Effect of Geological Preconditioning on Sediment Production in the Illgraben Catchment

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1 INTRODUCTION

The Illgraben catchment is located in the Valais area in Switzerland. With 2-7 debris flows per year it is one of the most active torrents in the European Alps. Different researchers have considered (e.g. McArdell et al., 2021) that the strong deformation of various rock types have set the conditions for a high debris flow activity. This means that during the Alpine orogenesis till this date, the rocks experienced intense deformation that led to pre-existing structures (e.g. faults). So far, research in the study site has been mainly on debris flow processes. This work explores the tectonic and geomorphological conditioning that lead to an exceptionally high sediment production rate.

2 METHODOLOGY & HYPOTHESIS

We use remote sensing, field work and fracture mapping from aerial photogrammetry to answer the following hypothesis:

Is lithological, tectonic and geomorphological preconditioning the reason for the high sediment production in the Illgraben catchment?

3 GEOLOGICAL SETTING

- Tectonically located in Bernhard Nappe (Middle Penninic)
- Deformation history:
  1. **Nappe stacking:** Emplacement of nappes with NNW directed thrusting
  2. **Brittle reactivation:** Controlled by Rhone Simplon fault zone **(RSFZ)**, that is active since 20 Ma until today.
- Variety of lithologies: Quartzite, gneiss, marble, dolomite and cargneule. Weak evaporates act as failure surfaces.

4 RESULTS

Main insights from tectonic lineament map (Fig. 1):

- Heavily disintegrated rock wall with 5 sets of **steeply dipping** faults
- Concentration of faults in rock wall closing the catchment to the west
- Main strike direction: **E-W**

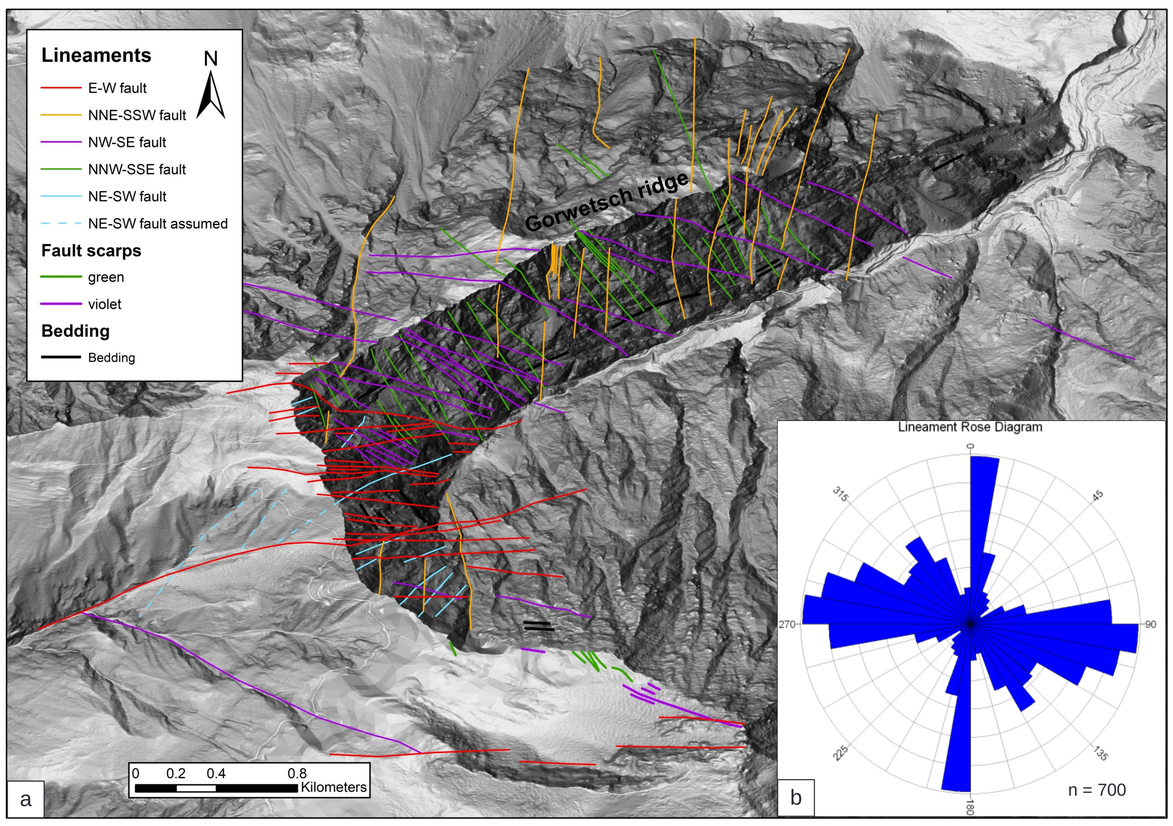

Fig. 1: a) Tectonic lineament map of the Illgraben catchment area: Most of the lineaments crossing the Gorwetsch ridge or the catchment edge keep going straight, which points to steeply dipping structures. Pseudo-lineaments (subhorizontal bedding) are indicated at a few locations. Basemap: Swisstopo. b) Rose diagram of lineament strike directions.

Geomorphological map of the La Tsayetta cirque (Fig. 2):

Main focus on determination of the spatial distribution of mass movements: Mapping has been conducted to identify sites where sliding and rock fall processes occur. The aim was to reconstruct how their occurrence has been conditioned by pre-existing tectonic structures.

