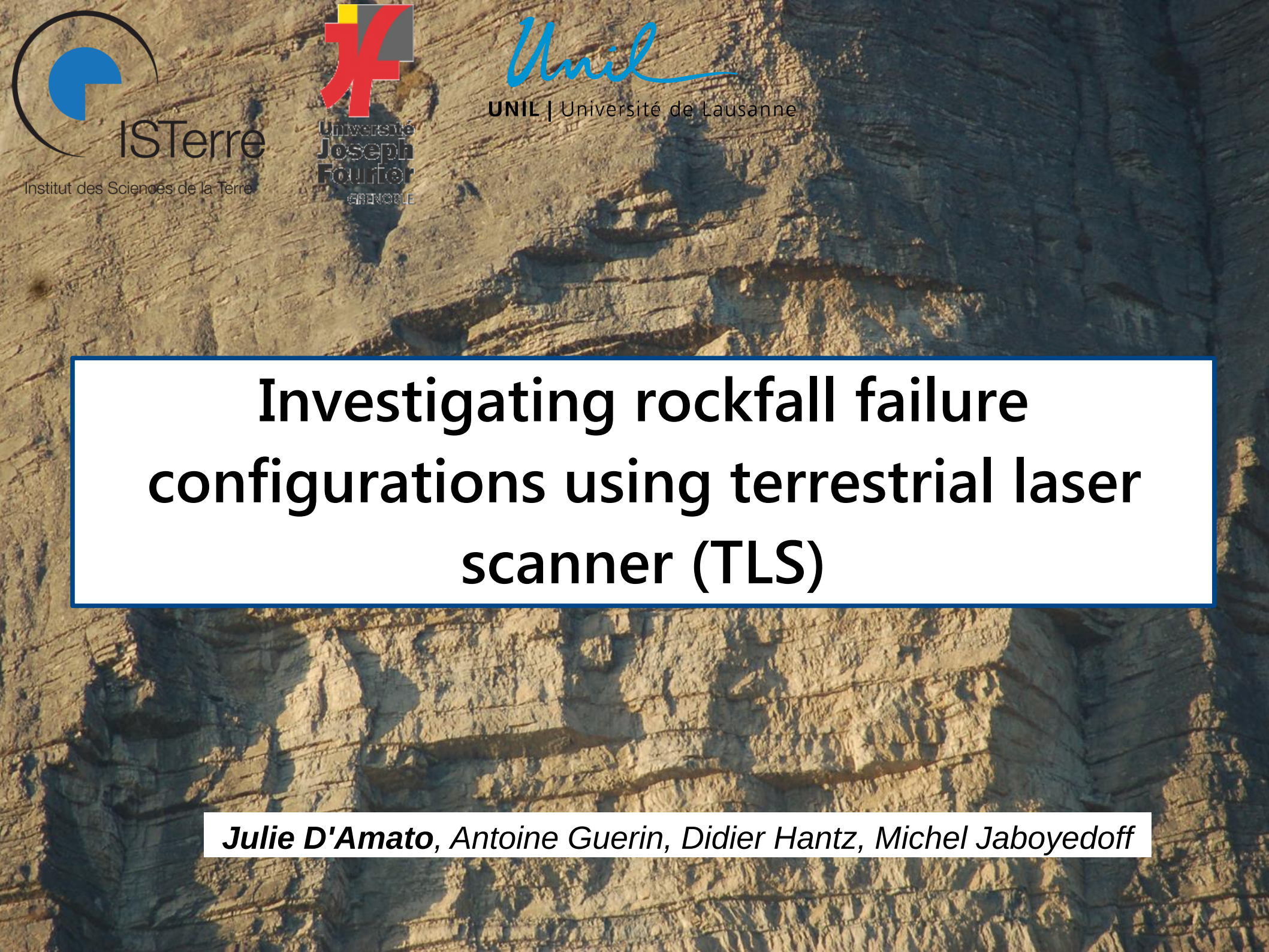

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Investigating rockfall failure configurations using terrestrial laser scanner (TLS)

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Outline

- Introduction
- The Mont Saint Eynard (French Alps)
- Structural analysis by laser scanner
- Failure configurations and mechanisms
- Conclusion

