Debris-laden flows as indicators of Holocene natural hazard variability in alpine regions: First results from Lake Heiterwang (Northern Calcareous Alps, Austria)

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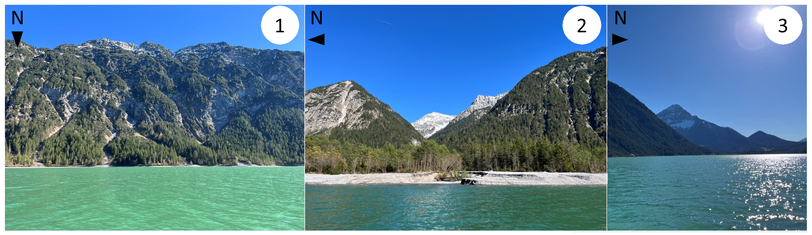
Motivation

- Reconstructing the **frequency** and **magnitude** of debris-flows and floods in the European Alps throughout the Holocene
- Understanding the influence of **climate change** on climatic natural hazards

Study area



- Northern Calcareous Alps, Austria, 976 m a.s.l.
- Surrounded by steep slopes of intensely jointed dolomitic rock
- Humid continental climate, high precipitation events in summer

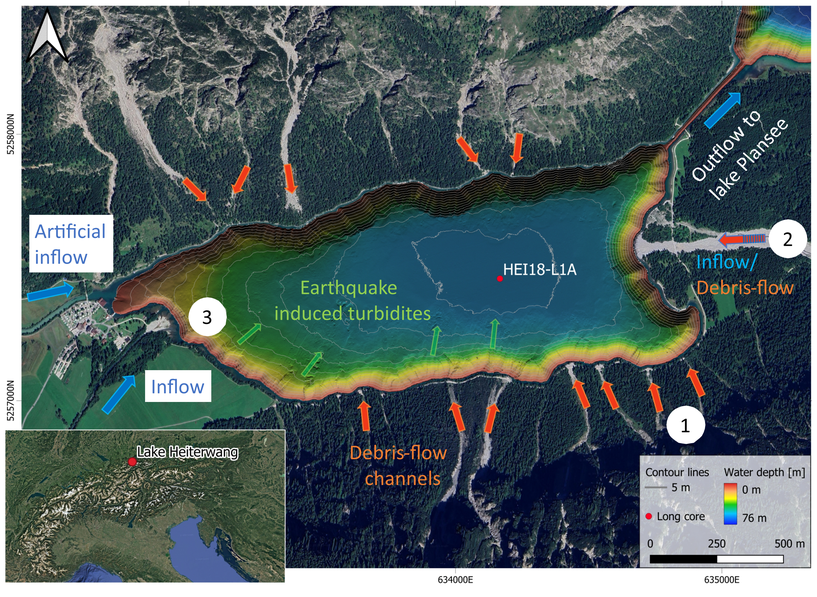
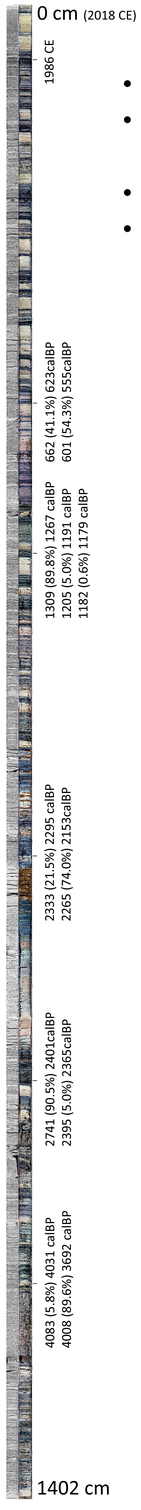


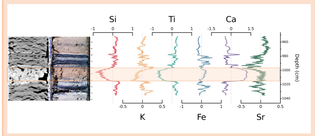
Figure 1 Overview map of Lake Heiterwang with the core location. The arrows indicate different sediment sources and transport mechanism responsible for the event layers in the core. Debris-flow inputs are marked with red, potential flood inflows with blue, and earthquake-induced turbidites with green arrows. The inflow to the east is a mix of river- and debris-flow-like input. The pictures of the study area are marked with numbered circles.



