Geophysical Research Abstracts
Vol. 19, EGU2017-17009, 2017
EGU General Assembly 2017

Numerical modeling of tunneling-induced seismicity

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Removal of rock mass in mining environment has been associated since long-time with seismic event of magnitude 3 and above, with the potential to cause damage to the infrastructures or even loss of human life. Although with similarities with mining, relatively unknown up to now are seismic events induced by tunneling. However with modern mechanized tunneling techniques, making possible to digging deeper and longer underground infrastructure, the risk is not negligible. As an example, the excavation of the 57km long Gotthard Base Tunnel has been associated more than hundred seismic events, with the largest one having magnitude of ML 2.4, damaging the tunnel infrastructures.
For future scenario of deep geological storage of nuclear waste, tunneling will constitute the primary activity during site construction. Hence, it will be crucial to understand the risk associated with the underground construction operation that can reactivate seismogenic features nearby the future location of emplacement tunnels.
Here we present numerical simulation aimed at understanding the potential for inducing seismicity during tunnel construction. The stress changes and their evolution during the excavation are evaluated with a finite element solver (FLAC3d). A strain-softening friction model is then used to simulate the occurrence of a sudden slip on a fault zone (if critical conditions for reactivation are reached). We also present a sensitivity analysis of the potential for inducing different seismic events by different tunnel sizes at varying distance from a nearby failure plane, with the final purpose of evaluating safety of a potential nuclear repository site on the short- and long-term.