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Sedimentary processes on the NW Iberian Continental Shelf since the Little Ice Age

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ABSTRACT

The OMEX core CD110 W90, retrieved from the Douro Mud Patch (DMP) off the River Douro in the north of Portugal, records the period since the beginning of Little Ice Age (LIA). The core chronology is based upon the data attributes for ^{210}Pb, ^{137}Cs and a ^{14}C dating from a level near the core base. Geochemical, granulometric, microfaunal (benthic foraminifera) and compositional data suggest the occurrence of precipitation changes which may have been, at least partially, influenced by the North Atlantic Oscillation (NAO), that contributes to the regulation of the ocean–atmosphere dynamics in the North Atlantic.

Southwesterly Atlantic storm track is associated with the negative phases of the NAO, when the Azores High is anomalously weak, higher oceanographic hydrodynamism, downwelling events and increased rainfall generally occurs. Prevalence of these characteristics during the LIA left a record that corresponds to phases of major floods. During these phases the DMP received a higher contribution of relatively coarse-grained terrigenous sediments, enriched in quartz particles, which diluted the contribution of other minerals, as indicated by reduced concentrations of several lithogenic chemical elements such as: Al, As, Ba, Ce, Co, Cu, Fe, K, La, Li, Mg, Mn, Mo, Na, Ni, P, Rb, Sc, Sn, Th, V and Y. The presence of biogenic carbonate particles also underwent dilution, as revealed by the smaller abundance of foraminifera and correlative lower concentrations of Ca and Sr. During this period, the DMP also received an increased contribution of organic matter, indicated by higher values of lignin remains and a benthic foraminifera high productivity index, or BFHP, which gave rise to early diagenetic changes with pyrite formation. Since the beginning of the 20th century this contribution diminished, probably due to several drier periods and the impact of human activities in the river basins, e.g. construction of dams, or, on the littoral areas, construction of hard-engineering structures and sand extraction activities.

During the first half of the 20th century mainly positive phases of the NAO prevailed, caused by the above normal strengthening of the subtropical high pressure centre of the Azores and the deepening of the low pressure centre in Iceland. These phases may have contributed to the reduction in the supply of both terrigenous sediments and organic matter from shallow water to the DMP. During the positive phases of the NAO, sedimentation became finer.

The development of mining and industrial activities during the 20th century is marked, in this core, by higher concentrations of Pb. Furthermore, the erosion of heaps resulting from wolfram exploitation leaves its signature as a peak of W concentrations recorded in the sediments of the DMP deposited between the 1960s and the 1990s. Wolfram exploitation was an important activity in the middle part of the 20th century, particularly during the period of the Second World War.

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1. Introduction

The NW Iberian Continental Shelf, located between 41°N and 42°50′N (Fig. 1), has a width ranging between 31 km and 45 km and is covered mainly by fine sand (Dias et al., 2002a). Sediments are transported from the Galician rias, Vigo, Pontevedra, Arosa and Muros and river floods from the five major rivers of northern Portugal, Minho, Lima, Cávado, Ave and Douro, feeding two main muddy deposits along the mid- and outer-continental shelf, known as the Douro Mud Patch (DMP) and the Galicia Mud Patch (GMP). These river catchments have been established from the highlands in the inner continental areas down to the coastline, running through Precambrian and Paleozoic rocks, such as the Pre-Ordovician Slate-Greywacke Complex (Carrington da Costa, 1950; Teixeira, 1955) and very diverse lithologies (Iglésias et al., 1983; Ribeiro et al., 1990) strongly affected by Variscan deformation, metamorphism and plutonism (Farías et al., 1987). The northern Portuguese rivers are the main suppliers of sediments to the NW Iberian Continental Shelf. The Douro alone introduces approximately 87% of all fluvial sediments into the area (Dias, 1987).

