Response to the short comment of M. M. Tiberti

We thank the reviewer M. Tiberti for her useful comments. Below we respond in detail to her comments.

Review of Mouslopoulou et al. by M. M. Tiberti
General comments
This paper presents the results of measurements and datings on a fan deposition sequence at Domata, on the southern coast of Crete (Greece). Crete Island is a key region in the Mediterranean area, as it is one of the few pieces of emerged land in the forearc domain of the Hellenic subduction zone. Dating geomorphic markers such as alluvial fans and comparing the results with the eustatic curve can contribute to separate the eustatic and tectonic components of apparent coastal uplift, thus constraining vertical tectonic rates. The Authors reconstruct the deposition history of the two alluvial fans and constrain their temporal evolution using IRSL results only (because OSL did not work properly) and stratigraphic considerations. Their results imply that the formation of the two alluvial fan was controlled mainly by climatic and eustatic factors during the general marine regression of MIS 3. No tectonic contribution is necessary to explain their evolution during this period. The state of preservation of the alluvial fans, however, requires that they have been never submerged during the sea-level rise after the last glacial maximum, thus implying that tectonic uplift rates constantly outpaced the eustatic rise during the last 20 ka.

This work presents new data that add an important piece of knowledge to a growing dataset of dated geomorphic markers along the coast of Crete by various authors. These data contribute to constrain the Quaternary geologic evolution of the coast of Crete, helping in separating climatic, eustatic and tectonic components in the Hellenic subduction zone. Hence, the paper address relevant scientific questions within the scope of ESurf, reaching substantial conclusions.

Despite the general good quality of the work, however, the paper lacks clarity and readability. I suggest the Authors to reorganize it in the classical section "Introduction", "Method", "Results" and "Discussion". The Method section should contain the description of how the survey and the datings were carried on, including technical details on OSL and IRSL determinations and soil analysis. The Results section is supposed to contain the Authors' findings, the measurements and age determinations for the alluvial fan deposits and the tentative reconstruction of their evolution. I recommend the Authors to not include other workers' results in this section. Comparison with other researchers' results should be placed in the Discussion section, along with the implications of their own results upon tectonic rates estimates. Considerations on the reliability and accuracy of the datings and their implication should also be included in the Discussion. *[We thank the reviewer for this suggestion. However, we will not change the structure of the paper, as the current structure is pretty classical: introduction, geological setting, data-methods, interpretation, and conclusions. What M. Tiberti suggests is not too dissimilar to what it already exists. Also, we don't agree that the comparison with other people's results should be done in an independent section. We feel it is more natural if comparisons are made within each relevant section. From our text, we believe, it is clear which results are our own results and which are published].*

In particular, the Author should add the discussion of their results in the general framework of existing data, including those that lead to different interpretations. *[We interpret our chronology of fan development with existing chronologies of other fans along the southern coastline of Crete (e.g., Nemec & Postma, 1993; Gallen et al., 2014; Pope et al., 2008, 2016 – the latter included in the revised version). We also compare the uplift rate derived here, with other published uplift rates derived from study of marine terraces on western Crete (Shaw et al., 2008; Strasser et al., 2011; Tiberti et al., 2014; Mouslopoulou et al., 2015 – all references included in the submitted version)].* This important point is at present almost completely disregarded. *We think that this is not the case. The following parts of our ms address this issue:*
1) Page 6, lines 6-12
2) Page 9, lines 9-11
3) Page 11, lines 24-32
4) Page 12, lines 14-15
The fact that some of these comparisons are made with our own published work is something we cannot avoid. Perhaps the reviewer means that we didn't include their work (Tiberti et. al., 2014) in lines 1-15 of Page 12, and this oversight has been corrected. We should have referred to their work which, for the last 20 kyr, also shows rapid uplift in western Crete whereas for the period 20-40 kyr shows slow subsidence. This, however, won't lead to any different conclusions of the current manuscript. In addition, we have now also included in the revised version a comparison of the results of our work with that published in Pope et al. (2016). The latter article was

missing from our submitted version as our work predated the publication of Pope et al., 2016]. They should also discuss the intrinsic limitations of the methods used and the consequent implications. *[We have expanded our discussion of the stratigraphic and geomorphic requirements for development of the Domata fan sequence and comment more specifically on errors in our IRSL dates and the way we use them].*

