How much tectonic deformation do we capture by sampling surface fault evidence?

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1. Introduction
The landscape morphology offers important data on the Earth’s deformation timeline, and elements for understanding the geometry of faults and their activity rate. In the case the sampled data derive exclusively from surface or shallow subsurface, however, they may carry with themselves also the effects of other processes. Caution is thus necessary for recognizing and eliminating the non-tectonic components when using such data for seismic hazard purposes. Causes other than primary faulting must be carefully considered in occasions of coseismic surface deformation associated with moderate and strong earthquakes and the same is true when studying the seismogenic fault slip rates in the interseismic period.

2. Case study – exposure of presumably active bedrock fault scarps in central Apennines
Central Apennines morphology is characterized by the bedrock fault scarps along which the carbonates are in contact with the slope material (FSEC contact). They are exposed at various heights, almost exclusively on the SE flanks of the mountains and their along-strike extent is limited to the length of each individual mountain front. Some of the bedrock fault scarp bearing mountain fronts bound intermountain basins, while others represent a limit of fluvo-glacial valleys and karstic plateaus. These areas are also prone to different types of active landsliding.

The bedrock fault scarps height and the concentration of accumulated cosmogenic nuclides along the scarp height have often been used to calculate the fault slip rates through an assumption that past earthquakes are the only controlling process of their evolution though not having any direct evidence of such a relation.

3. Results
During a 3.4 year-long observation period we detected either downward or upward movements of the slope deposit with respect to the fault surface between consecutive measurements. During the entire observation period all points, except one, registered a net downward movement in the 2.9 – 25.6 mm/yr range, resulting in the progressive exposure of the fault surface.

During the monitoring period no major earthquakes occurred in the region, demonstrating the measured exposure process is disconnected from seismic activity.

We do however observe a positive correlation between the higher exposure in respect to higher average temperatures, a characteristic typical for erosional processes.

Considering the dependence of the time interval on the (sub)surface processes, we show our exposure rates to be comparable with the slip rates calculated from the data on fault scarp heights and cosmogenic nuclide concentrations.

4. Conclusions and further investigations
The landscape morphology offers important data on the Earth’s deformation timeline, and elements for understanding the geometry of faults and their activity rate. In the case the sampled data derive exclusively from surface or shallow subsurface, however, they may carry with themselves also the effects of other processes. Caution is thus necessary for recognizing and eliminating the non-tectonic components when using such data for seismic hazard purposes.

References