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Recently exposed subglacial carbonate deposits at the retreating Triglav Glacier, Slovenia

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Subglacial carbonate deposits have been exposed on the lee sides of small protuberances on a bare polished and striated limestone bedrock surface in the immediate vicinity of the retreating Triglav Glacier in southeastern Alps. They are fluted and furrowed crust-like deposits generally around 5 mm thick and characterized by brownish, greyish or yellowish colour. The deposits are generally around 0.5 cm in thickness and internally laminated. They offer a unique opportunity to gain additional knowledge of the past glacier's behaviour and consequently the characteristics of the past climate which is essential to understand and predict future changes. Currently, the known extent and behaviour of the Triglav Glacier spans from the present to the Little Ice Age, the cool-climate anomaly between the Late Middle Ages and the mid-19th century, and is based on geomorphological remnants, historical records, and systematic monitoring. However, the preliminary uranium-thorium (U-Th) ages of the subglacial carbonates yielded considerably old ages: 23.62 ka ± 0.78 ka, 18.45 ka ± 0.70 ka and 12.72 ka ± 0.28 ka; the results indicate that these subglacial carbonate dates fall within the Last Glacial Maximum (LGM) and the Younger Dryas (YD).

The Triglav Glacier has generally been viewed as relict of the LIA, with discontinuous presence due to the Holocene Climatic Optimum, a period of high insolation and generally warmer climate between 11,000 and 5,000 years BP. Present chemical denudation rates of carbonate rocks in Alpine and temperate climate vary from ca. 0.009 to 0.140 mm/year. Taking the low and high extreme values for, e.g., 6 ka during the Holocene Climatic Optimum, the denudation in the Triglav area would be between 54 and 840 mm, so the exposed 5 mm thick subglacial carbonate would have already been denuded if exposed in the past. In addition, carbonate surfaces in periglacial areas are additionally exposed to frost weathering, promoting disintegration of depositional features. And lastly, glaciers cause pronounced erosion and in case of just a short-term retreat

beyond the subglacial carbonates, the re-advance of the glacier would likely abrade the deposits. Therefore, had the subglacial carbonate deposits been exposed in the past, they should have been eroded by chemical denudation, frost weathering, or erosion at the onset of individual Holocene glacial expansion episodes, such as the LIA. May the presence of subglacial carbonates dated to the LGM and the YD at the Triglav Glacier suggest the continuous existence of the glacier throughout all but the latest Holocene?