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Syn-deformational inverted metamorphism: Insights from 2D Thermo-kinematic numerical models

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Inverted metamorphism is characterized by the stacking of high-grade metamorphic unit structurally above unit presenting a lower metamorphic grade. Some main thrusts in major orogens are characterized by such an inverted metamorphism. Several cases have been already described (e.g. Variscan belt, Himalayas, Caledonian belt, Canadian cordillera), but the most popular and the most studied corresponds to the case associated to Main Central Thrust (MCT) in the Himalayan belt. The models that propose to explain how inverted metamorphism can occur are multiple, but they are still debated. Moreover, another issue related to the preservation of a thermal inversion is still not well solved.

In this study, we propose to address the problem by using a 2D-thermo-kinematical model. The velocity field (including isostasy compensation) is imposed in the whole model in order to simulate a crustal scale thrust. At each time step, we solve the heat diffusion equation on the grid. The temperatures are then advected by markers following the velocity field. We voluntary decided to simplify the model in order to control each parameter and test their influence on the possible inversion of the geotherms.

We thus realized a parametric study in order to quantify the impact of the initial conditions (thrust angle and convergence velocity) and the thermal properties of the rocks on the thermal evolution around a major compressive shear zone. Our results show that heat capacity, density and heat production of rocks have negligible effect on the geotherms inversion. However initial conditions, thermal conductivity and shear heating seem to be the most important parameters controlling the inverted metamorphism. Since the shear heating depends on the convergence velocity and the viscosity of the material in the thrust, we provide here the possible range of values of velocity and viscosity allowing the inversion and the preservation of inverted geotherm during time.