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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Tsunami deposits in Martinique related to the 1755 Lisbon earthquake" *by* Valérie Clouard et al.

Anonymous Referee #3

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The contribution of Clouard et al. documents an unusual sand layer found in an archaeological excavation pit on Martinique. The authors interpret the unit as evidence of the 1755 tsunami.

The 1755 Lisbon tsunami did not only cause severe flooding in Europe, but the tsunami also propagated through the Atlantic Ocean. Tsunami run up was reported from many Caribbean Islands, such as Sint Maarten (4.5 m), Antigua (3.6 m), Saba (7 m) – just to name a few (Lander et al., 2002). Reports for Martinique state that 'At Martinique, the water was reported to have withdrawn 1.6 km and returned to inundate the upper floors of houses'. Unfortunately, the contribution of Clouard et al. lacks a thorough review of existing historic reports and does for example, not even mention the quotation which I just cited.

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Discussion paper

Besides the missing information on historic reports of the 1755 tsunami in the Caribbean, there is more useful information missing in the text. For example the monthly or annual rainfall (see page 1, line 3). The authors state that the high amounts of rainfall hamper the preservation of the deposits, but give no values of the amount of precipitation. Second, speaking about preservation potential, there are a number of studies that address this topic, e.g., McAdoo et al., 2008; Nichol and Kench, 2008; Szczucinski, 2011.; Spiske et al., 2013; Andrade et al., 2014. But only the study of Bahlburg & Spiske (2015) is cited here. This shows that the authors are not aware of basic tsunami studies/publications. The same is true for the statement that 'few deposits are can be attributed' to the 1755 tsunami (p. 2, lines 14-15). This statement is not correct, as there is a number of publications that document both sand and boulders deposited by the 1755 tsunami. Most sites are in Portugal and Spain (e.g., Dawson et al., 1995; Font et al., 2010; Rodríguez-Vidal et al., 2011), and some more in Morocco and even in the Caribbean (e.g. Atwater et al., 2017). All these studies give convincing evidence supported by data, much more convincing than the pure description of Clouard et al.

Proposed tsunami unit:

The unit is up to 8 cm thick (p. 2. line 11 gives 8 cm, line 12 gives 6-9 cm). The authors state that this is an unusual thickness. I do not understand why. I would say it is an average thickness. As the thickness is not uncommon there is no need to try to explain why it is unusually thick.

The unit includes marine shells and pebbles (p. 3, line 25): are the shells broken or articulated? Which species? Which water depth? What is the size of the pebbles?

There is only one photo of the sand unit which is not informative because it is too small. Second, you need to show details. The outcrop is several meters long, but only a section which is a few tens of centimeters wide is described. You need to use the full extent of the outcrop, as otherwise you will not get any information on spatial trends.

Sediment sources: p. 4, line 3 states that there is a 'distinct origin' of the material of which the sand unit is composed. However no analyses were conducted to prove the marine origin of the white sand and the fluvial origin of the black layer. An inserted small photo (Fig. 4) with terrible resolution is not enough for a comparison. Any potential source needs to be analyzed the same way (components, grain size) as the proposed event unit.

p. 4, line 21 'The thin lightly-colored layer at the basement of the deposit can be attributed to the bottom of Fort-de-France's Bay, which presently exhibits the same kind of materials.' What is the water depth from which the material is supposed to have been eroded? If you know that the seafloor has the same sediments, I assume that you had a look and took samples. These samples need to be analyzed and documented as references samples.

Methods:

This work is highly incomplete and far from a scientific study. You can easily tell with by the fact that there is no methods-chapter. There is an utmost need to include grain size analysis, microorganisms, sediment composition and other suitable methods. Are there any sorting trends? Does the unit thin in seaward or landward direction?

As stated before, the material of all potential sources needs to be analyzed, too – otherwise no comparison is possible!

The material is siliciclastic and therefore you could check its age using OSL-dating.

It is ridiculous that you state (p. 6, lines 18-20) 'Our results indicate that the use of all available geological methodologies and collaborative studies with historians and archeologists might enable us to improve our historical tsunami catalogs in the future, thus helping the preparedness of tsunami hazard plans for coastal communities' as you have not applied any of the available geological methods!

Context:

There is no information on the height above sea level of the excavation site and the event unit. How far is the site from the former coastline? Fig. 4 seems to show that the site is actually within one of the channels – is that true?

