



## **The Tagus River delta (off Lisbon, Portugal) as a repository of landslides. Implications on trigger mechanisms, tsunami hazard and neotectonics**

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The seismic stratigraphy of the Tagus estuary ebb-tidal delta of Lisbon (Portugal) is investigated with the purpose of searching for evidences of possible sedimentary or erosive features associated with landslides or mass wasting deposits (MTD) events. A special attention was given to events that could have been triggered by large earthquakes that are known to have struck the West of Portugal and Spain in historical and pre-historical times. These earthquakes destroyed Lisbon at least twice in the last 500 years, being the 1755 Lisbon earthquake of estimated magnitude  $>8.5$ . To investigate these geological features the seismic reflection dataset used in this work consists of Chirp (Lisboa98 dataset), Sparker single channel (PACEMAKER 2011 dataset) and multichannel seismic (MCS) data (TAGUSDELTA 2013 dataset). Cross-lines of MCS data were acquired crossing the core sampling sites done in previous works. Calibration of the seismic lines with the core data led to infer that the Tagus ebb delta started its formation around 17ky BP and it consists of two main stratigraphic units, the younger of which initiated its formation at approximately 13ky BP. The lower deltaic unit contains several MTDs and/or landslides that could not be mapped with the present dataset. In the upper unit we report the existence of a landslide with 10km of length, 4.5km of width and 20m of maximum thickness that accounted for the collapse of half of the Tagus river delta front. The internal structure of the landslide varies laterally. The main different aspects are, as follows, i) the landslide can be dismembered along slope due to stretching parallel associated to differential movement along slope, ii) it can show internal discontinuities that represent mechanical detachments that separate imbricate wedges and iii) distal deposited bodies completely detached from the main landslide body. The age of the landslide is discussed; an estimated age of  $>8$ ky BP is proposed by stratigraphic correlation with existent cores in the Tagus pro-delta. The trigger mechanisms are discussed; there appears to be a correlation between large earthquakes and tsunami and onshore/offshore high energy deposits. The non-collapsed half of the delta front contains extensive shallow gas of still unknown origin and nature that was found thanks to the seismic surveys carried out in this study. Further geochemical and isotope studies are needed to investigate the origin of the gas as well as geotechnical studies are needed to investigate the rheology and stability of the delta. The stratigraphic model produced for the study area indicates subsidence of tens of meters from Pliocene times as the post-LGM deposits and possible coastal paleo-scarps fit well with the sea level curve for this interval whilst the Pliocene-Lower Quaternary appear to be tens of meters below the same curve. The estimation of the amount of subsidence needs a good chronostratigraphic control of the external continental shelf bodies.

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