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Estimation of Carbon Dioxide emissions along an active fault by using geoelectrical measurements

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In the last twenty years, a growing interest is noticed in quantifying non-volcanic degassing, which could represent a significant input of CO₂ into the atmosphere. Large emissions of non-volcanic carbon dioxide usually take place in seismically active zones, where the existence of a positive spatial correlation between gas discharges and extensional tectonic regimes has been confirmed by seismic data. Extensional stress plays a key role in creating pathways for the rising of gases at micro- and macro-scales, increasing the rock permeability and connecting the deep crust to the earth surface. Geoelectrical investigations, which are very sensitive to permeability changes, provide accurate volumetric reconstructions of the physical properties of the rocks and, therefore, are fundamental not only for the definition of the seismic-active zone geometry, but also for understanding the processes that govern the flow of fluids along the damage zone. In this framework, we present the results of an integrated approach where geoelectrical and passive seismic data are used to construct a 3D geological model, whose simulated temporal evolution allowed the estimation of CO₂ flux along an active fault in the area of Matese Ridge (Southern Apennines, Italy). By varying the geometry of the source system and the permeability values of the damage zone, characteristic times for the upward migration of CO₂ through a thick layer of silts and clays have been estimated and CO₂ fluxes comparable with the observed values in the investigated area have been predicted. These findings are promising for gas hazard, as they suggest that numerical simulations of different CO₂ degassing scenarios could forecast possible critical variations in the amount of CO₂ emitted near the fault.