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Lateral flow in the middle crust – Analogue experiments from the Svecofennian orogen

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The exposed Svecofennian crust (50-65 km) has been suggested to have thickened in continental accretion between Archean and Paleoproterozoic terranes, probably at a high convergence rate. It is likely that this thickened orogen experienced lateral spreading during its final stages. This post-orogenic event has reshaped the collisional framework and modified its bulk appearance. In this study, we have used scaled analogue centrifuge modeling to simulate extensional lateral flow at the Archean- Paleoproterozoic boundary zone during final stages of the Svecofennian orogeny. The analogue models simulate both the evolution of a mechanical boundary between two rheologically different tectonic blocks, and the role of pre-existing weaknesses at moderate angles (representing the old stacking structures). In models the upper layer is brittle, the middle layer is ductile, and the lower layer is more viscous. The layers represent upper, middle and lower crust, respectively. The Proterozoic layers have lower viscosity values than the Archean layers at similar depths.

The materials are based on the plastilina modelling putty, which is mixed with acid oil, silicone, sweetener and/or barium sulphate to get the appropriate composition for each layer. Both the Archean and the Paleoproterozoic blocks have a low-viscous middle crust. The three layered models are extended unilaterally.

The model results show that during extension the rheologically different layers deform and spread at different rates during the tectonic collapse. This results in 1) vertical rotation of the Archean and Proterozoic boundary; 2) the pre-existed faults become listric and discontinuous; and 3) the upward flow of the low viscosity middle layer to fill the newly-formed gaps between the upper layer blocks.

The experiments show geometrically similar crustal-scale structures to those observed in the deep seismic reflection profiles (FIRE). Thus it is possible that lateral flow has taken place in the core of the Svecofennian orogen. The rising of the middle layer indicates that large scale fold structures may form even extensional process. The middle crustal antiforms filling the gap of the upper crust may be observed in core complexes, where the upper parts of the middle crust may be exposed the field.