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Types of hydrogeological response to large-scale explosions and earthquakes

Ella Gorbunova (1), Evgeny Vinogradov (1), Alina Besedina (1), and Vasilii Martynov (2)

(1) Institute of Geosphere Dynamics of RAS, Moscow, Russian Federation, (2) Moscow Institute of Physics and Technology (State University), Moscow, Russian Federation

Hydrogeological response to anthropogenic and natural impact indicates massif properties and mode of deformation. We studied uneven-aged aquifers that had been unsealed at the Semipalatinsk testing area (Kazakhstan) and geophysical observatory “Mikhnevo” at the Moscow region (Russia). Data was collected during long-term underground water monitoring that was carried out in 1983-1989 when large-scale underground nuclear explosions were realized. Precise observations of underground water response to distant earthquakes waves passage at GPO “Mikhnevo” have been conducted since 2008. One of the goals of the study was to mark out main types of either dynamic or irreversible spatial-temporal underground water response to large-scale explosions and to compare them with those of earthquakes impact as it had been presented in different papers.

As far as nobody really knows hydrogeological processes that occur at the earthquake source it’s especially important to analyze experimental data of groundwater level variations that was carried close to epicenter first minutes to hours after explosions. We found that hydrogeodynamic reaction strongly depends on initial geological and hydrogeological conditions as far as on seismic impact parameters. In the near area post-dynamic variations can lead to either excess pressure dome or depression cone forming that results of aquifer drainage due to rock massif fracturing. In the far area explosion effect is comparable with the one of distant earthquake and provides dynamic water level oscillations.

Precise monitoring at the “Mikhnevo” area was conducted in the platform conditions far from active faults thus we consider it as a purely calm area far from earthquake sources. Both dynamic and irreversible water level change seem to form power dependence on vertical peak ground displacement velocity due to wave passage. Further research will be aimed at transition close-to-far area to identify a criterion that determines either irreversible or elastic behavior of hydrogeological response. This work was supported by the Russian Science Foundation (project no. 16-17-00095).