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Late-stage Alpine Continent-Continent Collision: Exhumation of Midcrustal Basement by Subvertical Large-Scale Block Extrusion

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The Aar Massif belongs to the External Cristalline Massifs of the Alps. New structural data illustrate a substantial vertical exhumation component, yielding in a considerable exhumed N-S metamorphic gradient (250°C-400°C over a horizontal distance of 15 km). Previously suggested thrust-related stettings cannot account for these constraints. Moreover, seismic tomography reveals pronounced high- and low-velocity anomalies underneath the Aar Massif and the Gotthard nappe, respectively, corresponding to lower crustal rocks and upper crustal rocks at shallower and deeper positions compared to an undeformed continental crust.

The combination of these observations lead us to a new geodynamic model for the exhumation of the Aar Massif. At a late stage of Alpine collision, slab rollback of the European lithospheric mantle, results in delamination in the lower crust. The missing slab pull forces in combination of buoyancy of mid- to upper crustal blocks lead to a steep rise of crustal block (vertical tectonics). This rise is accommodated along the steep reverse faults (Handegg phase, 22-17 Ma), which evolve and propagate from S to N being in charge for todays metamorphic gradient. Ongoing delamination in the lower crust and its buoyancy-driven piling up generates the excess of lower crust underneath the study area as manifest by the lower crustal thickening. In additon to the vertical component a weak compressional plate convergence component still persisted, as manifest by the structures of the Oberaar and Pfaffenchopf phase (<12 Ma). The associated strain partitionning between the northern and southern part of the Aar massif resulted in a further horizontal shortening and tectonic uplift component of several kilometers. It is this long lasting deformation history in combination with surface erosion, which resulted in the today's shape of the North Alpine front.