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Dynamic characterisation of gravitational movements affecting the southern edge of Belledonne massif (French Alps): contribution of CRE dating and thermal modeling

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The south western edge of the Belledonne Massif corresponds to a glacial plateau (Mont Sec plateau) bordered by steep slopes (around 40°), which were shaped during Quaternary by several glaciations cycles. These slopes have been affected by large rock mass instabilities, among which the Séchilienne landslide located on the right bank of the Romanche River is the most active one. We applied the Cosmic Ray Exposure (CRE) dating method to two other dormant landslides affecting the Mont Sec plateau. These chronological data compared with the data recently acquired on the Séchilienne landslide show the concomitant initiation of these instabilities, thousands years after the total downwastage of the valley. Several factors as earthquakes, kinetics of melting glaciers, weather changes and persistence of the permafrost can explain this observed lag time. To investigate the possible role of the permafrost persistence we modeled the temperature evolution of the Séchilienne slope, considering the temperature curve since the last glacial quaternary phase. The numerical model used, including heat diffusion, phase change and a ground surface transfer function to allow the characterization of the geometry and the persistence of permafrost inside the slope. The 2D modeling was performed with the Comsol Multiphysics finite element software. Numerical results evidence the great influence of porosity and near-ground processes in permafrost evolution, and suggest the possible persistence of a permafrost core into the slope during this delay.