Observing earthquakes in the laboratory.

(Proposer: Prof. Giacomo Pozzi)

Rationale

Earthquakes are one of the most expressive phenomena of our planet, able to suddenly reshape the surface of the Earth and affect countless lives every year. They are phenomena that emerge from a complex, dynamic system of mechanisms that operate at small scales at inaccessible depths within the Earth (Fig. 1). As such, it is impossible to observe the birth of an earthquake in its early stages in nature. To overcome this issue, rock deformation experiments in the laboratory represent the best way to reproduce conditions similar to the natural ones and to simulate small-scale earthquake cycles. The objective of this PhD project is to take a step further from traditional experiments using a new design of experiments to directly observe the mechanisms that operate behind earthquake nucleation.

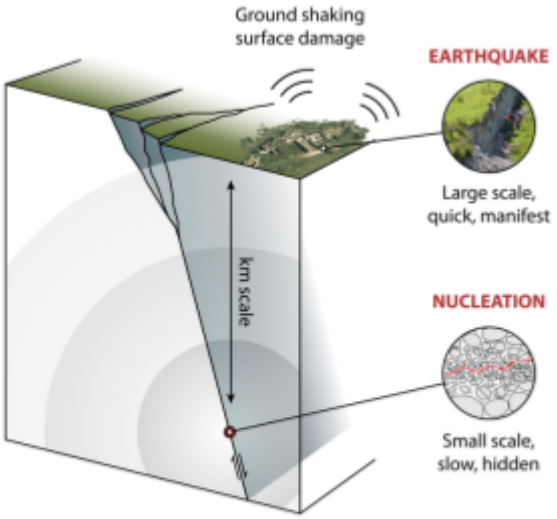

Figure 1 – The origin of earthquakes is in small-scale deformation mechanisms that reside undetected at depth in the crust.

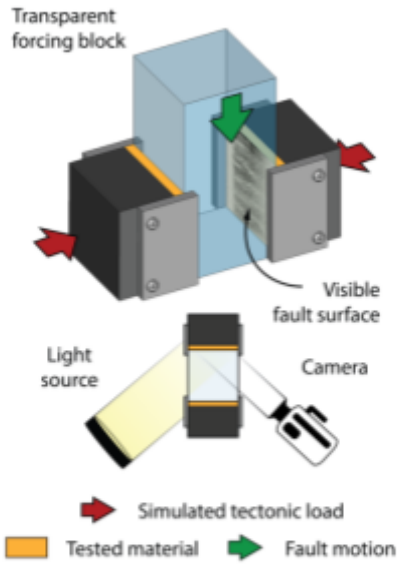

Figure 2 – Experimental configuration.

Research activities

The candidate will design and operate rock deformation experiments on the biaxial apparatus BRAVA to reproduce small-scale earthquake cycles. The sample holder will consist of transparent glass blocks (Fig. 2) that allow for the continuous optical monitoring of the deforming material throughout the experiment. The materials consist of a wide range of natural fault rocks, including carbonates and siliciclastic rocks typical of the Alpine and Apennine settings. Mechanical data will be integrated with footages captured with high-speed cameras (optical and thermal) to individuate the early stages of fault rupture and assess the mechanisms at play. Deformed samples will be recovered and prepared for microstructural investigation carried on scanning electron microscope. Field excursions are also planned to investigate meso- and micro-structures of natural faults in order to link laboratory activities with natural observations.

During their studies, the candidate will familiarise with the concept of fault structures, fault friction, rock deformation, earthquake physics, and deformation microstructures.

Collaborations and impact

The PhD candidate will work in a dynamic environment at the Istituto Nazionale di Geofisica e Vulcanologia and will collaborate with expert in earthquake physics Dr. Elena Spagnuolo and expert in techniques of digital imaging and rheology Dr. Jacopo Taddeucci. In Padova, the

candidate will work in strict collaboration with Prof. T. Tesei and Prof. G. Di Toro, experts in rock deformation and earthquake physics.
This project has the potential to shed new light on how the complexity of natural rocks affect the dynamics, moving towards the formulation of a new, more reliable physical framework for the description of earthquake nucleation. Furthermore, the production of novel video documentation of the early stages of earthquakes will provide strong dissemination material for a wide public.

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