



Research Paper

Optical dating of clastic deposits generated by an extreme marine coastal flood: The 1755 tsunami deposits in the Algarve (Portugal)

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ABSTRACT

Identification of past tsunamis is important for risk assessment and management of coastal areas. Obtaining accurate and precise ages of sediments originating from such extreme marine coastal floods is crucial for a reliable estimation of the recurrence interval of these often devastating events. We present here the results of quartz optical dating and ¹⁴C dating of two sites (Boca do Rio and Martinhal) on the Algarve coast (southern Portugal). These sites contain deposits of the great tsunami of November 1, 1755. The sections were described using sedimentological techniques; at both sites tsunami-laid sands and gravels were identified, intercalated between estuarine muds. Quartz luminescence ages from these sedimentary successions were derived using standard SAR-OSL dating using multi-grain sub-samples. A multiple sampling strategy was employed with several samples taken from the AD 1755 tsunami deposit and from the sediments bracketing the tsunami layer. Our SAR-OSL protocol was shown to be appropriate using dose recovery measurements (measured/given dose ratio of 1.004 ± 0.007 , $n = 165$). The several OSL ages from the 1755 tsunamigenic deposits are internally reproducible but yield age overestimates of between 20 and 125% (60–310 years respectively); this is in agreement with values reported in the literature for similar deposits. The age overestimation of the tsunami-laid sands is presumably due to the rapid erosion and deposition of older sediments, with insufficient light exposure for complete bleaching during the tsunami event itself. The absence of significant bleaching during the tsunami is also suggested by the shape of the dose distributions based on sub-samples made up of only about 100 grains. Analysis of the distributions with the minimum-age model seems to yield the expected age for two of the three distributions. It is important to note that age offsets of a few tens of years to a few hundred years rapidly become insignificant when dating older (>1 to few ka) tsunami layers.

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1. Introduction

Tsunamis can cause severe coastal erosion, but also transport and deposit different sized particles, ranging from clay to boulders, inland (Dawson, 1994). Establishing a chronology of tsunami events preserved in the geological record (e.g. Morales et al., 2008) is important for the estimation of the average recurrence interval and time dispersion of extreme marine coastal floods and in the assessment of seismic hazards of a region. Luminescence dating methods have previously been applied to tsunami deposits using thermoluminescence (TL; e.g. Bryant et al., 1996), infrared

stimulated luminescence (IRSL; e.g. Huntley and Clague, 1996; Ollerhead et al., 2001) and optically stimulated luminescence (OSL; e.g. Banerjee et al., 2001).

The earthquake of 1st November 1755 was of high magnitude (8.5) and generated a tsunami (Baptista et al., 1998a,b) that flooded the Algarve coast (southern Portugal) and deposited sediments in the lowlands of Boca do Rio (BDR) and Martinhal (MRT). At Boca do Rio the ages reported for those sediments in several independent studies are quite diverse (e.g. Dawson et al., 1995; Hindson and Andrade, 1999; Hindson et al., 1999; Allen, 2003). At Martinhal, the ages reported by Kortekaas and Dawson (2007) were found to be problematic because they are not in stratigraphic order, leading the authors to state that in their study luminescence dating was not a reliable method to date the 1755 tsunami layer.

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