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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Boulder accumulations related to extreme wave events on the eastern coast of Malta" *by* S. Biolchi et al.

Anonymous Referee #1

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This paper analyzed boulder transportation in the Maltese Archipelago by using boulder size and 14C dating data; faults were detected beneath the thick sediment layer. The paper will be useful for the estimation of the frequency and magnitude of extreme waves in the coastal area. However, I failed to understand the handling of the fluid-dynamics equations and the interpretation for the cause of the boulder movements. Hence, this paper needs to be revised for clarity purposes.

Major comments 1. Since the behavior of water after wave-breaking is very complicated, simple formula such as u2 = dgH (where u: fluid velocity; h: gravity acceleration; H: wave height; d(tsunami) = 4; d(swell) = 1) cannot be used. The d(tsunami) value can range between 0.5–4.0, and d(tsunami) = 4 corresponds to the maximum value, as shown by Matsutomi and Okamoto (2010). Importantly, the wave-height ratio of the

tsunami to storm, which can transport the boulders, is not constantly 4.0. Thus, the estimation of the wave heights of tsunamis based on the flow velocity is associated with large uncertainty. The estimation of wave heights of the storms also is associated with uncertainty. The author should check the results of calculations and discuss the uncertainty associated with the wave heights of storms and tsunamis, which could have moved the boulders.

Matsutomi, H. and K. Okamoto, Inundation flow velocity of tsunami on land, Island Arc 19, 443–457, 2010.

2. Lines 16–21 at page 5986: The author should indicate the period (start and end times) of the wave data. Moreover, please show the significant wave heights in terms of their 50-year (and 100-year if possible) probabilities for this region. The wave height for the 50-year probability will be higher than the recorded maximum one (5–5.5 m; line 17 at page 5996). These data will be useful when discussing the magnitude and frequency of extremely high waves in this region and the source of the boulder movement.

3. The author compares the 14C dating of the boulder with historical tsunamis in this region and estimates that the movements of some boulders correspond to historical tsunamis. However, the source areas that the author estimated are mainly distributed in eastern Sicily. In this case, it is unknown whether the tsunami arrived in the Maltese Archipelago. The author should discuss whether the tsunami heights estimated from the previous source fault model are consistent with the estimated runup height from the elevation of boulders and fluid-dynamics equation. The tsunami height at the boulder locations should be evaluated not only with the fluid-dynamics equation, but also with the elevations of the boulders. Moreover, the runup height is generally higher than the elevation of a boulder. The runup height distribution in the Maltese Archipelago should be discussed in a manner that includes these factors.

4. Regarding the possibility whether the boulders were transported by tsunamis or storm waves: As estimated from the photographs of the boulders in each area, the

boulders are distributed within the backshore area, where storm waves are known to have attacked frequently in the past (Figs. 3–6). This suggests that the boulders can be re-transported by storm waves after the tsunamis. Since the occurrence of large storm waves is more frequent than the occurrence of tsunamis, it is possible that the boulders will be transported by storm waves in general. The author should show that the boulders that were transported by the tsunami were in a stable position after the tsunami or explain that they have been re-transported by storm waves on the terrace.

5. To show that the boulders were transported by the tsunami, the author should show that the boulders were located at a position (elevation and distance from the shore) where the storm waves could not reach or could not move the boulder. However, all boulders were distributed within 55 m from the shore (Fig. 7). Moreover, the boulder Z1, which was the farthest among the boulders, was transported by storm waves. Since other boulders were distributed near the shore and their elevation was lower than boulder Z1, they could have been transported by storm waves.

6. Discussion, lines 24–27 at page 5995: The author provides the densities of limestone distributed in the area in lines 24–27. However, relations between boulder density, boulder volume, and the obtained results are discussed in the next paragraph. The information denoted in lines 24–27 is not used until the next paragraph. The relation between the information in lines 24–27 and the discussion in the next paragraph is not clear. The author should correct this portion of the text.

Minor comments 1. Abstract: An overview of the results has not been given in the abstract (lines 22–25 at page 5979). The author should denote these results briefly and state that most boulders were transported by storm waves, while some boulders were transported by tsunamis.

2. Introduction, lines 9–12 and lines 23–25 at page 5982: Please plot the epicenter of the events whose epicenters were estimated in Fig. 1. Moreover, please show the tsunami heights (if possible, tsunami heights in the Maltese Archipelago) for these

events.

3. Line 15 at page 5987: The word “N300W” should be changed to “N30W” or “300 degrees.”

4. Lines 13–14 at page 5988, lines 3–4 at page 5990, line 3 and lines 27–29 at page 5992, and lines 24–25 at page 5994: Please show the results for the hydrodynamic equations.

5. Lines 10–11 at page 5990, lines 12–13 at page 5991, lines 27–29 at page 5992, and lines 24–25 at page 5994: Please describe the results for the 14C dating.

6. Fig. 1: Please surround the Maltese Archipelago with the rectangular region that is shown in Fig. 2 to clarify the location of the Maltese Archipelago.

7. Fig. 7: The elevations of the boulders (AB1–AB5, C16, C85, and Q2) in Armier Bay are not plotted in this figure. Please insert the corresponding elevation values in this figure.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 5977, 2015.