Unfortunately, the contribution shows that the authors have only very limited knowledge and understanding of the state-of-the-art in sedimentological tsunami research, sediment transport processes and tsunami flow dynamics.

p. 6, line 6 and 15 'paleotsunami' – this is not the correct term. Paleotsunami units are lithified. Thus historical tsunami deposit would be the correct term.

p. 4, lines 1-2 'and the sand particles sub-horizontal lamination (Fig. 3c) shows that the water enters the site and the sediments deposit slowly, and that there is no contribution from upper backflow.' This hardy makes sense. If the sediment particles slowly settle from the flow, normal (suspension) grading will be produced. Lamination is not a sedimentary structure that represents slow deposition! Instead lamination is caused by changes in the supply of sediment, most of all in terms of grain size and grain density.

p. 3, line 32 'The black layer globally follows the light grey layer, indicating a coeval deposition.' The deposition is not coeval, but successive otherwise one layer would not lie on top of the other.

Attribution to the 1755 event: It is stated that the event unit was deposited in between 1726 and 1783 and thus I may resemble evidence of the 1755 tsunami. However, there was another tsunami in 1767 (see chapter 3). The 1767 tsunami was a regional event and thus could have had an even greater impact than the 1755 far field tsunami. In addition, a storm event is excluded, even though large storms/hurricanes are frequently hitting the region. There was a severe hurricane in 1780 which killed thousands of people on Martinique and I do not see any argument why the described event unit could not be likewise related to this event.

There is hardly any discussion on an alternative process that could have deposited the

unit. Only on page 3, lines 27-30, storms are quickly mentioned and excluded without a real discussion.

Fig. 4: if the site is in or close to one of the historical channels, the settling needs to be interpreted differently. Backwash will use preexisting channels or topographic lows and you need to discuss the deposition of the unit in terms of this setting.

Thickness and event magnitude (p- 4. Lines 16-19): The thickness of a tsunami deposit is directly related to the amount and grain size of available material, in addition to the topography (thicker units in topographic lows). There is no way to relate the magnitude of inundation or even of the event to sediment thickness! p. 6, line 11: I do not understand why it is concluded that the ~8 cm thick deposit needs to be produced by a 1 m tsunami wave. Where does this value come from? And still 8 cm is far from being unusual. The authors state (p. 6, lines 14-15) 'This indicates that the tsunami deposit thickness used in tsunami modeling is a parameter 15 that must be carefully checked in order to avoid overestimation of paleo-tsunamis and to correctly assess the tsunami hazard.' This is no new finding, but was already stated in several publications (e.g. Spiske et al., 2013). I do not see why the authors start the discussion of sediment thickness and inverse modelling because they did not do any inverse modelling. Roger et al. (2011) did forward modelling, but these results would only support the results of an inverse modelling approach.

p. 6, lines 13-14: What exactly, in your opinion, is the difference of the tsunami wave front and a tsunami-induced bore? Explain what the differences in flow are and how they influence the mode of transport and deposition. What about the role of successive waves of the tsunami wave train?

p. 6, lines 3-4 '1755 tsunami deposits can also be found in locations in eastern coastal American cities' – where should that be? Do you think that for example the US east coast was hit by the 1755 tsunami?

Language:

The language is in many parts very poor. Many sentences are difficult or not to understand. Just to give a few examples: p. 2, line 26 'whereas boulders can eventually outcrop' p. 3, line 31 'the black layer globally follows' p. 4, line 2 'upper backflow' – what is an upper backflow? Never heard of this before. p. 6, line 11 'the Americans' – totally unspecific. Where should that be? Fig. 1 'large uncertainties' – which uncertainties? I cannot understand to what this is related (runup height, locations, ?)

Figures and Table:

Fig. 1: runup height is given only as a number without unit. Add 'meters'

Fig. 2: add arrows that indicate the direction of the sea and the river. 'white background otherwise' – what does this mean? Are these areas interpolated? The legend only lists the black sand layer, but you state in the text that the tsunami unit is composed of a white and black layer. Add either the white layer to the map and legend or change 'black sand' into 'event unit' or 'proposed tsunami unit'

Fig. 3: add arrows that indicate the direction of the sea and the river. Sediment photo needs to be much larger and resolution needs to be much higher. Lamination is described in the text and you need to prove this in the photo!

Fig. 4: 4a has no scale! 4a and 4b need to be much larger. Again, just a visual comparison is worth nothing. Add more photos of the white layer and the proposed marine source material. Add lines for the topography. Otherwise the course of the inundation limit is hard to understand.

Tab. 1: What means 'H'? 'obs.' means 'observed'? Add explanation of the abbreviations to the captions.

Unfortunately I have to conclude that the only value of this contribution is the fact that the authors document an unusual sand layer within the remains of a historic building and its garden. The study has no scientific value as it does not meet the standards of thorough sedimentological research. The authors describe the sand unit, but do not

include any analyses. Hence, there is no data that allows for the interpretation and understanding of related processes, such as sediment entrainment, sediment transport, deposition and tsunami hydrodynamics. Yes, the unit could likely be a deposit of the 1755 tsunami. But without data and without a discussion on storm versus tsunami, it remains pure speculation.

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