MICROEARTHQUAKES INDUCED BY FLUID INJECTION: 3D DYNAMIC RUPTURE MODELS AND RADIATED WAVEFORMS

Elisa TINTI [1,2], ***Francesco MOSCONI*** [1], ***Alice-Agnes GABRIEL*** [3], ***Luca DAL ZILIO*** [4], ***Antonio Pio RINALDI*** [5], ***Men-Andrin MEIER*** [6], ***Emanuele CASAROTTI*** [2], ***Mariano SUPINO*** [2], ***Maria MESIMERI*** [6], ***Linus VILLIGER*** [5], ***Massimo COCCO*** [2]

[1] Department of Earth Sciences, Sapienza, Università di Roma, Rome, Italy

[2] Istituto Nazionale di Geofisica e Vulcanologia, INGV, Rome, Italy

[3] Institute of Geophysics and Planetary Physics Scripps Institution of Oceanography, University of California at San Diego, La Jolla (CA), USA

[4] Earth Observatory of Singapore, Nanyang Technological University, Singapore, Singapore

[5] Swiss Seismological Service, ETH Zürich, Zürich, Switzerland

[6] Institute of Geophysics, Earth Sciences, ETH Zürich, Zürich, Switzerland

contact: elisa.tinti@uniroma1.it

The ERC-Synergy project FEAR (Fault Activation and Earthquake Ruptures) hosted in the Bedretto Underground Laboratory (Swiss Alps) offers a unique opportunity to investigate fluid-induced micro-events at approximately 1500m depth recorded by a multi-sensor network. Modeling micro-earthquakes necessitates the precise determination of constitutive parameters such as stress, friction, and critical slip at small spatial scales (millimeters to centimeters), which are crucial for understanding rupture propagation over meter-scale distances (1-100 m). We conduct fully 3D dynamic rupture simulations assuming spatially variable stress drops caused by pore pressure changes and we simulate Mw $\leq$ 1 induced earthquakes. Several features inferred for accelerating dynamic ruptures differ from those observed during rupture deceleration in a self-arresting earthquake due to the spatial gradient of the effective normal stress. Analyzing the radiated synthetic waveforms, we examine the differences in the high-frequency content of simulated waveforms between self-arresting and run-away earthquakes and provide an estimation of source parameters obtained through spectral inversion. These estimations are then compared with dynamic forward models and provide critical insights into radiated spectrum, the potential contribution of near-field terms and attenuation enabling us to interpret some recorded events in FEAR experiments. These methods together with the exceptional FEAR monitoring system provide a controlled setting to study the intricate details of earthquake mechanics closely, and offer a chance to push the boundaries of current understanding of earthquake physics.