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Natural Hazards and Earth System Sciences
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Discussions

Interactive comment on "Internal structure of event layers preserved on the Andaman Sea continental shelf, Thailand: tsunami vs. storm and flash flood deposits" *by* D. Sakuna-Schwartz et al.

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Dear Anonymous Referee

We appreciate much the detailed and very helpful review, which led to quite substantial changes to the manuscript. We answer below to all the comments and we applied most of the suggested corrections.

1. The most critical is the reliability of Pb-210 dating. Generally, it is not easy to use this technique in such a heterogeneous succession as the Pb-210 density is also related to grain size. Although you only mention the average sedimentation rate throughout the

core, the sedimentation can be intermittent, and thus would be much faster or slower in places. You do not validate your correlation of facies A&C and C in cores 030310-C3 and 050310-C2, respectively, which occur deeper than tsunami deposit in other cores. If these facies are not 2004 Indian Ocean tsunami deposit, the conclusions might be revised. This validation could be a bit tricky but at least you have to mention it. The manuscript is generally not written clearly and in many places confusing although it appears not to contain serious failures. Generally, we have no problem with tsunami deposits being in different depth, because of different accumulation rates over the shelf. However, we agree that our interpretation of Core 050310-C2 was too ambitious, especially given the missing age control, and re-interpreted the core. Additionally, we toned down the use of 210Pb dating and relied more on sedimentological differences between the units. We also clearly stated the assumptions and limitations of the used 210Pb profile and gave references in the extended section 4.3. In addition, we emphasized that it is not possible to give accurate age models, and that accumulation rates can only serve as an approximation. Therefore, we also made the correlation between event layers and storms much more conservative, restraining from the identification of individual storms. Eventually, this can be done in subsequent work with more extensive dating efforts. Furthermore, we tried to re-write the manuscript in several places (see answers below) to ease the reading.

2. Page 7228-line 26-27: The Ayeyarwady-Salaween river, not possible to show in Fig.1? The Ayeyarwady-Salaween river is located to the far north, therefore we chose to not include to blow up the scale of the overview image too much.

3. Page 7229-line 26-27: Where are flash flood from? The flash floods are expected from heavily rainfall during southwest monsoon. While they have not been reported in the literature in the investigation area (but by local population), they are also reported in other parts of Thailand. We added a recent reference (Lim and Boochabun, 2012) to the Regional Settings chapter to better reflect this. A further example where flash floods are reported (however, not from a geoscientific point of view) is Cohen,

E.: Tsunami and Flash-floodsâĂŤContrasting Modes of Tourism-related Disasters in Thailand, Tourism Recreation Research, 32(1), 21-39, 2007.

4. Page 7231-line 19: insert “(SAR)” after “accumulation rates” Added "The sediment accumulation rates (SAR) presented in this study..."

5. Page 7238-line 1: As the input of terrigeneous material is supposed to be important for distinguishing tsunami from storm deposits, the Ti/Ca profile should more clearly described and examined in detail. In general, the Ti/Ca ratios didn't show much change. This, also, was not expected, as most of the tsunami material is backwash material or marine sands, which likely comprises a large majority of marine components that are differentiated by their Ti/Ca ratio from the remaining core. Definitely terrigenous particles were rarely observed (plant debris, laterite fragments). Therefore, Ti/Ca ratios seem unsuited to securely identify tsunami deposits. A corresponding line was added to the discussion in section 5.2.

6. Following the initial description of sediment facies observed in cores, you need to add a section that summarizes the classification of facies, especially A-C. We added a summary of the classification at the end of the Results section, to ease the reading of the following core details. Additionally, we now have five facies, which are related to tsunami (A and B), storms (C), floods (D) and regular shelf deposits (E). Figures and tables were adapted accordingly.

7. Page 7238-line 21: Given that some fine-grained layers are from flash floods, how do you exclude the possibility that the rest of them were formed by tropical storms. It is probably not possible to separate that. Intense flash floods in the investigation area (see also Lim and Boochabun, 2012) are expected at heavy rainfall combined with “storms”. While only a handful of exceptional strong storms have be recorded in the investigation area – which are likely responsible for the formation of thick sand layers – minor events will be able to rework and resuspend material during the monsoon. Such minor sediment dynamics are also indicated by repeated side scan sonar mapping

(page 7239 line 25, section 5.1). We added “reworked” to page 7238 line 22 (section 5.1), to better reflect this.

8. Page 7239-line 5: You have to clarify which particular river mouth (or even estuary mouth) is responsible for generating the flash flood in study area. As already mentioned in the regional setting that there is no big river or estuary in the study area (Rodolfo, 1969; Panchang et al., 2008; Schwab et al., 2012). On page 7239-line 1-5 would like to explain that increasing anthropogenic activities during the last century, such as tin mining, construction of tourist resorts, deforestation, agriculture and urbanization increased the delivery of fine sediment to the sea, with most of them transported to the sea during strong monsoonal rainfall.

9. Page 7239-line 20-21: This depends on the depth of bioturbation and thickness of the layer deposited. The sentence was re-written. The cited article should be changed from Wheatcroft et al., 2008 to Wheatcroft and Drake, 2003.

