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# Toward determining the uncertainties associated with the seismic histories retrieved from in situ $^{36}$Cl cosmogenic nuclide fault scarp dating: model reappraisal.

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How the past seismic activity of faults has varied over the last 20 ky is a crucial information for seismic hazard assessment and for the understanding of fault-interaction processes. Chlorine 36 in situ produced cosmogenic nuclide is increasingly used to retrieve past earthquakes histories on seismically exhumed limestone normal fault-scarps. Schlagenhauf et al. in 2010 developed a modeling code with a forward approach enabling the test of scenarii generated with a priori constraints (number of events, age and slip of events and pre-exposure time). The main shortcomings of this forward approach were the limited number of testable scenarii and the difficulty to derive the associated uncertainties. We present here a reappraisal methodology with an inverse approach using an optimization algorithm. This modelling approach enables 1-exploring the parameter space (age and slip of events), 2-finding the best scenario without a priori constraints and 3-precisely quantifying the associated uncertainties by determining the range of plausible models. Through a series of synthetic tests, we observed that the algorithm revealed a great capacity to constrain event slips and ages in a short computational time (several hours) with an accuracy that can reach 0.1 ky and 0.5 m for the age and slip of exhumation event, respectively. We also explore the influence of the pre-exposure history (amount of 36Cl accumulated when the sampled fault-plane was still buried under the colluvial wedge) and show that it has an important impact on the generated scenarii. This new modeling also allows now to accurately determining this parameter. Finally, the results show that any given [36Cl] profile results in a unique exhumation solution.

We then apply this new model to the Magnola fault (Italy) dataset (Schlgenhauf et al. 2011). In agreement the previously published results, our model also results in 3 intense periods of seismic activity. However, the contribution of the pre-exposure history is found to be 3 times higher in our modeling resulting in a shift of the ages of those events at 0.8±0.7, 3.1±0.2, and 5.4±0.6 ka, with 2.1±0.2, 5.3±0.9 and 4.6±0.4 m of slip, each most probably composed of several temporally clustered seismic slip events. Based on the retrieved pre-exposure age, we infer a long-term slip-rate of 0.8 mm/yr over the last 16 ky.