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Interactive comment on "River profile response to normal fault growth and linkage: An example from the Hellenic forearc of south-central Crete, Greece" *by* Sean F. Gallen and Karl W. Wegmann

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This paper presents a detailed analysis of vertical motions on active faults and of river profile evolution in response to normal fault growth and linkage in southern Crete. The paper presents good data sets, is well written and illustrated and gives a thorough review of literature. My comments focus on the structural framework of the study area and the interpretation of data in terms of fault growth and linkage. On these subjects I have concerns and questions regarding the application of models to the case study, terminology used and the derived interpretations.

The objective of the paper is to use uplift history derived from marine terraces and river profile analysis to study the timing and stages of fault growth and linkage (abstract and page 4 lines 17-20, for example) and to examine the behaviour od rivers in response to fault linkage. As presented in Figure 2, standard mechanical models for normal fault growth and linkage demonstrate uplift of the footwall on the two linking fault segments and subsidence in their hangingwalls. Because of the nature of coastal erosion, the southern Crete study integrates uplift data derived from marine terraces from the footwall of the Ptolemy fault with uplift in the hangingwall of the South Central Crete Fault (SCCF). In this case linking uplift rates and stream behaviour with fault mechanics theory is not straightforward and you need to be very clear and careful in your argumentation. It appears that you are comparing the uplift history of the SCCF hanginwall marine terraces directly to footwall uplift on the Ptolemy fault.

A regional component of uplift of the island of Crete appears to be superimposed on vertical motions generated by fault activity, thus exaggerating footwall uplift on both faults (Fig. 1c). When did this regional uplift occur with respect to the fault history? The observed net uplift in the hangingwall of the SCCF indicates that the regional component is greater than the hangingwall subsidence generated by the SCCF as the authors state in page 5, lines 30-33. So it must be a pretty substantial vertical motion! Can you quantify the regional uplift? This regional component should be removed before calculating D on the faults (see below).

Page 1, Line 16-17. 'Fault mechanics predicts that when adjacent faults link into a single fault the uplift rate in the linkage zone will increase rapidly'. You need to specify that you are referring to footwall uplift. To improve clarity in your analyses of uplift a suggestion is to consistently specify whether you are referring to composite footwall uplift or the composite hangingwall uplift.

The data represented in Figure 1c (maximum footwall topography) is derived from the footwall of both faults and shows the classic bell shaped curves typical of two fault segments. As the profiles represent the footwall of both faults the SCCF would not occur between the two profiles as indicated on the graph. It is notable that the footwall uplift on the SCCF is twice that on the Ptolemy fault, implying that it a larger fault, with

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perhaps a longer history? The highest topography is further back from the fault also suggesting a longer history of uplift and erosion? Can you comment on this? Is the difference in fault size and age relevant for your interpretation of the river behaviour?

The data in figures 1d (marine terrace correlations) and 3b (uplift rate from marine terraces) are derived from the footwall of the Ptolemy fault and the hangingwall of the South Central Crete Fault. The history of footwall uplift can therefore only be deciphered for the Ptolemy Fault. It is on this fault that you see the clear acceleration in uplift toward the relay zone. I am intrigued by the abrupt eastward termination of these footwall terraces along a NS line inland from stations 6-7. Can you comment on this? Is there a N-S fault here or is the map incomplete? This could be relevant for your interpretation. The mismatch and incoherence in marine terrace behaviour between the two blocks that you discuss as unusual, is in my opinion, because you are passing eastward across the fault from uplifting footwall to subsiding hangingwall. The decrease in uplift toward the centre of the Dikti block is exactly what you would expect in the subsidence profile of a normal fault hangingwall (Fg. 3b). This also fits perfectly with the fault mechanics model predictions when combined with a regional uplift.

P5, section 2.2. I see no evidence for horst structures on the maps you present, ie. I cannot see the conjugate north dipping faults on the north side of the Asterousia and Dikti mountains that would be necessary for these to be horst structures. Your maps indicate that these mountains represent fault block crests in the footwalls of the two studied faults. This would indeed have to be the case for you to apply the fault growth model presented in Figure 2.

Page 13, 4.1: Section 5.1 Calculation of D/L ratio (figure 1). You use maximum topography in the footwall of the two faults as a proxy for displacement and this to calculate D/L ratios for the faults. However observed footwall relief represents only footwall uplift, here combined with the regional uplift component. The throw or vertical component of fault displacement is the sum of footwall uplift plus hangingwall subsidence, a value that you probably don't have, as is often the case. The ratio of long-term footwall uplift

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to hangingwall subsidence (U:S) has been estimated in various rifts (e.g. Basin and Range; Stein et al 1988) and by elastic dislocation modelling of uplifted terraces in rifts such as the Gulf of Corinth (King, 1998; Armijo et al. 1996). These studies propose U:S values ranging from 1:6 to 1:1 (see McNeill and Collier 2004, for example). If no local constraints are available most authors use values for U:S of 1:2 or 1:3 to derive a reasonable estimate of throw. The displacement along the fault is then calculated assuming a reasonable dip for the normal fault. However you have the additional problem of having to remove the regional uplift component before doing this calculation. Why is D for the Ptolmey fault measured with respect to sea level while D for the South Central Crete fault is measured with respect to a higher reference level (200m above sea level?)?

As regards the river profile analysis, it is important to emphasise in your interpretations that the western rivers cut across only the footwall of the Ptolemy fault while the eastern rivers cut across both the footwall and hangingwall of the SCC fault. The regional component of uplift should not be forgotten in the interpretation of these rivers.

I conclude by requesting that the authors clarify the complexity of the structural framework of their study area, the true structural position of data sets, and the terminology used. This will probably have an impact on the presentation of interpretation of tectonic signals in river profiles.

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