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THESIS ABSTRACT

Overdeepened glacial basins as archives for the Quaternary landscape evolution of the Alps

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The Alps and the Alpine foreland have been shaped by repeated glaciations during Quaternary glacial-interglacial cycles. Extent, timing, and impact on landscape evolution of these glaciations remain, however, poorly constrained due to the fragmentary character of proximal terrestrial archives. In this context, the sedimentary infill of subglacially eroded, 'overdeepened', basins may serve as important archives to complement the Quaternary stratigraphy over several glacial-interglacial cycles. In this thesis, the infill of deep subglacial basins in the Lower Glatt valley (N Switzerland, Fig. 1) are explored to better constrain the Middle- to Late Pleistocene glaciation history and landscape

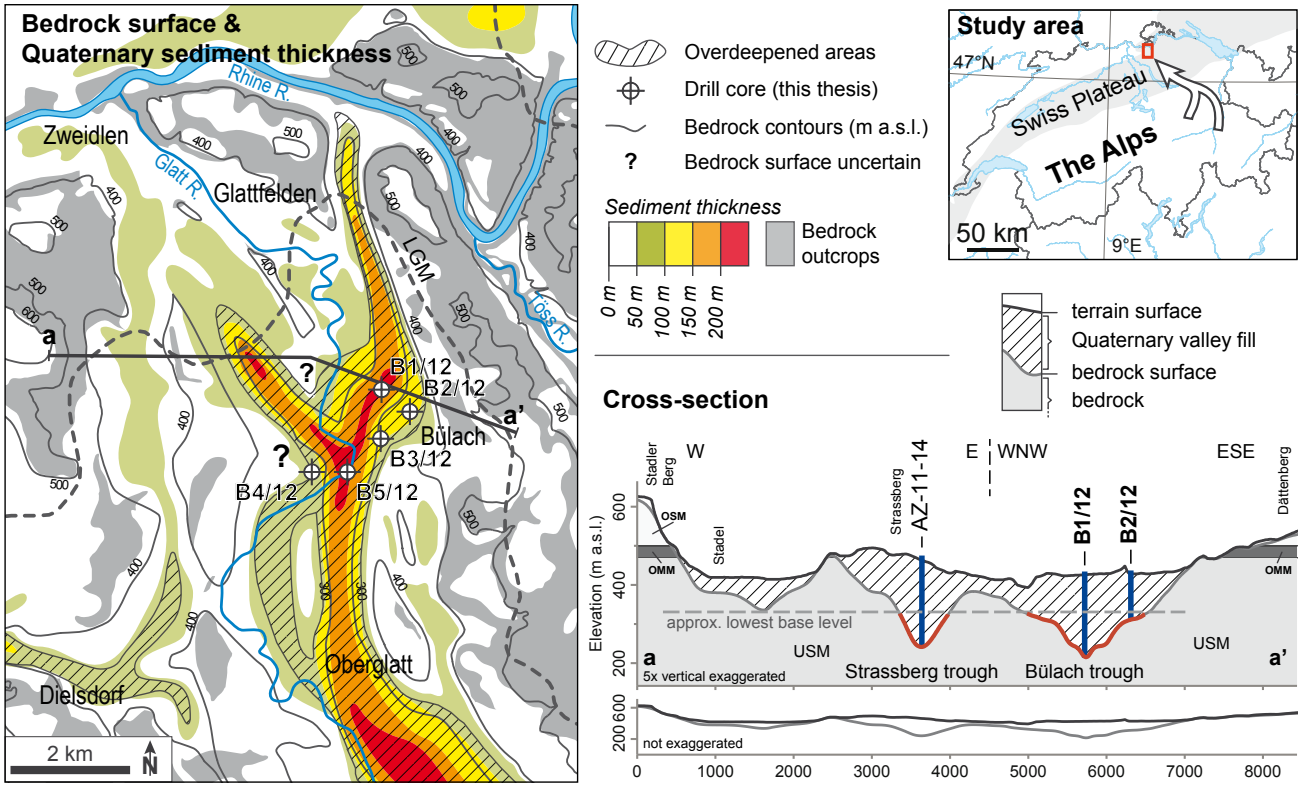

Fig. 1: The bedrock topography in the Lower Glatt Valley (N-Switzerland) is characterized by narrow bedrock depressions forming subparallel to bifurcating troughs attributed primarily to subglacial erosion. These troughs are inset into a broad valley geometry and cut up to ~100 m below lowest fluvial base level. The up to 200-m thick Quaternary sediments infilled into the eastern branch (Bülach Trough) have been recovered in five drill cores (B1-B5/12), which were analysed in detail for this thesis. Bedrock surface map is courtesy of Amt für Abfall, Wasser, Energie und Luft (AWEL), Zürich and Nationale Genossenschaft für die Lagerung radioaktiver Abfälle (Nagra), Wettingen.

evolution. Five drill cores gave direct insight into to the up to ~190 m thick valley fill at the study site and allowed for detailed analysis of sedimentary facies, age, and architecture of the basin fills.