Results

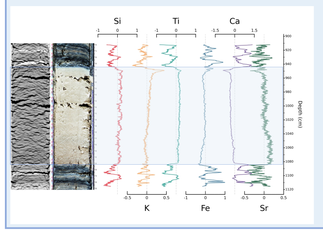
- 108 event layers > 1 cm in 14 m of core
- Background sedimentation is characterized by sulfur peaks and black colour
- Recent floods (2005 and 1999) are recorded in the core
- Event frequency increases towards present day

Type 1
(Debris-flow)



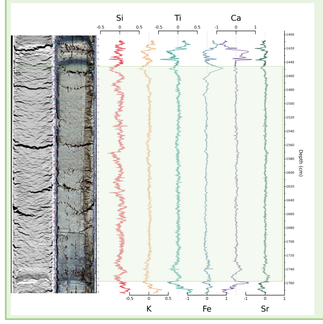
- Reddish color
- Higher density
- Relatively high in Ca
- 1-3 cm

Type 2
(Flood)



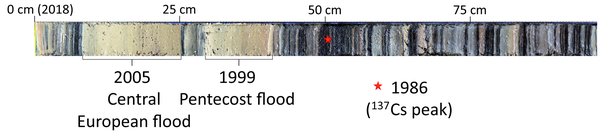
- Beige color
- Lower density
- Decrease of Ca and increase of e.g. K towards top
- > 3 cm

Type 3
(Earthquake?)



- Gray color
- Medium density
- Homogenous element distribution
- > 7 cm

Modern day analogue



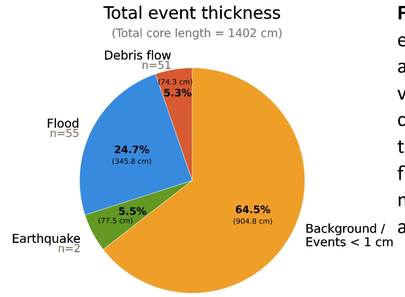


Figure 2 Thickness distribution of the identified event types and background sedimentation. Of all events, floods dominate in frequency and volume. The two potential earthquake deposits contribute a cumulative thickness comparable to that of all debris-flow events combined. Debris-flows show a lower individual thickness, with many events falling below the 1 cm threshold and are therefore not considered in the analysis.

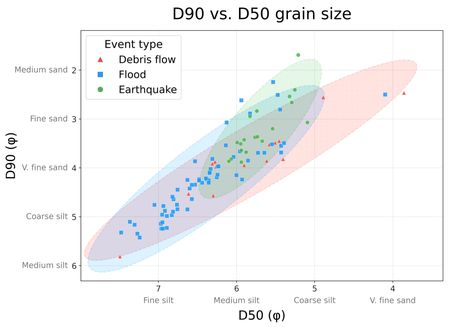


Figure 3 D90 vs. D50 grain size plot. Debris-flows and floods show similar evolutions, while the earthquake grain sizes show a steeper trend. The ellipses are drawn for a 95% confidence area.

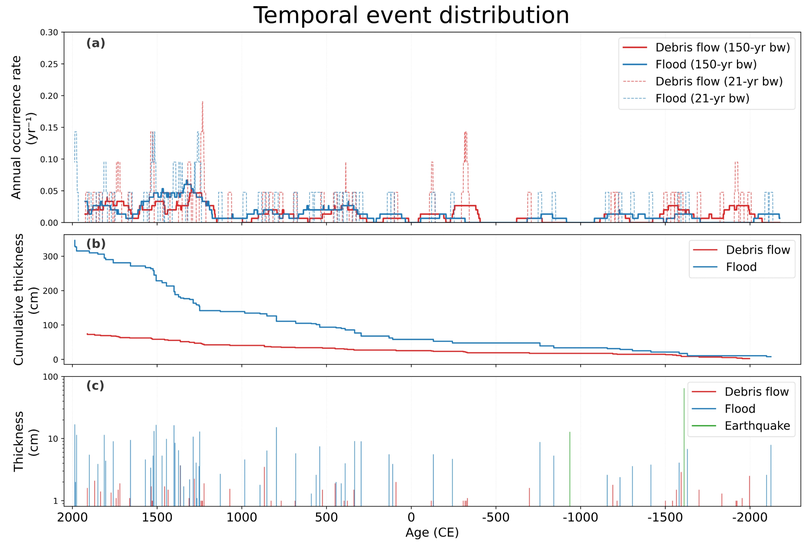


Figure 4 Temporal distribution of debris-flow- and flood-induced turbidites in long core HEI18-L1. (a) The annual occurrence rate with a 21- and 150-year bandwidth based on their mean age (see bottom panel). (b) Cumulative thickness over time. (c) Thickness distribution of 51 debris flows-, 55 flood-, and 2 earthquake induced turbidites.

Conclusion

- **Three main event types**
- Distinguishing events from background becomes more challenging towards the bottom → bias in frequency?
- More small-scale (< 1 cm) investigations are needed

*Author list and references: