Stages of strike-slip faulting and the associated dynamic effects

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Strain rate and displacement along the fault depend on the rate of weakening due to damage accumulation and reduction adhesion as well as on the value and law of friction variation. In so doing, a displacement value is determined by the fault length, accumulated energy, and external conditions. Thus, dynamic phenomena associated with the fault formation and growth are affected by many factors, including the structure of the fault zone and its evolution.

The paper presents the results of numerical investigation of the main fault and feathering structures in a sedimentary cover under the strike-slip displacement of the basement blocks. We analyze how gravitational and local tectonic stresses as well as strength properties of the medium affect the form and growth stages of flower structure and the main fault. The influence of the ratio of subhorizontal stresses on the vertical movement of central blocks above the basement fault is also studied.

Strike-slip faulting occurs by several stages. Separate fracture zones characterized by different strain rates form sequentially at each stage. At the initial stage the deformation develops most gradually, with numerous fractures at the fault tip at the base of the sedimentary cover as well as with localization bands in the surface layers. As the displacement increases, feathering structures grow from the basement fault to the surface. The strain rate increases significantly at the moment of their arrival at the surface and the formation of feathering structures. At the next stage, the displacement proceeds along feathers, as a rule, of a normal fault type. The form of feathering fractures and the main fault is determined by both the initial stress state and elastoplastic properties of the medium. At the final stage, the faults in the upper and lower layers coalesce, resulting in main faulting. This stage is characterized by the highest strain rate and displacement along the whole fault.

The modeling was carried out in a three-dimensional formulation; the system of dynamic equations for an elastic-brittle-plastic medium was solved. Inelastic behavior of the medium was described within the modified Drucker–Prager–Nikolaevskii model with the nonassociated flow rule.

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