COMMENTS ON Bruni et al. 2021

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We are the principal authors of Mouslopoulou et al. (2017), the conclusions of which are challenged by this submission.

The Domata/Klados River area is a beautiful and under-appreciated area of Crete and this manuscript by Bruni et al. discusses the relationship between a large landslide event and deposition within a confined catchment on the southern side of the island. We believe that while the significance of the landslide event in the headwaters of the Klados River is credible, as are some of the deductions that they have made regarding its impact on deposition through the catchment, there are important elements within this manuscript that are not as straightforward as the authors have presented. We will explore some of these issues in the comments below.

1. The authors claim that the alluvial deposits beneath the surface T2 post-date a regional-scale earthquake in AD365 that uplifted the coastline at Klados by c. 6 m. If this is true, most of the conclusions of this work are correct. If not, however, many of their conclusions are demonstrably wrong. Thus, the authors, in our view, should have taken special care to demonstrate solidly this relationship. Below we show that they have not.

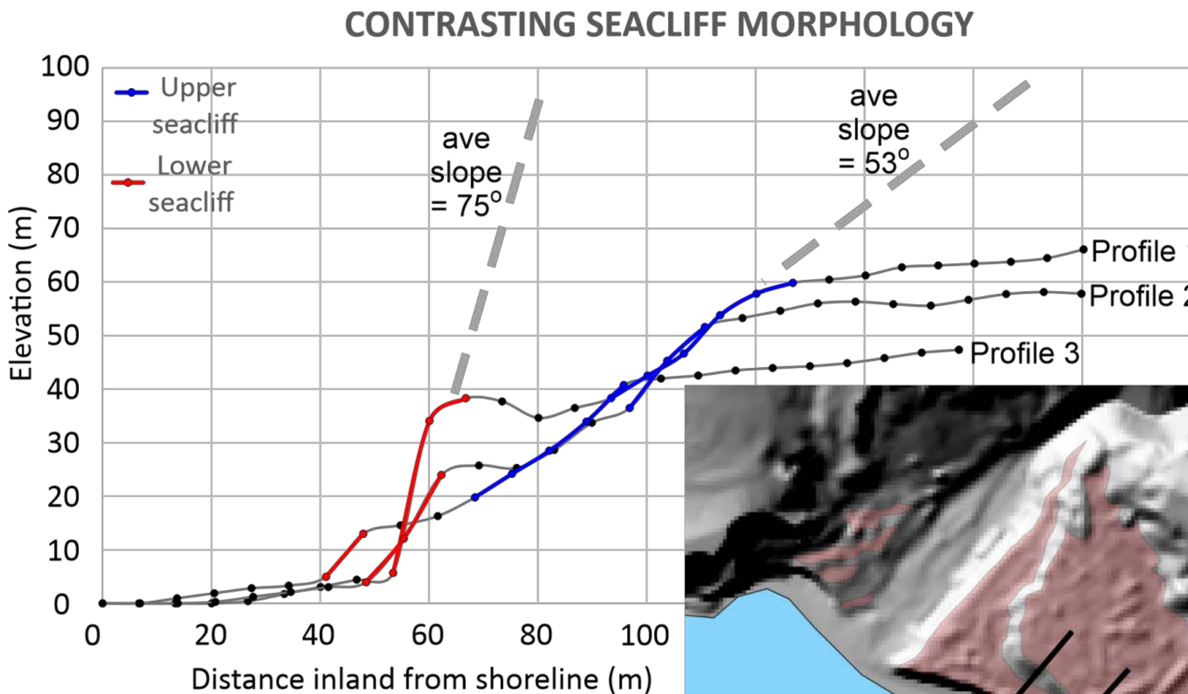
The relationship between the alluvial deposits underlying surface T2 and the AD365 "tidal notch" is not clearly presented. The authors in lines 233-234, 289-290 (and elsewhere) repeatedly claim that the AD365 "tidal notch" is overlain by alluvial deposits underlying terrace T2. However, neither Figure 4h nor 4i show this. Instead, these figures show the 365 AD tidal notch preserved on limestone bedrock (Fig. 4h) but missing from nearby gravels (Fig. 4h and 4i).

The "tidal notch" is not a deposit, it is a geomorphological feature, the result of local modification of the bedrock, here limestone, by marginal marine processes. The limestone is well lithified while the alluvial gravels are "unconsolidated" (see Section 4.3) and both lie at the inland extent of today's active beach. There is no discussion of the potential for these active marginal marine processes to erode these two lithologies differently. Would the AD365 "tidal notch", even if it had been present on the alluvial gravels (should they really be older), have been preserved? Why do they authors fail to consider this alternative scenario? The images presented do not identify the contact between limestone bedrock and "T2 deposits" (and therefore the relationship). Further, the cliff on the right-hand side of Fig. 4i comprises T2 alluvial materials and doesn't show the "tidal notch", but that does not mean that it wasn't once there before erosion by active marginal marine processes. This point is critical to the arguments, that "T2 infill deposits" (all 20 m of them) post-date the AD365 uplift event that is asserted in the rest of the paper.