In a first step, the characteristics and origin of the infilled sediments were studied using core descriptions, micro-sedimentology in thin-sections, and compositional analysis of different grain-size fractions. The study by Buechi et al. (2017a) focusses on the sedimentology of coarse-grained diamictons with sorted interbeds, which overlie bedrock in the deepest depressions and mark the onset of deposition in many other glacial bedrock troughs. The macro- and micro-sedimentology suggest that these sediments are emplaced subglacially and reflect deposition, re-working, and deformation in response to repeated coupling and decoupling of the ice–bed-interface promoted by high basal water pressures (Fig. 2, see Buechi et al. 2017a). These results therefore give insights into the subglacial conditions that existed in these otherwise inaccessible bedrock troughs. The overlying valley fill is dominated by submarginal to proglacial glacio-deltaic, glacio-lacustrine, and later lacustrine sediments that document glacier retreat from the basin. Interbedded subglacial tills indicate later glaciations forming nested, or 'inlaid', overdeepened basins with partial preservation of the older valley fill.

In a second step, an absolute chronology of the depositional and erosional periods was developed using luminescence dating of glaciolacustrine silts. Quartz OSL was identified as the luminescence signal of choice as it met all performance criteria and is least affected by incomplete bleaching. The results suggest glaciolacustrine deposition and infilling of the thick sedimentary sequence during different stages of the MIS6 Beringen Glaciation period. However, the resulting burial ages were relatively close to the upper dating limit of the method and the reliability had to be tested extensively in signal stability experiments (Buechi et al. 2017b). The burial ages of the lower glaciolacustrine units partly coincide with the ice-free MIS7 interglacial period. This overlap is interpreted to result from an overestimation of the true burial age