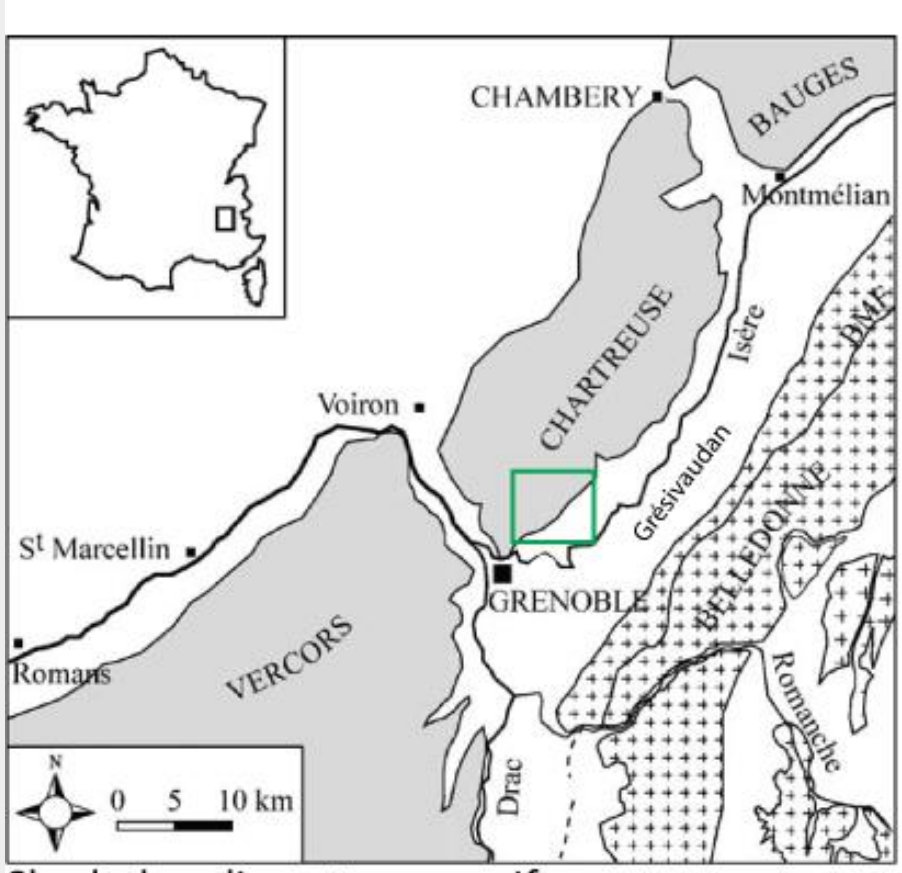
Introduction

Different processes can lead to a rockfall
=> influence of meteorological factors.

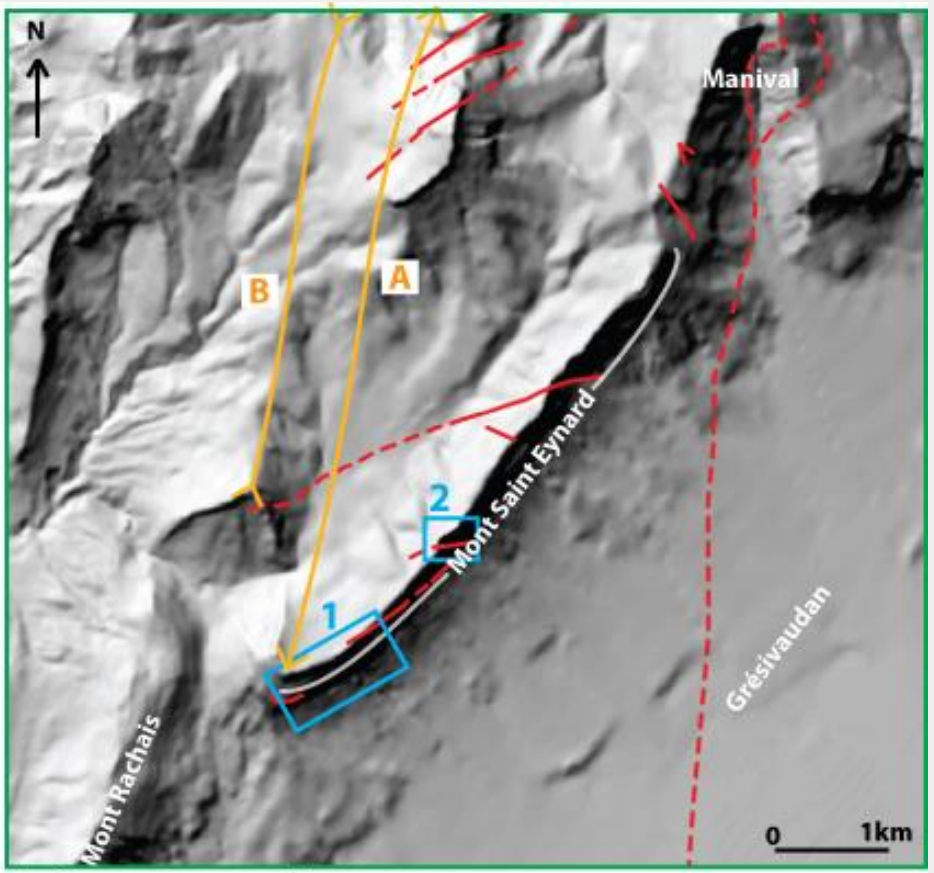
First step is, using TLS data, to know the influence of the rock mass structure on the prone-to-fail compartments:

=> structural analysis at different scales
=> links with failure configurations, shape of fallen compartments, failure mechanisms

