

Basement deformation during continental collision: a modelling example of the Swedish central Caledonides.

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Recent geophysical investigations (Hedin et al., 2012; Yan et al., 2015; Juhlin et al., 2015), carried out as part of the Collisional Orogeny in the Scandinavian Caledonides (COSC) project, provide an improved picture of the upper crust over the central Swedish Caledonides. The geometry and lithology of the basal detachment (surface to 1-2 km depth) are relatively well constrained by various observations (Seismic reflection, magneto-telluric, field observations ...), whereas deeper structures (1-2 km depth) observed in the Precambrian autochthonous basement are more ambiguous and may be interpreted as possible deformation zones or dolerite intrusions (dykes).

In this study we interpret these structures as shear zones formed during a pre- or syn-Caledonian convergence event, at the boundaries of strong layers (e.g.: dolerites dykes) intruding the basement. In this collisional context, shear zones would work as thrust sheets accommodating the shortening, while the dolerite intrusions would rotate but remain mostly undeformed.

We use a two-dimensional thermal-mechanical model to test this hypothesis. Our model is set up as follows: a 200km x 30km rectangular box composed of a sedimentary cover (5-7km thick) and a weak alum shale layer (100-500 m thick), overlying a continental basement intruded by vertical dolerite dykes and horizontal sills. Shortening velocities are applied on the right and bottom boundaries while the left side is fixed and the top boundary defined as a free surface. We use a visco-elasto-plastic rheology to characterize the three layers that compose the model and use consistent thermal parameters to define the temperature field. The governing equations of momentum, energy, and mass conservation are solved using COMSOL Multiphysics, a finite element software.

The three main objectives of this study are to: 1) Analyze the localization and distribution of deformation in the basement and in the overlying layers. 2) Quantify the amount of shortening/strain required to form the shear zones and rotate the dolerite dykes 3) Study the role of the alum shale in the decoupling between the Lower Allochthon cover and the Precambrian basement.