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Combining thermo-kinematic and mechanical modelling on thrust faults - a quantitative approach to crustal deformation history: Case study from SE Tibet

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Decoding the Tibetan plateau and its structural evolution has been a thorny issue for decades, triggering many controversial discussions between the proponents of the numerous key models. Numerical simulations of buoyancy forces associated with a thick crust and a low viscosity channel in the Tibetan crust predict continuous deformation, crustal uplift and thickening through an outward flow of partially molten middle/lower crust. Surface geological observations of fault systems, however, favor a model of localized deformation through the interaction between strike-slip and thrust faults. Here, we investigate the role of thrusting mechanisms involved in the plateau formation, which is essential in order to discuss these end-members competing models. We focus on the Muli thrust, a major Miocene thrust fault located at the eastern edge of the Tibetan Plateau, characterized by a pronounced topographic step of ~2000 m. We provide here an innovative quantitative approach combining thermo-kinematic modelling based on low-temperature thermochronology data, with conceptual 2-dimensional (2D) simulations of the crust's mechanical behavior. Using the code PECUBE, we test different scenarios of rock cooling by forward modelling and inversion method in order to constrain the amount and timing of exhumation, as well as its simplified first-order crustal geometry. Given that low-temperature thermochronology data only provides the thermal history of the upper part of the crust (< 10 km), such thermo-kinematic modelling does not reveal any direct evidence of the potential implication of the lower crust. To overcome such limitations, we performed 2D mechanical modelling of the Muli thrust to constrain its mechanical behavior at the crustal scale to decipher its importance in the thickening of the plateau margin. We present here, how complementary numerical simulations based on in-situ geological observations on thrust faults, combined with thermochronology data, can be used to have a better understanding of the geological processes involved in the thickening of the Tibetan crust, and discuss both the strengths and weaknesses of such modelling.