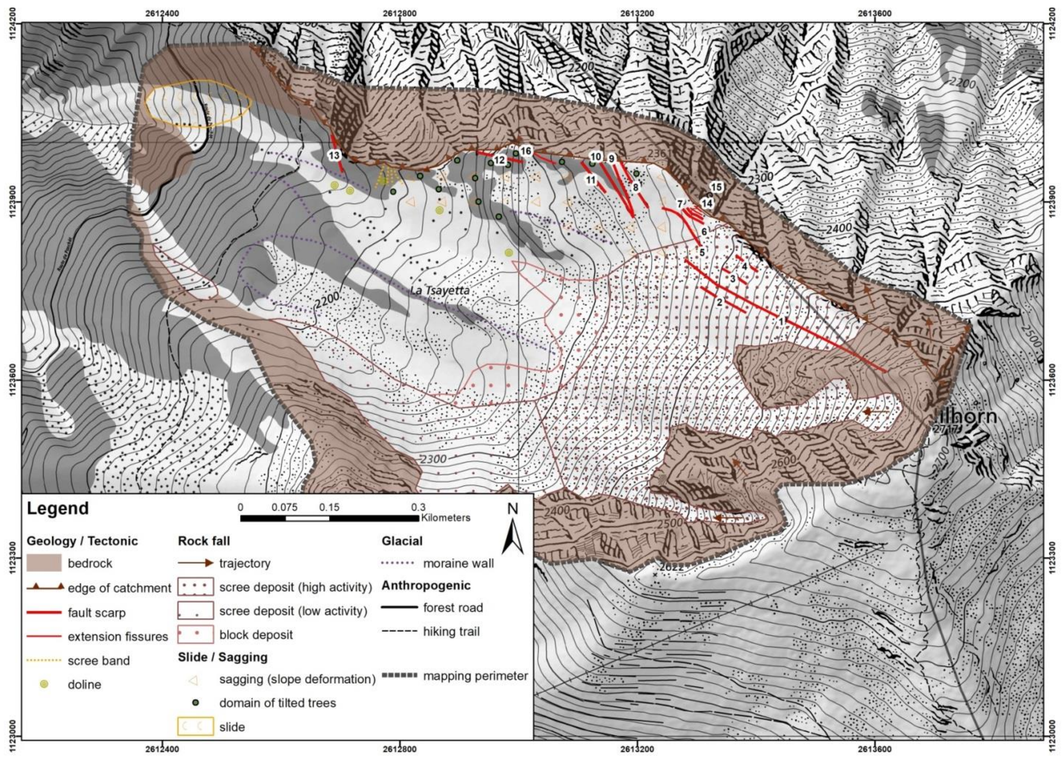

Fig. 2: Fault scarps are the most important features of the map and indicate regressive erosion at the catchment edge. Their orientation and a vertical offset indicate tectonic preconditioning by the NW-SE and NNW-SSE fault systems. Basemap: Swisstopo.

5 CONCLUSIONS

Clear evidence for lithological, tectonic and preconditioning in the study site

→ hypothesis verified

Tectonic Preconditioning:

- **Influence of the RSFZ:** Along the Illgraben trunk channel is a 2nd fault zone (see fault branch in Fig. 3). The abundance of RSFZ related faults create a connection between the Illgraben catchment and the Anniviers valley.

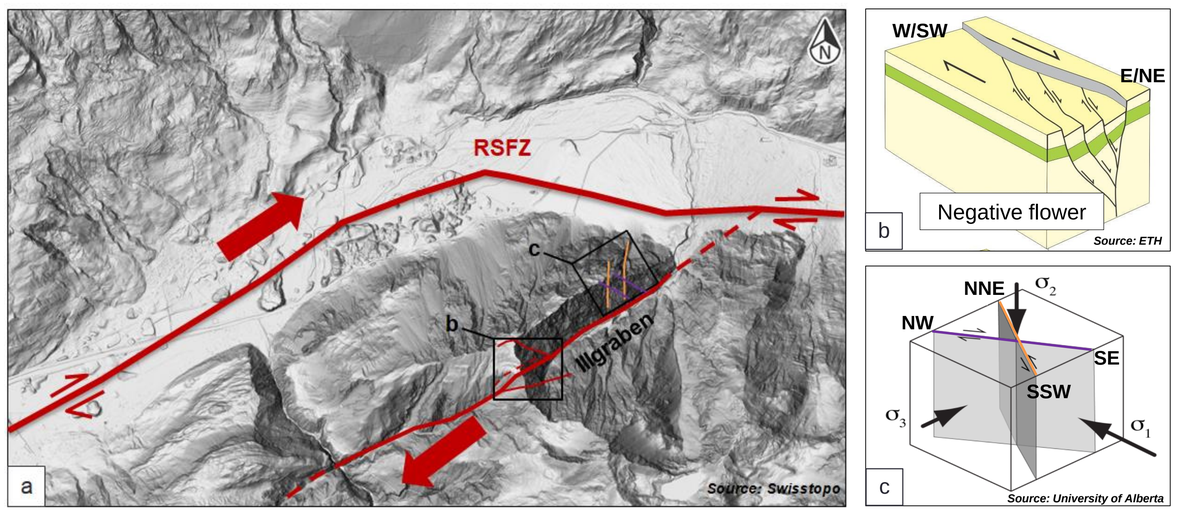

Fig. 3: a) Tectonic model: The major tectonic structure in the area is the RSFZ with dextral strike-slip faulting. A fault branch runs along the Illgraben trunk channel. b) Flower structure consisting of the observed E-W and NE-SW striking faults at the catchment edge. Flowers form where main fault zones bend. c) Shearing gets accommodated by a conjugated fault set.

Geomorphological Preconditioning:

- Reactivation of pre-existing structures by mass movements result in sediment production
- **Coupling between hillslopes and channel network** allows efficient erosion in the Illgraben catchment. Erosion process facilitated by steep walls from **glacial preconditioning**

References: McArdell, B. W. and Sartori, M. 2021. The Illgraben torrent system. https://doi.org/10.1007/978-3-030-43203-4_25.

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