The Characteristics of Pore Pressure Diffusion of Reservoir-Induced Earthquake in Longtan Reservoir, Guangxi

Liu Yaowei, Xu Liqing

Institute of Crustal Dynamics, Key Laboratory of Underground Fluid Dynamics, CEA, Beijing 100085, China

It is worthy of quantitatively analyzing the relationship between reservoir-induced earthquakes and the pore pressure diffusion and distinguishing influences of different structural types on the pore pressure diffusion. Consequently, such considerations may help to deeply analyze major impact factors affecting the reservoir-induced earthquakes. In this paper, we analyzed the microseismic events sequences from 2006 to 2007 of Longtan Reservoir in Jiangxi Province China by pore pressure diffusion mechanism. According to structural features and lithological characteristics of the reservoir area, we made analysis of the pore pressure diffusive characteristics of the microseismic events, and attempt to understand the active characteristics of deep fluid when reservoir-induced earthquakes occur. Our study shows that:

1, Longtan Reservoir-induced seismicity has relatively significant characteristics of pore pressure diffusion, which are characterized by a clear partition phenomenon. According to the spatial distribution of the Longtan reservoir-induced earthquakes, seismogenic area is divided into five seismic activity areas (A ~ E). Assuming that five regions of small earthquakes are triggered by their own sources of pore pressure, we got the estimated pore pressure diffusivity (D) of the five regions between 0.04m2 / s and 1.0m2 / s. Based on the estimated pore pressure diffusivity(D) , the five seismogenic areas can be divided into three types, of which type Ⅰ region (A zone) pore pressure speeds fastest with the Pore pressure diffusivity to 1.0m2 / s ; of which type Ⅱ region (B zone and E zone pore pressure diffusion rate is relatively slowest with Pore pressure diffusivity of 0.04m2 / s ~ 0.08m2 / s; of which type Ⅲ region (C zone and D zone) pore pressure diffusion rate between type Ⅰ and type Ⅱ region with pore pressure diffusivity of 0.25m2 / s ~ 0.4 m2 / s.

2, the main factors affecting the pore pressure diffusivity (D) value are the tectonic distribution and lithology characteristics. By analysis of the characteristics of tectonic distribution, we find that type Ⅰ region exposes significant fault structures, but there is no obvious fault exposed in type Ⅱ region surface, and a number of small, messy strike faults exist in type Ⅲ regions. Analysis of lithology shows that A zone (type Ⅰ) and B zone (type Ⅱ) are basically the same lithology, but there are significant differences in D values; C zone (type Ⅲ), D zone (type Ⅲ) and E zone (type Ⅱ) are the same lithology, but D values are also significant different, indicating that the influence of lithology is not obvious on the D value when structural factor plays a leading role.

3, analysis of pore pressure diffusive duration (t) and the maximum diffusive distance (r) of different types shows that, diffusive duration of type Ⅰ region is the longest with the furthest diffusive distance; type Ⅱ region diffusion has the shortest duration and the smallest distance; duration and diffusion distance of type Ⅲ region are between type Ⅰ and Ⅱ, which is corresponded to the relationship of pore pressure diffusivity (D) of different types. Our analysis showed that the faults of the seismic activity area may directly affect the proliferation of speed and direction, thus affecting the process of occurrence of seismic activity.

4, According to the largest earthquake in different seismic activity areas, it can be seen that the two biggest earthquakes with earthquake magnitude larger than ML4.0 in Longtan Reservoir both occurred in fault tectonic areas of type Ⅰ (A zone) and type Ⅲ (D zone), but in type Ⅱ area (B zone and E zone) maximum limits are ML3.5 and ML2.8. And there is not a obvious linear relationship between the number of induced earthquakes and D value.

5, seismic activity triggered by pore pressure diffusion has the characteristics of repeating occurrences in the same place. Spatial distributions of earthquake activities, which are induced by individual impoundment, consist to each other, while, trigger sources are the same.