The Mont Saint Eynard

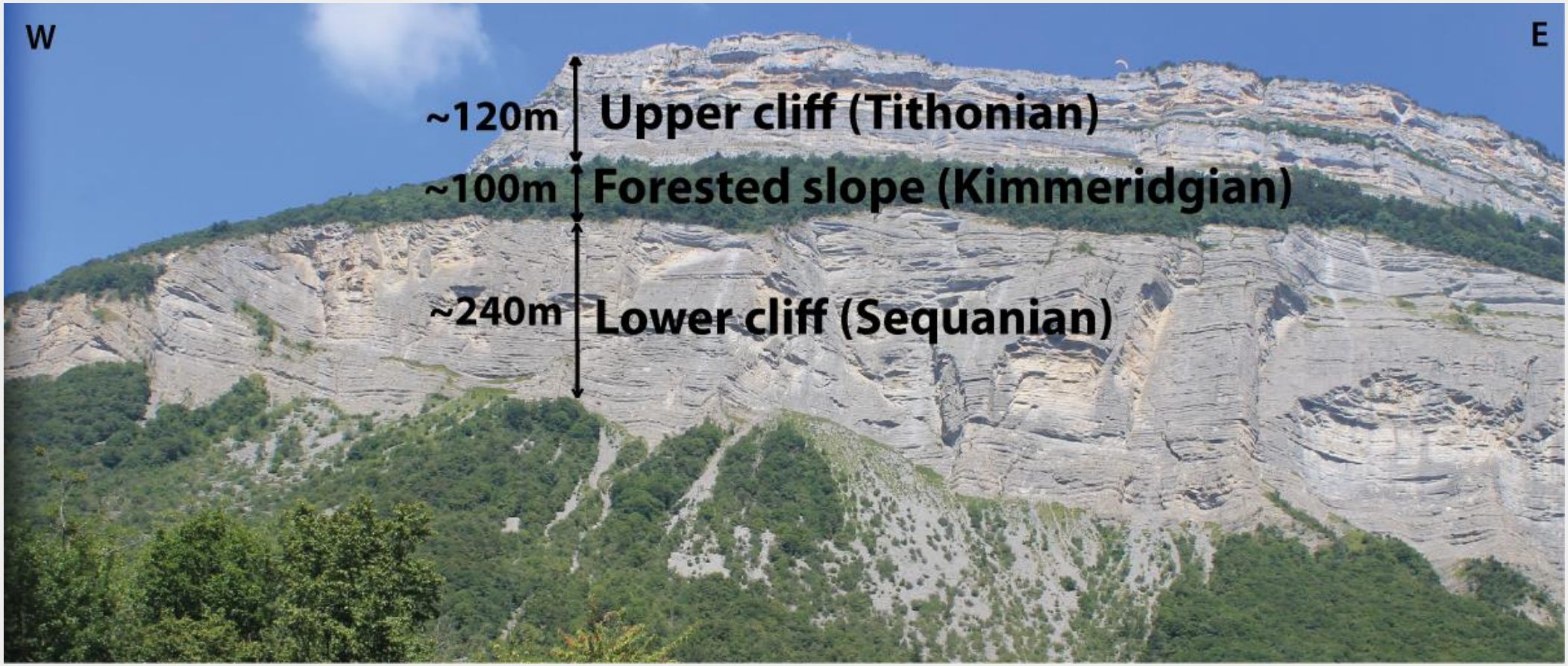


Shaded: sedimentary massifs
Cross pattern: external crystalline massifs
BMF: Belledonne Middle Fault
(*after Frayssines, 2006*)

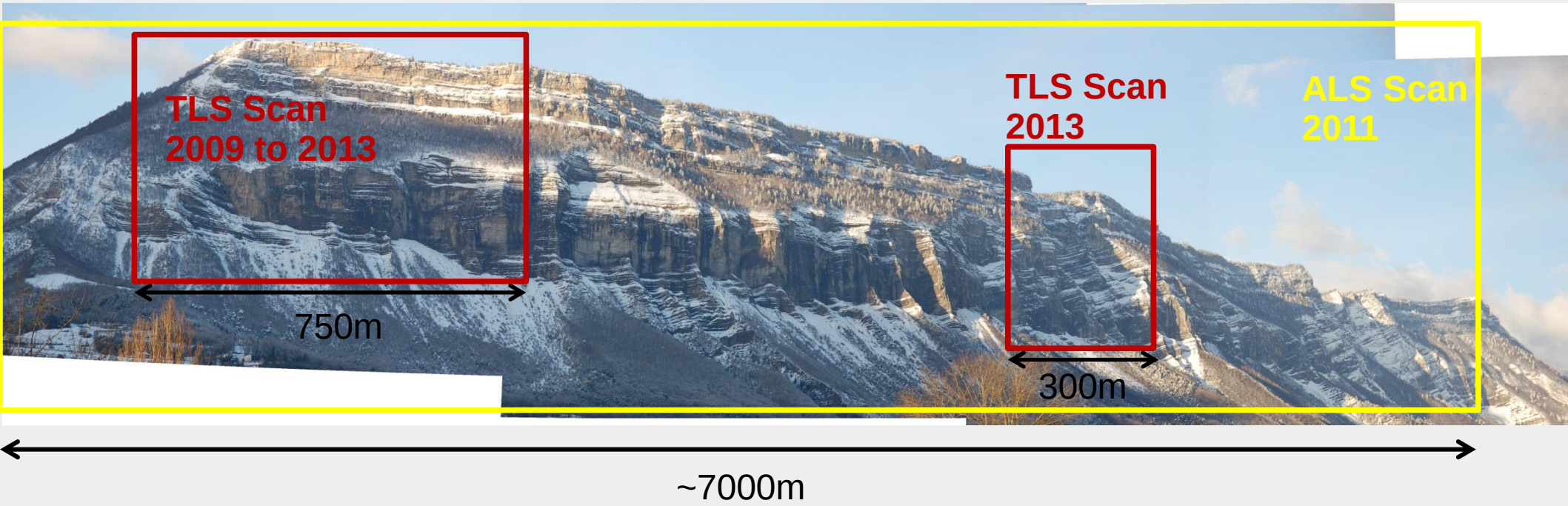


A: Sappey syncline
B: Ecoutoux anticline
Continuous and dashed red lines: faults
Blue squares: TLS investigated zones

