

# Seismohydrogeological phenomena as a trigger effect of seismicity on the hydrosphere

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For decades, the geosciences have been interested in studying the impact of earthquakes on the natural environment, including groundwater. The variety of such effects in groundwater levels, discharges, temperature, and hydrogeochemistry has not yet been fully explained. However, it is obvious that an important role in the variety of seismohydrogeological effects is played by the natural environment, as well as hydrogeodynamic and gas-hydrogeochemical characteristics of groundwater. Detailed and long-term observations in wells, springs and other water vents are necessary for a comprehensive study of the seismohydrogeological effects, since strong earthquakes in the same place occur quite rarely. Comprehensive consideration of seismohydrogeological effects involves a reasonable identification of individual components of the impact of an earthquake on groundwater. Such components include (1) changes in the stress-strain state of water-bearing rocks during the earthquake preparation, (2) the formation of a rupture in the earthquake source and a change in the static stress state of water-bearing rocks, (3) dynamic deformation of water-bearing rocks under the vibration effect of seismic waves and others. The study of the groundwater responses to earthquakes makes it possible to characterize the properties of water-bearing rocks and their variations on various spatial and temporal scales, which contributes to the reliable management of water resources and the ecological state of the environment in seismically active regions, as well as study of seismic effects in geophysical fields. New ideas and models about the groundwater response to seismic processes will also contribute to ongoing work on hydrogeodynamic and hydrogeochemical precursors for their use in earthquake prediction. The current state of research on seismohydrogeological effects is focused on solving a complex of research problems:

- a) systematic analysis and creation of the models of seismohydrogeological effects in groundwater changes on data of detailed observations;
- b) development of methods for assessing the quality of observational data in wells for creating and testing models of earthquake effects in groundwater;
- c) geophysical interpretation of the seismohydrogeological effects together with other seismological and non-seismological anomalies associated with the deformation of the earth's crust;
- d) statistical analysis of hydrogeodynamic, gas-hydrogeochemical and isotopic time series to assess the spatio-temporal scales of seismohydrogeological effects against the natural and technogenic processes impact;
- e) assessment of the statistical significance hydrogeodynamic and hydrogeochemical earthquake precursors for earthquake prediction.

In recent years, reviews of the results of long-term observations of seismohydrogeological effects in various seismically active regions and natural conditions have become important. A critical reassessment of such long-term data, combined with modern observational data, will make it possible to identify new promising areas of research on the seismic impact on groundwater and evaluate their practical significance.