INTERNATIONAL M2 INTERNSHIP (FRANCE-ARGENTINA) : LANDSLIDES AND PERMAFROST THAWING

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Internship topic

Permafrost is soil that remains below 0°C for at least two consecutive years. It covers approximately 15% of the Earth's land surface, mainly in high latitudes or in plateaus and mountains1. The underground ice acts as a cement, increasing the soil's cohesion and mechanical strength. However, due to global warming, permafrost degradation is accelerating worldwide: up to 40% could thaw by the end of the century. By reducing soil cohesion, this thaw increases the risk of landslides: in the Mont Blanc massif, their frequency has increased tenfold since 1970. Yet these landslides (an example is given on Figure 1c) can have tragic consequences, as seen in the recent August 2026 disaster in Nepal and Tibet, which claimed over 1,400 lives with 5,000 still missing at this time. However, although these events have been well documented in the field, the physical mechanisms underlying them remain poorly understood.

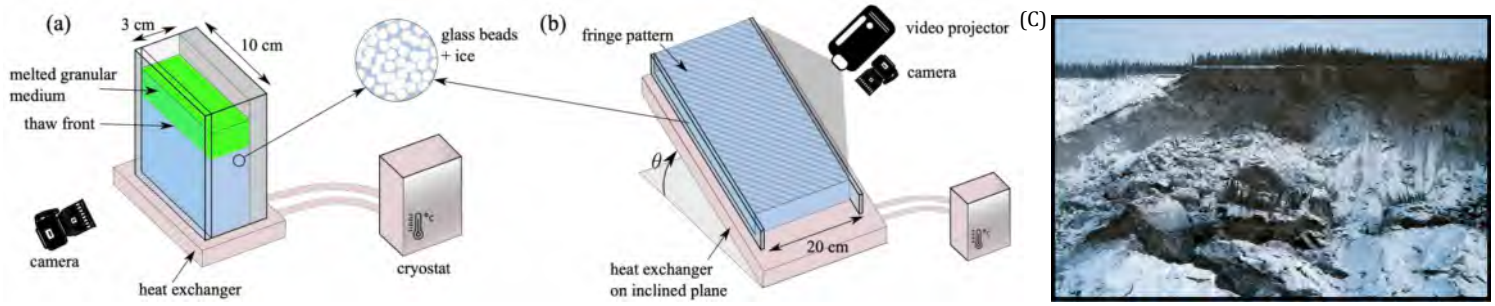


Figure: (a) Lab-scale experiment of a melting permafrost analog (MSC). (b) Experimental setup for the study of landslides due to permafrost thawing at the scale of the lab (IFADyFE). (c) Block landslide in permafrost along Mackenzie River(Canda, 1997).

At MSC, frozen blocks will be placed horizontally on a heat exchanger (see Fig. 1(a)). A side-view camera will track the position of the thaw-front. The frozen blocks will be prepared using fluorescein, which emits green light when illuminated whilst in the liquid phase, but not in the solid phase, thus allowing us to precisely detect the front motion.
For small water saturation values, we expect the capillary bridges joining the grains to become liquid without inducing any flow. We assume that the problem will then be modeled as a Stefan problem with an effective diffusivity depending on the saturation, which we shall characterize. For higher water fractions, melting should induce a gravity-driven flow within the porous medium. Ultimately, we will have empirical (and, if possible, theoretical) laws giving the position of the thaw-front as a function of time for all experimental parameters.
At IFADyFE, the question will be where, when, and how thawing triggers slope failure, and what the resulting avalanche dynamics are. Using the platform and protocol described in Fig. 1(b), we will systematically vary three parameters: the angle, the amount of water, and the grain diameter. Experiments will be repeated with an Andean soil simulant. Surface topography will be reconstructed with fringe pattern deformation throughout thawing. We will determine whether slopes remain stable, slowly creep, fail by block sliding or fluidize into debris-flow-like motion.

Working environment

The internship projet will be realized either in the International Research Laboratory (IRL) Institut Franco-Argentin de Dynamique des Fluides pour l'Environnement (IFADyFE) in Buenos Aires (Argentina) or at the Matière et Systèmes Complexes (MSC) laboratory in Paris (France) depending on the candidate's preferences. It will be supervised by Thomas Séon (IFADyFE - CNRS) and Axel Huerre (MSC - CNRS).
The internship might be followed-up by a PhD (ED PIF competition) that will be realized in both laboratories.



For this project, we choose to ban generative IA. For more information on this initiative, you can chat directly with us.