Cyclically induced deformations of fault zones.

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Examples of cyclically induced deformations of fault zones and mechanisms of their formation are presented. Three types of impact on the fault zone are considered: technogenic, exogenous and endogenous. The technogenic impact is demonstrated by the example of the operation of an underground gas storage and an extra-viscous oil field. The natural (exogenous and endogenous) impact is caused by the cyclical regime of changes in atmospheric precipitation and anomalous tidal deformations in the fault zone.

Cyclically induced deformations, as a phenomenon, can occur in the form of two forms of manifestation of cause-and-effect relationships between various processes. In the first case, it is forced, similar to the origin of forced oscillations. In the second case, these are induced processes, when the imbalance of mechanical systems is carried out by small, sometimes "not obvious" influences.

A mechanism for the formation of these anomalous deformations is proposed based on the models of poroelastic inclusion and poroelastic inhomogeneity. It is shown that the first model corresponds to forced cyclic deformations, and the second to cyclically induced ones. The problem of displacements of the surface of an elastic half-space containing a poroelastic region in the form of a vertical, extended rectangular prism, which is a model analog of an active fragment of a fault zone, is solved. Analytical formulas are obtained for estimating the displacements of the earth's surface for two variants of poroelastic models: inclusions and inhomogeneities.

On the example of the Ashgabat fault, both models are compared and it is shown that the mechanism of formation of anomalous deformations based on the model of poroelastic inhomogeneity describes the observed displacements much better than the model of poroelastic inclusion. An analysis of anomalous displacements of the earth's surface at an underground gas storage facility showed that local subsidence occurs both during gas extraction and during injection. It has been established that in the first case, cyclic settlements are formed according to the model of poroelastic inclusion, and in the second case, according to the model of poroelastic inhomogeneity. Local subsidence in the fault zone during the period of gas extraction is linearly related to changes in reservoir pressure. The formation of abnormal drawdowns during gas injection is non-linearly related to changes in reservoir pressure. This is a striking example of cyclically induced deformations of fault zones, when time variations of poroelastic parameters inside a fault zone in an environment of external quasi-static loads form a local perturbation of the stress-strain state in the vicinity of the fault.