Further, if the authors' interpretation above is correct: 1) the deposition of the "T2 infill deposits", 2) erosion of the lower coastal cliff and 3) incision by the Klados River below the T2 surface is required to have occurred after the AD365 earthquake. In such a scenario, the speed of deposition of the "T2 infill deposits" and their incision (by sea and river) to their present day configurations must have been exceptionally fast, with only 1600 years available to complete. Given the small catchment area and limited water flow, these events are less likely.

2. The unexplored problems associated with the "tidal notch" and deposition of the "T2 infill deposits" discussed above, are compounded by using their interpreted relationship to assume that the "paleobeach" deposit underlying "T2 infill deposits" must represent the AD365 shoreline. This is unproven. Instead, this correlation is based on the relationship that we questioned in (1) and on the elevation of each of the features. We argue that in our model (see Mouslopoulou et al., 2017) we would expect a "paleobeach" deposit seaward of the base of the marine cliff that truncates T1 – thus, this observation does not contradict an older age of the alluvial fans.

3. Reference is made by the authors to the "crisp" similarity in morphology of the two marine cliffs at Klados mouth. More careful examination of this statement shows that this is not true. The 5 m topo DEM that the authors used to derive their data is entirely adequate to contradict this assertion. See below profiles 1 to 3 across the Klados beach that illustrate that the lower sea-cliff is significantly steeper than the upper sea-cliff (75° vs. 53° average slopes). In addition, the base/crest of the lower-cliff is much sharper than those of the upper-cliff. The morphological differences between the two sea-cliffs are indicative of an age difference substantially more than 1600 years. These observations undermine the authors' assertion that the morphologies are equally immature and therefore both of late Holocene age and provide critical corroborative evidence that the upper sea-cliff is substantially older than the lower sea-cliff.



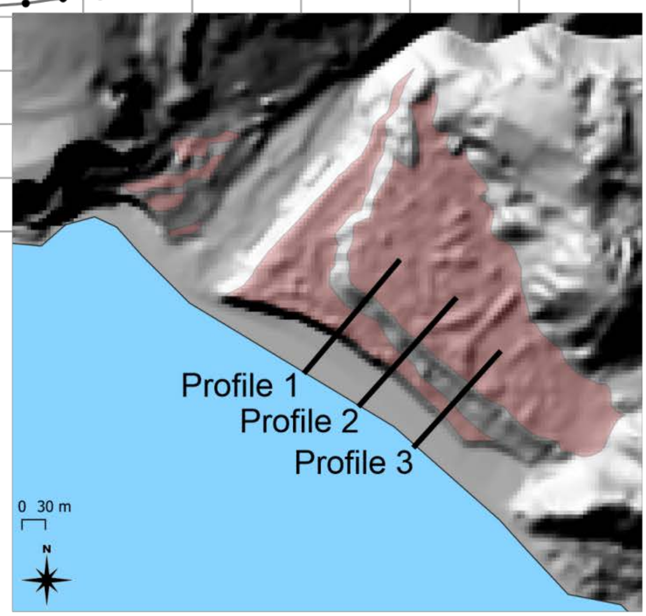


Figure 1 Elevation profiles at Klados River mouth, illustrating the contrasting morphologies of the upper and lower seacliffs. Profile lines are in black, but seacliffs are colour-coded, dark blue for the upper and red for the lower (note that the vertical scale = the horizontal scale). Profile locations are shown on the inset map, where the two fan surfaces (T1 - upper; and T2 - lower) are shaded in pink. The graphed elevation data are derived from the 5 m Hellenic Cadastre SA, as is the background hillshade of the map.

4. Unit AD in the current manuscript comprises aeolian silty sand and includes terrestrial gastropod shells. The authors argue that the deposition of this unit post-dated abandonment of the T1 surface and this is entirely reasonable. But to assign a depositional age for this unit to the period of incision of T1 gravels (lines 271-274), only because similar aeolian deposits are present around Crete (unreferenced statement), and without proving that they were indeed deposited during this incision phase and prior to deposition of the lower fan gravels, is inappropriate. So dating the gastropod from these aeolian deposits proves little other than that some aeolian silty sand was deposited locally in the late Holocene, necessarily after abandonment of the T1 surface.

