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High spatial resolution CRE dating on the head scarp of a major landslide (Séchilienne, French Alps): a key to constrain its Holocene dynamics

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Cosmic Ray Exposure (CRE) dating applied to an active landslide (Séchilienne landslide) affecting the slopes of a main alpine valley (Romanche valley, French Alps) shaped in micaschists by quaternary glacial erosion processes, provides information about its kinematics and dynamics from the initiation to the present day. The morphology of the valley displays steep slopes, around 40°, affected by active or past large scale rock mass instabilities between 400 and 1100 m elevation. Above 1100 m the morphology corresponds to a glacial plateau. Among these instabilities, the Séchilienne landslide located on the right bank of the Romanche River is the most active one. The upper boundary of the landslide corresponds to a vertical head scarp several hundred meters long and several tens meters high. This morphological feature separates the flat stable glacial plateau from the destabilized zone. The CRE data at 1100 m in the plateau area indicate the glacier retreated at 16.6 $\pm$ 0.6 10Be ka and the head scarp of the landslide was triggered at 6.4 $\pm$ 1.4 10Be ka. Comparing the date of the beginning of the landslide to the estimated age for the total downwastage of the valley yields a minimal pre-failure endurance of 5400 yr. Therefore the destabilization of the oversteepened slope is not an immediate consequence of debutressing in the Romanche valley. This result is consistent with those obtained from other huge alpine landslides (Flims, Fernpass, La Clapière). High spatial resolution CRE data, obtained from 3 vertical sampling profiles on the head scarp, show that the sliding process to be continuous from the beginning to present with an acceleration phase of the exposure rates between 2.3 and 1.0 10Be ka. After this acceleration phase, the exposure rates are similar to those obtained by the present day monitoring. The initiation phase of the Séchilienne landslide occurred during the Holocene climatic optimum whose temperature and precipitation changes, seem to have a worsening effect at the regional scale to trigger and maintain large slope instability dynamics in this glacial alpine valley.