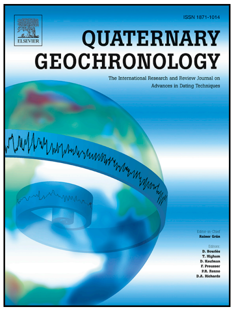

Luminescence dating of glaciolacustrine silt in overdeepened basin fills beyond the last interglacial

Marius W. Buechi, Sally E. Lowick, Flavio S. Anselmetti

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1. Introduction

Deeply incised subglacial basins are common landforms in the Northern Alpine foreland. They are often overdeepened, i.e. eroded below the fluvial base level, and are therefore interpreted as the product of subglacial erosion (e.g. Preusser et al., 2010; Dürst Stucki and Schlunegger, 2013). Complex subglacial basin morphologies and nested infills revealed in the Swiss sector of the Alps suggest that the overdeepened bedrock relief and its sedimentary infill are the result of repeated glaciation during the Middle- and Late Pleistocene (e.g. Schlüchter, 1989; Preusser et al., 2005; Jordan, 2007; Graf, 2009; Dürst Stucki and Schlunegger, 2013; Reber and Schlunegger, 2016). It is, however, largely unknown during which glaciations overdeepened basins were eroded and filled. Since overdeepened basins act as sediment traps during deglaciation, they are rapidly infilled by subglacial, ice-marginal and, later, glaciolacustrine sediments (e.g. Pugin, 1989; Hansen et al., 2009). Numerical dating of the infill of overdeepened basins can thus be used i) to determine a minimum age for the formation of the overdeepening, and ii) to constrain timing of depositional and erosional phases within the infill.

Luminescence dating techniques determining the length of the burial period are among the most promising approaches to constrain these erosion and infilling cycles (Preusser et al., 2005; Anselmetti et al., 2010; Dehnert et al., 2012; Fiebig et al., 2014). However, a critical assessment of the reliability of luminescence dating techniques within these sediments is needed due to two main limitations. Firstly, the glaciolacustrine sedimentation is expected to be prone to incomplete resetting of any initial luminescence signal depending on the particular transport paths (e.g. Fuchs and Owen, 2008; Livingstone et al., 2015). While fluvial transport in supraglacial or proglacial streams is more likely to completely reset any inherited luminescence (e.g. Alexanderson and Murray, 2013; Gaar et al., 2013), the sediment transport path in ice-contact lakes may be much less efficient in fully bleaching grains prior to burial (e.g. Duller 1994; Livingstone et al., 2015). To overcome this, the comparison of multiple luminescence signals allows the reliable discrimination of problematic, poorly bleached sediments, where harder to bleach signals should carry higher inherited signals (Murray et al., 2012; Dehnert et al., 2012).

Secondly, the expected Middle to Late Pleistocene age of most of these valley fills (e.g. Preusser et al., 2011) may bring commonly used luminescence signals to their upper dating limit as they approach saturation. The saturation level is sample-specific and depends on the mineral fraction, the grain-size fraction, and the rate at which the dosimeter is filled (dose rate, D_r). To date, luminescence studies in the Northern Alpine foreland have been successfully used to decipher the landscape evolution reaching as far back as Marine Isotope Stage 7 (MIS7: 191-243 ka, Lisiecki and Raymo, 2005) on the basis of different luminescence signals, protocols and grain sizes (Rentzel et al., 2009; Preusser et al., 2005; Dehnert et al., 2012; Lowick et al., 2015; Bickel et al., 2015a; b; Salcher et al., 2015).