DMP and GMP are aligned from north to south and are parallel to the coastline (Fig. 1). Their thickness varies between 1 and 3.5 m (Drago, 1995). The DMP, studied in this work, lies at a depth of 65–130 m to the northwest of the mouth of the Douro River and is close to the Porto Canyon head (Fig. 1). It is about 8–18 km wide and 42 km long and its western boundary is delimited by the outcropping rocks (Dias et al., 2002a,b). Lantzsch et al. (2009a, b, 2010) and Mohamed et al. (2010) reported ages in excess of

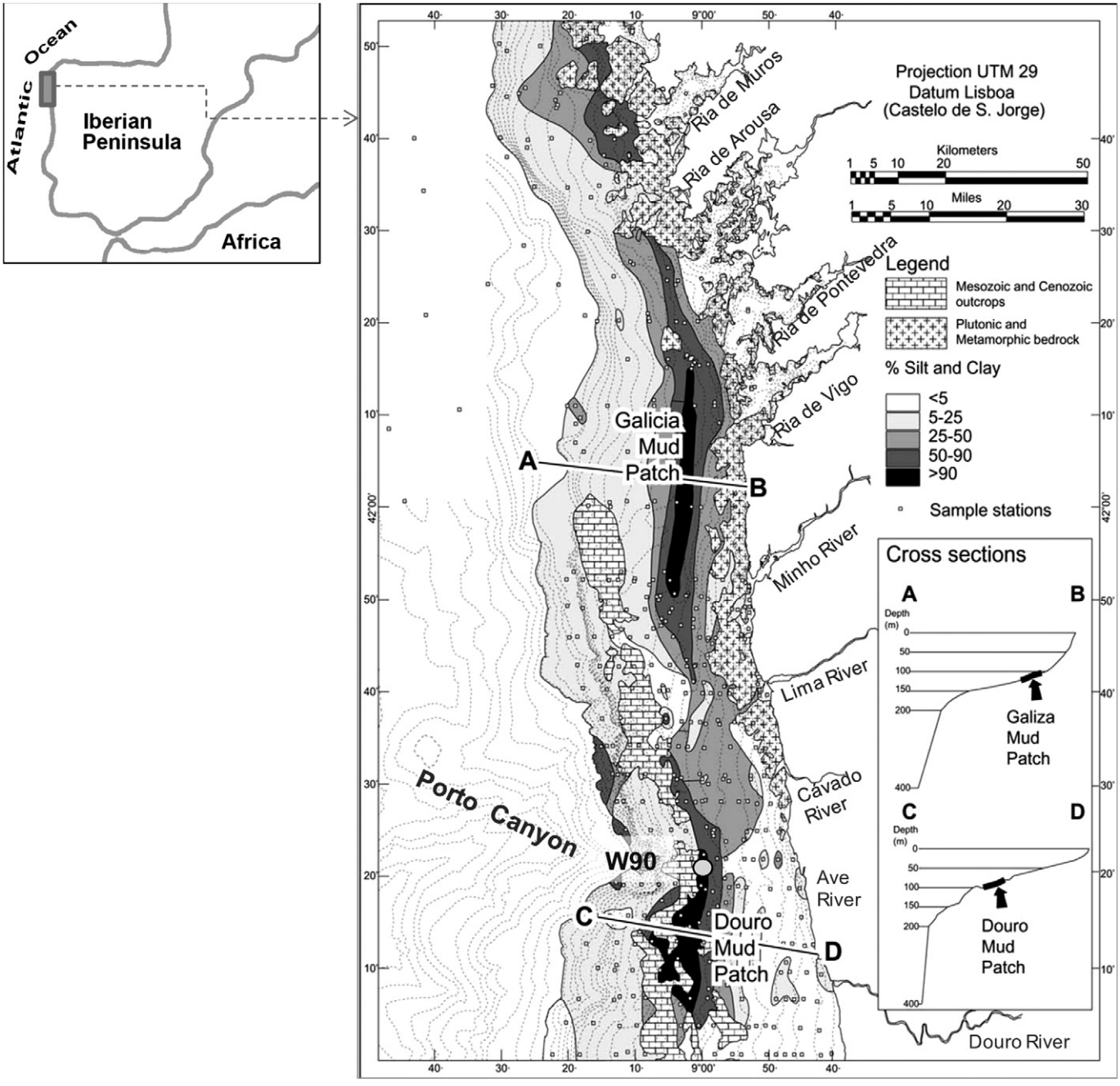

Fig. 1. Distribution of the percentages of silt and clay on the Galicia-Minho Continental Shelf (adapted from Dias et al., 2002b). The OMEX core W90 location in the Douro Patch.