

Multistage Rock-Slope Failures and Refined Recurrence Rates Deciphered From Lake Sediments (Eibsee, Bavarian Alps, Germany)

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Introduction

Recurrence rates of rock-slope failures are commonly underestimated and their magnitudes misinterpreted. Recent studies show that some mountain flanks do not collapse in a single event, but rather through multistage failures from the same or nearby scarps (e.g., Hermanns *et al.*, 2006; Knapp *et al.*, 2018). It might take hundreds of years for the source slope to restabilize – a period of stress adaptation in the rock walls, which may lead to more failures. For hazard assessment, it is essential to refine recurrence rates and better understand progressive failure and multistage reshaping of the impact zone. Where rock-slope failures impact water reservoirs like lakes, the sediment archive may record multiple event deposits on top of each other. Ideally separated by continuous lake background sedimentation, the event deposits can be deciphered in time and space.

Study area and methods

The ~200 mio. m³ Eibsee rock avalanche occurred at Mount Zugspitze in the Bavarian Alps (Germany) in the Holocene. The rock avalanche impacted and completely destroyed the paleolake Eibsee. In this study, sediment cores were retrieved from modern Lake Eibsee to refine the age of the event by radiocarbon dating at multiple sites in the lake, and to reconstruct the 'lake rebirth'. The BSG Research Grant supported the costs of dating.

Results

We identify and date three rock-slope failures at Lake Eibsee. The multiple events suggest successive failure from Mount Zugspitze. The age of the Eibsee rock avalanche is refined by radiocarbon dating at four sites in modern Lake Eibsee. Age dating alone does not conclusively disclose the event history. A multimethodological approach using geophysical profiles and sediment cores from the lake, radiocarbon dating, and geomorphological analysis is important to refine recurrence rates.



Figure 1: Impressions of fieldwork at Lake Eibsee showing the coring platform (left), retrieved wood from event deposits (middle), and sample preparation for radiocarbon dating in the lab (right).

Outcomes

This research project supported by BSG documents a complex history of erosion and sedimentation in Lake Eibsee. The complementary application of geophysics, sedimentology, radiocarbon dating, and geomorphology makes it possible to reveal the catchment response and the rebirth of the lake. Two articles on the Eibsee rock avalanche and Lake Eibsee have recently been published in *Earth Surface Processes and Landforms* (Knapp *et al.*, 2020a, <https://doi.org/10.1002/esp.5024>, and Knapp *et al.*, 2020b, <https://doi.org/10.1002/esp.5025>).