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Length and time scales of the continental deformation: A lithosphere-scale rock mechanics experiment

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The new generation of crustal deformation studies aim to build-up physical models of strain accumulation that carry a predictive power for future stress patterns. These studies require models to be consistent with all length and time scales of the deformation field and not just of its single snapshot. The new generation of space geodetic data will very likely revolutionize our understanding of crustal deformation, including fault friction and the rheology of the lithosphere. These parameters were, by necessity, estimated from rock and fault mechanics lab experiments that have to be run on spatial and temporal scales and under conditions far from natural environment. Nowadays, an earthquake initiates a lithosphere-scale rock mechanics experiment. We are able to chase the broad and continuous spectrum of behaviours existing between the seismic and the aseismic slip end-members that characterizes, nowadays, a system of active faults. We establish the geometry, initial and boundary conditions (e.g. kinematic parameters of faulting, geometry of the surrounding fault system and its complexity, structure of the Earth). We take the relevant deformation measurements at a wide range of spatio-temporal scales (e.g. seismology, space geodesy, earthquake geology and paleoseismology). We use models to resolve fault and rock constitutive properties (e.g. rate and state friction laws, visco-elastic modeling). We model the stress evolution and locate regions of stress accumulation. The joint use of the lithosphere-scale rock mechanics experiment together with the earthquake prediction algorithms such as M8, CN and RTP is likely to contribute to the physical understanding of the length and time scales of the preparation of a destructive earthquake.