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Relationship between the reservoir-induced seismic activity and the role of reservoir fluid - A case study of Zipingpu Reservoir, China

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After the 2008 Wenchuan earthquake, many have speculated on the role of Zipingpu Reservoir, which was impounded in 2005 near the epicenter. Based on the digital seismic waveform data observed from regional and reservoir seismic networks, a continuous small seismic activity series before the Wenchuan earthquake was reliably recorded with the impounding process of Zipingpu Reservoir. These small seismic activities in space scale could be classified into 3 regions according to their different distributions, such as A region's banded spread, B region's cluster distribution and C region's migration characteristics. We found that, A region's small seismic activities had a good time consistency with the reservoir filling, but B and C regions' were quite the opposite. Due to the complexity of RIS characteristics in Zipingpu Reservoir, the features of a reservoir-triggered quake have not yet been demonstrated.

In order to explore the relationship between Longmenshan Fault stability with Zipingpu Reservoir filling period, we present a mechanics' model which takes into account the reservoir geological structures, geophysical parameters, and the reservoir water process or history. The major results were shown as follows:

(1) A mechanics' model coupling fault displacement and reservoir flow was developed for quantitatively analysis of the dynamic evolvement of Longmenshan Fault. The Coulomb stress changes in response to the impoundment of the Zipingpu Reservoir and their impact on the Wenchuan earthquake were evaluated. The water factors lead to the change of the Coulomb stress by 0.01 to 0.05 MPa at the reported hypocenter.

(2) The permeability has an important influence on the mechanical response of faults. Our results showed that there may exist a new type of permeability structure for Longmenshan Fault, which is upper wall strata conduit and footwall strata barrier, and the main faults have channels for partially surface water displacement into deep strata. The difference of pore pressure caused by the difference of infiltration degree in the deep rock-masses, may lead to RIS depending on lithological condition.

(3) RIS in Zipingpu Reservoir is closely related to the changes of additional effective stress induced by the vast body of water and dam. The results showed that, the stress on the riverbed is small although the water piled behind the dam weighed more than 320 million tons. Hence Longmenshan Faults' instability might be promoted by the excess pore pressure. So the fault's hydrodynamics should be taken as an important study projects in RIS mechanism.