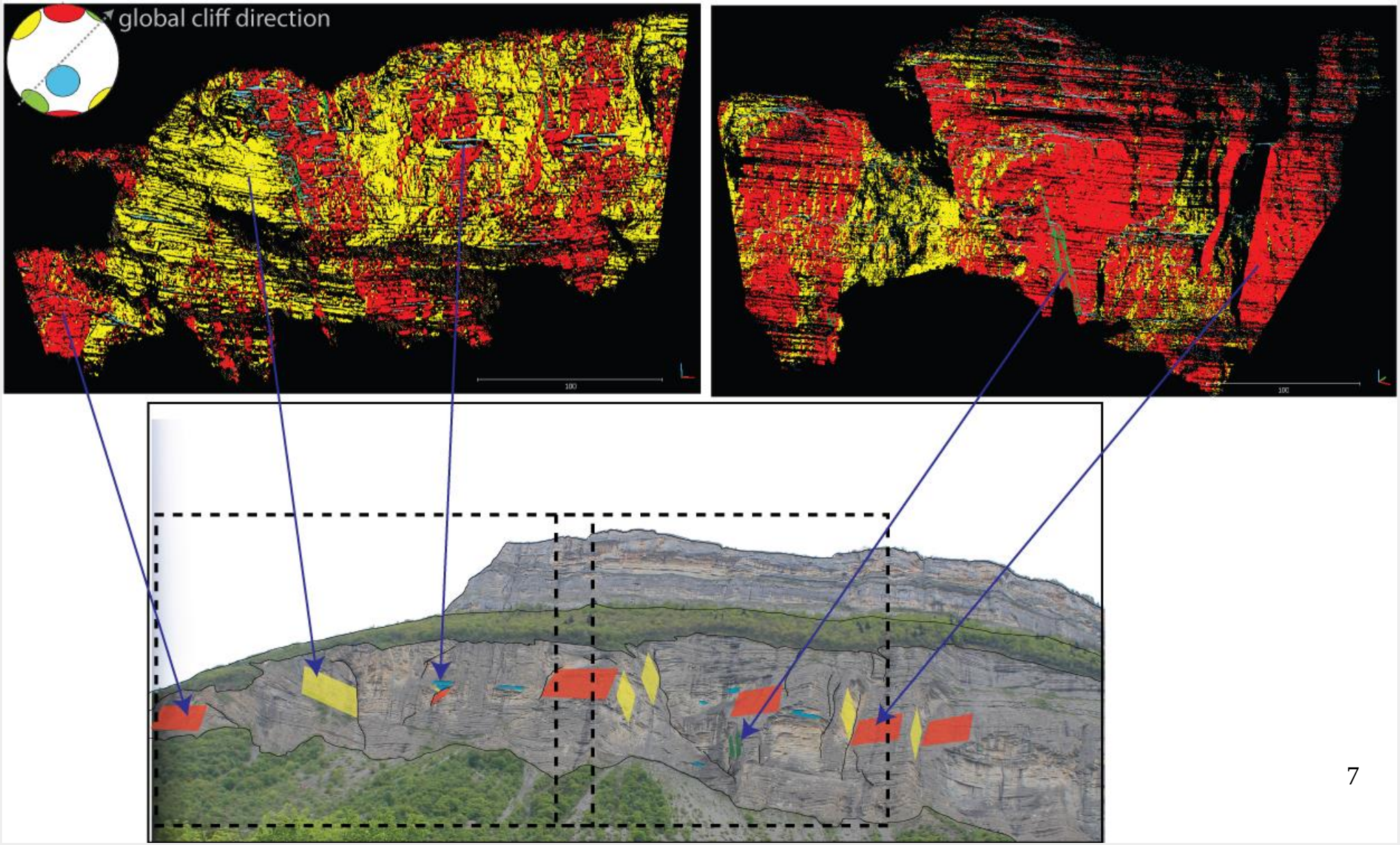
The Mont Saint Eynard



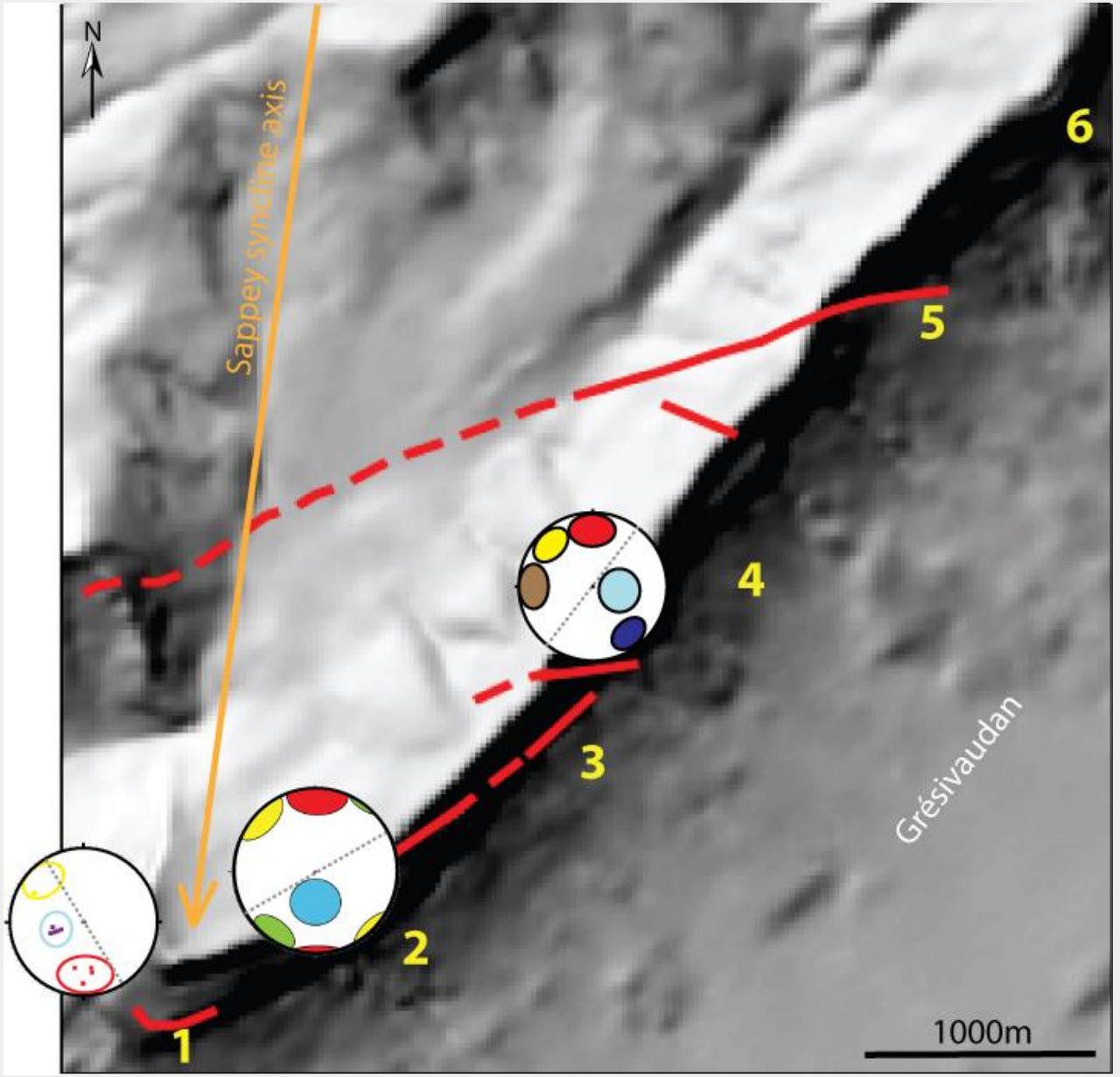
Laser scanning of the cliff



Structural analysis from TLS data

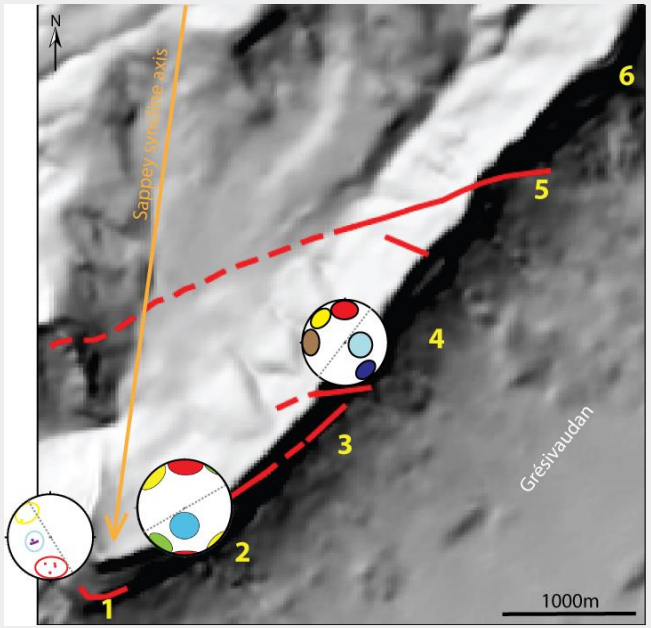


Structural analysis from TLS and field data