Specific comments

There is some confusion about OSL and IRSL datings throughout the text and in tables and pictures. In the text the Authors state that two kind of measurements were performed: quartz OSL and feldspar IRSL. Quartz OSL datings results were not used to constrain the evolution history of the alluvial fans, as they proved to be of poor quality. *[Please see our detailed response to Gallen and Wegmann comment about this issue].* They are cited in the text, but never appear in tables or pictures. *[We agree. We should use the term IRSL instead of OSL throughout the text].*

Figure 7 and table 1 apparently report only the results for feldspar IRSL. The Authors should be specific (i.e.: "quartz OSL" and/or "feldspar IRSL") when refer to these measurements, as the use of the general term "OSL" in titles and captions could be somehow confusing. In addition, quartz OSL results should be shown in any case, at least as supplementary material. *[See above].*

In the text, the Authors repeatedly state the "uniqueness" of the Domata site, without discussing it. Are they sure that there is not any similar situation along the southern coast of Crete? What is the difference between the Domata site and the other alluvial fan sequences described in the literature? (e.g. Peterek, et al., 2003; Pope et al., 2008; 2016). *[Please see our response to Gallen and Wegmann's short comment where we explain in detail that the geomorphology at Domata, and the Klados River Gorge itself, differ to other gorges in south Crete (For example: The Sfakia fan (Nemec & Postma, 1993; Gallen et al., 2014; Pope et al., 2008, 2016), is significantly different from the Domata fan in catchment area (c. 28 km^2 compared with c. 11 km^2), fan size (5.3 km^2 compared with 0.1 km^2), the presence of more than one feeder channel at Sfakia, and in the nature of deposits (primarily clast-supported gravels compared with primarily matrix-supported gravels)].*

Technical and other line-by-line comments

Abstract

Line 20: conventionally, the last glaciation corresponds to MIS2 not MIS3.

Line 23: *most* instead of *mot*

1 Introduction Line 30: please specify which sea-level curve are you using. *[See response to Gallen & Wegmann review].* From Figure 9 it turns out to be the one by Siddal et al. (2003). What do you mean with "international"? *We have now removed international. Our reasons for using the Siddall et al. curve are explained in our response to the Gallen & Wegmann's review.* The curve by Siddall et al. is reconstructed using oxygen isotope records from Red Sea sediment cores.

2 Geological setting of Crete and vertical tectonics

Lines 11-16: see also Zachariasse et al., 2008. *Reference included now.*

Line 18-21: *Using dated paleoshorelines and numerical models, it is shown that the island of Crete experienced, during the last 20 thousand years, periods of severe uplift (at rates of up to 8 mm/yr) while in the preceding ~30 thousand years, the vertical deformation on Crete was minimal (Mouslopoulou et al., 2015b).* Please add also Tiberti et al. (2014; already cited in other parts of the text) to Mouslopoulou et al. (2015b), as they state "*Attaining the S4 to S5 vertical separation thus requires a net subsidence rate of 2.6–3.2 mm/y in the period from ~42 to 23 ky ago. A period of sustained uplift of ~7.7 mm/y should have then followed the S5 abandonment (~23 ky ago) as suggested by the formation of S2, with sea level at -120 m, and S3 and S1-low with sea level at about the same elevation as today*". *Yes, we have added reference to this work now in the revised version – in the following paragraph though, where we talk about late Quaternary vertical tectonics. Thank you.*

Line 24: please add also Tiberti et al. (2014; same reason explained above). *[Yes, see above].*

Line 28: Strasser et al., *2011* instead of *2010* *[Thanks].*

Lines 28-30: Not only historical accounts, however, about the tsunami: see, for instance, Polonia et al., 2013. *[Reference included now, thank you].*

