Geophysical Research Abstracts
Vol. 13, EGU2011-5440, 2011
EGU General Assembly 2011

The reservoir-induced seismic activity and the fault hydrodynamics - A case study of Zipingpu Reservoir, China

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After the Wenchuan earthquakes, many have speculated on the role played by the Zipingpu Reservoir, which 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 impoundment of Zipingpu Reservoir. These small seismic activities in space scale could be classified into 3 regions according to their different distributed forms, such as A region's banded distribution, B region's cluster distribution and C region's migration characteristics. We found that, in A, B, C regions, A region's small seismic activities had a good time consistent with the reservoir impoundment, but B and C region's was quite the opposite. Therefore, the RIS characteristics in Zipingpu Reservoir represent was complicated, and we may not be able to demonstrate the features of a reservoir-triggered quake.
In order to know the relationship between Longmenshan Fault stability with Zipingpu Reservoir filling period, this study presents a fine quantitative model combined with the reservoir region's geological structures, hydrogeologic parameters, and the impoundment changes. The major results were shown as following:
(1) A coupled model between the fault's displacement and reservoir water flowing was developed to quantitative analyze the dynamic parameters' evolvement of Longmenshan Fault by finite element methods. Thus we could evaluate the Coulomb stress changes in response to the impoundment of the Zipingpu Reservoir and assess their impact on the Wenchuan earthquake. The impoundment changed the Coulomb stress by 0.01 to 0.05 MPa at location of reported hypocenter positions.
(2) The permeability had an important influence on mechanical response of the faults. Our results show that there maybe exists 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 infiltration degree in the deep rock-masses, which cause difference of pore pressure, may lead the RIS depending on lithological condition.
(3) RIS in Zipingpu Reservoir had closely related to the changes of effective additional stress induced by the vast body of water and dam. The water piled behind the dam weighed more than 320 million tons, and the corresponding stress on the riverbed was small, but the effect of excess pore pressure could promote fault's instability. So the fault hydrodynamics should be taken as an important study projects in RIS mechanism.