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How to build the Eiger: Surface expression of litho-tectonic preconditioning

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The north face of the Eiger has exerted a strong attraction on alpinists, but also on geologists during the past decades, mainly because of its triangular, nearly vertical shape. We build on this tradition and investigate the relationship between the shape of this mountain and its underlying lithology, and its history of folding and thrusting. To this extent, we constructed a geometric 3D geological model of the Eiger-Moench-Jungfrau mountain chain in the central Swiss Alps. We proceeded through compilations of geological maps that we combined with new mapping in the field and collection of structural data such as the orientation of lineaments and faults. The model itself was constructed by interpolation of interfaces between geological formations, thrust- and fold-geometries between several NW-SE running, balanced, cross-sections. In addition, new geological data from the Jungfraubahn railway tunnel was used to verify surface data and improve the resulting model in the depth.
The analyzed units of the Hercynian crystalline basement of the Aar massif and the Mesozoic cover rocks of the Helvetics form a foliated and thrusted stack. Multiple ductile structure sets bear witness of Alpine deformation and are dominant amid the mark of later brittle deformation across the whole mountain.
There are two major outcomes of this analysis. First, the thrust contact between two stacks, which comprise a foliated basement and cover rocks, are responsible for the shape and overall architecture of the Eiger and its famous north face. Second, the high-resolution 3D structural model paired with petrological data shows that second-order, horizontally aligned morphological steps in the north face are related to the foliation within the bedrock. We suspect the inherited fabric significantly modified the susceptibility to erosion mechanisms which in turn further amplified the morphological differences (expressed in e.g. terrain roughness or slope).