolectadas, el topónimo, las coordenadas geográficas. Además, se describen y discuten las condiciones del hábitat en el que fueron recolectadas y se elaboran los mapas de distribución de las especies en la ría.

## PRELIMINARY RESULTS OF CHEMICAL COMPOSITION OF THE SADO CANYON SEDIMENTS

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A significant amount of organic matter synthesized on the continental shelf is believed to be transported to the slope could thus become an important sink for the organic matter and pollutants associated with biogenic particles which could be sequestered in the slope regions. The Sado Canyon is located in the Portuguese shelf nearby two major estuaries which are surrounded by industrial areas. In these circumstances terrigenous organic matter and pollutant-particles associated are also expected to be transported through this feature.

The aim of this work is to study the chemical composition of the sediments from the Sado Canyon in order to understand the fate of particulate organic matter and metals. Four gravity cores (30 cm long) were collected in a cross section of the canyon, between 200 and 2000 meters, during the Tyro Cruise (October 1991) of the MARFLUX Project (MAST 0022). The cores were sliced in 1cm interval and metals (Pb, Cd, Cu, Zn, Fe, Mn), extractable lipids and lipid composition were determined in the sediment samples. In this work the following results were obtained: in deeper cores the first 7 cm of sediment were enriched in Mn; in the deepest core, lipid content decreased sharply within the first 5 cm; for the other sediment cores, a less pronounced depth variation was found; among neutral lipids wax esters/sterol esters were the most abundant lipid classes in all sediment layers analyzed; total Pb concentration decreased in depth, in the first 6 cm (deepest core) and in the displayed sub-surface enrichments; other metals showed differences among the sediment cores.

These results indicate (i) geographic variation in the concentration of some elements (Cu, Zn) which can be explained by grain-size composition, (ii) vertical differences on metal content due to anthropogenic sources (Pb) and diagenetic transformations (Mn, Cd), (iii) a significant degradation of lipids in the top layer of the sediments, and (iv) the wax esters/sterol esters were the most abundant lipid classes in the sediments reflecting probably zooplanktonic contribution as well as terrestrial material.

## A RE-EVALUATION OF DUNE VULNERABILITY CHECKLIST PARAMETERS<sup>(1)</sup>

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A significant number of dune systems located in north west Europe have been analysed with respect to dune vulnerability via a well designed checklist. The parameters selected related to (A) site and dune morphology, (B) beach condition, (C) the surface character of the seaward 200 metres of the dune system, (D) pressure of use, totalling 43 parameters indicating vulnerability - summed to give a Vulnerability Index (VI), and (E) 11 parameters relating to recent protection measures (PM). This proved to be an extremely workable and rapid procedure for dune managers to assess the balance between dune vulnerability and protection, the relationship being calculated with a vulnerability/protection measure index (VI/PM). Systems in management equilibrium have VI/PM ratios normally within a range of 0.8 to 1.3. However when applied to south European systems in Portugal and Spain, evidence emerged that the current checklist was not as robust as necessary and some of the parameters had to be excluded, modified, or added to the procedure. For example the wet slack indicator, the effects of rabbits and the impact of horse riding could be ignored for large numbers of Portuguese and Spanish dune sites. The initial checklist underplayed the importance of wave climate, wind speed, and assessment of the effectiveness of legislative measures, managed paths, sand traps and protection measures needed to be undertaken. In addition it became evident that site selection for assessment is important. Where systems show great contrast in the pressure of use e.g. Ancão, Portugal, more than one vulnerability index is required and the use of averaged values is misleading. At Ancão, the protection measure index varied from 19% (effectiveness of legislation) to 42% (existence of legislation) for the system. At Isla Canela in Spain, sections A to D showed little variation between old and new checklists, but section E changed from 50% to 29%, respectively reflecting the true nature of the system. Utilising the checklist and incorporating modifications described in this paper, results were produced more in keeping with the known dune protective measures for the south European dune contexts.

## BULK GEOCHEMISTRY OF SEDIMENTS FROM THE LISBON/ SETUBAL SUBMARINE CANYON SYSTEM, PORTUGAL.

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Sediments from ten box cores were taken within the Lisbon/Setubal submarine canyon system have been geochemically characterised. Sediments were dried, ground in agate and analysed by XRF, cross calibrated with an ICPAES. Grain size determinations were carried out by sieving and Sedigraph particle size analysis, whilst organic carbon concentrations were elementally determined.

Simple bivariate plots and correlation matrices give primary indications of elemental associations, specifically with regard to either typical nearshore muds or deep sea pelagic clays. A statistics package containing factorial, K-means and hierarchical clustering analysis was used to further examine the data set.

Factorial analysis gave 6 factors. These accounted for some 83% of the variance. However, only one factor, a "clay" rich factor dominated by % sediment < 63µm, Al, Ba, Fe, and V really seemed significant, singularly accounting for 42% of the variance. Other factors gave less information.

