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Application of buckle folding theory to the development of transverse ridges on a rockglacier

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Many rockglaciers feature a prominent transverse furrow-and-ridge geometry on its surface, which has previously been suggested to develop under the influence of compressive flow. The rockglacier Murtèl located in the Upper Engadin valley of the Swiss Alps is one prominent example and serves as our testsite. The surface geometry creates the impression of a quasi-sinusoidal buckle fold, which is the mechanical response of layered rocks to compressive deformation of a medium with sufficient viscosity ratio between the layers. The main purpose of our project is to test if the buckle folding theory is applicable to explain the occurrence of these ridges. If so, the buckle fold theory provides a relationship between the observed fold wavelength, the layer thickness, and the effective viscosity ratio between the folded layer and its surrounding material. With the aid of a high-resolution digital elevation model (DEM) obtained from photogrammetry we are able to extract the surface topography. The Fourier analysis of the DEM mid-section transect along the rockglacier reveals a dominant wavelength between 20 m and 26 m. Geophysical sounding and borehole data from previous studies give us a rough thickness average of 5 m for the top folding layer. Based on these values and using different versions of the buckle folding theory implemented in the Fold Geometry Toolbox (FGT) software, we obtained viscosity ratios (μlayer/μmatrix) with relatively small values below 10. This value is an annual average, because it is not possible to distinguish between surface structures changing over the seasons. The actual temperature-dependent viscosity ratio may significantly fluctuate around this value. Another limitation is that the buckle folding theories are only available in 2-D, but the natural structures are inherently 3-D. Future improvements may include using different transects along regions of the rockglacier where different physical processes are involved to study the variability of the wavelength and the resulting viscosity ratio. Despite some limitations and possible improvements, our preliminary results help better understand the rheology that best reflects the development of the observed surface structures. Also, using the resulting effective viscosity ratios, we can perform numerical simulations of the folds and use them to explain the topographical development of the rockglacier.