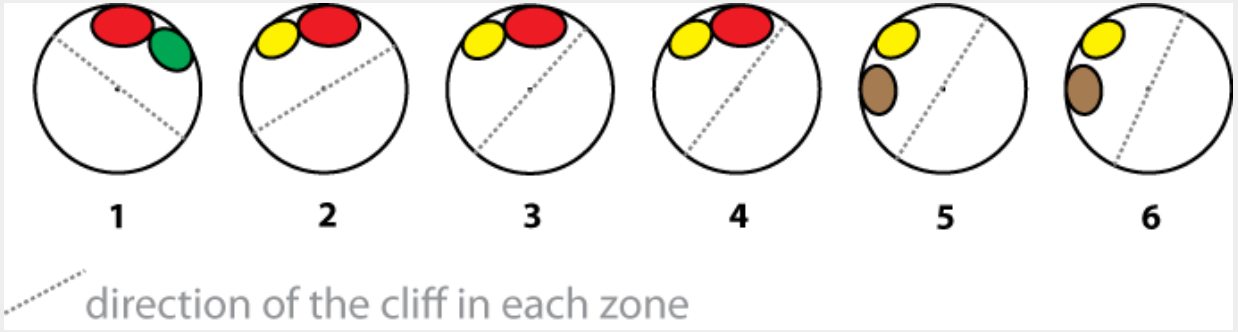


Field measurements ⟶

Structural analysis from ALS data



Structural field measurements
and structural analysis from TLS data

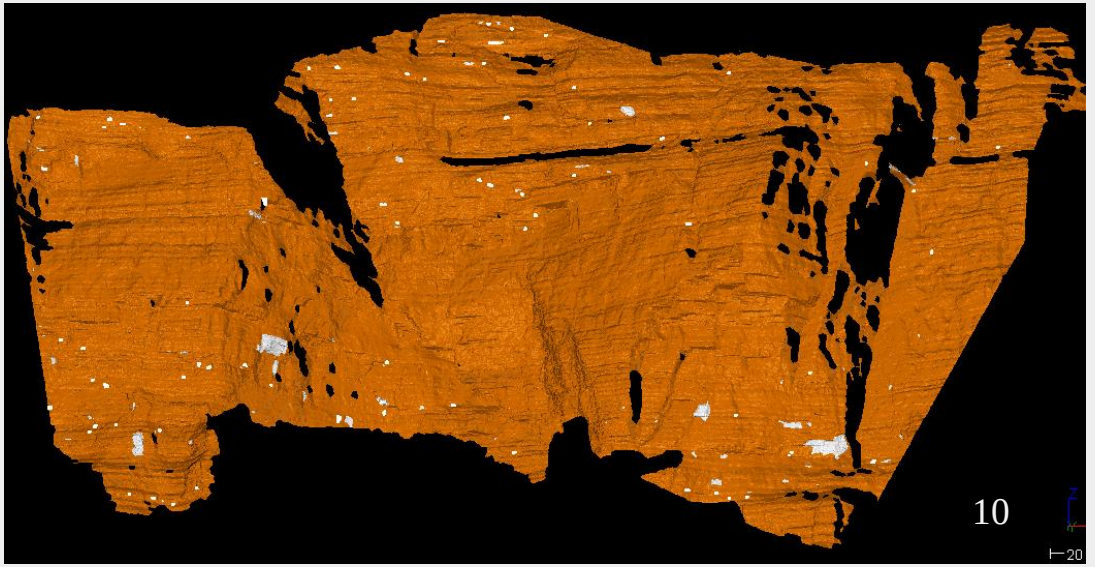


Rockfalls detection

162 studied events

