

## ***Interactive comment on “Box canyon erosion along the Canterbury coast (New Zealand): A rapid and episodic process controlled by rainfall intensity and substrate variability” by Aaron Micallef et al.***

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Here I address two general issues raised by reviewer 1. The issues related to landscape evolution modelling, geophysical data, and OSL measurements are addressed by the responsible co-author as personal short comments (Roger Clavera-Gispert, Mark Everett and Alida Timar-Gabor, respectively).

"2) The data presented are not fully synthesized into a clear and complete story or analysis. The challenge here is that it is hard to understand how each of the data the

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authors present ties into the overall picture of 'box canyon' erosion. As such, it is not clear as the paper is currently written what the contribution of the paper is towards understanding Earth surface dynamics. After reading the paper, the only things I got out of it are that the authors did a lot of work collecting a lot of data, but I can't say I understand what the contribution is. Two good examples are the luminescence ages and the geophysical resistivity surveying. The ages are used mostly in a passing way and the geophysical resistivity doesn't seem like it was very successful, so it not clear why it is included?"

In the revised version of the manuscript we will sub-divide and update the Discussion by clearly highlighting what inference each data set allows us to make, and how these can be integrated to reach the conclusions that we present at the end.

In our contribution we address two points: (i) the role that lithology and permeability play in box canyon initiation and evolution, and (ii) the temporal scale of box canyon formation. Because of the reliance on experiments and numerical models, and the paucity of process-based observations and instrumental analyses, previous studies had not thoroughly addressed these issues in the past. By integrating field data with modelling, we show that box canyon formation is an episodic process associated to groundwater flow that occurs when a threshold rainfall intensity is exceeded. The canyons in our study area are actively eroding, and erosion rates can be as high as 30 m per day. Hydraulically-conductive zones (e.g. relict braided rivers channels, tunnels) and sand lenses exposed at the cliff face control the location of the box canyons. We believe that these outcomes are important because: (i) there are only a few places where the mechanisms by which seepage erosion occurs have been clearly defined, and (ii) the results can be used to test and quantify models of canyon formation, and improve the reconstruction/prediction of landscape evolution by groundwater-related processes.

The points related to OSL data and geophysics are addressed in separate comments by Alida Timar-Gabor and Mark Everett.

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"3) The term Box Canyon doesn't bring to mind the features that the study focuses on. I understand box canyons to be canyons with vertical walls, flat bottoms, and generally ingress and egress is only possible through the mouth of the canyon. The classic box canyons are the narrow canyons typically associated with the arid western United States. I think what the authors are studying are actually gullies that progress into canyons when they collect enough drainage area. As the authors note in Lines 383-385, the younger and lower-discharge/drainage areas/stream orders of these features have V and U shaped cross sectional profiles. Whereas the typical box canyons I have seen in the field continue to have flat bottoms and vertical walls even at low stream orders. I think this will be a problem for the authors in that researchers looking for information on box canyons will not consider this work relevant, and those studying coastal gully erosion will miss this paper due to the title and mislabeling of the features of interest. Instead, I think the authors should rewrite this paper while avoiding the use of the term box canyon. Either referring to these as coastal cliff gullies, headward cliff erosion, or some new term the author's come up with."

The reviewer's point is valid. We will refer to these landforms as coastal gullies.

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