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Insight into the sediment dynamics of a high-impact low-frequency mass movement event using single-grain feldspar luminescence in the Pokhara valley, Nepal

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Mass movements play an important role in landscape evolution of high mountain areas such as the Himalayas. Yet, establishing numerical age control and reconstructing transport dynamics of past events is challenging. To fill this research gap, we investigated the potential of Optically Stimulated Luminescence (OSL) dating and tracing methods. OSL dating analyses of Himalayan sediments is extremely challenging due to two main reasons: i) the OSL sensitivity of quartz, typically the mineral of choice for dating sediments younger than 100 ka, is poor, and ii) highly turbid conditions during mass movement transport hamper sufficient OSL signal resetting prior to deposition which eventually results in age overestimation. In this study, we aim to bring OSL dating to the test in an extremely challenging environment. First, we assess the applicability of single-grain feldspar dating of mass movement deposits in the Pokhara valley, Nepal. Second, we exploit the poor bleaching mechanisms to get insight into the sediment dynamics of this paleo-mass movement through bleaching proxies. The Pokhara valley is a unique setting for our case-study, considering the availability of an extensive independent radiocarbon dataset (Schwanghart et al., 2016) as a geochronological benchmark.

Single-grain infrared stimulated luminescence signals were measured at 50°C (IRSL50) and post-infrared infrared stimulated luminescence signals at 150°C (pIRIR-150). As expected, results show that the IRSL50 signal is better bleached than the pIRIR150 signal. A bootstrapped Minimum Age Model (bMAM) is applied to retrieve the youngest subpopulation to estimate the palaeodose. However, burial ages calculated based on this palaeodose overestimate the radiocarbon ages by an average factor of ~8 (IRSL50) and ~35 (pIRIR150). This shows that dating of the Pokhara Formation with our single-grain approach was not successful. Large inheritances in combination with the scatter in the single-grain dose distributions show that the sediments have been transported prior to deposition under extreme limited light exposure which corresponds well with the highly turbid nature of the sediment laden flood and debris flows that emplaced the Pokhara Formation.

To investigate the sediment transport dynamics in more detail we studied three bleaching proxies: the percentage of grains in saturation (2D0 criteria), percentage of well-bleached grains (2σ range of bMAM-De) and the overdispersion (OD). Neither of the three bleaching proxies indicate a spatial relationship with run-out distances of the mass movement deposits. We interpret this as virtual absence of bleaching during transport, which reflects the catastrophic nature of the event. While single-grain feldspar dating did not provide reliable burial ages of the Pokhara mass movement deposits, our approach has great potential to provide insight in sediment transport dynamics of high-impact low-frequency mass movement events in mountainous region.

References

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