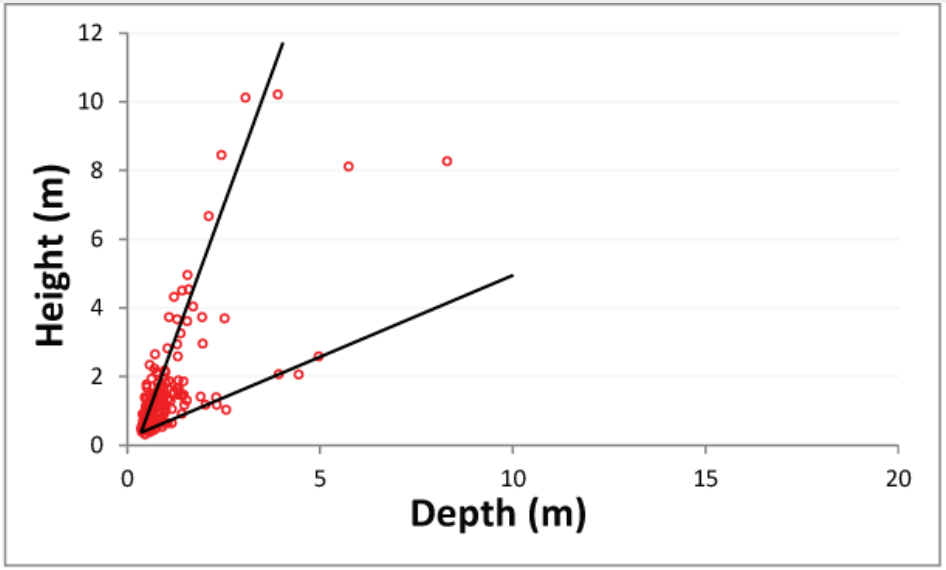
Volume range: 0.01m^3 to 100m^3

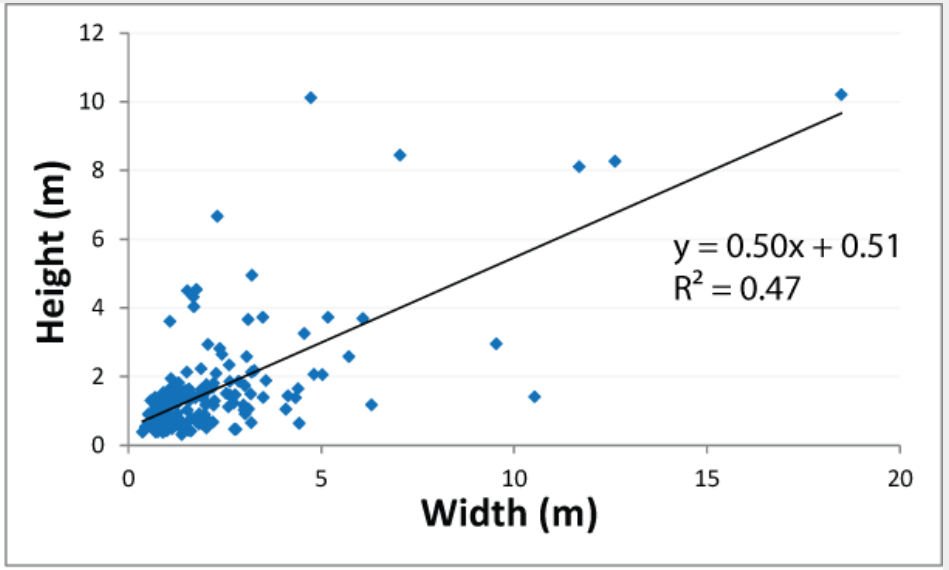
75% of the rockfall volumes smaller than 1m^3

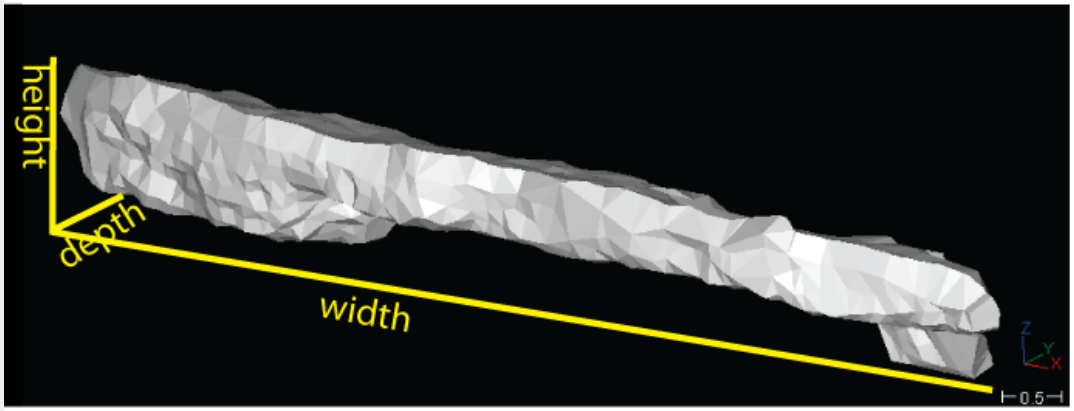


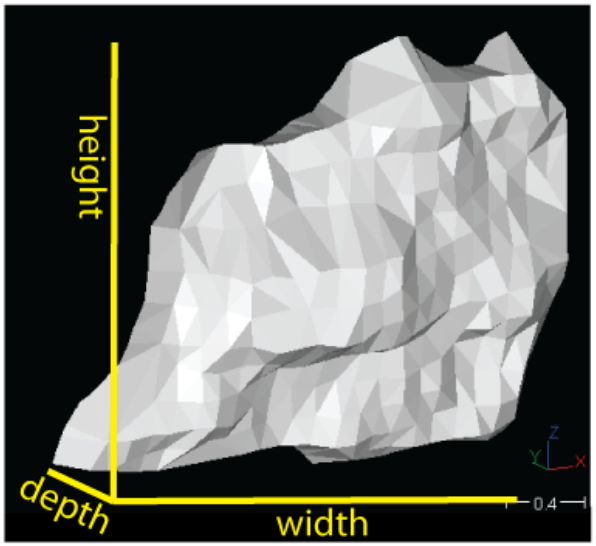
See Guerin et al, 2014 (NHESS D)

