
Reconstructing the seismic history of the Roccapreturo Fault (Italy) from dense ^{36}Cl profiles

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Abstract

The Roccapreturo Fault, within the Middle Aterno Valley Fault system of the central Apennines (Italy), represents an important target for improving regional seismic-hazard assessments. Although Quaternary deformation is well documented, the fault's Holocene earthquake record is still weakly constrained, and no historical events have been unambiguously assigned to this structure. Here we use high- and low-resolution cosmogenic ^{36}Cl concentration profiles from five locations along a limestone fault scarp to reconstruct the fault's surface-rupturing earthquake history. Inversions were performed with the PyMDS algorithm (Llinares et al., 2025), which applies a Markov Chain Monte Carlo (MCMC) framework to estimate the timing and slip of past ruptures.

The inversions reveal at least five major earthquakes over the past $\sim 18,000$ years, with consistent event groupings at ~ 5 ka, ~ 3.5 ka, $\sim 2-3$ ka, ~ 1 ka, and < 0.5 ka BP recorded at a minimum of two sites. The youngest rupture, dated to ~ 300 years BP, may correspond to a historical earthquake that has not previously been attributed to the Roccapreturo Fault. Pleistocene slip rates (SRs), derived from the high-resolution profiles, fall between 0.1 and 0.4 mm/yr, in agreement with earlier estimates (Falcucci et al., 2015; Tesson et al., 2020) and with InSAR observations (Daout et al., 2023). Holocene SRs are higher ($\sim 1-2$ mm/yr), pointing to temporal variability in fault slip. We also highlight methodological improvements enabled by dense sampling, including statistical changepoint detection to better quantify uncertainties in seismic histories derived from ^{36}Cl datasets on limestone fault scarps.

Overall, these results provide tighter constraints on the Roccapreturo Fault's earthquake behavior, demonstrate the benefit of combining multi-site observations with high-resolution sampling, and emphasize the value of additional paleoseismological work and historical investigation to further refine seismic-hazard estimates in the central Apennines.

Keywords: ^{36}Cl , modeling, paleoseismology

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