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Quantification of the role that organic matter and grain size has on the variability of magnetic susceptibility in sediments of transitional marine environments.

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Further improvements on the use and applicability of magnetic properties as proxies for environmental variables, such as pollution, Earths's surface processes, and (paleo)environmental changes require progress in the understanding of current and new developments in transference functions that relate these proxies with the unmeasurable variables. The most popular among the magnetic properties is magnetic susceptibility, but its performance has still room for improvement. In this contribution we explore the dependence of magnetic susceptibility on grain size and provide estimations on the controls exerted by hydrodynamic forces and organic matter content and provenance, and propose a simple model to relate magnetic susceptibility to the main variables that control its variability in transitional marine environments.

Variability on the concentration of (oxyhydr)oxides in sediments with median sizes larger than 63 63 microns (sands) is essentially determined by the proportion of diamagnetic material (e.g. quartz, $CaCO_3$, etc.), which effectively acts as a diluting medium. Conversely, muddy sediments are not as dependent on the physical dilution of ferromagnetic minerals in the diamagnetic or paramagnetic matrix, compared to the large impacts of their dissolution during early diagenesis. Therefore, in these finer sediments, the organic matter content, which typically correlates negatively with grain size, is the main controlling factor. In our study area, the Ria de Muros in NW Iberia, we found that maximum values of magnetic susceptibility appear in sands with a d50 of 68 microns, where the balance between dilution and TOC-promoted dissolution is optimal for the preservation of ferromagnetic minerals.

We quantified this dependence on organic matter content and grain size by developing a simple kinetic model, which reveals a negative exponential function established between magnetic susceptibility, grain size, and TOC content in the fine-grained fraction. Based on this model, we found that in the Ria de Muros, half of the concentration of magnetite in these sediments is reduced when modest TOC increases of 0.35%. Adjacent similar environments also show this relationship, although with different coefficients. Therefore, the quantification of magnetic susceptibility is strongly dependent on the texture of the sediments, mineralogy, lability of organic matter, and even wave climate, water depth and oxygenation and resuspension of the sediments.