K means analysis produced 5 clusters. Cluster 1 was high in >63µm material, Ca, S, Sr, Si, Na, and Co, and was interpreted as a coarse sand and shell mixture. Clusters 2 and 5 showed an intermediate grain size character and contained the highest concentrations of Y and Zr. Cluster 3 contained the highest proportion of sediment between 2 and 63µm, and elements such as K, Corg, Pb, Rb, and Zn. Finally, cluster 4 showed high concentrations of sediment <2µm, Al, Ba, As, Fe, Mg, Corg and other associated elements.

Hierarchical analysis initially showed two distinct clusters. These were combined with results from K means analysis to identify which samples belonged to which cluster. One cluster dominated, containing almost 75% of the samples, and was typified by clay rich, mainly river derived sediments high in Al, Corg and associated trace elements. The other, much smaller, cluster was shown to contain a sand/shell mixture rich in Ca, Sr, Co and S. Continued investigation of the data showed that further subgroups could be determined, mainly splitting the large first cluster into clay rich and silt rich samples, and the second cluster into sandy and shelly samples.

Thus, overall, the statistical analyses showed a suite of cores dominated by clay rich river input, which occasionally experiences inputs of coarser sediments. It also clarified points about sources to the southern Setubal Canyon, showing that cores in the lower part

of the canyon are different from those above. Moreover, it showed that chemical analysis of sediments is not enough to explain sediment characteristics. The chemistry of these sediments cannot be fully explained in terms of inputs to the sediment column without regard for either hydrodynamical controls on grain size, i.e. variations with respect to distance offshore and water depth, or grain size relationships with mineralogy.

## THE EARLY DIAGENESIS OF MANGANESE IN SEDIMENTS FROM THE LISBON/SETUBAL SUBMARINE CANYON SYSTEM, PORTUGAL.

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Seven box cores from the axes of the Lisbon/Setubal submarine canyon system were taken in Autumn 1989. Porewaters were extracted under N<sub>2</sub> and analysed colorimetrically for Mn<sup>2+</sup>, whilst the solids were ground in agate and organic carbon determined by Carlo Erba CNS analyser.

Diagenetic Theory suggests that as bacteria oxidise organic carbon, a number of definite chemical processes occur as first oxygen is utilised followed by other secondary oxidants. One of these secondary processes is the reduction of Mn oxides, which introduces Mn<sup>2+</sup> into porewaters. The depth in the core at which any one of these processes occurs is determined by organic carbon flux and sedimentation rate, increasing organic C flux results in a shallowing of the depth of Mn<sup>2+</sup> remobilisation. Since organic carbon flux and sedimentation rate generally decrease offshore, Mn<sup>2+</sup> should peak lower in the cores as distance from shore increases.

In the Lisbon Canyon this theory holds true, and has been seen as a reflection of lower organic carbon contents further offshore. However, in the Setubal Canyon the opposite geographical trend was found to occur again reflecting the organic carbon contents which in this canyon are greater offshore than onshore. This increased carbon flux to the mouth of the canyon may indicate that the River Sado possibly discharges sediment to the lower canyon rather than the canyon head. If this is true, this is possibly linked to the deposition of the Troia Spit, which has subsequently forced the river mouth northwards. Out towards the Tagus abyssal plain, the organic carbon contents decrease still further, and the Mn<sup>2+</sup> peaks even lower down the core, thus supporting the relationship between organic C flux and diagenesis, as seen in the canyons.

**EL GÉNERO *Callochiton* GRAY,  
1847 EN LA PENÍNSULA IBÉRICA.  
ASPECTOS TAXONÓMICOS Y  
ZOOGEOGRÁFICOS.**

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El género *Callochiton* Gray, 1847, en la Península Ibérica, presenta cierta controversia debido a que los caracteres observados en la ornamentación de las placas no han permitido diferenciar claramente las especies (Monterosato, 1879; Pilsbry, 1938; Leloup y Volz, 1938; Malatesta, 1962). Es por ello por lo que se ha considerado una sola especie con dos subespecies *C. septemvalvis septemvalvis* (Montagu, 1803), de distribución atlántica y *C. septemvalvis euplaeae* (O.G. Costa, 1829) de distribución mediterránea (Kaas, 1978; 1985).

A partir de ejemplares de *Callochiton* capturados en el litoral atlántico y mediterráneo de la Península Ibérica se ha estudiado su anatomía, tanto macroscópica como microscópicamente con el microscopio electrónico de barrido. Los ejemplares atlánticos difieren de los mediterráneos principalmente por presentar un mayor tamaño, y disponerse las megalostetas sobre tubérculos y presentar microestetas de aspecto alargado y de menor tamaño.

En función de tales diferencias se propone la separación de dos especies: *C. septemvalvis* (Montagu, 1803), de distribución atlántica y *C. euplaeae* (O.G. Costa, 1829) de distribución mediterránea, las cuales son redescritas en el presente trabajo. Además de ello, se revisa la distribución geográfica de ambas especies.