3.2 OSL dating of alluvial fans

Line 21: *The results of OSL analysis are presented in Table 1 and Figure 7.* Please specify exactly which kind of analysis: both Table 1 and Figure 7 seem to show only IRSL results. *[Yes, see above].*

3.2.2 OSL results

Page 8, Line 15: *IRSL* instead of *OSL* *[Yes].*

3.3 Soil development

Line 33: *IRSL* instead of *OSL* *[Yes].*

Page 9, Line 14: *IRSL* instead of *OSL* *[Yes].*

4 Landscape evolution at Domata

Line 18: *international sea-level curve*: please remove "international" *We have removed "international" and replaced it with "the Siddall et al. (2003) sea level curve". Our reasons for using the Siddall et al. curve are explained in our response to the Gallen & Wegmann's review.*

Page 10, Line 31: *deposition of the upper and lower-fan deposits*: please remove "deposits" *[Yes, done].*

5 The importance of tectonic uplift at Domata

Lines 24-30: for the sake of completeness, you should mention the other average uplift rates estimates over the last 50 ky based on quantitative datings along the SW coast of Crete:
1.5 mm/y by Wegmann (2008)
2 mm/yr by Shaw et al. (2008)
1-1.5 mm/y by Strasser et al. (2011)
2.5-2.7 mm/y by Tiberti et al. (2014)
But…. we do say that our results (ca. 2.2 mm/yr) are in very good agreement with the published results above (and we provide the references). Now we have also provided a range of uplift rate values for these studies.

Page 12, Lines 5-6: *no significant uplift was accommodated on Crete as the region between ca. 20-45 kyr was experiencing a tectonically quiet period (Mouslopoulou et al., 2015b).* Please notice that for the same period (42 to 23 ky ago), Tiberti et al. (2014) postulated a net subsidence rate of 2.6-3.2 mm/y. *[Yes, we have included a statement including reference to your findings - thanks].*

Page 12, Lines 14-15: *Comparable uplift rates have been independently recorded at numerous localities on western and eastern Crete for the last 20,000 years by Shaw et al. (2008), Tiberti et al. (2014) and Mouslopoulou et al. (2015b).* Shaw et al. (2008) never mention an uplift rate of 7 mm/y or similar values over the last 20 ky. They estimate a ca. 2 mm/y uplift rate on the basis of a 20-24 m elevated shoreline dated 41-53 ka. *[For Shaw et al.: we mean the rate over the last ~2 kyr - since the 365 AD event)].*

6 Conclusions

Line 23: *IRSL* instead of *OSL* *[Yes].*

Figure 1

Please add a coordinates reference frame. Use bold for numbers indicating GPS values. Enlarge letters indicating the sites on the southern coast of Crete and use a darker color (e.g. blue instead of yellow) for the circles. In the caption: *WM* instead of *WG* = White Mountains.

Figure 6

Caption, Line 5: *100 m* instead of *100's metres* – *[No, it is 100's as the Domata beach is more than 500m long]*

Figure 7

Caption, Line 11: *IRSL* instead of *OSL*. Please change this also in the picture. *[Yes].*

Figure9

Caption, Line 21: *IRSL* instead of *OSL*. Please change this also in the picture. *[Yes].*

References cited in this review

Mouslopoulou, V., Nicol, A., Begg, J., Oncken, O., and Moreno, M. (2015) Clusters of mega-earthquakes on upper plate faults control the Eastern Mediterranean hazard, Geophys. Res. Lett., 42, 10282–10289.

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Spiegelbild eustaticher, tektonischer und gravitativ-tektonischer Prozesse. Essener Geog. Arb. 35, 39–56.

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Zachariasse, W. J., van Hinsbergen,D. J. J. & Fortuin,A. R. (2008) Mass wasting and uplift on Crete and Karpathos during the early Pliocene related to initiation of south Aegean left-lateral, strike-slip tectonics. Geol. Soc. Am. Bull. 120, 976–993, doi:10.1130/b26175.1

Thank you!

Sincerely,

V. Mouslopoulou and co-authors