Analysis of gravity, stress and strain variation in the study of Reservoir-Triggered Seismicity

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Abstract

Reservoir-triggered seismicity is considered a phenomenon with anthropogenic influence, recorded concomitantly and/or after the filling of a reservoir, that may be classified as initial and prolonged seismicity. The first one is associated with the filling of the reservoir in which there is a variation in the water level, resulting in an increase in charge or discharge and a late effect due to pore pressure diffusion. The second one is less observed and its related to the amplitude and frequency of the oscillation of the reservoir and the poroelastic properties of the superficial rocks. Regardless of the given classification, it is understood that the characterization of seismicity triggered by a reservoir depends on the variation of the state of stress applied in a region. Understanding this phenomenon is very important for the study of seismic risk which, in turn, may be closely associated with the occurrence of structural damage and natural disasters. Therefore, this work proposes to discuss the main aspects related to the analysis of reservoir-triggered seismicity, considering the relationship between the influence of the additional load caused by filling the reservoir and the variation of the gravity field and the state of stress and strain in the study area. For this, it was decided to analyze the region of the Irapé Hydroelectric Power Plant, in Minas Gerais state, Brazil, where local earthquakes were recorded during the filling of the reservoir. As a methodology, both the variation of the gravity field and the variation of the state of stress and strain were estimated considering the variation of the reservoir water mass at different filling intervals. The first was estimated using gravitational attraction involving regular prisms, while the last two were estimated using the finite element method. The estimated results allowed classifying and confirming that the events that occurred during the filling of the reservoir are triggered earthquakes. The reason was that, in addition to having a correlation with the variation of the gravity field, they are also located within the limits of variation of the state of stress and strain in the region.