



Research papers

Recent benthic foraminifers of the Basque continental shelf (Bay of Biscay, northern Spain): Oceanographic implications

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ABSTRACT

We describe the spatial distribution of recent benthic foraminifer assemblages from the western area of the Basque shelf in relation with some environmental parameters. A total of 138 species have been identified, being the most abundant *Cassidulina laevigata*, *Gaudryina rudis*, *Lobatula lobatula*, *Rosalina globularis* and *Textularia sagittula*. Multivariate analyses (cluster Q-type and Detrended and Canonical Correspondence Analysis) performed with the benthic foraminifers of these samples show the separation of two main groups of species related with the sediment grain size: (1) coarse to very coarse sand and (2) medium sand and sandy silt. Seven clusters are characterised by their typical foraminifer assemblage and average values of particular parameters: clay-silt content of the sediment, depth, and percentage of foraminifer species indicative of hypoxia. The main features of marine currents of the area are reflected by these foraminifer assemblages. Thus, the occurrence of specimens typical of the estuaries as *Ammonia tepida*, *Criboelphidium williamsoni* and *Haynesina germanica* in this shelf, points to an eastward lateral transport forced by the littoral current below 60 m. The occurrence of small individuals of littoral (*Asterigerina mamilla*) and deep water (*Globocassidulina subglobosa*) species in the middle-outer shelf is indicative of wind, water density and tide forced N–S surface currents. In the outer shelf species characteristic of deep and cold waters appear (*Fontbotia wuellerstorfi*, *Hoeglundina elegans*), together with abundant individuals of species resistant to hypoxia (*Bulimina marginata*, *Hyalinea balthica*, *Melonis barleeanum*, *C. laevigata* and *Uvigerina peregrina*) that suggest upwelling currents through the canyons located in this area. These species are then transported eastward following the Normal Circulation current between 100–200 m depth.

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1. Introduction

The evaluation of fine sedimentation patterns in continental shelves is important since it is determinant of the chemical and biological quality of the environment, which is anthropogenically influenced. Furthermore, this evaluation allows us to estimate the supply of fine materials to wider regions of the Atlantic Ocean, since coastal areas act as traps for continental sediments.

In order to study the sediments of the Basque shelf (Fig. 1), an oceanographic cruise “Euskased 2003” was carried out in 2003. In order to decipher the role of sedimentation in these areas of the shelf and the upper slope, as well as their relationship with the open ocean, a detailed sampling was performed including the characterisation of sedimentary facies, heavy metals, sedimentation rates and the impact of surface sediments in the benthos.

Preliminary results of this study (Jouanneau et al., 2008) give a general canvas of the sedimentation in the Basque shelf (Fig. 2). This work shows that the sedimentation of fine particles is concentrated in the eastern area of the Basque basin (43°18′ to 43°36′N and 1°30′ to 2°23′W). In the present study we describe the benthic foraminifer assemblages of the western sediments of the Basque basin (2°23′ to 3°20′W), where sandy sediments dominate (see Fig. 1).

Recent foraminifer assemblages are very useful to understand geological and historical marine environmental changes. Thus several proxies have been developed in the palaeo-ecologic and palaeo-oceanographic reconstruction (Murray, 1991, 2006). Nevertheless, it is basic to understand the role of environmental factors in the distribution of foraminifer assemblages to apply them as proxies. Therefore, foraminifers can be used as environmental proxies due to their nature of simple organisms that have no pressure on the ecosystem but they are influenced by it. Van der Zwaan et al. (1999) claim that the use of foraminifers as proxies is very limited to distributions related to depth, oxygen level and organic matter flux. More recent publications include also other microhabitat characteristics such as the redox index and the

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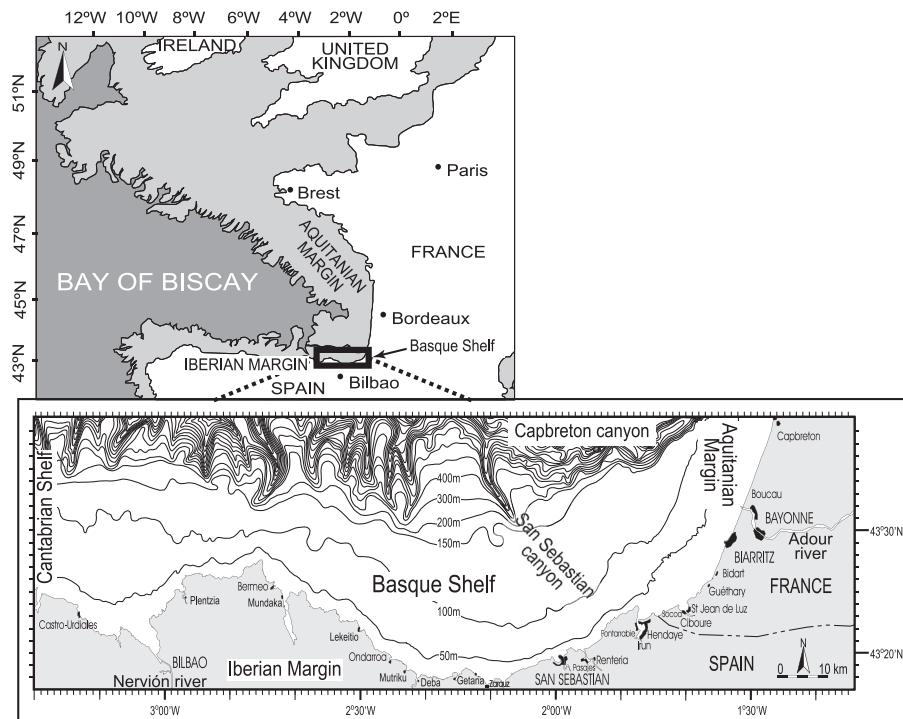


