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Time to reconcile thermal inversion models around thrusts

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Inversion of metamorphic thermal isograds is commonly observed around mega-thrusts, particularly in close association with major thrusts in collision belts. However, the processes leading to such thermal inversion still constitute an open issue. Various models have already addressed their possible syn-deformational origin during thrusting. However, because they concentrated on specific contexts and processes, none of these models has achieved a general consensus. Hence, in order to reconcile these different models of syn-deformational thermal inversion, it becomes crucial to find a way allowing to determine the key process controlling the thermal evolution for any thrust zone.

Here, we present a dimensional analysis allowing to quantify the relative control of heat diffusion, advection and shear heating on the thermal evolution around thrusts. Our analytical solution invokes parameters that can define any thrust scenario in terms of kinematics, rheological strength and thermal context. Our study focuses mainly on the role of the thrust thickness, h, the shear zone dip angle, θ, the convergence velocity, V, and the effective viscosity, η, of the shear zone. Our dimensional analysis shows that for typical values applicable to intracontinental thrusts (h = 1-5 km, θ = 15-45°, V = 1-3 cm/yr, η = 1e19-1e21 Pa.s) heat diffusion as well as advection as well as shear heating can be the dominant process controlling the thermal evolution around thrusts. This result explains the difficulty of finding a unique model for inverted metamorphism.

From this, we first validate our dimensional analysis with two-dimensional thermo- kinematical models: for typical values and scenarios applicable to different thrusts, our numerical results show specific thermal evolutions. Then, we apply our first-order coupled analytical-numerical method to natural occurrences of inverted zonation of metamorphic peak temperatures. In this way, our analysis suggests that the inverted metamorphism associated to the Main Central Thrust in the Himalayas, for instance, can be mainly a result of shear heating.