Controls on the magnetic properties of sediments from the NW Iberian Margin

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Abstract: Marine sediments are one of the most important archives of environmental processes. They have the potential to provide the longest continuous records of environmental changes, with a high degree of temporal continuity and limited stratigraphic disturbances, especially away from continental margins. The analysis of magnetic properties in marine sediments has been successfully applied to reconstruct many processes in sediments, such as climatic changes, chemical changes during burial, or the extent of anthropogenic impacts in these settings. To correctly interpret the environmental significance of sedimentary magnetic properties it is essential to understand the controls in the magnetic properties being investigated. In this contribution, we provide some examples of the main factors controlling changes in magnetic properties of surficial and down-core sediments in marine sediments of the NW Iberian Margin. We begin by presenting the main forcing mechanisms explaining the observed variability in magnetic properties in shallow water settings, with case studies from the Rias Baixas of Galicia (NW Spain) and in deeper oceanic settings: continental shelf, slope and abyssal plain further offshore.

In the Rias Baixas of Galicia, the concentration-dependent magnetic properties of surficial sediments show a marked increase towards de deeper external parts of these embayments, and towards the central axis of these drowned valleys. This pattern is partly explained by dilution with coarse diamagnetic material, mostly biogenic carbonates that become concentrated in the high-energy margins of the rias. If only the fine fraction is considered the same pattern is exacerbated. The main controlling factors explaining this variability were identified in the Ria de Pontevedra by Rey et al., (2005) as the result of periodic resuspension of sediments by waves. Surficial magnetic properties also seem to be linked to the concentration of organic matter in the sediments, as highlighted by Andrade (2012) in the Ria de Muros. The concentration of magnetic minerals in surface sediments is controlled by the concentration of organic matter and follows an exponential decrease. This model estimates that a 0.35% TOC increase leads to a 50% reduction in magnetic susceptibility. Our results confirm the same relationship in surficial sediments of the Rias of Vigo and Pontevedra.

Down-core magnetic properties in the Rias also show a gradient towards the open ocean, as highlighted by Rey et al., (2005) and Mohamed et al., (2011). This gradient is controlled by the intensity and extent of early diagenetic reduction of magnetic minerals, which becomes progressively more intense towards the inner rias, leading to the complete dissolution of magnetic (oxyhydr)oxides faster and closer to the sediment surface in the internal, organic-rich, ria sediments. Departures from the natural pattern of down-core variability in magnetic properties have allowed to detect areas altered by anthropogenic activities, potentially leading to chemical changes that may release and may increase the bioavailability of heavy metals.

In the continental shelf, detrital processes related to the adjacent continental margin controlled the magnetic properties of the sediments during the last 2,000 years, allowing the reconstruction of the climatic history in this period. However, organic matter is still high due to coastal upwelling, leading to complete dissolution of magnetic (oxyhydr)oxides and their paleoclimatic information prior to this period.

Further offshore, in the continental slope and abyssal plain, the concentration of magnetic properties increases significantly repeatedly down-core. Concentration-independents magnetic properties, FORC results and isotopic fingerprinting confirm that the successive arrival of IRDs is the main factor controlling changes in concentration of magnetic minerals. Easy identification of these phenomena, linked to abrupt changes in the climate system, with the use of magnetic properties underlines its utility as a sensitive, fast and economic screening tool to detect sites with a high potential as a paleoclimatic archive which may subsequently be studied using other high precission, but more time consuming techniques.

Keywords: Galician Rias, Marine Sediments, Environmagnetics, Diagenesis, IRDs

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