Fig. 1. Geographical location of the study area and detail of the Basque shelf (modified from Jouanneau et al. (2008)).

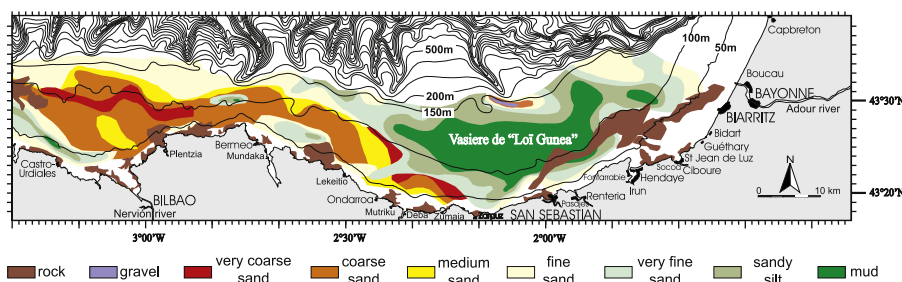


Fig. 2. Distribution of the main sedimentary facies identified in the Basque shelf (modified from Jouanneau et al. (2008)).

organic carbon content as important factors in the distribution of these organisms (Fontanier et al., 2002, 2005, 2006). On the other hand, palaeoecological interpretations of fossil foraminifers are based on the understanding of ecological processes acting today, so studies as proposed in this work, considering the recent distribution of benthic foraminifers and their environmental context, help to clarify some of the past environmental factors affecting the benthic foraminifers.

Previous studies of benthic foraminifers of the Bay of Biscay were focused in the French marine shelf, taking into account their distribution and their relationships with several environmental factors: in Bretagne (Moulinier, 1967; Dupeuble et al., 1971; Rosset-Moulinier, 1972; Rosset-Moulinier and Roux, 1977), in the northern French shelf, (Schnitker, 1969), off the Gironde River (Caralp et al., 1970; Rouvillois, 1970; Pujos, 1972, 1976), southern Capbreton Canyon (Fontanier et al., 2002; Duchemin et al., 2007) and along the Aquitaine margin (Caralp et al., 1967; Pujos-Lamy, 1973; Fontanier et al., 2003, 2005; Langezaal et al., 2006; Ernst et al., 2008; Duchemin et al., 2008; Mojtahid et al., 2010).

Nevertheless foraminifer studies in the Basque–Spanish shelf have been scarce and most of them are related to estuaries and coastal areas of the Basque Country (Pascual, 1984, 1992; Pascual et al., 1998, 2002, 2004, 2006; Pascual and Rodríguez-Lázaro, 2006; Cearreta, 1988, 1989; Leorri and Cearreta, 2009; among others). The first foraminifer study performed in this shelf is that

of Colom (1974) who analysed samples obtained between 300 m and 600 m water depth. Recently, Pascual et al. (2008) describe for the first time the recent distribution of benthic foraminifers and ostracods in the eastern area of the Basque shelf and evaluate the anthropogenic influence on these assemblages.

In the present work we complete that study with benthic foraminifers from the western area of the Basque basin with the aim to evaluate the response of this microfauna to the substrate types, depth and the hydrodynamic characteristics of the area.

2. Study area

The study area is located in the western part of the Basque basin, in the southern Bay of Biscay (Fig. 1). This shelf (43°18' to 43°36'N and 1°30' to 3°20'W) lies between the Iberian Margin to the South and the Capbreton Canyon to the North and laterally limits with the Aquitaine Margin and the Cantabrian shelf. The presence of canyons that are tributaries of the Capbreton Canyon and interfluvials produce the shelf break in depths between 300 m and 800 m. This shelf is relatively narrow (7–20 km) and allows a direct transportation of suspended particulate matter by the Basque rivers, from littoral to deeper areas of this Bay (Frouin et al., 1990). These rivers also transport important amounts of sediments to the shelf with high percentages of suspended

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