



## **Subglacial tunnel valleys dissecting the Alpine landscape – an example from Bern, Switzerland**

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The morphology of the Alpine and adjacent landscapes is directly related to glacial erosion and associated sediment transport. Here we report the effects of glacio-hydrologic erosion on bedrock topography in the Swiss Mittelland. Specifically, we identify the presence of subsurface valleys beneath the city of Bern in Switzerland and discuss their genesis. Detailed stratigraphic investigations of more than 4000 borehole data within a 430 km<sup>2</sup>-large area reveal the presence of a network of >200 m-deep and 1000 m-wide valleys. They are flat floored with steep sided walls and are filled by Quaternary fluvio-glacial deposits. The main valley beneath Bern is straight and oriented towards the NNW, with valley flanks more than 20° steep. The valley bottom has an irregular undulating profile along the thalweg, with differences between sills and hollows higher than 50-100 m over a reach of 4 kilometers length. Approximately 200 m high bedrock uplands flank the valley network. The uplands are dissected by up to 80 m-deep and 500 m-broad hanging valleys that currently drain away from the axis of the main valley. We interpret the valleys beneath the city of Bern to be a tunnel valley network which originated from subglacial erosion by melt water. The upland valleys are hanging with respect to the trunk system, indicating that these incipient upland systems as well as the main gorge beneath Bern formed by glacial melt water under hydrostatic pressure. This explains the ascending flow of glacial water from the base towards the higher elevation hanging valleys where high water discharge resulted in the formation of broad valley geometries. Similarly, we relate efficient erosion, excavation of bedrock and the formation of the tunnel valley network with >20° steep shoulders to confined flow under pressure, caused by the overlying ice.