SESSION 23- Fluid Triggered Earthquakes

Conveners
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Session Description

The role of fluids in earthquake generation has emerged as one of the most dynamic frontiers in seismological research, bridging the disciplines of geophysics, geochemistry, and tectonophysics. This proposed session on **"Fluid Triggered Earthquakes"** aims to bring together researchers investigating the multifaceted influence of pore-fluid pressure, fluid migration, metamorphic dehydration, and induced seismicity processes on fault stability and crustal strength. The session intends to explore how fluid presence modifies the effective stress regime, reactivates pre-existing faults, and contributes to transient weakening in the seismogenic crust and upper mantle.

The scope of the session encompasses field, laboratory, and modeling studies that examine natural and anthropogenic fluid–fault interactions. Topics include naturally occurring fluid triggered seismicity in convergent margins and rift environments, induced seismicity associated with hydrocarbon extraction, wastewater disposal, CO_2 sequestration, and geothermal operations. Special emphasis will be placed on understanding the **temporal and spatial evolution of pore pressure**, the feedback between seismic slip and fluid redistribution, and the transition from aseismic slip to dynamic rupture driven by fluids. Studies that connect geophysical observations with geological, petrological, hydrological and geochemical data will be particularly encouraged.

The key objectives of the session are:

1. To synthesize current understanding of fluid-mediated fault mechanics and its role in earthquake initiation and propagation.

2. To highlight recent methodological advances in detecting and quantifying subsurface fluid movements using seismological, geodetic, and electromagnetic techniques.

3. To foster interdisciplinary collaboration among scientists working on induced and natural fluid-driven seismicity.

4. To identify key research priorities for assessing seismic hazards in fluid-rich and injection-prone regions.

The session will address several pivotal themes, including:

- Stress and pore pressure coupling and its impact on fault stability.
- Laboratory rock deformation experiments replicating fluid injection and pressure cycling.
- Numerical and analytical models of fluid diffusion and rupture nucleation.
- Case studies of induced seismicity in oilfields, geothermal zones, volcanic arcs, and rift systems.
- Integration of seismicity patterns, focal mechanism solutions, and Coulomb stress transfer with fluid flow models.
- Machine learning and statistical approaches for detecting fluid-related seismic clusters.
- Geological, Petrological Geochemical and isotopic tracers as diagnostic tools for fluid sources and migration pathways.

Methodologies to be highlighted include seismic tomography, ambient noise analysis, fault zone imaging, moment tensor inversion for fluid-induced microearthquakes, and joint inversion frameworks linking seismic, geodetic, and electromagnetic datasets. Contributions employing numerical modeling (poroelastic, hydro-mechanical, and thermo-hydromechanical coupling) and laboratory simulation experiments on fluid injection and fault slip are also welcome.

By uniting observations from deep fault zones, induced seismicity reservoirs, and theoretical modeling, this session seeks to refine our conceptual and quantitative understanding of how fluids trigger and modulate seismic processes. The discussion is expected to strengthen predictive capabilities for fluid-driven earthquakes, advance risk mitigation strategies for subsurface industrial operations, and enhance our

comprehension of earthquake generation mechanisms in fluid-rich tectonic environments.