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Length scale and thermal imprint of thermo-mechanical shear localisation

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Shear localisation is responsible for focussing strain in a specific area of a material, it is thus a key element for plate tectonics. We use two-dimensional thermo-mechanical models to study shear localisation. Under geologically relevant loading conditions using laboratory derived power law flow laws, shear localisation is triggered by shear heating. Dimensions of the modelled shear zones do not depend on the numerical resolution: they are controlled by physical parameters. The results of the models are well explained by a scaling law that allows predicting shear zone thickness. For long term deformation shear zones are the order of 1000 m whereas for laboratory conditions shear zone thickness can decrease down to the mm-scale, in agreement with some natural observations and experimental results. Shear localisation occurs together with a temperature increase. Whereas the strain remains localised inside the shear zone, the thermal imprint is diffused such that small temperature gradients ($\sim$10 C/km) across the shear zone boundaries were obtained. Our results suggest that shear zones caused by shear heating can exhibit small to moderate temperature variations across them, which is in agreement with natural shear zones.