Insight into the mechanics of seismic swarms triggered by water-reservoir impoundment

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Water Reservoir Impoundment (WRI) can trigger swarms and strong earthquakes under favorable geological conditions. Although many studies have investigated the relationship between the pore pressure changes due to WRI and the observed seismicity, hydromechanical models that explain the observed processes are rare. We investigated the role of hydromechanical interactions in producing earthquake swarm bursts under pore pressure changes, using the Song Tranh 2 Water Reservoir Impoundment (WRI) in Vietnam as an example. Our work contributes to the investigation of the physical mechanisms responsible for earthquake swarms. We find that the seismic swarms accompanying WRI represent the shearing of a damage fault zone composed of multiple interfering surfaces. The source parameters of seismic swarms image the quasi-dynamic weakening of the fault damage zone. Fault weakening during the propagation of seismic rupture is a key process governing the earthquake rupture dynamics and energy partitioning. Quasi-dynamic weakening evolution means here that it captures histories of fault zone slip, including the seismic slip phases within this zone, and slip weakening shows a memory effect that fades with time. Based on the calculated traction evolution within the damage zones in ST2 we estimate the effective slip-weakening distance, which is a significant parameter for characterizing a fault-weakening process. The observed quasi-dynamic weakening process is fluid driven at slower migration velocity of the order of meters/day but over short duration the migration of seismicity accelerates to velocities of kms/day. We therefore conclude that the seismic swarms are driven by a combination of fluid pressurization and stress perturbation through aseismic slip induced by pore pressure changes.

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