Marine Geology 416 (2019) 105983

Contents lists available at ScienceDirect

Marine Geology

journal homepage: www.elsevier.com/locate/margo

The Tagus River delta landslide, off Lisbon, Portugal. Implications for Marine geo-hazards

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ARTICLE INFO

Editor: Michele Rebesco

Keywords:
Tagus River – NE Atlantic
Ebb-tidal delta
Seismic stratigraphy
Submarine landslide
Tsunami hazard

ABSTRACT

The stratigraphy of the Tagus river ebb-tidal delta off Lisbon (Portugal) is investigated using high resolution multichannel seismic reflection profiles with the purpose of searching for sedimentary or erosive features associated with landslides. The Tagus delta is sub-divided in two prograding seismic units of 17 ky to 13 ky and 13 ky to Present based on the calibration of seismic lines using gravity and box-cores in the Tagus pro-delta. We report the existence of a buried landslide with 11 km of length, 3.5 km of width and a maximum thickness of 20 m that accounted for the collapse of half of the upper unit of the Tagus river delta front in Holocene times. The non-collapsed half of the delta front contains extensive shallow gas of still unknown origin and nature. An estimated age of ~8 ky BP for the Tagus delta landslide is proposed based on stratigraphic correlation. The trigger mechanisms of the newly identified Tagus landslide are discussed as well as of the several landslides also found in the lower delta unit. These findings present a first step towards a future assessment of the susceptibility of the nearby coastal areas and the off-shore infrastructures to hazards related to such large collapses.

1. Introduction

Deltas are sedimentary bodies with high sedimentation rates that are very sensitive to changes in environmental conditions, such as climate changes or anthropogenic alteration of hydraulic regimes of the rivers and their sedimentary load (e.g. construction of dams, irrigation for agriculture). For these reasons the study of deltas, together with pro-deltas and estuaries are key features to investigate the record and evolution of environmental changes in Holocene and Late Pleistocene times. Deltas and nearby coastal areas are regions where some of the highest concentrations of population in the world take place in both modern times and old cultures. Physical instability of deltas is an important societal concern as it can affect a variety of aspects, from destruction of civil engineering facilities (dwelling or industry), to agriculture, land, marine or submarine facilities (communication cables, aquaculture, harbors, etc.). Delta-front collapses are potential triggers of tsunami that could affect both port areas and coastal towns (Hughes Clarke et al., 2012). A recent example is the 1979 Nice submarine landslide that occurred along the Var delta front in the SE coast of France, followed by a tsunami that caused several casualties and infrastructural damage of the Nice-Antibes airport (Pelinovsky et al., 2002; Sultan et al., 2010; Sahal and Lemahieu, 2011).

Slope failure of the delta front is the major mechanism for the supply of coarse sediment into the pro-delta, contributing for its development and growth (Maillet et al., 2006; Kim and Chough, 2000). Slides and slumps formed by failure of delta front can be up to tens of meters thickness and hundreds of meters in length (Nichols, 2009). Gravity flows, such as debris flows and turbidity currents, can feed and/or erode the pro-delta and reach further distances into the continental slope and abyssal plains. The pro-delta sediments usually display

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https://doi.org/10.1016/j.margeo.2019.105983
Received 24 February 2019; Received in revised form 12 June 2019; Accepted 6 July 2019
Available online 07 July 2019
0025-3227/