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Deformation localization forming and destruction over a decompression zone.

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Development of a hydrocarbon field is accompanied by deformation processes in the surrounding rocks. In particular, a subsidence of oil strata cap above a decompression zone near producing wells causes changes in the stress-strain state of the upper rocks. It was shown previously, that the stress spatial changes form a kind of arch structures. The shear displacements along the arch surfaces can occur, and these displacements can cause a collapse of casing or even man-made earthquakes. We present here the results of laboratory simulation of such a phenomenon. A laboratory setup was made in the form of narrow box 30x30x5 cm3 in size with a hole (0.6 cm in diameter) in its bottom. As a model of porous strata, a foam-rubber layer of 4.0 –10.5cm in thick was used, which was saturated with water. The foam was sealed to the bottom of the box; the upper part of the box was filled by the dry sand. The sand was separated from the foam by thin polyethylene film to prevent the sand wetting. For visualization the sand deformations, the front wall of the box was made transparent and the sand was marked by horizontal strips of the colored sand. In the experiments, the water was pumped out the foam layer through the bottom hole. After pumping-out 50 ml of the water, the localization of sand deformations above the sink hole became noticeable; after pumping-out 100 ml of the water, the localized deformation forms an arch. At the same time, there was no displacement on the upper surface of the sand.
To amplify the localization effect, the foam was additionally squeezed locally. In this case, three surfaces of the localized deformation appeared in the sand. The vertical displacements decreased essentially with height, but they reached the upper layers of the sand.
An influence of vibration on arches forming was investigated. Several types of vibrators were used, they were placed inside the sand or on the front side of the box. Resulting accelerations were measured by the accelerometers placed into the sand.
It was found, that if the amplitudes of the accelerations are equal or greater than 0.37g, the localized deformation did not appear near the vibrator location, but arose at some distance from it. If the vibration amplitudes exceed the threshold value 0.39g everywhere in the sand, the deformation localization did not occur. When the vibrator is displaced from the center of the model, the localization vanished near its position.