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# Physics-based estimates of maximum magnitude of induced earthquakes

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In this study, we present new findings when integrating earthquake physics and rupture dynamics into estimates of maximum magnitude of induced seismicity (Mmax). Existing empirical relations for Mmax lack a physics-based relation between earthquake size and the characteristics of the triggering stress perturbation. To fill this gap, we extend our recent work on the nucleation and arrest of dynamic ruptures derived from fracture mechanics theory. There, we derived theoretical relations between the area and overstress of overstressed asperity and the ability of ruptures to either stop spontaneously (sub-critical ruptures) or runaway (super-critical ruptures). These relations were verified by comparison with simulation and laboratory results, namely 3D dynamic rupture simulations on faults governed by slip-weakening friction, and laboratory experiments of frictional sliding nucleated by localized stresses. Here, we apply and extend these results to situations that are representative for the induced seismicity environment. We present physics-based predictions of Mmax on a fault intersecting cylindrical reservoir. We investigate Mmax dependence on pore-pressure variations (by varying reservoir parameters), frictional parameters and stress conditions of the fault. We also derive Mmax as a function of injected volume. Our approach provides results that are consistent with observations but suggests different scaling with injected volume than that of empirical relation by McGarr, 2014.