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Predicting sequences of thrusting in accretionary wedge based on the maximum rock strength

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The objective is to predict the three stages in the life of a thrust which are, the onset of thrusting along its ramp, the construction of a relief, and the arrest because of the subsequent thrusting event. A simple kinematics is adopted for the geometry of the thrust, as proposed by Suppe (1983); work is dissipated according to the Coulomb criterion along velocity discontinuities. The evolution of the thrust is optimized at every step of the three stages to provide the least upper bound in tectonic force, according to the maximum strength theorem (Maillot and Leroy, 2006). The development of the thrust or the initiation of the subsequent structure is decided by selecting the event which leads to the lowest upper bound in tectonic force. It is shown, to validate the methodology, that the position of the first failure mechanism is indeterminate for the critical taper wedge of Dahlen (1984). For subcritical conditions, the first thrust is at the front of the prism. The parameters controlling the thrust life are the friction angles of the décollement ϕ_D, of the back thrust ϕ_B, as well as the initial and final friction angles of the ramp (ϕ_{Ri}, ϕ_{Rf}). The latter is smaller then the former to account for weakening. The larger ϕ_D is, the shorter is the thrust life. The larger the difference $\phi_{Ri} - \phi_{Rf}$ is, the longer is this life. In a normal sequence event, the next thrust ramp and back-thrust are rooted on the décollement below the end of the relief created by the current thrust. Each new event implies the convection of the previous thrusts leading to duplexes. Once the overall relief reaches a critical mass, an out of sequence thrusting is predicted. The number of thrusting events before that depends on the friction coefficients selected. The above predictions are compared favorably with sand box experiments in terms of the shape of the relief and the measured compressive force.