5. This brings us to the authors' preference, in this instance, to believe radiocarbon ages instead of IRSL ages. The authors state that they collected most of the bulk sediment samples from close to terrace surfaces where the materials were accessible. As acknowledged within the text, they all have very low total organic carbon contents, but the origin of the carbon within the samples receives little discussion (Section 4.4) regarding whether it is possible that there may have been contamination from plants (living and dead, surface litter and root systems). These contaminants arguably have the potential for minimizing resulting ages, and even making the ages irrelevant to the timing of events they are designed to investigate. The question-marks regarding the radiocarbon ages presented are at least as compelling as the arguments they use to dismiss the validity of our substantially older IRSL ages. Interestingly, the authors do argue for younger contaminants in their landslide deposits to explain their younger ages (lines 399-400).

In lines 395-396 the authors state that "The deposition order obtained from the radiocarbon dating agrees with the sequence of events established in the field." This statement is demonstrably incorrect, as further explored in their following sentences (396-404). Notably, the radiocarbon age for L1 is younger than those for T1 and T2, but the authors claim stratigraphic evidence that L1 pre-dates T1 and T2. By their own pen, the statement is clearly incorrect and should be removed from the manuscript.

6. Local soil development is highly variable and is influenced by a number of factors, including climate, parent material (including chemistry) and topography (Lin 2011). Thus, comparing soil development in Klados with areas such as Tsoutsouros in central southern Crete (130 km away) is risky. The Bt and Bk horizons in Tsoutsouros alluvial fans (Gallen et al. 2014) are about 2 m deep and similar horizons at Sfakia (20 km away) range from 5-16 cm (Pope et al. 2008; p 214, Section 7). A B horizon is present on the T1 fan surface at Klados but is limited in depth (Mouslopoulou et al. 2017).

7. The manuscript interprets the presence of the double coastal sea cliff at Klados to result from deposition of a landslide and uplift associated with the AD365 earthquake. However, double (or even multiple) sea cliffs are present at different elevations in other coastal fan deposits along southern Crete that lack a landslide source for sediment supply. For example, west of Aradaina Gorge (Figure 2) these sea-trimmed fans are present along a 3 km length of the coastline.

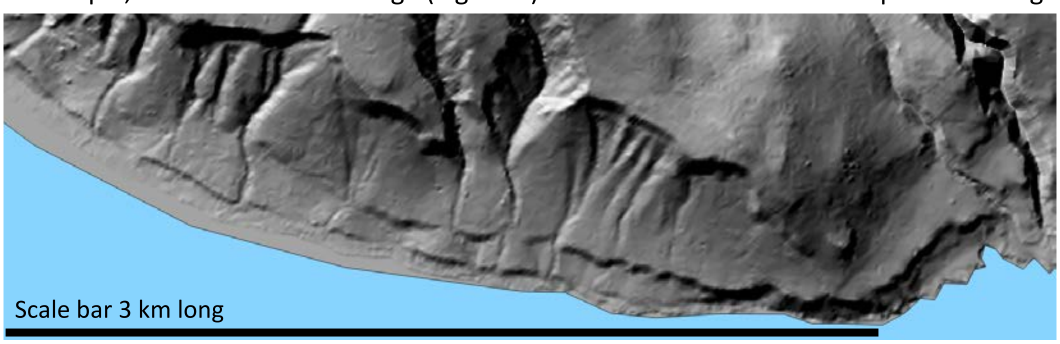


Figure 2: Double sea-trimmed fans between Agia Roumeli and Aradaina Gorge, southwest Crete.

Similar twin sea cliffs, but at a higher elevation, are present at the settlement of Agia Roumeli, at the mouth of the Samaria Gorge (see Figure 3). Thus, the deposits/processes at Klados/Domata may not be as unique for Crete as the authors present (lines 106, 426, 429 and 503).

In summary, we are pleased that this paper provides new information on the likely presence of a landslide in the upper Klados catchment. The presence of this landslide and its deposits certainly raises the question whether stochastic events may account for geomorphology, erosion and deposition. However, due to the ambiguities associated with inconclusive stratigraphic and geochronological data identified above, this manuscript fails to prove its hypothesis that 'the entire fan and terrace sequence' (lines 22-24) at Klados is late Holocene in age. Thus, in this comment we question some of Bruni et al's primary conclusions, despite the fact that they are presented with such certainty.

Mouslopoulou, V., *Begg, J., Fülling, A., Moraetis, D., Partsinevelos, P., and Oncken, O., 2017. Distinct phases of eustatic and tectonic forcing for late Quaternary landscape evolution soutwest Crete, Greece.* Earth Surface Dynamics *5, 1–17, https://doi.org/10.5194/esurf-5-511-2017, 2017.*

Lin 2011, Three Principles of Soil Change and Pedogenesis in Time and Space. SSSAJ: Volume 75: Number 6.