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Benchmarks and sediment source(s) of the 1755 Lisbon tsunami deposit at Boca do Rio Estuary☆

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ABSTRACT

Standardizing the signature of tsunami deposits has been identified as a major limitation for the identification of paleo-tsunami deposits. This limitation mostly arises from the strongly source-dependent nature of these deposits, which in turn determines their composition and depositional architecture, and from the effect of the local morphology of the corresponding depositional environment. Here, we provide new high-resolution mineralogical, geochemical and micro/macrofauna data of the 1755 tsunami layer of Boca do Rio estuary (Algarve, Portugal) with the aim of unraveling the signatures of estuarine tsunami deposits and linking them to possible sediment sources. We also apply for the first time diffuse reflectance spectrophotometry (DRS) analysis. Our results show that the 1755 tsunami deposit of the Boca do Rio estuary is featured by an enhancement in Sr and Ca, which are linked to the input of biogenic and detrital carbonates (shell fragments and limestone clasts) from the beach foreshore and a strong depletion in most terrestrial- and marine-sensitive indicators. The latter is interpreted as resulting from the reworking of the estuarine clays and subsequent dilution within a huge volume of sand eroded from the coastal barrier. It confirms that in the case of the Boca do Rio estuary, the sediment source is essentially proximal and coastal. Textural and mineralogical features between the base and the top of the tsunami layer suggest the imprint of run-up and backwash currents derived from a unique wave. Micro and macrofauna analysis and DRS data of the siliciclastic fraction show slight but significant environmental changes occurring just after the tsunami, which could be provoked by an eventual closure of the estuary mouth.

1. Introduction

In the last decades, numerous investigations have focused on resolving tsunami deposit benchmarks in order to identify sediment sources and to evaluate their impact as natural hazards. However, if recent tsunamis are well described on the basis of historical records (e.g. Delange and Healy, 1986; Baptista et al., 1998; Papadopoulos, 2003; Dominey-Howes, 2007; Baptista and Miranda, 2009; Ambraseys and Synolakis, 2010), the identification of paleotsunami deposits is in counterpart more controversial since it reposes on geological evidences that can be shared by other high-energy events such as storm-induced deposits (e.g. Cundy et al., 2000; Pratt, 2002; Goff et al., 2004a; Kortekaas and Dawson, 2007; Morton et al., 2007; Tappin, 2007; Barbano et al., 2010; Chague-Goff, 2010; Goff et al., 2012; Ramirez-Herrera et al., 2012). To attempt to solve this problem, geologists have accessed a wide range of geological, geophysical and geochemical proxies to distinguish between storm- and tsunami-induced deposits, improving the so-called "tsunami proxy toolkit" (see review in Chague-Goff et al., 2011). Sedimentological (i.e. grain size), macro- and micropaleontological and geomorphological features are the most conventional proxies (see review in Morton et al., 2007; Chague-Goff et al., 2011; Goff et al., 2012). Geochemical approaches are less explored despite the fact that chemical composition of interstitial waters and sediment from coastal and lagoonal environments has been successfully used as an indicator of tsunami inundation (Andrade et al., 2003; Chague-Goff, 2010; Chague-Goff et al., in press). Also, magnetic approaches (i.e. bulk rock magnetic properties and anisotropy of magnetic susceptibility) were recently applied to modern tsunami deposits

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