Fallen compartments dimensions

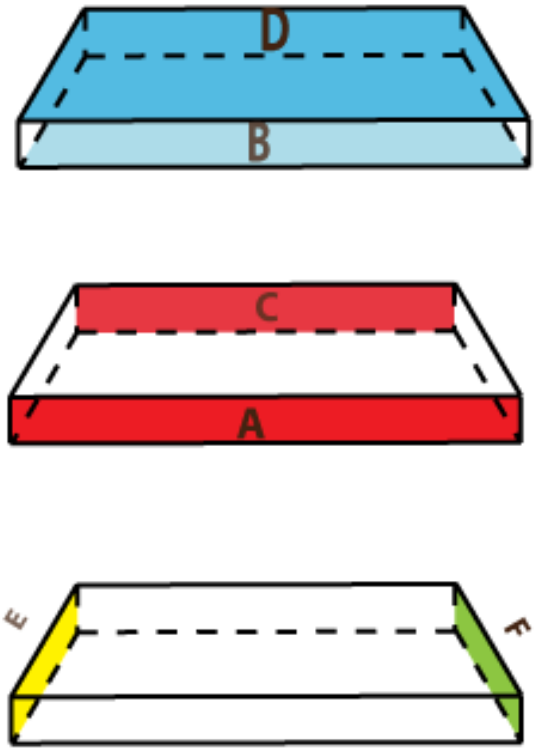


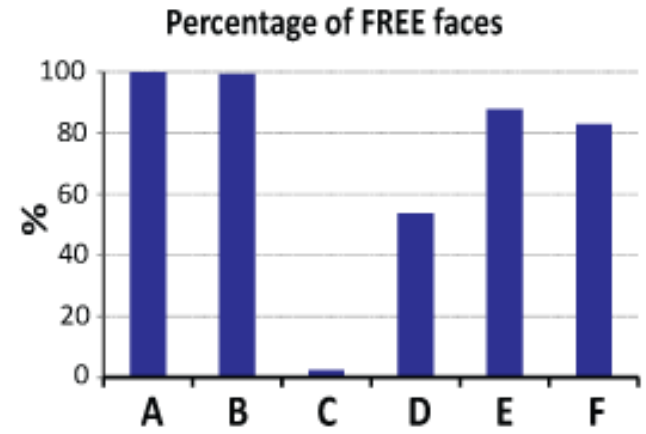


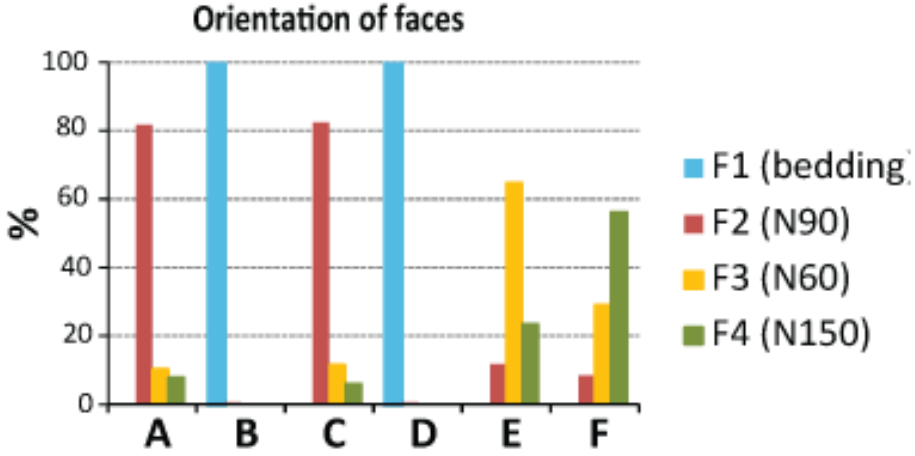




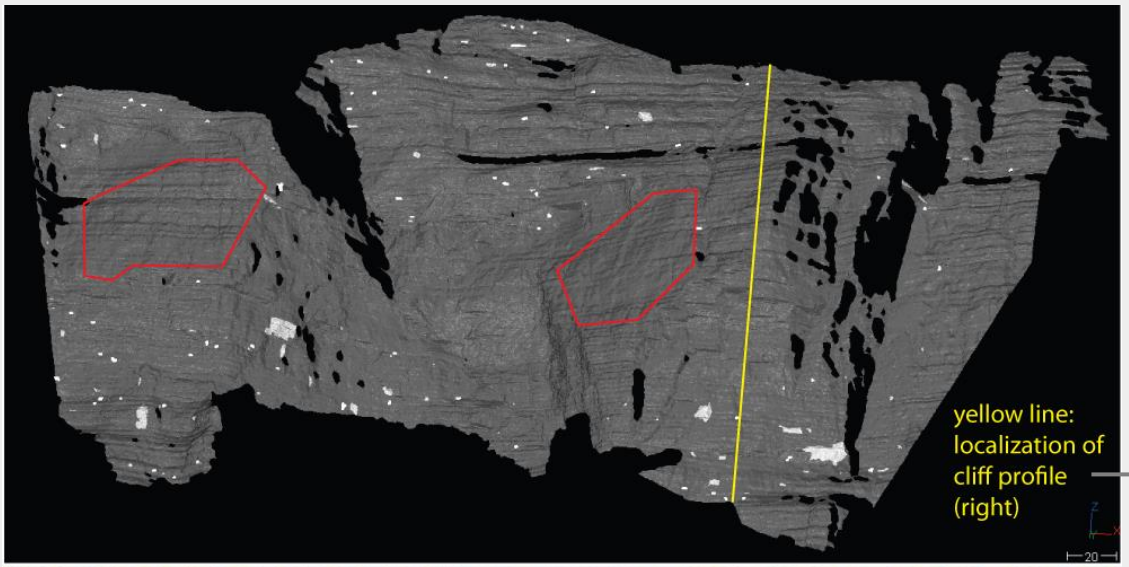
Fallen compartments configurations

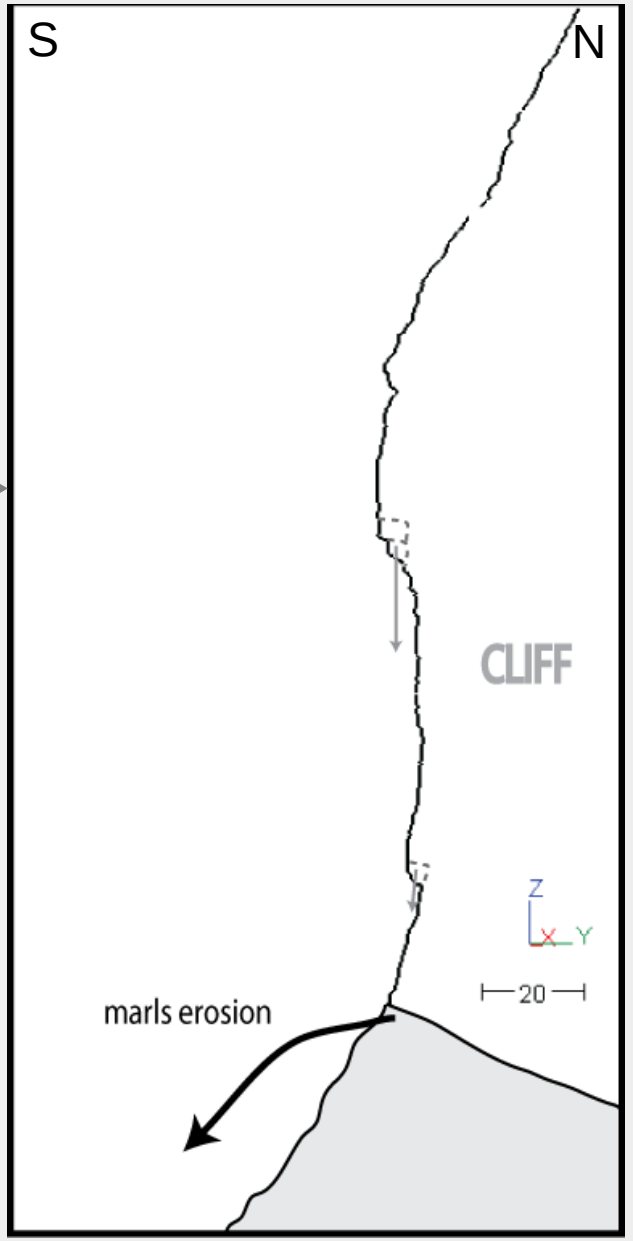




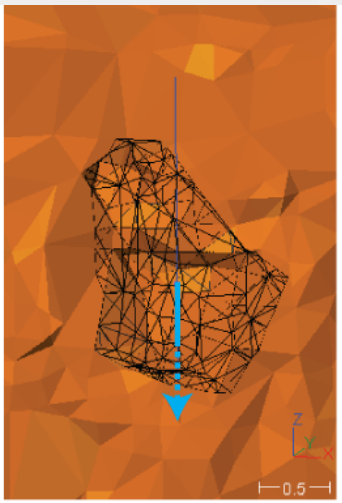


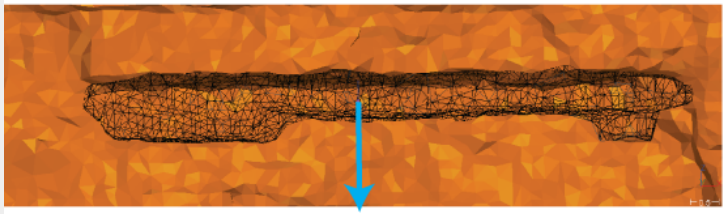
Cliff morphology





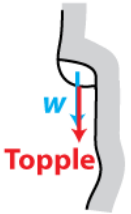
Failure mechanisms





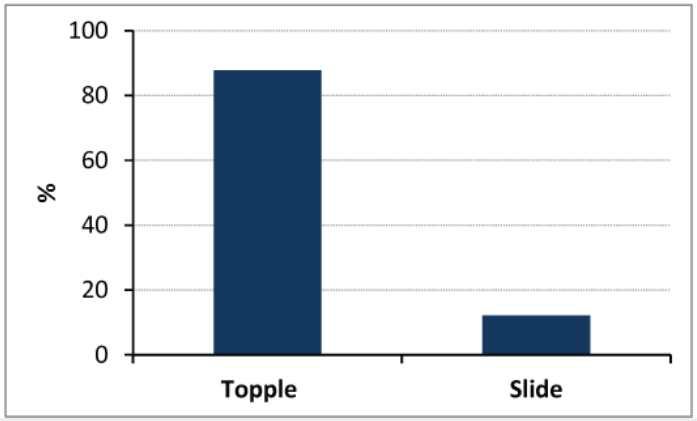
w intersects a jointed face: **Slide**

Shear strength of discontinuities is mobilized



w intersects a free face: **Topple (or free fall)**

Tensile strength of discontinuities is mobilized



Conclusion

Based on laser scanner data, the structural analysis permitted to know the joint sets cutting the rocks, and their link with the global cliff morphology and the failure configurations.

The main failure configurations and mechanisms have been identified and could be used for localized hazard detection.

The next step of this work is to associate the rockfalls detected with meteorological conditions thanks to a continuous photographic survey (each 10min, since January 2013), which will provide the date and hour of each event.