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Changes of the mechanical properties of active earthflows inferred by periodic REMI-MASW surveys

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Earthflows are landslides in fine-grained materials characterized by a complex style of movement: they alternate long periods of dormancy to short periods of rapid motion during which they are able to generate flow-like geomorphic structures such arcuate ridges, lateral levees, and streamlines.
A number of studies suggest that earthflows essentially move along well-defined basal and lateral shear-surfaces and attribute the flow-like appearance to distributed internal shearing; other authors relate flow motion and the flow-like structures to significant changes in the mechanical properties of the material (such as a loss in shear stiffness or an increase in water content).
Although geological variability and different local conditions probably can partially explain the different behavior observed in the field (shear failure of a plastic solid vs flow of a liquid material), more data need to be collected to understand whether earthflows change their mechanical properties during rapid surging or not.
In this study, we used Rayleigh wave velocity to infer the characteristics of four large earthflows triggered by heavy rainfall in the Emilia-Romagna region (Northern Apennines of Italy); Rayleigh velocities were measured using the active Multichannel Analysis of Surface Waves (MASW) technique. This type of survey provided an estimate of shear wave velocity and shear stiffness of the earthflow material, and allowed us to monitor for changes during the different stages of movement. We performed periodic measurements soon after the failures and in the subsequent months in order to investigate the temporal variation of Rayleigh velocity and the derived parameters. The collected data generally show an increase in shear wave velocity and hence in shear stiffness. The changes in soil properties are here interpreted as a change in void ratio, related to a consolidation process that can involve the earthflows material in the period following the activation events.