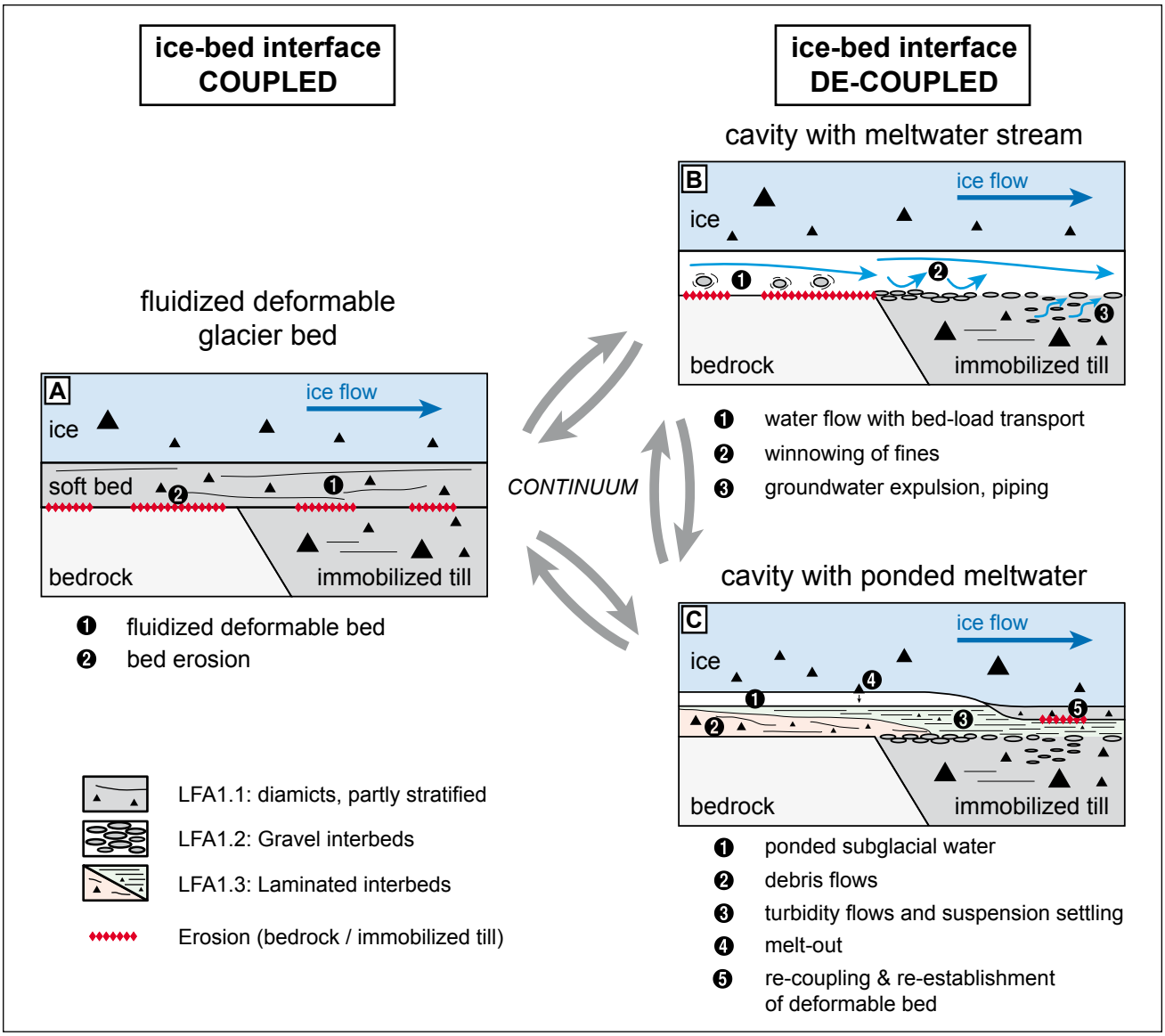

Fig. 2. Schematic diagram showing different states of the ice–bed-interface in the deepest part of the subglacial basin (Buechi et al. 2017a). In this model, the interbedding of subglacial tills with gravels and laminated fines results of repeated switching between a coupled and decoupled ice–bed-interface in space and time.

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most likely caused by admixture of unbleached older valley fill material.

This litho- and chronostratigraphic framework was then used to reconstruct the local to regional glaciation history and landscape evolution (Buechi et al. in review). The valley fill is grouped into nine formations, which are related to the Birrfeld Glaciation (~MIS2), the Beringen Glaciation (~MIS6), and up to three earlier Middle Pleistocene glaciations, tentatively correlated to the Hagenholz, Habsburg, and Möhlin Glaciations (Preusser et al. 2011). The complex valley fill and bedrock architecture are therefore interpreted to be result of multiple erosion and infilling cycles and reflect the interplay of subglacial erosion, glacial to lacustrine infilling of overdeepened basins, and fluvial downcutting and aggradation in the non-overdeepened valley fill. Evidence suggests that in the study area deep bedrock incision, and/or partial re-excavation, occurred mainly during the Beringen and Hagenholz Glaciation, while older structures may have existed. Together with the observation of minor, 'inlaid' glacial basins, dynamic changes in the magnitude and focus of subglacial erosion over time are documented. The preservation of sediments in subglacial basins over several glacial-interglacial cycles demonstrates the importance of subglacial basins as archives for glaciation history and landscape evolution of the Alps and glaciated mountain ranges worldwide.

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