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Post-glacial dynamics of alpine Little Ice Age glacitectonized frozen landforms (Swiss Alps)

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Glaciers and frozen debris landforms have coexisted and episodically interacted throughout the Holocene, the former having altered the development, spatial distribution and thermal regime of the latter. In the Alps, the apogee of last interaction phase occurred during the Little Ice Age (LIA). Since then, due to glacier shrinkage, interactions between glaciers and LIA pre-existing frozen debris have gradually diminished and are leaning towards being non-existent. Post-LIA glacier forefields in permafrost environments, including associated glacitectonized frozen landforms (GFL) have shifted from a thermal and mechanical glacier dominant regime towards a periglacial or even post-periglacial regime. GFL are undergoing thermal and mechanical readjustments in response to both the longer-term glacier recession and the more recent drastic climatic warming. They can be expressed by a combination of mass-wasting processes and thaw-induced subsidence.

In various regions of the Swiss Alps, slope movements occurring in a periglacial context have been inventoried in previous works using differential SAR interferometry (DInSAR) (Barboux et al., 2014). In the scope of this study, and focusing solely on mass-wasting GFL, the former inventory allowed the identification of the latter under various spatial configurations within LIA glacier forefields. While most observed GFL are disconnected from the associated glacier, some are still connected. Additionally, ground ice occurs as interstitial or massive (buried) glacier ice. This potentially infers the ongoing of non-uniform morphodynamical readjustments.

To understand the site-specific behaviour of GFL, the analysis of long-term time-series of permafrost monitoring and multi-temporal high-resolution Digital Elevation Models will allow the assessment of the recent evolution of the Aget and Ritord/Challand LIA glacier forefields (46°00’32” N, 7°14’20” E and 45°57’10” N, 7°14’52” E, respectively) and their associated GFL (i.e. push-moraines). Both glacier forefields present a contrasting spatial configuration, making their morphodynamical evolution to differ partly from one another. The Aget push-moraine is a back-creeping GFL, which has been disconnected from the Aget glacier since the 1940s at latest. For the last two decades, surface displacement velocities have decelerated in comparison to the accelerating regional trend (PERMOS, 2019). Additionally, a 30% decrease of the electrical resistivity of the frozen ground, combined with locally observed thaw-induced subsidence of up to

10 cm/year suggest an advanced permafrost degradation. The Ritord/Challand system presents a push-moraine disconnected from its glacier as well as several push-moraines connected to a still existing debris-covered glacier. Between 2016 and 2019, surface lowering up to 10 m attesting massive ice melt has been locally detected in the former where buried glacier ice was visually observed. Whereas in the latter, subtle surface displacements ranging from 10 to 30 cm/year occur. This confirms the heterogeneity of the morphodynamical processes occurring in GFL, expressed as a function of both their spatial configuration and ground ice properties.

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