10. Page 7240-line 1 - Page 7241-line 6: Not clear how many layers were formed and preserved after these historical storms. It seems more storms occurred than the number of preserved layers. You also assume the measured sedimentation rate at other core sites. This is likely misleading, as the rate is highly variable in inner-shelf environment. Although I do not request you to add more dataset, this assumption should be presented clearly not to mislead readers. We agree that we were overambitious and removed the paragraph detailing with the interpolated cores. Generally, while we think the relationship of storms to event layers is interesting, it was not strictly necessary for the framework of the paper – the important point here is, that the event layers attributed to storms are older than the inferred tsunami deposits. However, we allowed for a larger uncertainty in dating by giving a period of storm events that could be responsible for the formation of the sand layers in the sediment cores. Also, we discussed that given the low accumulation between the occurrences of individual storms, it is likely that later events may have reworked the earlier deposits given that the events show clear erosive bases.

11. Page 7240-line 17: the age could be older than 50 yrs if you adapt the rate 0.54 cm/y. See answer above. We removed the correlation to individual storms.

12. Page 7241-line 7: While the depth of the tsunami deposit appears consistent in cores 030310-C2, 050310-C4, and 030310-C7, it is variable in other three cores. How do you exclude the possibility of storms for forming facies A and C in cores 030310-C3 and 050310-C2? How old are these tsunami layers estimated according to Pb-210? Core 050310-C2 was re-interpreted, and the deep layer is no longer interpreted as a tsunami layer. In general, we do not assume that the depth of the tsunami layer is constant in all cores, as the sedimentation rates on the shelf may be different over short distances. In core 030310-C3 being the uppermost event layer makes a strong point for this being the tsunami. Also, as the reviewer mentioned otherwise and is at least indicated from the 210Pb dating, accumulation rates on the shelf can differ widely, therefore we see the different burial of the tsunami layer as unproblematic. Then, the interpretation of the uppermost event layer as tsunami deposit is based on the similarities of the layer with tsunami deposits in other layers based on the sedimentological description. A reliable age cannot be given, as we discuss in the new section 4.3. On the estimated accumulation rates (which large uncertainties), the layer is between 4 and 9 years old (sampled in 2010).

13. Page 7241-line 16-17: You have not mentioned that Ti/Ca ratio is lower in the tsunami deposit. Please see answer to comment 5.

14. Page 7241-line 27: These data show, if I understand correctly, the limited extent of sediment transport, and do not exclude the possibility that tsunami deposit occur in deeper water. Corrected, the sentence “However, it cannot be ruled out that tsunami deposits exists beneath the shelf break, as no samples are available here” was added.

15. Page 7242-line 3-18: This paragraph is largely unclear. It is even not easy to understand what is inversed and what is normal. Should be restructured. The paragraph was reworded.

16. Page 7242-line 4-5: an inverted sequence is found in core 030310-C3: The inferred tsunami deposit in 030310-C3 seems too deep relative to other cores. You do not mention the rationale of validity of Pb-210 for this core. We discussed the limitations of Pb-210 dating in the new section 4.3 and in the discussion of 5.1, and brought forward sedimentological evidences that the upper layer of core 030310-C3 is most likely related to the tsunami.

17. Page 7242-line 10-11: Please make sure if this is concordant with page 7242-line 27. There is only 26 lines on page 7242, we are uncertain whether the correct page is given.

18. Page 7242-line 16-18: Just two waves may be enough to account for the inversion. Indeed two waves may enough but as three waves were reported to hit the coastline, we used the actual number.

19. Page 7242-line 22: You said “several” in L17 and here specified three? Changed as mention above.

20. Page 7242-line 23-25: Cross lamination is very common even other types of sandy deposits. This argument is not meaningful as the cross lamination observed here is not bidirectional and has not information useful for the interpretation. We removed the cross bedding as a separate tsunami facies. As it is sandwiched between tsunami deposits, it had to be created during the tsunami event, most likely due to the frequent flow reversals as the three wave trains approached the coastline. This is now explained in the discussion.

21. Page 7244-line 15: Again, check page 7241-line 16-17. Tsunami facies type A (page 7241-line 16-17), which is assumed to be created from marine origin has lower in Ti/Ca ratio. While tsunami facies type C (page 7242-line 11-12) is assumed to be created from tsunami backwash flow origin has no different in Ti/Ca ratio when compared to flash flood deposits. So the context on page 7244-line 15 is corrected.

22. Page 7244-line 23: I cannot imagine how “ephemeral channels” look like. This seems not be a common terminology of coastal terminology. Is there any satellite image showing the development of this type of channel in study area? Ephemeral is generally used for channels that are not active continuously, but only during times of increased water discharge, e.g., during the SW monsoon in the investigation area (“..ephemeral channels are characterized by short periods of flow, following local and intense rainfall, ...”; Picard, M.D. and High Jr., L.R.: Sedimentary structures of ephemeral streams. Developments in Sedimentology 17, Elsevier, 223 pp., 1973). We are not aware of any satellite images in the investigation area, however, as there are not large river in the areas, water during the monsoon has to reach the sea by seasonally active channels, especially considering the strong deforestation in the area for touristic use (also refer to answer to 3.).

23. Figure 3: Not clear to find where these images were taken in Fig. 1. To not further “clutter” Fig 1., we refrained from drawing the rectangles of the images shown in Fig 3 within Fig 1. Cross reference has to be made by core numbers.

24. Table 5: Occurrence (max water depth): How can you constrain the maximum water depth of these facies occurrence just based on the six cores. Especially, flash flood has never been studied in this region as you mentioned in page 7229-line 27. Actually, the occurrence of identified event facies have been made on all of sixty retrieved cores not only six selected cores, partly shown in Feldens et al. 2009, 2012 and Sakuna et al. 2012, where no corresponding deposits have been observed. Still, we agree that given a maximum water depth may be inappropriate for this paper. We reworded the table to “max. observed water depth” and added citations to further relevant papers

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/2/C3746/2015/nhessd-2-C3746-2015-supplement.pdf

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